

BAT
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NEWS



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BAT RESEARCH NEWS

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Volume 38: No. 1

Spring 1997

Acceptance of an Artificial Roost by LeConte's Free-Tailed Bats *Tadarida brasiliensis cynocephala*

W. M. Kiser and K. V. Glover

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Introduction

The use of large-scale, artificial roosts (bat towers) as a means of conserving populations of bats was initiated in the United States in 1909. Charles Campbell, a physician, constructed several large bat towers in San Antonio, Texas, in an effort to control malarial mosquitoes. Although many others were constructed in the southeastern United States and Italy during the 1910s and 1920s, few succeeded in attracting bats (Campbell, 1925; Greenhall, 1982; Storer, 1926). Many considered the towers a failure, so construction ceased for many years. Herein we report the overwhelming success of a large-scale, artificial roost and suggest that their usefulness in conservation may be promising.

In Gainesville, Alachua Co., Florida, a colony of ca. 5,000 LeConte's free-tailed bats, (*Tadarida brasiliensis cynocephala*) occupied the attic of an historic building (Johnson Hall) at the University of Florida for many years. When fire destroyed the wooden building in 1987, bats were displaced into two concrete sports stadiums. The track and field stadium and nearby tennis complex were constructed with pre-stressed concrete beams and slabs, bolted together in a stair-step fashion. Bats occupied horizontal crevices (19-25-mm high by 35-cm deep), where the horizontal and vertical beams were joined. The height of the crevices (4.6-12.2 m), western and southern exposures, and unobstructed flyways were features that created an attractive home for the bats. However, when odors from urine, guano, and sebaceous-gland secretions of the bats became objectionable, and when bats began swooping over the heads of spectators, university officials decided that the bats had to be removed.

Eradication was never considered, but a solution was sought in which the bats might be encouraged to roost on campus, yet at a reasonable distance from humans. After consulting with several experts on bats, the university decided to construct an artificial roost. Exclusion from the stadiums, followed by capture and relocation to the artificial roost, would be attempted once the new roost was completed.

Location, Design, and Construction

The decision as to where to locate the roost included such factors as proximity to fresh water, distance to occupied buildings, distance from pesticide-use areas, and lack of obstruction of flyways. A wildlife sanctuary at Lake Alice, in the center of campus, was chosen. The artificial roost was located near the lake, in an open field used for legume research and adjacent to garden plots. Construction began in March 1991, and was completed in ca. 5 weeks, with an estimated cost of \$20,000.

The roost was an enclosed, wooden structure, supported on five, 9-m-long, treated, wooden posts, that were 51 cm in diameter (Fig. 1). The frame was constructed of untreated pine planks, and the outside was covered with exterior-grade plywood. The roost has a floor area of 28 m² and a four-gabled tin roof, creating a 2 m-tall attic space, accessible by a door for humans and by slotted gable vents on the east and west ends for the bats. Below the floor of the attic was the primary roosting area, which consisted of a series of double-layered plywood slats in four separate quadrants (the area of each quadrant was 7 m²). The slats were 19-mm thick, 2.4-m long, by 0.5-m tall, and were installed vertically on edge. Crevices of 19, 25, and 40 mm in width and 0.5 m in depth were provided between slats in a repeating pattern (Fig. 2); all slats were oriented north-south. Guano collected from the previous roost sites were sandwiched between the plywood layers as slats were assembled. Inside the roost, fiberglass insulation was added in the walls, floor, and roof to stabilize temperatures. A plywood covering was used to prevent bats from coming into direct contact with the insulation.

Exclusion and Initial Attempts at Relocation

Prior to completion of the roosts, ca. 80-90% of the crevices in the stadiums were sealed, using hardware cloth and silicone caulk. This procedure effectively concentrated the bats into manageable areas and considerably reduced the number of entry and exit points. After the artificial roost was completed, bat-excluding devices (tube-shaped pieces of hardware cloth ca. 4-5 mm in diameter and 10-15 cm in length) were attached over the remaining exit points, allowing bats to leave the roost, but not return. Cages were attached to eight excluders to capture bats as they exited.

On 23-25 September 1991, ca. 3,000 bats were captured and removed from the stadiums and were released inside the attic of the artificial roost. At the same time, exclusion of bats from the stadiums was completed. As bats exited the cages, they flew about the attic until they found small crevices (created out of old lumber) to hide in. No effort was made to keep the bats inside the artificial roost after release.

After each of the three attempts at relocation, bats left after the first night, and none returned to the new structure. Because bats were unable to return to the stadiums, the main colony dispersed, and groups of 30 to more than 1,000 bats moved into as many as 15 campus buildings in 1991 and 1993. At least 1,000 bats were captured from more than 10 campus buildings and translocated to the artificial roost from October 1991 to January 1994, but no bats remained in the new roost on a permanent basis.

Modifications to the Roost

To enhance the attractiveness of the artificial roost to bats, several modifications were made. The slotted gable vents were partly covered with a sunscreen film to reduce the amount of light entering the attic. Concrete blocks were stacked on edge in the attic to create additional crevices. The reflective Thermoply wallboard in the attic was covered with wooden paneling to reduce interference with echolocation. Two sheets of plywood were attached to the slats underneath the roost, to provide darker, more enclosed roosting sites. Additional guano was collected and scattered inside and underneath the structure.

As an added measure to attract bats, small bat houses (ca. 30-60-cm tall) were attached to the roost. Also, a tape recording was made of a group of captive bats, and it was played on an automatic, reversible, cassette player, connected to a 12-volt automotive battery installed in the artificial roost. The recorded sounds were successful in stimulating activity when played near buildings occupied by bats. However, it was feared that the sounds being broadcast were of alarm or distress, because the recording was made of bats in captivity. After several weeks, the recordings were discontinued. Despite these additional measures, the roost remained unoccupied.

Chronology of Use

In 1993, several indications of successful occupation were noted. In February, ca. 175 bats were captured and translocated from several campus buildings during exclusion. After release, seven male bats remained in the crevice under the roost for several weeks, but after a severe storm in March, with high winds, tornadoes, and subfreezing temperatures, the roost was abandoned. In September, 34 males were present, but these soon left.

In January 1994, ca. 30 bats were captured from a building near campus and taken to the artificial roost. Before their release, one bat was observed roosting in the slats underneath the roost. Because no attempt at relocation had been performed for many months, this bat apparently had accepted the roost. Five or six of the translocated bats remained in the southeast quadrant of the roost throughout January, and in February, the number of bats fluctuated from one to 16. In March, the number of bats was greater than 60, and by April, more than 200 bats were observed in the southeast quadrant. However, by 15 April, bats abandoned the roost again, and did not return in 1994.

In January 1995, ca. 200 *Tadarida* were present in the crevices in the southern quadrant, and the number of bats continued to increase throughout the year. In February, ca. 1,000 were observed; on 28 March, ca. 2,000 were seen; and on 10 April, the number of bats present was ca. 3,000-4,000. On 26 May, the first young-of-the-year was observed, suggesting that a maternity colony was established. In June, an accurate count of the young was not possible without disturbing the bats, but possibly several hundred young were present. On 11 September, more than 8,000 were counted exiting the roost at dusk, and by 17 November, the number of bats increased to ca. 10,000, when all four quadrants were occupied. The northwest quadrant was almost full, and the northeast quadrant had more than 300 bats.

On 8 January 1996, approximately 10,000 *Tadarida* were present, as was a southeastern myotis *Myotis*



Figure 1. Artificial roost constructed for *Tadarida brasiliensis* at the University of Florida.



Figure 2. Underside of the artificial roost, showing roosting crevices that were 19, 25, or 40 mm in width.

austroriparius) that was found dead underneath the roost. Seven *Tadarida* apparently had fallen from the roost but were still alive; ambient temperature was -3.9°C . Another freeze during the first week of February apparently killed 130 *Tadarida*, when minimum temperature at the roost was -7.2°C . On the 6th

of February, 54 free-tailed bats had fallen to the ground, but were not dead. These were wrapped in a blanket and taken inside a building. After noon, these were released back into the crevices, apparently unharmed. On 9 April 1996, 10,000 *Tadarida* were believed to occupy the artificial roost, and by May, the roost had been occupied for 17 consecutive months. All four quadrants were used, and 20 cm of guano had accumulated underneath the roost. As of 6 May, ca. 15,000-20,000 bats were estimated in the roost; all 180 crevices contained bats, with an estimated 100 bats in each crevice.

Prior to September 1995, bats used the 19- and 25-mm wide crevices almost exclusively, and only the southeast and southwest quadrants underneath the roost were used. However, all three sizes of crevices were used the following winter, and all quadrants were occupied. The attic of the roost was never occupied. It is hoped that the bats will continue to use the structure as both maternity and winter roosts. The artificial roost (or smaller, less-expensive versions) could be useful for conservation of other colonies of *Tadaridab. cynocephala*, which apparently is declining in several states, and perhaps for other species of "house bats."

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- Greenhall, A. M. 1982. House bat management. United States Department of the Interior, Fish and Wildlife Service, Resource Publication, 143:1-33.
- Storer, T. I. 1926. Bats, bat towers, and mosquitoes, *Journal of Mammalogy*, 7:85-90.

* * * * *

A Second Species of *Carollia* from Trinidad

Karl F. Koopman and Arthur M. Greenhall
American Museum of Natural History, New York, NY 10024

Carollia perspicillata is a common bat in Trinidad but, until now, has been the only species of its genus (or indeed of the subfamily Carollinae) known from that island or from nearby Tobago and Grenada (Goodwin and Greenhall, 1961; Pine, 1972). In response to an inquiry concerning specimens of *C. brevicauda* from Trinidad at the Royal Ontario Museum, Dr. Burton K. Lim very kindly went through the Trinidadian specimens at that institution and found one that he considered to be *brevicauda*. The specimen has been sent to us on loan and proves indeed to be *Carollia brevicauda*.

The specimen (ROM 45609) is a well-made skin and skull, originally in alcohol. It was collected from "Verdant Vale Shaft," Arima Ward, St. George County, on 8 December 1958, by E. Ache. It is an adult female (field number 58-4398) with only the following field measurements: forearm length, 39 mm and weight, 11.3 g. Selected skull measurements are condylobasal length (not including procumbent incisors), 18.7 mm; length of maxillary toothrow, 6.7 mm; width across last molars, 6.8 mm; and mastoid width, 10.4 mm.

ROM 45609 clearly does not agree with a large number of *Carollia perspicillata* in the American Museum of Natural History from Trinidad and Tobago, agreeing much better with specimens of *C. brevicauda* from northern Venezuela (states of Aragua, Lara and Merida). Skull characters figured by Pine (1972) are reasonably reliable for distinguishing between the two species, and on this basis, we would definitely identify ROM 45609 as *C. brevicauda*.

It is surprising that none of the large number of Trinidadian *Carollia* in the American Museum, most of which were studied by Goodwin and Greenhall (1961), are *C. brevicauda*, which presumably is only accidental in Trinidad. Handley (1976) lists numerous localities throughout Venezuela for *C. brevicauda*. One of these (San Augustin in the state of Monagas) is quite close to Trinidad. The Trinidadian specimen is, therefore, not entirely unexpected, but it does represent a significant range extension.

Of the various bat collectors working under the direction of the junior author, E. Ache was one of the best. However, he also maintained a private collection, and it was probably from this source that R. E. Mumford obtained the specimen. Mumford eventually sold his bat collection to the Royal Ontario Museum.

We thank Dr. Burton K. Kim of the Royal Ontario Museum, Toronto, for going through its

collection of Trinidadian *Carollia* to extract the unique specimen of *C. brevicauda* and lending it to us.

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- Handley, C. O., Jr. 1976. Mammals of the Smithsonian Venezuelan Project. Brigham Young University Science Bulletin, Biological Series, 20:1-91.
- Pine, R. H. 1972. The bats of the genus *Carollia*. Technical Monograph, Texas Agricultural Experimental Station, Texas A&M University, 8:1-125.

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NOTICE

E-mail Directory for Subscribers to Bat Research News

Since we first sent out response cards to all of you asking if you wished to be listed in an e-mail directory to be published in *Bat Research News*, we have received responses from over 300 individuals. This means there are still about 300 cards hiding securely on 300 desks around the world. We all know how easy it is lose a small card when you put it someplace where it will be easy to find when you "have more time" to fill it out and mail it. Since this is an e-mail directory, I should have merely asked you to e-mail your address to me. It is our intention that the directory be kept up to date and the directory will be revised and published once each year in the summer issue of *Bat Research News*. This directory will not be made available to any person or agency except to the subscribers to *Bat Research News*.

If you wish to be included in the directory please send me an e-mail telling me your exact e-mail address. Deadline: June 30,'97. My e-mail address is: horstgr@potSDam.edu

If you do not wish to be included please send me an e-mail to that effect.

And while you're at it, why not include a few lines (or paragraphs, or pages) of news for our NEWS section. We want to hear about what you are doing in the world of bats that might be of interest to our readers.

Thank you in advance, for your response and for your efforts as a "news correspondent" for *Bat Research News*.

G. Roy Horst.

P.S. If you already sent your card, thank you. If you can't remember, send me an e-mail, then we are certain that you will be included.

News from Bat Biologists

Ed. Note: In the last issue we promised that we would give two free banquet tickets at the next symposium (in Tucson, AZ) to the first person who responds with a news item for this issue. Our first response came from Karen Campbell, of Albright College, in Reading, PA. The response from the rest of you was gratifying as well. Your efforts are to be commended. Thank you all very much. G. R. Horst

from Pennsylvania

John Hall is alive and well at Albright College, and for someone who is "retired" he seems to be on campus quite a bit, teaching, doing research and gloating about not having committee responsibilities! Perhaps John's retirement mentality is best reflected by his shift in research site. After 30+ years of crawling through the caves of Pennsylvania and West Virginia, John has been studying the bat populations of San Salvador Island in the Bahamas. He and Craig Stihler (WV - DNR) have initiated population studies of *Natalus tumidifrons* and *Erophylla sezekorni* on the island, and seem to focus their field work in January....an elaborate plan to avoid the PA and WV winters, I think.

We also have a crew of undergraduate bat researchers at Albright, working under the direction of Karen Campbell. Geoff Robbins is investigating genetic polymorphisms in bats as an application of polymerase chain reaction (PCR) techniques. This honors project is based upon an earlier study in which we used arbitrarily primed DNA to identify polymorphic sites that appeared to be useful in determining relationships between individual bats. Geoff has been using samples obtained from Gary Kwiecinski's lab *Artibeus* colony at the University of Scranton to work out the techniques, which is great because Mark Nebzydoski has such nice records of mother-pup relationships. Geoff will graduate from Albright in May, only to spend the summer with a group from the Kunz lab doing field work at the Picatinny Arsenal in New Jersey.

The National Park Service has established a cooperative agreement with Albright College, which will enable Karen to actually support her research students directly over the summer for the next few years, rather than enticing them with jobs in the college dining hall! Delaware Water Gap National Park has plans to construct a new trail linking towns at the North and South ends of the park, and since the park encompasses habitat for 3 protected species (bald eagles, bog turtles, and the ever-elusive Indiana bat) funding has been made available for some survey work. So, Jason Schwenk, Bryan Thompson and Lawrence (Rusty) Ward will be working with Karen to survey bat populations and activity in the park. Rusty will be using this project as an opportunity to conduct independent research on bat community interactions as the basis for his honors thesis. Jason will also be working with the ANABAT system this summer, to assess its suitability for this kind of survey work in the northeastern United States. Bryan will be continuing a study of the bat activity at the now-gated Durham Mine.

Meanwhile, Karen is keeping the community amused (and educated?) with the usual array of "bat programs". This year's schedule ranges from elementary school audiences to Audubon and other conservation groups, and even includes the Baird Ornithological Club in Reading (influence of Mark Brigham, perhaps?). And so, while not necessarily keeping out of trouble, Karen is keeping busy.

submitted by Karen Campbell

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from Kentucky

Hopefully the readers of *BRN* will be interested in my bat related activities. I must preface what I will share with you with a little general back ground material about myself. Professionally, I do network design and analysis of large scale computer systems for an international corporation. My degree is in computers, and I have no formal biology training. The mixture of computers for a vocation, and bat conservation as an avocation may seem strange to most people; however it works for me. Currently, I do not have a formal project of my own, but I am working with the U. S. Forest Service, Stanton Ranger District, Daniel Boone National Forest, in Eastern Kentucky. Standard data is gathered on species composition, and habitat utilization for a wide variety of species.

Two species of primary concern are; *Corynorhinus townsendii*, and *Myotis sodalis*. It is well documented that female *M. sodalis* leave Kentucky in early spring to give birth in Ohio, Indiana, and parts of Michigan (Barbour and Davis, Bats of America). An interesting point here is that DBNF has a fair amount of classic Indiana bat habitat suitable for maternity colonies; however there are no records of this kind for the Forest. The methods employed involve mist-netting around known hibernacula on the district

and the use of radiotelemetry for roost discovery.

Daniel Boone National Forest is a fairly populated (human) area and receives considerable recreational use. Data gathered on species composition, and habitat utilization will help land managers in making key decisions on forest land usage, timber salvage operations, and with educating the public sector.

On a separate note, this summer during the course of our normal operation I hope to begin making recordings of vocalizations to build a database that can be used for species recognition. The methods employed will be; recordings to be done on release of the bats, equipment used is a Pettersson D240 detector (time expansion), Sony Walkman recorder, and a PC based analysis tool. I will have more information on the subject at a later date as other ideas occur. I would be happy to communicate with anyone interested in my project or in receiving ideas or suggestions about this sort of work. I can be reached via e-mail at "burke_short@fuse.net"

submitted by Harold Burke

e-mail: burke_short@fuse.net

from India

Just a few lines to let you all know about our recent research. We have already reported that the Indian false vampire bat *Megadermalyra* detects frogs on the ground by passively listening to the noise associated with the movement of the prey (frogs). While detecting frogs from the surface of the water the bat actively echolocates. The work is being continued by providing freshly killed frogs on different substrata like asbestos sheets, wet sandy floors, and dry sandy floors. We are planning playback experiment to provide the noise recorded while the prey moves on these substrata and to determine the response of the bats; We are also interested in measuring the error shown by the bats while localizing the prey on the ground. We have also begun another study on the foraging behavior of *Cynopterus sphinx* under natural conditions.

submitted by G. Marimuthu

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from New Mexico

I am a Research Wildlife Biologist with the U. S. Forest Service Rocky Mountain Experiment Station (Forest Service Research) in Albuquerque. I have been studying the maternity roosting habits of *Myotis volans*, *M. evotis*, and *M. thysanodes* in pinyon-juniper woodlands of New Mexico. My focus has been on above ground roosts - trees and rocks, which is what they have been mainly using. This season I am also starting a project to examine maternity roosting habits of bats along the Middle Rio Grande River (primarily Species of Concern). Hope this little writeup helps some of you know what I'm doing and might initiate exchange of ideas with those of you who are engaged in similar conservation projects.

submitted by Alice Chung

e-mail: /S=A.CHUNG/OU1=S28L01A@mhs-fswa.attmail.com

from West Virginia

I'm currently working on prey-predator interactions, with bats as predators and a variety of prey. I've been trying to figure out the relationships between arctiid moths and bats and the role of the moths' clicking behavior. I have a student who's looking at the responses of guppies to signals like those of fishing bats dragging their claws through the water, comparing fishes from populations that are preyed upon by *Noctilio* with those from areas where *Noctilio* very probably (at least) does not hunt. Has anybody looked at calcium and protein metabolism in neotropical fruit bats, especially pregnant and lactating females? It would seem likely to me that they don't really have problems with overall caloric intake, but how they get calcium and protein from a steady diet of fruit may be more of a mystery. Are there any seed-eating bats? This seems an empty niche, one that is amply filled among birds but unoccupied by our furry birds. It also would solve the protein problem - if any.

submitted by Dorothy Dunning

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from India

I would like to take this opportunity to inform the readers of our research foundation. It is a non-profit trust dedicated to the conservation of flora and fauna of Tamilnadu State, India. We have a bat conservation project and we are currently conducting surveys of fruit bats throughout Tamilnadu State, India. Please include us in your e-mail directory and also send us any literature you may have on bats. Thank you.

submitted by G. Agoramoorthy

e-mail: moorthy@mail.nppi.edu.tw

from Washington, DC

I have just finished a small book on bats for the general public, called "Bats in Question." It will be published by the Smithsonian Institution Press in June. It is a basic "everything you have always wanted to know about bats" done in question and answer format. The best part of the book is lots of beautiful color plates of bats by Merlin Tuttle.

We (Sue Ruff and I) are also working on another book for Smithsonian Press called "The Complete Book of North American Mammals." It will have species accounts, distribution maps, and color plates of each of the species of mammals in North America, including the bats. The individual accounts are authored by people who have actually worked with the species, so we feel that this volume will be of interest to professional mammalogists as well as the general public.

The Office of Biodiversity Programs here in the National Museum of Natural History is also currently running a program to inventory and monitor populations of plants and animals occurring in the Urubamba Valley in Peru. We are working at some new drilling sites being established by Shell Oil Co., and bats will be one of the important indicator species for the project. Robert Baker from Texas Tech University, Ricardo Guerrero from Venezuela, and Cesar Ascorra from Peru are key collaborators on the project.

submitted by Don E. Wilson, Director, Biodiversity Programs, Smithsonian Institution.

e-mail: WILSON.DON@NMNH.SI.EDU

from New Mexico

Troy Best visited New Mexico 19 March to meet with Scott Altenbach to select photos for the next release of the "Bats of . . ." posters. The next iteration titled "Bats of the Western States" should be available in mass quantities this fall.

The first round of invitations to attend the Euro-American Mammal Congress to be held in Santiago de Compostela, near Galicia, Spain from 20-24 July 1998 were mailed on 10 March with a due date of 11 March. Luis Ruedas assures Batyologists that they are more than welcome. Luis emphasizes that those individuals interested in organizing a symposium should contact him soon. Luis can be reached at lruedas@sevilleta.unm.edu at the University of New Mexico and is a member of the Steering Committee. Registration and other information should be directed towards galemys@pinar1.csic.es.

And a humorous note about one of our fearless world travelers entitled, "**Kunz Made It**"

Jim Findley (University of New Mexico) recounts a story where Professor Kunz was invited to UNM for a dissertation defense and seminar in the early 1980's. Apparently he took a wrong turn in Denver and ended up in Oakland instead of Albuquerque. This time Tom made the transfer successfully for another dissertation defense and seminar. At a social gathering the evening before his departure, Dr. Kunz was awarded, among other things, a map showing Boston ("home"), Albuquerque ("You are Here"), and Ecuador ("Where you are going next week"). There was also a marker near India saying "No, Tom, not here --> you are going to Ecuador."

submitted by William L. Gannon

e-mail: wgannon@unm.edu

from Rhode Island

For those of you who have not heard, I have changed location here at Brown University from the Department of Psychology to the Department of Neurosciences. It seems a better "fit" for my research and my research is also a bit more compatible with their activities.

Our bat stuff is going wonderfully--we presently are doing neurophysiology that yields multi-cell responses which explain the ability of *Eptesicus* to perceive nanosecond changes in echo delay, and the nature of these responses has the potential for upsetting most of what is known about the physiological basis for perception. Hardly anyone believes us, but we certainly haven't let that stop us before. Recently I was invited to go to Taiwan for a meeting and lucked into an opportunity while there to catch five *Hipposideros armiger*, which we have been flying, along with *Eptesicus*, in a new type of obstacle-avoidance test. These bats are huge (60 cm wingspan), and great to study. I have never had a species of *Hipposideridae* live well in captivity before, and people interested in CF bat behavior should know about them.

submitted by James Simmons

e-mail: james_simmons@brown.edu

from Oregon

My current research interest is in behavioral studies of megachiropteran fruit bats. I am working with the bats at the Metro Washington Park Zoo in Portland. Working with students at the University of Portland, I have studied activity, maternal/infant interactions, play behavior, hand preference, reproduction, and agonistic interactions in *Eidolon helvum*, *Pteropus rodricensis*, and *Epomophorus wahlbergi* in captivity. In addition, UP student Jean Mulcahy has examined the effect of bat education on childhood reactions to bats.

submitted by Becky Houck, Dept. of Biology, University of Portland e-mail: houck@uofport.edu

from Minnesota

My background and interest with bats began as a graduate student in the early 1980s, when the Nongame Program of the Minnesota Department of Natural Resources provided funding to my advisor, Elmer Birney, to determine the distribution and status of bats in Minnesota, and later to identify important hibernacula in this region.

I now work for the Minnesota Department of Natural Resources as Animal Survey Coordinator for the Minnesota County Biological Survey, where the status of bats in Minnesota continue to be an important component of my survey work. As part of my job responsibilities, as well as a personal interest in bats and subterranean areas, I continue to explore the state's caves, mines, and sewers for new hibernating sites.

submitted by Gerda Nordquist e-mail: Gerda.Nordquist@dnr.state.mn.us

from Australia

I have bought a small building and house at Wellington Caves, where I have done research on Quaternary Mammals, and will work from there for about half of the year from July 1999. The building used to be a clock museum and I have converted it into a paleontological lab and set it up as the 'Wellington Caves Fossil Studies Center'. There are good macroderma fossils!

submitted by Michael Augec e-mail m.augec@unsw.edu.au

from Oregon

My interests are in assessing forest management issues and how bats relate to them, particularly here in the Pacific Northwest. I am also interested in developing techniques that would assist biologists/managers in surveying for bats. Current projects include bridge use by bats in the Coast Range of Oregon.

submitted by Mike Adam, Department of Forest Science, Oregon State University, Corvallis, OR 97330
e-mail: adam@ccmail.orst.edu

from Washington

Bats Northwest is a new non-profit bat conservation group based out of Seattle, Washington. Like other, small conservation groups, our primary goals are to educate the general public about bats and to protect bats and their habitat in the Pacific northwest. We are set up to function as a clearing-house for information concerning bat conservation, bat research, and volunteer opportunities in the area. BNW contributes information to local schools, community groups, museums, zoos, and the media. In addition, BNW has conducted public bat-walks around Greenlake City Park in Seattle that have been well attended. We are pleased to announce that we have funding available for a Training workshop in the Teanaway of eastern Washington this summer. We encourage contributions and new memberships - Our first newsletter will be out very soon!

Upcoming events include:

Summer 1997 Greenlake Bat Walks and Talks, and City Parks Census

August 1997 Training Workshop - Teanaway

October 1997 Pacific Science Center Bat Exhibit and Pacific Science Center Bat Ball

Contact BNW at 4742 42nd. Ave. SW, Seattle, WA 98116. Tel 206-256-0406, FAX 206-933-8057.

subitted anonymously

no e-mail given

BOOK REVIEW

Bats in Captivity

Susan M. Barnard

This book is surely "something for everybody". *Bats in Captivity* is Sue Barnard's sixth and best book on bat care and she's been providing us with this important information since her first publication, *The Care and Handling of Your Newly Acquired Big Brown Bat*, in 1986. Readers who subscribe to "Batline" (e-mail list-server) are familiar with Sue's frequent responses to questions about all aspects of bat care, medical treatment, banding, etc. She gives generously of her time and energies to assist those helping and studying bats. Her publication covers a broad spectrum of information (not available in any other single publication) that anyone seriously interested in bats should have in their library. This book is an *essential* reference for every person or institution that keeps bats in captivity for rehabilitation, research, education, or captive propagation of rare species. This edition now includes information specific for insectivorous bats, Old and New World fruit bats, and vampires.

Within its 193 pages, Barnard covers a lot of territory. A partial list of chapters includes handling bats; transportation and temporary holding; environment and housing for adult and infant bats (lighting, temperature and humidity, caging); feeding adults; hand-raising infants; health and medical care (also public health concerns and animal hygiene); caring for bats on public display; exercising; and marking bats for identification. Much of the information in the chapters described above is further subdivided to address the considerations of specific kinds of bats, i.e. frugivorous bats, crevice-dwelling bats, etc. The book is extensively illustrated with well-produced photographs and diagrams of the "how to" variety. For example, many designs (measurements) for cages and holding facilities are included along with names and addresses of equipment and supply companies. Many data graphs and tables illustrate her recommendations for diets, feeding regimes, nutrient contents, and weaning ages. Those who have actually kept insectivorous bats in captivity will appreciate the chapter on maintaining insect colonies. One can easily spend more money purchasing mealworms and crickets from a pet store to feed two pallid bats for a month than it costs to feed two large dogs (I know!).

Finally, the book includes a good literature reference section and products list. Professional bat biologists may not use all of the information in this book: However, if you are known as the local bat expert, you will find yourself referring to it on many occasions for very concise answers all those questions about bats one receives from the general public.

Bats in Captivity, like all of Sue's previous books, is the latest version of a work-in-progress. The next edition is being planned for the year 2000. Until then, this book remains the world's best comprehensive publication on bat care. Details concerning Sue Barnard and how and where to purchase this book is contained in the advertisement on the inside back cover of this issue of *Bat Research News*.

submitted by Pat Morton

BOOK REVIEW

Murciélagos de Nuevo Leon, Nuestros Invaluables Aliados

Arnulfo Moreno Valdez.

This handsome 95-page book was produced as an anniversary publication of the 400th year of the founding of Monterrey, Mexico, capital of the Mexican state of Nuevo Leon. It is illustrated throughout with 37 color photographs by Merlin Tuttle. Much of the book is dedicated to a comprehensive introduction to the world of bats. Few such books exist in Spanish and even fewer feature a regional collection of bat species. Chapters deal with bat origins and evolution; habitats; reproduction; communication; diet; myths and legends; public health; ecological and economical importance; resolving problems; and building a bat house. The final chapters are devoted to the bats of Nuevo Leon and feature 36 species accounts (description, distribution, natural history) and a key to identification.

Arnulfo is a doctoral candidate at Texas A & M University and also a leader in Bat Conservation International's *Programa para la Conservación de Murciélagos Migratorios*. In the past several years, Arnulfo has translated many English language bat texts (Fenton, Kunz, etc.) and publications into Spanish for his students in Mexico. He now offers students and the Mexican public a superb publication in Spanish about

the bats he has studied and enjoyed throughout his life.

The hard-cover book is available from Impresora Monterrey, S. A. de C. V., Mexico. A soft-cover edition will be published in the near future and will be available from Bat Conservation International.

submitted by Pat Morton

POSTER REVIEW

Bats of the Eastern United States

Troy L. Best, Michael J. Harvey, and J. Scott Altenbach

This attractive and eye-catching 24" x 36" poster, illustrated with stunning color photographs by J. Scott Altenbach, is a comprehensive education tool. Not only does it feature individual photos of the 19 bats found in the eastern U.S., but the reverse side of the poster includes a range map for each species and a brief natural history including size, distribution, ecology and behavior, food habits, reproduction and population status. Another section on bat facts provides a general introduction to the world of bats. Finally, a book list has been added for younger and older students. This poster contains a book's-worth of information about eastern bats. Suggested retail price is \$9.95. Contact Troy Best, Dept. of Zoology and Wildlife Science, 331 Funchess Hall, Auburn University, AL 36849-5414. Plans are underway to produce a companion poster on *Bats of the Western United States*. Watch for future announcements in this publication.

Submitted by Pat Morton

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 as 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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Bat Meetings: Past, Present, and Future

in Ireland

There will be an **Irish Bat Seminar** later in May and I would be happy to send you a short article or summary of the meeting. Anyone and everyone who is doing something on bats in this corner of the world will be there. It is the first such meeting in many years and hopefully it will generate more interest in bats than presently prevails, which really shouldn't be too hard. I am still the only person in the fortunate position of working full time with payment on bats (and I am employed by British Wildlife Trust!) so we have a long long way to go before bats are given serious consideration here. Maybe the seminar will improve things. Eleven people will give papers on a wide variety of topics. I know it will not rival the content of some of the American meetings you report on in BRN but I am really hoping that some good will come from it. Submitted by Kate McAney

Hopefully Kate will provide us with abstract of this meeting and we can include them in the next issue of *Bat Research News*.

If you wish to contact Kate about this meeting her e-mail address is mcaney@iol.ie [GRH]

in Cost Rica

SYMPOSIUM: CONSERVATION AND ECOLOGY OF TROPICAL BATS

ORGANIZER: KATHRYN E. STONER

DATE: TUESDAY, JUNE 17 A.M.

(in conjunction with the Annual Association of Tropical Biology Meeting held in San Jose)

Kathryn Stoner. Changes of abundance and sex ratio of frugivorous and nectarivorous bats in tropical dry forest and their implications for seasonal migration.

Jose Manuel Mora and Bernal Rodriguez. A comparison of the bat fauna of four Costa Rican mammalian zones.

Luis Iniguez. Ecology of *Sturnira lilium* in the cloud forest of the Sierra de Manantlan, Jalisco, Mexico.

Theodore H. Fleming. The long and short of it: Comparative ecology of two plant-visiting phyllostomid bats.

Marco Tschapka. Resource partitioning in a community of nectar-feeding bats in a tropical rainforest.

Elizabeth Kalko. Conservation of Neotropical bats: Monitoring techniques, community comparisons, and long-term studies.

Thomas H. Kunz. Tent architecture and tent-making behavior in Neotropical and Paletropical bats.

Anne P. Brooke. Pteropidid bats of American Samoa.

Kathryn Stoner. Summary and closing remarks.

While this symposium may have already passed by the time BRN reaches you, I thought it is of sufficient interest that our readers should know about it as quickly as possible. There will be copies of the abstracts of this meeting and a summary by Kathryn Stoner in the next issue of *Bat Research News*. GRH

Kathryn Stoner's e-mail address is: kstoner@cariari.ucr.ac.cr

in Arizona, USA**The 27th Annual North American Symposium on Bat Research***will meet in Tucson, Arizona from October 8 to 12, 1997.**Program Committee Chair: Thomas Griffiths**Local Committee Chair: Ginny Dalton*The meetings will be held at the **Double Tree Hotel** in Tucson, AZ.

The first call for papers will be mailed in mid June. All recipients of Bat Research News in the western Hemisphere will automatically receive the registration materials. All others should contact Dr. Griffiths at the earliest opportunity.

Contact addresses and numbers are:

Thomas H. Griffiths: e-mail> tgriff@titan.iwu.edu < tel. 309-556-3230

Ginny Dalton: e-mail> Plecotus@aol.com < tel.602-743-3941

Double Tree Hotel: tel. 1-800-222-8733 [no e-mail number given]

Note: When contacting the Hotel be sure to mention that you are affiliated with the North American Symposium on Bat Research if you wish to receive the very large discount offered to the group.

* * * * *

in Mexico**Seventh International Theriological Congress****Acapulco, Mexico September 7-11, 1997**

Rodrigo Medellín, Chair, ITC-7 Organizing Committee

Centro de Ecología, UNAM Ap. Postal 70-275 04510 Mexico, D.F.

e-mail:> medellin@miranda.ecologia.unam.mx <

* * * * *

in Spain**Euro-American Mammal Congress****to be held in Santiago de Compostela, Galicia, Spain****20-24 July 1998.**

The first round of invitations to attend the were mailed on 10 March with a due date of 11 March, Luis Ruedas assures Batyologists that they are more than welcome. Luis emphasizes that those individuals interested in organizing a symposium should contact him soon.

Luis can be reached at e-mail> lruedas@sevilleta.unm.edu < or at the University of New Mexico and is a member of the Steering Committee. questions concerning registration and other information should be directed to: e-mail > galemys@pinar1.csic.es <.

* * * * *

in Brazil**11th International Bat Research Conference****Universidade de Brasília, August, 1998**

(exact dates to be announced)

Conference Host: Jader Marinho-Filho, Departamento de Zoologia, Universidade de Brasília,

Brasília, DF 70910-900 Brazil. e-mail:> jmarinho@guarany.cpd.unb.br <

Each successive issue of Bat Research News will have additional, more detailed announcements of this conference.

BAT RESEARCH NEWS

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Number 1

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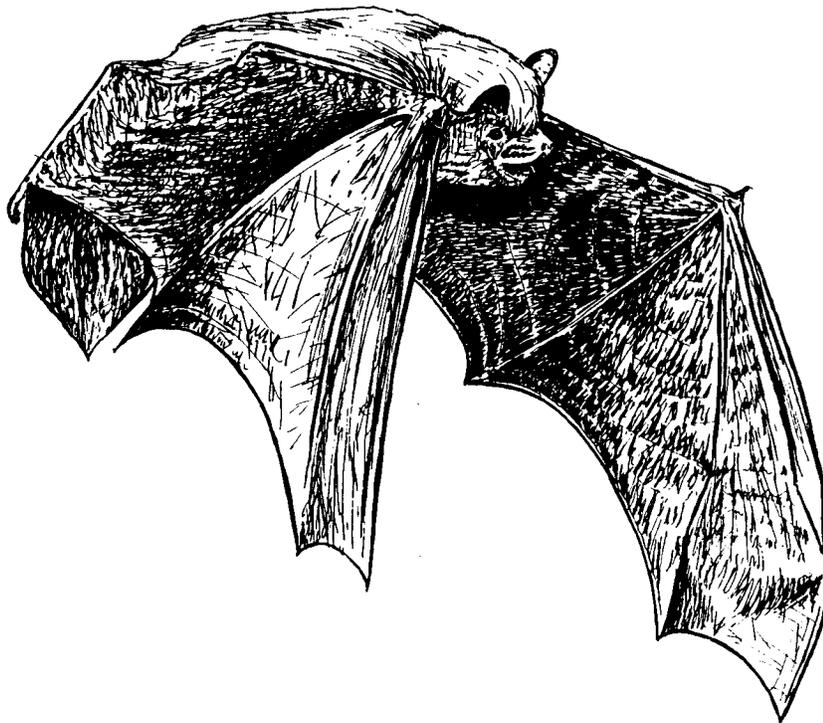
Front Cover

The front cover illustration appears on the personal stationary of Elke Berg of Germany. The artist is identified as P. Penicaud, address unknown. A very handsome line drawing indeed. We are eager to receive very clear line drawings such as this one, or good high contrast photographs of bats for future covers. If we use your drawing or photo, we will add one year's free subscription to your account.

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Noteworthy Records of Bats from the Central African Republic

Darrin Lunde¹ and Pamela Beresford²

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American Museum of Natural History, Central Park West at 79th street, New York, NY 10024

The bat fauna of the Central African Republic is among the most poorly known in Africa. Schlitter et al. (1982) provided a comprehensive survey of what little was known of that fauna, along with 20 new species records for the country. The following year Hill (1983) reported an additional four species, bringing the total species count to 49.

During November and December 1996, the American Museum of Natural History initiated a collecting expedition to the Dzanga Sangha Special Dense Forest Reserve, in southernmost Central African Republic. We netted at the confluence of the Sangha and Babongo Rivers, approximately 6 km north of Bayanga. Habitats sampled include dense, inundated forest, characterized by stilt-rooted trees (*Uapaca* sp.) and vast areas of herbaceous plants of the Marantaceae family, and secondary forest along logging roads (Carroll, 1988).

Eleven bat specimens were collected, representing eight species from four families; only towards the end of the collection effort was it discovered that the local residents were regularly taking bats from nets to supplement their diet. Yet despite the small sample size, three of the eight species collected were new records for the country. We report on these specimens and provide an amended list of all species known from the Central African Republic (Table 1). This addition to the chiropteran fauna of the southwestern Central African Republic augments the expectations of Schlitter et al. (1982) that several dozen species remain as of yet unreported from this poorly collected region of central Africa. The specimens are housed in the Department of Mammalogy of the American Museum of Natural History.

Acknowledgments

We thank Allard Blom of the World Wildlife Fund's Dzanga-Sangha Project for hosting the American Museum in the Central African Republic, and Dr. Joel Cracraft of the Department of Ornithology (AMNH) for organizing and leading the expedition. Nancy Simmons and Karl Koopman made comments on an earlier version of the manuscript.

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continued >>

Table 1. Species of bats from the Central African Republic reported by Schlitter et al. (1982), Hill (1983), and the present study. Specimen numbers for bats caught during the present study and housed at the American Museum of Natural History are given in parentheses. An asterisk indicates a new record for the Central African Republic. Records of *Epomophorus labiatus* (as *E. anurus*) and *E. wahlbergi* reported in Schlitter et al. (1982) were doubted by Bergmans (1988). Taxonomic amendments are in accordance with Koopman (1993).

Pteropodidae

Casinycertis argynnis (269915)*
Eidolon helvum
Epomophorus gambianus
Epomophorus labiatus
Epomophorus wahlbergi
Epomops franqueti (269902, 269916)
Hypsignathus monstrosus
Megaloglossus woermanni
Micropteropus pusillus
Myonycteris torquata
Nanonycteris veldkampii
Rousettus angolensis
Scotonycteris zenkeri

Emballonuridae

Coleura afra
Taphozous mauritanus
Taphozous perforatus

Nycteridae

Nycteris arge
Nycteris grandis
Nycteris hispida (269913)
Nycteris thebaica

Megadermatidae

Lavia frons

Rhinolophidae

Rhinolophus alcyone (269922)*
Rhinolophus fumigatus
Rhinolophus landeri

Rhinolophidae (continued)

Hipposideros abae
Hipposideros beatus
Hipposideros commersoni gigas (269871)
Hipposideros cyclops (269893)
Hipposideros lanosa

Vespertilionidae

Chalinolobus beatrix (269872, 269876)*
Chalinolobus variegatus
Eptesicus guineensis
Eptesicus somalicus
Eptesicus tenuipinnis
Kerivoula lanosa
Mimetillus moloneyi
Myotis bocagei (269932, 269933)
Nycticeius schlieffeni
Pipistrellus nanus
Pipistrellus rusticus
Scotoecus hirundo
Scotophilus dinganii
Scotophilus viridis

Molossidae

Chaerephon ansorgei
Chaerephon nigeriae
Mops brachypterus
Mops condylurus
Mops spurrelli
Mops thersites
Myotis daubentonii
Otomops martiensseni

A Post Bat House Design

Dan Dourson and John MacGregor
Daniel Boone National Forest

Following is a short summary (from a one year study) on a new bat house design (see fig. 1) being used in the Daniel Boone National Forest in Eastern Kentucky. This area lies within the Cumberland Plateau where fourteen species of bats are known. In this study 38 bat houses were placed in a variety of forest, riparian, and urban habitats. The best use was in houses that were located on forested ridgetops (100%). About 75% of houses placed along riparian habitats were used and about 50% of houses are used along mixed riparian and urban habitats, but boxes receive very little use when placed in pure urban areas. The low use of bat houses in urban settings may be due to the increased amount of available roosting habitat in the way of old buildings, barns, and dwellings which have historically provided an excellent variety of roosting habitat.

Some of our houses have contained as many as 15 bats of at least two species: the northern long-eared bat *Myotis keenii* and the big brown bat *Eptesicus fuscus*. Many other bats have been observed in the bat houses but could not be identified to species. The bat houses were not designed to see the bats easily. However one could simply hinge two of the sides to make viewing the bats more convenient. Bats have moved into these houses in as little as two weeks after being erected.

For best results the bat houses should be located; 1] in upland forest habitats on south or southwest slopes in open canopy; 2] in small openings along edge habitat near ponds; 3] along riparian zones, forest roads, powerline, pipeline, or waterline rights of way where conditions are more open so houses receive more sunlight; 4] within forest shelterwoods, along forest clearcuts, or along edges of small forest groups. We avoid placing bat houses close to barns, out-buildings and dwellings. It appears that the more urban the area is, the less likely bats will use the houses. None of the houses were painted; placement appears to be a more important factor.

These bat houses are more like bats' natural summer roost sites - trees with exfoliating bark. The bats can move freely within this design (much like in a dead tree) and can move to either cooler or warmer sides of the structure (depending on their needs) as the sun moves across the sky. If a snake climbs up to the structure, the bats are not trapped. They can simply move to the opposite side and easily exit the box. If predation becomes a problem then predator guards can be added to the post.

The best wood to use for the post is oak, red cedar, or black locust. Avoid using pine or poplar wood, as these woods will decay quickly in the ground. The box itself can be made of lighter wood since it is not in direct contact with the ground and is partly covered by the roof as seen in figure 1. Use only galvanized screws to assemble the box. If the post is in the ground for at least three feet there is no need to secure it with concrete. Spacing between the inner sides of the box and the post is critical. Any larger than three quarters of an inch will make it more attractive to mud-daubers and paper wasps.

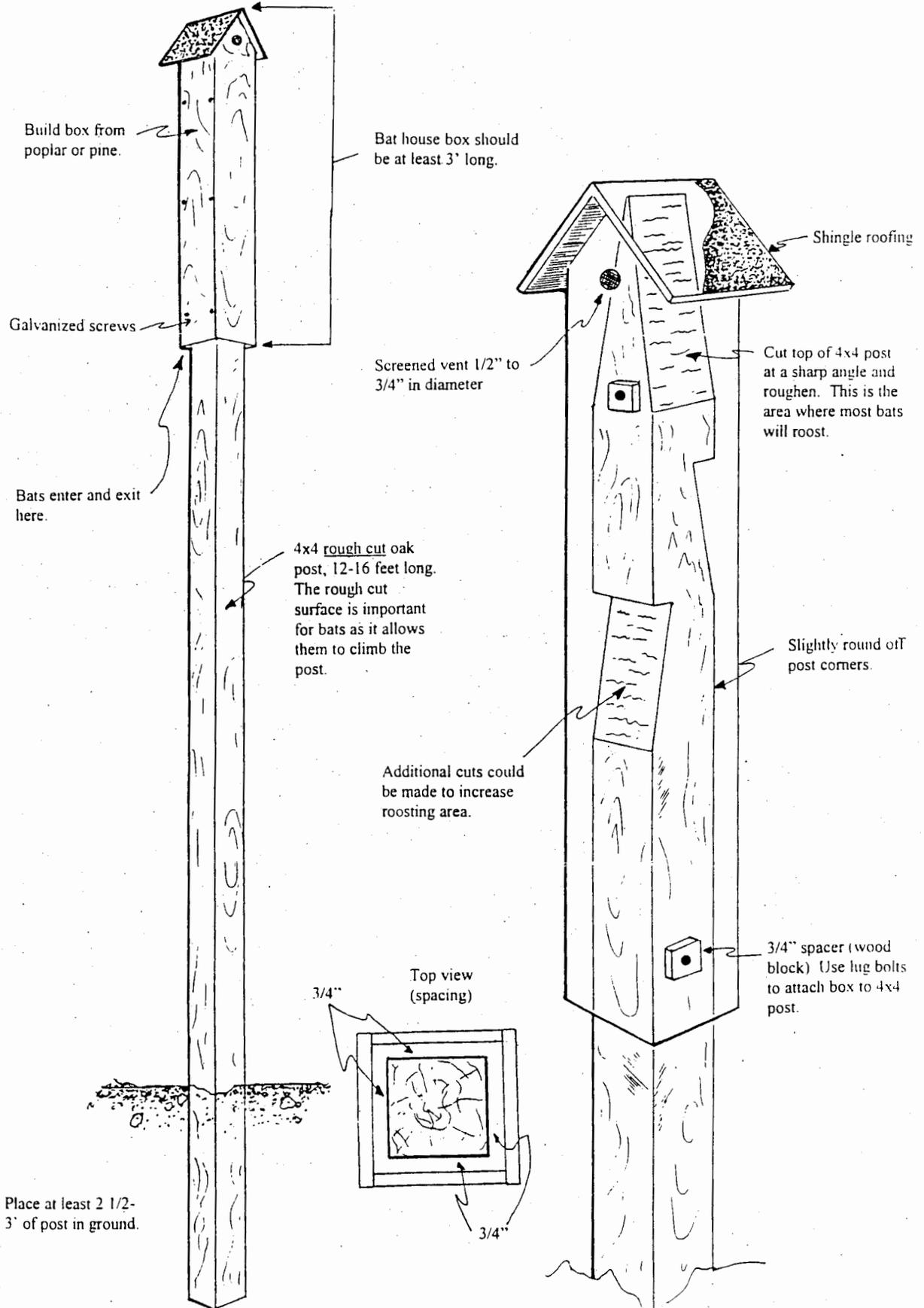
A schematic design of the bat house follows on page 22

Ed. note:

This article was submitted to BRN by Dr. Wayne Davis on behalf of the authors. The editor has made a few minor grammatical changes. Any alterations in fact are unintentional and are the sole responsibility of the editor. GRH

Dr. Davis was the founder and first editor of Bat Research News.

If any readers use this design the authors would appreciate hearing of your success. Please contact them at 606-663-2852(Dourson) or 606-745-3100(MacGregor).



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 as 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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LETTER TO THE EDITOR...

The recent trend by public-health and wildlife departments to restrict the possession, exhibition, rehabilitation, and interstate movement of bats native to the United States, has in many cases seriously impeded the use of these animals by legitimate researchers, educators, and wildlife rehabilitators, each of which contributes to bat conservation and human health.

In an attempt to address the concerns of those whose primary responsibility is to public health, Basically Bats Wildlife Conservation Society hosted a symposium on interstate movement, captive holding, and educational use of native bat species at Zoo Atlanta, Atlanta, Georgia, on 21 May 1997. Participants included government and university research affiliates, wildlife conservationists, educators, rehabilitators, and regulatory agents, and representatives from the zoological and human-health communities. The proposed guidelines and symposium participants will be made available by this September.

I am hopeful that the agenda of the Atlanta meeting will be continued at each annual North American Symposium on Bat Research. Kim Williams and Rob Mies, Co-directors of The Organization for Bat Conservation, are currently working with the organizers of this year's symposium in Tucson, Arizona to include a continuing discussion of this important issue.

Participants for the Tucson meeting should include Arizona state and local public-health officials, wildlife regulators, Tucson animal control officers, and all interested attendants at the symposium. Bat workers and regulatory agencies must work together if bat conservation is to be successful. Keep in mind that regulations controlling the movement of bats between their points of origin to research facilities, or between facilities, are becoming ever more complex and restrictive. Such cumbersome and time-consuming regulations make research and conservation ever more difficult.

submitted by Sue Barnard

Sue Barnard can be reached at the following address: Sue Barnard, Lead Keeper, Department of Herpetology, Zoo Atlanta, 800 Cherokee Ave. SE, Atlanta, GA 30315

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FAX: (404) 627-7514 Web site: <http://www.lads.com/basicalllybats/index.html>

Response from Program Director

The Program Committee of this year's symposium in Tucson will schedule a discussion period to deal with this issue. This topic will undoubtedly generate considerable interest and discussion, and should have more time than can be assigned to it at the business meeting. The Program Committee will schedule a meeting time and place for this discussion which will not conflict with any of the formally scheduled presentation sessions.

Thomas Griffiths, Program Director, 27th Annual North American Symposium on Bat Research

Response from *Bat Research News*

Bat Research News recognizes the significance of this problem and will publish any comments, suggestions, or contributions by our readers concerning this issue. *BRN* is willing to serve as avenue of communication between all those concerned with obtaining, keeping, or moving bats for the purpose of research, conservation, and education. Please send items for publication to Roy Horst or to Sue Barnard. We are especially interested in how those of you from countries other than the United States (which in this case is literally 50 separate "countries") are dealing with this situation.

G. Roy Horst, Publisher, *Bat Research News*. e-mail horstgr@potdam.edu

Additional abstracts of presentations at the Seventh European Bat Research Symposium held in Veldhoven, the Netherlands, in August 12-16, 1997.

The following abstracts arrived after the symposium was over and did not reach the Publisher of Bat Research News until much later. Since English was not the first language of any of these authors, some of the abstracts required fairly extensive corrections. If the author's intended meaning has been distorted or misrepresented, these introduced errors are inadvertent. The Editors assume full responsibility for any such errors and offer sincere apology to any author so affected. GRH.

The Poznan Fortifications as Important Bat Hibernacula

Radoslaw Dzieciolowski, Andrzej Gawlak & Andrzej Kepel
The Polish Society for Nature Protection "Salamandra"
ul. Ratajczaka 19/60, 61-814 Poznan, Poland

Since 1989, investigations were carried out annually on the hibernating bat population in the 19th century Poznan fortification system. Before 1988, the system was visited occasionally. During the investigation period the number of bats, consisting of 9 species, increased up to 1,812 individuals in 1996. Beside the following species which are abundant in Poland including *Eptesicus serotinus*, *Myotis myotis*, *M. daubentonii*, *M. nattereri*, *Plecotus auritus* and *Barbastella barbastellus*, rarer species as *M. mystacinus/brandtii*, *M. dasychneme*, *Vespertilio murinus* and *Plecotus austriacus* were also found. The number of bats and the species richness make the Poznan fortification system the second best hibernation site in Poland. For this reason conservation activities were started, such as renting and purchasing parts of the system, making management agreements with users to ensure the hibernation conditions as optimal as possible, grilling of entrances, increasing the number of accessible shelters, preventing unfavourable factors such as strong draught, and education. Also being considered is increased attention to such aspects as historical and botanical values of this location.

Activities of the PTPP "Pro Natura" Bat Conservation Group

Roman Guziak
PTPP "Pro Natura" *ul. Podwale 75, 50-449 Wroclaw, Poland*

The Bat Conservation Group (BCG) was founded in 1992 as a part of the Polish Society of Wildlife Friends "Pro Natura". The main aim of the group is to contribute to the conservation of bats in Poland. The BCG has mainly, but not exclusively, centered its activities in SW Poland. The activities consist of training/research camps, training courses, lectures, and conservation projects as grilling of caves, installation of bat boxes, and raising funds for other bat conservation measures. The group recruits volunteers and school and university students into its activities, and encourages public awareness to the need of bat conservation by leaflets, radio and TV interviews and press communications. Currently, the group has about 20 active members and some less regular supporting volunteers.

Hibernating Bats in Caves in the Polish Part of the Tatra Mountains

Andrzej Kepel and Ewa Olejnik
The Polish Society for Nature Protection "Salamandra"
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During the winter seasons of 1992-93, to 1995/96, the authors and a group of biologists from the Polish Society for Nature Protection "Salamandra" have made population counts of hibernating bats in caves in the Polish part of the Tatra Mountains. In 16 caves, the following eight species were found: *Myotis myotis*, *M. brandtii*, *M. mystacinus*, *M. nattereri*, *M. daubentonii*, *Barbastella barbastellus*, *Plecotus auritus* and *Eptesicus nilssonii*. Furthermore, *Vespertilio murinus* was found in summer. *Eptesicus nilssonii*, *M. mystacinus* and *M. brandtii* are rare species in the Polish territory, but were most common in the investigated area. There was an obvious decline in the hibernating population of *Eptesicus nilssonii*, in absolute numbers as well as in percentage of the total numbers of bats ('92/'93: 41%; '93/'94: 17%; '94/'95: 14%; '95/'96: 9%). In some caves, bat populations are endangered by uncontrolled tourism.

Results of Bat Banding in Tajikistan

Tolibjon K. Khabilov
Khujand State University, Khujand, Tajikistan

In the period 1976-1992, more than 4300 individuals of 11 bat species were banded: *Rhinolophus hipposideros*, *R. ferrumequinum*, *R. bocharicus*, *Myotis blythii*, *M. emarginatus*, *M. mystacinus*, *Plecotus austriacus*, *Barbastella leucomelas*, *Pipistrellus pipistrellus*, *Hypsugo savii* and *Vespertilio murinus*. Most banded species were *P. austriacus* (35.3 %), *P. pipistrellus* (26.6%), *M. blythii* (16.1%), *B. leucomelas* (10.8%) and *R. bocharicus* (3.5%). The majority of the bat species in Tajikistan are non-migratory and show only seasonal short distance movements between valleys and mountains. Migratory species are *M. blythii*, *V. murinus* and *P. austriacus*. *Myotis blythii* is not known from the winter period, *V. murinus* is not present in summer, and *P. austriacus* is rarely seen in the winter period. Longevity records are: *R. ferrumequinum* and *R. bocharicus*, >8 years; *M. blythii*, >9 yrs; *P. austriacus* >10 yrs; *B. leucomelas* >5 yrs; and *P. pipistrellus* > 6 yrs.

Red Data Book Bat Species of Tajikistan

Tolibjon K. Khabilov
Khujand State University, Khujand, Tajikistan

Bat research carried out in Tajikistan in the period 1976-1993 revealed the presence of 19 bat species, belonging to the Rhinolophidae, Vespertilionidae and Molossidae. Insectivorous bats are considered to be useful in the prevention of insect pests. Unfortunately, a decline in numbers of some species was observed in Tajikistan since the last 20 years. In addition, some populations vanished, mainly by human influence. The Red Data Book of Tajikistan, issued in 1988, includes 14 bat species. Investigations revealed that *Eptesicus serotinus* is rare in the north and common in the south-west of Tajikistan. *Eptesicus bottae* is as abundant as *Pipistrellus pipistrellus* on the right bank of the Karakum water reservoir in the Syr-Darya valley. *Barbastella leucomelas* is a common hibernating species in the mountainous area of Tajikistan. *Plecotus austriacus* is abundant in abandoned mines in the Gouzion Mountains where colonies of 160-180 individuals can be found. These data require a partial revision of the Red Data Book of Tajikistan.

Observations on Flight Activities of *Pipistrellus pipistrellus* and *Eptesicus bottae* on the Right Bank of the Karakum Water Reservoir in North Tajikistan

Tolibjon K. Khabilov
Khujand State University, Khujand, Tajikistan

In the periods of June-July 1990 and May 1991, observations were made on the emergence and foraging flight activities in the sandy area of the right bank of the Karakum water reservoir in the north of Tajikistan. The reservoir is situated 40 km east of Khujand. The total observation time was about 30 hours. At the end of June and the beginning of July *Eptesicus bottae* emerge between 21:19 and 21:25, while *Pipistrellus pipistrellus* emerge about 30 minutes earlier. Both species emerge through the night but show 2 or 3 peaks. The second and third peak are attributed to repeated foraging flights. Mass flights of Diptera (*Chironomus plumosus*) were noticed between 22:00 and midnight, and at 4:00 and 6:00 in the morning, corresponding with the emergence peaks. The main abiotic factor affecting the foraging behaviour was an unremitting western wind.

Importance of Marine Caves for the Reproduction of Bats Along the Coast of the Adriatic Sea

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The coastal line of the Adriatic sea in Croatia is 1778 km long. Together with the coastal line of the islands, the entire coast is 5790 km long. In the Croatian part of the Adriatic Sea there are more than one

thousand islands, reefs and cliffs. This predominantly karst area contains most of the 6500 known speleological objects in Croatia. More recent speleological research show that this is only a small part of the existing speleological objects. The climate of this area is mediterranean and submediterranean. A review of the bats of this area is given by Dulic & Tvrtkovic in *Bijdr. tot De Dierkunde*, 1970. Most of the species inhabit the area during the warmer part of the year. Big summer colonies are already known to exist including colonies of *Myotis myotis* (Pokrovnik, over 1000), *M. blythii* (Milna, 100, Baska), *M. capaccinii* (Pokrovnik, 300), *M. emarginatus* (Vis), *M. schreibersii* (Hvar, Krk, Lastovo, Pokrovnik), *Rhinolophus ferrumequinum* (Hvar, Lastovo, Vis), *R. hipposideros* (Krk, Korcula). During the last ten years several new colonies have been discovered in natural and artificial speleological objects - Hvar (*R. ferrumequinum* and *M. emarginatus*), Neretva (*R. ferrumequinum*), Dugi otok (*M. mystacinus*), Bigevo (unknown species), Brsec (unknown species), Povile (*R. ferrumequinum*), Vis (*Tadarida teniotis*), Peraco blato (*M. blythii*), Bok-anjgko blato (*R. ferrumequinum*), Novi Vinodolski (*M. blythii*). One of the more important new findings is *N. lasiopterus* (Tvrtkovic i Baltid, *Nat. Croat.*, 1996.) on the island of Mljet. The largest part of the area concerned is poorly known since no systematic research has been carried out. Therefore the importance of marine caves for the reproduction of bats, especially for migratory species, but also for rare and endangered species, is not well known. In this paper the first results of the research are presented as an introduction to a longer and more systematic study of the importance of marine caves on the Adriatic coast and islands for bats and their reproductive ecology.

Habitat Preference and Activity of Bats in Bialowieza Primeval Forest

Alek Rachwald

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Studies were carried out in Bialowieza National Park, the best preserved part of the Bialowieza Primeval Forest, in eastern Poland. Observations of bat activities were made with bat detectors in five forest habitats: dense deciduous forest, dense coniferous forest, natural clearings in both types of forest, and river valleys. The data collected consist of 1100 series of signals. The maximum species diversity was found in clearings in coniferous forest (7 species and one genus), and the minimum diversity in dense deciduous forest (3 species and one genus). *Nyctalus noctula*, *Myotis* spp., *Pipistrellus nathusii*, *Eptesicus nilssonii* and *Vespertilio murinus* were most abundant. All species showed most of their flight and foraging activities near the rivers and in the clearings in coniferous forest. Social calls were heard in clearings of both types of forest, and in dense coniferous forest. *Myotis* spp. were most frequently observed in dense deciduous forest (440/0). *N. noctula*, however, was common in clearings in coniferous forest (34%), where *Myotis* spp. were hardly present (1%). *Nyctalus* spp., *Eptesicus* spp. and *V. murinus* were most frequently observed in forest clearings near the rivers, where *Myotis* spp., *Pipistrellus* spp. and *Barbastella barbastellus* occurred most frequently in dense forest. In all mentioned habitats, the bats' activities were studied in three nocturnal periods (evening - midnight - morning). In the river valleys, activities were similar in every period, while in the other habitats an obvious peak was observed in the evening. In this paper the first results will be presented of a project supported by the Polish Committee for Scientific Research.

Changes of Flying Activity and Body Weight in *Plecotus auritus* : Seasonal and Nocturnal Aspects

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An intensive study of the seasonal and nocturnal activity of bats was done in 1993-1995 on the unique locality Ledovd sluje [Ice caves] near Vranov nad Dyji (Podyji National Park, Czech Republic). Bats were mistnetted (nine netting periods per year), species determined, sexed, weighed, measured (LAT) and ringed, in 1994-'95 fecal pellets for a food analysis were collected. *Plecotus auritus* was the most abundant species;

a total ca 1850 bats were captured. Seasonal dynamics of flying activity displays two peaks- lower in the spring (April), higher in the late summer or early autumn (August and/or September). Minimum was found in the midsummer (June). Body weight (the arithmetical mean of the body weight of all captured males) also displays characteristic seasonal changes. It is increasing from March to July, than it falls (probably mostly as the result of incoming young bats into the locality) and repeatedly increasing with maximal speed in October and December. Character of body weight changes was compared with the second most abundant species - *Myotis daubentoni*. Flying activity and body weight changes in the course of the night have three phases. The first phase is characterized by increased flying activity and simultaneous increase in body weight. High flying activity and decrease of body weight are characteristic of the second phase. The third phase displays mostly low flying activity, sometimes with a lower activity peak. The body weight is usually increasing slightly. All three phases are evident at the beginning and at the end of the growing season when nights are long. They are reduced in the summer optimum when nights are short.

Flight Activity of Bats at Cave Entrances during the Non-hibernating Period

Zdeněk Reháček and Jan Zukal

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In 1991-1994, from 15 March till 14 November, bats were netted at the entrances of six caves (Sloupské cave, Hladomorna c., Katerinská c., Byci skala c., Ochozská c. and Netopyrka c.) within the area of the Moravian Karst (central Moravia, the Czech Republic). The nettings usually commenced before sunset and ended at about midnight. Unlike winter censuses of bats hibernating in these caves high species diversity was recorded. In all, 2,421 bats of 15 species were netted, viz., *Myotis myotis* (751 records), *M. daubentoni* (378), *M. nattereri* (314), *M. bechsteini* (275), *M. emarginatus* (212), *Barbastella barbastellus* (131), *Plecotus auritus* (131), *Rhinolophus hipposideros* (101), *M. mystacinus* (34), *Eptesicus serotinus* (26), *P. austriacus* (22), *M. dasycneme* (19), *Nyctalus noctula* (13), *M. blythii* (7) and *M. brandtii* (7). The species composition of netted samples differed in individual sites of nettings. The main peak of flight activity as calculated from nettings was recorded during late summer and autumn migrations, when the total number of bats entering the caves in the course of the first half of the night was significantly higher than the total number of bats leaving the caves. The second weak peak was recorded in spring, when the number of leaving bats was higher than the number of entering ones. While during the spring period the flight activity of bats leaving their hibernacula was highest at the onset of darkness, during late summer and autumn migrations the flight activity reached its maximum at about midnight. In late summer and autumn, the bats flying out dominated only at the beginning of the night; the bats flying in, on the contrary, considerably dominated during the second half of the time span sunset-midnight.

The Diet and Foraging Strategy of *Eptesicus serotinus* in Southern Moravian Agrocoenoses

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The main aim of this study was to investigate the diet and foraging activity of *Eptesicus serotinus* in anthropically influenced habitats of southern Moravia. The structure of diet was studied by means of faecal analysis. Line transects with bat detectors and visual censuses were used to study foraging behaviour. The bats foraged in all habitats under study. The highest intensity of foraging activity, however, occurred in forests and along forest edges. The lowest occurrence was over fields. Significant seasonal changes in habitat preference were recorded. *E. serotinus* foraged around trees at the edges of forests and windbreaks and between 5-10 meters above forest roads. In rural habitats, gardens and the surroundings of street lamps

or large solitary trees were most frequently used by bats. The diet of serotines consisted of seven insect orders - Diptera, Coleoptera, Hymenoptera, Heteroptera, Lepidoptera, Homoptera and Orthoptera. Coleoptera (Carabidae and Scarabaeidae) and small Diptera (Chironomidae) were dominant in the diet at the nursery colonies under study. Opportunistic foraging of swarming insects (Hymenoptera - Formicoidea and Ichneumonidae, and some Heteroptera - Lygaeidae and Corixidae) was found to be dependent on the time of year. On the other hand, Lepidoptera were selectively caught during the entire season in the surroundings of street lamps. *Eptesicus serotinus* used specific behaviour patterns to ensure optimal exploitation of its trophic niche and to minimize food competition with other bat species. A single foraging strategy (hawking) tended to be preferred within the southern Moravian agroecosystems studied, however, habitat preferences changed through the year resulting in a change in the diet structure.

* * * * *

Education and Conservation

Editors' Note

The following article was submitted to Pat Morton, Editor for Education and Conservation. After some minor editing we thought it would be of interest to those of you who are involved in working with school children. Many of you have related how you are giving "bat-talks" to children, and the children want to get more involved than merely being passive listeners. This project describes how three teachers really did get their students involved. For reasons of space we did not include the letters that were sent to parents, etc., but the authors are eager to provide copies of these if you contact them. Their e-mail addresses are listed at the end of the article. PM and GRH

All About Bats: Building Bat Houses: [A Project for Grade School Children]

Dyanne M. Tracy¹, Karen Steele², and Gerrie Arnold³

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For most of this decade, the National Council of Teachers of Mathematics Standards documents (1989, 1991, and 1995) and the American Association for the Advancement of Science Benchmarks (1993) has urged educators to develop learning experiences in which students in cooperative groups use a multitude of skills and prior knowledge while simultaneously learning new concepts that have meaning in real-life contexts presently and in the 21st Century that emphasize authentic assessment. If you are gasping for breath, then you, too, understand that educators have been asked to satisfy many educational requests for reform--all of which have a sound educational rationale.

As participants in the Teacher Telementoring Project funded by the Department of Education Funding for Innovation in Education, we have been part of a community of learners who have strived to meet such educational requests for reform. Our community of learners consist of students, student teachers, cooperating teachers, family volunteers, and mathematics and science methods' professors who communicated, via electronic mail (Eudora, 1996) and conferencing (FirstClass Client, 1994). Three teams of participants, located in Michigan, New York, and Pennsylvania each developed an innovative unit as a by-product of their own professional development. We thought the readers of Bat Research News would enjoy learning about our unit.

Our project was titled "Bats It Was!" When we decided to develop a unit about Bats for our third graders which integrated mathematics, science, and technology, we were mildly enthused. When each of us added one or more of our personal interests: (a) environmentalist, (b) budding computer techie, and (c) woodworking, we really started to get excited. We sent a letter* to the families of our students that presented a summary of the All About Bats unit. Soon students and families alike were fully engaged in the Bat study. Within a week of the first letter, we sent a second letter home* describing details about building bat houses. In the meantime students had become hooked on bats! They completed hands-on activities about echolocation, diet, navigation, scents, anatomy, and habitat. After the cofounder of the Organization for Bat Conservation, Rob Mies, visited the students, they were on the edge of their seats!

Their knowledge was astounding. After getting to see four live bats within 30 cm of their noses, asking questions and viewing colorful slides, students finished by examining two bat houses. They looked at several views, put their hands inside the bat houses and asked questions specifically related to bat house construction.

Bat House Construction

What a wonderful experience to see girls and boys using power and manual woodworking tools. Shop safety was stressed at all times. Over a dozen adult family members assisted students throughout the three days of construction. Cooperative groups of three students each completely assembled a bat house all from donated scraps and other supplies.

Technology

Since completing the bat houses, students have learned more about word processing, especially fonts and borders; videography--producing a Bat House Construction Infomercial; and using e-mail and the Internet. Thank you letters, scientific questions, and bat house adoption letters have all been student created using technology as a tool.

Please Contact Us! We purposely kept this article short because we want you who are working with bats and kids to drop us an electronic line. Our entire curricular unit will be available in electronic form later this year. We are willing to send you teaching tips, picture files, and even a video. Our students are counting down the days until their seven bat houses are actually installed. In the meantime, please contact us and our students:

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Irish Bats Seminar

The first meeting concerned specifically with the conservation of bats in Ireland was held May 31-June 1, 1997 at Corofin, Co. Clare. The meeting was co-organized by Congella McGuire and Kate McAney who provided the following abstracts of the presentations. Kate's excellent summary of the symposium appears on page 38.

Bat recording - importance and methods

Pamela Allen, Honorary Records Sec.
Northern Ireland Bat Group

In a situation, or with a subject about which there is very little known, any information at all is of value. Where there is very little known, it is difficult to assess what aspects may turn out to be important, so it is worthwhile to record any interesting features-within reason.

Records only in field notebooks are of value only to the owner of the notebook. If they contribute to published work, either by one person or as a cooperative effort, they become available to others, but often in a summarized form. If raw data is lodged in an information "bank", it should be there in full detail for as long as that bank exists; the rights of those who supply the raw data can be safeguarded, but the data will not be lost forever when the original observer dies, or loses interest. Our "bank" in N. Ireland is CEDaR, the Centre for Environmental Data and Recording, based at the Ulster Museum.

When the Northern Ireland Bat Group came into existence, we learned that bats all over the world were declining in numbers. We were unable to say whether or not this was so in our own area because we had too little information about the situation in the past. We also had too little information about the present, but at least we could do something about that.

Initially, we envisaged the records as forming a useful baseline for comparison when monitoring our bat population in future years. We now find that we are asked for data for particular areas by Environmental Consultants preparing Environmental Impact Assessment statements about planned developments. We are also being approached by Research Students with requests relevant to their research needs, and this means that they can get off to a better start than would otherwise be so.

One important feature of our recording system in Northern Ireland is that all records come to one source, the Northern Ireland Bat Group, and we would hope to keep it that way rather than have a fragmented data base. In all this, we are helped greatly by the Environment and Heritage Service of the Department of Environment (N.I.), by Ulster Museum and by CEDaR; all four organizations benefit from this mutual cooperation.

Over the years, we have developed a record card for bat roost visits and single bat finds. We try to make our members aware of the need to fill in the card at or soon after their visit, to keep a copy, to submit cards quickly, and the need for accuracy, legibility and the desirability of completing as many spaces on the card as possible. This information is then typed into the "Recorder" programme on computer, for Bat Group use and for submission to CEDaR. Well over 1000 bat site records have been stored in this way.

The trials and tribulations of the Galway Bat Group: What have they done since their foundation?

Tina Aughney, Galway Bat Group

In Britain in the 1980's, following the introduction of the Countryside and Wildlife Act, there was a boom in interest in bats and their conservation. This led to the setting up of bat groups by people interested in bats in order to increase the effectiveness of their work. The concept of the bat group took off and there is now a network of over 90 groups covering Britain. The setting up of bat groups in the Republic of Ireland mirrored the interest in Britain in the 1980's, with groups forming in Cork, Dublin, and Galway. The Galway Bat Group, which we will be talking about today, was formed in 1988 and to date continues to run under the wing of Batman and Robin and company. The group has firmly established itself as a conservation organisation in Galway through its many activities. The Galway Bat Group provides an informal array of educational talks, exhibition stands, bat walks, bat detection training, and surveys of bat populations and their habitats. In today's paper, a summary of activities and achievements of the group will be presented in their full glory as well as the results of some important surveys carried out by this group. Keep on batting!

[abstracts of Ireland seminar continued]

In Dublin's Fair City

Brian Keeley, Dublin Bat Group

Bats are a very important part of the fauna of Ireland. Of the seven species found on this island, five have been found in the Dublin area in recent years. The most commonly recorded species in the urban area are the pipistrelle and the Leisler's bat. The pipistrelle is our smallest and most common species. It is found in a variety of roost types, ranging from boiler room chimneys to newly-built houses. This species is the easiest one to encounter due to its willingness to adapt to human dwellings. It can be found in even the most urban of settings, for example, Blessington Street Basin.

Leisler's bat is our largest bat. It is found in tree hollows as well as in attics and other human constructions. Ireland has been a stronghold for this bat in Europe. But even here, this species is encountering serious threats. This is due mainly to its close association with housing. Fear and intolerance can affect important maternity roosts. Hibernation in trees considered unsafe also poses problems for this bat. Many of the most important roosts in Leinster have been excluded or disturbed.

Long-eared bats are often closely associated with our public parks and suburban churches. They are usually found in buildings with large attics. They are the second most widespread bat in the country; more common in country/rural areas than in suburbia.

While very few Daubenton's roosts are known in Dublin, this bat can be seen along most lakes, canals, and rivers, such as the Liffey, the Tolka and the Dodder. Their feeding technique of low flight over water makes them very visible to the patient watcher. On bright nights, they and their reflections can be seen moving along a water course like a miniature hovercraft.

Whiskered bats are extremely rarely recorded in the Dublin area. One was found sleeping on a factory window ledge in Ballyfermot. The only other record in recent times came from a dead bat in Enniskerry. As it is one of our smallest bats and due to its sparse distribution, it is most unlikely that roosts of these bats will be frequently encountered.

All of Ireland's bats face the threat of pesticide poisoning through timber treatment in buildings and through agricultural spraying. Sealing of bridge holes with pressurized cement poses a serious problem for some bats, especially Daubenton's bats. Pressurized wall cavity insulation may also threaten the house-dwelling bats. Tree-felling is a real threat to maternity roosts and to hibernacula. Fear and dislike of bats may lead some people to drastic measures ranging from exclusion of nursing female bats to more cruel actions. Thoughtless building work can also destroy maternity roosts.

Protection for our bats must be undertaken and enforced to prevent further loss of important roosts. Even and especially in urban area, bats are an important aspect of our environment.

The work of the Vincent Wildlife Trust in Ireland.

Kate McAney, The Vincent Wildlife Trust, Donaghpatrick, Headford, Co. Galway.

The Vincent Wildlife Trust was formed in 1975 by Vincent Weir. It is an independent charitable body engaged in wildlife research and conservation. Income derives from the Trust's own resources and donations. Much of the work of the Trust has been directed towards the study and conservation of the European Otter but it has also carried out national surveys of the otter, mink, pine marten and vole. At present there are twelve field officers working on otters, pine martens, polecats, stoats, weasels, and bats, specifically greater and lesser horseshoe bats and Bechstein's bats. Over thirty publications have been produced by the Trust since it was established. The Trust owns six small reserves, one of which has the largest breeding colony of greater horseshoe bats in Britain and leases a further five which are important lesser horseshoe bat sites.

The Trust's involvement in Ireland spans two different periods, the first period from July 1991 to December 1994 and a second period which began in June 1995 and will continue until December 1999. The period from July 1991 to December 1994 spans the time when the Trust entered a joint project with the Office of Public Works and employed a full time bat conservation officer in Ireland. The aims of that three and a half year project were six fold: to continue the national bat survey; to arrange protection for sites under threat; to produce and distribute educational material; to deal with queries from the public; to promote bats by public lectures and contact with the media; and to liaise with voluntary bat groups. Examples of the work carried out under these headings will be described in the presentation. The joint Vincent Wildlife

Trust - Office of Public Works bat project ended in December 1994 but the VWT continues to support bat conservation work in Ireland by employing a field officer to work primarily on conserving two bat species, the lesser horseshoe bat and Leisler's bat. This work will be described in the remainder of the presentation.

Survey of lesser horseshoe bats *Rhinolophus hipposideros* and other bat species in north County Clare

Congella McGuire, National Parks and Wildlife Service, Burren National Park, Co. Clare

A detailed survey of bat roosts was undertaken in 1995, covering an area of 225 sq km in north County Clare. All bat species were sought, with a particular emphasis on the lesser horseshoe *Rhinolophus hipposideros*. The survey was divided into three parts, a survey of summer roosts, hibernation roosts, and roosts in bridges. The results show that north Clare is important for lesser horseshoe bats. More than half the roosts located were lesser horseshoe, with up to 1,000 bats counted in 24 summer roosts and a further 165 bats in hibernation. Overall, almost 2,500 bats of seven species were recorded in 75 summer roosts in the survey area.

Research techniques for the investigation of the bat fauna in Northern Ireland.

James O'Neill, Queen's University, Belfast.

Research techniques for the investigation of bat ecology have changed markedly in recent years. Recent developments in technology have meant that the face of bat research has changed radically. This presentation will describe the main research techniques in use today, the impact of new technologies upon bat research, and the ethical issues raised by the use of these methods. Simple techniques capable of delivering high quality data will be outlined to emphasise the fact that high technology and its associated costs are not prerequisites for successful research.

Surveys, special areas of conservation, and forestry: The importance of each to Irish bats

Patrick O'Sullivan, National Parks and Wildlife Service.

Surveys: The first national bat survey (1985-1988) was very important as it represented the first time that there was a major effort made to determine the distribution of our bat species. Although a tremendous amount of information was collected on all seven species, the survey should not be seen as representing a complete picture of the status of Irish bats. Rather, it should be used to help us focus on where there are still gaps in our knowledge so that these can be addressed and further work undertaken to complete our understanding of this important group of Irish mammals.

SACs: Approximately nineteen bat sites have been designated as Special Areas of Conservation (SACs) and some have also been designated Natural Heritage Areas (NHAs). Only lesser horseshoe bat sites have been designated SACs as this is the only Irish bat species which is an ANNEX II species under the Habitats Directive. Designation will mean protection for these sites which requires that a management plan be drawn up for the sites and a budget allocated for the implementation of this plan. Many bat sites will be designated as parts of other SACs but, once again, protection of the bats will be taken into consideration when the overall management plan is drawn up. It is believed that SAC designation and the subsequent protective measures will benefit bats at these sites.

Forestry: In recent times concern has been expressed in many quarters at the current developments in Irish forestry. The time has come for a major rethink in this area, particularly regarding the choice of species planted, the use of fertilisers and pesticides and the methods of harvesting, certainly in so far as these affect bats. Interested parties, such as bat groups, should start campaigning for such changes.

[abstracts of Ireland seminar continued]

The use of bat detectors in field research.

Jon Ross, Queen's University, Belfast.

It is only relatively recently that bat detectors have become a widely accepted tool in the field of bat research. In many respects they have provided us with a "window" through which to monitor bat behaviour in the field - something that was virtually impossible before their invention. Echolocation signals produced by bats are very complex as they must provide the bat with information about its surrounding environment and prey. Although the structure of echolocation calls are constrained by habitat and prey preferences, there is a certain degree of plasticity in their echolocation calls which must be understood before attempting to investigate bat behaviour on a higher level. In addition to the production of echolocation calls, bats also emit complex social calls which are specific to bat species. A bat detector is simply a device which converts ultrasonic signals produced by bats into audible sounds. There are a number of methods used to do this: (1) heterodyning, (2) frequency division and (3) time expansion.

Heterodyning is most commonly used in a wide variety of ways to provide a lot of information with regards to bat activity in the field, such as presence or absence of bats, comparisons of bat numbers between different habitats and automatic recording systems.

Frequency division and time expansion (FD/TE) are more advanced methods as they reproduce echolocation calls in their entirety. They are very effective when combined with sound analysis software to produce sonagrams of the calls. They are particularly useful in confirming the identity of bats observed in the field and in making direct behavioural acoustic comparisons between and within bat species and colonies, such as differences in echolocatory behaviour and social signalling.

It is vital to have an understanding of bat echolocation in order to make use of bat detectors effectively when researching bat behaviour in the field. Indeed, a basic understanding of bat calls interpreted through a simple bat detector can give us a valuable insight into a bat's echolocatory world as well as producing valuable data.

Bat conservation in a European context.

Henry Schofield, The Vincent Wildlife Trust, 10 Lovat Lane, London.

During this century ringing and census studies in a number of European countries highlighted major declines in many bat populations. One of the best documented cases is that of the extinction of the lesser horseshoe bat population in the South Limburg area of the Netherlands. In a study which began in 1936, Leo Bels ringed over 2000 lesser horseshoe bats. By 1980 his successors could only find 4-6 bats. Although the populations of some species appear to be recovering, or even expanding in the case of the Daubenton's bat, the overall picture is one of decline and fragmentation of populations.

The seriousness of these declines led to the establishment of a major bat conservation movement across Europe. Publicity drives and lobbying of governments has placed bats high on the conservation agenda in many countries. Most European states have national legislation protecting bats and their roosts. In addition, three pieces of international legislation give protection to bats. The Bern Convention seeks to ensure that governments take into account the conservation interests of species during the formulation of policies on planning and development. It also seeks special protection for particularly endangered species. The Bonn Convention seeks to harmonise legislation across national boundaries to protect migratory species. Finally in 1992, the EC Habitats Directive prioritised certain biotypes and species and requires early implementation of measures to conserve these. A number of bats are listed under this directive as species requiring the designation of special areas of conservation or SACs.

In order to implement these legislative measures effectively, considerable research has been undertaken into the ecology of bat species. Protection and enhancement of winter and summer roosts has been undertaken and in some countries sites have been set up as bat reserves. The provision of alternative roosts, such as bat box schemes or bat houses, has been used for those bats which frequently roost in trees. Finally, ecological research is leading to an understanding of landscape use by different species thus enabling conservationists to protect and enhance the habitat surrounding roosts.

The diet of Leisler's bat in Ireland

Caroline Shiel, Zoology Department, University College Galway

The analysis of bat droppings is now generally considered to yield reliable information on the diet of insectivorous bats. In order to analyze the diet of Leisler's bat, alternative techniques such as the examination of stomach contents, visual observations of foraging bats and examination of culled fragments prove to be unsatisfactory for a variety of reasons. Faecal analysis works well because insect skeletons are composed of a substance called chitin which is highly resistant to digestion. But bats chew their food very thoroughly so that the insect remains appear in the droppings as tiny fragments.

Since 1991, I have been concerned exclusively with the droppings of Leisler's bat *Nyctalus leisleri* as part of my Ph.D. thesis. Other parts of this research included bat detector surveys of foraging areas, emergence counts and extensive radio-telemetry in 1994 and 1995.

Leisler's bat is widely distributed throughout Europe, but it is scarce except here in Ireland where it is common. In fact, Ireland is the stronghold of its world distribution.

From 1991 to 1993, I analyzed the diet of Leisler's bat in Ireland. I examined droppings from six roosts around Ireland. In order to be able to compare the diet in Ireland to that in other countries where Leisler's bats are rare, I examined Leisler's droppings from two roosts in England in 1993 and 1994 and from three roosts in Germany in 1995. A total of 1,895 pellets were analyzed. All of the Irish and English droppings were collected from buildings whereas the German material was obtained from bat boxes.

Photographs of the retrieved insect fragments were taken by attaching a camera to a monocular microscope. A range of slides of fragments from some of the major prey groups will be shown including fragments of Ephemeroptera, Hemiptera, Neuroptera, Lepidoptera, Trichoptera, Diptera (Tipulidae, Anisopodidae, Culicidae, Chironomidae, Sphaeroceridae and Scathophagidae), Hymenoptera, Coleoptera and Siphonaptera.

A new guide to the analysis of bat droppings, published by the Mammal Society, is due out later this year. It is entitled "The Identification of Arthropod Fragments in Bat Droppings", by Caroline Shiel, Catherine McAney, Claire Sullivan and James Fairley.

A survey of bats and bridges

Patrick Smiddy, National Parks and Wildlife Service

A survey of bats using bridges as roosting sites was carried out in August and September 1989 in east Cork and west Waterford. A total of 366 bridges were examined for evidence of bat use, and each bridge was assessed for its suitability as a bat roost. All details were recorded on a standard form.

Fifty one (14%) of the bridges contained roosting bats. Forty more (11%) showed evidence of recent bat use. Another 95 bridges (26%) were considered suitable for roosting bats but no evidence of frequent use could be found. The remaining 180 bridges (49%) were unsuitable as roost sites.

The majority of the bats were Daubenton's. Up to four different roost sites were occupied on some bridges, but in most cases only one or two sites contained bats, and the maximum numbers of bats in a single bridge was seven. The long-eared bat occurred in eight bridges. Three other species, Whiskered, Natterer's and Pipistrelle occurred in one's or two's in three, four, and three bridges respectively.

Surveyors examining bridges for bats will need a good torch and a strong step ladder. All crevices and holes in the bridge roof and sides should be examined carefully. Droppings or fur marks may be visible in cracks even when bats are not present. Sometimes bats may be hidden from view but their presence may be detected by their chirping in the roost site. In the latter case identification will have to remain unconfirmed, although use of a bat detector may help. If the bats are roosting in a "dry arch" their droppings may be found on the ground beneath the site. All identifications need good views of the bats, hence the torch and ladder. While most bats in bridges are Daubenton's, this survey shows a wide range of species that may use bridges at least occasionally.

The best type of bridge for use as a roost by bats is one built of stone, and not of recent vintage, the older the bridge, the more likely that mortar will have fallen from between stones, creating perfect roosting sites. While very low bridges and culverts may hold roosts of bats, it is rarely possible to survey bridges with a clearance over water of less than three feet. The main problem facing bat roosts in such situations seem to be bridge repairs. Because many of the bridges used by bats are quite old it follows that

[abstracts of Ireland seminar continued]

repairs and maintenance may be necessary for safety reasons. The main type of repair jobs carried out by county councils is to cement the underside of each arch using pressure equipment. This eliminates all roost sites and may entomb bats. Bridges may also be used by bats in winter, so there is no safe time to carry out repairs. Before repair work is carried out each bridge should be surveyed, visually and with a bat detector, at dusk as well as by day. It may be possible to incorporate new roost sites in the repair job, and this should be investigated where possible with the local authority and wildlife consultants. Even new bridges being built with mass concrete, which are always unsuitable for bats, could be made more bat friendly by the incorporation of bat boxes in the structure. Where possible this should be drawn to the attention of local authorities and engineers when new bridges are being constructed.

Summary of the Symposium

Kate McAney

The Vincent Wildlife Trust, Donaghpatrick, Headford, Co. Galway, Ireland

A seminar to highlight Irish bats took place over the holiday weekend of May 31st/June 1st 1997 in Co. Clare, the home of the Burren limestone landscape in the west of Ireland. When the idea to hold such a seminar was mooted by Congella McGuire, a wildlife ranger with the National Parks and Wildlife Service, few people thought that there would be sufficient interest to sustain an entire weekend or that more than twenty people would turn up. As it happened, almost sixty people attended the two-day event on two of the hottest days experienced in Ireland so far this year (hot summer days in Ireland are almost as rare as bat workers). The aim of the seminar was to bring together, if not for the first time, certainly for the first time in many years, all those currently working on or interested in bats in Ireland. Unlike other countries where there are many bat species, numerous university departments conducting long term bat studies and hundreds of committed volunteers employed in conservation work, Ireland as an island can only boast seven bat species (although an eighth was found in Northern Ireland this spring), a handful of individuals involved in research and just tens of voluntary bat workers. Despite that, nine papers on a wide variety of topics were delivered, two practical sessions were held and a dusk bat detector walk took place.

The papers presented covered the work of the voluntary bat groups (Dublin, Galway and Northern Ireland), current research being undertaken at two of the universities (Galway and Belfast), the work of the Vincent Wildlife Trust in Ireland and that undertaken by staff of the National Parks and Wildlife Service, the government body responsible for bat conservation in the Republic of Ireland. One visiting speaker presented a paper on bat conservation in a European context and a second visiting speaker presented a bat identification practical session.

During the open discussion which wrapped up the seminar, the following issues were identified as areas of concern to those present: the limitations within the 1976 Wildlife Act as it relates to bats; how roosts and habitats of the lesser horseshoe will be protected under the EC Habitats Directive; the need for more basic research; the lack of a central (or any) database in southern Ireland for recording roosts; the problems involved in changing peoples perception of bats; and the loss of bats and roosts in bridges during local authority road repair operations. By the time all the bills were paid, it was possible for a small donation to be made to the three bat groups who had contributed so much to the seminar. The organisers are grateful to the National Parks and Wildlife Service for financial support and to various businesses which donated prizes for a raffle. With such a packed weekend, there was little time for delegates to socialise but it is hoped that this will be addressed fully at the next seminar which will take place in 1999.

Conservation and Ecology of Tropical Bats

On June 17, 1997 a short symposium entitled "Conservation and Ecology of Tropical Bats" was held in San Jose, Costa Rica. The Symposium was organized by Kathryn Stoner, and she has kindly provided the following abstracts of the presentations at the meeting. GRH

Changes of abundance and sex ratio of frugivorous and nectarivorous bats in tropical dry forest and their implications for seasonal migration.

Kathryn Stoner, Escuela de Biología, Universidad de Costa Rica, San Pedro, Costa Rica.

Neotropical bats play an important role in pollination and seed dispersal of tropical trees. However, little is known about the relationship between plant phenology patterns and bat migrations following these plant resources. My data suggest that the abundance of several species of dry forest bats is lower during periods of low food availability. The study site was the tropical dry forest at Parque Nacional Palo Verde in Guanacaste, Costa Rica. The bat population was monitored bimonthly from December 1994 through June 1996. Two mist nets were opened in a designated area for approximately 4 hours each night. Phenology data was collected from 35 species screened monthly for fruit and flower development. The abundance of different bat species varied seasonally. Peak abundance of most of the frugivorous and nectarivorous bats coincides with peaks in bat fruits and flowers (i.e. in June-July and Jan-Feb). There is a significant difference in the sex ratio for *Carollia perspicillata* over time. In 1995 and 1996 there were significantly more females than males in the dry season and significantly more males than females in the beginning of the wet season. These preliminary data suggest that some bat species are migrating from Palo Verde during certain periods of the year.

A comparison of the bat fauna of four Costa Rican mammalian zones.

Jose Manuel Mora and Bernal Rodriguez

Escuela de Biología, Universidad de Costa Rica, San Pedro, Costa Rica

[no abstract available]

Ecology of *Sturnira ludovici* in the Sierra de Manantlan, Jalisco, Mexico.

Luis Ignacio Ininguez

Universidad de Guadalajara- Centro Universitario

Costa Sur, Jalisco 48900, Mexico.

The subtropical cloud forest is the latitudinal and altitudinal limit for many frugivorous bats' distributions. I studied the frugivorous bat community in the subtropical cloud forest of Las Joyas Scientific Station, Jalisco, Mexico. The objectives of my study were: 1) to determine the dynamics of this community in the cloud forest, and 2) to evaluate the importance of the interactions between the frugivorous bats and these forests in order to develop strategies for their conservation. I mist netted and monitored frugivorous bats for three and one half years. Experiments on fruit selection and nutritional aspects of diet were conducted. Radiotelemetry was used to describe activity patterns and day roosts. *Sturnira ludovici* is the most abundant species in the study area, accounting for approximately 50% of all individuals. This species demonstrates seasonal dynamics, being present during the bat fruit production period (May- October) and migrating altitudinally the rest of the year. The food base seems limited to a few high quality species (i.e. *Solanum* spp. and *Conostegia volcanalis*). The overall male:female ratio was 1 : 2.7. Twenty-seven percent of adult females captured were pregnant or lactating, suggesting that they likely go to this habitat during the additional stress of reproduction to take advantage of high quality resources seasonally available in the subtropical cloud forest.

**The long and short of it:
Comparative ecology of two plant-visiting phyllostomid bats.**

Theodore H. Fleming, University of Miami, Coral Gables, FL 33124, USA.

With nearly 150 species, the chiropteran family Phyllostomidae displays an ecologically diverse array of lifestyles in the New World tropics and subtropics. Most phyllostomids are plant-visitors and serve as pollinators and/or seed dispersers for many trees and shrubs. In this talk I will compare the ecology of two of these plant visitors, *Carollia perspicillata*, an 18 g frugivore, and *Leptonycteris curasoae*, a 23 g nectarivore/frugivore. I will emphasize differences in their roosting, social, reproductive, and foraging behavior and will relate these to differences in the spatio-temporal variability in their food supplies. *Carollia* has a much more sedentary lifestyle than *Leptonycteris*. The annual home range of a typical female *Carollia* is about 500 km² whereas the annual home range of a female *Leptonycteris* is about 300,000 km². As a consequence, conservation strategies for protecting these two species differ tremendously in scale. This scale must be international for *Leptonycteris*; it can be regional for *Carollia*.

**Resource partitioning in a community of nectar-feeding bats
in a tropical rainforest.**

Marco Tschapka, Universität Erlangen, Germany.

Neotropical rainforests support guilds of nectar feeding bats (Phyllostomidae:Glossophaginae). What mechanisms permit the coexistence of these species? The high level of transparency in energy flow for nectarivore communities permits quantitative assessment of both resource production and use. Bats were captured (8/94- 1/97) in lowland forest at the La Selva Biological Station, Costa Rica. Food plants were determined by analysis of pollen loads and fecal samples. Four Glossophagines were found to co-occur at La Selva: two permanent residents (*Glossophaga commissarisi*, *Hylonycteris underwoodi*) and two species occurring in small numbers only during seasonal periods of nectar superabundance (*Lichonycteris obscura*, *Lonchophylla robusta*). The two resident species differed in their temporal feeding strategies: after the main flowering peak, *G. commissarisi* shifted to a more frugivorous diet, while the smaller population of the apparently more specialized *H. underwoodi* fed on the few remaining bat-flowers. Throughout the annual cycle *H. underwoodi*'s diet principally consisted of plants that provided only low energy density (kJ/ha/day), as revealed by phenology, flower density and nectar values. Wing proportions support the idea that *H. underwoodi*, with its lower wing-loading, is better adapted to exploiting low densities of flowers in energy-efficient flight than is *G. commissarisi*, which primarily feeds on more concentrated floral resources. That these patterns of resource partitioning along energetic gradients are similar to those known from simple communities of hummingbirds suggests parallel trends in community organization.

**Conservation of neotropical bats:
monitoring techniques, community comparisons, and long-term studies.**

Elizabeth K. V. Kalko

Animal Physiology, University of Tuebingen, D-72076 Tuebingen, Germany.

Bats are ecologically more diverse than another group of mammals. Due to their large biomass and diverse feeding habits they play indispensable roles in tropical forests through seed dispersal, pollination, and control of insect populations. Unfortunately, our knowledge of tropical bat communities and their conservation needs are still poor, mostly because of difficulties with sampling techniques and lack of long-term studies. Here, I present a draft of an acoustic identification key that is being developed for Neotropical aerial insectivorous bats, where species are under represented and often completely undetected in community studies. Based on echolocation call design, most aerial insectivores can be identified to genus and many to species. The use of several sampling techniques including mist-netting to assess New World leaf-nosed bats (Phyllostomidae) and acoustic monitoring for identification of aerial insectivores allows for the first time comprehensive community comparisons. Comparison of diversity and organization of bats in various habitats suggest that some species are particularly vulnerable to fragmentation of forest and isolation of

patches. Furthermore, analysis of population trends in an 8-year study in Panama revealed short-term fluctuations of some species, possibly an indication of seasonal migration, while long-term population trends of the whole community remained stable.

Tent architecture and tent-making behavior in Neotropical and Paleotropical bats.

Thomas H. Kunz

Department of Biology, Boston University, Boston, MA 02115.

Tent-making or tent-roosting behavior in bats has been described for fifteen species of the microchiropteran family Phyllostomidae (subfamily Phyllostomatinae: tribe Stenodermatini), three members of the megachiropteran family Pteropidae, and one member of the microchiropteran family Vespertilionidae. I review evidence for tent-making/tent-roosting behavior, summarize current knowledge of bat-tent architecture, examine tents, and present a graphical model that predicts the relative numbers of tents that should be constructed and maintained. Over 100 plant taxa are used by bats for tent construction, although there are a limited number of leaf forms that can be modified into tents. Eight architectural styles of tents have been described: seven from the Neotropics (conical, palmate umbrella, apical, bifid, pinnate, paradox, boat tents), three from both the Neo- and Paleotropics (conical, palmate umbrella, and apical tents), and one (stem tent) exclusively from the Paleotropics. Stem tents are constructed by bats from altered vines, leaves and branches of trees, flower and fruit clusters, and root masses of epiphytes, and are among the most variable and durable of tents. The similarity in tent architecture observed in the Neo- and Paleotropics may be a consequence of convergence in leaf morphology.

Pteropid bats of American Samoa.

Anne P. Brooke

Department of Marine and Wildlife Resources, Pago Pago, American Samoa, 96799-3730 USA.

The similar appearing Pteropid bats are present in the Samoan archipelago, near the eastern limit of the genus range. The Samoan bat, *Pteropus samoensis*, found only in Samoa and Fiji, is an extreme generalist. Bats are active both during the day and at night. The Samoan bat eats a wide array of fruits, nectars, pollens, leaves and saps. The other flying fox present, *Pteropus tonganus* has a wide range from near New Guinea to the Cook Islands. This species also has a varied diet but is nocturnal in behavior. *Pteropus tonganus* becomes active during the day under stress, at times of low food availability, or after hurricanes.

NEWS from the Readers of *Bat Research News*

from Alberta, Canada

The news from the University of Calgary: Robert Barclay is off on a one-year sabbatical to the University of Queensland in Brisbane, Australia. While there he will be working with Les Hall in the Department of Anatomy (yes you heard it right) on the role of calcium in the reproduction and diet selection of fruit and nectar feeding bats. He'll also drop in at the Australasian Bat Meetings next Easter and will (he promises) send a report for BRN.

Meanwhile, Carolina Caceres is finishing off her MSc research looking at the ecological and behavioural differences between *Myotis evotis* and *M. septentrionalis* and trying to determine the critical habitats for *M.septentrionalis* in British Columbia. Jill Holloway (MSc) is also finishing off her work looking at the importance of riparian zones in the prairies as roosting and foraging habitat for bats. They will likely take a trip to Aussieland and try to write their theses.

Bryan Chruszcz has just started his MSc research investigating the thermoregulatory patterns of *Myotis evotis* in natural roosts in the prairies. He will then get in a second field season in Australia and is hoping to radiotrack *Nyctinomus australis*.

Aside from other students studying bird behaviour, kangaroo rat torpor and mountain gorilla populations, things are reasonably calm in Calgary. Robert looks forward to the 1998 bat meetings and perhaps a second Bat Forest symposium.

submitted by Robert Barclay

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from Texas, U.S.A.

Bat Conservation International's 1997 Student Scholarship Program: A Quick Summary.

This year has been another outstanding year for BCI's student scholarship program. A record 41 proposals were submitted to our scholarship program, compared to 24 in 1996, and 14 in 1995. This constitutes an almost three-fold growth over just the past two years. Of the 41 submitted proposals, BCI was able to fund 14 projects this year, by giving the full amount of requested funding to the top six proposals, and partial funding to the following eight. Students have begun field work this summer conducting research in 11 countries: Argentina, Brazil, Canada, Colombia, Indonesia, Mexico, Panama, Paraguay, United Kingdom, United States, and Venezuela. The information gained from these projects will prove essential to managing and conserving bat populations around the world. We expect outstanding results from these bright students, and are sure you will hear from them in the future! Hopefully some of them will be making presentations at the Bat Research Symposium in Tucson in October.

Information and application forms for the 1998 BCI Student Scholarship Program will be available after August 1, 1997 by e-mailing aengland@batcon.org or writing to: Bat Conservation International, Scholarship Program, PO Box 162603, Austin, TX 78716-2603 USA.

submitted by Angela England

e-mail aengland@batcon.org

from New Mexico, U.S.A.

The Aridlands Project of USGS-Biological Resources Division in Albuquerque has several bat projects ongoing this summer. One is centered on the Black Hills of South Dakota and is in its third and final year. We have been tagging bats with radios and tracking them to roosts. In addition, we do a lot of surveying with mist nets. Previous annual reports are available for those who may want a copy. In New Mexico we have a similar project centered in the Jemez Mts., near Los Alamos. Work this year is also in the third and final year of the project. Last year's report is available. We started a new project this summer on biology of bats in historic National Park structures in the Rocky Mountain region of Colorado, Wyoming, and Montana. This work involves basic surveys, searching for roosts, and temperature comparisons of occupied and unoccupied roosts. In addition, we have some baseline inventory work in progress at various sites in Utah, New Mexico, Colorado, and Arizona.

submitted by Mike Bogan

e-mail: mbogan@unm.edu

from Idaho, U.S.A.

Hello! My name is Kirsten (Kisi) Bohn and I am a graduate student at Idaho State University. My thesis project is on tree roost selection and the effects of timber harvesting on bat populations here in

Idaho. Also I came across a book titled "Bats Incredible!" It has a 100 pages of lessons and fun activities for grades 2-4 which use bats to teach physical and life science concepts. Being relatively new to the 'Bat Scene' I did not know whether this book was well known. It is published by AIMS (Activities Integrating Mathematics and Science) and their address is: AIMS Education Foundation, P.O. Box 8120, Fresno, CA 93747-8120. If you know of anyone involved in education this is an excellent book.

submitted by Kirsten Bohn

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from Wisconsin, U.S.A.

I am a (relatively) new grad student in the Zoology Dept of the Univ. of Wisconsin - Madison, working with Dr. John Kirsch and fellow grad student, Jim Hutcheon. In addition to the bat systematics work that goes on in our lab, I am interested in bat ecology and conservation biology. My current project involves characterizing the habitat use, temporally and spatially, of the bats that hibernate in the Neda Mine, an abandoned iron mine near Horicon WI. This hibernaculum is the largest identified in the Midwest, and the geologic ledge it is part of has been identified as a prime area of wind energy development for the state. From my research I hope to develop some guidelines for the placement and operation of the wind turbines that will avoid any negative impact they may have on the bats.

In the future I hope to develop a project that combines molecular and conservation biology. Perhaps looking at population structure, or answering questions of species diversity and viability. If any one is interested in bouncing some ideas back and forth, please, don't hesitate to send an e-mail.

submitted by Deanna Byrnes

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from Ontario, Canada

We are trying to adapt to life after a 55 day-long strike by faculty members. You perhaps can imagine just how much fun that has been. Took advantage of this "break" and spent a couple of weeks on the Zambezi watching *Nycteris grandis* and *Nycteris thebaica*, while monitoring the odd echolocation call. Just the kind of reality therapy that hits the spot. Meanwhile, I'm gearing up for a field course in August.

submitted by Brock Fenton

e-mail: bfenton@circus.yorku.ca

from Oregon, U.S.A.

I first became interested in bats as an undergrad at the University of California-Davis while working in the teaching museum. In June of 1994, I had the opportunity to take a field class through the University of San Francisco lead by Dr. Elizabeth Pierson. A week in the field with Dixie and the bats and I was hooked. I spent as many weeks as I could in Mt. Shasta and Yosemite helping Dixie and Bill Rainey net bats.

After graduating with a B.S. in Wildlife Biology in March of 1995, I moved to Portland. I have tried several venues in the area from calling the Department of Mines to exterminators trying to find some way to work with bats, but I have not been successful. My greatest outlet has been working in a local nature store helping to raise bat awareness and I am currently putting together a bat house survey to gather information from around the Portland metropolitan area.

The Pacific North West is a fascinating area to study bats because of the amount of rainfall it receives west of the Cascades. Do the bats here migrate or hibernate? A common line in Oregon is that you are never more than 100 feet from a bat and I would definitely hope to prove that that is true. However, most of the bats I have seen are in the eastern desert areas of Oregon. Overall, my biggest interests are in the direct conflicts and coexistence of human and bat populations. I marvel at the prevalence of bats in high traffic human areas such as major metropolitan cities and highway bridges. I am also interested in our recreational impacts on their populations and roosting habits. In a state that is currently experiencing a huge rise in new construction and new residents, active programs of education and awareness are needed.

If anyone has information about bats in Oregon that they would like to share with me, I would be grateful if you would contact me at my e-mail address below.

submitted by Jolie Henricks

e-mail: BattyCat@aol.com

from Iowa, U.S.A.

Though not a mammalogist, I work with fleas and thus can't get away from bats and other mammals. I publish a bi-annual newsletter called *Flea News* that deals with literature and other matters involving fleas. While it does not contain a great deal on bats, there are more bat-flea articles than one might expect. Since I am retired I am now working at home which it is more convenient. For those bat workers who may be interested, I may be contacted at: 3906 Stone Brooke Circle, Ames, IA 50010-4174, phone (515) 232 7714, Fax (515) 233 1851.

submitted by Bob Lewis

e-mail: relewis@iastate.edu

from New York, U.S.A.

Bat research is going strong at the American Museum of Natural History. Karl Koopman is finishing up a long-term project (with Guy Musser) on the bats of Celebes, and he recently submitted a manuscript on two species of *Lasiurus* from the Galapagos.

Nancy Simmons is finishing several long-term projects. These include a report on the results of a 4-year faunal inventory project in Paracou, French Guiana, which includes species accounts for 79 species of bats. Nancy and graduate student Jonathan Geisler have recently finished a phylogenetic analysis of the relationships of Eocene bats to extant forms, a project that has exciting implications for understanding the evolution of flight and echolocation in bats. They are currently slaving away on a manuscript describing this study. Nancy is also beginning a collaborative project with Ron Van Den Bussche at Oklahoma St., trying to bring together morphology and molecules to sort out higher-level relationships of bats.

Andrea Peffley, now a graduate student at Columbia University, is continuing her graduate research on molossid phylogeny and evolution. She is also working hard to finish a manuscript (with Nancy Simmons and Matt Rockman) on phyllostomid relationships and the origin of feeding guilds. On a recent trip to Cost Rica, Andrea studied aspects of behavior in *Carollia perspicillata*.

Leonard Avila, an undergraduate intern from Brazil, is spending the summer of 1997 at the AMNH working on fossil phyllostomid bats from Brazil. He brought beautiful fossil skulls of *Tonatia* with him, which he will compare with specimens from the AMNH and other museums.

Collections Manager Darrin Lunde and graduate student Pamela Beresford recently submitted (to BRN) a record of bats they collected from the Central African Republic. They collected a total of 11 bat specimens, representing 8 species (and 4 families). Three of the species were new records for the country. Post-doc Albert Ditchfield continues to work on a formal revision of the genus *Trachops*. He is using morphological data to test the taxonomic hypotheses generated from his molecular work on variation in cytochrome b sequences. He has been busily visiting museums all over the U.S., and will be off to Europe this summer to see the holotypes (yeah right!).

Post-doc Bill Schutt continues to uncover interesting phenomena as he studies the morphology of the chiropteran hindlimb (he is currently working on megachiropterans). He co-authored a recently published Mammalian Species Account (with Arthur Greenhall) on *Diaemus youngi* and has submitted manuscripts on several topics including the dynamics of jumping in *Desmodus*, the digitiform calcar of *Diphylla*, and the evolution of blood-feeding in bats.

submitted by Bill Schutt

e-mail: waschutt@amnh.org

from Alberta, Canada

The Bat Conservation Society of Canada is going VERY well! We had an incredible response to our recent renewal drive, and now have over 350 members across Canada! For the third year in a row, we have provided some financial support (albeit in a small amount) to a post graduate Canadian student studying bats. This year's recipient is Gillian Holloway from the University of Calgary who is working with *Myotis ciliolabrum* in the SE area of Alberta. She has discovered some interesting information pertaining to roosting sites and diet with respect to these bats!

We have been averaging over 100 phone calls to the Society (and the numbers are increasing now that the bats are back!) per month from people requesting information ranging from bat houses to diseases to found bats to exclusion techniques. Overall the Society is healthy and we are proud to be associated to all you "learned" types!!

submitted by Bob Young

e-mail: BCSC@cadvision.com

from Australia

I have pit-tagged almost 400 hand-reared or rehabilitated or wild Grey-headed Flying-foxes *Pteropus poliocephalus* over the last couple of years in the Gosford area in New South Wales. The automatic scanner covers the only hole in a cage filled with food and adjacent to my captive colony....the bats are squirming through the whole and the results are starting to come in. It is all extremely exciting! However my main interest with these animals is in their diet and nutrition...not that I have managed to do much in this field. I keep getting distracted by other projects!

submitted by Kerry Parry-Jones

e-mail: wambina@ozemail.com.au

from Finland

At the present time I am investigating the distribution and status of the Finnish bats. Forsten Stjernberg and Juhani Lokki are also working with me studying hibernation patterns of bats in Finland. I am also studying the variability in coloration of *Eptesicus nilssonii*, and working for the protection of bats in Finland. [this is part of a longer letter to GRH]

submitted by Olli Haukkovaara

e-mail: olli.haukkovaara@vkl.fi

from Australia

Bat research continues in our Vertebrate Palaeontology Lab here at the University of New South Wales in Sydney. Most of my batty interests have been taken up lately by the ever-increasing amount of mystacinid material recovered from Oligo-Miocene sites at Riversleigh in northwestern Queensland and Bullock Creek in northwestern NT. The dental and postcranial material is building a most interesting picture about mystacinid evolution and relationships. It strongly suggests that New Zealand's mystacinids come from Australia rather than South America, and that New Zealand's *Mystacina tuberculata* is the sole surviving member of a radiation of "mystacinoids". Another interesting addition to the Riversleigh bat list is a species of *Mormopterus* (*Hydromops*) which appears to be closely related to *H. nonghenensis* from Miocene sediments in Thailand. This paper has been submitted to the proceedings of the BioChroM 97 (biocorrelation) conference held in Montpellier, France in April, 97. Natalie 'noseleaf' Saville has finished her Honours research project on hipposiderid noseleaves and their value in phylogenetic analyses, and we hope to have a manuscript ready for publication shortly. Another student, Woo Je Ha from Korea, has begun investigating intraspecific morphological variation in a number of early Miocene hipposiderids from Riversleigh's Bitesantennary (sic) Site.

On another note, the CD-Rom on Australian prehistory that we have been working on furiously for the last 18 months has at last been pressed and is ready to hit the stands. Anyone interested in "Tales from the Kangaroo's Crypt: 3 Billion Years of Australian Prehistory" can contact me by email. (NB: this may have a different title for overseas markets).

submitted by Sue Hand

e-mail: d.morris@unsw.edu.au

from Illinois, U.S.A.

Tom Griffiths continues to work on his long-term project of describing the hyoid morphology of nearly every genus and most species of microchiropteran bats, using characters of the hyoid region to produce cladograms showing evolutionary relationships of bats to one another. He is rapidly nearing completion on the yinochiropteran side, but still has a very long way to go in describing all members of Karl Koopman's Yangochiroptera group. Meanwhile, in collaboration with students Jim Erickson (now a grad student in evolutionary biology at Cornell), Aimeé Rousseau, and Melissa Immel, he has been examining the hyoid morphology of other mammals, notably tree shrews, "flying" lemurs, and primates. It appears as though hyoid morphology will be exceedingly useful in sorting out systematic relationships within the primates, as well as in other orders of mammals.

submitted by Tom Griffiths

e-mail: tgriff@titan.iwu.edu

from Moravia, Czech Republic

Moravia is the smaller western part of the Czech Republic (CZ) and is situated in the heart of Europe. Due to its relatively warm climate and other ecological features it has a very good population of the lesser horseshoe bat, *Rhinolophus hipposideros*. I have been monitoring the numbers of hibernating *R. hipposideros* for about 40 years. The present census of hibernating bats is done visually without handling the animals and concerns, some 150 hibernacula, all of which are in Moravia. After a decline in the past, the numbers of *R. hipposideros* tend to increase since 1989 in nearly all hibernacula checked regularly where this species occurs. As an example following numbers per year were found in the Na Turoldu cave in southern Moravia, close to the state border with Austria (the first year = 1989, the last one = 1997): 116, 105, 124, 132, 142, 172, 208, 243, and 202. Various papers argue that bat populations, and horseshoe bat populations in particular, are influenced by climatic factors. In this respect it may be of interest that this summer has been quite unusual in Moravia and disastrous to humans. At the time of this report (21 July), from several regions in Central Europe, Moravia was the worst affected by floods which came in two waves. Forty six people were reported to have lost their lives and there were >2000 wounded as the result of these two floods. Many rivers and streams rose to extremes (hundred or even thousand year water) and the main river Morava (March) reached a level never recorded before. Continuous heavy rains were accompanied by unusually low temperatures for that time of year. I wonder to what extent this disaster has affected the horseshoe bats. The answer is expected as the result of next census in January-February 1998.

submitted by Jiri Gaisler

e-mail: gaisler@sci.muni.cz

from England

My main interest in bats has revolved around the production of Conservation Action Plans. In 1992 I published jointly with Tony Hutson and Paul Racey the Old World Fruit Bat Action Plan. Currently we three are working on an Action Plan for the Microchiropteran Bats which should be published this year. I am also interested in compiling information on the distribution and status of bats worldwide as well as taxonomic issues concerning bats.

submitted by Simon Mickleberg

e-mail: info@fauna-flora.org

from Kentucky, U.S.A.

The great floods in March of this year in southern Indiana and northern Kentucky have had a very serious impact on many species of mammals in the area, but most are expected to recover fairly quickly. The single exception is a population of Indiana bats, *Myotis sodalis*, which inhabit a cave in Carter County in northeastern Kentucky. The wintering colony numbered about 30,000 individuals but an estimated 3,000 died as a consequence of the flood. This is Kentucky's largest known colony of *Myotis sodalis* and represents a significant loss to this endangered species.

submitted by Nixon Wilson

e-mail: nixon.wilson@uni.edu

from Kentucky, U.S.A.

My colleagues and I have documented an interesting find on the maternity roosting habits of *Myotis septentrionalis*. The three sites cover two different types of habitat, and involve the use of 'bat boxes' within a managed forest (See, The Bat House Researcher, vol. (5) no. (1), 'Rocket Box' in Kentucky). We are now in the process of gathering cited reference on; (1) life history, and (2) roosting habits of *M. septentrionalis*. One of us (Dan Dourson, USFS) has discussed the observations with Dr. Wayne H. Davis. Dr. Davis is of the opinion that we could have some breakthrough information, indeed. If you are aware of any other researchers doing work with *M. septentrionalis* that are available for exchange of ideas, please return their names and/or email addresses in your reply.

submitted by Harold Burke

e-mail: burke_short@fuse.net

from New York, U.S.A.**REQUEST FOR ADDITIONAL NEWS!!!**

I am gratified by the strong response to our request for **NEWS**, (as in Bat Research News). We are always interested in what all of you are doing out there. Please drop me a line or two or a paragraph or more, about your latest bat research projects, travels, student activities, or if you are relatively new to our group, a few lines of introduction. Thank you in advance for your correspondence.

submitted by Roy Horst

e-mail: horstgr@potdam.edu

**The 27th Annual North American Symposium on Bat Research
will meet in Tucson, Arizona from October 8 to 12, 1997.**

Program Committee Chair: Thomas Griffiths

Local Committee Chair: Ginny Dalton

The meetings will be held at the Double Tree Hotel in Tucson, AZ.

The first call for papers was mailed in mid-June. All recipients of Bat Research News in the western Hemisphere will have received the registration materials by this date. All others should contact Dr. Griffiths at the earliest opportunity.

Contact addresses and numbers are:

Thomas H. Griffiths: e-mail> tgriff@titan.iwu.edu < tel. 309-556-3230

Ginny Dalton: e-mail> Plecotus@aol.com < tel.602-743-3941

Double Tree Hotel: tel. 1-800-222-8733 [no e-mail number given]

Note: When contacting the Doubletree Hotel be sure to mention that you are affiliated with the North American Symposium on Bat Research if you wish to receive the very large discount offered to the group.

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in Mexico, September 1997

Seventh International Theriological Congress

Acapulco, Mexico September 7-11, 1997

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 <

* * * * *

in Virginia, June 1998

78th Annual Meeting of the American Society of Mammalogists

will be convened from **June 6-10, 1998**

at **Virginia Polytechnical Institute and State University**

For more information see recent issues of Journal of Mammalogy, or contact H. Duane Smith, Life Science Museum, Brigham Young University, Provo, UT 84602-0200

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in Spain, July 1998

Euro-American Mammal Congress

to be held in Santiago de Compostela, Galicia, Spain

20-24 July 1998.

The first round of invitations to attend the were mailed on 10 March with a due date of 11 March, Luis Ruedas assures Batyologists that they are more than welcome Luis emphasizes that those individuals interested in organizing a symposium should contact him soon.

Luis can be reached at e-mail: lruedas@sevilleta.unm.edu or at the University of New Mexico and is a member of the Steering Committee. Questions concerning registration and other information should be directed to :e-mail: galemys@pinar1.csic.es

in Brazil, August 1998

11th INTERNATIONAL BAT RESEARCH CONFERENCE

Brasilia, Brazil

August 2-6, 1998

In order to promote scientific interchange and cooperation among bat researchers throughout the world, the 11th International Bat Research Conference is being organized by the Department of Zoology of the University of Brasilia. Technical sessions of the meeting will take place at the Pousada dos Pireneus Hotel, in Pirenópolis, a small, charming town near Brasília.

Meeting Location

Brasilia is the purpose-built capital of Brazil, located in the central region of the country. It is a new modern city, founded only 37 years ago, with its late twentieth century design and architecture that has caused UNESCO to declare the city a Human Heritage site. The Central Brazilian Highlands are a region of great ecological value, covered by approximately 2 million square km of tropical savanna known as "cerrado" that contains 80 species of bats. The climate is mild: the sun beating down hard at noon, but the air is cool by night. July corresponds to the cool and dry season when virtually no rain occurs and relative humidity may fall to less than 20%. Brasilia has an international airport with flights to and from the US, Europe and within Latin America. From Brasilia one can reach any part of the country by plane, by car or long-distance buses.

Scientific Content of the Meeting

The meeting will emphasize cutting edge and little known aspects of scientific knowledge regarding neotropical bat biology. However, contributions in any field of bat research in the world will be welcomed. The contributions will be grouped in sessions that will cover general subject matters, symposia, or workshops. The latter will deal mainly with subject matter focused for a more restricted audience. The themes currently projected for the general sessions are: Behavior and Communication; Conservation; Echolocation and Feeding Ecology; Ecology; Education; Evolution and Systematic- Morphology, Growth and Development; Physiology; and Reproduction.

Those individuals interested in organizing a symposium or workshop should contact ibrc11@guarany.unb.br or 11 IBRC, Caixa Postal 04474, Brasilia DF, 70919-970, Brazil. Papers contributing to general sessions are unrestricted in subject matter, while participants in symposia or workshops should get in touch with their respective conveners or organizers.

Site of the Meeting and Accommodations

The technical sessions will take place at the Pousada dos Pireneus Hotel, in Pirenópolis. Participants will be checked in at the Pousada dos Pireneus, a five star country hotel, at low prices for this event. There are other possibilities of even cheaper accommodation in town within walking distance to the meeting place.

[Brazil Symposium continued]

Registration Costs

Firm information regarding registration costs is not available at the present time but will be provided in the second circular. However, it is anticipated that rates will be held down to moderate levels. Students and those individuals who register early will enjoy a substantial discount in registration costs.

Correspondence

In order to facilitate communication among participants and organizers of the meeting and the sending of registration information and abstracts, the organizers call on all potential participants to use electronic mail whenever feasible. The electronic mail address to be used for all queries and requests is:

> ibrc11@guarany.unb.br <

To minimize the work load of the participants and organizers, future circulars will also be sent by electronic mail to those participants who request this option, and will also be distributed through a variety of distribution lists and List-servers.

Organizing Committee

Postal address for correspondence.-
11th International Bat Research Conference
Universidade de Brasilia
C. Postal 04474
70919-970 - Brasilia-DF, BRAZIL.
FAX number: 55-61-274-1141.

Conference Host

Jader Marinho-Filho, Universidade de Brasilia, Brazil

Program Directors

Wilson Uieda (UNESP, Botucatu, Sao Paulo) and
Ludmilia Aguiar (Universidade de Brasilia, DF)
[Bat Research News will publish all further announcements of this symposium]

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in Poland, August, 1999

VIII European Bat Research Symposium Krakow, Poland in August 1999.

Convener: Bronislaw W. Woloszyn
Chiropterological Information Center
Institute of Animal Systematics and Evolution, Polish Academy of Sciences
31-016 Krakow, ul. Slawkowska 17, Poland
Tel.: + 48-12-22-80-00, FAX: + 48-12-22-42-94
e-mail: woloszbr@isez.pan.krakow.pl

[Bat Research News will publish all further announcements of this symposium]

Directory of Bat Workers Worldwide

Please bear in mind the following as you use this directory.

1. This directory is certainly not complete.
2. e-mail numbers are subject to change. Some of these are undoubtedly no longer correct. It would be a herculean task for me to verify each on a regular basis.
3. Some e-mail systems differentiate between upper and lower case type in the address. If you try one of these numbers and do not get through, e-mail me, as I may have an updated address.
4. This directory will be revised as time passes and a new revised edition will be printed each summer.
5. Many have suggested that each entry include mailing addresses, telephone and FAX numbers and a very short clue about the individual's interests in bats. I agree that it would be nice to have that kind of data but this would be an enormous undertaking. Perhaps we may be able to do that in future, but for the moment this is beyond our budget. Do I hear any volunteers to help gather this sort of data? If so, you know where to call to volunteer.

If you have corrections, please e-mail them to me.

I hope you find the directory useful and convenient. G. Roy Horst

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BAT RESEARCH NEWS

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FRONT COVER

The drawing of a *Myotis* on the front cover is by Margaret Langworthy, presently of Jacksonville, FL. She gave the drawing as a gift to Eugene Studier, who includes it on his letterhead, and has kindly sent it along to us. Ms. Langworthy has a significant history with the bat group, as she was my technician in Arizona in the late 60's and assisted in organizing the first few North American Bat Symposia. She accompanied me on my move to the University of Vermont. After several years with me at UVM she became technician to Dr. Charles Woods, then at UVM, and moved with him to the University of Florida.

G.R.Horst



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Editors note: The following article may seem a bit esoteric to some of our readers but seems to be of great interest to others. While we prefer articles that concern the biology of bats, we have no feature length articles for this issue. We offer you the following article by Scott Pederson concerning the role that bats have played in military mythology.

Bats in Military Service: United States Air Force, Royal Air Force and its Commonwealth Air Forces

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This is the second of two articles providing information on bats that have served as military insignia in the armed forces. The first article dealt with bats that were enlisted as United States Navy and Marine Corps insignia (Pedersen and Siegfried, 1996). Here, I present further information (including Table 1 that was unintentionally omitted from the first article) on the use of bat-related insignias and weapon systems used by units of the United States Air Force, the Royal Air Force and its commonwealth air forces.

History

Like their cousins in naval aviation, pilots of the U.S. Army Air Corps, which became the United States Air Force (USAF) 1947, have included bats in their squadron's insignia because of the animal's remarkable ability to navigate and attack in the dark. Indeed, bats have been a popular design for nightfighter and reconnaissance squadrons in the air forces of the United States, England, and Canada since World War Two (WWII; Figs. 1-4, Tables 2 and 3).

Typically, squadron insignia are unique, designed to represent the unit, and even depict the unit's assignment (e.g., bomber squadron). Insignia are found painted on squadron aircraft and equipment, whereas cloth patches bearing the same design decorate flight jackets. Official insignias of the USAF conform to regulations governing size, shape, and the political-correctness of the design. However, ubiquitous, unofficial insignias vary in size and shape, and tend toward the humorous, irreverent, and even pornographic.

Bats in Uniform

Unlike U.S. Navy insignia that tend to utilize whole bats in the design, insignia of the USAF depict bat-winged objects such as bombs, skeletons, devils, and various animals (Table 2). Like the Navy, once a design is chosen (e.g., a bat) it may be shared among related squadrons in the same air group or combat wing, retained by a squadron for many years despite changes in their assigned mission (e.g., fighter to attack squadron), or reused by another squadron after the original unit is disestablished.

Bats have appeared in nose-art, or as aircraft nicknames painted on the sides of individual airplanes. For example, during WWII, the nose-art of a 6th Nightfighter Squadron Northrop P-61A-1 Black Widow depicted a large bat wearing boxing gloves on its hind feet (named "Jap Batty"), whereas the nose of another P-61A of the 548th Nightfighter Squadron was graced with a painting of Batgirl (named "Bat outa Hell"; Davis and Menard, 1990). A rather large bat was painted on the nose of a Consolidated B-24-G Liberator that flew as a crew-training aircraft during WWII (simply named "The Bat"; Davis, 1987). The words "Bat out of Hell" were painted on the noses of a 92nd Bomb Group B-17-F Flying Fortress and an 11th Bomb Group B-24-J (Lloyd, 1986), whereas another Liberator, named "The Blind Bat," flew with the 479th Antisubmarine Group. During the Viet Nam conflict, the Republic EF-105-F Thunderchief was the aircraft designated to fly "Wild Weasel" surface-to-air missile suppression missions. One of these aircraft flew with the 44th Tactical Fighter Sqd. ("Vampires") and displayed a caricature of a bat on its wing-root (named "Sinister Vampire"; Davis, 1993).

One group of particular interest was the 499th Medium Bomb Group that operated in the Pacific during WWII. Their unit flew the North American B-25 Mitchell that had taken part in the first bombing raid of Tokyo much earlier in the war, one of these being named "Lucky Bat" by her crew. This group was involved in ground-attack missions and anti-shipping strikes and each aircraft in the squadron had the entire nose section painted to look like the head, body, and wings of a huge bat.

Project Batty

Project Batty was an early attempt by the USAF to use remote-controlled, stand-off weapons to attack well-defended or "hardened" targets (Lloyd, 1986). This Project utilized the GB-4 glide bomb. This device was composed of a 2,000-pound general ordnance bomb strapped to a simple 600-pound glider that was 12 feet long with a 12 foot wingspan. As the bomb dropped away from the "mother-ship" (Boeing B-17G Flying Fortress) magnesium flares in the tail of the GB-4 would ignite to help the bombardier follow the trajectory of the bomb across his television screen/bomb sight. Though television was still in its developmental infancy, it was sufficient to aid the bombardier as he controlled the path of the glide bomb by radio-control. Late in WWII, Project Batty was used against German-occupied facilities at the port of LeHavre, France, with dubious success.

Royal Air Force and Commonwealth Air Force Bats

In direct contrast to the insignia employed by the USAF, USMC, and USN, bats that appear in the heraldry of the Royal Air Force (RAF), the Royal Canadian Air Force (RCAF), and the South African Air Force (SAAF) are relatively simple in design (Fig. 3). They are framed by a formal badge and must conform to strict heraldic guidelines (Mann, 1944; Moyes, 1964; Rawlings, 1969). Caricatures fall into four distinct types: pteropid-like animals - 153 SQD and 724 Unit, stenodermine-like animals - 9 and 966 SQD, vespertilionoid-like bats - 162 and 440 (RCAF) SQD, SCAAME, and animals meant to represent, but bear no resemblance to, vampire bats - 4 SQD, 25 Group, 203 AFS, 595 SQD (each of these squadrons were at one time equipped with de Havilland Vampire aircraft).

In summary, the majority of bat insignia depict either caricatures of bats or vertebrate chimeras that possess bat wings (Tables 1-3). However, several insignia deserve a special note as they designate a specific genus: *Myotis* — Strike Command Air-to-Air Missile Establishment, RAF; *Epomophorus*— VT-27 US Navy, unusual in that this genus is found in Africa rather than throughout the Philippines where the squadron was in fact stationed; *Vespertilio* — VQ-1 US Navy, "*Vespertillo militaris*," sic. It has been suggested that the "Cuban Fruit Bat" depicted in the earliest insignias of the United States Navy (VCS-2, VO-3, VS-5, and VS-6) was based on the well-known Bacardi rum label. This is unlikely because the USN bats are tail-less. However, this is not to say that Bacardi rum wasn't involved at some point in the decision making process.

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Table 1. Insignia of Navy and Marine Corps Units. Note that a single squadron may be represented throughout its lineage by many couplets, each reflecting a different squadron redesignation. Long-lived squadrons may or may not have used bat images throughout their commission. Text accompanying insignia is generally not described in the table. Abbreviations are: AW--All Weather; b--gunnery observation subunit; CAG--Carrier Air Group; CV/CVA--Aircraft carrier; Det.--Detachment; FAW--Fleet Air Wing; HL--4-engine, land plane; HS--Helicopter; HSL--Helicopter anti-submarine; RVAH-- Recon attack; VM--Marine heavier-than-air vehicle; s--scouting subunit; V--Navy heavier-than-air vehicle; VA--Attack; VAH--Heavy Attack; VAW--Carrier Early Warning; VAAW--All Weather Attack; VB--Bomber; VC--Composite Group; VC(N)--Composite Group (nightfighter); VCS--Cruiser Scout; VF--Fighter; VF(N)--Nightfighter; VMF--USMC Fighter; VMFA(AW)--USMC All Weather Fighter/Attack; VMS--USMC Scout; VO--Battleship Scout; VP--Patrol; VPB--Patrol Bomber; VQ--Fleet Air Reconnaissance; VS--Scout; VT--Torpedo; VT(N)--Night Torpedo; VW--Air Barrier (Distant Early Warning); VX--Aircraft Test/Evaluation.

A. Recon /Observation Units

Squadron	Description of Insignia
VAW-11	Bat caricature with 2 lightning bolts in feet (Fig. 1).
VAW-12, VAW-127	Bat silhouette flying over aircraft carrier and storm in a night sky.
VAW-12 (Det. 33)	Stylized bat over #12 and the planet earth.
VAW-12 (Det. 60)	Bat wings crossed by a red lightning bolt, superimposed on white disc.
VAW-111	Bat silhouette in front of lightning bolt and trident, circled by 7 stars (Fig. 1).
VAW-111 (Det. 31)	Anatomically correct bat, with radio signals leaving head.
VC(N)-2	Bat-winged skull wearing a flight helmet that emits radio-signals; all placed over bomb and machine gun.
VC-3	Bat silhouette on shield carried by lance-carrying bulldog, superimposed on thunderhead that emits lightning.
VC-11 (Det. Delta)	Bat caricature holding two lightning bolts in feet, superimposed over triangle.
VC-12	Bat silhouette flying over aircraft carrier and storm in a night sky.
VC-35 (Det. 24)	Bat caricature superimposed over single arrow and Russian submarine.
VC-35 (Det. Echo)	Bat caricature carrying tail-hook in hind legs, superimposed over an outline of Korea and the moon.
VCS-2, VO-3, VS-5, VS-6	"Cuban bat" superimposed over letter S, and the numbers 2, 3, 5, and 6 respectively.
VMS-3	Bat-winged devil.
VMSB-342	Bat-winged torpedo flying through explosion.
VP-4, VP-HL-4	Bat caricature carrying a bomb, with lightning bolts coming out of bat's eyes (Fig. 1).
VP-HL-13	Bat caricature standing on a round cartoonlike bomb, holding another aloft; all superimposed over #13.
VP-24	Batgirl (pin-up version) figure in front of ASW torpedo, superimposed over cutlass; insignia are trimmed by either blue or yellow rings.
VP-24 (Variant)	Bat-signal logo from Batman cartoon television series, in black on yellow background (Fig. 1).
VP-25	Bat caricature on round cartoonlike bomb, holding same aloft.
VPB-151	Bat caricature with devil's tail, with a bomb in its feet and small bombs at wing tips.
VQ-1	Bat caricature in front of globe, with lightning bolt passing behind and orbiting electrons on bat's chest (Fig. 2).
VQ-1 (Variant)	Bat caricature in front of globe and lightning bolt. Olympic 5-ring symbol adorns bat's chest.
VQ-1 (Variant)	Bat silhouette in front of lightning bolt and P-3 Orion aircraft.
VQ-1 (Variant)	Bat with electronic warfare symbol in right foot and lightning bolt in left foot; flying with a EP-3 Orion.
VQ-1 (Variant)	Bat flying in front of lightning bolt and globe. Reads: "Militaris Vespertillo, Desert Shield Air Recon, VQ-1 World Watchers".
VQ-1 (Det. Atsugi)	Bat caricature with lightning bolt passing in front, positioned above mountains. Several variations exist.
VQ-1 (Det. Atsugi)	Bat caricature in horse-harness, ridden by white knight chasing a kidney bean through clouds.
VQ-1 (Det. Atsugi)	Bat caricature wearing ear-muffs, scarf, long underwear, standing on a steam-radiator, in front of storm clouds.

- VQ-1 (Det. Atsugi) Bat silhouette with Russian hammer and sickle.
- VQ-1 (Det. Bravo) Bat caricature flying across white shield.
- VQ-1 (Det. Bravo) Bat silhouette in front of lightning bolt, Douglas A3D Skywarrior, and CV-61 (Ranger).
- VQ-1 (Det. Charlie) Bat caricature with #1 on chest, superimposed over globe and lightning bolt.
- VQ-1 (Det. Cubi Pt.) Bat caricature coming to abrupt halt, emitting lightning bolts from nose, in front of red, white, and blue disk.
- VQ-1 (Det. Diego Garcia) Bat silhouette superimposed over lightning bolt and outline of Diego Garcia, bat carries two fishing poles.
- VQ-1 (Det. Echo) Bat caricature with Lockheed EP-3 Orion; all over map of Middle East. Several variations exist.
- VQ-1 (Det. Echo) Bat caricature in front of lightning bolt, with orbiting electrons on chest; all placed below multi-national flags.
- VQ-1 (Det. Echo) Bat caricature superimposed over map of Middle East, holding U.S. flag and making obscene gesture.
- VQ-1 (Det. Echo) Small bat caricature above shield covered by map of the Middle East.
- VQ-1 (Det. Misawa) Globe superimposed over large bat silhouette (Fig. 2).
- VQ-1 (Det. Murphy) Bat caricature crashes into brick wall with a yellow explosion.
- VQ-2 Bat echolocating above clouds, carrying lightning bolts in feet (Fig. 2). Unit name: "Batmen".
- VQ-5 Stylized bat caricature superimposed over lightning bolt and purple disk.
- VQ-5 (Variant) Stylized bat caricature behind drawing of a Grumman ES-3A Viking; all in front of lightning bolt.
- VQ-5 (Variant) Stylized bat caricature behind outline of a Grumman ES-3A Viking.
- VQ-5 (Det. A) Pair of bat silhouettes on triangle, above American and Korean flags.
- VQ-6 Bat-signal logo from the cartoon series, but with the addition of two large breasts.
- VS-72 Bat-winged "Centaur-vampire," wrapped around Earth.
- VS-775 Bat caricature with lightning flashing from its eyes and carrying anti-submarine torpedoes.
- VW-14 Bat caricature with lightning bolt coming from mouth, flying over island, iceberg, and sun.

B. Attack and Fighter Units

- | Squadron | Description of Insignia |
|---------------------------|---|
| VA-13 (A), VA-134, VA-174 | Cartoon bat designed by Walt Disney; see VB-81. |
| VA-18 (A), VA-175 | Bat-winged devil, riding a hypodermic needle. |
| VA(AW)-35 (Det. Echo) | Caricature of bat's head and wings pictured above bomb, machine gun, and shield labeled "35 E." |
| VA-127 | Bat silhouette over torch and black and white disk. |
| VAH-13, RVAH-13 | Bat caricature on disk (Fig. 3). Variant: the word "tenth" stretched into a bat-shape. Unit name: "Bats." |
| VF(AW)-3 | Bat silhouette on shield carried by lance-carrying bulldog, stands on thunderhead that emits lightning. |
| VF(N)-90 | Batgirl (pin-up version) figure superimposed over full moon. |
| VF(N)-91 | Bat caricature with a witch's head, holding a knife in her mouth. |
| VF(N)-103 | Batgirl (pin-up version) figure superimposed over full moon. |
| VF-174 | Cartoon bat designed by Walt Disney, see VB-81 (Fig. 3). |
| VMF-312 | Bat-winged bulldog carrying cluster of machine guns. |
| VMF(N)-513 | Stylized bat on tail fin (patch unknown). |
| VMF(N)-541 | Bat caricature. Unit name: "Bat-Eyes." |
| VMFA-232 | Bat-winged devil holding a trident (bat-wings lost in later versions). |
| VMFA(AW)-242 | Bat caricature superimposed over lightning bolt (Fig. 3). Unit name: "Batmen." |
| VMFA-312 | Bat-winged bulldog carrying large rocket, all superimposed over a black and white, checkered banner (Fig. 3). |

C. Bombing and Torpedo Units

Squadron	Description of Insignia
VB-81	Cartoon bat designed by Walt Disney. Bat is dropping two bombs, and head resembles a folding razor adorned with horns; machine gun projects from mouth (original use of this design). Unit name: "Hell razors."
VT-27	Flying fox (Epomophorus) carrying two bombs.
VT-82	Bat-winged devil riding a hypodermic needle.
VT(N)-90	Cartoon bat (cute) riding a falling bomb; designed by Walt Disney.

D. Miscellaneous units

Squadron	Description of Insignia
CAG-81 VB-81	Design appears with two others on this CAG-81 collage patch.
FAW-4	Bat silhouette flying over ocean into Japan's Rising Sun.
HS-443	Bat silhouette with "BATATTITUDE" written across chest.
HSL-44 (Det. 3)	Bat-signal logo from Batman cartoon/television series presented above #442, #446, #5 and reversed #5.
VMFT(N)-20	Bat caricature with lightning bolt crossing in front.
VT-11	Bat-winged and bat-headed devil puppeteering a small training aircraft.
VX-5, VX-9	Bat silhouette superimposed over lightning bolts, sun, moon, and explosion (Fig. 2). Unit names: "Vampires."
FAWTULANT	Bat-winged owl flying among storm clouds (Fleet All Weather Training Unit - Atlantic).
NAEC	Bat-winged "unknown" with long tongue over vertical chevron (Naval Aviation Engineering Center).
Unknown unit	Bat caricature echolocating from mouth in four directions. Reads: "3 SQN, Air Wing 3, "Night Dipper."
Unknown unit	Bat-winged Tomcat (caricature) standing over "A+."
Unknown unit	Caricatures of a bat and kangaroo, placed on map of Australia. Reads: "Pitchblack '91, Bats Down Under."

Table 2. Insignia of United States Air Force Units. Note that a single squadron may be represented throughout its lineage by many couplets, each reflecting a different squadron redesignation. Long-lived squadrons may or may not have used bat images throughout their commission. Text accompanying insignia is generally not described in the table. Squadrons numbered 100-199 belong to Air National Guard units. Abbreviations are: AS--Attack; AS--Anti-submarine; BS--Bombardment; CCTS--Combat Crew Training; ESS--Elect. Surveillance; FS--Fighter; FWg--Fighter Wing; IS--Intellegence; NFS--Nightfighter; RS--Reconnaissance; RWg--Reconnaissance Wing; TASTS--Tactical Air Support Training; TCF--Tactical Recon Flight; TCS--Tactical Command; TFS--Tactical Fighter; TFTS--Tactical Fighter Training; TS--Training; TRS--Tactical Reconnaissance.

A. Recon /Observation Units

Squadron	Description of Insignia
3rd AS	Bat caricature, flying over flames.
27th RS	Cloaked bat-man caricature, riding an aircraft above cloud formation.
43rd RS	Cartoon bat, wearing crash helmet and holding camera.
91st RS (TRS)	Bat-winged devil, carrying trident, chased by mounted Knight into sunset.
107th RS	Bat-winged devil, carrying trident.

488th IS Bat silhouette, above EC-135 aircraft and outline of Britain.
 728th TCS Bat caricature with lightning bolts leaving ears, above Earth.
 6988th ESS Bat silhouette in front of bull's eye.

B. Fighter Units

Squadron	Description of Insignia
1st FS	Batgirl (cartoon "Furie") holding skull, perching on cloud.
44th FS	Bat-winged bat head. One variant reads: "Bats rule the night - Vampire Vision."
44th TFS	Bat-signal logo from the Batman television cartoon series. Unit name: "Vampires."
132nd FS	Bat-winged skeleton, carrying a bomb.
186th FS	Bat-winged devil, holding trident.
399th FS	Bat caricature with dragons head.
422nd NFS	Bat caricature, wearing flight goggles, carrying dagger and pistol; encircled by stars grouped 4-2-2.
423rd NFS	Cartoon bat, carrying a machine-gun.
549th NFS	Horned bat caricature with lightning bolts coming from eyes, carrying machine guns with it's feet.

C. bomber Units

Squadron	Description of Insignia
39th BS	Bat silhouette in front of hemi-bulls-eye, Strategic Air Command ribbon, and lightning bolt. Motto: "Per tartarum ad metam" (Through Hell against the target).
40th BS	Bat-winged bomb.
318th BS	Silhouette of bat-winged male figure, holding several bombs and throwing another.
335th BS	Bat silhouette with lightning bolts coming from eyes; carrying bombs in it's feet.
374th BS	Bat-winged devil carrying bombs with its feet.
382nd BS	Bat-winged skeleton carrying bomb.
392nd BS	Bat wings on a falling bomb.
449th BS	Bat-winged bomb with grinning face, designed by Walt Disney.
465th BS	Bat-winged devil, wearing goggles; standing on a cloud emitting a lightning bolt.
498th BS	Lizardlike caricature of bat, snorting steam and holding bombs in it's feet.
499th BS	Devil-like bat caricature riding a flaming bomb. Note: When this Sqd. flew the B-25 Mitchell, the noses of their aircraft were painted to resemble large bats.
601st BS	Bat-winged human infant, carrying a trident and wearing goggles, helmet, and halo.
650th BS	"Demi-batman" holding a bomb over head.
819th BS	Bat caricature flying over flames.

D. Miscellaneous Units

Squadron	Description of Insignia
1st TFTS	Batgirl (cartoon "Furie") holding skull, perching on cloud.
57th FWg (Det. 3)	Bat silhouetted in front of bull's eye.
57th FWg	The 57th WG, Det. 3 insignia appears among three other unit insignia on this 20-year patch.
108th TCF	Bat silhouette above 8-spoked wheel, superimposed over the Earth.
422nd TS	Bat caricature, wearing flight goggles, carrying dagger and pistol; encircled by stars grouped 4-2-2.
502nd Airborne Inf. Regt.	Bat-winged skull with parachute.
534th TS	Bat caricature, hovering above open text book, Earth, and seven orbiting stars.
541st Airborne Inf. Regt.	Bat-winged panther.
549th TASTS	Bat caricature, emitting lightning bolts from eyes.
553rd RWg	Bat-winged "Batcat," running across globe.
4417th CCTS	Bat silhouette, superimposed on chart divider.

Table 3. Insignia of Royal Air Force and its Commonwealth Units. Each squadron is represented by a single couplet. Long-lived squadrons may or may not have performed the same role throughout their commission. One idiosyncrasy of the British notation system is that the correct reference is "Seven-two-four Squadron," rather than "724th Squadron." Abbreviations are: RCAF--Royal Canadian Air Force; SAAF--South African Air Force.

Squadron	Description of Insignia
4 Sqd. Fighter	Cartoon bat with blood dripping from fangs, in front of shield bearing a cross (SAAF).
9 Sqd. Bomber	Anatomically correct bat. Motto: "Per noctem volamus" (We fly through the night).
34 Sqd. Bomber	Bat-winged torch bearing numerals XXXIV, flanked by bomb and mine (SAAF).
153 Sqd. Nightfighter	Anatomically correct bat, in front of 6-point star. Motto: "Noctivudus" (We see by night).
162 Sqd. Anti-radar	Bat's head, in front of shooting star.
203 Sqd. Training	Anatomically correct bat, in front of shooting star.
440 Sqd. Recon	Anatomically correct bat, in front of cloud (RCAF).
595 Sqd. Anti-aircraft	Anatomically correct bat, in front of crossed arrows.
724 Sqd. Signals	Anatomically correct bat, in front of half-disk of the sun. Motto: "Search by day or night."
966 Sqd. Signals	Anatomically correct bat, in front of lightning bolts. Motto: "Eyes of defiance."
25 Group	Anatomically correct bat, in front of mace and meteor.
SCAAME	Anatomically correct rendering of Myotis, in front of red disc and arrow-head (Strike Command Air-to-Air Missile Establishment).
SSOC	Malayan Bat Mask in front of Kris sword (Southern Sector Ops Centre, Singapore). Motto: "Menehari dengan sunyi" (Silently we seek).

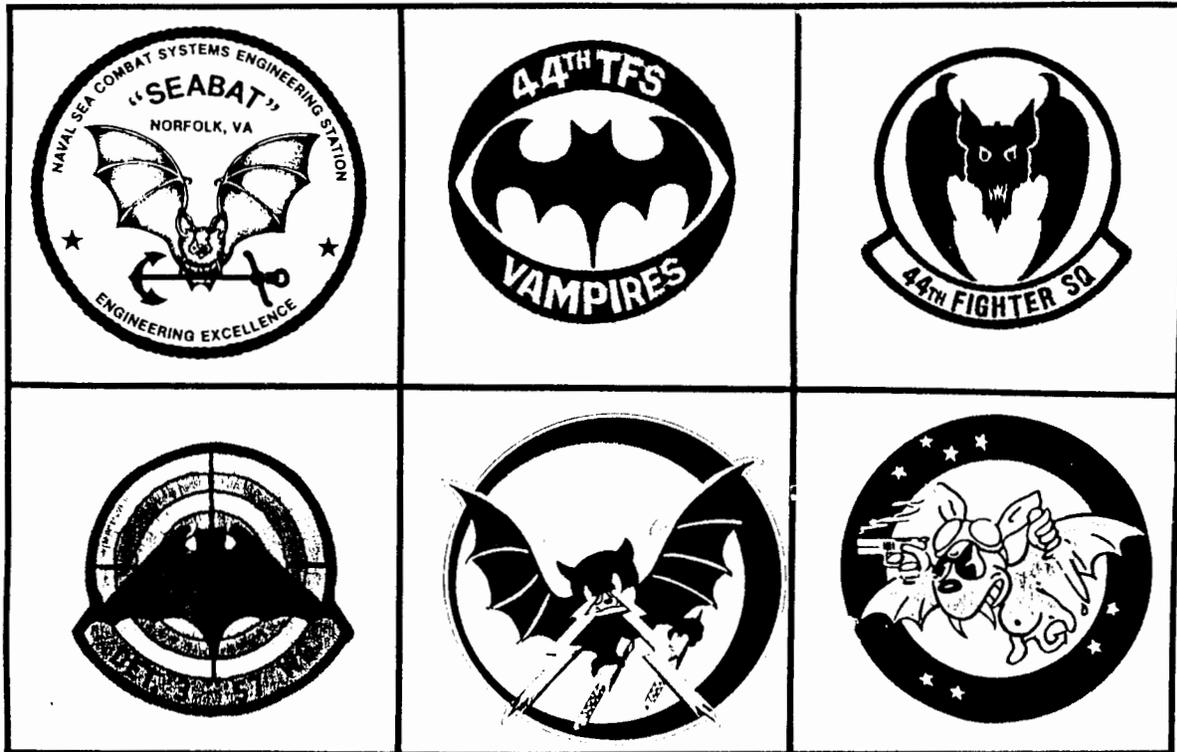


Figure 1.—Air Force Fighter Squadrons: Clockwise from upper left, "SEABAT", Naval Engineering Station (from Horst, 1992), 44th TFS, 44th FS, 422nd NFS, 549th NFS, 57th Fighter Wing.

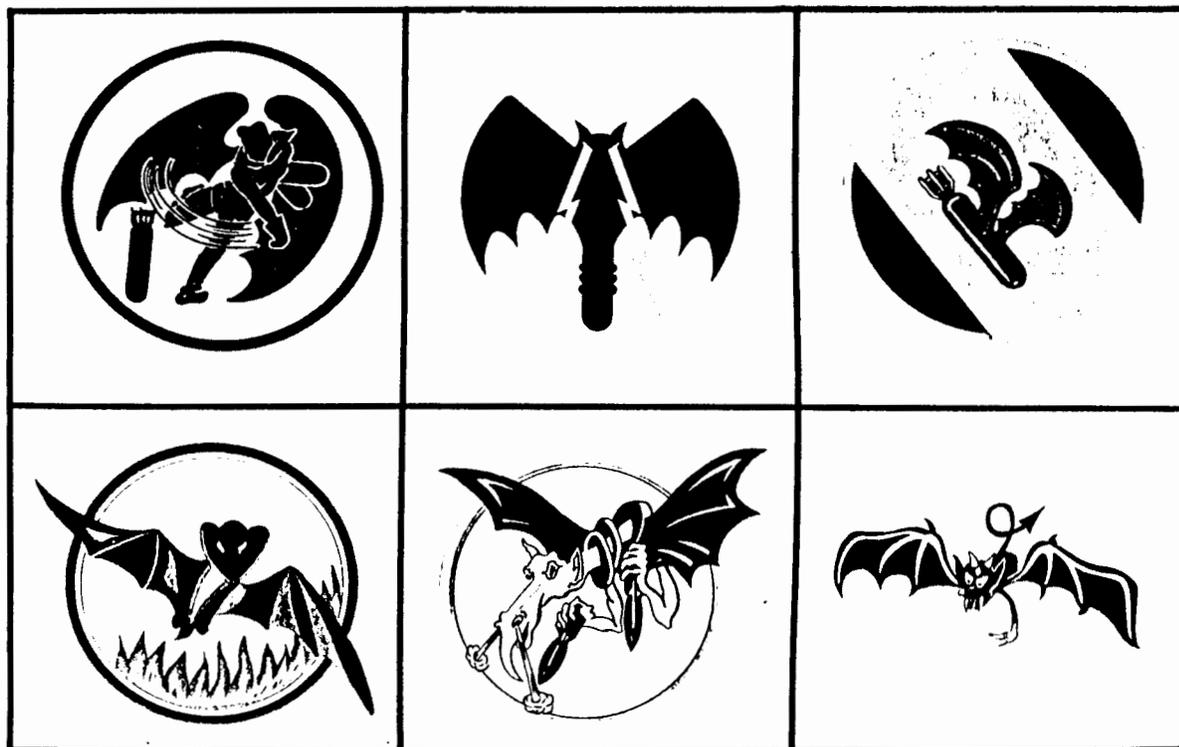


Figure 2.—Air Force Bomber Squadrons: Clockwise from upper left, 318th BS, 335th BS, 392nd BS, 499th BS, 534th BS, 819th BS.

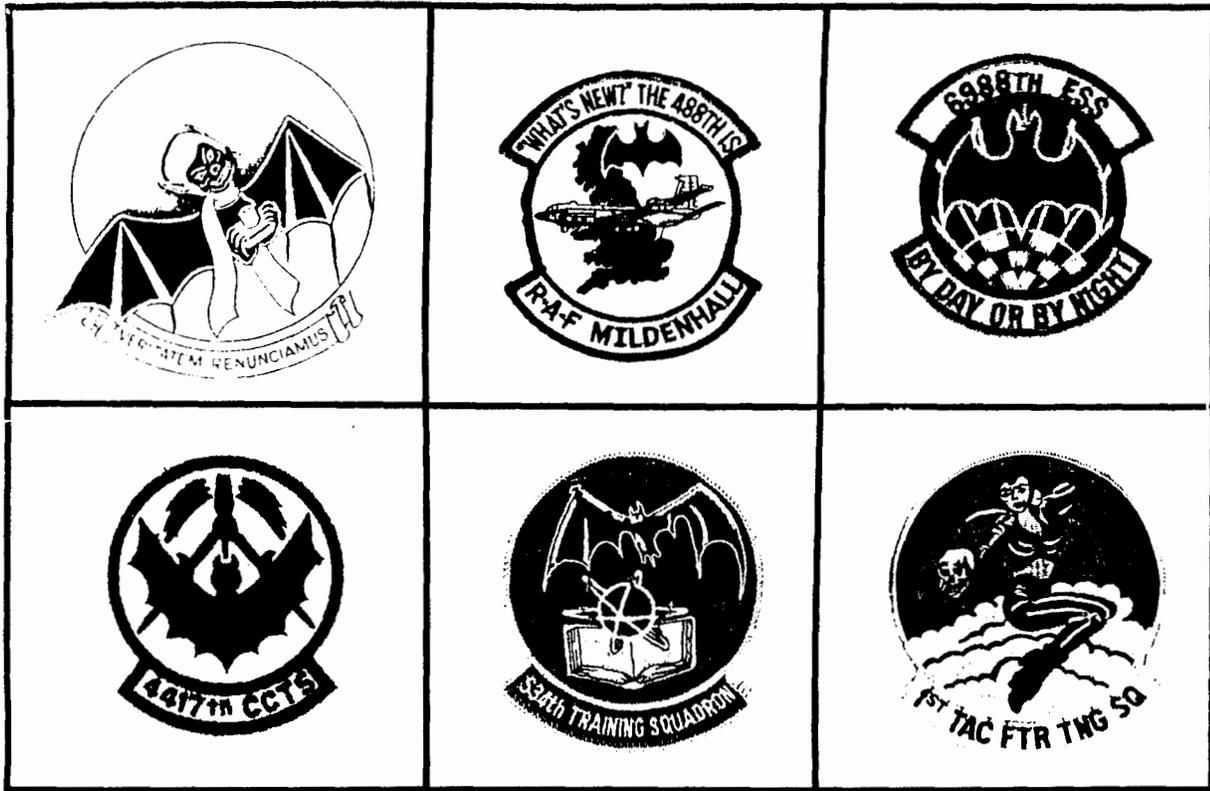


Figure 3.—Air Force Reconnaissance, Intelligence, and Training Squadrons: Clockwise from upper left, 43rd RS, 488th IS, 6988th ESS, 1st Tactical Fighter Training Squadron, 534th TS, 4417th Combat Crew TS.

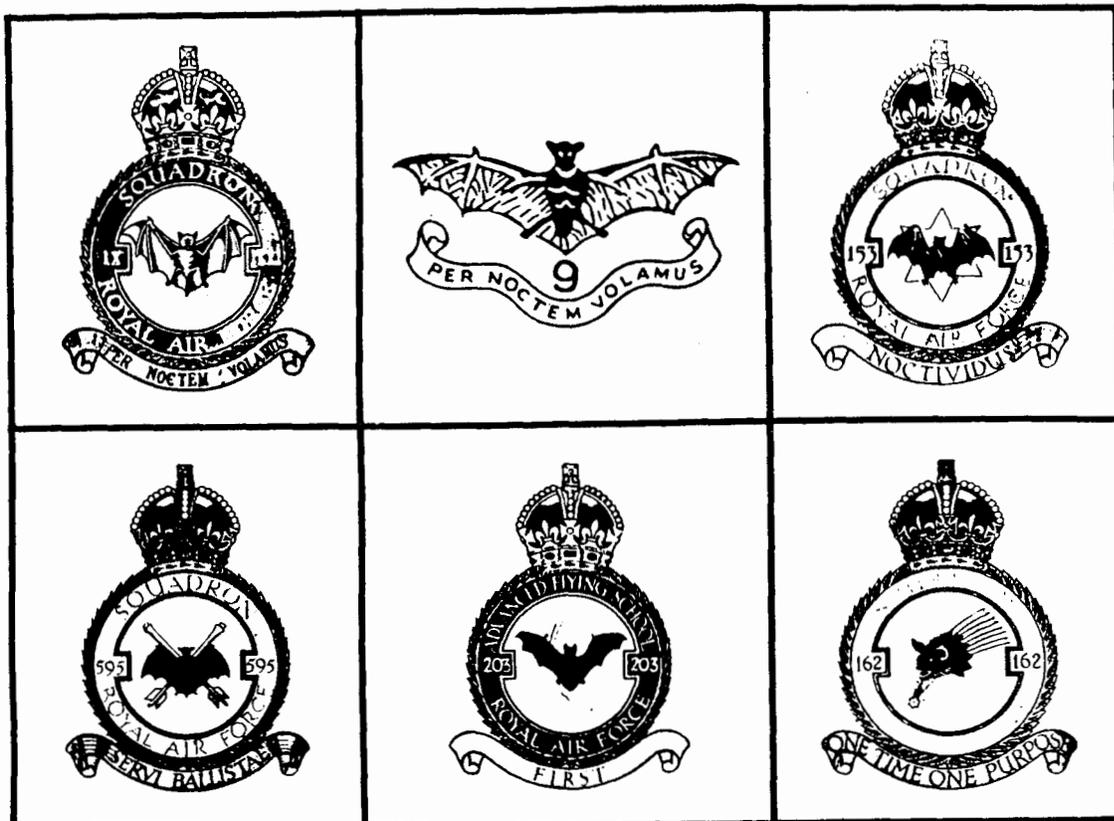


Figure 4.—Royal Air Force Squadrons: Clockwise from upper left, 9th Bomber SQD, 9th Bomber SQD (early), 153rd Nightfighter SQD, 162nd Anti-radar SQD, 203rd Adv. Training School SQD, 595th SQD.

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 sent to Alan Kurta, Feature Editor or Roy Horst, Managing Editor. Letters can also be sent by e-mail to the addresses which appear inside front cover.

Notes Related to Bats and Foraging in the Central Oregon Cascade Range

The spruce budworm *Choristoneura occidentalis* is a defoliator that can severely impact commercial forests. In 1993 The United States Forest Service decided to forego spraying for western spruce budworm using a biological insecticide, *Bacillus thuringiensis* var. *kurstaki* (Btk) in the Santiam Pass of the Oregon Cascade Range. This decision was based on the unknown effects of Btk on non-target Lepidoptera (moths and butterflies) species because of the potential indirect effects to Townsend's big-eared bat *Corynorhinus townsendii* which is thought to preferentially feed on Lepidoptera (Whitaker et al. 1977, Whitaker et al. 1981, Clark et al. 1993). While the biological evaluation solely addressed Townsend's big-eared bat because of its status as a State and Forest Service Regional (Oregon and Washington) sensitive species, other insectivorous bat species in the area also are known to forage on Lepidoptera (Belwood and Fenton 1976, Whitaker and Lawhead 1992). The Biological Evaluation was insightfully orchestrated by Forest Service Biologist Cheryl Friesen with assistance from Mike Gerdes, Ron Archulata, and Kathy Johnson.

The decision to abstain from spraying Btk triggered an in-depth study by Oregon State University on the effects of Btk on non-target Lepidoptera species (Miller 1995a). The study included an assessment of species richness and abundance for Lepidoptera on lands adjacent to U. S. Forest Service land in treated (sprayed with Btk) and untreated (not sprayed with Btk) forest stands and addressed the application of results to the diet of Townsend's big-eared bat. The report is long (236 pages) because it includes several data sets and complex details of Lepidoptera and host plant associations. In short, the results of this study indicate that non-target Lepidoptera are significantly reduced in treated stands and that 33-67% of the species component (richness) was lost from spraying Btk. During the larval stage (caterpillar), many of the Lepidoptera species are associated with species-specific host plants. Additionally, snowbrush (*Ceanothus* spp., especially *Ceanothus velutinus*), green leaf manzanita (*Arctostaphylos patula*), and ocean spray (*Holodiscus discolor*) hosted large numbers of caterpillars and may be good indicator host plants for monitoring purposes of Lepidoptera populations, or could be used for habitat restoration. Miller concluded that if Townsend's big-eared bat relied on the 33-67% of nontarget Lepidoptera species affected by Btk it would be affected in areas of spraying and if females depend on these species under conditions such as nursing young they may be forced to forage longer and further from their roosts.

What I also find of interest is the relation of caterpillar abundance with the presence of *Ceanothus* spp. This plant genus is associated with early seral conditions and can be a main component of vegetation initiation after disturbance regimes such as fire. For the many bat species we have that are snag roosters, it's possible that fire creates a positive ecological spike for these species - because a large number of potential roost sites with excellent solar exposure are available and they are surrounded by a concentrated food source.

Miller (1995b) developed a handbook with a key and pictures of caterpillars of the Pacific Northwest which is available through the U. S. printing office.

Another note related to foraging and bats: Some forest-dwelling insects are known to have symbiotic relations with fungi, carting them around to help breakdown cellulose in woody plants that the insects feed on. I collected guano samples (in 1995) from 30 female bats, primarily long-legged myotis and little brown bats, that were night roosting under 3 bridges in the central Oregon Cascades during the summer of 1994. I was curious to see if fungal spores could be detected in the guano implicating bats as spore dispersers. Dr. Jim Trappe and Efren Cazares, mycologists from Oregon State University, were kind enough to assuage my whim and spent a portion of a morning with me peering at bat guano through their microscopes. We found no fungal spores in any of these samples. Dr. Trappe suggested that collecting

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guano with the intent of detecting fungal spores may be more appropriate during Spring or Fall, rainy periods when the fruiting bodies of fungi are more apt to be present than in Summer.

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Diurnal Foraging of Phyllostomid Bats in Southeastern Brazil

A striking feature associated with bats is that most of their foraging is nocturnal. In a recent review, Speakman (*Symp. Zool. Soc. London*, 67, 1995) pointed out that the nocturnal habits of bats cannot be explained by a single evolutionary pressure, such as predation, competition, or thermoregulation. Although bats are nocturnal foragers, some species do fly by daylight (Speakman, 1995). Diurnal activity has been reported for some flying foxes (*Pteropus* spp.--Cox, *Mammalia*, 47:519-523, 1983; Tideman, *Aust. Mammal.*, 10:89-91, 1987; Brooke and Thomson, *Bat Research News*, 36:52, 1995), as well as for insectivorous bats from temperate regions (Speakman, 1995). Apparently, there are no reports of diurnal flights for neotropical bats, especially frugivores, and in this report we describe diurnal flights by some phyllostomid bats.

Observations were made at Reserva Florestal da Companhia Vale do Rio Doce, located in Linhares Municipality, Espírito Santo State, southeastern Brazil (19°06'-19°18'S; 39°45'-40°19'W). The area is a 22,000-ha fragment of Atlantic Forest. The climate is characterized by the presence of a moderate dry season (May-September) and a wet, hot one (October-April, with annual rainfall of 1,300 mm and mean annual temperature about 23°C (Jesus, A Reserva Florestal da CVRD. *Anais do VI Congresso Florestal Estadual, Nova Prata, Rio Grande do Sul*, 1:59-112, 1988).

From 10 to 13 July 1996, we saw bats flying during the day around the canopy of a fig tree (*Ficus* sp.: Moraceae) about 15 m tall. Conditions were sunny and clear, allowing good viewing of the bats. We observed the bats for a total of 18 h, over 3 consecutive days--on the 1st day from 1600 to 1800 h, and on the 2nd and 3rd days from 1200 to 1800 h. The bats were first observed from the ground, but by using climbing devices, we reached the canopy, making possible closer observations, approximately 1 m from the bats. Although we could not identify them to species, we could clearly see that there were three individuals from the genus *Artibeus* (Phyllostomidae: Stenoderminae). They were approximately the size of *A. jamaicensis*, *A. planirostris*, *A. fimbriatus*, or *A. lituratus*; each of these species is similar in body

size (forearm length: 56-82 mm), and all are reported for the study area (M. Zortéa, pers. comm.).

Bats were flying around the fig tree, taking fruits at regular intervals and performing the same behavior described for nocturnal foraging. After approaching the fig tree, bats circled the branches, looking for ripe figs on a branch with both ripe and unripe fruits. The bat made repeated approaches to a given branch, about two or three, after which it landed very briefly, before taking the ripe fig away to a nearby feeding roost. We located the feeding roost about 50 m from the fruiting fig, and with a binocular device, we could see the bats hanging and eating the fruits.

Diurnal flights by bats can be the result of disturbance at a roost or general behavior. The flights that we observed, however, were clearly associated with both foraging and feeding. It is possible that the bats we observed experienced a shortage of fruit, and diurnal foraging was essential to avoid starvation. Such a behavior would be consistent with the risk-averse hypothesis (Speakman, 1995), namely that in some situations, diurnal flights would be a profitable strategy to adopt. Besides having a longer period to forage, this group of bats is certainly taking figs before other bats and, for a non-renewable resource such as fruits (Marinho-Filho and Sazima, Rev. Bras. Biol., 49:777-782, 1989), such a behavior could yield a considerable advantage over interspecific competitors.

We would like to thank to B. Fenton and F. Olomos for their critical comments and suggestions, and to Companhia Vale do Rio Doce for the logistical support. D. Faria was supported by CNPq.

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Rehabilitation and Conservation Measures Concerning the Indian False Vampire Bat, *Megaderma Lyra*

Indian false vampire bat *Megaderma lyra* is often eclectic in its selection of day-roosting sites, which are found mostly in large dark caves, ruined and unfrequented temples and old dilapidated and abandoned buildings. Our decade-long survey has shown that these bats prefer to roost close to human habitation, especially those areas where agricultural activities are intense and irrigational facilities are well developed. This would seem an ideal habitat where the bats feed on a rich and varied diet, ranging from large insects swarming the fields and dung pits, to smaller vertebrates such as geckoes, frogs, small birds and rodents of the fields and ponds (Balasingh, 1990). Our main study area is the site at Krishnapuram, a village in Tirunelveli District, Tamil Nadu, South India (8° 44' N, 77° 42' S). The centuries old temple at Krishnapuram, beside housing one of the masterpieces of the sculpture's art has also been the favourite roost for over 350 false vampire bats for many years. This colony of bats first came under our investigative scrutiny in 1986. Since then several studies have been carried out on this population including mark and recapture studies (Balasingh, et al. 1992), studies on social behaviour (Balasingh, et al. 1993), foraging behaviour (Audet, et al., 1991, Subbaraj and Balasingh, 1996) breeding behaviour and post-natal development (Balasingh, 1990). Since 1986 there has been a drastic reduction in numbers of this colony from 350 to 150.

Modernization involves urbanization and in the process there are bound to be drastic changes in the habitat. Recent renovations of the old abandoned temples and ancient unfrequented historical buildings has been accompanied by increased human activity and resulted in insensate slaughter of many of the bats. We have made an attempt at rehabilitating the survivors of this destruction, transferring some of them to safer roosts which include the upper tiers of temple towers. These bats are fitted with collars bearing reflecting tapes making it possible to monitor their progress in their new locales. Results have been encouraging. Over 90% of the new arrivals are doing well in their new environment. We have also rented old dilapidated buildings for large colonies of bats to roost. Field assistants keep watch and hired helpers keep intruders out. By educating the farming community on how beneficial the bats are in destroying insects, rodents, and other pests, we created a sympathetic environment for these species which before this were not always seen in the right perspective. A proper climate for further research has been created.

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Submitted by J. Balasingh¹, S. Suthakar Isaac¹, J. King Emmanuel¹,
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News from our colleagues

from Regina, Saskatchewan, Canada

Some news of my goings on in the past year. I spent July 1996 - June 1997 on sabbatical leave working with Fritz Geiser at the University of New England in Armidale NSW Australia. Fritz is well known internationally for biochemical, and physiological work on the use of torpor and hibernation by a variety of mammals. He proved to be a most excellent host which contributed largely to the work that I was able to accomplish. Armidale is about half way between Sydney and Brisbane, 150 km or so inland from the coast and virtually straddling the Great Dividing Range. At 1000 meters above sea level, the climate was classified as temperate (in real terms), frigid (by Aussie standards) or tropical (by western Canadian standards!).

The main focus of my research was to investigate the use of torpor by some "almost bats" called Australian Owlet-nightjars (*Aegothele cristatus*; Aegothelidae). These birds are relatives of goatsuckers, about the same size as poorwills (50 g), but they roost and nest in tree cavities. The gist of my findings was that like bats and poorwills, torpor is employed outside the period when there are dependent young or eggs (= gestation). Unlike bats and poorwills, torpor tends to be shallow and the lowest T_b recorded was only 25°C. As a consequence of having radio-tags attached, I also collected data on roost site selection (relative to random trees, the birds choose trees with cavities near to the ground, trees with many cavities and trees that are close to other trees with cavities). Like bats, the birds switch roosts regularly for reasons unknown. From a foraging perspective, they are not influenced by moonlight to the degree exhibited by poorwills or whippoorwills.

Since we were netting in the forest at night we also caught bats and opportunistically conducted two projects which I talked about at this years bat meetings in Tucson. We compared the foraging behaviour of two Australian long-eared bats *Nyctophilus gouldi* and *N. geoffroyi* based on light-tagging data. As predicted, these two species (8 and 10 g respectively) which have statistically indistinguishable wing morphologies, fly in the same types of habitats. Unlike our predictions, light-tagging data suggest that gleaning is not a common strategy of these bats. I also made use of Fritz's expertise and we conducted metabolic work on the two species showing that they could both drop T_b in the lab to 2 degrees for extended periods of time. This resulted in >95% metabolic energy savings. It remains to be seen whether these animals truly hibernate for the winter or just use periodic torpor. Fritz is also working on bats-Blossom bats (tiny Pteropodids) - *Syconycteris australis* and *Macroglossus minimus* trying to determine if the ability to enter shallow torpor effects distribution range.

By way of students in my lab who were forced to cope (celebrate) at my absence. Paul Bradshaw finished up a M.Sc. degree on vertical stratification of forest levels by bats on Vancouver Island. Paul hopes to continue on to do a Ph.D in the lab, but that is dependent on funding from the forestry sector. Chris Woods' work on the use of torpor and hibernation (?) by those almost bats, Common Poorwills is currently ongoing. He is actually living in Tucson and working a several sites nearby where poorwills are year round residents and migrants. Torpor seems to be a regular component of the behaviour of these birds in this part of their range through all seasons which isn't than at the northern edge of their range in Canada.

Submitted by R. Mark Brigham

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from Ontario, Canada

Despite working full-time for an NGO bird conservation/research organization (Bird Studies Canada/Long Point Bird Observatory) I have been continuing my bat research in South-east Asia (at least they both fly...). Since 1995, with support from the Wildlife Conservation Society (WCS), I have carried out surveys for 3-5 weeks per year in various areas in Laos PDR (that little land-locked country squeezed between Vietnam, Thailand and Cambodia). So far, these have produced some very exciting results, with no end in sight to new discoveries. We've captured about 75 species of bats, of which at least 6, and probably closer to 10, are undescribed species. Several more represent previously unrecognized species (e.g. 2 or more described "subspecies" occur sympatrically in Laos, indicating they are obviously separate species).

The Annamite Mountains, which are shared by Laos and Vietnam, have become famous for the numbers of new large mammals that have been discovered there recently. Our bat surveys indicate that there is an even greater diversity of unknown bat species in the region.

I have several collaborators in this work. Joerg Habersetzer and Dieter Koch at the Senckenberg in Germany are assisting with analysis of echolocation calls and descriptions of some of the new species, especially the horseshoe bats. Mark Engstrom and his colleagues at the Royal Ontario Museum are assisting with study of some of the other taxa. Toni Guillen has joined me in the field in both 1996 (in Malaysia) and 1997 (in Laos) and is analysing DNA sequences from the horseshoe bats to study their phylogeny as part of his post-doctoral fellowship at the University of Missouri. We also hope to get somebody involved in analysis of the fecal samples we collected from most of these bats for dietary studies. We plan to continue further surveys in additional areas in Laos in 1998.

Submitted by Charles M. Francis

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from Ithaca, New York

This summer not many of the Cornell bat group are on campus so it's rather quiet. Wilson Uieda is preparing to finish his work here and return to Brazil. He is already heavily involved in planning and organizing the International Bat Conference to be held there in August.

Claudia Coen is in Columbia working on vampire bat nutritional physiology. She had returned to Cornell briefly in May, but has returned to her laboratory at the Istituto Agroprecaurio station in Palmira. One of her efforts includes a project on the regional distribution and abundance of vampires in the Cauca Valley.

Nina Ingle has been working for an extended period in the field in the Philippines. Her work is taking her farther into the field of botany as she is training herself to look more intensely into the floristic side of the story about the role of fruit bats in reforestation patterns. She claims to avoid being "sidetracked" by the nearby colony of over one thousand flying foxes while she compares the diets of and seed dispersal services of fruit bats and frugivorous birds. On a more poignant note, she offers that the above mentioned flying foxes fit closely with the nutritional plans of the local human inhabitants. A public education effort is underway but has a great distance to go to achieve success.

I (John Hermanson) have been away since January on sabbatical leave working with Ron Terjung at the medical school in Syracuse, New York. That's just far enough away from Ithaca (90 km) so I can't attend

Hermanson continued...

departmental meetings! We are studying the mechanisms of muscle breakdown, as opposed to normal muscle structure and function.

We are most pleased with the outcome of the initial phase of the Cornell Community Bat Project. As do many readers of Bat Research News, we get constant requests from homeowners to come out and look at their bat "problems". Sometimes in triaging these requests, I wish we had a better way of getting straight to the more interesting or manageable cases, as opposed to the occasional homeowner who has one transient bat in the attic (i.e., a crisis!) or the homeowner who has a significant number of bats in the attic (also a crisis!) but won't listen to your advice anyway (a tremendous crisis!). Claudia Coen was responsible for pulling together a small group of undergraduate students who are interested in bats and biology. In March of 1996 the students were graciously treated to a training session about bat biology and bat banding at the Luce Foundation in Florida. Starting in May two local *Myotis lucifugus* roosts were studied for two nights weekly, until the bats departed for their winter hibernacula. Both were maternity roosts and had come in conflict with the human cohabitants. In both situations the human occupants were interested in the long term welfare of the bats. Strategies for bat exclusions were discussed among the students and our hosts, and plans for studying both colonies during this transitional year (as exclusion plans were implemented) were developed by the students. Approximately 400 of these bats were banded. We plan to follow up with future nettings in the neighborhoods to determine if we can track any of the bats. Exclusion was initiated after all females and young had left the roosts to prevent any unwanted mortalities. We would like to determine if the animals remain in adjacent structures and feeding areas. Milo Richmond and I served as faculty advisors.

The students learned a great deal about the pitfalls of designing and carrying out field studies with these animals. Some of the activity of our first netting night of the season in 1996 was recorded by CNN (television) for airing on their science news programming. But, even with university administrators fretting about every little interpretation of public relations, animal welfare, and dirty fingernails, the students and faculty weathered the storm quite nicely. I actually cut a bat out of an old trustworthy mist net rather than have the cameras home in on one poor bat that had managed to tie a bird's net (or bat's nest) into the nylon. Audrey Taylor was the principal coordinator of the nightly studies and recently graduated with Honors in recognition of her study on activity patterns and demographics of the two roosts. If a major objective was to expose the student to the conflicts inherent in conservation biology and public health issues, I think the first run through the project was a success. I hope we will see another generation of students share this experience as well. Claudia and I return from our travels.

Submitted by John Hermanson, Cornell University, Ithaca, NY

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from the "Bat Crew" in Oregon

For the sixth year the "Bat Crew", a collection of dedicated high school and college students from the Eugene-Springfield area under the supervision of Stuart Perlmeier, is involved in several research projects in conjunction with the U. S. Forest Service and the Oregon Department of Fish and Wildlife (ODFW). Our work with the Willamette National Forest (contact person, Pat Ormsbee) involves a longitudinal study of night roost fidelity on three different watersheds on the Forest. Several species of bats in this region use bridges as night roosts. We will be comparing fidelity levels by species and gender across the three watersheds. In addition to our fidelity study, we are assessing the effectiveness of our "guano gutters" as a tool for measuring relative night roost activity over the course of the season. We are in the process of installing plastic rain gutters on the walls of selected bridges and collecting guano on a weekly basis.

The "bat crew" has completed its second year of work on the Deschutes National Forest (contact person, Sheri Chambers) where we are surveying bats at several sites in Central Oregon. One of these locations, South Ice Cave, may be a potential swarming site for several species of bats in the region. At this site in particular we are investigating changes in the bat populations by species and gender on an hourly basis during the summer and early fall months.

Finally, in conjunction with ODFW, we are working with a private landowner in the area to secure and monitor a population of Townsend's big-eared bat (*Corynorhinus townsendii*) that are roosting on his

Perlmet continued...

property. These bats were first detected at this site during a survey we conducted in 1992. Increased human activity at the cave in subsequent years (a local party spot) may have resulted in this population abandoning the site for several years. We are hoping to reduce the level of human disturbance at the site by monitoring it on a weekly basis. We are encouraged by our efforts as evidenced by the fact that a colony of 40+ individuals was observed in the cave during late August. So much work, so little time!!!

Submitted by Stuart Perlmet,

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Book Review

Don E. Wilson, **Bats in Question**. Smithsonian Institution Press, Washington, DC

My first knowledge of Dr. Don Wilson's communication skills came ten years ago while I was working in Costa Rica. A friend of mine has just completed an Organization for Tropical Studies ecology course on which he was a faculty member. She relayed to me that when it came time for him to leave the OTS field station, students boarded the bus and carried him off--obviously wanting more of what he had to offer. What he offers the public in his new book, *Bats in Question*, also leaves me asking the question, "Don, when can we have more?"

Many people seek out books on bats to find answers to specific questions. The Smithsonian's "in question" book format is ideal for finding those answers quickly. But his book is far more than quick information. Beyond just giving an answer to a question, Don intrigues the reader with fascinating examples that tie information into a broader ecological context which helps to develop a more comprehensive perspective on bat natural history. The book is extensively illustrated with Merlin Tuttle's photographs that have been reproduced with superb clarity and color. This reviewer had a difficult time putting the book down.

Bats in Question is organized into three main sections: (1) Bat Facts, with answers many of the commonly asked questions, what do bats eat, where do they live, which are the largest and smallest, how intelligent are they, etc. (2) Bat Evolution and Diversity, with nicely written and well illustrated summaries of families or a unique genera and (3) Bats and Humans, the section that covers many of the public health, exclusion and superstition issues that probably send many people looking for a book like this. On questions of public health, Don does an excellent job of putting potential risks into perspective and providing helpful advice to solving problems. A nice addition to this final section are three good questions and answers about becoming a bat biologist. This is a nice follow-up for the many young people whose interest will be piqued by what they find between the covers of this good book. For students of all ages, the general and subject bibliographies offers references for more detailed information.

Finally, Don has compiled an appendix on the conservation status of bats that includes the scientific and common names and known status. Glancing through the 21 pages of species, it is quite sobering to see in black and white the number of "no assessment" listings. It reinforces the importance of books like this that stimulate interest in bats with well-written text and fascinating pictures.

This very affordable book (\$24.95 soft, \$49.00 cloth) belongs in every public library and yours. Most of us respond to many inquiries from the public and often need a good reference to copy from or recommend. This is the book you need. What is also needed are translations of this publication--especially into Spanish, Portuguese and French. This book is urgently needed in those parts of the world where bat diversity and abundance is highest and information in native languages is scarce. I sincerely hope this book will find its way around the world where it can stimulate bat conservation actions and inspire young people to join the fascinating profession of bat biology.

Submitted by Pat Morton, Texas Department of Parks and Wildlife, Austin, TX

**Report on Bat Papers Delivered at the Annual Symposium
of the Zoological Society of Southern Africa,
Cape Town, 7-11 July 1997**

Submitted by Dr. Peter Taylor
Durban Natural Science Museum, Durban, South Africa

Two sessions of papers (eight papers in all) at the 1997 Annual Symposium of the Zoological Society of Southern Africa (ZSSA) were devoted to recent and ongoing bat research in southern Africa, reflecting a growing interest in bat conservation and research in this region. A wide variety of topics was covered, including taxonomy, foraging ecology, reproduction, physiology and conservation. It is hoped that all these papers will be published within a single special issue of the South African Journal of Zoology.

The two sessions were followed by an informal workshop on bats which culminated in the formation of a Southern African Bat Working Group (SA-BWG) under the auspices of the ZSSA, the first such body devoted to conservation and research of bats. The group's aims include the creation of a bat roosts database and an echolocation sounds library. Close liaison is planned between this working group and spelaeological and conservation groups in southern Africa, as well as other bat conservation groups internationally.

Starting with taxonomy, Teresa Kearney presented a paper (by Kearney & Taylor) entitled "Bacula and chromosomal characters - can they improve current taxonomy of southern African *Eptesicus* and *Pipistrellus*?" At the species level, the answer was a definite yes: chromosomal and bacular characters have clarified species and distributional limits of *P. anchietai* and *P. kuhlii*, which are poorly resolved in the present morphologically-based key. At the generic level, chromosomal and bacular data for southern African species provide some support for recent revisions which recognize a subgenus *Neoromicia* within *Pipistrellus* for many species previously included in *Eptesicus*; this conclusion awaits ongoing morphometric (geometric and conventional) and electrophoretic studies.

Rauri Bowie reported on a study (by Bowie, Jacobs & Taylor) of diet and wing morphology in morphologically similar insectivorous bats (*Nycteris thebaica* and *Hipposideros caffer*) sharing the same night roost (at Mkuzi Game Reserve in KwaZulu-Natal Province of South Africa). In spite of similar habitat, wing design and flying ability, the two species showed distinct dietary differences, with *N. thebaica* preferring non volant orthopterans and arachnids, and *H. caffer* preferring moths. These differences were attributed more to distinctive echolocation differences than to the subtle morphological differences measured (although the latter did suggest *N. thebaica* to be a more adept "gleaner" of non-volant prey, having a significantly lower wing aspect ratio and significantly longer wingtips).

Based on a study of a community of five bat species at Sudwala Cave in Mpumalanga Province of South Africa, David Jacobs presented a paper on "Bats versus moths: have bats won the arms race?" He argued that the short-eared trident bat, *Cloeotis percivali*, has decisively won the arms race through: 1) having an echolocation call inaudible to moths (CF component of 208KHz, followed by a descending frequency modulated sweep down to 180kHz); and 2) through its relative rarity in a community of five species of bats, suggesting that selection pressure it imposed on moth hearing was negligible relative to that of the most common bat, *Miniopterus schreibersii*. The results supported the allotonic frequency hypothesis, and there was a significant correlation between peak echolocation frequency and percentage volume of moths in the diet of the bats comprising this community.

Two papers dealt with thermal challenges imposed on colonies of the Angolan free-tailed bats (*Mops condylurus*) occupying man-made structures in the hot lowveld of Mpumalanga Province of South Africa. In the first paper, Bronner, Buffenstein and Maloney (presented by Gary Bronner) found that high solar loads in autumn and summer resulted in roost temperatures (under a corrugated iron roof) that exceeded 40° C for 6 hours or more daily, with a maximum of 50 - 60° C. Bats maintained a T_b of 30° C by night but became thermolabile (torpid) by day, exhibiting extraordinary heat tolerance for a small mammal. In the second paper, Robinson, Buffenstein and Bronner (presented by Andrew Robinson) measured the effects of housing

Angolan free-tailed bats in pairs or groups of six on Vo_2 , evaporative water loss (EWL), and T_b at ambient temperatures (T_a) of 15, 25, 30 and 42 C using an open-circuit respirometry system. The results demonstrated that huddling behaviour in Angolan free-tailed bats conferred thermoregulatory and energetic advantages at high temperatures (e.g. huddling resulted in a smaller $T_b - T_a$, as well as a and 27% drop in Vo_2 at a T_a of 42 C).

Bernard and Cumming (presented by Ric Bernard) summarised patterns of reproduction in three taxon-based groups: Megachiroptera, Molossidae, and nonmolossid Microchiroptera. While all the groups are seasonally or aseasonally polyoestrus at tropical latitudes, only the latter group demonstrate reproductive delays (e.g. sperm storage) at temperate latitudes. The occurrence of short periods of reproductive delay in some tropical species led the authors to propose that reproductive delays evolved in tropical regions as an adaptation to the long dry season characteristic of African tropical latitudes. Rather than invoking mate choice and sperm competition as causal factors in the evolution of reproductive delays in bats, the authors suggested that they can be adequately explained using purely energetic arguments.

Finally, Peter Taylor reported on the formation and progress of amateur-based bat interest groups in South Africa, of which two currently exist (in Durban and Pretoria). In order to evaluate the success of this approach (which was based on the successful British bat groups), statistics for the Durban Bat Interest Group (DBG) from 1994 to 1996 were reviewed. The number of public "contacts" (including "problem bat" and general enquiries, slide-shows, exhibitions, media exposure, rescued live bats, and club functions) increased from 106 (1994) to 173 (1996). Through the efforts of the group, two species of bats have been recorded for the first time in South Africa. Conservation efforts have focussed on the roof-dwelling large-eared free-tailed bat (*Otomops martiensseni*) (endemic to the Durban area, in South Africa), which, through the efforts of DBG and the Natal Parks Board, has been classified as "endangered", and now enjoys provincial government protection, as does a second species, the short-eared trident bat (*Clootis percivali*).

A paper on "Reproductive ecology of Commerson's leaf nosed bat (*Hipposideros commersonii* (Chiroptera: Hipposideridae) in south central Africa: interactions between seasonality and large body size" was to have been presented by Fenton Cotterill from the Natural History Museum in Zimbabwe, who was unfortunately unable to attend. Based on the abstract provided, this paper, which is to be published soon, describes seasonal changes in body mass in association with reproductive activity and seasonal influences. In mid-pregnancy, females migrated away from the maternity roost for two months before returning to give birth. Data on prenatal and postnatal development (including time to weaning) were presented. Although this paper provides new insights into the life history of this large hipposiderid (one of Africa's largest microchiroptera) it raises intriguing questions about the ecology of the species, especially the role of migration and use of other roosts.

It is gratifying to see the increase in both public and scientific interest in bats and bat conservation in southern Africa, and particularly, South Africa. Tribute must be paid to earlier research pioneers such as Ric Bernard, Naas Rautenbach, Lloyd Wingate and Mac Van der Merwe who have laid much of the necessary foundation for bat research and conservation in this country. There is still a long way to go!

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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 mailing address) to tgriff@titan.iwu.edu by e-mail. Receipt of reprints is preferred as 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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A Request for Assistance from Cuernavaca, Mexico

Dear Colleagues:

Early in 1997 a small center of investigation was established as Centro de Estudios de Fauna Silvestre (CEFS). Its staff will consist of several professors from the Universidad Autonoma del Estado de Mexico, Universidad Autonoma del Estado de Morelos and from la Universidad Nacional Autonoma de Mexico. Our studies will be concentrated in the states of Morelos and Mexico. The Center is beginning to develop basic research and conservation of natural resources, with special attention to aquatic zones (Wetlands) and the Neartic and Neotropical transition zone.

The University is currently in a very difficult financial condition and we are in need of the any support our colleagues can provide to help us to advance our proposed projects on the flora and fauna of this region. We are making a modest beginning in obtaining equipment for the different areas of investigation. We are especially in need of publications, books, or reprints of papers which you have published for the library as well as the classrooms. We would be grateful for any used books, field guides, tapes, and computing hardware and software for the C.E.F.S. We and our students greatly appreciate any support you can provide us and are deeply grateful for your kindness and consideration.

If you would like to help us, please respond to:

M.S. Marco A. Gurrola Hidalgo, Universidad Nacional Autonoma de Mexico C.E.F.S.

AC Gabino Vazquez # 7, Col. Jiquilpan, CP 062170 Cuernavaca, Morelos MEXICO

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A request for assistance from California

I have a request of fellow bat researchers. While doing a literature search for the Mammalian Species account of *Pteropus poliocephalus* I realized that I had accumulated quite a reference collection for *Pteropus* and Megachiroptera in general. With that seed planted I have begun compiling a bibliography of the Megachiroptera of the world. Previous bibliographies are seriously out of date. So far I have approximately 700 actual physical copies of references and an additional 1,500 citations to be entered and categorized according to keywords in a computerized bibliographical database (the 700 have been entered). I am also going through each paper's literature cited section and will add those to the list. I then attempt to locate a physical copy to make notes concerning genera discussed, key topics, etc.

To this end I would like to ask your help. I would greatly appreciate any references that anyone might have relating to Megachiroptera. Any reference will do: journal papers, popular magazine articles (e.g., Natural History), books, and book chapters, symposia and proceedings, etc. I will not include abstracts from meetings but will include foreign language articles. An actual copy or reprint would be preferred as I can then enter keywords into my database; but even a list of references would be most helpful. If I have a reference but no copy, I hopefully will be able to hunt down a physical copy through the University of California library system and interlibrary loan.

I hope to make the bibliography available to all by publishing it, putting up a web page, or perhaps distributing it on my own. I envision it being arranged by genus (*Acerodon*, *Haplonycteris*, *Myonycteris*, *Pteropus*, *Rousettus*, etc.) and subdivided into key topics such as diseases and parasites, taxonomy, conservation and management, genetics, ecology, diet, physiology, reproduction, etc. Any ideas or suggestions regarding publishing, format, etc. would also be greatly appreciated.

Reference lists or suggestions can be sent via the e-mail address below. Reprints or copies of articles would be greatly appreciated and can be sent to the mailing address below. Thank you for your time and consideration and I hope to hear from many of you.

Rick Spaulding, Biologist/Environmental Analyst/Specialist, Ogden Environmental and Energy Services
1 East Anapamu St., Santa Barbara, CA 93101, Phone: (805)962-0992 x229
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Offer of Assistance: Bat Banding Records Available

Dear Roy, Thanks for your suggestion on putting a note in Bat Research News regarding the availability of my bat banding data from New York and Pennsylvania. The records are on the standard bat-banding cards and include both the original as well as any recovery data. The records include banding done by my students and me in New York from 1963 to 1966 and by Richard F. Myers and colleagues in 1953 and 1954 in New York and Pennsylvania. The major banding locality in both data sets is the tunnel in Letchworth State Park, Livingston County, New York. The Letchworth data include numerous recoveries over a period of many years. The bulk of the records (ca. 4500) are for *Myotis lucifugus*, but *Eptesicus fuscus*, *Pipistrellus subflavus*, *Myotis leibii*, and *M. septentrionalis* are represented with from 19 to 128 records each. If it would be any help to persons interested in these records, I would be happy to provide copies of any of my field notes pertaining to the banding.

Thanks for your interest and best regards, Jim.

James N. Layne, Archbold Biological Station, P.O. Box 2057, Lake Placid, FL 33852
e-mail jlayne@strato.net

Tucson Bat Symposium T-Shirts for Sale

Kim Duffek still has a number of T-shirts from the 27th North American Symposium on Bat Research held in Tucson. The price is \$15.00 plus \$3.00 shipping and handling. These are particularly handsome shirts, and everybody who likes bats must have one. If you are interested in purchasing a shirt(s) please contact Kim at PO Box 86691, Tucson, AZ 85754. Tel. 520-743-7905, FAX 520-883-2500.

If anyone of the undersigned meets you and you are wearing one of these shirts, you are entitled to a free drink of your choice! G. Roy Horst, Tom Griffiths, Ginny Dalton, and oh yes, Merlin Tuttle.

Vampire Bats Symposium:
Review of Biology, Problems, Control, and Conservation
 at The International Bat Research Conference, Brasilia, Brazil in August 2-6, 1998

Conveners: Wilson Uieda, Joaquim Arroyo-Cabrales, Timothy McCarthy, and Anthony Hutson

Vampire bats are unique to the neotropical region. The Eleventh International Bat Research Conference as the first International Bat Research Conference held in South America will host the Vampire Bats Symposium to review aspects of biology, economic and public health impact, control efforts, and education. All interested bat biologists, agricultural and health professionals, and educators are invited to attend. The goal of this event is to review aspects of the systematics, ecology, behavior, and paleontology of the three blood-feeding species; focus on the importance of population control especially for *Desmodus*; and address questions of discriminate control, education, and conservation. The symposium will have two sessions: 1) 14 oral presentations, each 25 minutes; 2) an open workshop will address "Is *Desmodus rotundus* a bat species of special concern?" and other related questions. Submission of vampire bat research and related topics are encouraged for the Posters and Oral Sessions of the 11th IBRC. Two honoraria as memorials to Dr. G. Clay Mitchell will be given for: 1) best vampire bat research presentation: 2) best overall bat research by a Latin American student.

Oral Presentations

The history of vampire bat research.

Bernardo Villa-Ramirez Universidad Nacional Autonoma de Mexico, Mexico, DF, Mexico.

Systematics and distribution.

Oscar Sanches-Herrera, Toluca, Mexico.

Paleontology and vampire bats.

Joaquin Arroyo-Cabrales, INAH, Mexico, DF, Mexico.

Ecology and behavior of *Desmodus rotundus*.

Uwe Schmidt, University of Bonn, Bonn, Germany.

Social organization in vampire bats.

Gerald Wilkinson, University of Maryland, USA.

Ecology and behavior of *Diaemus youngi* and *Diphylla ecaudata*.

William Schutt Jr., Bloomfield College, Bloomfield, NJ, USA,
and Wilson Uieda Unesp, Botucatu, SP, Brasil.

Rabies and vampire bats.

George M. Baer, Laboratorios Baer, Mexico.

Vampire bats and screw worms flies.

Cathy Merriman, World Wildlife Foundation, Toronto, Canada.

Ecology and epidemiology of attacks upon humans by vampire bat.

Maria Cristina Schneider, OPS, Washington, DC, USA, and Wilson Uieda, Unesp, Botucatu, SP, Brasil

The common vampire bat in urban areas.

Wilson Uieda, Unesp, Botucatu, SP, Adalberto Cesari, Belo Horizonte, MG, and Carlos E.L. Esberard,
Fundagco Rio-Zoo, Rio de Janeiro, RJ, Brasil.

continued over...

*Oral presentations continued:***Vampire bat control and economic losses in Middle America with special reference to Mexico.**

Raul Flores Crespo, Centro Nacional de Investigaci6n en Parasitologia, Morelos, Mexico

Vampire bat control and economic loss in South America excluding Brazil.

Rexford Lord, Reading, PA, USA.

Vampire bat control and economic losses in Brazil.

Rogério S. Piccinini, Santo Antonio de Padua, RJ, Brasil.

Educational programs and conservation of vampire bats.

Steve Walker, Bat Conservation International, Austin, TX, USA

Open Workshop

We anticipate this workshop to be hosted by Rodrigo Medellin and Anthony M. Hutson. This venue will provide an opportunity for conference audience to participate with symposium speakers in discussion of various questions developing around the theme, "Is *Desmodus rotundus* a species of special concern?" We are inviting everyone interested in vampire bats to participate and submit other questions for the conveners in advance of the conference.

*For additional information, please contact:***WILSON UIEDA**

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E-mail Addresses

These are new or changed e-mail addresses. If your e-mail has changed since the original e-mail Directory was published in July 1997, please send me **via e-mail** your new (or corrected address). The entire up-dated version of the Directory will be published in each summer issue of BRN. G. Roy Horst.

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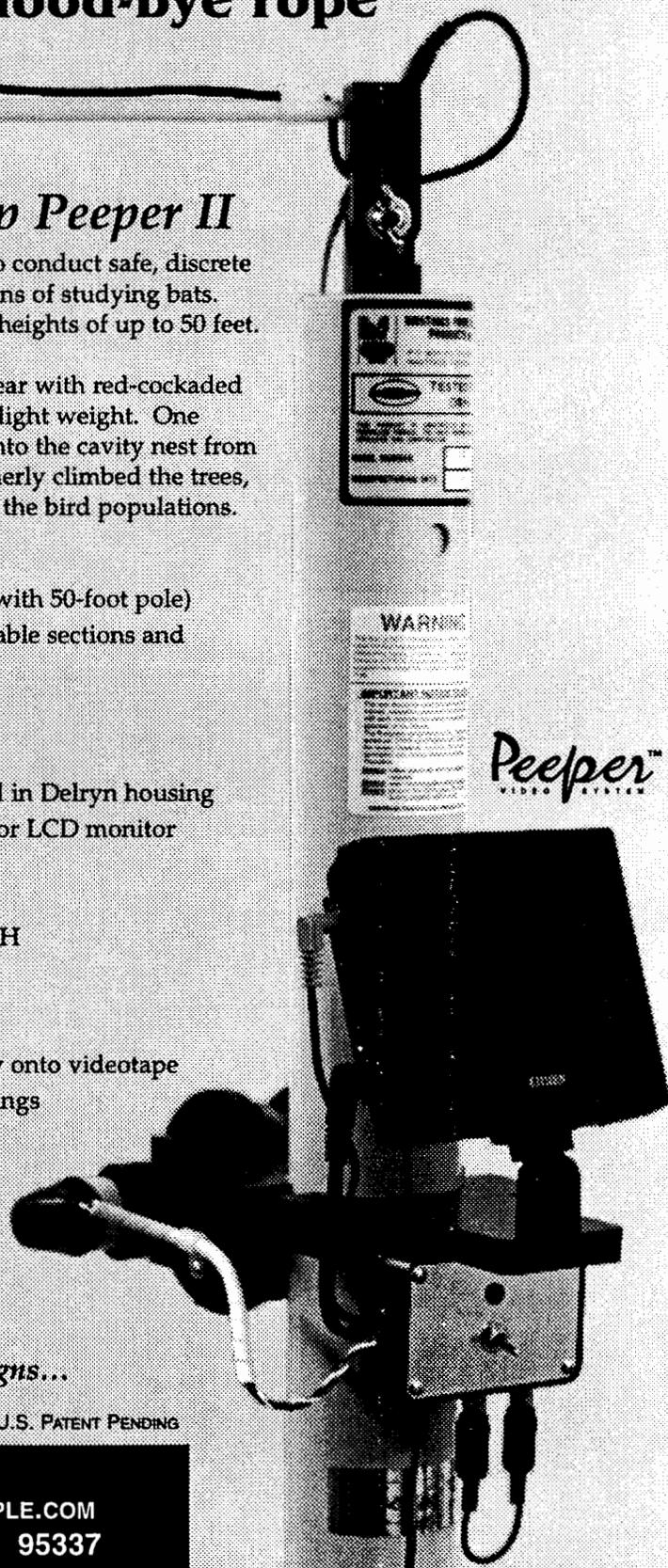
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FRONT COVER

The illustration of *Myotis daubentoni* on the front cover of this issue is by Philippe Penicaud from his very handsome series of drawings representing the bats of France. He has given his kind and generous permission to display several of these as our front cover. The rendition of *Myotis mastacinus* which appeared on the Spring issue of Bat Research News (Vol.38: No.1) is another example of his work. Philippe is an artist specializing in illustrations of animals for educational purposes. He is very active in bat protection and conservation activities in Brittany with the *Société Française pour l'Étude et la Protection des Mammifères*. The exceptional quality of his illustrations make them a "must have" for anyone involved in teaching about bats at any level.

His address is: 16 bis, route du Port, F-29252 Plouezoc'h, FRANCE. Tel/Fax 33/2 98 67 29 39



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Bat Research News is published four times each year, each year consisting of one volume of four issues, appearing in Spring, Summer, Fall, and Winter. *Bat Research News* publishes short papers, general interest notes, etc., which are edited by at least two reviewers. Manuscripts dealing with original work should be submitted in duplicate following the latest *CBE Style Manual*, or following the style used in the *Journal of Mammalogy*. In addition, latest news on bat research, correspondence, book reviews, meeting announcements, reports, and an extensive review of recent literature titles are included. Communications concerning recent literature should be addressed to Griffiths, manuscripts of feature articles to Kurta, conservation and education to Morton, all other matters to Horst.

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Human Rabies and Silver-haired Bats in the United States

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Abstract

The variant of rabies virus associated with the silver-haired bat *Lasiurus noctivagans* has been identified as the major source of human cases acquired within the United States since 1980. The identification of bat-associated variants of rabies virus has been based upon genetic and antigenic analyses of human brain tissue performed at the Centers for Disease Control and Prevention (CDC), rather than known or suspected exposure to rabid bats. Bats as the major source of human rabies in the United States is unexpected, because wildlife rabies has been diagnosed in much higher numbers in raccoons and skunks than in bats. Furthermore, there was no reported bite or scratch by bats in most of the human cases. Biological differences in the variant of rabies virus associated with silver-haired bats may be responsible for rare cases of viral transmission from rabid bat to human that may occur with only limited physical contact.

Rabies is a bullet-shaped, lipid-enveloped, and RNA-containing virus in the family Rhabdoviridae. Rabies virus has a wide range of hosts including both domestic (dogs, cats, cattle, horses) and wild animals (raccoons, skunks, foxes, coyotes, and bats--Fishbein and Bernard, 1995). Rabies in humans is an almost always fatal disease of the central nervous system that is acquired by exposure, through bites or scratches, to saliva containing the virus. Human rabies has become relatively rare in the United States because of animal control and mandatory annual vaccination of pet dogs and cats (CDC, 1997b), plus post-exposure immunization of humans exposed to potentially rabid animals and pre-exposure immunization of persons at high risk, such as veterinarians and animal handlers (Committee on Infectious Diseases, 1997). The highly effective and safe post-exposure prophylaxis in the United States is a combination of passive immunization with one dose of high-titer anti-rabies human immunoglobulin (HRIG) and active immunization with five doses of one of three licensed vaccines containing inactivated rabies virus.

For the period of 1946-1965 in the United States, bats were reported as the source of rabies virus in only five of 236 human cases (2.1%), with dogs reported as the source for 122 human cases (51.7%); other animals were reported for 22 cases, and no animal species was reported for 87 cases of human rabies (36.9% --Held et al., 1967). Only one of these bat-associated cases in humans was attributed to a silver-haired bat --a 53 year-old female who was bitten on the finger while handling a moribund bat in 1958 (Humphrey et al., 1960). The identification of bats as the source of human rabies in the United States prior to 1978 depended upon a known or suspected exposure to rabid bats, because the available diagnostic techniques could not distinguish between different variants of rabies virus in brain tissue from the victims.

Of the 36 human cases in the United States from 1980 through 1997, many were diagnosed in state laboratories post-mortem or only several days before death because there was no prior report or suspicion of exposure to a rabid animal. Identification of the specific animal source of the rabies virus in patient tissue depended upon analyses of the major internal protein of rabies virus (N nucleocapsid protein) with a panel of monoclonal antibodies or the corresponding viral RNA gene sequences by reverse transcriptase-polymerase chain reaction (RT-PCR) and DNA sequencing, conducted at the Centers for Disease Control

and Prevention (CDC) in Atlanta, Georgia (Smith et al., 1986, 1992).

Based upon these diagnostic tests and patient histories, 12 of the 36 cases had rabies variants associated with dogs and were presumably acquired outside of the United States, in regions where canine rabies is still endemic (Krebs et al., 1996; CDC, 1997c; pers. comm.). Of the remaining 24 cases, 21 had variants associated with insectivorous bats, with 15 being characteristic of silver-haired bats, *Lasiomycteris noctivagans*; Table 1). The association of the majority of these indigenous human cases with the *Lasiomycteris* variant is somewhat surprising, because raccoons and skunks have accounted for the majority of animal cases of rabies reported to CDC since 1980, with raccoons increasing to approximately half of the almost 8,000 animal cases in 1995 (CDC, 1997a). During this time, there have been no human cases in the United States associated with the raccoon variant and only one case associated with a skunk variant (CDC, 1995b; Krebs et al., 1996), presumably because exposure of humans to raccoons and skunks is more likely to be recognized as a potential source of rabies, and prompt post-exposure prophylaxis is received.

Since 1980, only one human case associated with bats or bat variants of the rabies virus had a documented history of a bat bite, and two had possible bat bites; there was no known or suspected contact with bats in nine cases. There are two major questions concerning bat-associated rabies in humans since 1980. First, how was the virus transmitted from rabid animal to human when there was no history of a bite or scratch from a bat? Second, why have most of the bat-associated cases had the silver-haired bat variant of rabies virus, including the eight cases with no known exposure or contact with bats? Are there any unique properties of the rabies variant associated with this bat species?

The reported numbers of rabid bats in the United States increased dramatically from the initial discovery in 1953 (Constantine, 1970) through the early 1980s, although much of this increase may have reflected increased testing of bats rather than a real increase in rabies in bat populations (Brass, 1993). One or more cases of bat rabies have been reported for all states, and have included most species of insectivorous bats in the United States (Constantine, 1970, 1979, 1988). Constantine (1970) reported that the rate of infection with the rabies virus was generally higher in migratory bats than in nonmigratory species, with a seasonal peak in autumn, and that unprovoked attacks and aggressive biting of humans was characteristic of small, solitary species, such as the California myotis *Myotis californicus*. Bat rabies is most prevalent in the Mexican free-tailed bat *Tadarida brasiliensis* in southwestern states, the red bat *Lasiurus borealis* in southeastern and mid-Atlantic states, the big brown bat *Eptesicus fuscus* in the northeastern United States (Childs et al., 1994), and the common vampire bat *Desmodus rotundus* in Latin America (CDC, 1991a).

The silver-haired bat occurs throughout most of North America (Kunz, 1982). It is widely distributed from Alaska to the southern United States during fall and spring, but it is relatively uncommon throughout this range (CDC, 1993, 1994b). The silver-haired bat is infrequently submitted to state laboratories for rabies testing compared to other insectivorous bats (CDC, 1994b); of approximately 25,000 bats tested in 15 states from 1956-1992, only 796 (3%) were silver-haired bats, and only 41 of these (5%) were positive for rabies. In New York state for the 1988-1992 period, 312 of 6,810 bats were positive (4.6%); however, only 25 of the submitted bats were the silver-haired species, and only two of these were positive for rabies (Childs et al., 1994).

The identification of a specific variant of rabies virus in a human victim does not necessarily prove that the natural host species was the direct source of the rabies virus, because there is the possibility of interspecific transmission and transmission from the intermediate host to humans. However, intermediate carnivorous hosts or other large mammalian hosts (such as a cow; Table 1) are unlikely for the silver-haired bat variant, because of the large number of cases in which this variant was implicated with no report of a bite from a large animal. Experimental transmission studies of bat variants of rabies virus have met with variable success (Constantine, 1970, 1988; Trimarchi et al., 1986). Natural transmission of variants of the rabies virus between different species of bats is not well understood, and the 1994 case in West Virginia (Table 1) was the first human case with a possible association of the silver-haired bat variant of rabies with the red bat. An aerial attack on a silver-haired bat by a rabid hoary bat *Lasiurus cinereus* has been reported by Bell (1980), suggesting that interspecific transfer of rabies virus may occur among bats.

With respect to biological differences between the silver-haired bat variant and other rabies viruses,

Morimoto et al. (1996) reported two potentially important differences in cell culture replication--enhanced replication in epithelial and fibroblast-like cells relative to a coyote-associated variant, and higher titers of viral infectivity at 34° vs. 37°C. These results suggest that the silver-haired bat variant of rabies may be more efficient in initiating infection in epidermal cells at the surface of the body than other well-characterized rabies viruses from dogs, raccoons, and skunks.

Differences in one region of the major glycoprotein (G protein) of the viral envelope between the silver-haired bat variant and most other strains of the virus may be responsible for such differences; the G protein is the component that is responsible for attachment and penetration of virus into cells of the host animal and eliciting protective, virus-neutralizing antibodies in vaccinated animals and humans (Fishbein and Bernard, 1995). In spite of these antigenic differences in the G protein of the silver-haired bat variant, conventional vaccines for the rabies virus appear highly effective in protecting against the bat variant in studies with mice (Morimoto et al., 1996).

Because a number of the human victims were in direct contact with bats, but did not report a bite, scratch, or exposure of broken skin or mucous membranes to the saliva of an infected bat, much more limited physical contact may have resulted in human infection. Furthermore, bites from bats may be difficult to observe by the unaided eye (Feder et al., 1997). These conclusions have altered the recommendations from CDC (CDC, 1996a) such that post-exposure prophylaxis should now be given in situations where a bat is physically involved and the possibility of even a small bite or exposure of a mucous membrane could not be excluded, unless capture and testing of the bat excludes infection by the rabies virus. These recommendations may be especially important in cases that involve a bat in a room with a sleeping person or child, such as two of the human cases reported in 1995 (Table 1). It is not practical or feasible to control bat rabies by reducing bat populations (CDC, 1997b), but potential exposure of humans to rabid bats may be reduced by excluding bats from houses and surrounding structures and educating people not to handle sick or injured bats.

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Table 1. Human rabies cases attributed to insectivorous bats in the United States, 1980-1997.

#	Date of death	Locality	Age, gender	Viral variant	Known or suspected exposure	References
1	23 Oct '97	Warren Co., NJ	32, M	<i>L. noctivagans</i> ¹	handled multiple bats in home	CDC, 1998
2	21 Oct '97	Houston, TX	71, M	<i>L. noctivagans</i> ¹	bat landed on him in motel	CDC, 1998
3	18 Jan '97	Mason Co., WA	64, M	<i>E. fuscus</i> ¹	none; lived in heavily wooded area	CDC, 1997e
4	5 Jan '97	Blaine Co., MT	65, M	<i>L. noctivagans</i> ¹	bat in home several days; late summer	CDC, 1997d
5	19 Dec '96	Missoula Co., MT	49, M	<i>L. noctivagans</i> ¹	bats occasionally seen outside home/work	CDC, 1997d
6	15 Oct '96	Cumberland Co, KY	42, F	<i>L. noctivagans</i> ¹	none; lived in rural area	CDC, 1996b
7	9 Nov '95	Butte Co., CA	74, M	<i>L. noctivagans</i> ¹	occasionally caught bats	CDC, 1997e
8	31 Oct '95	Greenwich, CT	13, F	<i>L. noctivagans</i> ¹	bat flew inside house; girl asleep 19 Aug	CDC, 1996a
9	21 Sep '95	San Benito Co., CA	27, M	<i>T. brasiliensis</i> ¹	possible contact with bats on ranch	CDC, 1996b
10	15 Mar '95	Lewis Co., WA	4, F	<i>Myotis</i> sp. ¹	bat found in her bedroom 18 Feb and destroyed; exhumed bat rabies-positive	CDC, 1995c
11	23 Nov '94	Cumberland Co, TN	42, F	<i>L. noctivagans</i> ¹	none	CDC, 1995b
12	15 Oct '94	Wirt Co., WV	41, M	<i>L. noctivagans</i> ¹	shot & examined bat outside house June / July 1994; descriptions of <i>L. borealis</i>	CDC 1995a; Sang et al.
13	11 Oct '94	Barbour Co., AL	24, F	<i>T. brasiliensis</i> ¹	frequently removed dead or dying bats from chimney of work facility; 3 of 5 bats on 14 Dec were positive for rabies	CDC, 1995b
14	18 Jan '94	California	44, M	<i>L. noctivagans</i> ^{1,2}	none; frequently camped without tent, most recently Sep 1993	CDC, 1994b
15	9 Nov '93	eastern Texas	82, M	<i>L. noctivagans</i> ¹	none; exposure to cow that died of unknown disease 3 months earlier	CDC, 1994a
16	11 Jul '93	Catskill Mtns., NY	11, M	<i>L. noctivagans</i> ¹	none; active outdoors in wooded area	CDC, 1993
17	8 Oct '91	Walker Co., GA	Adult, M	<i>L. noctivagans</i> ^{1,2}	none	CDC, 1991b, 1995b
18	25 Aug '91	Clark Co., AR	Adult, M	<i>L. noctivagans</i> ²	in early July, bat landed on mouth; possible bites/scratches on thumb & chest	CDC, 1991b
19	5 Jun '90	Hidalgo Co., TX	22, M	<i>T. brasiliensis</i> ²	bitten on finger by bat 13 April	CDC 1991a
20	29 Sept '84	Danville, PA	12, M	<i>Myotis</i> sp. ^{1,2}	none	CDC 1984; Krebs et al.
21	9 Mar '83	Branch Co., MI	5, F	<i>L. noctivagans</i> ¹	possible bat bite late Aug 1982	CDC 1983; Krebs et al.

¹ diagnosis by RT-PCR of viral RNA and DNA sequencing

² diagnosis by monoclonal antibody analysis of viral antigen

Possible Ground-foraging by the Northern Long-eared Bat *Myotis septentrionalis*

Gordon L. Kirkland, Jr.

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The northern long-eared bat *Myotis septentrionalis* is described as a foliage-gleaning bat (Faure et al., 1993). The observation by LaVal et al. (1977) that this species tends to forage below the canopy layer and just above shrubs is consistent with this mode of foraging. The relatively long ears of *M. septentrionalis* coupled with echolocation pulses that are of short duration, high frequency, and low intensity (Faure et al., 1993), provide further support for this foraging strategy. As described in the present paper, the capture of a long-eared bat in a snap trap (Museum Special) set on the ground suggests that the foraging behavior of this species also may involve ground-foraging, either while moving on or hovering above the ground.

The specimen in question (SUVN 24,818) was taken on 8 October 1994 in a mature, mixed, deciduous forest on the Powdermill Biological Station, 3.9 km S and 2.5 km W of Rector, Westmoreland Co., Pennsylvania. The specimen was a male with the following measurements: total length, 80 mm; tail length, 34 mm; hindfoot length, 10 mm; ear length, 16 mm; forearm length, 34 mm; and mass, 5.2 g. With the exception of hindfoot length, these values lie at the low end of the ranges for these measurements provided by Kurta (1995) for this species. This small size, coupled with the fact that epiphyses in the hand were not completely fused, suggests that this bat was a juvenile.

The trap in which the northern long-eared bat was taken was set next to a mossy rock. Living ground cover within 3 m of the trap was <25% and included mossy rocks, Christmas fern *Polystichum acrostichoides*, and hickory seedlings *Carya* sp. Principal canopy trees included white oak *Quercus alba*, sugar maple *Acer saccharum*, American beech *Fagus grandifolia*, black cherry *Prunus serotina*, and hickory. The shrub-sapling zone was dominated by spice bush *Lindera benzoin*, witch-hazel *Hanamelis virginiana*, and saplings of the dominant trees.

The serendipitous capture of a *M. septentrionalis* on the ground provides potential new insight into the foraging behavior of this species. The possibility exists that this young bat may have had an accident while foliage-gleaning, landed on the ground, and was endeavoring to reach a perch from which to become airborne when it encountered the trap. Best-site trapping was being employed, with three traps set within 2 m of each other at stations scattered through the forest. The probability of a bat on the ground encountering one of the traps seemingly would be low. Another possibility is that the bat, when captured, was endeavoring to catch insects or invertebrates that had been attracted to the bait on the traps. Daily rebaiting of snap traps often is necessary due to consumption of the bait by invertebrates, such as ants and millipedes.

The question of whether or not *M. septentrionalis* exploits food resources on the ground, either by hovering or moving on the ground, would be answered were the remains of terrestrial invertebrates to be identified in the stomach contents or feces of this species. For example, the discovery of the remains of flightless species of carabid beetles in the feces of the large mouse-eared bat *M. myotis* was a major clue in determining that this species forages on the ground (Bauerova, 1978). Researchers who capture *M. septentrionalis* in mist nets should retain these bats in cloth holding bags until the bats have defecated. The resulting feces should then be examined for the remains of epigeal arthropods.

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Age of Sexual Maturity in Male *Cynopterus sphinx*

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The author has been studying the feeding and breeding behavior of several species of bats inhabiting Kerala, the southernmost state of India, both in the wild and specimens kept in captivity. The present note embodies some observations on the age of sexual maturity of male *Cynopterus sphinx* in captivity. Based on circumstantial evidence, earlier workers concluded that females of this species attain sexual maturity within 5 months after birth; males, in contrast, do not reach sexual maturity until they are at least 15-16 months of age, if born in February-March, and at least 19-20 months of age, if born in June-July (Sandhu, 1984, 1988; Sandhu and Gopalakrishna, 1984). They arrived at these conclusions by examination of specimens collected from the wild. Badwaik (1993) arrived at nearly the same conclusions by examining the sex ratio of wild specimens during different phases of growth. Observations presented in the present note offer direct evidence to indicate that males born in July may attain sexual maturity and participate in fertile copulation for the first time at 15-16 months of age.

One lactating specimen with its newly born male offspring (body mass: 8 g), about 2-3 days old, was put in a wire-mesh cage (3 m by 2 m by 1.3 m) on 29 July 1995. The cage was kept on a roofed verandah that was open on three sides. This simulated the natural roosting sites of this species, namely, under the eaves of windows, roofs of cowsheds, and hollows formed by drooping palm leaves. Fruits such as banana, guava, sapota, and other seasonal fruits were placed in the cage in ample quantities, and water was kept in a large shallow basin on the floor of the cage. Food and water were changed every day.

The young one was consistently attached to the breast of the mother until 15 August 1995. On the morning of 15 August, the young crawled out from under the mother's breast and was hanging from the roof of the cage a short distance from the mother. During the following days, the young returned to the mother to suckle several times during the day. The young was found for the first time fluttering inside the cage on the evening of 7 September 1995. It was first seen eating fruits on 19 September 1995 at 2000 h, but it still occasionally returned to the mother for suckling. After 10 October 1995, the young one was completely dependent on fruits for food and, by then, it had nearly attained the size of the mother. On 23 and 24 October 1996, the male was lying close to the female, exhibiting vigorous precopulation behavior. The two bats occupied different parts of the cage on 25 October 1996. Examination of the cage on 20 February 1997, at 0550 h, revealed that the female had delivered a male neonate (body mass: 8 g), which was clinging to the mother's breast.

The foregoing account indicates that the first male participated in successful, fertile copulation when it was 15 months of age, calculated from the last week of October 1996. Each female of the species experiences two pregnancies in quick succession; the first commencing in October-November and terminating with delivery in the following February-March, and the second pregnancy commences within a few days after parturition and ending with delivery in the last week of July (Sandhu, 1984). In the caged specimen under study, the female could have experienced estrus in October 1995 and March 1996, but it could not conceive because of the absence of an adult male. However, since she delivered in February 1997, she likely became pregnant in October 1996, and since the only male (her first son) that could have fathered the second offspring was born in July 1995, it is evident that the first male had attained sexual maturity and participated in fertile copulation in October 1996, when 15 months of age.

The author expresses his gratitude to Professor A. Gopalakrishna for his continued guidance in bat study. Financial support from U.G.C., New Delhi, and from the State Committee on Science, Technology and Environment, Government of Kerala, is gratefully acknowledged.

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Letters and News from our Readers

From Toyoma, Japan

By way of introduction, I am a zoo keeper at Toyama Municipal Family Park in Toyama Prefecture, Japan.

I have been interested in hibernation and daily torpor of insectivorous bats for about 5 years. Since that time, I been doing reserch on the type of daily torpor in *Myotis macrodactylus* in a tunnel in my free time. At the beginning of my study from spring of 1996 to fall of 1996, once each month I counted the number of bats and measured body weight(BW), body surface temperature(TBS), and wall surface temperature(TWS) and ambient temperature(TA) in the tunnel where the bats were resting.

Myotis macrodactylus used this tunnel from late March to August this year(perhaps before the onset of the mating season). In midsummer(July and August) the bats were in daily torpor; their average of TBS was 14° C. This tunnel was also used by *Rhinolophus ferrumequinum* throughout the year. In midsummer, *Rhinolophus ferrumequinum* moved in and flew around in this tunnel. In this period, the averages of their BW were increasing slowly. In April, average of TBS was higher than average of TWS and average of TA, and average of TWS was higher than average of TA. All of these measurements (TBS, TWS, and TA) were increasing slowly from April to August. But in May, average daily TA crossed to TBS and TWS. Average of TA was higher than average of TBS and average of TWS after this month. Fluctuation of average of TBS was parallel with average of TWS. All of TBS were higher than TWS that I measured during this research.

I think that when *Myotis macrodactylus* is in daily torpor, the temperature of the wall surface where they are resting may be an important factor in the fluctuation of their body temperature, because when *M. macrodactylus* are resting, their ventral surface is in very intimate contact with the tunnel wall. I am continuing this research and collecting the same kind of data concerning daily torpor and hibernation in *Rhinolophus ferrumequinum*, for comparison of these phnenomena between these two species.

I am very interested in hearing the opinions of the readers of Bat Research News of this research and will welcome any suggestions as to how I might proceed with this research. Thank you, Hitoshi Murai
My address is 202 High-corp Shiroyama, 3264-7 Yoshizukuri, Toyama City, Toyama PRF
JAPAN 930 - 0142 and my e-mail is rumbat@tym.fitweb.or.jp

From France

Editorial note: The author of the following communication has requested that we publish it with minimal editing. He is very concerned that in even modest editing, some meaning or tone may be misrepresented. Some of our more sophisticated grammarians may find an occasional misuse, but we urge the readers to enjoy the message in the spirit of cordiality it was transmitted. We present it to our readers essentially as received. G. Roy Horst, Managing Editor and Publisher.

Please address all comments or questions concerning this letter to its author.

From Dr. Bernard Sigé

UFR des Sciences de la Terre, Université Claude-Bernard - Lyon I, 27-43,
blvd. du 11 Novembre, 69622 Villeurbanne, France.

Fossil bats have been the subject of my research since 1964, continues as my role as member of French National Center for Scientific Research (CNRS). This work began and has continued at the University of Montpellier, and also for various periods in the Paris National Museum of Natural History, and it was recently transfered to the University Claude Bernard at Villeurbanne (Lyon 1).

Since the beginning the recollection of fossil material has been performed in permanent collaboration with numerous colleagues in different domains. This extends from field work, which represents the essential condition for ground improvement and progress in paleontology, as well to the geological, chronological, faunal and paleoenvironmental settings of the material under study.

Fossil bat remains are collected in numerous localities and stratigraphic formations of Paleocene and

Neocene periods (i.e. Lower and Upper Tertiary era) ranging from the Early Eocene (ca 55 million years) up to the Late Pliocene (ca 2 My). However most of the material under study is Paleocene in age. For this period the problems deal principally with the origin, phylogeny and evolution of the major extinct or extant units.

The largest part of the material under study comes from French localities. Some fossils were collected during investigations in other countries, or proposed for study, or are studied in collaboration with foreign colleagues. Finally the geographic distribution includes Europe, the Arabo-African area (Morocco, Tunisia, Egypt, Oman), Australasia (Australia, Thailand), and North-America (Wyoming). The most productive source for fossil bats in France lies in the intrakarstic deposits of different ages and regions. The richest area is the Quercy (SW France) which provides an almost continuous record since the Early to Middle Eocene transition up to the Early Miocene.

The material available for study consists of dental and skeletal elements in a more or less fragmentary condition. More rarely found are skeletons preserved in anatomical connexion, with possibly soft body and wing outline and other informations such as gut contents; these come from particular deposits (lacustrine shales or thin lamelled limestones) such as those of the varied bat fauna from the famous Messel basin in Germany (ca 49 My) intensively studied by German colleagues.

Comparative morpho-anatomical study allows the identification of taxa, the recognition of trends and the definition of morphological and/or size stages within evolutionary specific lineages, always seen in a chronological perspective. The description of original taxa adds to an improving knowledge of the natural groups, much more diversified in the past than they appear today. More surely (to Sigé's opinion) when using an empirical simpsonian (i.e. non-cladistic) interpretation of characters and their time and space parameters, the fossil material and especially the new taxa can enlighten the phylogenetical relationships of bats. From these studies are inferred information about dispersal (paleobiogeography), time-range of taxa (biostratigraphy), evolutionary processes and stages within specific lineages (biochronology) and, using actualist reference, paleoecology.

The bats being studied within such an approach include practically all the major systematical groupings, with the exception of neotropical phyllostomatoids. The published data deal with rhinolophoids (hipposiderids, megadermatids, nycterids, rhinolophids), emballonuroids (emballonurids), vespertilionoids (natalids, vespertilionids, molossids), pteropodids, as well as Early Tertiary archaic bat groups remaining up to now without clear relations to modern families.

This activity involved the training and supervizing of previous students, then full researchers. Henri Menu has revised the very diverse vespertilionine group according to a thorough tooth morphology analysis (by the way applying a traditional paleontological approach to recent forms). He is currently studying fossil and recent representatives. Serge Legendre has first studied Mediterranean Neocene bats, then applied the tooth morphology analysis in a revision of recent and fossil molossids. In relation with his current main paleoecological study of living and fossil mammal communities, he supervizes a program of size and body mass data recollection at the scale of the bat Order.

To date, the most important problems for me have arisen after recent discoveries in karstic or fluvio-lacustrine deposits of Early and Middle Eocene age. Up to now these periods remained with rather poor bat record. These formations have now yielded remains of original types, i.e. new patterns that can be related to different archaic or modern groups. These forms significantly enlarge the spectrum of early radiations in many major groups. Some of them represent original offshoots without known representatives in younger or modern faunas (among archeonycterids, emballonurids, nycterids, incertae sedis groups). Some other materialize relationships between natural extant clades that are considered quite different or even without common ancestor (e.g. emballonuroids and rhinolophoids). Some other substantiate possible links between until now incertae sedis archaic groups and some modern taxa (e.g. between paleochiropterygids and vespertilionoids).

The following colleagues have been active in collaboration with me in my research on bats: Drs. Serge Legendre, Henri Menu, France; Suzanne Hand, Univ. NSW, Sydney; and Gerhard Storch, Senckenberg Museum, Frankfurt.

A list of papers of the Paleo-bats informal work group, with thematic index, can be obtained on request to B. Sigé, Mailing address as shown above; Tel. : (33) 72 44 84 15
e-mail: UMR5565@univ-lyon1.fr

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Reminder, if you have not already done so, please send a reprint or title of your most recent publication(s) to Tom Griffiths at:

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**Abstracts of Presentations at the
27th Annual North American Symposium on Bat Research
October 8 - 11, 1997
Tucson, Arizona**

The following abstracts appear in alphabetical order of first authors. Many of the abstracts have been edited for spelling or other errors, and nearly all have been reset in type face other than the original. If in this process any errors have inadvertently been introduced these are fully the responsibility of the editors, in this case, Thomas Griffiths and Roy Horst.

Growth of the Wing in *Myotis lucifugus*: The Dynamics of Size Over Shape

Rick A. Adams, University of Wisconsin, Whitewater, WI

The processes of morphogenesis require that tissue interactions (developmental integration) occur in such a way that the process itself does not adversely affect the performance (functional integration) of the morphological systems. The level of functional integration observed in adult morphology is likely achieved through developmental integration, but, consequently, integration among tissues may evolutionarily limit morphological diversity, because few structures can modify independently. Inquiries into the epigenetic interplay between soft and hard tissues are essential for understanding both developmental and functional integration in vertebrates. Because bone is reactive to stresses, its ultimate morphology is the product of differential forces induced via soft tissues during ontogeny. However, modularity (linkage) among functionally integrated bones results in interlaced morphogenetic units that both develop and evolve collectively. Epigenetic events during morphogenesis largely control a structure's ultimate integrity. In efforts to maintain developmental and functional integration, bones may compensate their dimensions relative to muscle stresses and proximity to geographical relatives. Recent developmental studies of bats suggest that soft tissues play a unique role during morphogenesis and are responsible for the functional integration of derived characters. This paper addresses how the wing membrane and skeletal system in bats are developmentally and functionally integrated during morphogenesis in *Myotis lucifugus*. Growth of the forearm as well as third and fifth digits of the manus and a truss network are used to quantify soft and hard tissue morphogenesis. Change in wing size (PC-1) contributes 78% of growth variation, whereas shape changes (PC-2, PC-3) contribute only about 18%. ANOVA run on component scores shows significant differences in size (PC-1) of the wing between juveniles and subadults, whereas no significant difference in shape (PC-2 & 3) was found. Growth compensation occurs among sequentially developing skeletal elements comprising the hand wing. Coefficients of variation were significantly higher for phalangeal lengths than for total wing length and width. Compensation Scores, generated by summing residual scores produced by bivariate plots of wing bones, show variable levels of compensation among individuals, but do not correlate with wing size ($r = 0.089$). Apparently, selection has favored a developmental system within which wing shape is conserved while simultaneous plasticity in finger bones helps maintain functional integrity during rapid wing morphogenesis in juvenile *M. lucifugus*.

**Use of Artificial Roost Structures by Bats
in the Ouachita National Forest of Arkansas**

Brady Baker, V. R. McDaniel, J. D. Wilhide, and Betty G. Crump*

Arkansas State University, State University, AK; *Ouachita National Forest, Caddo District, Glenwood, AK

There has been recent concern about the decline of available natural roost structure for bats in the Caddo Ranger District of southwest Arkansas. The decline is a result of timber removal after infestations of the Southern Pine beetle. The United States Forest Service has installed artificial roost structures in several deforested areas. Two types of artificial structures were used: the baffle style bat box and the rocket style bat box. The purpose of this study is first to determine if bats will use the artificial roost structures and second to determine which type they prefer. Monthly visual surveys have been conducted of each installed box. In addition to the visual surveys conducted on the boxes, mist net surveys have been conducted at

water sources in close proximity to the boxes, in an attempt to determine what species of bats are locally available to utilize the boxes. Bats captured in the nets have been banded to determine if they later use the artificial roost structures. Preliminary results of this study have not indicated that the banded bats are using the boxes. However, unbanded bats have used both baffle and rocket style boxes, but have occurred in a larger percentage of rocket style boxes for longer periods of time.

Nocturnal Activity Patterns of Lactating Silver-haired Bats

Burr J. Betts and Maarten J. Vonhof.

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We trapped and placed radio transmitters on all members of two maternity colonies of silver-haired bats *Lasiorycteris noctivagans* in southern British Columbia, Canada. The 11 members of one colony and 18 members of the other colony were reunited by the second and third nights after trapping, respectively. With one exception, emergence counts and radiotelemetry indicated that the members of each colony remained together and were not joined by other individuals until young became volant. The stability of group membership suggested the presence of some level of social organization and the possibility of coordinated movement during roost shifts. Thus, we examined nocturnal activity patterns to determine, if possible, when the juveniles were moved, and if one female appeared to lead the moves by consistently being the first to shift activity to the new roost tree. We remotely recorded the presence of bats at the roost with a telemetry receiver set to scan the frequencies about every two minutes and automatically record the presence of any bats detected. Every 2 to 10 minutes, depending on time of night and the likelihood of a roost shift, we also scanned the frequencies by hand from one or two locations from which activity at a new roost could be detected. The pattern of activity on a typical night when bats did not shift roosts included a long period away from the roost followed by intermittent visits of variable length until about 0300. Then most bats were at the tree from about 0300 to after 0400 when they left for a short time before returning for the day around 0500. On a typical night when bats eventually shifted roosts, the initial absence from the original roost was much shorter and the bats irregularly visited both the original and new roost trees until about 0300. There appeared to be no coordination between bats in these visits. The bats had apparently moved to the new tree by the start of the extended period in the roost exhibited by most bats at about 0300 and activity thereafter was similar to that on a non-move night. Because the bats did not move en masse between roosts, it was not possible to determine when the juveniles were moved or if any particular female initiated the move.

Ecology of Bats at Los Alamos National Laboratory and Bandelier National Monument, Jemez Mountains, New Mexico

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¹U. S. Geological Survey, Biological Resources Division, University of New Mexico, Albuquerque, NM and ²USGS-BRD, Fort Collins, CO

In 1995 Los Alamos National Laboratory, Bandelier National Monument, and the Midcontinent Ecological Science Center initiated cooperative studies of bats in the Jemez Mountains of New Mexico. Although some previous bat research has been conducted here, our goals were to assess the current status of bats (particularly species of concern), elucidate distribution and relative abundance, and obtain information on sites in the mountains used by bats as roosts. We captured and released over 1200 bats of 15 species *Myotis californicus*, *M. ciliolabrum*, *M. evotis*, *M. thysanodes*, *M. volans*, *M. yumanensis*, *Lasiorycteris noctivagans*, *Lasiurus cinereus*, *Pipistrellus hesperus*, *Eptesicus fuscus*, *Euderma maculatum*, *Corynorhinus townsendii*, *Antrozous pallidus*, *Tadarida brasiliensis*, and *Nyctinomops macrotis*. Netting sites were located in a variety of habitats ranging from low-elevation pinon-juniper to high-elevation mixed coniferous forest. The most abundant species were *L. noctivagans*, *M. evotis*, *E. fuscus*, *M. volans*, *A. pallidus*, *M. ciliolabrum*, and *M. thysanodes*. Most of these species are typical inhabitants of montane forests in New Mexico. The abundance of *L. noctivagans* (nearly all males) is a function of their presumed migration through the area and they are relatively uncommon at other times. Captures varied across years, but for many species we netted more males than females. During 1996 and 1997 we instrumented bats with

miniaturized radio transmitters and followed them to roosts; we also obtained some nocturnal activity information. Bats in the Jemez Mountains used a variety of sites for roosts including narrow cracks and crevices in high, steep cliffs, cavities and pits in less extensive cliff faces, under rocks and boulders on the ground, in ponderosa pine trees, and in buildings. We observed and counted exit flights of bats from roosts and obtained some of the first information on roosts of *Euderma maculatum* and *Nyctinomops macrotis* in New Mexico. We successfully netted all bat species of concern in the mountains and obtained valuable information on distribution and abundance.

Home Range of the Lesser Bare-backed Fruit Bat, *Dobsonia minor* (Pteropodidae), in Papua New Guinea

Frank J. Bonaccorso and John R. Winkelman.

Papua New Guinea National Museum and Art Gallery, Boroko, Papua New Guinea;
and Gettysburg College, Gettysburg, PA, USA.

Movements of two subadult, male lesser bare-backed fruit bats, *Dobsonia minor*, were followed by radiotelemetry in lowland rainforest at the Kau Wildlife Area, Madang Province, Papua New Guinea. These two individuals were tracked over a period of 9 and 5 days resulting in 110 and 48 respective position determinations used to calculate home ranges, core use areas, and day-roost areas. Foraging movements were concentrated in patches of *Piper aduncum* (non-native) and around large, canopy *Ficus spp.* trees that were producing mature fruits. Day-roost areas of these two individuals did not overlap, however, both individuals used the same *P. aduncum* patch for foraging. Day roost areas for both individuals were in areas of primary rainforest, however, foraging activity occurred in both primary and secondary forest.

Foraging Ecology and Metabolism by Two Species of Australian *Nyctophilus* Bats: How Different is Different?

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Although notoriously difficult to document, interspecific competition is assumed to occur for a variety of resources at a variety of spatial and temporal scales. Previous work on two common species of Australian vespertilionids, *Nyctophilus geoffroyi* (7-8 g) and *Nyctophilus gouldi* (10- 12 g) suggests there is considerable overlap in diet, roost site selection, echolocation call design, and visual abilities. Although these data do not prove the existence of competition, we were stimulated to measure foraging habitat use and physiological variables to further assess the degree of overlap in an area of sympatry.

We hypothesized that because of similar wing morphologies and echolocation call design, foraging by the two species should be largely the same. Given laboratory observations, we also expected both species to "glean" prey from the ground. We collected data for 34 light-tagged *N. geoffroyi* (2800 sec) and 13 *N. gouldi* (1300 sec) foraging in a forest near Armidale, NSW. There was no statistical difference in the habitat use by the two species. Typically, we observed bats of both species to fly relatively slowly in large circles, approximately 2-5 m above the ground amongst the trunks of large trees. Surprisingly, we observed gleaning on only one occasion.

We collected metabolic data on wild-caught individuals transported back to the lab and held captive for up to 72 hours, using open flow respirometry. BMR values of 1.36 and 1.22 mL/g/h for *N. geoffroyi* and *N. gouldi* respectively, were not different but were lower than predicted from allometric equations. The TNZ (thermal neutral zone) for both species was approximately 29-33°C. Minimum torpid metabolic rates were 0.044 and 0.060 mL/g/h respectively (less than 4% of BMR) at ambient temperatures of 5-10°C. The minimum body temperature for both species was approximately 2°C. Both species readily entered torpor to achieve significant metabolic savings and physiologically speaking, resembled bats from temperate North America or Europe.

In short, we found that both the foraging ecology and physiological variables we measured were remarkably similar for these two species of *Nyctophilus*. It remains to be seen whether competition for resources does occur and what resource, if any, is partitioned.

Traditional Roosts and Disaster Induced Roost Changes of *Pteropus tonganus*, a Colonial Pacific Island Flying Fox.

Anne Brooke, Box 102, Newfields, NH (Aprooke@aol.com)

Colonial roosts of *Pteropus tonganus* in American Samoa are located on steep mountainsides or on cliff faces above the ocean, far from people or in protected areas. *Pteropus tonganus* roost in the branches of large trees and, like other colonial bats in the genus *Pteropus*, are faithful to roost sites. Bats return to preferred sites after hurricanes or other disturbance has caused abandonment of the roost. At least three roosts have had large colonies present for the past 60 years or within living memory of elderly people in American Samoa.

Roosts of *P. tonganus* were monitored from 1987-1996, including two years when severe hurricanes devastated the population and caused many roost changes. Bats were observed roosting in 22 tree species, 18 species (81%) were also used for food. Both the tallest and shortest roost trees were found at the same site suggesting that tree height is less important than roost location. Following the two hurricanes, the number of roosts on the southern side of the island increased from 3 (1987) to 15 (1992) and were significantly closer to houses than roosts on the northern side. During the year following the second hurricane, 33 of the 37 roosts were used for less than 3 months and none were used continuously for the year.

Four years after second hurricane (1996) 11 of 13 roost sites had been used previously within the past nine years and four of these sites had large colonies prior to the hurricanes. All roosts were on slopes in excess of 400 and all but one over 500 m from the nearest house. Distance to the nearest house, slope, and elevation of roosts used in 1996 was not significantly different from roosts used in 1986.

In places where bats are not hunted, roosts are close to people. Roosts at Kolovai, Tonga and one in Suva, Fiji, are both in urban areas where bats are subjected to noise and human activity however they are not hunted. It seems reasonable to assume that the isolated locations of colonies in American Samoa is in response to human disturbance and hunting.

Roosting Behavior of Pallid Bats *Antrozous pallidus* in the California Desert as Determined by Radio-telemetry

Patricia E. Brown, Robert D. Berry, Karen L. Miner and Heather Johnson.

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The bats in this study were captured in August 1997 in mist nets in the cottonwood-willow riparian vegetation along the dry river bed of the Mojave River at Camp Cady, a wildlife preserve owned by the California Department of Fish and Game near Barstow, California. The 7 telemetered pallid bats (2 adult males and 5 post-lactating females) roosted 5-11 km from their foraging area. Most day roosts were in small holes or crevices, although the type of substrate included cracks in basalt boulders, spaces between rocks in conglomerate cliffs, mud tubes in badland formations, and dead trees. Night roosts were in mine adits or trees. Individual roost fidelity was exhibited for a general area, although the specific crevices utilized changed at times. This was especially evident when a storm passed through during the night and prevented the bats from returning to their regular day roost areas. The number of bats in a crevice varied from 1 to 6, including the telemetered bats. A previous study on pallid bats at Coso Hot Springs in June 1980 (conducted during the maternity season) showed larger colonies of females and non-volant young in rock crevices, while males roosted alone and changed roosts frequently.

Bat Habitat Enhancement and Preservation

Timothy Kent Brown

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-age 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 (wildlife trees). We believe that

thoughtful habitat development using mechanical means to create tree-form heterogeneity will markedly improve the chances for recovery of endangered and threatened species. Rather than destroying habitat, chain saws can be wielded to enrich habitat. I have demonstrated that by sculpturing bark slits and flanges, cave-starts and snags, heterogeneous tree-forms can be produced which invite bat singles or colonies by augmenting the diminishing 'natural' habitats.

Patterns of Chiropteran Diversity in New Mexico: Ecological and Geographical Correlates from Four Years of Field Work.

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Since the summer of 1994, teams of biologists from the Museum of Southwestern Biology have been surveying the bat fauna of New Mexico. Approximately 600 mist-netting nights at 75 localities across the state nights have yielded approximately 2000 individuals from 20 species. Netted bats have been sampled for ectoparasites, fecal samples have been collected, mass and forearm lengths have been taken, and calls have been recorded using the Anabat system. Additional data were gathered from the surrounding habitat in which the bats were captured, including vegetative communities, temperature, wind, moon phases, and cloud cover. This presentation is a summary of a portion of these data to determine if any geographical or ecological trends are apparent. Specific questions addressed are: 1) What are the geographical distributions of the bats in New Mexico? 2) Do the morphological measurements show any geographical trends (inter- and intraspecifically)? 3) Do the bats from this study appear to prefer certain ecological or geographical settings? Analysis of the geographic trends shows distinct patterning in bat ranges in the state, with clear gradients in species diversities. The significance of these patterns remains unclear.

Characterization of Spatial and Temporal Habitat Use by Bats in the Neda Mine State Natural Area

Deanna Byrnes¹, Maureen Rowe², Steven Ugoretz², Jerry Bartelt², James Reinartz³.

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The construction of wind turbines is being considered for generating commercial electrical energy along the north-south oriented portion of the Niagara Escarpment in eastern Wisconsin. An abandoned iron mine at the southern end of the escarpment, in the town of Neda, Dodge County, is the largest known bat hibernaculum in the Midwest, housing up to 500,000 individuals of four species in the winter months. Few reports of bat mortality due to collisions with man-made objects exist in the literature, though bird mortality is well documented. Because of the increasing development of wind energy and its well documented impact on migrating bird populations, there is increasing concern for bats, especially those that occur in high densities.

Spatial habitat use by the bats in the area surrounding the Neda Mine during emergence in the spring and in preparation for hibernation in the fall has not yet been thoroughly documented. Previous studies at the Neda Mine have begun to characterize seasonal and daily activity patterns of the bats, but none has examined which habitat areas outside the mine are important, or how peak activity times might be predicted. This study, in its early stages, will utilize volunteers to continue visual observations of emergences, acoustically monitor transects and remote grids, monitor emergences at mine adits using infra-red counters, and net and band individuals during the spring and fall. The project is designed to serve several purposes: to evaluate the potential impact of wind energy development on the mine's bat populations, to increase the understanding of bat movement patterns and interactions with the ecosystems of Horicon Marsh Wildlife Refuge and the Niagara Escarpment, and to gain a solid population baseline for future studies of midwestern bats. This information will not only contribute to the understanding of "cave-bat" ecology, but is essential to making recommendations regarding the proposed wind-energy development to safeguard this important hibernaculum.

A New Method in the Study of Bat Activity Patterns

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Telemetry is an accepted method in the study of bats and their activity patterns. One of the problems associated with telemetry is the amount of time and effort necessary to collect detailed activity data. We devised an automated system to collect telemetric data. The system records the transmitter signal strength and the pulse rate in any time increment set by the researcher. The unit also can be used to collect environmental data such as relative humidity, light intensity, and temperature. The system can be used with a scanner to track multiple animals. To interpret the data collected, the researcher must understand the factors that affect the results including the effect of distance on the signal strength, temperature on pulse rate, and the limits of the equipment. With this knowledge and a correctly programmed system, researchers can gain a minute-by-minute knowledge of bat activity patterns.

Bat Usage of the Weymer Creek Cave System on Northern Vancouver Island

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Ministry of Environment, Lands and Parks, Nanaimo, British Columbia,

Island Karst Research, Victoria, B. C., and Royal B. C. Museum, Victoria, B. C.

Weymer Creek karst area, located in forested coastal northern Vancouver Island, British Columbia, is an important hibernaculum site for *Myotis volans*, *Myotis lucifugus*, and the endangered *Myotis keenii*. Very few bat hibernation sites have been located in British Columbia and Labyrinth Cave in Weymer is the only known hibernaculum for *Myotis keenii*. Since the largest known hibernaculum in Labyrinth Cave has its main entrance above 900 metres, we suspected that bat hibernation in coastal areas may be related to the constant cool temperature over the hibernation period in the higher elevation caves. If this were true, then efforts to locate and conserve bat hibernacula in coastal karst areas might be focused on higher elevation sites.

In order to investigate year-round temperature regimes in relation to bat usage in this forested karst environment, we deployed a replicated series of temperature and humidity loggers on the surface, within cave entrances, and deep within caves near sea-level, at 600 metres and 900 metres elevation in both natural and 20 to 25 year old clearcuts. We then monitored cave use by bats by placing ultrasonic bat detectors near cave entrances and within caves. Cave inspection, guano catchment sheets, bone collection, and netting also provided information on which cave systems were used by bats at which times of year.

Thus far, with nearly one year of temperature and humidity data, it appears that the high elevation caves have year round low, stable temperatures (between 5°-7° C). All significant caves above 500 metres have bat use, including caves in the clearcuts. We captured four species of bats using the caves: *Myotis lucifugus*, *M. yumanensis*, *M. volans*, and *M. keenii*. *Myotis californicus* was captured in the adjacent forest but was not recorded using the caves. Over two August netting periods we witnessed "swarming" bats flying in and out of the caves. Between August 9th and 13th we captured over 80 individual bats, including 5 *Myotis keenii*. Except for 3 non-breeding females, all bats were males with enlarged genitals. Our work thus far points to the importance of the caves for bats at all times of year. We are seeking funding to continue temperature monitoring, cave use monitoring and radio-telemetry to provide further information on bats and their relationship to forested karst environments.

The abstract of Clark, et al, **Radio-tracking of *Corynorhinus rafinesquii* and *Myotis austroriparius* in South Carolina** appears at the end of this section

Digestion and Assimilation of Blood by Two Species of Vampire Bats *Desmodus rotundus* and *Diaemus youngi* and its Implications for Resource Partitioning.

Claudia E. Coen. Section of Ecology and Systematics, Cornell University, Ithaca NY

This paper received the Bat Research News Award as best paper on any topic by a student.

A study was conducted to determine if there are physiological differences in the digestion and assimilation of blood by two genera of vampire bats, *Desmodus rotundus* and *Diaemus youngi*. *Desmodus rotundus* feeds terrestrially, primarily on mammalian blood and has become a significant pest of domestic livestock. *Diaemus youngi* feeds arboreally primarily on avian blood. Hypotheses which support resources partitioning by these two species on the behavioral and morphological level exist. Differences in feeding behavior have been documented and differences in morphological features associated with feeding have been described. This work investigates if there is evidence for resource partitioning of the sanguivorous niche at the physiological level by these two species.

Two male, adult *Desmodus rotundus* and five male, adult *Diaemus youngi* were subjected to quantitative nutritional trials under controlled experimental conditions for seven days. The animals were housed individually in digestion chambers especially designed for nutrition studies with bats. Each animal was fed its own weight in defibrinated, cow blood daily. Consumption and excretion were recorded on a daily basis. Urine and feces were collected together as excreta. Pooled samples of feed and excreta were analyzed for dry matter, protein, ammonia, urea, fat, calcium, phosphorus and sodium. Data were analyzed by one-way ANOVA. T-tests of the means for these two species showed that there is a significant difference in the assimilation of dry matter, protein, urea, calcium and phosphorus by *Desmodus rotundus* and *Diaemus youngi* fed defibrinated cow blood.

These results indicate that *Desmodus rotundus* and *Diaemus youngi* are physiologically constrained to their respective diets suggesting that they are partitioning the sanguivorous niche beyond the behavioral and morphological levels alone. Additionally, rigorous studies are currently underway to test this hypothesis further.

Microsatellite Analysis Reveals High Levels of Genetic Variation in Captive and Wild Populations of the Endangered Rodrigues Island Fruit Bat

Lisa B. Comeaux, Gary F. McCracken, and Kim Whitman.

University of Tennessee, Knoxville, TN; and Zoological Society of Philadelphia, Philadelphia, PA

This paper received the Bat Conservation International award as best paper on Conservation by a student.

Following severe population declines, two captive breeding programs were established in 1976 for the Rodrigues fruit bat, *Pteropus rodricensis*, one at the Jersey Zoo, and one on Mauritius. The captive populations have now grown to more than 470 individuals, held at various institutions. The sole wild population on Rodrigues Island remains below 1500 individuals. We developed a suite of six microsatellite primers which are effective for assessing genetic variation in numerous pteropodid species. Using these primers, we compared genetic diversity between wild and captive individuals descended from both the original Jersey colony (held by the Lube Foundation, Inc.) and the Mauritius colony. Samples from 14 wild-caught individuals were obtained from Rodrigues Island in 1995. Three of these primer pairs revealed high levels of heterozygosity in both the captive and wild populations. The remaining primers show no genetic variation in *P. rodricensis*, despite showing moderate levels of variation in other *Pteropus* species. Primer 18 reveals seven alleles in the wild and Lube populations, and five alleles in the Mauritius colony, with heterozygosity values of 0.85, 0.79, and 0.7, respectively. Primer 4 produces four alleles in both the wild and captive colonies, however the Lube colony possesses an allele not found in the Mauritius colony or the wild population. Conversely, the Lube colony lacks an allele found in the wild population and the Mauritius colony. Heterozygosity values are 0.79 for the wild population, 0.42 for the Lube colony, 0.5 for the Mauritius colony. Primer 9 produces the same four alleles in all populations. Heterozygosity values are 0.62 for the wild population, 0.59 for the Lube colony, 0.50 for the Mauritius colony. Overall average heterozygosities at these three loci are 0.76 for the wild population, 0.60 for the Lube colony, 0.57 for the Mauritius colony. Our microsatellites demonstrate that the captive populations retain substantial allelic diversity and heterozygosity despite the small size of their founder populations and unquestioned history of inbreeding and genetic drift. These data also reveal the apparent loss of variation levels from that of the wild population

Elevational Tendencies of Reproductive Female Bats in the Southern Black Hills of South Dakota.

Paul M. Cryan, Michael A. Bogan, and Gregor M. Yanega.

Biological Resources Division, United States Geological Survey, Albuquerque, NM

Located in the midst of the Northern Great Plains and more than 200 km from the nearest mountain range, the Black Hills provide a unique setting for mammalian studies. The Black Hills sustain a diverse assemblage of bat species, many of which are not known from the surrounding plains. Previous capture records indicated that 10 bat species, with both western and eastern affinities, breed in the region during the summer months. However, very little was known about the seasonal movements or roosting habits of reproductive bats in the area. We mistnetted bats in the southern Black Hills for three summers as part of our ongoing effort to understand population trends and roosting habits of bats in the region. We incorporated our capture data with data gathered in the same area by other researchers during three previous summers. Combined, these data represent a total of more than 1800 capture records from over 43 sites in the southern Black Hills. Males comprised more than 79% of the total number of bats captured in the region and all ten species captured exhibited sex ratios that favored males. Analysis of capture data revealed that elevation is a significant factor affecting the distribution of reproductive female bats. Reproductive females were captured primarily at lower elevations, while males and non-reproductive females were captured in a wider range of elevations. Further evidence indicates that there is a relationship between elevation and reproductive success of female bats in the area. There are several benefits that reproductive female bats may gain by selecting lower elevations that may not necessarily apply to males and non-reproductive females. It is likely that many of the benefits gained by females are associated with warmer temperatures at lower elevations. Could these lower elevation roosts be limited in some way?

Application of Arbitrarily Primed PCR to Genetic Studies of Bats

Michael J. Davies, Gerald Kreider and Karen A. Campbell. Albright College, Reading PA

The Polymerase Chain Reaction (PCR) is an extremely useful tool in molecular biology, as it allows for extremely small amounts of DNA to be amplified to provide suitable quantities of genetic material for analysis by more conventional techniques. For this reason, PCR has become an essential research tool in disciplines such as population genetics and molecular evolution, in addition to its more prominent role in forensic DNA analysis. We have been working to develop a protocol for application of PCR technology to bat biology, to address questions of genetic familial relationships within colonies as well as detecting gene flow between bat colonies.

Essentially, the underlying theory behind PCR involves amplifying specific regions of "target" DNA along with short sequences of nitrogenous bases on either side of the target, termed "primers." Typically, as with human DNA fingerprinting, the exact sequence of DNA to be amplified is known, as is the sequence of the primers. As one moves to other species however, including most bats, there has been considerably less work done to determine sequences of genomic DNA, and so the process is not as straightforward. In this case, arbitrary primers of varying sequences have successfully been used to fingerprint genomes and have been found to provide useful genetic markers.

We have used arbitrary primers to randomly amplify polymorphic DNA in a pilot study using genomic DNA from *Artibeus jamaicensis*. It seems as though this technique can be as readily applied to other questions in bat population genetics, despite the absence of genomic sequencing data for most bat species.

Behavioral Comparison of Two Species Of Flying Fox in a Captive Colony at the Cape Tribulation Tropical Research Station

Karen DeAngelis and Hugh Spencer.

Cornell University, Ithaca, NY and Cape Tribulation Tropical Research Station, Queensland, Australia

Flying foxes (Megachiroptera: Pteropodidae), members of the genus *Pteropus*, are found in a wide geographical area in the tropics and sub-tropics of the Old World and encompass about 80 species, four of which are found in Australia (Pudiccombe, 1981). This group of large frugivorous and nectivorous bats

play an important part in the regeneration of rainforests and eucalypt forests by acting as pollinators and by dispersing seeds (Roberts, 1996). However, Australian flying fox populations are in danger: their habitats and food sources are being destroyed through logging, agriculture and development; they are being killed by farmers when they raid orchards, and some conservation efforts aimed at protecting them are suffering as a result of the recent discovery that flying foxes can carry two viruses harmful to man. Not enough is currently known about flying foxes to solve any of these problems.

Spectacled (*Pteropus conspicillatus*), black (*P. alecto*) and little red (*P. scapulatus*) flying foxes often occupy the same roost areas, with the smaller bats often excluding the larger ones from the colony sites. A comparative behavioral study of the two species groupings of flying fox, *P. conspicillatus* / *P. alecto* and *P. scapulatus*, was carried out in a captive colony at the Cape Tribulation Tropical Research Station. It aimed to determine if there were significant differences in social and feeding behavior between these species and the nature of any differences which might have management significance. Twenty-four hour activity level studies were conducted and intensive long-term observations of fourteen individuals in the captive colony were carried out. It was found that both groups have similar schedules of activity within a twenty-four hour time period and exhibit more positive (beneficial) behaviors towards conspecifics, while the negative (antagonistic) behaviors are directed equally towards conspecifics and those of the other species. Most of the positive behaviors occurred during the morning, while the negative behaviors occurred more frequently during the evening. Further studies need to be conducted with wild flying foxes to determine if these findings can also be applied to those populations to determine a long-term management plan.

Prey Selection by Insectivorous Bats in New Mexico: A Consideration of Sampling Bias.

Tagide N. deCarvalho, William L. Gannon, John B. Kendall, Andrew R. Deans, and Richard B. Fagerlund.
Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM

We sampled about 20 sites for both insectivorous bats and their potential prey species. Bats were captured using mist nets or a harp trap; echolocation calls were recorded using an Anabat bat detector. Insects were sampled using a battery-operated ultraviolet light trap, as well as by sweep netting. Some insects were collected by hand. Chiropteran fecal samples were analyzed for insect remains from bats that were captured and released. Stomach contents were examined from bats that were retained as voucher specimens. We present results comparing abundances of free-ranging insects versus insect abundances as determined from fecal counts and stomach contents of bats. Light traps may be biased in sampling available prey resources because they only emit in the UV range. Numerous available prey may not be sampled using only one type of light trap. The primary outcome of this initial work is to create a reference collection of potential bat prey. We hope to determine that by sampling both bat and insect community year round whether bats select prey opportunistically (prey abundance dependent) or in a fashion that might reduce interspecific competition, independent of absolute prey abundances.

Evidence of Early Parturition in Several Bat Species in Big Bend National Park.

Michael Dixon¹, Susanne Foxworth¹, Jana Higginbotham², and Loren Ammerman².

¹Texas Wesleyan University, Fort Worth, TX; and ²The University of Texas at Arlington, Arlington, TX

Big Bend National Park hosts the largest assemblage of bat species in North America. In spite of this diversity only one major study has been done in this region of the Chihuahuan Desert. We caught bats in mist nets above water sources during the months of March through October 1996 and 1997. We captured 1,606 bats representing 18 species. Pregnant females were found earlier than previously reported in the following species: *Mormoops megalophylla*, *Leptonycteris nivalis*, *Myotis yumenensis*, *M. velifer*, *Pipistrellus hesperus*, *Eptesicus fuscus*, *Tadarida brasiliensis*, *Nyctinomops femorosacca*, *N. macrotus*, and *Eumops perotis*. This probably reflects the limited sampling conducted during the spring months by Easterla (73a,b). Our most notable finding was two pregnant *L. nivalis* captured on April 25, '96. This is approximately two months earlier than previously recorded and is before *Agave*, their main food source has started to flower. This record gives evidence that this taxon gives birth in the United States as well as Mexico.

Food Hardness and Feeding Behavior in Frugivorous Phyllostomid Bats.

Elizabeth R. Dumont, Northeastern Ohio Universities College of Medicine, Rootstown, OH

Frugivorous bats of the family Phyllostomidae have long been recognized as exhibiting an exceptionally diverse array of craniodental morphologies. Many studies have linked this diversity to variation in fruit preferences. Analyses of vertebrate faunas have demonstrated that food hardness in particular often plays an important role in resource partitioning. This study investigates the impact of food hardness on feeding behavior within and between five sympatric phyllostomid species.

Individuals of *Artibeus jamaicensis* (n=3), *Dermanura phaeotis* (n=2), *Sturnira lilium* (n=3), *Carollia perspicillata* (n=3) and *Glossophaga soricina* (n=1) were videotaped at Curú Wildlife Refuge (Puntarenas Province, Costa Rica) while feeding on figs and ripe papaya carved to mimic the size and shape of figs. The mean puncture resistance of the figs was five times greater than that of the papaya pieces. Variables, including the location of bites along the toothrow, the use of head movements during biting, the numbers of bites used to remove a bolus of food and the number of chews used to process a bolus were recorded.

Clear differences in feeding behavior are associated with food hardness both within and between species. All species (except *Glossophaga*, which did not eat figs) employ different types of bites when eating fig and papaya. While *Artibeus*, *Dermanura*, and, to some extent, *Sturnira* shift their bite points posteriorly and to one side during fig-eating, *Carollia* almost always bites well behind the canines and on both sides simultaneously. *Sturnira* uses head movements during biting far more frequently than any other species, especially when eating figs. Regardless of food type, *Artibeus* and *Dermanura* use more chewing cycles to process mouthfuls of fruit than other species. Finally, while *Carollia* uses more bites to remove mouthfuls of fig, the opposite was true of some stenodermines.

It is likely that interspecific differences in feeding behavior are associated with the morphologic diversity in craniodental structure among these species. Further studies of feeding performance and the mechanical implications of variation in craniodental morphology may provide further insights into the patterns of ecological diversification among phyllostomid frugivores.

Phylogenetic Relationships of the Family Emballonuridae, and Convergences Between Taphozoines and Diclidurines.

Jenna M. Dunlop, York University, Ontario, Canada

The family Emballonuridae is a pantropical group of bats whose affinity for roosting in open areas makes them familiar to many bat researchers. The group has been the focus of several phylogenetic studies, but no consensus had been reached on the relationships between genera. This study examines the phylogenetic relationships between most of the emballonurid species in an attempt to ascertain the monophyly of genera as well as examine the intrafamilial relationships. Forty-three emballonurid species and three outgroup species were coded for 153 morphological characters. The results show that all genera, with the exception of *Emballonura*, are monophyletic. *Emballonura* is clearly paraphyletic, and is rendered monophyletic by the inclusion of *Coleura*. There are several well defined clades within the family. The genera *Taphozous* and *Saccolaimus* are both well supported and together form a well supported basal clade in the family. The genus *Mosia* is the sister group to the clade containing *Emballonura*, *Coleura* and all of the New World emballonurids. There is no support for the monophyly of the New World emballonurids in this study. Several interesting facial characteristics show homoplastic distributions within the Emballonuridae, and are discussed in context of this phylogeny.

The Duty Cycles of Arctiid Moth Clicks are Too Low to Interfere with the Echolocation Abilities of Insectivorous FM Bats.

Dorothy C. Dunning, Lee A. Miller and Vibeke Furrup, West Virginia University, Morgantown, WV, USA and Odense University, Odense, Denmark

It appears that the defensive clicks produced by some arctiid moths in response to tactile and bat-like acoustic stimuli do not interfere with the bats' abilities to find and capture palatable prey. Flying bats catch aerial prey in the presence of the clicks of sympatric arctiids, even when normal sequences of moth clicks occur when the bats are already in the terminal, buzz phase of their echolocation sequence, and the

intensities of the clicks are similar to those measured from live moths and louder than the echoes of the bats' buzz pulses. Moth clicks occur either as single pulses (in moths that lack microtymbal striae) or in bursts (in moths with microtymbals), when the tymbal is deformed and again when it returns to its original configuration. As consequences of this mechanism, it may be that the duty cycles of arctiid moth clicks are too low to interfere with the echolocation abilities of bats, for echoes of buzz pulses may occur in the silent intervals between individual moth pulses and between bursts. The duty cycles of many Nearctic and Neotropical arctiid moth clicks support this hypothesis, for they range from about 10% to 47%, and buzz-like pulses (and probably their echoes) often occur between moth signals.

Utility of Point Transacts and Ultrasonic Recordings for Estimating Bat Habitat Use and Abundance.

Laura E. Ellison, A. Lance Everette, Thomas J. O'Shea, and Michael A. Bogan.
U.S. Geological Survey, Midcontinent Ecological Science Center, Fort Collins, CO

We conducted surveys for bats in Bandelier National Monument and Los Alamos National Laboratory, New Mexico using ultrasonic detectors during the summers of 1996 and 1997. Our primary goals were to assess the utility of AnaBat detectors and point transect methodology for estimating bat activity, diversity, and habitat use and to develop a reference library of echolocation calls of known species from the Jemez Mountains. A secondary goal was to determine whether a density or volume of foraging bats could be estimated with the use of DISTANCE sampling theory in 3-dimensions. We used the AnaBat II bat detector interfaced with a laptop computer in the field, which enabled us to view the frequency time structure of echolocating bats at the time of detection. Our echolocation reference library was developed by recording vocalizations from hand-released bats at 10 mist-netting sites. Eleven species of bats were recorded from hand releases: *Myotis evotis*, *M. volans*, *M. ciliolabrum*, *M. thysanodes*, *M. californicus*, *Eptesicus fuscus*, *Antrozous pallidus*, *Corynorhinus townsendii*, *Lasiorycteris noctivagans*, *Lasiurus cinereus*, and *Nyctinomops macrotis*. We made additional recordings of free-flying *Myotis yumanensis*, *Euderma maculatum*, *Pipistrellus hesperus*, and *Tadarida brasiliensis*. In conjunction with developing a call reference library, we also conducted 17 pilot transect surveys in four major habitat types during the summer of 1996: Riparian/Canyon bottom, Mixed Coniferous Forest, Pinyon-Juniper Woodland, and the 1977 La Mesa fire area. Encounter rates (number of "bat passes" detected/number of points along the transect) were calculated for each habitat type. Four of these transects were replicated in 1997 to examine annual variation in bat activity. Encounter rates varied dramatically among the four habitat types and among points with the highest average encounter rate found along Riparian/Canyon bottom habitats. Mixed Coniferous Forest, Pinyon-Juniper Woodland, and the fire area were less active. Due to the difficulty of estimating a distance to an individual foraging bat, we were not able to use DISTANCE sampling theory to determine foraging densities or volumes. We will summarize the overall utility of conducting point transects with ultrasonic detectors and discuss the limitations and future uses of this methodology.

A Progress Report on the U. S. Geological Survey's Biological Resources Division Bat Population Database.

A. Lance Everette, Laura E. Ellison, Michael A. Bogan and Thomas J. O'Shea.
Biological Resources Div., U.S.Geol. Survey, Midcontinent Ecological Science Center, Fort Collins, CO

There has been increasing concern about declining bat populations in the United States and a large proportion of the U. S. bat fauna has been categorized as Species of Concern (former Category 2 species), or Endangered. However, there has been no single effort to synthesize and evaluate the relatively fragmented information on the topic. In 1995, the National Biological Service (NBS) initiated a project to compile, review and synthesize existing information on the status of bat populations in the United States and Trust Territories. This work is continuing under the U. S. Geological Survey's Biological Resources Division. The primary objective is to provide a central database that can be used to estimate population trends, and perhaps eventually help form the basis for a national monitoring program that can guide priorities for bat conservation. Initial efforts have focused on the construction of a relational database using the software Access and entering count data (1 population estimate/species/date/location) for bat species

from the available published scientific literature. Early emphasis has been on bats considered Species of Concern in the U. S. and Trust Territories. To date the database includes nearly 7,000 observations, with over 2,200 records entered from some 350 publications and the remainder from several state agency databases. We are actively seeking additional data inputs, particularly from unpublished sources including state agency records. An interactive tour of the database and its features will be available during the poster session. Data protection (especially confidential location information), contribution guidelines, future Worldwide Web access, and database products will be discussed.

The Bat Fauna on the Disney Wilderness Preserve and the Occurrence of a Rare Species: *Corynorhinus rafinesquii*.

L. S. Finn. Fly By Night, Inc., Deltonia, FL

The Disney Wilderness Preserve (DWP) consists of 11,000 acres in Osceola and Polk counties, Florida and is managed by the Nature Conservancy (TNC). The preserve consists of pine flatwoods, scrub, forested wetlands, and old grazing land. Under a TNC contract a survey of bats using this property took place in the summer/fall of 1995. Mistnets, bat detectors and night vision scopes were used to detect the presence of bats. Seven species including one classified as rare, and two as status undetermined, by FCREPA (Florida Committee on Rare and Endangered Plants and Animals) were captured. One of these, *Corynorhinus rafinesquii* (the southeastern big-eared bat), was found using an abandoned trailer adjacent to DWP in Sept. 1993. This species had not been previously studied in the state and prior to the discovery of this colony it had not been confirmed with a resident viable population. This site is the southernmost known location of a *C. rafinesquii* maternity colony. From Dec. 1994 to Dec. 1995 the trailer-roost was monitored for presence of bats and hygrothermographs were placed in each room in which the bats were roosting. In the Spring of 1997 the South Florida Water Management District built a structure near the trailer-roost to provide an alternate roost site for this colony. Currently, under a grant from the Walt Disney World Company, temperature, humidity, light level, and bat activity in the new structure and the trailer-roost are being monitored. The details of the property survey and information learned from monitoring the trailer-roost will be discussed.

Is Fruit Set in Saguaro Cactus *Carnegiea gigantea* Bat-Dependent?

Theodore H. Fleming. University of Miami, Coral Gables, FL

The saguaro cactus, *Carnegiea gigantea*, is one of many species of Mexican columnar cacti that bear large white flowers that open at night and contain copious amounts of pollen and nectar. Bats, primarily of the genus *Leptonycteris*, would appear to be the major, if not the exclusive, pollinators of these flowers. Saguaro, however, is the northernmost of these cacti, and its flowers open later at night and remain open much longer the next day than other Mexican columnar cacti. This raises the question: To what extent is fruit set in saguaro bat-dependent?

To answer this question, I report data on the results of pollinator exclusion experiments at three sites (2 in Arizona, 1 in Mexico) over a total of 7 years. Fruit set in saguaro is uniformly high (mean = 63.6%) across sites and years, but the contribution of bats to fruit set usually is low. In 6 of 7 years, fruit set contributed by bat pollination averaged only 23.4% of total fruit set; diurnal birds and honeybees accounted for the other 76.6% fruit set. Only in 1995 at Bahia Kino, Mexico, did pollination by *Leptonycteris* bats account for most (86%) of saguaro fruit set. Spring 1995 at Bahia Kino was unusually cool, and saguaro flowered earlier in the year than cardon (*Pachycereus pringlei*), which outcompetes saguaro for bat visits when both species bloom together.

Fruit set in saguaro is less bat-dependent than that in other Mexican columnar cacti. I hypothesize that migratory *Leptonycteris* bats are less reliably available as pollinators than diurnal pollinators at the northern distributional limits of columnar cacti. Saguaro is "hedging its bets" by making its flowers available to both nocturnal and diurnal pollinators. The major outcome of this flowering strategy is the evolution of a different flower opening and closing schedule and a different nectar secretion schedule from that of bat-dependent columnar cacti.

Censusing Bats Using Advanced Digital Infrared Detection and Image Processing Techniques.

Jeff D. Frank, Jeffrey Heath and Thomas H. Kunz.

Indigo Systems Corporation, Santa Barbara, CA; Boston University, Boston, MA

The protection and conservation of endangered and threatened fauna requires accurate and reliable methods for estimating numbers of animals present in the natural environment. For gregarious taxa, such as some bat species, visual counts in roosts or during nightly emergence can be highly effective. However, for other species which form exceptionally large roosting aggregations, direct visual counts either within the roost or during nightly emergence have proven to be impractical and unreliable. We tested the feasibility of censusing Mexican freetailed bats (*Tadarida brasiliensis*) using an advanced infrared detection system coupled to a digital image recording and processing system. Imagery collected at an artificial roost (University of Florida Bat House, Gainesville, Florida) and at a natural cave (Eckert James River Cave, Mason, Texas) will be presented. In the infrared spectrum, emerging bats are high-contrast targets against natural backgrounds, allowing for easy detection in a wide variety of conditions independent of ambient light. Digital infrared imagery recorded continuously at high speed produces data that can then be subjected to image processing techniques which reliably segregate and count individual bats in an emerging column. Our preliminary results suggest that this system has tremendous potential for censusing bats for conservation research. Additionally, a proposed in situ population monitoring system will be described that would allow census data for bat populations to be collected and reduced on a daily basis, providing potential insights into bat activity as a function of life-history stage, climate, season, human interference, and other environmental factors.

[HTTP://SEVILLETA.UNM.EDU/~WGANNON/BATCALL.HTML](http://sevilleta.unm.edu/~wgannon/batcall.html): An Interactive Web Page.

William L. Gannon & Chris Corben.

Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM

In 1995 we formed the New Mexico Bat Survey and Acoustic Library as a web site on the server of the Sevilleta Long-Term Ecological Research project in the Department of Biology of the University of New Mexico. The purpose of this web site is to post echolocation call sequences recorded by the AnaBat bat detector system from bats that have been caught, identified (verified), and hand-released prior to recording in the field. Currently we are able to provide uploading and downloading of calls (via File Transfer Protocols), downloading of the current version of the AnaBat software, and postings by researchers using the AnaBat system. Furthermore, we have listed several documents to assist newcomers to bat acoustics in using bat detectors. A list of literature citing use of bat detectors also is available. This web site is linked to other known regional bat call libraries, to the Sevilleta LTER page, to the Museum of Southwestern Biology page, and to several other sites of interest to mammalian ecologists. A demonstration of this page will be provided during the meeting.

The Establishment of a Bat Colony in a Dedicated Structure (Bat House) and its Impact on Neighboring Human-occupied Educational Structures: An Environmental/Educational Bat Management Strategy for the Suppression of Colonization by *Tadarida brasiliensis cynocephala* in University of Florida Buildings.

Kenneth V. Glover and William Properzio.

University of Florida, Gainesville

Responding to environmental pest problems associated with the colonization of two athletic stadiums by *Tadarida brasiliensis cynocephala*, the University of Florida Environmental Health and Safety Division and University Athletic Association embarked on a project to construct a habitat (bat house) and relocate the problem colonies. Following unsuccessful efforts to artificially establish a colony at the newly-built Bat House from 1991 - 1994, sustained, voluntary occupancy began in early 1995. Spring of 1997 marked

the third year of sustained occupancy by a non-migratory maternity colony, currently estimated at 60,000. This has resulted in the total elimination of problems reported in association with bat invasion and colonization of campus buildings. Prior to sustained, voluntary occupancy of the UF Bat House in early 1995, colonization of and exclusion from human-occupied educational structures had occurred in 19 buildings and two mass-seating structures from 1991-1994. The University has established a formal observation area to allow the public to observe the nightly outflight of the bats, resulting in a heightened public awareness of the value of bats in the environment and the need for preservation of the species. A summary of the steps taken to exclude and relocate a native bat species to a specialized structure will be reviewed. The features of the structure will be outlined with emphasis on efforts that may have contributed to the acceptance of the habitat, as well as discussion of aspects of the project which may have had a detrimental or delaying effect on its eventual success. The site of the current bat house is scheduled for campus building expansion, and advanced planning is currently underway to design and construct a replacement facility.

Summer Use of Highway Bridges by Roosting Bats in North Florida.

Jeffery A. Gore and Julie A. Hovis.

Florida Game and Fresh Water Fish Commission, Panama City and Ocala, FL

We evaluated the use of highway bridges in north Florida as roosting sites for bats by surveying a random sample of bridges and by soliciting information about known roosts. In May and June 1995 we checked 263 (10%) of 2,612 highway bridges in 34 north Florida counties and found bats roosting at 9 bridges (3%). Roosts were on bridges that passed over other roads or railroads as well as on bridges that crossed water. Bridges made of wood comprised 16% of the sample, but we found bats roosting only on bridges that had decks, girders, or supporting columns made of concrete. In addition to the 9 randomly selected bridge roosts, incidental surveys and reports from other sources provided 20 other bridges in north Florida with roosting bats. Occupied bridges had large components of concrete with vertical expansion joints approximately 1.5 -3.0 cm wide in which most bats roosted. Not all roosting bats could be identified; however, *Tadarida brasiliensis* and *Eptesicus fuscus* were each found at 19 bridges, often together. *Myotis austroriparius*, *Nycticeius humeralis*, and *Corynorhinus rafinesquii* each roosted at 1 bridge. *C. rafinesquii*, unlike the other bats, roosted on open concrete surfaces and not within expansion joints. At least 13 of the 29 occupied bridges supported >1 species and at least 1 maternity colony of each species was found.

Systematic Relationship of the New Zealand Short-tailed bat *Mystacina tuberculata* Mystacinidae to Other Bats, Based on Hyoid Morphology.

Thomas A. Griffiths. Illinois Wesleyan University, Bloomington, IL

The New Zealand short-tailed bat has been placed with the families Emballonuridae, Noctilionidae, Phyllostomidae and Molossidae by various authorities at various times since its original species description by Gray in 1843. In recent decades, most authorities have followed Miller's (1907) tentative placement of mystacinids near the large families Vespertilionidae and Molossidae, within the superfamily Vespertilionoidea. However, in the mid-1980's, Elizabeth Pierson's immunological data suggested a close relationship of *Mystacina* to *Noctilio* in particular and the superfamily Noctilionoidea (=Phyllostomoidea) in general. Dissection of the hyoid region of *Mystacina* reveals that it shares a suite of hyoid character states that collectively compose what I have called a "free-floating" hyoid region. Among the Chiroptera, only noctilionid, mormoopid, and phyllostomid bats have previously been shown to possess the free-floating character states, though some vespertilionoid families have a primitive version of this condition. Analysis of the hyoid data strongly supports placement of *Mystacina* with the New World Noctilionoidea, as Pierson suggested, though the data do not clearly indicate a close relationship with any of the three families within the superfamily. I have suggested in the past that development of the free-floating hyoid condition may have been at least partly responsible for the ability of noctilionoid bats to exploit a wide variety of trophic niches (insects, fruit, nectar, and fish, among others). It is interesting to note that *Mystacina*, although clearly primarily insectivorous, also has been observed to be a carnivore and frugivore, and may take nectar and pollen during certain times of the year.

An Update On the Status and Conservation of Pennsylvania's Cave-dwelling Bats

James A. Hart, Cal Butchkoski, and Jerry Hassinger.

Shippensburg University, Shippensburg, PA; Pennsylvania Game Commission, Wildlife Diversity Section, Millersburg, PA; Pennsylvania Game Commission, Petersburg, PA

During the nine years following the publication of "Status of Cave-Dwelling Bats in Pennsylvania" (Dunn and Hall, 1989, Journal of the Pennsylvania Academy of Science 63:166-172), a great deal of additional information has been gathered. The Wildlife Diversity Section of the Pennsylvania Game Commission, with the assistance of volunteers of various caving organizations, has continued to carry out mid-winter bat hibernacula surveys. In the process of accumulating this data, the PGC has developed an information base that is widely recognized by bat conservation groups as one of the most complete pictures of any states over-wintering bat population. The construction of "bat-friendly" gates at several of the sites has led to increases in the populations of bats at those sites. Along with the protection of bats, many previously unknown species occurrence records have been discovered. Among these are 20 new localities for the small-footed bat *Myotis leibii* which includes 4 county records in Westmoreland, Fayette, Bedford and Snyder counties, 34 new localities for the northern long-eared Myotis (*Myotis septentrionalis*) with 6 county records in Monroe, Lehigh, Northumberland, Lawrence, Mercer and Venango counties and 4 additional sites for the Indiana Bat (*Myotis sodalis*) in Luzerne and Mifflin counties. While the majority of sites continue to be found in limestone caves, significant hibernating populations have been found in both limestone and iron mines. Mist netting and harp trapping at several anthracite mines in the northeast region of Pennsylvania has revealed significant numbers of swarming bats during late fall, but due to the inherent danger of these sites, underground surveys have not been carried out. Other ongoing programs include an annual Summer Maternity Colony Survey and a Bat Box Monitoring Program.

Use of Noncontact Thermometers For Temperature Mapping of Bat Roost Sites

Paul A. Heady III. Mount Hermon, CA

One possible parameter for roost selection is temperature. Preliminary research on the use of noncontact infrared thermometers to assess substrate temperatures in roost sites has been conducted in California this summer. These infrared thermometers allow immediate, long distance, noninvasive temperature assessment. These devices were used in many settings such as attics, caves, buildings, and bridges.

Using a Plastic Gate to Evaluate Bat Compatibility Prior to Construction of a Steel Gate on an Abandoned Mine.

Susanna G. Henry¹, David C. Dalton², Marion C. Vittetoe³, Virginia M. Dalton², Nancy Nicolaj⁴, Pat Brown⁵, and Robert Berry⁵. ¹Bureau of Land Management, Yuma, AZ; ²D2 Chiropterology; ³Tucson, AZ; ⁴Bureau of Land Management, El Centro, CA; and ⁵Brown-Berry Biological Consulting

There has been increasing interest in recent years in protecting valuable bat habitat in abandoned mines and in caves by constructing steel gates. The gates are designed to exclude human entry by unauthorized persons who might knowingly or unknowingly disturb bats. The steel gates are designed to allow access by bats. Gates have been found to be an effective protection measure for some species of bats but have not been accepted well by others. Our study site is the 3C Mine, an abandoned mine on public land in southeastern California. We are examining the effect of placing a steel gate on the mine on California leaf-nosed bats (*Macrotus californicus*) and a maternity colony of Yuma myotis (*Myotis yumanensis*) by initially installing a removable plastic gate. The gate is composed of three-inch diameter polyvinyl chloride (PVC) pipe. After constructing the gate, we videotaped the reaction of the bats during an outflight using a videocamera equipped with a night-vision scope and used infrared lighting. Additional monitoring on other nights was completed without videography. Our initial results indicate that construction of a steel gate in the same configuration as the plastic gate is likely to be well-accepted by the bats at the 3C Mine.

High Anaerobic Potential of Flight Muscles in the Big Brown Bat, *Eptesicus fuscus*.

John W. Hermanson. College of Veterinary Medicine, Cornell University, Ithaca, NY

Previous studies on flight muscle design have shown that vespertilionid bats have relatively homogeneous designs: there is a single muscle fiber type throughout the muscle assayed either by the type of myosin isoforms or by the qualitative presence or absence of aerobic and anaerobic enzyme pathways. Previous research suggested the hypothesis that *Myotis lucifugus* (Vespertilionidae) and *Tadarida brasiliensis* may exhibit this focused aerobic design in the flight muscle to facilitate endurance flights lasting longer than 2 hours. The present study was undertaken in response to the suggestion by Brigham et al. (1992. J. Comp. Physiol., 160:283) that bats exhibiting shorter duration flight times (less than 2 hours) may have elevated anaerobic potential. Four *E. fuscus* (2 males and 2 females) were used in the present study. Standard histochemical analysis (ATPase and two metabolic enzyme assays) and immunocytochemical analysis (fast and slow myosin antibodies) demonstrated that the pectoralis, serratus ventralis (caudal portion), and subscapularis were all composed in their entirety of type Iia fibers, a designation based on myosin ATPase and isoform systems. These three muscles were also uniformly composed of muscle fibers with a strong reaction to nicotinamide adenine dehydrogenase (NADH-TR) indicating high aerobic potential as well as a strong reaction for α -glycerolphosphate dehydrogenase (GPD). The short head of the biceps brachii also contains uniform populations of type Iia fibers, however, approximately 50% of the fibers are high GPD, and the remainder are low or intermediate GPD fibers. These data suggest that some bats exhibiting short nightly flight bouts may have some of the metabolic properties of a sprinter. Further analysis will include biochemical assays for activity levels of the specific enzymes.

Noteworthy Records on Several Species of Rare Bats of Big Bend National Park.

Jana L. Higginbotham, Loren K. Ammerman and Michael T. Dixon.

The University of Texas at Arlington, Arlington, TX and Texas Wesleyan University, Fort Worth, TX

Field work conducted in Big Bend National Park, Brewster County, Texas during 1996 and 1997 yielded noteworthy records concerning several bat species of the desert southwest. Foremost is the capture of the Western Yellow Bat, *Lasiurus xanthinus*. One Yellow Bat was captured in a mist-net over an intermittent stream in the river floodplain region of Big Bend National Park. This represents the first capture of the Western Yellow Bat in Texas. Known localities for *L. xanthinus* include parts of New Mexico, Arizona, California and Mexico. Additionally, seasonal records for several rare bats were recorded during the two study seasons. In 1996, an early capture date was recorded for *Leptonycteris nivalis*, the Mexican Long-nosed Bat. Late capture dates were recorded for both *Nyctinomops femorosacca*, the Pocketed Free-tailed Bat and *Nyctinomops macrotis*, the Big Free-tailed Bat. In the spring of 1997, early capture dates were obtained for both *Nyctinomops macrotis* and *Eumops perotis*, the Western Mastiff Bat. Another noteworthy record includes the first capture of a Spotted Bat, *Euderma maculatum*, in Big Bend National Park since 1971.

A mist-netting survey over water sources at fourteen sites throughout the park during the 1996 field season yielded totals of 515 netting hours and 725 bats. All captures were weighed, sexed, measured and checked for reproductive condition. *N. femorosacca*, *N. macrotis* and *E. perotis*, molossids considered uncommon in Texas, comprised 28% of the individuals captured at two study sites during the 1996 survey. Similar results have been encountered in the 1997 survey. These rare molossid species appear to be utilizing specific regions of the river floodplain.

Post-natal Growth and Milk Composition in Four Species of *Pteropus*.

Wendy R. Hood, Boston University, Boston, MA

Growth measurements were taken and milk samples collected from four species of *Pteropus*, *P. hypomelanus*, *P. pumilus*, *P. rodricensis*, and *P. vampyrus*) housed at the Lubee Foundation, Gainesville, FL between 1991 and 1996. Post-natal growth rates were established for several different anatomical features including body mass, wing area, zygomatic breadth, forearm, thumb, 1st through 3rd metacarpal,

tibia, and ear length. The reliability of each parameter for age estimation and differences in growth rates based on gender of the young, weight of the mother, and season are examined.

Using conventional methods, milk samples from individual bats were assayed for proximate or mineral components. Proximate components assayed included fat, protein, carbohydrate, dry matter, and energy. Mineral components measured included calcium, potassium, sodium, magnesium, and phosphorus. Both proximate and mineral components were consistent in all species throughout the four to six month lactation period. The species specific means for fat, protein, and carbohydrate composition ranged between 6-9%, 5.5-6.5%, and 2.5-3%, respectively, variation between species was not significant. Similarly, mineral content was also consistent. The species specific means for calcium, potassium, sodium, magnesium, and phosphorus ranged between 1-1.4, 0.7-9.5, 0.85-1.5, and 1.0 mg/g wet sample, respectively. The most variable components were fat content and calcium. Factors which may be associated with this variation are addressed, including time of day milk was collected, maternal condition, and season.

Metabolic Rate as a Function of Ambient Temperature in *Artibeus jamaicensis* and *Phyllostomus discolor*.

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¹Potsdam College of S.U.N.Y., Potsdam, NY and ²University of Scranton, Scranton, PA

Many papers have appeared describing various aspects of thermoregulation in phyllostomid bats and there appears to be much variation in thermoregulatory strategies between species depending on body mass, diet, geographical distribution, food availability, and other variables. We compare the metabolic response to decreasing ambient temperature (T_a) in *Artibeus jamaicensis* and *Phyllostomus discolor*, two species which have very similar diets, are of very nearly the same body mass, and are sympatric in many parts of their ranges. In an attempt to reduce the stress on the bats during this procedure we attempted to make the experiments as unintrusive as possible. Rather than placing the individuals being tested in strange or exotic metabolic chambers, we re-designed our cages so that the metabolic chamber is actually part of their permanent cage. The chamber is small, dark, and quiet, and when not being tested, the bats preferred to roost in this small extension of their cage. We determined that bats "at ease" in our chamber had metabolic rates 20 to 50% lower than bats in a "standard" metabolic chamber under similar conditions.

We also examined the difference in metabolic rate of isolated single bats compared to a group of seven animals tested together, and found that at temperatures within their thermoneutral zone there is no significant difference in metabolic rate but when tested at T_a below the thermoneutral zone, the difference between single bats and groups became ever greater with decreasing T_a . Bats tended to huddle ever more tightly as T_a declined.

As T_a decreased below the thermoneutral zone, metabolic rate increased in both species but there is a wide variation between individuals in both species. The low end of thermoneutral zone appears to be nearly the same for both species; but the variation within one species is greater than the variation between the two species. Some bats begin to increase metabolic rate at T_a 24°C while others wait until T_a is below 20°C. We are in the process of lowering T_a to the point where the bats "give up" and become heterothermic and some abandon homeothermy as early as T_a of 22°C. Others continue to maintain homeothermy T_a as low as 15°C. *Phyllostomus discolor* is clearly more capable of dealing with lower ambient temperatures than *A. jamaicensis*.

Introduction Of Rodrigues Fruit Bats *Pteropus rodricensis* into a Mixed Species Chiropteran Zoo Exhibit.

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University of Portland, Portland, OR; Disney's Animal Kingdom, Lake Buena Vista, FL;
and Metro Washington Park Zoo, Portland, OR

Chiropteran captive breeding programs are often restricted by available space to maintain populations. Use of existing zoo exhibit space simultaneously by several species can offer opportunities to make efficient use of limited space. However, dramatic differences in size and strength, combined with territorial and agonistic behaviors of many megachiropteran species, pose potential problems in integrating species.

Eight male and eight female Rodrigues fruit bats *Pteropus rodricensis* were introduced into a mixed species chiropteran exhibit at the Metro Washington Park Zoo in Portland, Oregon in 1994. At the time of the introductions, the exhibit contained host populations of 28 *Eidolon helvum* (male and female), 31 *Rousettus aegyptiacus* (male), and 21 *Artibeus jamaicensis* (male). Concerns about interspecific and intraspecific aggression in this mixed species environment were unfounded, with no serious injuries or increase in agonistic interactions associated with the introduction. Other measures of well-being, including successful reproduction and individual weight gains, also indicated that the introduction was successful. Observations were expanded to include mother-infant interactions, play behavior in juveniles, and exhibit space utilization.

We now have three years of observations with the original population and captive-born progeny, all supporting maintenance of populations of *P. rodricensis* in mixed species exhibits. Such integration can substantially increase the amount of space available to captive breeding programs for endangered bat species. Additional data were collected at the Lubee Foundation, Gainesville, FL.

The Making and Breaking of Bat Protection: When Biological Knowledge Bumps Against Politics and Personal Agendas.

D. J. Howell. Department of Defense Regional Ecosystem Office, Portland,

Experts have provided a body of information on bat natural history, habitat and food preference, physiology, acoustics and response to disturbance sufficient to begin enlightened management/protection for many species. However, field/academic knowledge goes unutilized, unknown or ignored in response to public pressure, competing land use, or biologists' desires to escape the office for the joys of field work with intriguing animals. How much we choose to impact environmental politics by activism is a personal decision, however, the ethics and information with which we do bat biology should involve us all, lest we become part of bats' problems. In the 25 years since the first bat conference, the number of bat biologists has risen dramatically. Our numbers are now strengthened by many agency land managers doing bat work. The impact on populations studied can be dramatic. A call is made for monitoring and guiding regional bat work in order to minimize disturbance and maximize the bang for the research buck. Although "oversight" and "self-policing" may not be politically correct concepts, it is the history of any growing group, whether it be civilizations, villages, clubs, or scientific groups, that guidelines and regulatory provisions be emplaced. Failure to do so is anarchy; bat species pay the price. Examples, horror stories, and constructive suggestions are provided from 3 years' work developing NW bat protection documents and from 25 years work with endangered species.

Foraging Areas and Habitat Use of Rafinesque's Big-eared Bat in Southeastern Kentucky.

Tracy E. Hurst and Michael J. Lacki. University of Kentucky, Lexington, KY

Rafinesque's big-eared bat *Corynorhinus rafinesquii* is classified at some level of concern in each state where it occurs, yet limited information on the life history of this rare bat is available. We used radiotelemetry to identify foraging areas and habitat use of this species at maternity roosts in Robinson Forest and Daniel Boone National Forest, Kentucky. The size of foraging areas ranged from 61.6-225.3 ha. The distance of the geometric center of foraging areas to the maternity roost ranged from 0.12-1.22 km. No bat was detected >2.5 km from the roost of capture; however, observations indicate that bats in a relatively isolated colony remained closer to the roost than bats in a colony that was in close proximity to other known roosts of this species. Bats selectively foraged along ridgelines in upland oak-hickory forest at one of the maternity roosts, with no pattern in habitat selection observed for bats of the other maternity roost. These data demonstrate variability in foraging patterns between maternity colonies of Rafinesque's big-eared bat, preventing generalizations in these life history traits for use in the conservation of this rare species.

Chiropteran Community Composition on the Masoala Peninsula, Madagascar: Distribution, Diversity and Demographics.

James M. Hutcheon. The University of Wisconsin Zoological Museum, Madison, WI
This paper received the Lube Foundation award as the best paper on conservation of pteropids

The Masoala peninsula comprises a large tract of rainforest in the northeastern area of Madagascar. Utilizing mist-nets, sampling of bats was conducted at eight different sites ranging in habitat type from highly degraded villages/towns to primary rainforest. This program was carried out intermittently beginning in 1993 for a total of 10 months of field time. Eight species were collected, with *Rousettus madagascariensis* and *Emballonura atrata* being the most frequently encountered bats. In addition to the mist-netting program, notes were made on the distribution of roosts of *Pteropus rufus* and all reported roosts were visited for verification. Interestingly, *P. rufus* appears to be quite widely distributed on the Masoala peninsula and probably occurs at higher densities than at any other known sites in Madagascar. This observation is reinforced by a review of historical collection and distributional data. A marked finding was the apparent decrease in species diversity with increasing distance from the "mainland." This peninsular effect was observed irrespective of habitat type across almost all observed bat species, and is corroborated by similar observations of a wide range of taxa including reptiles, butterflies, and several species of plants.

Roost Site Selection of Red Bats in Mixed Mesophytic Forests.

Jeff Hutchinson and Michael J. Lacki. University of Kentucky, Lexington, KY

We examined roost sites of red bats *Lasiurus borealis* in mixed mesophytic forests in eastern Kentucky during May through August, 1996-97. Roost trees were located by tracking radio-tagged bats, with bats observed 20-30 minutes before dusk to confirm use of trees and location of bats in the canopy. We recorded a total of 33 roost trees for 10 red bats (male=3; female=7). Red bats selected roost sites high in the canopy near the outer edge of the foliage in dominant or co-dominant hardwood trees. Species of trees used for roosting by red bats included American beech, mockernut hickory, pignut hickory, shagbark hickory, sugar maple, red maple, sweet birch, chestnut oak, white oak, yellow-poplar, sycamore, and American basswood. The mean distance of roost sites to forest edge was 278 m (S.E.=45.8), with all roost sites located >50 m from any edge. Mean height of roosts was 16.7 m (S.E.=0.46), with the mean height and d. b. h. of roost trees being 18.9 m (S.E.=0.38) and 40.4 cm (S.E.=2.11), respectively. Estimated size of foraging areas used by red bats ranged from 198-925 ha. Hobo-temp data loggers were used to measure temperature profiles of roost sites relative to ambient temperatures; the results of these comparisons will be presented.

Differences in the Learning Rates for Pallid Bats from Two Different Environments.

Dave S. Johnston^{1,2} and M. B. Fenton¹.

¹York University, Toronto and ²H. T. Harvey & Assoc.

Pallid bats *Antrozous pallidus* with individually known dietary histories from coastal California and Death Valley were captured and tested for differences in learning abilities and foraging behaviour at the individual and population levels. Latency rates of learning and searching behaviour were measured for 3 foraging tasks in a laboratory situation for each of the subject animals. The coastal bats from an environment with more uniform prey had significantly faster latency rates of learning than the Death Valley bats from an environment with more patchy prey. Coastal bats did not show significant individual differences in latency rates of learning, but Death Valley bats did. Five types of search behaviour were compared at the individual and population levels, and Death Valley bats roosted more time and spent less time on the ground during searches than coastal bats. We tested naive non-volant juveniles for an affinity to low frequency sounds, but these results suggested that adult bats' attraction to low frequency sounds is learned.

The Texas Bats and Bridges Project.

Brian W. Keeley and Merlin D. Tuttle. Bat Conservation International, Austin, TX

Human disturbance and destruction of natural habitats have forced many bats to take advantage of bridges and culverts as alternative roost sites. Although bat use of highway structures has been well documented, minimal information exists that defines bat-preferred characteristics. Evidence from this two-year study identifies preferred characteristics by comparing bat-occupied bridges to unoccupied bridges of similar design, and provides information on statewide bat use of bridges and culverts through a survey of 1,160 highway structures from 39 counties in 9 ecological regions. The study also provides information on bat roost impact on structures, and on public and workman safety and methods of including bat-friendly habitat into highway structures. The new National Bats and Bridges Project will also be discussed.

The Affinity of *Mystacina tuberculata* , Based on DNA Hybridization.

John Kirsch, James Hutcheon, Deanna Byrnes and Brian Lloyd.

University of Wisconsin, Madison, WI; and Department of Conservation, Wellington, New Zealand

We carried out DNA-hybridization comparisons among representatives of the major groups of Chiroptera, utilizing carefully-preserved material from an adult female *Mystacina tuberculata* (Chiroptera: Mystacinidae) captured in September 1996 on Mount Ruapehu in central North Island, New Zealand. All analyses confirmed the noctilionoid affinity of *Mystacina* suggested by Pierson's serological study, with bootstrap support of 98% or higher. However, a specific association with *Noctilio* was never found in more than 13% of the bootstraps. Our estimate of the timing of the divergence of *Mystacina*, based on independent indications that extant bat lineages began to diversify in the latest Cretaceous, is 52 myrbp -- much earlier than Pierson's tentative estimate of 35 myrbp. Such a date would allow for distribution of the noctilionoid-mystacinid common ancestor over Australia, Antarctica, and South America (but not New Zealand) before the final sundering of Australia from Antarctica, and for the divergence of Mystacinidae as a possible result. This hypothesis is supported by fossil mystacinids from the Early Miocene at Riversleigh, Queensland showing that Mystacinidae had been resident in Australia from at least as early as 25 myrbp. The most obvious scenario explaining the presence of Mystacinidae in New Zealand is therefore fortuitous dispersal across the Tasman Sea. Alternatively, *Mystacina* may have island-hopped via the archipelagic arc which apparently existed between North Island and northeastern Australia about 40-45 myrbp, and which has been invoked to explain the similarly-dated sister-group relation of kiwis with emus and cassowaries to the exclusion of other ratites. Our results suggest that Mystacinidae ought to be considered a member of Superfamily Noctilionoidea.

Infrared Thermal Imagery as a Tool for Research on Bat Thermoregulation.

Thomas H. Kunz and Jeff D. Frank.

Boston University, Boston, MA and Indigo Systems Corporation, Santa Barbara, CA

Most published studies on thermoregulation in bats have employed invasive procedures, including implanted thermister probes, thermocouples, or radiotransmitters. Body temperatures of bats have either been recorded when individuals were restrained in a roosting situation or tethered to cables in highly restricted flight situations (small flight chambers or wind tunnels). Surface-mounted radiotransmitters have been used with some success to assess body temperatures of free-ranging bats, but the accuracy and reliability of this method are highly variable. Use of advanced digital infrared imagery makes it possible to non-invasively record and monitor changes in surface temperatures of free-ranging bats either while roosting or in free flight, without interfering with their normal activity. The sensitivity of this infrared imagery system makes it possible to monitor surface temperatures of bats under a variety of situations, including arousals from hibernation, thermal gradients in clusters, while in flight, and in different roosting situations. Our preliminary results demonstrate thermal gradients in megachiropterans ranging from a warm body to cool wings at different ambient temperatures. During flight, a bat's surface temperature is highly variable, typically marked by a thermal gradient that decreases from the body to the periphery of the wing.

Typically, the nose of a bat is cooler than the rest of the body, suggesting an important role of the nose in water regulation. Other thermal images indicate potential avenues of heat loss from both roosting and flying bats. The body surface and wing temperatures of Mexican free-tailed bats *Tadarida brasiliensis* showed marked differences as they exited from and returned nightly to their roost. The latter observations support the view that bat wings play an important role for thermoregulation both during roosting and while in flight. Our preliminary results support the hypothesis that bats which roost in the center of a cluster have higher body temperatures than those on the periphery.

High Altitude Foraging by Mexican Free-Tailed Bats: Vertical Profiling Using Kites and Hot Air Balloons.

Gary F. McCracken, Ya-Fu Lee, John K. Westbrook, Ben B. Balsley, and Michael L. Jensen.
Univ. Tennessee, Knoxville, TN; USDA-ARS-SPA, College Station, TX; and Univ. Colorado, Boulder, CO

Mexican free-tailed bats are major predators on agricultural insect pests that fly at high altitudes. Radiomicrophone bat detectors were attached to the tethers of high-tech kites and flown to altitudes of over 1200 m above ground level (agl) at a site approximately 12 km south of Frio Cave in the Winter Garden Agricultural Region near Uvalde, Texas. The simultaneous ascent of three radiomicrophones spaced at 300 m intervals provided continuous, all night, vertical profiling of bat foraging activity. Large numbers of bats are eating insects at all altitudes. We don't yet know their upper limits. In early evening, most bat activity was recorded at altitudes of 500 to 1200 m. In early morning, bat activity was concentrated at lower altitudes, being especially intense at altitudes of 200 to 500 m. Typically, 10 to 30 knot southerly winds develop each evening, mostly at these lower altitudes. These winds persist until after dawn and are used for northward, nightly transport by insect migrants. High altitude activity in the evening suggests that bats leaving the cave and flying south into the agricultural area, go high to avoid the stronger opposing winds below them. On their northward return to the cave in the morning, the bats appear to fly lower to take advantage of the same winds that they avoided earlier. In flying lower, the bats also enter the stream of migrating moths where continuous feeding activity occurred in morning.

Bat and moth activities also were monitored during two hot air balloon ascents between 0400 to 0700h, and to altitudes of over 1500 m. Hot air balloons provide a stable and quiet platform for visual and acoustic recordings and have the advantage of allowing the direct observation of bat and moth activities.

Field Identification of Bat Species Using Ultrasonic Voice Prints.

Karen S. McDonald. Ferrum College, Ferrum VA

The analysis of search patterns in echolocating bats demonstrates that there are distinct difference in species ultrasonic voice prints. Using the Anabat II detection unit four key species of bat were recorded in western Virginia emerging from species specific roost sites. Over one hundred calls were analyzed using discriminate function and cluster analysis. Six parameters were processed to delineate between interspecific calls. These included duration, time between calls, range, frequency high and low, and center frequency. The majority of variation occurred between characteristic frequency and call pattern. This study suggests that individual species may be identified solely by their call, limiting the necessity for direct capture or visual observation and reducing stress on individuals and sensitive populations.

Seasonal Activity of the Hawaiian Hoary Bat on the Island of Hawaii.

Theresa Cabrera Menard. University of Hawaii, Honolulu, HI

The Hawaiian hoary bat *Lasiurus cinereus semotus* is the only extant bat in the tropical Hawaiian Islands. I investigated habitat use by this endangered bat on the island of Hawaii, which is the highest (13,796 ft) and biggest (4,038 square miles) island in the archipelago and presumably supports the largest population of hoary bats in the state. We know the bat uses a variety of habitat types over a wide elevational range (i. e., primarily from sea level to 7,000 ft), but we do not know the degree to which the bat is associated with low-elevation (i. e., less than 2,300 ft), mid-elevation (i. e. 2,300 to 4,600 ft) or high-elevation, (i. e., greater than 4,600 ft) sites at different times of year. From site records in the

literature and my own observations, I identified 23 sites where bats commonly forage. From February 1996 through April 1997, I monitored bat activity at a subset of these sites, as well as at other various locations. Some bats were active at low-, mid-, and high-elevation sites throughout the year; however, the degree of activity varied temporally, seasonally, and with elevation. From January to March, bats were detected more frequently at mid- to high-elevation sites, than at low-elevation sites. In April and May, bats were also detected frequently at low-elevation sites, especially at the coast. Foraging aggregations of 10 to 15 bats occurred along the Kona coast in April 1996 and 1997 and were associated with high densities of termites and beetles. In June and July, no coastal foraging aggregations were observed, though bats were present at the coast and up to 6,200 ft. No monitoring was conducted in August or November 1996, but from late September through early October bat activity was greater than during any other time of the year surveyed. And, along the Kona coast bats again formed foraging aggregations, which were associated with a high density of beetles. In December, bats occurred at low- to high-elevation sites, but did not form foraging aggregations at the coast. Bat activity before sunset was noted at the coast in April, July, September, October, and December, but at sites up-slope bat activity before sunset was only observed during late September and early October.

A Quantitative Comparison between Tree Roosts of the Red Bat and the Seminole Bat.

Michael A. Menzel, Timothy C. Carter, and Brian R. Chapman.
D. B. Warnell School of Forest Resources, University of Georgia, Athens, GA

We tested for differences in roost characteristics between the red bat *Lasiurus borealis* and the Seminole bat *L. seminolus*. The characteristics of roost trees used by red and Seminole bats were compared to all neighboring trees within a 0.04 ha circular plot. We located 64 roosts of the red bat and 34 roosts of the Seminole bat using standard radiotelemetric techniques. The number of trees in the overstory, percent canopy cover, percent conifers in the overstory, overstory height, and richness and diversity of both the overstory and understory differed significantly between the roosts of the red bat and the Seminole bat. Roosts of the red bat were almost always located in hardwoods (97%), while roosts of the Seminole bat were almost always located in pines (94%). Roost trees selected by red and Seminole bats were significantly larger in terms of both diameter and height than neighboring trees. A G2 log-likelihood ratio test indicated that the roosts of red bats were located significantly less often in red maples *Acer rubrum* and loblolly pines *Pinus taeda* and more often in white oaks *Quercus alba* and water oaks *Q. nigra* than expected based on the random occurrence of these species in the roosting areas.

Acoustical Identification of Free Flying Bats in Belize Using ANABAT II: It Really Works.

Bruce W. Miller and Michael J. O'Farrell.
Wildlife Conservation Society, Tropical Forest and Reserve Planning Project, Gallon Jug, Belize, Central America;
O'Farrell Biological Consulting, Las Vegas, NV

In 1995 we began an ongoing study to test the efficacy of the Anabat II bat detector and analysis system for obtaining identifiable vocal signatures for the identification of non-phyllotomid bats. We continue to sample a wide range of elevations and associated habitat types throughout Belize and build on the library of vocal signatures. Some Anabat users have experienced difficulty in identifying bats to species from data collected passively on tape. We find this difficulty minimized by proactively collecting data using a laptop computer, providing an instantaneous output of echolocation call structure and ability to save directly to the hard drive. With experience, many such vocalization patterns are immediately recognizable to species. Unfamiliar patterns are archived for examination at a later time. The Anabat system has proven to be an excellent tool for acoustical identification of most free-flying, non-phyllotomid bats in Belize. Of the 37 species of non-phyllotomid bats expected or known from Belize, nearly 70% (25 species) are now identifiable by vocal signatures. Vocalizations of eight other distinct species are recognizable, but remain unidentified pending capture and verification. Even unidentified vocal

signatures provide information on "morpho species" spatial and temporal distributions, as well as providing a means to measure foraging activity. Archived echolocation calls of unidentified species can be easily updated when identification is made. Using Anabat we have found that species once considered very rare, such as *Centronycteris maximiliani centralis*, may be common in suitable habitats. Anabat has allowed us to select areas based on activity of bats, prior to harp trap placement, to maximize capture potential of focal species. The system also provides a means to survey species that often elude traditional capture methods, such as high flying molossids and many understory emballonurids. Anabat allows rapid detection and identification of bats on the wing during driving transects and during stationary monitoring. Acoustic identification has become an accepted and standard technique in field ornithology for secretive avian species. We suggest that acoustic identification for monitoring bats will become a standard field technique. Once mastered, we have found that the Anabat II system provides a portable, field hardy and cost effective means for accurate acoustical detection and identification of many free-flying bats in the field.

Preliminary Observations of Nightly Activity of the Indiana bat, *Myotis sodalis*.
Susan W. Murray. Eastern Michigan University, Ypsilanti, Michigan, USA

The behavior and ecology of tree-roosting bats is often logistically harder to study than that of bats roosting in more permanent sites, such as manmade structures and caves, and therefore, more research on behavior has been done on bats roosting in permanent structures. This study examined the behavior and nightly activity pattern of a colony of Indiana bats, *Myotis sodalis*, at their day roosts. The two main goals of this study were to determine if the bats were away from the day roost for extended periods, and therefore possibly night-roosting, and secondly, to compare nightly activity patterns of pregnant versus lactating bats. Data were collected at four roost trees in Michigan, from June to August, 1997. A bat detector was used to count bat passes at the roost trees from sunset to sunrise, grouped into ten minute blocks. Behavior of the bats was noted at sunset and sunrise when they were emerging and/or re-entering the day roost (light permitting). Also, the presence or absence of individual bats in the roost was recorded every 10 or 30 min, using radio-telemetry. The results show that there was little or no activity at the day roost for most of the night during pregnancy. The radio-telemetry data show that individual bats left approximately 0.5 h after sunset and did not return until approximately 0.5 h before sunrise. In comparison, there was activity at the day roost all night, during lactation, with two main peaks of activity. The telemetry data show that during lactation, these two peaks of activity were when the transmitter bats were near or in the roost. The lactating bats generally returned to the day roost twice during the night and on average spent less than 20 min in the roost each time. These data suggest that pregnant bats were away from the day roost long enough that they were presumably night roosting for a significant portion of the night. Because the lactating bats returned to the day roost during the night, it is unknown if they were night-roosting in locations other than the day roost. The data indicate that the overall pattern of nightly activity differed between pregnant and lactating bats. The preliminary data from this study will be used to gain further information about night roosting requirements in hopes of expanding the management plan for the endangered Indiana bat.

Soaring & Non-soaring Flying Foxes: Wing Morphology and Flight Performance.

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Because thermal convective air currents are absent at night, bats cannot usually make use of thermal flight. But on some oceanic islands a few large diurnal megachiropteran bats *Pteropus* spp. frequently use thermal soaring or slope soar during foraging flights. We compared the flight morphology of soaring versus non-soaring *Pteropus* species, one pair on the Samoa and one on the Comoro Islands, to estimate their flight performance. We theoretically calculated the gliding and circling performances of both the soaring and non-soaring species. The soaring species on American Samoa, *Pteropus s. samoensis* (0.375 kg) is about 38% smaller than the sympatric, non-soaring, species *P. tonganus* (0.518 kg). It also has lower aspect ratio, lower wing loading, lower relative wing loading, and a longer and more pointed wingtip

than does *P. tonganus*. The non-soaring subspecies *P. s. nawayensis* (0.350 kg) on Fiji is a little smaller than *P. s. samoensis*, and has a slightly lower aspect ratio, higher wing loading and more rounded wingtip. The species pair on the Comoro Islands shows the reverse pattern as regards body size and aspect ratio; the soaring *P. livingstoni* (0.680 kg) is about 50% larger than the non-soaring *P. seychellensis* (0.455 kg) has a slightly larger aspect ratio, almost similar wing loading, but lower relative wing loading. Wingtip roundedness is about the same in both species.

In spite of the opposite relationships of body size and aspect ratio in the soaring vs non-soaring species pairs on the two islands, the soaring and circling performances show similar trends for the soarers versus the non-soarers. The soaring *P. s. samoensis* has a slightly lower minimum sinking speed and a smaller minimum turning radius than has the non-soaring, sympatric *P. tonganus*. On the other hand, the non-soaring *P. s. nawayensis* has similar sinking speed and minimum turning radius as the allopatric *P. s. samoensis*. The soaring *P. livingstoni* also has a lower minimum sinking speed but only a slightly smaller minimum turning radius than has the non-soaring *P. seychellensis*. But when the latter is scaled up to the size of *P. livingstoni* (thus correcting for effects of their size difference), its sinking speed and minimum turning radius turn out to be larger than in the soaring *P. livingstoni*.

Techniques for Evaluating Echolocation Calls of Free-flying Bats Using the Anabat Detector: I. Qualitative Identification.

Michael J. O'Farrell, Bruce W. Miller, and William L. Gannon.

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A variety of bat detectors have been used over the past three decades to identify free-flying bats. Analyses of recorded echolocation calls was slow and the output reduced to relatively few calls and at a resolution obscuring the details of call structure. The relatively new Anabat II bat detector and associated zero-crossings analysis system allows an immediate examination, via a laptop computer, of the time-frequency structure of calls as they are being generated by a bat. These calls can be stored to the hard drive for later examination, editing, and measurement. Bats can be identified to species by qualitatively using certain call structure characteristics, primarily maximum and/or minimum frequencies and aspects of call morphology (e. g., linearity, changes in slope). It is paramount to use sequences of related calls rather than individual calls. A quantitative examination of call characteristics among some species resulted in a variable ability to separate them due to overlap yet qualitative characters (e. g., shape) allowed separation. All calls are not equal and many fragmentary calls must be discounted before making a determination. Each sequence of calls must be examined to ensure multiple bats (i. e., same species or different species) are not being simultaneously displayed, which confounds correct identification. We found the percentage of non-usable calls within usable vocal sequences to be highest in vespertilionids (20 to 40%) whereas other families examined were frequently below 10%. Active rather than passive data collection maximizes the quality and quantity of diagnostic calls and provides a contextual base for the investigator.

Selection of Day Roosts by Female Long-legged *Myotis* .

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We radio-tracked 16 female long-legged myotis *Myotis volans* in the central Oregon Cascades that used a total of 41 day roosts. Large Douglas-fir *Pseudotsuga menziesii* snags averaging 97 + 6.6 cm dbh and 38 + 2.8 m high were the most commonly used roost structures (88%). The odds that a snag is used as a day roost increased as snag height increased; given snag height, the odds of use decreased as the height of the stand within 20 m of the snag increased. The frequency of occurrence of roosts between young and late seral stands did not differ from what was expected to occur by chance in these two stand conditions. Day roosts generally occurred in upland habitats associated with streams that contained night roosts. Management of large diameter, tall, snags that extend above the canopy will provide one component of day roost habitat for long-legged myotis in managed landscapes.

Major Population Differences in a Local Central Arizona Bat Fauna: 1972 & 1997.

Thomas J. O'Shea and Terry A. Vaughan.

U. S. Geological Survey, Fort Collins, CO; and Rimrock, AZ

Considerable discussion has taken place about likely long-term changes in bat populations in the southwestern United States. Prompted by such discussion, in summer 1997 we returned to a unique study area on public land in the Verde Valley of central Arizona where we previously studied bats in 1972 (J. Mammal. 57:19-42; J. Mammal. 58:269-284; J. Mammal. 61:118-119; Southwest. Nat. 21:321-326). Our objective was to determine if major population changes were detectable. The earlier studies emphasized finding day and night roosts of local bat colonies by thorough and repeated searches of ancient Indian dwellings and crevices in surrounding cliff faces. We conducted these searches again in late June-early July 1997 when maternity colonies should have been present and obvious. Major changes were noted. Pallid bats *Antrozous pallidus*, once conspicuous and locally abundant (peak counts of about 180 adults and volant young in 1972), were virtually gone. A colony of about 5000 cave myotis *Myotis velifer* present in 1972 no longer existed. Free-tailed bats *Tadaridabraliensis* had a maternity colony in the area in the late 1960's and were easily netted at the site in 1972, but were not taken in mist nets during our 1997 visit. Small colonies of up to 30 Yuma myotis *Myotis yumanensis* observed roosting at the site in 1972 were not located in 1997. However, during a one-day preliminary visit in August 1996 (a post-breeding period) Yuma myotis were present as isolated singletons in crevices, and fresh droppings of a disbanded, moderate-sized colony of an unknown species were present in one shallow cave. In 1997 we found breeding big-eared bats *Corynorhinus townsendii* at the site, which were unknown at this location in 1972. Small numbers of big brown bats *Eptesicus fuscus*, California myotis *Myotis californicus* and western pipistrelles *Pipistrellus hesperus* occupied the site in both 1972 and 1997. The most obvious change in local conditions over the 25-year period is a dramatic increase in recreational use of the area.

The Behavior and Natural History of the Forgotten Pollinator: *Choeronycteris mexicana*

William D. Peachey. Colossal Cave Mountain Park, Tucson, AZ

Seasonal investigations of the Mexican Long-tongued Bat *Choeronycteris mexicana* from 1993 through 1997 at low elevation sites in eastern Pima County, Arizona, U. S. A. reveal new insights concerning the behavior and natural history of one of North America's least known species. The largest known number of maternity roosts for the species is found within Colossal Cave Mountain Park and the Cienega Natural Preserve within upper Sonoran habitat at a mean elevation of 1067 meters. There, an expanded range of occupancy from early May to mid-November, is used to raise young upon the nectar of a cactus and two species of agaves. Discovery of two time periods of roost vulnerability accent the need for human protection of roost sites despite this species habit of carrying its young.

The Largest Maternity Roost of *Leptonycteris curasoae* and its Relationship to Organpipe Cactus, *Stenocereus thurberi*.

William D. Peachey and C. Thomas Bethard. Colossal Cave Mountain Park, Tucson, Arizona

The distribution and vector orientation of a disjunct population of Organpipe cacti *Stenocereus thurberi* coincide with the least effort pathway to the nearest food supply for the largest maternity roost (100,000 +) of *Leptonycteris curasoae*. This relationship provides the first proof that nectar feeding bats are not only responsible for pollination of Sonoran Desert columnar cacti but are also responsible for their dispersal. The disjunct population of the Organpipe cactus *Stenocereus thurberi* was mapped at the geological and geographical limit of the species on the lava flows of northwestern Sonora, Mexico. It is in the Lower Colorado River Valley subdivision of the Sonoran Desert botanical region and the Sonoran Desert sub-province of the Basin and Range geological province. Within an extensive area, an intensive search has resulted in the mapping of over 200 Organpipe cacti. Lack of drainage and suitable substrates combined with hyper-aridity contrast this population with conditions at other relatively "mesic" populations in the region. The unusual character of the cactus distribution is further revealed in the nurse relationships exhibited by the one meter and under size class portion of the population. The linearity, density gradient, and statistical shape that describe the distribution upon the landscape clearly suggest a seed "shadow" vector relationship with a maternity roost of the nectar and fruit eating *Leptonycteris curasoae*.

Blown in, Blown off, and Blown up: the Bats of Montserrat, B.W.I.

Scott C. Pedersen, University of Washington, Seattle, WA.

The British Crown Colony of Montserrat, a small volcanic island of 100 square kilometers, was devastated by Hurricane Hugo in September 1989, causing near total defoliation of the island. Beginning July 1995, Montserrat has been further devastated by the continuing eruption of the Soufriere Hills volcano. Pyroclastic flows have reduced most of the southern half of the island to an ecological wasteland, destroying roost sites and foraging habitat.

Five surveys covering twenty years (1978, Jones & Baker; 1984, Pierson et al.; 1994, Pedersen; 1995, Morton & Fawcett; 1997, Pedersen) have established a data base that includes nearly 1200 captures of ten species from 45 locations: *N. leporinus*, *M. plethodon*, *S. thomasi*, *C. improvisum*, *A. jamaicensis*, *A. nicholli*, *B. cavernarum*, *N. stramineus*, *T. brasiliensis*, and *M. molossus*. After Hurricane Hugo, there was a 10-fold decrease in the bat population (as estimated by captures per net per night), and the composition of the bat community shifted from smaller frugivorous species to one of more omnivorous and larger frugivorous species. Since Hugo, *Chiroderma improvisum* has not been collected on Montserrat, whereas a new record for *Sturnira thomasi* was reported in 1994. It would be of great interest to know if these two species were transient or still exist as rare species on the island. The bat population had not shown signs of recovery in 1995 when the volcano first erupted.

The results of the present census (July 1997) do not differ dramatically from the previous post-Hugo surveys. However, a large roost used predominantly by *Brachyphylla cavernarum* was destroyed by pyroclastic flows in 1996. Stress on this cave-roosting species, due to the loss of this important roost, may explain why 90% of *Brachyphylla* captured exhibited 100% mange. The single population of *Noctilio* on Montserrat is found along the Belham River and is at greatest risk because pyroclastic flows have already destroyed the upper half of the Belham drainage.

Relationship of the Diversity of Forest Bat Maternity Colonies to Snag Abundance.

J. Mark Perkins, Joshua R. Peterson, and Ralph G. Anderson.

PNW Bat Research Team, SLC, UT and Wallowa-Whitman National Forest, Enterprise, OR

We compared diversity of bat species' maternity colonies at individual capture sites with abundance of snags and living trees, the latter characterized by size class and tree species. Significant correlations exist between diversity of maternity colonies and all snags ($p < 0.05$), of all *A. grandis* and *P. menzeisii* snags > 25 cm dbh ($p < 0.041$, $p < 0.024$ respectively), and abundance of snags of > 50 cm dbh for *A. grandis*, *P. engelmanni*, *P. ponderosa* and *P. menzeisii* ($p < 0.020$, $p < 0.026$, $p < 0.014$ and $p < 0.010$ respectively). Maternity colony diversity was negatively associated with stands dominated by smaller sized live tree species where timber harvest previously occurred. We attributed this to a significant lack of snags in these stands ($p < 0.029$). We also demonstrated that areas of low diversity in maternity colony species are significantly dominated by larger more aggressive bat species ($p < 0.04$). Our data suggest that if snags > 25 cm dbh are less than 70/ha, the species diversity of local maternity colonies is diminished.

Utilization of Agaves by Lesser Long-nosed Bats, *Leptonycteris curasoae*, at Coronado National Memorial, Arizona.

Yar Petryszyn, University of Arizona, Tucson, AZ

Beginning in latter July, a transient roost of up to 18,000 *Leptonycteris curasoae* take advantage of the numerous blooming *Agave palmeri* at Coronado National Memorial at the south end of the Haachuca Mts. From 1994 to 1997 information on number of visits to agaves, behavior and interactions was gathered with the use of night-vision goggles. The peak number of bats at the roost varied from a low of 9,300 in 1995 to 18,000 and 17,000 in 1993 and 1996, respectively. The number of visits (or "hits") to an agave/night also varied greatly and appeared to be influenced by number of bats present at the roost. A "hit" is when a bat actually dips into a flower. All agaves monitored were within three miles of the roost. Up to 3,500 hits/agave were recorded for a single night with 1,000 or more hits/agave/night common. Each hit lasted

from 1-3 seconds. Individual bats were observed to visit the same agave 65-75 times in quick succession. The most frequent visits were by single bats followed by pairs (probably mother and young) arriving at the agave together. On several occasions antagonistic behavior reminiscent of hummingbirds was observed. Of note was flight behavior that included looping low to the ground, moving directly from one umbel to a higher umbel, chasing of a screech owl, and antagonistic behavior towards large moths.

Mastiff Bat Use of Quitobaquito Pond, Organ Pipe Cactus National Monument, Arizona.

Yar Petryszyn, Stephen Russ, and Ami Pate.

Univ. of Arizona, Tucson, AZ; Tri-Star Medical, Oakland, CA; Organ Pipe Cactus National Monument, Ajo, AZ

Two species of mastiff bats, *Eumops underwoodi* and *E. perotis*, utilize Quitobaquito Pond in southwestern Arizona. Netting over the pond was conducted on two consecutive nights bimonthly from April 1994 to February 1995. Of the 524 bats of nine species captured, 49 were *E. underwoodi* and two *E. perotis*. *E. underwoodi* was active in all seasons of the year with peaks in late spring and early summer. Females outnumbered males 1.27 : 1. Almost 2/3 of *E. underwoodi* captures occurred on the first night of the two-night episodes. Most captures were before midnight (34 vs 15). Reproductive activity occurred from April through August. In an attempt to determine if numbers and activity have changed over time, results were compared to data from 1979-83. There was no significant difference for number of *E. underwoodi* captured before midnight per night between 1979-83 and this study (2.7 bats vs 2.9 bats), sex ratio (1.21 : 1 versus 1.27 : 1) or in seasonal peak. At Quitobaquito Pond, molossids accounted for 92% of the captures with *Nyctinomops femorosaccus* being the most numerous (405 captures). Why vespertilionids are not more numerous considering that other water sources in the park are dominated by them, is open to speculation.

A New Approach to Sample Collection for Determining Molecular Relationships Between Individuals and Species of Eastern Pennsylvania's Bat Populations.

Trinh H. T. Pham. Albright College, Reading, PA

During the past 50 million years, molecular evolution has given its share to more than 900 living species that comprise the Chiroptera, each with its own unique genome. Six species which predominate Pennsylvania's bat population will be used to study the molecular relationships among these species as well as among individuals within given colonies.

Previous studies in our lab have used the polymerase chain reaction to amplify arbitrarily primed sequences of DNA to identify polymorphisms useful in determining relatedness. DNA can be obtained from a significantly small number of cells, which substantially reduces the risk of endangering the bats' well-being. These previous studies also revealed that sample collection in the field is technically complicated, particularly when working with protected or endangered species where muscle biopsy, blood collection, and wing punches are typically prohibited. This study was designed to enable collection of cells in a method suitable for field work which minimizes the risk of harm to the bats. Specifically, samples of epithelial cells from the mouth lining and cells from hair follicles, both provide sufficient DNA for techniques common to molecular genetics. This method of sample collection is ideally suited for field conditions, and provides for uncontaminated cell collection through an approach in which toothpicks and tweezers are the principle tools.

The DNA sampled in this manner will be used to examine genetic variations such as chromosomal polymorphisms and protein polymorphisms in six species of bats sampled this summer: *Eptesicus fuscus*, *Myotis lucifugus*, *M. septentrionalis*, *M. leibii*, *Pipistrellus subflavus* and *Lasiurus borealis*. Bats were captured in several locations of eastern Pennsylvania, including two maternity colonies, a known hibernaculum, and numerous sites surveyed at the Delaware Water Gap National Recreation Area. In this way I will be able to study the genetic relationships among bat populations as well as within different colonies, possibly including determination of relationships between parents and offspring.

Roosting and Foraging Behavior of *Myotis yumanensis* and *Myotis evotis* along the Upper Sacramento River in Northern California.

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Radiotracking in September 1991 and August-October 1996 examined the roosting and foraging behavior of *Myotis yumanensis* and *Myotis evotis* in the upper Sacramento River drainage of northern California. *M. yumanensis* is one of the most commonly encountered species in the area, and *M. evotis* one of the rarest. Both species predictably used bridge night roosts. Yet, except for one maternity roost of *M. yumanensis* located in a building attic, no day roost locations were known for either species. Banding showed that the largest bridge night roost (> 400 *M. yumanensis*) did not correspond with the known day roost. All radiotagged individuals (10 *M. yumanensis* and 3 *M. evotis*) captured at bridge night roosts occupied tree day roosts, and no two individuals roosted in the same tree. *M. yumanensis* roosted under flaking bark or within concealed bole cavities of large (mean DBH = 74.9 cm) mid-stage snags (sugar pine, incense cedar and oak), whereas *M. evotis* roosted under flaking bark of black oak (two males in small trees [mean DBH = 18.8 cm] and one female in a larger tree [DBH = 35 cm]). Two of the *M. evotis* also roosted in small voids on a slope of highway stone riprap, and changed roosts frequently. *M. yumanensis* foraged almost exclusively over pools in the river, travelling up to 6.0 km from the day roost and returning to the same foraging area every night observed. For more than half the animals the distance from the foraging area to the night roost exceeded the distance from the foraging area to the day roost. The *M. evotis* all foraged less than 1 km from their day roosts, returning to the same areas each night. Each individual foraged early in the evening over riparian vegetation at the river's edge, and later in the evening moved several hundred meters upslope, appearing to forage beneath the forest canopy. Within this forest setting, even *M. yumanensis*, one of the species most frequently associated with anthropogenic roosts, relies heavily on trees, and its roost preferences appear to differ from those of *M. evotis*. Additionally, these data are not consistent with assumptions that a night roost aggregation corresponds to a single day roosting colony, nor that night roosts are selected for their proximity to foraging areas.

Do Patterns of Male Copulatory Behavior Determine Birth Synchrony in Greater Spear-nosed Bats?

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Exploring mechanisms of optimal reproductive timing in mammals may suggest novel means for regulating mammalian reproduction. Births are synchronized within the stable reproductive social groups of greater spear-nosed bats *Phyllostomus hastatus*, which consist of 8-40 females and one adult male. This temporal coordination of births does not transfer between individuals of different groups that habitually share a roosting cavity, indicating that this species synchronizes reproduction through a mechanism other than the airborne chemical cues reported for a number of mammal species, including human females. Because the resident male monopolizes nearly all copulations and paternity within the group, males might influence birth synchrony by a behavioral stimulation of estrus onset in, and/or by impregnating, all female groupmates at similar times. An analysis of the videotaped roost activities of 32 bats in 2 captive groups revealed that the onset and time span of the males' mating behavior, as well as the order in which they mated with individual females, could not account for the temporal pattern of the subsequent pup births. However, the order in which females reached their peaks in proceptive behavior correlated significantly with their subsequent parturition order.

Diversity and Patterns of Bat Community Structure in the Spring Mountains of Southern Nevada.

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A fundamental question in ecology is concerned with the factors that contribute to the regulation of species diversity in natural communities. I investigated relationships between local (alpha) bat diversity and local environmental variables, and changes in bat species diversity among habitats (beta diversity) in the

Spring Mountains of southern Nevada from June 1992 through September 1994. Local diversity varied along an elevational gradient, with high elevation, pine-fir habitats exhibiting the lowest diversity, and low elevation, pinon-juniper sites exhibiting the highest. Explanations for these patterns are offered based on 1) positive correlations between high bat diversity and permanent water, high water flow, large pool perimeter, increasing distance to trees, large-sized geologic material, and abundant washes and cliffs; and 2) negative correlations between bat diversity and vegetation height and cover, number of canyons and buildings, and greater pool obstruction. Little species turnover was exhibited within habitats, however significant differences in diversity were found among macrohabitats, with greater diversity at low elevation sites (blackbrush and lower-elevation pinon-juniper) than at higher-elevation sites (pine-fir and higher elevation pinon-juniper). Because species turnover among macrohabitats was high, local (alpha) diversity does not approximate regional (gamma) diversity, thereby illustrating that more than regional processes are involved in structuring local bat communities. The conclusion is that diversity changes in the Spring Mountain bat community are caused by both regional and local factors, including temperature, resource conditions, and habitat heterogeneity.

Systematics and Ecomorphology of Rhinolophoid Communities: Point Comparison of African Mainland with Sundo-Wallacean Insular Assemblages.

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I used univariate (ANOVA) and multivariate (principal component) statistical analyses to analyze uni- and multivariate morphometric niche space partitioning in rhinolophoid communities. The samples were derived from disparate localities: one assemblage came from Kriel Cave, near Lusaka, Zambia; the other assemblage was derived from collections carried out along an elevational transect in the Zambales Mountains of Western Luzon Island, Philippines. I addressed two questions: 1) are mainland and insular rhinolophoid communities similarly structured (that is, do disparate species occupy the same multivariate niche space on mainland vs. insular communities)? And 2) Is multivariate niche space more finely partitioned in mainland rhinolophoid communities than in insular communities?

The results to date point to a number of trends. Rhinolophoid communities occupy almost identical multivariate niche space in both mainland and insular rhinolophoid communities. However, fewer species occupy the same niche space in insular than in mainland communities. Along with occupying a broader morphological niche space, insular species tend to display higher variance in the morphological characters analyzed. The analyses so far have been compounded by the fact that, particularly in the African sample, the specific identity of numerous individuals have been erroneous, or the specimens cannot be identified using current species boundaries. The current rhinolophoid a-systematics needs to be carefully re-evaluated to reflect the true underlying species diversity, which presently is obscured.

North American Bat Conservation Partnership.

Steven Schmauch. Bat Conservation International, Austin, TX

The North American Bat Conservation Partnership (NABCP) was formed to ensure efficient and effective conservation initiatives on a long-term, continent-wide basis. NABCP partners share resources, information, and matching funds with private conservation organizations, foundations, corporations, and government agencies. Partners collaborate: 1) to educate the public and enlist their support; 2) to acquire knowledge of bat status and needs; 3) to set and carry out key habitat protection priorities; 4) to establish cohesive regional conservation strategies; 5) to create specialized databases on bat needs and protection priorities; 6) to establish a national Internet site designed to share the latest guidelines on bat conservation and management; and 7) to develop a library of specialized, partner-produced bat conservation handbooks and training materials.

The NABCP is headquartered at Bat Conservation International (BCI) in Austin, Texas. Its conservation, education, and research priorities are recommended by leading bat biologists and conservationists who serve on three regional Working Groups. All major policies, procedures, and final strategic plans are subject to the review and approval of an Advisory Council of nationally recognized experts from Canada, Mexico, and the United States. Extensive field support for partnership initiatives is

provided by research colleagues, government biologists, member volunteers from BCI, the American Cave Conservation Association, the National Speleological Society, and any other groups who share our goals.

The NABCP's founding partners in Mexico include the Asociacion Mexicana de Mastozoologia, Fondo Mexicano para la Conservacion de la Naturaleza, and the Instituto de Ecologia UNAM. In the United States they include the Bureau of Land Management, Environmental Protection Agency, Federal Highway Administration, Fish and Wildlife Foundation, Forest Service, Geological Survey, National Fish and Wildlife Service, National Park Service, and the Natural Resources Conservation Service.

The project recruits as many federal and state agencies, foundations, private conservation organizations, corporations, sportsman's groups, veterinary and public health experts, and land owners as feasible in a broad, voluntary collaboration to help conserve America's declining bats.

BCI plays the lead role in raising NABCP funds from private donors, foundations, and government agencies in partnership with the National Fish and Wildlife Foundation. Each year, funds are set aside to encourage peer-reviewed, matching-fund collaboration between partners and other responsible organizations or individuals who share NABCP goals.

An Ecological Risk Assessment for *Myotis sodalis* and *Myotis grisescens*. Are the Bats at Risk from Certain Military Aerosols?

Angela Schmidt, R. Rommé, and K. Tyrell.

3D/International, Inc., Environmental Group, Cincinnati, OH

Certain military installations use chemicals that may be toxic to endangered bat species. Obscurants and pesticides are released in an aerosol from various devices. We completed ecological risk assessments to determine the minimum concentration (toxicity threshold) of fog oil, terephthalic acid, hexachloroethane (military obscurants); and Malathion and Dursban (pesticides) that may cause adverse toxicological effects. We selected NOAEL (No Observable Adverse Effect Level) as our toxicological benchmark value. No NOAEL values for *Myotis sodalis* and *Myotis grisescens* were available in the literature. NOAELs were developed using a procedure commonly employed in human health risk assessments. Air dispersion models were used to determine contaminant concentrations at predicted exposure points, including maternity caves, hibernacula, and foraging habitat. The dispersion of aerosols from release points was modeled. Short-term and long-term exposures were evaluated. We estimated acute and chronic intakes based on life history characteristics, and physiological and morphological parameters. Risks were determined for acute and chronic exposures using the Hazard Quotient (HQ) technique, where HQ is the ratio of expected exposure to safe exposure. We estimated the minimum safe distance between aerosol release points and receptors. Results of the risk assessment were important in preparation of two Biological Assessments and two NEPA documents assessing effects of military activities.

Developing Cave Air Flow Models for *Myotis sodalis* hibernacula and *Myotis grisescens* maternity colonies.

Angela Schmidt, J. Salyers, A. Black, R. Rommé, and K. Tyrell.

3D/International, Inc., Environmental Group, Cincinnati, OH

Air movement is unique among caves. Air flow can vary around openings in a cave and throughout the cave. At an opening, air may be drawn into a cave or it may be pushed out. The air flow pattern of a cave depends upon several factors: cave volume, barometric pressure, wind speed, temperature, relative humidity, and the air flow mixing characteristics (mixing constants). 3D/International, Inc., collected data at six caves on Fort Leonard Wood, Missouri and developed mathematical models to describe air flow in each cave. Cave air flow models were based on data collected at each cave. Two meteorological stations were installed at each of four Indiana bat hibernacula and two gray bat maternity colonies. An external station was located nine meters from the outside entrance to each cave and an internal station was located approximately 30 meters from the entrance of the cave. Meteorological stations consisted of: datalogger, solar panel, 2 meter tripod (external also had a lightning rod), temperature/relative humidity sensor, barometric pressure sensor, anemometer, wind vane, antenna, control box with interface, computer interface module, battery, cellular

transceiver, and storage module. We mapped the inside of each cave to determine the cave volume. We determined the mixing constant for each cave by measuring the time and concentration distribution of 0.5 to 10 micron particles generated from a nebulizer. We determined the cave air intake and dilution characteristics. A material balance method for work rooms developed by NIOSH was employed to determine chemical concentrations in caves. Cave air flow models and material balance equations were used to estimate the length of time a toxic concentration of a chemical would remain in Indiana bat hibernacula or gray bat maternity colonies.

Morphology and Homology of the Chiropteran Calcar: A Cautionary Tale.

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Many specializations for flight in bats involve the wing membranes (patagia) and their support structures. The uropatagium (interfemoral membrane) is an accessory flight membrane present between the hindlimbs in both microchiropteran and megachiropteran bats. Besides providing an additional lift surface, the uropatagium functions in braking and turning maneuvers, aerial feeding behavior, and as a "safety net" to cradle newborns during parturition. Most bats that have a uropatagium also possess an associated structure commonly referred to as a calcar. The calcar is typically described as a slender cartilaginous or bony spur that projects from the ankle and terminates in the uropatagium. The calcar functions by helping to spread the uropatagium and to adjust its camber during flight. Additionally, it straightens and braces the posterior border of the uropatagium. In past studies that offered partial or complete descriptions of bat hindlimb anatomy, cartilaginous or bony structures projecting medially from the ankle region into the uropatagium were variously referred to as "supplementary calcaneal bones," "styliform bones," "spurs," "stylets," "calcars," "les éperons," and "Fusswurzeltachels." Despite the fact that these structures varied in appearance, composition, anatomical position, and associated musculature, most authors have recognized them as representing a single, uniquely chiropteran structure: the calcar.

We examined hindlimb morphology in representative specimens from both chiropteran suborders. We also examined specimens (when available) and literature accounts of 5 fossil bat genera including the Oligocene fossil *Archeopteropus*, which is widely regarded as an early megachiropteran. The goals of this study were: (1) to determine if morphological evidence supports the assumption that the calcar is a homologous structure in all bats, (2) to interpret the results of our morphological comparisons in the context of previous hypotheses of bat relationships, and (3) to reevaluate the placement of *Archeopteropus* in Megachiroptera.

Our results indicate that the chiropteran "calcar" is not homologous in all bats. We propose retaining the term calcar for the microchiropteran structure. We propose the term uropatagial spur for the megachiropteran structure. In the light of previous evidence and new data on chiropteran hindlimb morphology, our findings indicate that *Archeopteropus* is not a megachiropteran.

Application of ANABAT II to Pennsylvania Bat Surveys.

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Recent studies have shown that the ANABAT II detector and analysis system can provide information about the distribution and activities of Chiroptera that mist-netting is unable to furnish. Some Pennsylvania bat species can be distinguished from others by just listening to a tunable detector. Others, like *Pipistrellis subflavus* and *Myotis lucifugus* are not as easily separated. I used the ANABAT II detector system to enhance the identification of eastern Pennsylvania bats -- specifically, *M. lucifugus*, *M. leibii*, *M. septentrionalis*, *P. subflavus*, *Lasiurus borealis* and *Eptesicus fuscus*.

Since call libraries do not yet exist for bats of the northeastern United States, I recorded call sequences from known bat species to serve as a basis for comparison. These recordings were made under different conditions to allow for call variation, including light-tagged releases, recordings in a flight laboratory, and recordings at known single-species colonies. From this call bank I determined mean high, low and average

call frequency and mean call duration for each bat species. These values then provided me with a key that I was able to use to identify unknown bat calls.

ANABAT II proved to be a useful survey tool, but it cannot provide all of the data needed for an accurate bat survey. Some species had very similar ranges of call frequency and duration, and so definite identification was not possible. Having information on call harmonics and intensities, not available through ANABAT recordings, would help to differentiate between species. I also found that some bat species modulate their calls in different surroundings, so the call structure is different when a bat is in a closed lab, flying through the woods or foraging over a field. Building a complete call library is further complicated by call variation associated with different activities. It becomes important, therefore, to make recordings from known bats in settings similar to those in which unknown bats are recorded in order for ANABAT II to provide a useful complement to traditional survey methods involving bat captures.

Atmospheric Pressure, Meteorological Forecasting and a Pressure Altimeter.

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For flying animals, bats and birds, atmospheric pressure is a potential source of information that might be used as the basis of a pressure altimeter and/or meteorological forecasting. The prominent properties of variation in atmospheric pressure are absolute magnitude and the rate of pressure change. Absolute pressure magnitude is a reliable indicator of altitude while pressure change can be separated into two types: rapid changes associated with altitude changes in flight and relatively slow changes associated with meteorological events. A prerequisite for an animal to have a functional response to variation in atmospheric pressure is that the animal be able to detect the pressure variation. I have previously reported that some bats appear able to detect and respond to the atmospheric pressure changes associated with meteorological events (primarily *Eptesicus fuscus* and *Myotis lucifugus*) and flight altitude changes (*Tadarida brasiliensis*, *Myotis velifer* and *E. fuscus*). A putative atmospheric pressure receptor, the paratympenic organ, is a small vesicular organ found in the middle ear of most birds and, perhaps, some bats. My recent anatomical survey of bats failed to confirm an observation from early this century of a paratympenic organ in *Pipistrellus pipistrellus*. I also did not observe a paratympenic organ in *P. subflavus*, *M. velifer*, *E. fuscus*, *T. brasiliensis*, *Rhinolophus rouxi*, *Pteronotus parnellii*, *Pteronotus quadridens*, *Natalus stramineus*, *Eumops perotis* and *Leptonycteris* sp. It seems likely, therefore, that bats detect pressure changes through mechanisms such as those used by some non-flying mammals (via stretch receptors in the tympanic membrane) rather than like birds.

Design and Testing of an Artificial Bat Roost for Tree Roosting Bat Species on the Kaibab Plateau, Northern Arizona.

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Artificial roosts are now in use across North America, accommodating nursery colonies of several bat species. However, these are typically made of wood that lasts less than 10 years, sometimes less than five, and they are conspicuous targets for vandals. Such houses also may detract from the natural appearance of the landscape. We developed an artificial bat roost ("Bat Bark") that is visually indistinguishable from natural bark, that provides appropriate space and special ventilation slots, and may last up to 50 years. This flexible Bat Bark fits a wide range of tree sizes, can be attached to living trees with aluminum screws, and can be adapted to mimic a variety of tree species across North America. Our main objective for this study was to produce and test suitable artificial roost structures that were easily manufactured, inexpensive, long lasting, and inconspicuous and unlikely to attract attention from vandals. Field testing was carried out in six forested locations near sites already known to be used by bark-roosting bats. Four Bat Bark structures were installed on large diameter trees around each of six known waters (total of 24 Bat Bark structures) where tree-roosting bat species had been caught in previous years. Bat Bark was monitored on a weekly basis to determine use. We also used radio telemetry on 24 bats (*Myotis volans*, *M. evotis*, and

M. thysanodes) at these six waters to locate natural roosts in the same vicinity. Comparisons were made between the natural roosts and the Bat Bark (both used and unused sites) to evaluate if changes should be made to the design or installation of Bat Bark. It is hoped that several crevice-roosting bat species will form nursery colonies beneath Bat Bark and that this material will prove effective in reestablishing declining populations of forest-dwelling bats, especially those that are endangered or candidate species, for roosting during the breeding season.

Long Foraging Distance for Two Uncommon Bat Species *Euderma maculatum* and *Eumops perotis* in Northern Arizona.

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The Kaibab Plateau of north-central Arizona is a high elevation, limestone plateau on the northern edge of the Grand Canyon. We used radio telemetry to determine foraging areas for seven lactating female spotted bats *Euderma maculatum* captured on the Kaibab Plateau and located roosts for four of these bats. We also captured Greater Western mastiff bats *Eumops perotis* and located a roost area for this species. Roosts for both spotted and mastiff bats were in xeric cliffs in or near Grand Canyon National Park (GCNP) at approximately 650 to 1040 m elevation. Distances from capture location to maternity roosts ranged from a minimum of approximately 28 to 42 km. Capture sites and foraging areas were located at approximately 2600 m elevation for spotted bats and 2100 m for mastiff bats. Mist net surveys we conducted on the plateau in 1994, 1995, 1996 and 1997 resulted in 20 bat species captured. The high bat species diversity we observed may be due to the proximity of the Kaibab Plateau to the Grand Canyon, and the great range of elevations and habitats available from the floor of GCNP (600 m elevation, desert) to the meadows (2600 m elevation, subalpine) on the Kaibab Plateau. Characteristics of foraging areas and maternity roosts will be discussed.

Use of *Agave palmeri* by *Leptonycteris curasoae* on Fort Huachuca, Arizona.

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Both species of nectar-feeding bats, *Leptonycteris curasoae* and *Choeronycteris mexicana*, roost on the Fort and have been monitored since 1990 (Sidner, 1996). Although it has been assumed that *L. curasoae* feeds upon flowering agaves on Fort Huachuca, there has been no documented evidence of this foraging behavior. The Department of Defense was interested in such information because of requirements to protect this endangered species and its potential food supply on federal land. In addition, the federal recovery plan for the species requested information about foraging habitat (USFWS 1995).

I conducted a field project to document use of agaves on the Army installation by *L. curasoae*. The objectives were to observe whether bats were actively using agaves; and if so, what species of bats were foraging on agaves, and to what extent and in what areas were bats foraging on agaves. In 16 localities across 16 km on the Fort, 31 *Agave palmeri* were selected for observation if 1) they had a flower stalk with panicles showing at least some flowers in bud and others with mature stamens protruding, and 2) they were relatively close to a road.

In order to obtain data under natural conditions, the project was intentionally designed not to disturb bats by capture or with the burden of bands or tags. Observers used night vision goggles and moonlight, skylight, or accessory infrared light to observe agaves after dark. In this manner, bats were discovered foraging at agaves. At three localities, foraging bats were photographed for identification, and when *Leptonycteris* were documented, that locality was no longer photographed. The 31 agaves were observed for timed 15 minute periods. Observers tallied the number of foraging strikes (defined as an actual touch of the flower for more than a "split-second") made by nectar-feeding bats on the flower panicles. The 15 minute counts were conducted throughout the night with at least one period during each hour of the night.

During August and September of 1996 at Fort Huachuca, nectar-feeding bats were observed foraging on *A. palmeri* in all 16 localities. All the identifiable bats in the photographs were *Leptonycteris*. Bats were

observed foraging during each hour of the night. Timed-counting periods totaled 975 minutes with a total of 4088 feeding strikes counted. This is an average of 64 foraging strikes per 15-minute period (range 3-427/15 min) or 4.3 strikes per minute.

**Sonar Images Produced by Binaural SCAT --
An Auditory Computational Model of FM Bat Echolocation.**

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What bats might "see" with their sonar is one of the most fascinating questions about their biology. The content of the sonar images perceived by echolocating big brown bats *Eptesicus fuscus* has been assessed in behavioral experiments, with the initial data being reported at the First North American Bat Research Symposium in Tucson. From knowledge of the FM sonar signals transmitted by the bat, the nature of echoes from targets, and constraints imposed by the external, middle, and inner ears on sound reception and transduction, we have developed a large-scale computational model of echolocation that produces images whose content is similar to images perceived by bats. The model uses two "ears" to receive echoes and then implements algorithms for Spectrogram Correlation And Transformation (SCAT) to mimic central auditory processing of sonar broadcasts and echoes. To evaluate the model's biological utility, we "fly" an artificial bat through such classic tasks as obstacle avoidance and insect capture to determine whether SCAT images are good enough to guide the bat in complicated acoustic conditions. For this purpose, we have assembled a wealth of data by repeating obstacle-avoidance and insect-capture studies with *Eptesicus* using video motion analysis to reconstruct the bat's flight path and movements in 3-D. Images produced by the SCAT model show surprising fidelity for registering multiple objects in their proper locations and suggest new experiments to conduct on bats.

**Use of Elkhorn Cave, Pendleton County, West Virginia,
by a bachelor colony of *Corynorhinus townsendii virginianus*.**

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During the summer, Elkhorn Cave, Pendleton County, WV, harbors a "bachelor" colony of *Corynorhinus townsendii virginianus*; these bats do not appear to hibernate in this cave during the winter. The numbers of *C. t. virginianus* in the cave were monitored using night vision equipment to observe bats during their nightly emergence and ultra-sound detectors to aid in species identification. Emergence counts were conducted on 17 nights between 12 Jun 1996 and 23 Jun 1997. Bats were mist-netted at the cave entrance on 6 nights between 6 Sep 1995 and 30 Jun 1997. A few bats (N=3) were present in the cave as early as the first week of April, but most of the bats did not arrive until mid-June (N=66 on 14 Jun; N=92 on 23 Jun). Mist netting in early July resulted in the capture of 27 male and 2 non-reproductive female *C. t. virginianus*. The number of *C. t. virginianus* increased unexpectedly in late August (N=159). Thirty-eight *C. t. virginianus* captured in mid-September represented both males (most were scrotal) (N=21) and females (N=17). When released, several males chose not to leave the area, but landed on holding cages containing females. Most of the bats left the cave by late October. Bat surveys during the winter 1996-97 resulted in band returns of 18 bats banded at Elkhorn Cave. These bats were observed in four known *C. t. virginianus* hibernacula located up to 32 km from Elkhorn Cave. Elkhorn Cave appears to be an important breeding site for this endangered bat.

Behavioral Predictions of Population Genetic Structure in an Old World Tent-making Bat, *Cynopterus sphinx*.

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Adult males of the short-nosed fruit bat, *Cynopterus sphinx* (Pteropodidae), chew the stems of trees and dense flower/fruit clusters to create enclosed roost-cavities (tents) which attract groups of 1 to 25 females. These groups of breeding females are each defended by a single male and this harem social organization is maintained through each of two annual reproductive periods. We investigated the social structure of a *Cynopterus sphinx* population in western India by sampling tent-roosting harem groups and censusing marked individuals. Census data on the length of male breeding tenure and the size and compositional stability of harem groups indicate the potential for extremely high variance in male reproductive success and small effective population sizes for social demes. The magnitude of genetic drift operating in this socially-subdivided population is estimated by long-term census data as well as spatial and temporal (i. e., adult-progeny) variance in microsatellite allelic- frequencies over three successive breeding periods.

Streetlamps Interfere with Moths' Bat Defence.

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Bats often prefer to forage near streetlamps, where they exploit moths in particular. There are at least two hypotheses which may explain the apparent increase in the availability of moths to bats feeding around streetlamps: i) the moths become concentrated and therefore more profitable to exploit, and ii) the light interferes with the moths' evasive flight behaviour. We tested the second of these hypotheses by exposing flying male winter moths *Operophtera* spp. to bursts of ultrasound (27 kHz, 110 dB SPL) from an electronic source. The light from a 125 W mercury vapour lamp had a quantitative effect on the moths' evasive flight response at close range (within 4 m), inhibiting it totally in nearly half (43%, N=125) of the cases. By contrast, moths flying in the surrounding woodland and without interference from the light always responded to the sound. Streetlamps of the mercury vapour type (white lamps) thus interfere with the defensive behaviour of moths and presumably increase their vulnerability to echolocating bats. This may have implications for the conservation of both moths and bats.

The Effects of Gating on Bat Activity at a Historic Hibernaculum.

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In the summer of 1991, swarming activity was monitored at a historic hibernaculum, an abandoned mine in Durham, PA. The site was surveyed weekly over a three month period during the summer months, providing data regarding bat species swarming at the entrance of the mine and presumably using the mine as a hibernation site. In 1994 a gate was constructed at the only remaining mine entrance. The combination of these events provided a unique opportunity to determine the effects of gating on the bat populations swarming at a known hibernaculum by repeating the 1991 study during this past summer.

In both the 1991 and 1997 surveys, the same modified harp trap (one meter squared) was placed at the mine entrance on a weekly basis from June to October. Bats entering the mine were captured for a four-hour period beginning at sunset. The species, sex and time of capture were recorded and a numbered band was placed on each bat.

Hibernation counts provided by the Pennsylvania Game Commission show an increase in the number of bats using the mine since the time of gating. A greater number of swarming bats was therefore expected in this survey, although the general composition of species and sex captured was expected to remain the same. Likewise, the time of capture relative to sunset was not expected to vary greatly from the previous data.

Many of these expectations have been met in this sampling year. The general composition of species and sex of bats captured seem to correlate with the prior data, and the same increase in captures throughout the season reflects the pattern shown in 1991. The main difference observed this season is the propor-

tionally fewer number of captures per week at the mine entrance. These data are somewhat surprising considering the recent increase in hibernation counts, although seasonal variations in temperature may account for this apparent decrease in swarming activity.

Rabies Mysteries and Conservation Consequences for North American Bats.

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Eighteen United States cases of human rabies have been attributed to bats since 1980, a rate of slightly more than one per year. Of these, 14 (78%) were from species that roost individually or in groups of dozens and are not normally found in buildings or in contact with humans. Twelve were attributed to a variant closely associated with the silver-haired bat, and more than half of these cases were from people with no known exposure history. Three additional cases were from Mexican free-tailed bats with known contact, and one was attributed to a big brown bat variant with no known contact. Recent incidents have triggered the most intense anti-bat publicity in decades, leading to claims of aerosol transmission or transmission from contact with droppings in yards, and there are widespread attempts to ban bat houses and to rid neighborhoods of bats in general. Leading public health experts do not agree or condone this, but it remains a serious problem for bats. Statistically speaking it is still far more dangerous to have pets, use playground equipment, plant flowers, or ride a bicycle than it is simply to live near bats. Yet, exclusion and eradication efforts are common and focused exclusively on colonial species, particularly big and little brown bats, despite the fact that no cases have been attributed to little brown bats and only two to big brown bats in North American history.

New Educational Programs and Materials About Bats.

Janet Tyburec. Bat Conservation International, Austin, TX

Bat Conservation International is producing a variety of new educational programs and products to benefit biologists, teachers, and natural history interpreters. These include training workshops, publications, videos, audiocassette tapes, and lesson plans in both English and Spanish languages. In addition to the Bat Conservation and Management Workshops in Arizona and Pennsylvania each year, BCI is also now presenting workshops focused on cave, mine, and forest conservation for bats, land management decision-making, and effective interpretation techniques for watchable wildlife site stewards.

Several new educational products have recently been produced. Our Bat Chat audiocassette and slide set provides an instructional and entertaining journey into the world of bat echolocation. The new Discover Bats! is the most exciting educational package yet produced by BCI. Our live action video, The Secret World of Bats, has been re-edited and re-mastered with youthful narrators into three 10-minute videos. The accompanying teacher's activity book offers more than 150 pages of lessons that teach bat behavior, habitat, ecology, and conservation in conjunction with reading, writing, arithmetic, and comprehension, and communication skills. We have also developed several new Spanish-language publications in the last year. Two new books, *Marcelo el Murcielago*, and *Murcielagos de Nuevo Leon* have also been developed and distributed in the last year to biologists, teachers, and students throughout Mexico and Latin America.

Analyzing Pathways for Exposure to Pesticides in Bats.

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Pesticide poisoning is thought to have increased mortality in several species of bats. Direct contact with pesticides is harmful to bats. Exterminators have applied chemicals such as DDT directly to bats to control colonies that roost in human dwellings. Although direct application of harmful chemicals is damaging, another problem is inadvertent pesticide poisoning of bat populations. Pesticides are considered one cause of decline in populations of endangered species, particularly gray bats *Myotis grisescens*. In the past, pesticide exposure was recognized by unusually high bat mortality. Tissue analysis of dead bats at

roosts revealed lethal body burdens of pesticides. In addition to mortality, sublethal effects of pesticides on bats may include: reduced fecundity, abnormal behavior, immunodepression, etc. These effects can go unnoticed and are difficult to link to pesticides with laboratory tests. However, these types of effects can have significant long-term population consequences. Exposure pathway analysis is an effective method to identify sources of exposure to pesticides (or other chemicals). Exposure pathways qualitatively describe mechanisms by which receptors (species of concern) contact and are affected by a chemical. There are five steps to develop an exposure pathway: characterize the receptor, characterize the pesticide, determine exposure points, determine routes of exposure at each exposure point, and combine information together. A pathway analysis addresses primary effects from ingestion, inhalation, and dermal absorption; and secondary effects, such as change in the availability of prey. Exposure pathways include primary and secondary effects, which gives a better picture of the total effect of the chemical on the population. Adverse effects to behavior and survival may result from indirect exposure to pesticides. The advantage of developing exposure pathways is many potential points of exposure are identified, which may not be considered otherwise.

Albinism in Bats with Special Reference to the Common Vampire Bat.

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Complete albinism is a rare phenomenon that occurs in all vertebrate groups. In bats, albinism has been recorded in several species but there is not a recent review about that and an analysis of its importance. I compiled cases of albinism from the literature and present additional examples. Complete albinism in bats is documented in eight families, 29 species, and 53 individuals females and males (F=57.7%, M=42.3%, n=26). From these, 29 individuals were observed and/or captured in sheltered roosts, such as caves and mines (70%), buildings (houses and temples; 20%), and hollow trees (6.7%). An albino fruit bat *Artibeus jamaicensis* is recorded here for the first time and was collected from foliage. I suggest that sheltered roosts favor the survival of albino bats, offering protection against sunlight, water loss, and visually hunting predators. Four additional cases of albino individuals of the common vampire bats *Desmodus rotundus* are presented, which were captured during vampire bat control activities in Brazil. I observed one albino female of *D. rotundus* in captivity for 28 months in mixed groups with normal male and female vampires. At irregular intervals, I examined all females and only two dark brown ones became pregnant. Vampires fed upon live pigs and chickens and defibrinated cow blood. My data suggest that the habits of the albino vampire are not different from normal individuals. In most situations, I observed the albino feeding alone and generally after the normal ones. Agonistic interactions between the albino and normal individuals were not observed at feeding places although these interactions among normal vampires were previously reported under both wild and captive conditions.

Dietary Analysis of the Mexican Long Tongued Bat *Choeronycteris mexicana* using Pollen Analysis of Guano Collected in Cienega Creek Natural Preserve.

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The diet of Mexican long tongued bats *Choeronycteris mexicana* was determined by sampling guano from recently discovered bat colonies living within Cienega Creek Nature Preserve. Guano sheets were placed under active roosts, collected, guano identified and extracted for pollen. The guano samples contain predominantly pollen from three species, *Cereus gigantea*, *Agave schottii*, and *A. palmeri*. *Choeronycteris mexicana* migrate to the area during late April to early May and stay until late October to early November before returning to Mexico. Guano samples span this period and results of the pollen analysis will be presented for the years 1996 and 1997. *Cereus gigantea* pollen is recorded in the guano during the blooming season, April thru June. During the rest of the year samples are dominated by *Agave* spp. pollen. Results will be presented that differentiate the agave species within the samples. *A. schottii* blooms from April to July and *A. palmeri* blooms from June to August. Late season guano samples continue to be dominated by these pollen types revealing the importance of off-season blooming to the maintenance of these populations so late into the year.

The Bat Community of a Temperate Rainforest in Clayoquot Sound, British Columbia, Canada.

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Clayoquot Sound on the west coast of Vancouver Island, is an area of high-profile land-use conflict. We began wildlife studies in 1996, under direction from the Clayoquot Scientific Panel and a local planning team, with the goal of identifying critical habitats for endangered and forest using bat species. Due to its remote location and wet conditions, there was almost no existing information on Clayoquot Sound bats. Our data will assist in delineation of protected habitats and management zones in Clayoquot Sound and other similar areas in British Columbia.

We used mistnetting to determine species presence, and remote echolocation call monitoring in various replicated forest stands to compare bat habitat use in five watersheds from sea level to 2,650 feet elevation. The presence of seven species of bats was confirmed in this rainforest: *Lasiurus cinereus*, *Eptesicus fuscus*, *Myotis californicus*, *M. lucifugus*, *M. yumanensis*, *M. evotis* and the endangered *M. keenii*. Remote echolocation detectors recorded higher numbers of bat passes in open forests with a low density of shrub cover. The data suggest that structure in this rainforest may affect the flying and foraging activities of bats as dense stands may reduce flight manoeuvrability. We radio-tagged two lactating *M. lucifugus* to determine maternal roost sites and discovered one in a western red cedar snag of diameter 3.17 metres. The second was roosting in a rock crevice on a broad cliff band at 3,000 feet elevation.

A Comparison of the Foraging Behavior of Female Insectivorous Bats During Different Reproductive Phases.

Lawrence Ward, Albright College, Reading PA

This study was designed to compare the foraging behavior of *Myotis lucifugus* and *Eptesicus fuscus* females. Foraging activity and range were monitored by light tagging individuals from a maternity colony of each species, including pregnant, lactating, post-lactating, and nulliparous adults, as well as juvenile females. Bats were captured as they exited the roost, tagged, and released so that foraging range and behavior could be recorded for single individuals. The average foraging time for the *Eptesicus fuscus* colony throughout the summer was also determined by observing the activity at the single point of exit from the church where the colony is housed. Comparisons are made of foraging behavior both within and between species over the reproductive season.

Comparison of Bat Communities in Mature Forest, Secondary Forest, Corridors, and Pasture in Piedras Blancas National Park, Southwestern Costa Rica.

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Bats contribute to the maintenance and regeneration of tropical forested ecosystems because of their roles in seed dispersal, pollination and consumption of insects. We assumed they may be useful biological indicators of habitat disruption. In this study we compared bat faunal diversities in mature forest, secondary forest, corridors, and pastures at Piedras Blancas National Park in southwestern Costa Rica. The objectives of the study were: 1) to document bat species composition in the lowland rainforest area of Piedras Blancas in southwestern Costa Rica, 2) to compare species richness and dominance of the bat fauna in habitats with different levels of disturbance, and 3) to evaluate the importance for bats of remnant corridors between forested areas. Bats were mist netted for 38 nights from 2 January to 26 March 1997. A total of 922 individuals from 38 different species were captured. Mature forest habitat demonstrates the highest number of species while pasture habitat has the lowest. Secondary forest and corridor habitats lay in-between them. A comparison with a Kruskal-Wallis test showed significant differences among habitats in both indices. The highest index of richness and the lowest index of dominance were found in mature forest habitat. The richness values were similar in secondary forest and corridors, and lowest in pasture habitat. Dominance

was highest in secondary forest, due largely to the high abundance of two species of the genus *Carollia*, followed by pasture and corridor habitat. Corridors provided important habitat allowing bats to move from one forested area to another. This study indicates that bat species richness and dominance are useful indicators of the degree of habitat disruption.

Chiropteran Use of Artificial Box Roosts in Colorado.

Ethan P. White. The Colorado College, CO

Protection of roost sites has become increasingly important in bat conservation efforts, and recently, bat houses have been used in the hope that they will replace bat roosts that are being destroyed or create new roosts where roost selection is limited. Few studies have investigated the effectiveness of these artificial roosts and until now data from Colorado was limited to six houses included in a study by Bat Conservation International. In the present study the sample size is expanded to greater than 65 houses, which were measured for a broad range of variables related to house characteristics, placement, and ecological conditions in the vicinity of the houses. Houses were checked repeatedly from June through September for day time use. Night surveys of the houses were also conducted to determine if they were being used as night roosts. The results will be used to document factors associated with the use of bat houses. They represent the first baseline information on bat house use in Colorado.

Conservation of the Rodrigues fruit bat.

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The Rodrigues fruit bat, *Pteropus rodricensis*, is endangered and endemic to the Mascarene island of Rodrigues in the western Indian Ocean. Historically abundant, the wild population of these bats was reduced to less than 100 individuals by the mid-1970's due to hunting, habitat destruction, and the effects of severe cyclones. Today, the population is estimated to be more than 1200 bats. A further 470 bats are held in captivity. The captive population is registered in an international studbook. Implementation of the captive management plan has been slow because of difficulties determining parentage and uncertainty about the amount of genetic diversity and its partitioning in the captive and wild populations. In 1995, we attempted to answer the question of diversity by collecting wing punches from fourteen wild bats and ten bats in the captive Mauritius colony. A 1.2 kb fragment of mitochondrial DNA encompassing the control region was sequenced. Initial results demonstrate that there is a repeat region of different lengths in each specimen. Additionally, there are 66 polymorphic sites in a 973 base pair segment. These data suggest that there is significant variation in the control region among these individuals.

To assess the distribution of bats on Rodrigues, Whitman conducted a survey for possible roost sites. A new maternity roost was discovered that contained approximately 300 bats of which 75% had dependent young. As this site was unprotected, Whitman proposed to the National Parks and Conservation Service of Mauritius that this area be fenced. This proposal is under consideration.

To address the conservation education needs for this species, an education kit was developed by the American Zoo Association's Bat Taxon Advisory Group. The kit used non-traditional teaching tools such as games, puppets, and toys to introduce topics in bat biology, ecology, and conservation. The kit was introduced to teachers at a teacher's workshop. Subsequently, Whitman and Jamieson presented one hour lessons to each of the 25 fifth grade classes on Rodrigues. Pre and post lesson questionnaires clearly demonstrated that student's attitudes and knowledge about bats significantly improved after the program.

Habitat Selection at Four Spatial Scales by Bats along Coastal Maine.

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The importance of coastal wetlands to foraging bats has not been investigated in the northeastern U. S. Most studies assessing habitat selection by bats are limited to a single spatial scale. Because animals can

select different habitats at different spatial scales, studies that limit their analysis to a single scale may overlook important patterns. The objective of my research has been to investigate habitat selection at four spatial scales by bats along the central coast of Maine. The four scales, from smallest to largest, are: microhabitat (habitat variables that may influence bat activity within a single habitat patch), single habitat (habitats surrounding survey points), multiple habitat (composition of habitats within a 50 m radius of survey points), and landscape. My study area was located in Acadia National Park and adjacent Navy lands and comprised a mosaic of spruce-fir forests, bogs, emergent wetlands, small ponds, and lakes. I conducted species inventories with mist nets and Anabat bat detectors, and used bat detectors to determine how intensely bats used different habitats. Of the six species observed in the study area, little brown bats *Myotis lucifugus* and northern long eared bats *M. septentrionalis* were the most common. Preliminary analyses indicate that at the microhabitat scale, presence of vegetative cover 0-4 meters above ground, tree density, and distance to open water appear to be the best predictors of bat activity. At the single habitat scale, bat activity was highest over open water and in corridors. I will present updated analyses of selection at all spatial scales.

Microsatellite Analysis of Mating Systems and Genetic Variability in Straw-colored Fruit Bats *Eidolon helvum*.

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A central question in population biology has been: What happens to genetic variability over time in small, isolated populations? The current captive population of *Eidolon helvum* in American Zoological Association (AZA) institutions is uniquely suited to address this question. This captive population was founded by seven individuals and has grown to nearly 100 individuals in four zoological parks. The presence of these founders and the subsequent generations, as well as the opportunity for concurrent behavioral studies, make the AZA populations of *E. helvum* an excellent model for predicting the genetic consequences of increasing habitat fragmentation, and over hunting of wild *E. helvum*. Seven microsatellite loci, developed in the laboratory of Dr. Gary McCracken for Old World fruit bats of the genus *Pteropus*, were tested for applicability in *E. helvum*. Primer sequences for all seven microsatellites are present in *E. helvum*. In all cases the amplified DNA fragment is of similar size to those found in the genus *Pteropus*. Preliminary studies show variability within several of the microsatellite loci. Comparison of the genotypes of known mother/pup pairs will be made in order to identify the paternal genetic contribution. Microsatellite variability will be used to exclude potential sires of pups until the actual sire can be determined. Analysis of parentage in the AZA breeding colonies will be used to determine the captive mating system of *E. helvum*. In addition, any loss of genetic variability in these colonies will be tracked. Knowledge of relatedness and the captive mating system will be used to recommend an optimal captive breeding program for *E. helvum*.

Radio-tracking of *Corynorhinus rafinesquii* and *Myotis austroriparius* in South Carolina

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Between 15 May 1996 and 30 September 1996, 40 roost trees were located for two bats that are considered rare in the southeastern United States, *Corynorhinus rafinesquii* and *Myotis austroriparius*. Most trees were located by radio-telemetry. Most tagged bats were tracked to roost trees the day after they were outfitted with a transmitter. Roosts found for bats that were not tagged were located by inspecting cavities of large trees in the vicinity of known roosts or in areas that had clusters of cavity trees. All roost trees were found on or near creeks, or within the swamp forest floodplain, and most trees were surrounded by water at some point during the study. Bats moved from tree-to-tree frequently, *C. r afinesquii* moved more often than *M. austroriparius* and used more trees. Tree roosts of *C. rafinesquii* were often clustered and alternate roosts were generally found in close proximity to each other. Roost trees of *C. rafinesquii*

were more variable in the size and shape of the cavity opening than were trees used by *M. austroriparius*. All trees used as day roosts were in live gum (*Nyssa* sp.) trees although there were cypress (*Taxodium distichum*) trees with large cavities in the study area. A group of *C. rafinesquii* was observed night-roosting in a dead, burned-out cypress snag in the vicinity of a cluster of day roosts for this species. All roost trees were within the forest and none recieved exposure to direct sunlight after leaf-out. The results of this study demonstrate that mature bottomland hardwood forests contain important roost sites for two rare bats. The need to identify and protect such areas in the southeast may be critical to preventing population declines for these two species.

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We have made every effort to include all those who have registered and attended; if we omitted anyone, it is perhaps because that person was not registered (and did not pay the registration fee). To those who did register and are not included here, our apologies.

Twenty-seventh Annual North American Symposium on Bat Research

T. A. Griffiths, Program Director, N.A.S.B.R.

Dept. of Biology, Illinois Wesleyan University, Bloomington, IL 61702

The twenty-seventh annual North American Symposium on Bat Research met at the DoubleTree Hotel in Tucson, AZ, from October 8-11, 1997, sponsored by the University of Arizona, Pima Community College, and Arizona Game & Fish. Dr. Ginny Dalton was the conference host, ably assisted by the members of her Local Committee: Debbie Buecher, Cartographer and Bat Specialist; Roger Carpenter, a Bat Biologist of some renown; Sandy Ditty, a Wildlife & Fisheries graduate student at the University of Arizona; Kim Duffek, of the Arizona-Sonora Desert Museum; and Sarah Schmidt, also a Wildlife & Fisheries graduate student at the University of Arizona. There were 269 registered participants (not counting the educators who attended the special Bat Conservation Workshop on Saturday morning). In terms of numbers of participants, the 27th annual meeting was the largest regular (non-international) North American meeting ever held (Horst, 1995). One hundred and two scientific papers were presented at the meeting, not counting the special presentations for teachers made during the Saturday morning workshop. Twenty-six of these were poster presentations. According to data in Horst (1995), this number of presentations is the largest number ever given at a regular meeting.

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. Four cash prizes of \$250

each were awarded at the Friday evening banquet to Claudia Coen of Cornell University, Lisa Comeaux of the University of Tennessee, Susan W. Murray of Eastern Michigan University, and Moritz Weinbeer of the University of Würzburg in Vaihingen, Germany. A special SPELEOBOOKS merchandise prize was awarded to Theresa Cabrera Menard of the University of Hawaii. Generous monetary donations from Roy Horst at Bat Research News, Roger Haagenson and John Seyjagat of The Lubee Foundation, and Emily Davis Mobley of SPELEOBOOKS made all of the prizes possible.

The Friday night banquet, a medley of Southwestern cuisine, was very well attended. Gary Nabhan, co-author of "The Forgotten Pollinators" was the featured banquet speaker. Three special awards were presented at the banquet. Fred Anderka of Holohil Systems, Ltd. received an award for his contributions to the development of superb bat detection equipment. Jim Findley was made the first Lifetime Member of the North American Bat Research Society (which means I can no longer charge him a registration fee to attend these meetings). And Gary McCracken received the society's highest honor, The Gerrit S. Miller, Jr. Award, joining a very distinguished group of bat researchers honored through the years for their contributions to bat biology (I can still charge Gary!).

Sandy Reith, Heidi Vasiloff, and other Arizona Game & Fish personnel organized and ran a special bat education workshop on Saturday morning of the conference. It was very well attended by Arizona teachers, park and conservation workers, and other local persons interested in the conservation of bats. This was the second year in a row that we have run this workshop in conjunction with the NASBR. We hope to do this again this fall in Hot Springs, Arkansas, and annually thereafter. I thank Sandy and Heidi for their efforts which made the workshop possible. Kim Williams and Rob Mies also organized the first annual workshop on Standardization of Possession, Exhibition, and Interstate Transportation of U. S. Indigenous Bats. They hope too to make this an annual special event at the NASBR. I thank them for their hard work.

E. Lendell Cockrum very graciously donated some of his scientific reprints to a "Take what you want -- Pay what you think they are worth" table, which generated nearly \$30 for student prize money at future meetings. The late Karl F. Koopman, who attended every bat meeting from the second to the twenty-sixth, was honored by contributions from his friends to establish an annual Karl F. Koopman Prize, to be awarded for the best student paper presented at the meeting in the areas of bat systematics or zoogeography. We hope to award the first Koopman Prize at the Hot Springs meeting in 1998. Finally, let me extend Ginny Dalton's and my special thanks to Dave Dalton (Ginny's husband), Margaret Griffiths (my wife), and Roy Horst (Head Honcho Emeritus) for all the hard work they did to make this meeting a rousing success.

Literature Cited

Horst, G. R. 1995. A brief history of the annual North American Symposia on Bat Research. *Bat Research News*, 36: 129-132.

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Announcements of Bat Meetings around the World

**April 14-17, 1998
The 8th Australasian Bat Conference
Rockhampton, Queensland, Australia**

The particulars of this meeting have appeared in a previous issue of Bat Research News, and it is too late for submission of titles, but there are still a few days in which to make your travel arrangements. The abstracts of the proceedings at this conference will be published in the next issue of Bat Research News.

This meeting is being convened by David Gee, Mary McCabe and Dianne Vavryn. If you have a last minute intense interest David Gee may be contacted via e-mail at dgee@mildura.net.au

**June 6 - 10, 1998
The 78th Annual Meeting of the American Society of Mammalogists
Virginia Tech University, Blacksburg, Virginia**

The American Society of Mammalogists annual meeting is rather larger than most such meetings and covers all aspects of mammalian biology. There are usually a great number of excellent papers and posters concerning bat biology. A large number of North American Bat Biologists also attend this meeting. If you are interested in attending contact:

Jack Cranford, Department of Biology,
Virginia Tech, Blacksburg, VA 24061
tel: 540-231-5371 FAX 540-231-9307
e-mail cranford@vt.edu

**August 2 - 6, 1998
11th International Conference on Bat Research
Brasilia, Brazil**

The 11th International Bat Research Conference, promoted by the Department of Zoology of the University of Brasilia, will be held at the Hotel Pousada dos Pireneus, in Pirenopolis, a small picturesque old (XVIII century) gold mining town near Brasilia. Both Pirenopolis and Brasilia lies at the heart of the Cerrado, a savanna-like vegetation growing on the flat relief of the Central Braziln Plateau. This is the second largest biome in Brazil and south america, covering approximately 2 million km² which is equal in area to the United Kingdom, Gernay, Spain and France combined. The Cerrado is also one of the most threatened Brazilian ecosystems since it is now the main agricultural frontier in the country. The Cerrado harbors 80 bat species, or 60% of the 138 species with confirmed occurrence in Brazil.

The Conference will meet August 2 through 6, 1998. There are at present at least three special sessions being organized. One on "Evolution of Echolocation and Flight Behavior", convened by Nancy Simmons and Elizabeth Kalko. The second symposia concerns "Flowers and Bats in South America: a Tribute to Stefan Vogel", will be convened by Marlies Sazima and Susana Buzatto. The third symposium

continued over>>

is entitled "Vampire Bats: Biology, Myth, Problems, Control and Controversy" convened by Wilson Uieda, Joaquin Arroyo C. and Anthony Hutson.

Registration cost for the meeting is \$150.00 (\$ U.S. funds or the equivalent) for regular participants and \$100.00 for students.

For more complete information and registration materials contact:

11th IBRC/FINATEC
Universidade de Barsilia - UnB
Caixa Postal 4474
70919-970 - Brasilia - DF- Brazil
The website is <http://www.unb.br/zoo/projetos/circular2.htm>
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October 28-31, 1998

**Twenty-eighth Annual North American Symposium on Bat Research
Arlington Resort Hotel and Spa, Hot Springs, AR**

The 28th Annual NASBR will be held from October 28-31, 1998, in Hot Springs, Arkansas. The Local Host for the conference will be David Saugey of the U. S. Forest Service in Jessieville, Arkansas. A block of rooms has been reserved for the symposium at the Arlington Resort Hotel & Spa at a special conference rate. The Arlington is a grand old hotel built for patrons of the famous mineral baths. Al Capone frequented the Arlington, most of the Twentieth Century American Presidents have been there, and a number of famous celebrities have "taken the waters" at the Arlington. The hotel is located in the historic downtown district of Hot Springs, within easy walking distance of dozens of fascinating shops and restaurants, and just a short walk from the hot springs and some spectacular mountain trails. The foliage and climate should be beautiful there in late October. If you are a current subscriber to Bat Research News or if you attended last year's meeting in Tucson, you will receive information by mail in the late spring. Please let Tom Griffiths know if your address has changed recently. We also hope to have a NASBR web site set up soon, with information about the Hot Springs conference and downloadable registration materials.

For hotel reservations: **1-800-643-1502** outside of Arkansas and **501-623-7771** in Arkansas --
**be sure to mask for the special rates for the
North American Symposium on Bat Research**
for additional information contact Thomas Griffiths tgriff@titan.iwu.edu

**August 22-27, 1999
The 8th European Bat Research Symposium, Kraków, Poland
convened by Bronislaw W. Woloszyn**

Detailed announcements will follow in the next several issues of Bat Research News.
for long range advance planning contact Woloszyn at: VIIIEBRS@isez.pan.krakow.pl

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Front Cover

The illustration on the front cover of this issue was created by Kim Duffek of the Arizona-Sonora Desert Museum and graced the front cover of the 27th Symposium program and proceedings.

We are always looking for high quality line drawings for our front covers; if you have some good "bat-art" that you would like to share with us please send me a copy and I will contact you at the earliest opportunity. GRH