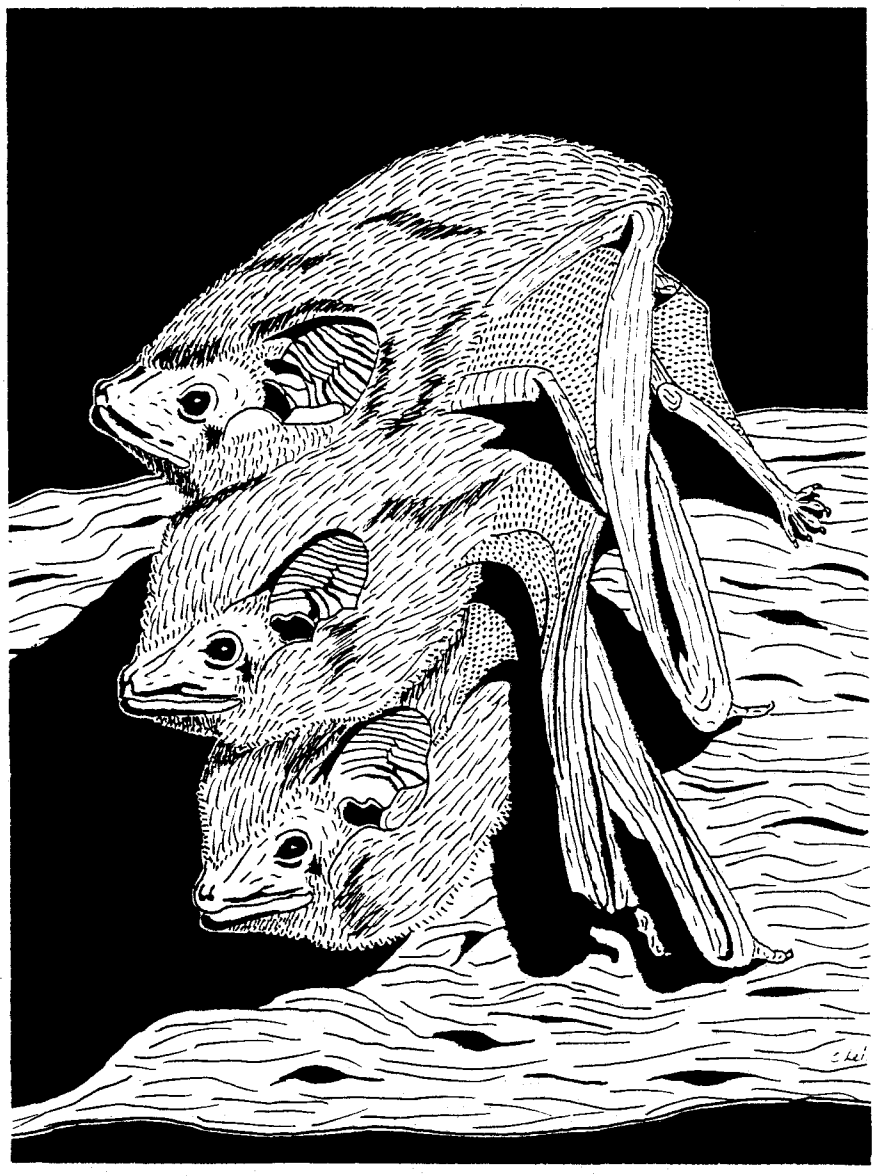
BAT RESEARCH NEWS



Volume 40: No. 1 **Spring 1999**

BAT RESEARCH NEWS

Volume 40: Numbers 1–4 **1999**

Original Issues Compiled by Dr. G. Roy Horst, Publisher and Managing Editor of *Bat Research News*, 1999.

Bat Research News is ISSN # 0005-6227.

BAT RESEARCH NEWS

Table of Contents for Volume 40, 1999

Volume 40: Number 1, Spring 1999

Volume 40: Number 2, Summer 1999

BAT RESEARCH NEWS

Table of Contents for Volume 40, 1999

(cont.)

Volume 40: Number 2, Summer 1999 (cont.)

Volume 40: Number 3, Fall 1999

BAT RESEARCH NEWS

Table of Contents for Volume 40, 1999

(cont.)

Volume 40: Number 3, Fall 1999 (cont.)

Volume 40: Number 4, Winter 1999

BAT RESEARCH NEWS

Volume 40: No.1 Spring 1999

Publisher and Managing Editor
G. Roy Horst
Bat Research News, P.O. Box 5068, Potsdam,NY 13676
Tel. 315-267-2259 FAX 315-267-3170 E-mail: horstgr@potsdam.edu.

Editor for Feature Articles
Allen Kurta, Department of Biology, Eastern Michigan University, Ypsilanti, MI 48197
Tel. 734-487-1174 FAX 734-487-9235 E-mail: bio_kurta@online.emich.edu

Editor for Recent Literature
Thomas A. Griffiths, Department of Biology, Illinois Wesleyan University, Bloomington, IL 61702
Tel. 309-556-3230 FAX 309-556-3411 E-mail: tgriff@titan.iwu.edu

Editor for Conservation Education and Book Reviews
Patricia Morton, Texas Parks and Wildlife Department, Suite 100, 3000 IH 35 South, Austin, TX 78704
Tel. 512-912-7046 FAX 512-912-7058 E-mail: patricia.morton@tpwd.state.tx.us

Instructions to Contributors and Subscribers:

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 to Kurta (address above). 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.

Subscriptions to individuals per volume (year) are in United States, Mexico and Canada, $18.00 [U.S. funds] , all other countries are $20.00 per volume(year). All issues are sent surface mail, postage paid by ***Bat Research News*** to all addresses world-wide. **Air Mail** is $10.00 per volume extra.

Subscriptions to institutions are $ 30.00 per volume(year).

Please make all checks payable to; ***Bat Research News.*** Subscribers outside the United States can pay by checks in U.S. dollars, drawn on banks with an affiliated office in the United States. Payment can also be by **VISA, MASTERCHARGE**, or **DISCOVER** card (no American Express) by sending in letter from or by e-mail (to Horst) your credit card account number, name exactly as it appears on your card, the expiration date, and the amount you wish to charge to your card.

Your credit card data is safely **destroyed** as soon as our account is credited with your payment.

Bat Research News is : ISSN 0005-6227

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

BAT RESEARCH NEWS

Volume 40: No.1 **Spring 1999**

Measuring Bat Activity with the Anabat II System

E. R. Britzke, K. L. Murray, B. M. Hadley, and L. W. Robbins
Department of Biology, Southwest Missouri State University, Springfield, MO 65804

The Anabat system of detecting and recording echolocation calls has experienced a dramatic increase in popularity in recent years (Betts, 1998). This system has been used to identify bats by their echolocation calls (Betts, 1998; Krusic and Neefus, 1996; O'Farrell et al., 1999) and examine the effects of forest management on bat activity and presence (Crampton and Barclay, 1996; Hayes and Adam, 1996; Parker et al., 1996). Bat activity has been quantified with the Anabat system by determining amount of time a tape recorder recorded echolocation calls (Perdue and Steventon, 1996), counting number of files saved (Erikson and West, 1996; Hayes and Adam, 1996; Parker et al., 1996), and counting number of passes recorded (Crampton and Barclay, 1996; Hayes, 1997). A pass is defined as a sequence of calls that ends with a break of 1 sec or more before the next sequence begins (Hayes, 1997). Because this is roughly the same criterion used by the Anabat system to determine when to save calls to a file, the number of files and number of passes are roughly equivalent. Therefore, for the remainder of this paper, the two methods collectively will be referred to as the number of files saved.

Current methods of determining bat activity may provide reliable estimates of bat activity under some circumstances, but they have one potentially serious drawback. They fail to take into account length of the call sequence and, therefore, can lead to under- or overestimates of activity in an area. For example, files from some areas may contain many calls, whereas files from other locations may contain far fewer calls. If number of files saved were comparable, activity levels in these two areas erroneously would be considered equal. Because of this, we felt the need to investigate other methods of estimating bat activity.

In this study, we examined two alternative techniques to quantify bat activity--number of calls per file and the buffer size of each file. The number of calls per file can be counted manually from displays of recorded calls. However, this technique can be time consuming, especially when dealing with long sequences of calls. In addition, when counting the number of calls, the researcher must determine what is and what is not an echolocation call. This may be a difficult and subjective decision when dealing with broken or fragmentary calls or calls recorded to a tape player.

There is a maximum number of data points that can be stored in the data buffer used by the Anabat system, and in this paper, we will use the term "buffer size" to represent the percentage of the maximum number of data points that are actually recorded in an individual Anabat file. In contrast to number of calls per file, buffer size, as we define it, is calculated automatically by the computer using the Anabat software, and this number appears on the screen whenever a recorded file is displayed. Thus, buffer size may be used as an easy, objective means of estimating bat activity with the Anabat system.

However, there is a drawback to this technique. Size of the buffer is determined by including all data points within a file. These points may include echolocation calls, echoes of those calls, and other extraneous noise picked up by the detector (e.g., insects). So, in areas with a high incidence of echoes or high insect activity, use of buffer size may lead to misinterpretation of bat activity in the area. Nevertheless, this problem can be nearly eliminated by adjusting the sensitivity of the detector to filter extraneous noise.

We examined the relationship between these two proposed methods of determining bat activity. Anabat files were recorded while passively monitoring directly into a laptop computer, in a variety of different habitats, over several nights, and at several levels of activity. We manually counted number of echolocation calls per file and compared this to buffer size for the same file. There was a strong correlation between these two measures of bat activity ($r_s = 0.965$; $P < 0.001$), indicating that both methods yielded similar estimates of bat activity. However, for the above-mentioned reasons, we felt that buffer size is the easier and more consistent measure of bat activity.

To compare nightly patterns of activity obtained by the traditional method (number of files) with those

obtained by calculating buffer size, we sampled an open habitat with low bat activity and over a pond with high bat activity. We divided the night into 15-min intervals, counted the total number of files recorded, and summed the buffer size resulting from each file for each interval (Fig. 1). Differences between methods are most apparent in areas of high bat activity (e.g., Fig. 1b). This difference is a by-product of the way that the software passively records files. Files are saved in two ways--after a pause in a call sequence or after 15 sec of continuous detection of calls. Files from areas with constant activity are only saved after the 15 sec, and consequently, there are a maximum number of large files that can be recorded. In areas with discontinuous activity, frequent pauses occur between call sequences and more files can be then be saved during the same sampling period (15 min in Fig 1). As a result, in areas with constant activity, fewer files may be recorded than in areas with intermittent activity.

Use of number of files also may be a problem when comparing activity in two distinct areas. For example, in a flyway, call sequences are often short, whereas in a foraging area, call sequences tend to be longer. Thus, when only using number of files, activity in a flyway would be overrepresented, while activity in a foraging area would be underrepresented. Total buffer size considers both number of files and size of those files and, therefore, may yield a better estimation of bat activity in a given area.

The observed correlation between buffer size and number of calls per file was obtained from files that were saved directly to a laptop computer, but use of tape recorders may disrupt this strong correlation. A magnetic tape contributes background noise to the file and consequently increases buffer size independent of call sequences. Also, using laptops, we were able to examine visually our initial sequences and adjust sensitivity of the detector to limit extraneous noise (O'Farrell et al., 1999). With tape recorders, it is more difficult to reduce any extraneous noise recorded. This should be a minor problem, but it could reduce the correlation between buffer size and number of files. However, our strong correlation was obtained from files recorded passively, indicating that the close relationship between these two measures is present despite differing habitats and varying levels of extraneous noise and activity.

Another concern with use of tape recorders is that, when simultaneously recording with one detector attached to a tape recorder and one attached to a laptop computer, a different number of files may be recorded by the two techniques. Also, we have noticed that the number of files saved by Anabat after the tape is played through the ZCAIM may vary with each playback of the tape. This difference in number of files should be considered when comparing results from areas sampled with different recording methods or results from previous studies.

We have shown that there are different techniques that can be used to determine bat activity with the Anabat system. These methods represent different approaches that have their own strengths and weaknesses. Once a working definition of activity is determined for a specific question, the method that best determines bat activity under those circumstances should be utilized.

Literature Cited

Betts, B. J. 1998. Effect of interindividual variation in echolocation calls on identification of big brown and silver-haired bats. Journal of Wildlife Management, 62:1003-1010.

Crampton, L. H., and R. M. R. Barclay. 1996. Habitat selection by bats in fragmented and unfragmented aspen mixedwood stands of different ages. Pp. 238-259 in Bats and Forest Symposium (R. M. R. Barclay and R. M. Brigham, eds.). British Columbia Ministry of Forests, Victoria, British Columbia, Canada.

Erickson, J. L., and S. D. West. 1996. Managed forests in the western Cascades: the effects of seral stage on bat habitat use patterns. Pp. 215-227 in Bats and Forest Symposium (R. M. R. Barclay and R. M. Brigham, eds.). British Columbia Ministry of Forests, Victoria, British Columbia, Canada.

Hayes, J. P. 1997. Temporal variation in activity of bats and the design of echolocation studies. Journal of Mammalogy, 78:514-524.

Hayes, J. P., and M. D. Adam. 1996. The influence of logging riparian areas on habitat utilization by bats in Western Oregon. Pp. 228-292 in Bats and Forest Symposium (R. M. R. Barclay and R. M. Brigham, eds.). British Columbia Ministry of Forests, Victoria, British Columbia, Canada.

Krusic, R. A., and C. D. Neefus. 1996. Habitat associations of bat species in the White Mountains National Forest. Pp. 185-198 in Bats and Forest Symposium (R. M. R. Barclay and R. M. Brigham, eds.). British Columbia Ministry of Forests, Victoria, British Columbia, Canada.

O'Farrell, M. J., B.W. Miller, and W. L. Gannon. 1999. Qualitative identification of free-flying bats using the Anabat detector. Journal of Mammalogy, 80:11-23.

Parker, D. L., J. A. Cook, and S. W. Lewis. 1996. Effects of timber harvest on bat activity in southeastern Alaska's temperate rainforests. Pp. 277-291 in Bats and Forest Symposium (R. M. R. Barclay and R. M. Brigham, eds.). British Columbia Ministry of Forests, Victoria, British Columbia, Canada.

Perdue, M. and J. D. Steventon. 1996. Partial cutting and bats: a pilot study. Pp. 273-276 in Bats and Forest Symposium (R. M. R. Barclay and R. M. Brigham, eds.). British Columbia Ministry of Forests, Victoria, British Columbia, Canada.

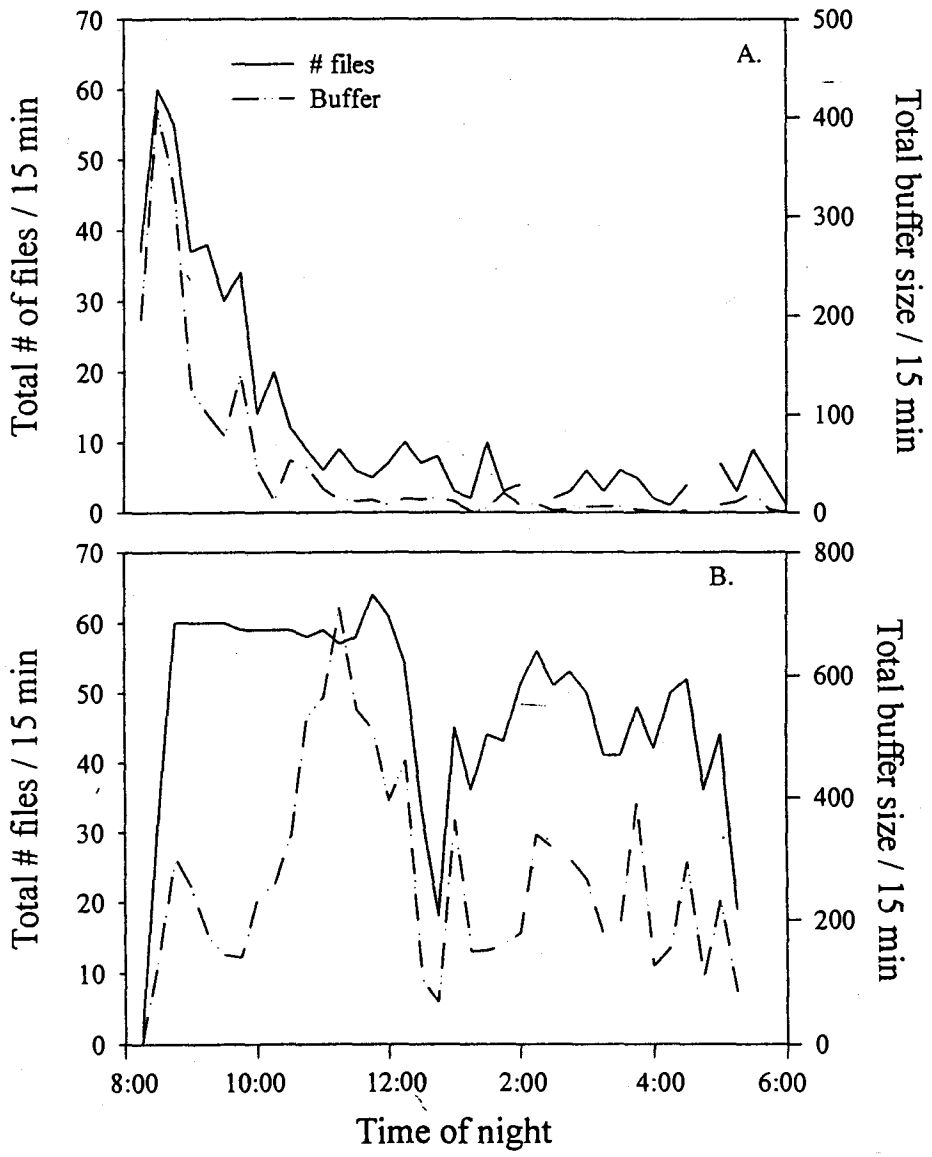


Figure 1. Nightly bat activity, summed over 15-min intervals, using number of files saved and buffer size of each file saved at a) an area of low activity and b) an area of high activity. Sunset occurred both nights at ca. 2000 h.

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 the Feature Editor, Alan Kurta

Roadrunner Preys on Mexican Free-tailed Bat

Ya-Fu Lee and Yen-Min Kuo
Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville, TN 37996

Most previous records of avian predation on Mexican free-tailed bats, *Tadarida brasiliensis mexicana*, involved regurgitated pellets or direct observations of raptors pursuing bats (Wilkins, 1989). The only report of an avian predator other than a raptor was by Herreid (1960), who observed roadrunners preying on free-tailed bats at Davis Cave, Blanco Co., Texas. The greater roadrunner *Cuculidae, Geococcyx californianus* can run at speeds exceeding 30 km/h, but it also occasionally makes low, short-distance flights, up to 6 m off the ground (Green, 1994; Kavanau and Ramos, 1970; Hughes, 1996). It is omnivorous and opportunistic, generally gleaning its prey from the ground (Hughes, 1996). Major foods include arthropods, lizards, snakes, rodents, juvenile rabbits, resting birds, and eggs (Hughes, 1996; Parmley, 1982; Meinzer, 1993). In the present report, we describe the second record of a roadrunner preying on Mexican free-tailed bats.

At 0935 h on 6 August 1996, we were sampling Mexican free-tailed bats during their dawn return to Frio Cave, Uvalde Co., Texas, when we saw a greater roadrunner sneak out from mesquite (*Prosopis*) shrubs and eventually walk down a slope into the cave. We could not see how far the roadrunner entered the cave, but ca. 2-3 min later, the bird emerged with a Mexican free-tailed bat in it's beak and then vanished into brush on the west side of the cave. The bat was alive, as indicated by its actively flapping wings, and its dark brown fur suggested that it was an adult.

Herreid (1960) observed predation by roadrunners outside Davis Cave, and stated that there was no need for roadrunners to enter the cave, but our observation indicates that roadrunners do enter caves for prey. Frio Cave has a total length over 610 m, and it contains one of the largest Mexican free-tailed bat colonies in the United States (ca. 10 million--Wahl, 1989). Inside the cave, bats roost in a series of large chambers, generally on the ceiling, ca. 10-20 m above the floor. Distance from the main entrance to the first big chamber that bats use to roost is at least 150 m. Although some bats may hang on side walls before the main roosting chambers, we have never seen live bats below a height of 3 m. An entrance pit above the cave allows some light to enter, and we have gone 50-60 m into the cave without using lights. The diurnal roadrunner probably could explore at least this far, but whether it captured an incoming bat as it dove into the entrance, flew up to take a bat that was hanging low on the wall, or found a fallen bat on the cave floor is not known.

The only other bat species that has been reported as roadrunner prey is the red bat *Lasiurus borealis* (Wilks and Laughlin, 1961). Although nocturnality makes bats generally inaccessible to diurnal roadrunners (Kavanau and Ramos, 1970), the large colonies of Mexican free-tailed bats in Texas may provide potentially easy prey for this bird. Greater roadrunners are very common outside caves used by colonies of free-tailed bats in central-southern Texas. Presumably, roadrunners search for their typical prey most of the time and only prey on bats occasionally, but actual predation may be more common than previously thought. Future studies of greater roadrunners within the range of bat caves, focusing either on direct observations or searching for bat remains around nests, may provide more detailed information on the predator-prey relationship between greater roadrunners and Mexican free-tailed bats.

We thank I. Marbach and B. Cofer for granting access to their properties at Anondale Ranch and Frio Cave. YFL thanks Bat Conservation International and The Nature Conservancy of Texas for funding. The Texas Parks and Wildlife Department issued a scientific permit (SPR-0695-744) for bat sampling. We also thank G. Anderson, S. Echternacht, L. Manne, and G. F. McCracken for critical comments on an earlier version of this manuscript.

Literature Cited

Green, C. A. 1994. Roadrunner predation on purple martins. Purple Martin Update 5:12.
Herreid, C. F., II. 1960. Roadrunner a predator of bats. The Condor 62:67.

continued>>>

Lee and Kuo continued>>>

Hughes, J. M. 1996. Greater roadrunner (Geococcyx californianus). In The birds of North America, No. 244 (A. Poole and F. Gill, eds). The American Ornithologists' Union, Washington, D.C.

Kavanau, J. L. and J. Ramos. 1970. Roadrunners: activity of captive individuals. Science, 169: 780-782.

Meinzer, W. 1993. The roadrunner. Texas Tech Press, Lubbock, Texas.

Parmley, D. 1982. Food items of roadrunners from Palo Pinto County, north central Texas. Texas Journal of Science, 34:94-95.

Wilkins, T. 1989. Tadarida brasiliensis. Mammalian Species, 331.

Wilks, B. J. and H. E. Laughlin. 1961. Roadrunner preys on a bat. Journal of Mammalogy, 42:98.

* * * * *

Summer Foraging and Roosting Behavior of an Eastern Pipistrelle *Pipistrellus subflavus*

Timothy C. Carter, Michael A. Menzel, Brian R. Chapman, and Karl V. Miller
Daniel B. Warnell School of Forest Resources, The University of Georgia

Little is known about diet, foraging behavior, and summer roosting ecology of the eastern pipistrelle *Pipistrellus subflavus*. The eastern pipistrelle hibernates in caves and mines throughout the eastern United States (Menzel et al., 1997). In spring, many of these animals leave the mines and caves, but we have only anecdotal information on where they go for the summer.

From 13 to 28 August 1996, we radiotracked a single, adult, female pipistrelle at the Savannah River Site, near Aiken, South Carolina. The nonreproductive female was fitted with a small radio-transmitter (model LB-2, 0.45 g; Holohil System Ltd., Ontario, Canada) and located 40 times while she foraged over the 15 days. Telemetry readings were taken 4 or more minutes apart to minimize autocorrelation (Swihart and Slade, 1985). Home range, as delineated by the 95% contour (Kie et al., 1996), was 395.5 ha.

The bat locations and the home-range polygon derived from the locations were imported into PC Arc/Info Geographical Information Systems (GIS; Environmental Systems Research Institute, Inc., Redlands, CA) for analysis. The home range consisted of bottomland hardwoods (88%), pine stands (9.5%), and upland hardwoods (2.5%), but 43% of foraging locations were located in bottomland hardwoods, 33% in pine stands, and 24% in upland hardwoods. Bottomland hardwoods made up 70.5% of the available habitat within the study area, whereas pine stands and upland hardwoods composed 27.3% and 2.2% of the area, respectively. Although 24.3% of the study area was aquatic or palustrine habitat, only 8% of foraging locations were associated with these habitats. Another 8% of foraging locations were associated with edge habitat (roads, power-lines, railways, and streams); 11.8% of the study area was classified as edge habitat.

One fecal pellet from the radio-tagged female and five pellets from an adult male that was captured were analyzed for dietary information (Whitaker, 1988). Diet of the female consisted of caddisflies (Trichoptera, 80% by volume), true bugs (Hemiptera, 10%), and moths (Lepidoptera, 10%). The male consumed beetles (Coleoptera, 40%), true bugs (Hemiptera, 30%), moths (Lepidoptera, 15%), and leaf hoppers (Homoptera, 15%). Other studies have reported moths, beetles, and flies (Fujita and Kunz, 1984; Carter et al., 1998).
The radiotracked pipistrelle used six roost trees over the 15 days. All roosts were in bottomland hardwood forests, and we quantitatively sampled vegetation surrounding the roost trees following Menzel et al. (1998). The most common species of tree in bottomland communities included laurel oak (*Quercus laurifolia,* 17.8%), swamp chestnut oak (*Quercus michauxii*, 17.8%), green ash (*Fraxinus pennsylvanicus*, 14.3%), red maple (*Acer rubrum,* 12.1%), and sweetgum (*Liquidamber styraciflua*, 10.0%). Three roosts were in swamp chestnut oaks, and one each in sweetgum, laurel oak, and American elm (*Ulmus americana*); all were living trees in good condition. Average diameter at breast height and height of roost trees was 23.3 + 9.0 (SD) cm and 21.5 + 4.3 m, respectively. Average dbh and height of overstory trees in the bottomland community was 21.2 + 12.9 and 19.0 + 7.7 m, respectively. Exact location of the bat in the tree was not determined but appeared to be somewhere among the leaves in mid-canopy. Although these data increase our understanding of the foraging behavior and roosting ecology of the eastern pipistrelle, in-depth studies are needed to better predict how land management decisions affect these animals.

continued>>>

Carter et al continued>>>

Acknowledgments

Funding was provided by the U.S. Forest Service Biodiversity Program at the Savannah River Site (Supplement No. 264 to 12-11-008-876), the University of Georgia, D. B. Warnell School of Forest Resources, and the Savannah River Ecology Laboratory. We thank personnel at the U.S.D.A. Forest Service Southern Research Station and E. Eckley and H. Whiffen for assistance with GIS.

Literature Cited

Carter, T. C., M. A. Menzel, D. M. Krishon, and J. Laerm. 1998. Prey selection by five species of vespertilionid bats on Sapelo Island, Georgia. Brimleyana, 25:158-170.

Fujita, M. S., and T. H. Kunz. 1984. *Pipistrellus subflavus*. Mammalian Species, 228:1-6.

Kie, J. G., J. A. Baldwin, and C. J. Evans. 1996. CALHOME: a program for estimating animal home ranges. Wildlife Society Bulletin, 24:342-344.

Menzel, M. A., T. C. Carter, B. R. Chapman, and J. Laerm. 1998. Quantitative comparison of tree roosts used by red bats *Lasiurus borealis* and Seminole bats *L. seminolus*. Canadian Journal of Zoology, 76:630-634.

Menzel, M. A., M. Monroe, T. S. McCay, and J. Laerm. 1997. Use of abandoned mines in North Georgia as hibernacula by the eastern pipistrelle *Pipistrellus subflavus*. Georgia Journal of Science, 55:224-230.

Swihart, R. K., and N. A. Slade. 1985. Influence of sampling interval on estimates of home-range size. Journal of Wildlife Management, 49:1019-1025.

Whitaker, J. O., Jr. 1988. Food habits analysis of insectivorous bats. Pp. 171-189 in Ecological and behavioral methods for the study of bats (T. H. Kunz, ed.). Smithsonian Institution Press, Washington, D. C., 553 pp.

* * * * *

Leaf Wrapping Behaviour in the Flute-nosed Bat *Murina florium*

Martin Schulz

School of Resource Science and Management, Southern Cross University,
P.O. Box 157, Lismore, NSW 2480, Australia

Roost usage in the rare rainforest microchiropteran, the flute-nosed bat *Murina florium* (Vespertilionidae) is poorly known. The few roosts that have been documented are of a single specimen sheltering in the ceiling of a bunkhouse in Papua New Guinea (van Deusen, 1961) and a single individual located under the suspended dead fronds at the base of an epiphytic fern against the trunk of a rainforest canopy tree in north eastern Queensland, Australia (Schulz and Hannah, 1996). The only study of roost usage in this species was by Schulz and Hannah (1998) who located four types of roosts in north-eastern Queensland: seven in the enclosed nests of the Yellow-throated Scrubwren *Sericornis citreogularis* (n=6) and Fernwren *Oreoscopus gutturalis* (n=1), three in vertically suspended clusters of dead leaves and one in the curled base of a dead palm leaf that had fallen and snagged vertically on a liana. All these roosts were located in rainforest understorey ranging from 2 to 8 m above the ground and the majority (82%) were occupied by single individuals. This note describes unusual roosting behaviour observed in four day released *M. florium* in dense simple microphyll vine-fern forest (Tracey and Webb 1975) on the edge of a track at the Walsh River crossing in Mt Baldy State Forest, north-eastern Queensland, Australia (17018íS, 145025íE).

Bat One: An adult female was released at 0905 hrs on 12 December 1995. On release this individual flew approximately 12 m and landed amongst foliage in an unidentified rainforest subcanopy tree approximately 8 m above the ground and 5 m from the edge of the track. On landing the bat moved between eight individual leaves before settling down. The leaves were approximately 11 cm long and 5 cm wide. At each leaf visited the bat appeared to attempt to lift a margin of the leaf with either the hindfoot or thumb. At the eighth leaf the individual positioned itself on the underside of the leaf to one side of the midvein facing downwards head angled towards the ground. Since *M. florium* is small with the head and body length ranging from 47 to 57 mm (Richards et al. 1995) the size of the leaf resulted in no parts of the stationary bat protruding outside the leaf margins. From this position the bat gathered the leaf over its body by dragging the edge of the leaf across with the right hindfoot and thumb. It appeared that the tips of

the thumb and hindfoot nails provided sufficient grip to achieve the observed manouevre. While undertaking this action the bat was not observed to bite side veins and interconnecting tissue to help collapse the leaf. After executing this manoeuvre the bat was obscured from view from most angles and no further movements were observed. Only when looking directly upwards from the ground so that the space between the two folded sections of the leaf was visible could parts of the stationary *M. florium* be discerned. The bat remained in this position for the remainder of the day. The time duration from release to the bat becoming stationary under the leaf was less than two minutes and the actual time from landing on the last leaf to becoming motionless was less than 10 seconds.

Bat Two: On release at 0932 hrs on 15 December 1995 this adult female flew approximately 5 m to a subcanopy tree on the edge of the track where it briefly landed on foliage. It took flight and flew in tight circles around the trunk of another subcanopy tree landing twice on leaves before alighting on a leaf about 7 m above the ground. Similar to Bat One this individual while facing downwards dragged the edge of the leaf over her body with the right hindfoot and thumb and then appeared to hold it in place. The entire observation sequence was completed in 74 seconds with five leaves sampled prior to settling down to roost.

Bat Three: This adult female was released at 0715 hrs on 16 December. Similar to the other two individuals this bat landed on a leaf approximately 6 m above the ground, positioned herself so that she faced downwards and dragged the edge of the leaf over her body so as to be virtually obscured from view. This observation sequence took 65 seconds with one leaf sampled before settling down to roost.

Bat Four: An adult male was released at 0738 hrs on 16 December 1995. On release this bat flew directly into and alighted amongst the foliage of an unidentified subcanopy tree 6 m above the ground on the edge of the track. Unlike the other individuals this bat dragged an adjacent leaf with its left thumb over the top of its body and appeared to hold it in place with both the thumb and one hindfoot. The time from release to becoming obscured from view took 82 seconds with no additional leaves sampled prior to settling down to roost.

This roosting behaviour is referred to here as leaf wrapping due to the manual manipulation of single leaves to obscure the resting bat from view. Such behaviour does not appear to have been previously reported in the literature. Leaf wrapping behaviour differs from that of tent-making bats where the veins and interconnecting tissue of leaves are cut to help collapse the leaf (e.g. Kunz 1994, Kunz et al. 1994). In addition, species of tent-making bats appear to select leaves that are growing approximately horizontal (Timm and Mortimer 1976) rather than distinctly angled leaves as observed used by the present species.

Leaf wrapping behaviour was not noted in the three radio-tagged *M. florium* that were tracked to foliage roosts in the same area (Schulz and Hannah 1998). These individuals were located roosting amongst small dead clumps of leaves that had fallen from canopy trees and become snagged in vegetation in the understorey. In all cases these bats were detected roosting singly amongst vertically suspended clumps of dead leaves with no evidence of the manipulation of individual leaves.

Although leaf wrapping behaviour was only observed as a result of day released individuals, the speed with which this behaviour was executed and the similarity in the behaviour between four separate individuals suggests that leaf wrapping may represent an alternative roost strategy used by *M. florium*. Such roosting behaviour which diminishes the visibility of the stationary bats is likely to provide shelter from weather such as direct sunlight and rain and reduce vulnerability to predation from visual-searching diurnal predators such as the Pied Currawong *Strepera graculina* and Spotted Catbird *Ailuroedus melanotis*. Further research is required to determine whether the leaf wrapping behaviour reported in *M. florium* occurs in situations other than with day-released individuals.

Acknowledgments

Special thanks to Dave Hannah for assistance with field work. Financial assistance was provided by the Forest Wildlife section, Resource Science Centre, Department of Natural Resources and grants from the Wet Tropics Management Authority and the ëAustralian Geographicí.

Literature Cited

Kunz, T.H. 1994. The world of tent-making bats. Bats, 12: 6-12.

Kunz, T.H., M.S. Fujita, A.P. Brooke, and G.F. McCracken. 1994. Convergence in tent architecture and tent-making behavior among neotropical and paleotropical bats. Jour of Mammalian Evolution, 2: 57-78.

continued>>>

Schulz continued

Richards, G.C., R.B. Coles, and H.J. Spencer. 1995. Tube-nosed insect bat *Murina florium*. Pages 496-497, in The Mammals of Australia (R. Strahan, ed.). Reed, Sydney.

Schulz, M. and D. Hannah. 1996. Notes on the tube-nosed insect bat *Murina florium* from the Atherton Tableland, north-eastern Queensland, Australia. Mammalia, 60: 312-316.

Schulz, M. and D. Hannah. 1996. Relative abundance, diet and roost selection of the tube-nosed insect bat, *Murina florium*, on the Atherton Tablelands, Australia. Wildlife Research, 25: 261-271.

Timm, R.M. and J. Mortimer. 1976. Selection of roost sites by Honduran white bats, *Ectophylla alba* (Chiroptera: Phyllostomatidae). Ecology, 57: 385-389.

Tracey, J.G. and L.J. Webb. 1975. Vegetation of the humid tropical region of north Queensland. CSIRO, Brisbane.

Van Deusen, H.M. 1961. New Guinea record of the tube-nosed insectivorous bat, *Murina*. Journal of Mammalogy, 42: 531-533.

* * * * *

Roosting Sites of an Eastern Pipistrelle during Late-summer Swarming

Allen Kurta[1], Chris M. Schumacher[2], Mark Kurta[3], and Scott DeMers[3]

[1]Department of Biology, Eastern Michigan University, Ypsilanti, MI 48197,

[2]U.S.D.A. Forest Service, Huron-Manistee National Forests, 412 Red Apple Road, Manistee, MI 49660, and

[3]Beach Middle School, Chelsea, MI 48118

The eastern pipistrelle *Pipistrellus subflavus* is a tiny (4-7 g) insectivorous bat that occurs in parts of Mexico and southern Canada and throughout most of the eastern United States (Fujita and Kunz, 1984). In some areas, such as the Ohio River Valley, it is one of the most commonly encountered species (Barbour and Davis, 1969), whereas in other areas, such as the central basin of the Great Lakes, the species is extremely rare (Kurta, 1995). Despite its wide distribution and localized abundance, there is little information on roosting habits of this species outside hibernation.

On 27 August 1998, we were capturing swarming bats with a harp trap stationed inside the spillway of Tippy Dam, near Wellston, Manistee Co., Michigan. Tippy Dam is a hydroelectric facility that is a known hibernaculum and swarming site for bats (Kurta and Teramino, 1994; Kurta et al., 1997). While processing bats captured between 2300 and 2330 h, we noticed a small, light-colored bat that subsequently was identified as a juvenile female eastern pipistrelle. This pipistrelle was only the fifth ever captured in the Lower Peninsula of Michigan and the first taken outside the hibernation season anywhere in the state (Unger and Kurta, 1998).

To obtain information on roosting habits of this uncommon species, we attached a radiotransmitter (7.6% of body mass; model LB2, Holohil Systems, Carp River, Ontario) to the animal using a surgical adhesive before releasing it. We initially detected the signal late the following day, and about 15 min after sunset, the bat was found roosting in a white oak (*Quercus alba*). The tree was 30 cm in diameter and located in a 14-ha shelterwood cut on the Manistee National Forest, 1.9 km W of Tippy Dam. The stand had been thinned in 1993 to promote regeneration of oaks and had a basal area of only 4.6 m^2 /ha and a resulting canopy cover of about 20-30%. After verifying which tree the bat was in, we were bent over, removing notebooks from our packs, when the bat began flying; consequently, we did not see specifically where in the tree the bat was roosting. There were no cavities in the trunk or major branches of this healthy tree. Bark on the trunk was slightly scaley, and the bat could have been partly concealed by one of the small flakes; however, it seemed more likely that the bat had been roosting in the foliage.

The next day, the bat had moved about 1.5 km NE to a tree that was located on a steep, heavily forested slope, leading down to the floodplain of the Manistee River, about 0.84 km below the dam. This 21-ha stand contained mixed hardwoods, primarily red oaks (Q. rubra), and some maples, particularly red maple (*Acer rubrum*). Basal area was 23 m^2/ha with a resulting canopy cover of 80% or greater. The roost tree was a healthy red oak with a diameter of 30 cm. The pipistrelle was tracked to this tree everyday between 29 August and 5 September, and we watched the bat leave to forage on four nights during this period. It appeared to have been roosting near the top of the tree, perhaps 25 m above the ground. There were no large, dead branches on the red oak, and the small size of branches at the top of the tree precluded hollows large enough to shelter even a six-gram bat; hence, it appeared that the pipistrelle was roosting in the

foliage. On three nights, it was the only bat to leave the tree, but on one night another small bat, which we could not positively identify, appeared to have left the same tree.

During the maternity season, eastern pipistrelles roost occasionally in buildings or caves, but the low frequency of colonies in these types of sites suggests that most roost elsewhere. Whitaker (1998) noted that pipistrelles that did use buildings typically were found inside the structures, rather than behind shutters or exterior siding. He believed that this behavior indicated that most pipistrelles actually roosted within tree hollows, and Menzel et al. (1998) provided some anecdotal support for this idea by capturing pipistrelles in a pitfall trap set near the opening to the basal cavity of a tree. Findley (1954), in contrast, reported a solitary male pipistrelle roosting among the leaves of a tree in Mexico, and our observations also suggested a foliage-roosting habit for the juvenile female that we radiotracked during the swarming season.

Acknowledgments

Field work was funded through a cooperative agreement between the U.S.D.A. Forest Service and Eastern Michigan University. Personnel of the Forest Service (R. Ennis, P. Huber, and T. Filippi) participated in our roost watches. R. Ennis commented on the manuscript. D. Battige, Consumers Energy, arranged access to Tippy Dam.

Literature Cited

Barbour, R. W., and W. H. Davis. 1969. Bats of America. University Press of Kentucky, Lexington, 286 pp.

Findley, J. S. 1954. Tree roosting of the eastern pipistrelle. Journal of Mammalogy, 35:433.

Fujita, M. S., and T. H. Kunz. 1984. *Pipistrellus subflavus*. Mammalian Species, 228:1-6.

Kurta, A. 1995. Mammals of the Great Lakes region. University of Michigan Press, Ann Arbor, 376 pp.

Kurta, A., and J. A. Teramino. 1994. A novel hibernaculum and noteworthy records of the Indiana bat and eastern pipistrelle (Chiroptera: Vespertilionidae). American Midland Naturalist, 132:410-413.

Kurta, A., J. Caryl, and T. Lipps. 1997. Bats and Tippy Dam: species composition, seasonal use, and environmental parameters. Michigan Academician (Papers of the Michigan Academy of Science, Arts, and Letters), 29:473-490.

Menzel, M. A., L. T. Lepardo, and J. Laerm. 1996. Possible use of a basal cavity as a maternity roost by the eastern pipistrelle, *Pipistrellus subflavus*. Bat Research News, 37:115-116.

Unger, C. A., and A. Kurta. 1998. Status of the eastern pipistrelle (Mammalia: Chiroptera) in Michigan. Michigan Academician (Papers of the Michigan Academy of Science, Arts, and Letters), 30:423-437.

Whitaker, J. O., Jr. 1998. Life history and roost switching in six summer colonies of eastern pipistrelles in buildings. Journal of Mammalogy, 79:651-659.

* * * * *

Drinking by the Common Bent-wing Bat *Miniopterus schreibersii* and Calcium in Cave Water

Jonathan Codd[1], Brian Clark[2], and Ken Sanderson[1]

[1]Department of Biological Science, Flinders University, GPO Box 2100, Adelaide, South Australia, and [2]NPWS, Naracoorte Caves, South Australia, Australia

The common bent-wing bat, *Miniopterus schreibersii*, is the dominant cave-dwelling species of southeastern Australia. A maternity colony of up to 200,000 individuals roosts in Bat Cave, Naracoorte, South Australia, from about October through April. In 1995, the cave was equipped with four, infrared, remote-controlled cameras to allow observers aboveground to watch bats without disturbing them. Soon after cameras were installed, bats were noticed drinking from a site near camera 2, where water permeates through the limestone, often just before bats left the cave to forage. This drinking behavior was observed many times by a variety of people and generated speculation (on "Batline") that water dripping from limestone might provide an additional source of minerals for bats, in particular calcium ions. Calcium levels are low in insect prey, and restricted availability of calcium has been suggested as a constraint on reproduction, litter size, and bone development in bats (Barclay, 1994, 1995; Bernard and Davison, 1996; Kwiecinski et al., 1987; Studier et al., 1991).

To test some of these speculations, water samples were collected from Bat Cave in autumn 1997 and

from nearby caves (Blanche and Wet caves) and surface waters (Bool Lagoon 1 and 2 and Mosquito Creek). Analyses were carried out by Waite Analytical Services, using inductively coupled plasma-atomic emission spectrometry. Levels of 11 elements were measured in duplicate 50-ml samples from each site. The elements Fe, Mn, Cu, and Zn were found at less than 0.05 mg/l at all sampling locations, and P was less than 1 mg/l at all sites. However, the other six elements were distinctly more abundant in surface waters--B: 0.06 mg/l in Bat Cave vs. 0.3-0.4 mg/l in surface waters; Ca: 42-72 mg/l in caves vs. 69-129 mg/l in surface waters; Mg: 1-6 mg/l in caves vs. 42-206 mg/l in surface waters; Na: 13-52 mg/l in caves vs. 265-3450 mg/l in surface waters; K: 2-4 mg/l in caves vs. 7-47 mg/l in surface waters; and S: 1-4 mg/l in caves vs. 22-173 mg/l in surface waters.

Following a suggestion from G. Kwiecinski (pers. comm.) that bats might get more calcium if they licked the surface of the limestone, we were able to observe (on 22 December 1998) that some bats were indeed licking the limestone in Bat Cave. Kwiecinski also suggested that the ratio of calcium to phosphorus in cave waters (about 50:1 at Naracoorte) might be significant, since humans prefer a calcium to phosphorus ratio of about 3:2.

In summary, observations of bats with infrared video cameras at Bat Cave, Naracoorte, show that M. schreibersii lick limestone in caves and drink cave water containing reasonable calcium levels, without high levels of other minerals. Thus by drinking cave water, the bats do not incur the high sodium load they would get if they drank from surface waters. Availability of this calcium may be significant at times of calcium stress, such as might occur during lactation. We thank R. Barclay and G. Kwiecinski for discussion of these points.

Literature Cited

Barclay, R. M. R. 1994. Constraints on reproduction by flying vertebrates: energy and calcium. American Naturalist, 144:1021-1031.

------. 1995. Does energy or calcium availability constrain reproduction by bats? Symposia of the Zoological Society of London, 67:245-258.

Bernard, R. T. F., and A. Davison. 1996. Does calcium constrain reproductive activity in insectivorous bats? Some empirical evidence for Schreibers' long fingered bat (Miniopterus schreibersii). South African Journal of Zoology, 31:218-220.

Kwiecinski, G. G., L. Krook, and W. A. Wimsatt. 1987. Annual skeletal changes in the little brown bat, Myotis lucifungus lucifungus, with particular reference to pregnancy and lactation. American Journal of Anatomy, 178:410-420.

Studier, E. H., D. P. Viele, and S. H. Sevick. 1991. Nutritional implications for nitrogen and mineral budgets from analysis of guano of the big brown bat Eptesicus fuscus. Comparative Biochemistry and Physiology A, 100:1035-1040.

* * * * *

Two Additional Records of Bats Accidentally Transported to Guam

Gary J. Wiles

Division of Aquatic and Wildlife Resources, 192 Dairy Road, Mangilao, Guam 96923

By virtue of their small size and cryptic roosting habits, many species of microchiropteran bats are ideal candidates for unintentional human-assisted transport. The most common agents of conveyance are ships and airplanes (G. J. Wiles and J. E. Hill, 1986, J. Mammal., 67:600-601). Theses authors reported finding a probable *Myotis lucifugus* that was apparently carried aboard a military aircraft from North America to Guam (13°25'N, 144°45'E), an oceanic island in the western tropical Pacific. This note describes two, recent, additional records of bats being transported to Guam and supplies further documentation of accidental movements of bats over long distances.

On 28 November 1997, customs officials retrieved the carcass of a freshly dead bat from an outer deck of a 76-m-long, commercial, survey ship that had arrived at the Guam's seaport at Apra Harbor two days earlier. The crew had no knowledge of the bat's origin. It was later identified as a Eurasian noctule, *Nyctalus noctula* (United States National Museum #568000--A. Gardner, in litt.). This species ranges widely from western Europe and North Africa to eastern China and central Japan, with scattered records from Taiwan and Southeast Asia (R. M. Nowak, 1994, Walker's Bats of the World, John Hopkins Univ. Press, Baltimore, Maryland). Prior to docking on Guam, the ship's most recent ports of call were Hong Kong, from 12 to 15 November; San Fernando on Luzon in the Phillipines, from 2 to 5 November; and

Naha, Okinawa, from 21 to 25 October. Based on these dates and the geographic distribution of N. noctule, the bat probably boarded the vessel in or near Hong Kong, about 3,500 km NW of Guam. Because the ship did not haul cargo, the bat probably flew aboard, rather than being carried inside a consignment of freight.

The second record came from a woman and man living in Piti, Guam, who discovered single small bats inside their home on 26 and 27 October 1997. Both animals were injured during capture and discarded outdoors. Neither specimen was recovered during my investigation the next day. The occurrence of the bats held possible significance because the island's only native microchiropteran, *Emballonura semicaudata*, is believed extirpated and has not been recorded since 1972 (T. O. Lemke, 1986, J. Mammal, 67:743-746). However, the house was a modern well-kept concrete building that was tightly sealed for central air conditioning, so it was improbable that the bats entered from outside on their own.

Questioning of the couple revealed a more likely explanation of the animals' origin. Ten hours before the first bat was seen, the couple had returned home from a four-day vacation in Bali, Indonesia, 4,100 km southwest of Guam. While in the city of Ubud, they purchased some souvenirs, but only one item, a set of bamboo wind chimes, offered suitable hiding places for small bats. The chimes consisted of six, dangling, 40-cm-long pieces of bamboo. The upper portion of each piece was a hollow tube varying in length from 14 to 17 cm, with three tubes having inner diameters of 3.7 cm and three of 2.6 cm. The chimes came from a shop with numerous sets of similar chimes hanging on display, outdoors, on the front porch, so bats seeking a day roost would have found the bamboo tubes easily accessible.

The couple purchased the chimes at 1000 h on 25 October, returned to their hotel room, and packed them in their luggage at 1400 h. They traveled to the airport and departed Bali at 2125 h (local time), arriving on Guam 5.3 h later, at 0445 h (local time). The couple did not unpack their luggage until about 1200 h and then left their house for several hours. Shortly after their return at 1500 h, they found the first bat flying in the house. I examined the chimes, but did not find any hair or stains inside to suggest they served as a regular roosting site for the animals. Many of Bali's souvenir shops have open store fronts and tall darkened ceilings where handicrafts are hung for display and storage. These setting offer numerous and seemingly ideal roosting opportunities for bats.

* * * * *

Use of Buildings and Tolerance of Disturbance by Pallid Bats *Antrozous pallidus*

Greg Tatarian
Wildlife Research Associates, 1010 Lakeville Street, Suite 3A, Petaluma, CA 94952

Relatively little has been written about roosting ecology of pallid bats, *Antrozous pallidus*, in California since R. T. Orr's (1954, Proc. California Acad. Sci., 28:165-264) pioneering work. More recent observations of roosting by pallid bats have been of animals primarily from Arizona and Oregon (J. W. Hermanson and T. J. O'Shea, 1983, Mammalian Species, 213:1-8; S. E. Lewis, 1993, Ph.D. dissertation, University of Minnesota, St. Paul). In general, pallid bats show a high degree of flexibility in choice of roosts. Natural roosts include tree hollows, caves, rock crevices and overhangs (Hermanson and O'Shea, 1983). In addition, P. E. Brown et al. (1997, Bat Research News, 38:100) described day roosts near Barstow, California, in small holes and crevices, as well as mud tubes and cracks in basalt boulders. Use of anthropogenic roosts by pallid bats also is well documented, with bridges and mines often being utilized (G. P. Bell, 1980, Can. J. Zool., 58:1876-1883; Hermanson and O'Shea, 1983).

We have made several observations of pallid bats using buildings as roost sites during the past seven years in parts of northern California. We have found that pallid bats use buildings for either day or night roosting, even when natural roosts, such as a large oak with hollows or caves, are nearby. Our observations of building roosts in Napa, Sonoma, Marin, and Mendocino counties showed that most (ca. 20) were used as maternity roosts, and only two were used as overwintering sites. Eight sites were night roosts around the exterior of a building, which was not used as a day roost.

In general, day roosts are usually in more enclosed, protected spaces than are night roosts--a trait that is consistent with the behavior of other rock-crevice and cave-dwelling species. For example, day roosts of pallid bats in buildings are usually found in wall sections, behind fascias, in spaces between vaulted interior ceilings and roofing materials, and similarly enclosed spaces. Occasionally, pallid bats will roost in larger spaces such as attics. The physical features of most building roosts provide at least some degree of isol-

lation from human activity and from the outside environment.

In contrast to this more expected type of roost, we have observed groups of pallid bats repeatedly day roosting in a relatively exposed site, under the front porch roof of an office building at a winery in Napa, California. The porch extends ca. 3 m from the building; the height of the porch roof above the ground is ca. 3 m at the wall, sloping down to ca. 2 m at the open front. Two short exterior walls join the front wall at each end, forming two inside corners. These corners and the short walls have been used extensively by pallid bats for day roosting. This site also is used regularly as a night roost by this species, and occasionally by other species, including Tadarida brasiliensis and Myotis yumanensis. Roosting occurs from about March through November each year, but the roost is not occupied every day; extended periods of one to two weeks often pass with no roosting by bats. Primarily male bats use the roost, except in autumn when juveniles and adult females have been observed.

Disturbance at this exposed site is random and sometimes intensive. Factors include visitors to the winery office, ingress and egress of staff, and daily and nightly activity by pet cats. The main driveway to the facility is located ca. 6 m from the roost; although the driveway is not visible to the bats, due to the slope of the roof, the noise from passing vehicles certainly can be heard by the bats. Despite the disturbance, we observed day roosting by pallid bats at this site since 1994, and the building owners reported this species using the roost four to five years previous to that time. During 1998, however, little diurnal roosting occurred, and perhaps this was related to the presence of two domestic dogs, which were kept at the site.

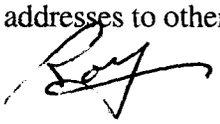
* * * * *

Please Notice: E-Mail Directory

The next issue of Bat Research News Volume 40 : No. 2, Summer, 1999, will include the updated version of the e-mail directory. Please check your e-mail address listed in Volume 39: No.2, Summer, 1998. If it has changed, or was incorrect, please send me you new or corrected address. If your e-mail address was not listed and you would like to be included, please send me your e-mail address. Send all information concerning the directory to me at : **horstgr@potsdam.edu** before June 15, 1999.

The e-mail directory is widely used by a great many people and includes e-mail addresses from 40 countries and lists nearly 700 bat biologists. Bat Research News receives more mail about the directory than all others subjects combined. If you are not listed, and have an e-mail address, please consider adding your address to the directory.

I have affirmed repeatedly that this directory will not be sold to vendors, other individuals or other organizations. I do however provide individual e-mail addresses to other individuals who identify themselves.

Thank you,  G. Roy Horst, Publisher

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

BEHAVIOR

Schutt, W. A., Jr., F. Muradali, N. Mondol, K. Joseph, and K. Brockmann. 1999. Behavior and maintenance of captive white-winged vampire bats, *Diaemus youngi*. Journal of Mammalogy, 80: 71-81. [Natural Science Division, Southampton College, Long Island University, Southampton, NY 11968]

CONSERVATION

Arita, H. T., and K. Santos-del-Prado. 1999. Conservation biology of nectar-feeding bats in Mexico. Journal of Mammalogy, 80: 31-41. [Inst. de Ecologia, Univ. Nacional Autónoma de México, Apartado Postal 27-3 (Xangari), 58089 Morelia, Michoacán, Mexico]

Eisler, R., D. R. Clark, Jr., S. N. Wiemeyer, and C. J. Henny. Unknown year. Sodium cyanide hazards to fish and other wildlife from gold mining operations. Pp. 55-67 *in* J. M. Azcue, Ed. Environmental impacts of mining activities. Publisher unknown, pagination unknown.

Medellin, R. A., and J. Soberon. 1999. Predictions of mammal diversity on four land masses. Conservation Biology, 13: 143-149. [Univ. Nacl. Autonoma Mexico, Inst. Ecol., Apt. Postal 70-275, Mexico City 04510, DF, Mexico]

Swanepoel, R. E., P. A. Racey, R. F. Shore, and J. R. Speakman. 1999. Energetic effects of sublethal exposure to lindane on pipistrelle bats (*Pipistrellus pipistrellus*). Environmental Pollution, 104: 169-177. [Shore: Inst. Terrestrial Ecology, Monks Wood, Abbots Ripton, Huntingdon PE17 2LS, Cambs, England]

DISEASE

Uieda, W. 1998. Rabies in the insectivorous bat *Tadarida brasiliensis* in southeastern Brazil. Revista de Saude Publica, 32: 484-485. [Caixa Postal 510, BR-18618000 Botucatu, SP, Brazil]

DISTRIBUTION/FAUNAL STUDIES

Brault, J.-P. 1998. Reprise d'une noctule de Leisler (*Myotis leisleri*) dans le Loir et Cher. Arvicola, 10: 11. [122 route de Montrichard, 41400 Monthou sur Cher, France]

Courtois, J.-Y. 1998. Contribution à la connaissance de la répartition et des caractéristiques biologiques du murin de Capaccini (*Myotis capaccinii*) en Corse. Arvicola, 10: 42-46. [Association Cortenaise de Spéléologie, 7 bis rue du Colonel Feracci, 20250 Corté, France]

Haffner, P., S. Aulagnier, D. Masson, Y. Tachker, and H. Maurin. 1998. Atlas des mammifères d'Europe: l'apport des mammalogistes français. Arvicola, Actes du XXIème Colloque Francophone de Mammalogie, pp. 77-82. [Service du Patrimoine Naturel, I.E.G.B., M.N.H.N., 57 rue Cuvier, 75231 Paris Cedex 05, France]

O'Donnell, C. F. J. 1998. Accidental importation of an Australian bat (Mammalia: Chiroptera: *Vespadelus vulturnus*) into New Zealand. New Zealand Journal of Zoology, 25: 455-456. [Dept. Conservation, Science & Res. Unit, Christchurch, New Zealand]

Pons, J.-M., and L. Granjon. 1998. Liste des mammiferes de Guyane Française (Juillet 1997). Arvicola, 10: 12-15. [Laboratoire de Zoologie, Mammifères et Oiseaux, Mus. National d'Histoire Naturelle, 55 rue de Buffon, 75005 Paris, France]

Roue, S. 1998. Découverte du murin des marals (*Myotis dasycneme*) en Franche-Comté. Arvicola, 10: 5. [C.P.E.P.E.S.C., 3 rue Beauregard, 25000 Besançon, France]

Simmons, N. B., and R. S. Voss. 1998. The mammals of Paracou, French Guiana: A neotropical lowland rainforest fauna part - 1. Bats. Bulletin of the American Museum of Natural History, 237: 1-219. [American Museum Natural History, Dept. Mammalogy, Central Park West at 79th St., New York, NY 10024]

ECHOLOCATION

Fenton, M. B., C. V. Portfors, I. L. Rautenbach, and J. M. Waterman. 1998. Compromises: sound frequencies used in echolocation by aerial-feeding bats. Canadian Journal of Zoology, 76: 1174-1182. [York Univ., Dept. Biology, 4700 Keele St., North York ON M3J 1P3, Canada]

Tupinier, Y. 1998. Sonar in Chiroptera: a reflection of behaviour [in French]. Bulletin de la Societe Zoologique de France, 123: 255-266. [Ecole Super Chim. Phys. & Elect., LASSSO, 43 Blvd. 11 Novembre 1918, BP 2077, F-69616 Villeurbanne, France]

ECOLOGY

Courts, S. E. 1998. Dietary strategies of Old World Fruit Bats (Megachiroptera, Pteropodidae): how do they obtain sufficient protein? Mammal Review, 28: 185-193. [Jersey Wildlife Preservation Trust, Dept. Res., Les Augres Manor, Trinity JE3 5BP, Jersey, England]

Gerardo Herrera M., L. 1997. Evidence of altitudinal movements of *Leptonycteris curasoae* (Chiroptera: Phyllostomidae) in central Mexico. Revista Mexicana de Mastozoologia, 2: 116-118. [Dpto. de Zoologia, Inst. Biologia, A.P. 70-153, 04510 Mexico DF, Mexico]

Gerardo Herrera M., L. 1998. Pollen digestion by New World bats: effects of processing time and feeding habits. Ecology, 79: 2828-2838.

Guettinger, R., J. Lustenberger, A. Beck, and U. Weber. 1998. Traditionally cultivated wetland-meadows as foraging habitats of the grass-gleaning lesser mouse-eared bat (*Myotis blythii*). Myotis, 36: 41-49. [Wildlife Research and Conservation Biology, Zoological Institute, University of Zurich-Irchel, CH-8057 Zurich, Switzerland]

Hosken, D. J. 1998. Testes mass in megachiropteran bats varies in accordance with sperm competition theory. Behavioral Ecology & Sociobiology, 44: 169-177. [Univ. Zurich Irchel, Zool. Museum, Winterthurerstr. 190, CH-8057 Zurich, Switzerland]

Kurta, A., and J. O. Whitaker, Jr. 1998. Diet of the endangered Indiana bat (*Myotis sodalis*) on the northern edge of its range. American Midland Naturalist, 140: 280-286. [Dept. Biol., Eastern Michigan Univ., Ypsilanti, MI 48197]

Strait, S. G., and J. F. V. Vincent. 1998. Primate faunivores: physical properties of prey items. International Journal of Primatology, 19: 867-878. [Marshall Univ., Dept. Biol. Sci., Huntington, WV 25755]

Thomson, S.C., A. P. Brooke, and J. R. Speakman. 1998. Diurnal activity in the Samoan flying fox, *Pteropus samoensis*. Philosophical Transactions of the Royal Society of London B, 353: 1595-1606. [Speakman: Dept. Zoology, Univ. Aberdeen, Tillydrone Ave, Aberdeen AB24 2TZ United Kingdom]

Whitaker, J. O., Jr., S. S. Issac, G. Marimuthu, and T. H. Kunz. 1999. Seasonal variation in the diet of the Indian pygmy bat, *Pipistrellus mimus*, in southern India. Journal of Mammalogy. 80: 60-70. [Dept. Life Sciences, Indiana State Univ., Terre Haute, IN 47809]

PALEONTOLOGY

Sigé, B., J. Habersetzer, and G. Storch. 1998. The deciduous dentition and dental replacement in the Eocene bat *Palaeochiropteryx tupaiodon* from Messel: The primitive condition and beginning of specialization of milk teeth among Chiroptera. Lethaia, 31: 349-358. [Univ. Lyon 1, UFR Sci. Terre, Ctr. Paleontol. Stratig. & Paleoecol., 27-43 Blvd. 11 Novembre 1918, F-69622, Villeurbanne, France]

PHYSIOLOGY

Baker, H. G., I. Baker, and S. A. Hodges. 1998. Sugar composition of nectars and fruits consumed by birds and bats in the tropics and subtropics. Biotropica, 30: 559-586. [Univ. California Berkeley, Dept. Integrative Biol., Berkeley, CA 94720]

Hosken, D. J., and P. C. Withers. 1999. Metabolic physiology of euthermic and torpid lesser long-eared bat, *Nyctophilus geoffroyi* (Chiroptera: Vespertilionidae). Journal of Mammalogy, 80: 42-52. [Zoologisches Museum der Universität Zürich-Irchel, Winterthurerstr 190, 8057 Zürich, Switzerland]

Korine, C., and Z. Arad. 1999. Changes in milk composition of the Egyptian fruit bat, *Rousettus aegyptiacus* (Pteropodidae), during lactation. Journal of Mammalogy, 80: 53-59. [Dept. Biol., Technion-Institute of Technology, Haifa 32000, Israel]

Smith, A. B., and H. I. Griffiths. 1998. Apparent recovery from a broken femur in the Indian flying fox, *Pteropus giganteus* (Chiroptera, Pteropodidae). Mammalia, 62: 457-460. [Atherfield, Five Oak Green TN12 6TJ, Kent, England]

POPULATION BIOLOGY

Petit, E. 1998. Qu'est-ce qu'une population? Apports de la génétique moléculaire. Arvicola, Actes du XXIème Colloque Francophone de Mammalogie, pp.43-46. [Inst. Zoologie II, Univ. Erlangen, Staudtstrasse 5, 91058 Erlangen, Germany]

REPRODUCTION

Rasweiler, J. J., and N. K. Badwaik. 1999. Discoidal placenta. Pp. 890-902 *in* E. Knobil and J. D. Neill, Eds. Encyclopedia of Reproduction, Volume I. Academic Press, San Diego, CA, pagination unknown. [Dept. Obstetrics & Gynecology, Cornell Univ. Medical Coll., 1300 York Ave., New York, NY 10021]

French, B., and A. Lollar. 1998. Observations on the reproductive behavior of captive *Tadarida brasiliensis mexicana* (Chiroptera : Molossidae). Southwestern Naturalist,43: 484-490. [Bat Conservation International, Austin, TX 78746]

SYSTEMATICS

Bhatnagar, K. P., and E. Meisami. 1998. Vomeronasal organ in bats and primates: extremes of structural variability and its phylogenetic implications. Microscopy Research & Technique, 43: 465-475. [Univ. Louisville, School of Medicine, Dept. Anat. Sci. & Neurobiol., HSC, Louisville, KY 40292]

Cooper, S. J. B., T. B. Reardon, and J. Skilins. 1998. Molecular systematics of Australian rhinolophid bats (Chiroptera : Rhinolophidae). Australian Journal of Zoology, 46: 203-220. [S. Australian Museum, Evolutionary Biology Unit, North Terrace, Adelaide, SA 5000, Australia]

Pumo, D. E., P. S. Finamore, W. R. Franek, C. J. Phillips, S. Tarzami, and D. Balzarano. 1998. Complete mitochondrial genome of a neotropical fruit bat, *Artibeus jamaicensis*, and a new hypothesis of the relationships of bats to other Eutherian mammals. Journal of Molecular Evolution, 47: 709-717. [Hofstra Univ., Dept. Biology, Hempstead, NY 11549]

TECHNIQUES FOR STUDYING BATS

Barclay, R. M. R. 1999. Bats are not birds -- a cautionary note on using echolocation calls to identify bats: a comment. Journal of Mammalogy, 80: 290-296. [Dept. Biol. Sci., Univ. Calgary, Calgary, Alberta, Canada T2N 1N4]

Kervyn, T. 1998. Méthodes de détermination du régime alimentaire des Chiroptères insectivores. Arvicola, Actes du XXIème Colloque Francophone de Mammalogie, pp. 53-56. [Inst. Zoologie, Univ. Liège, quai Van Beneden 22, 4020 Liège, Belgium]

Motte, G., T. Kervyn, and R. Libois. 1998. Comparison entre deux techniques d'étude de l'utilisation de l'habitat par la sérotine commune (*Eptesicus serotinus*): le radiopistage et la prospection avec un détecteur d'ultrasons hétérodyne. Arvicola, Actes du XXIème Colloque Francophone de Mammalogie, pp. 25-28. [Inst. Zoologie, Univ. Liège, quai Van Beneden 22, 4020 Liège, Belgium]

O' Farrell, M. J., B. W. Miller, and W. L. Gannon. 1999. Qualitative identification of free-flying bats using the Anabat detector. Journal of Mammalogy, 80:11-23. [O'Farrell Biological Consulting, 2912 N. Jones Boulevard, Las Vegas, NV 89108]

O' Farrell, M. J., and W. L Gannon. 1999. A comparison of acoustic versus capture techniques for the inventory of bats. Journal of Mammalogy, 80:24-30.

O' Farrell, M. J., C. Corben, W. L. Gannon, and B. W. Miller. 1999. Confronting the dogma: a reply. Journal of Mammalogy, 80: 297-302.

ZOOGEOGRAPHY

Hisheh, S., M. Westerman, and L. H. Schmitt. 1998. Biogeography of the Indonesian Archipelago: mitochondrial DNA variation in the fruit bat, *Eonycteris spelaea*. Biological Journal of the Linnean Society, 65: 329-345. [Univ. Western Australia, Dept. Anatomy & Human Biol., Nedlands, WA 6907, Australia]

BACK ISSUES OF BAT RESEARCH NEWS

I am receiving an increasing number of requests for older issues of BRN (those before volume 21: 1980) Since there are no longer any of these older issues available, I am considering reprinting all issues prior to Volume 21. These would be available for a modest price. Perhaps about $3.00 each, $10.00 per Volume year or $100.00 for the entire set. However this would be a very time consuming project, and I am reluctant to undertake this without some idea of how great the demand would be. If you are interested in such an offering, please e-mail me with your suggestions and interest. Please note that your response is not an order, only an expression of interest. GRH horstgr@potsdam.edu

Announcing a Symposium on Using Anabat Detectors.

Convened by William Gannon

Included in the American Society of Mammalogists meeting announcement and registration papers, was an announcement that William Gannon will be moderating a Symposium on using Anabat detectors. The gist of the papers presented includes the hard core user (Michael O'Farrell), the applied (Laura Ellison), the analytical (John Hayes), and the alternatives (Gareth Jones). We are anticipating about twelve formal presentations and are assured a lively discussions will follow the presentations. We invite you and all your colleages having to do with field-applied bat acoustics - such as surveys, using detectors, remote identification, whatever to join us in our discussions. It is our hope that these papers can be combined into a Symposium-Meeting publication. We are still working on the details of this publication. We look forward to seeing you at the meeting and joining in our discussions.

Bill Gannon can be reached at e-mail: wgannon@unm.edu

Information about the American Society of Mammalogists Meeting can be found at:
http://www.cfr.washington.edu/outreach/asm99.html

* * * * * * *

ANNOUNCING A NEW JOURNAL FOR BAT RESEARCH

ACTA CHIROPTEROLOGICA

First Call for Papers!

We are pleased to announce the creation of a new international journal, Acta Chiropterologica, fully devoted to all aspects of bat biology (in the broad sense). It will be published twice a year by the Museum and Institute of Zoology, Polish Academy of Sciences, Warsaw, Poland. The language will be English and should be submitted with the understanding that they have not been published elsewhere and are not being considered for publication elsewhere. This restriction does not apply to abstracts published as an abstract presented previously at symposia, meetings or workshops. Prior to acceptance for publication each manuscript will be reviewed by two anonymous referees.

The Editorial Board is composed of: Joaquin Arroyo-Cabrales, Mexico DF; Hans J. Baagoe, Copenhagen, Denmark; M. Brock Fenton, North York, Ont., Canada; Gareth Jones, Bristol, England; Leslie Hall, St. Lucia, Queensland, Australia; Elizabeth Kalko, Tuebingen, Germany; Eugenia Kozhurina, Saint Petersburg, Russia; Thomas H. Kunz, Boston, MA, U.S.A.; Jesus Molinari, Merida, Venezeula; Robert D. Owen, Lubbock, TX, U.S.A.; Jorge M. Palmeirim, Lisboa, Portugal; Zdenek Rehak, Brno, Czech. Republic; Nancy B. Simmons, New York, NY, U.S.A.; John Speakman, Aberdeen, U.K.; Friederike Spitzenberger, Vienna, Austria; Chris Tidemann, Canberra, Australia, Wilson Uieda, Botucatu, Brazil; and Bronislaw W. Woloszyn Krakow, Poland.

The first issue is planned for July, 1999. Send in your manuscripts now and be part of the inaugural issue! Information concerning subscriptions and instructions for authors are available upon request from Bogdanowicz at: wieslawb@robal.miiz.waw.pl.
tel. (+48) 22 628 73 04
tel./fax (+48) 22 629 63 02

Send your manuscript to:
Dr. Wieslaw Bogdanowicz,
The Editor, Acta Chiropterologica,
Museum and Institute of Zoology,
Polish Academy of Sciences, Wilcza 64, 00-679 Warszawa, Poland.

The 29th Annual North American Symposium on Bat Research

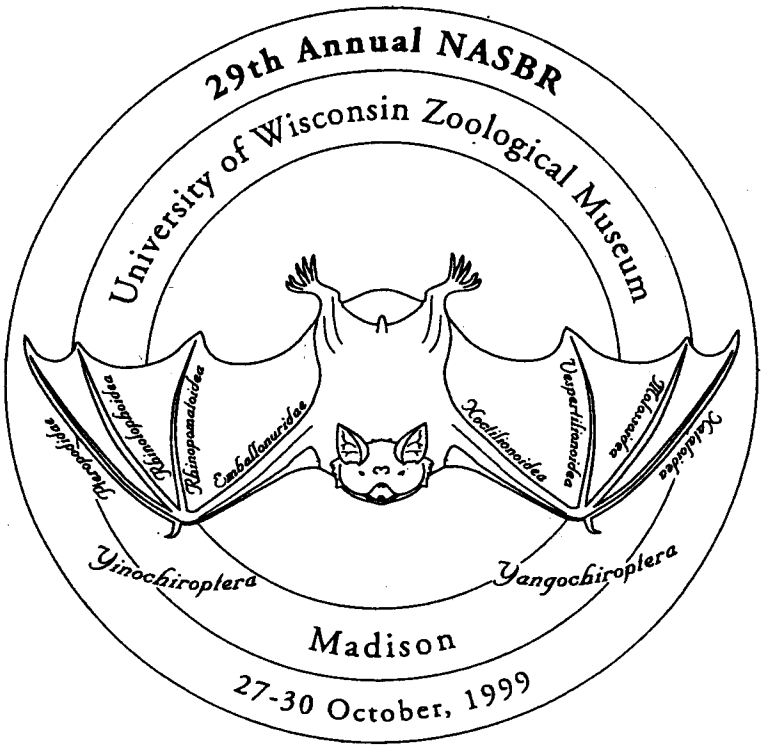
October 27 - 30, 1999

will be hosted by

the University of Wisconsin-Madison Zological Museum, Madison, WI

Conference Host: John Kirsch, University of Wisconsin, Madison, WI

Program Director: Tom Griffiths, Illinois Wesleyan University, Bloominton , IL



The conference logo above, by William Feeny, is a stylized representation of the lessor New Zealand short-tailed bat, *Mystacina velutina*, with spred wings symbolizing the abiding mystery of chiropteran phylogeny.

All North American Subscribers to Bat Research News and all who attended last year's symposium in Hot Springs, Arkansas will receive a registration packet by mail in late spring/early summer of 1999. All others interested in receiving information or registration materials for the symposium, please contact the University of Wisconsin Memorial Union Conference Center at 608-257-6534. Contact: nasbr@macc.wisc.edu if you preferr to use e-mail. This year for the first time, it will be possible to register and/or submit an abstract electronically using a credit card. Details will be included in the registration packet.

We recommend that you reserve a room at the earliest possible date at either of the two conference hotels. the **University Inn** at 800-279-4881 or 608-257-4881 or **Madison Inn** at 608-257-4391.

One can also call: www.travelbase.com/destinations/madison/madison inn.

Special rates have been arranged with these hotels, so be sure to tell the hotel reservation desk that you are participating in the North American Symposium on Bat Research.

THE NINTH AUSTRALASIAN BAT CONFERENCE
APRIL 25 to 28, 2000.

Where

Tocal Agriculatural College, Paterson, The Hunter Valley, NSW. The Hunter Valley is famous for its unique blend of scenery, historical towns and award winning wineries. It is a major tourist destination with tourists tasting wine at more than 70 regional wineries and in their more sober moments succumbing to the excitement of sky diving, hot air ballooning and whale watching (to name just a few activities). Just the place for our conference! Actually the Hunter Valley is a rich area for bats. Ratcliffe (1931) identified 9 flying-fox colony sites in the Hunter and certainly we know of a similar number in existence today, probably the same sites! While there is a considerable microbat fauna with some spectacular colonies of some species in the area.

Travel

Road: Paterson is located a couple of hours north of Sydney by road. Road maps to Tocal will be issued on request.

Train: The closest train station is Maitland and from here delegates will be met by shuttle bus and transported to Tocal. It is anticipated that the shuttle bus will also meet some train services at the Newcastle stations.

Air: We will meet arrivals at the Newcastle Airport in Williamtown. This is serviced by Eastern Australia Airlines and Impulse Airlines among other carriers and there are incoming flights from Brisbane, Coolangatta, Lismore, Coffs Harbour, Port Macquarie, Tamworth, Sydney, Wollongong, Canberra, Cooma, and Melbourne.

Accommodations

Tocal College provides accommodation for conference delegates from $25 per night which includes free use of all facilities such as tennis courts, etc. We are hoping that most delegates will be able to be housed on site, however we have started booking extra accommodation the local caravan parks and motels close to the venue.

Social Events

There will be social activities on each of the evenings of the ABC 2000 including Fri 28th April. All activities will be held on site at Tocal with the exception of the Conference Dinner. This will occur at a local Winery. More details later! Trips to local mega and micro bat colony sites will be available to delegates during the Conference.

Post-conference field trips

A post-conference field trip is planned for the week-end 29th/30th April. This will involve microbat survey work.

Cost

The Organising Committee is committed to keeping the cost of registration as low as possible. Full-time students will be eligible for discounted registration, as usual.

Expressions of Interest

Further details will appear in upcoming editions of ABS Newletter. If you are interested in attending please contact us and register an expression of interest. This does not cost anything nor does it obligate you to attend, however it does give us a rough estimation of the number of people who may be coming. Also it will put you on a mailing list so that further information on the Conference as well as your registration papers can be mailed to you.

Organisation

We are looking for volunteers to help with the Conference. If you would like to join the Organising Committee please contact us.

email:	HYPERLINK mailto:wambina@ozemail.com
email:	wambina@ozemail.com.au ,
FAX:	02 43 653232
post/mail:	RMB 30 Wambina Rd Matcham 2250 NSW, Australia.
Organizer:	Kerryn Parry-Jones

Other Future Bat Meeting Announcements

June 1999

The Second Irish Bat Conference
will take place at the Burren College of Art,
Ballyvaughan, Co. Clare on June 4th - 6th.

Brochures and booking forms will be available in March.
For further information, please contact either
Kate McAney, Tel:+353-93-35360; email: mcaney@iol.ie,
or
Congella McGuire, Tel:+353-65-40266. email:mcguirec.ennis@tinet.ie

* *

August 1999

VIIIth European Bat Research Symposium
Kracow, Poland in August 23 - 27, 1999.

Address all communications to:
Professor Bronislaw W. Woloszyn, Chiropterological Information Centre,
Institute of Animal Systematics and Evolution, Polish Academy of Sciences,
ul. Slawkowska 17, 30-016 Krakow Poland
e-mail address: woloszbr@ isez.pan.krakow.pl or: VIIIEBRS@isez.pan.krakow.pl
TEL. + 4812/422-64-10 or + 4812/422-19-01 FAX + 4812/422-42-94

* *

April 2000

Australasian Bat Society Conference
25th-28th April 2000

at Tocal College, Paterson New South Wales, Australia.
for further information please contact:
Kerryn Parry-Jones. e-mail wambina@ozemail.com.au
Bat Research News will publish any new announcements as they arrive.

* *

June 2000

The American Society of Mammalogists
June 17 - 21

University of New Hampshire, Durham, New Hampshire
for further information contact
H. Duane Smith, Secretary-Treasurer
Monte L. Bean Life Science Museum
Brigham Young University, Provo, UT 84602-0200

additional meetings continued over>>

additional meetings:

October 2000

The 30th Annual North American Symposium on Bat Research

October 28 - 31, 2000

University of Miami, Miami, Florida
Convened by Thomas Griffiths and hosted by Ted Fleming
Bat Research News will publish any new announcements as they arrive.

* *

August 2001

The 12th International Bat Research Conference will convene 5 - 9 August, 2001, in Bangi, Malaysia

The Conference will be convened by Dr. Zubaid Akbar
All enquires should be directed to:
Dr. Zubaid Akbar,
Department of Zoology, University Kebangsaan Malaysia
43600 UKM BANGI MALAYSIA.
Tel/Fax: [60] 603-8293827
e-mail: zubaid@ukm.my or zubaid@pop.jaring.my
Website: www.fsh.ukm.my/fsh/dept/bz/zubaid.htm
Bat Research News will publish any new announcements as they arrive.
All subscribers to Bat Research News are on Dr. Akbar's mailing list.

* *

October 2001

The 31st Annual North American Symposium on Bat Research

October (exact dates not yet determined), 2001

University of Victoria, Victoria, British Columbia
Convened by Thomas Griffiths and hosted by Mark Brigham
Bat Research News will publish all new announcements as they arrive.

If anyone knows of any future meetings that we have not included, or meetings that are in the planning stages, please send the information to G. Roy Horst.

BAT RESEARCH NEWS

Volume 40 **Spring 1999** **Number 1**

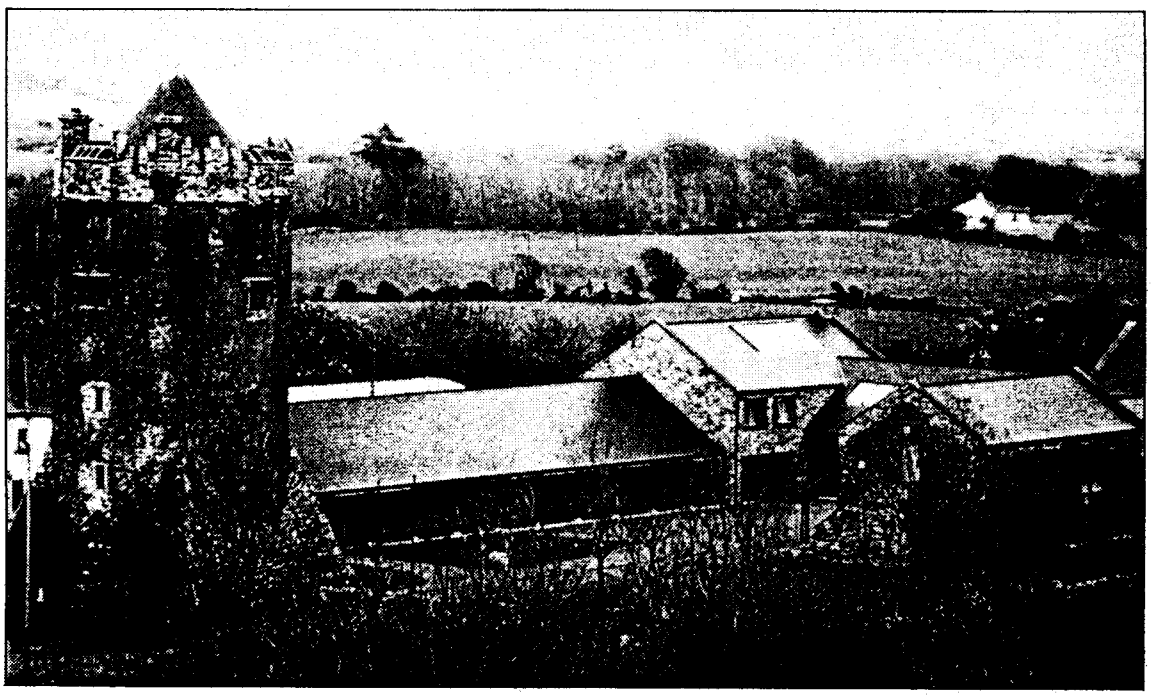
CONTENTS

Front Cover

The illustration of three charming*Taphozous georgianus* on the front cover of this issue was generously provided by Conor Kelleher of "Northants", Spring Lane, Carrigagulla, Ballingree, Macroom, County Cork, Ireland.

We are in need of good cover illustrations. If you can provide one that is satisfactory for our use, send it to Horst, and if we use it, win a free banquet ticket at the next bat conference you attend.

BAT RESEARCH NEWS



Volume 40: No.2 Summer 1999

E-Mail Directory

BAT RESEARCH NEWS

Volume 40: No.2 Summer 1999

Publisher and Managing Editor
G. Roy Horst
Bat Research News, P.O. Box 5068, Potsdam,NY 13676
Tel. 315-267-2259 FAX 315-267-3170 E-mail: horstgr@potsdam.edu.

Editor for Feature Articles
Allen Kurta, Department of Biology, Eastern Michigan University, Ypsilanti, MI 48197
Tel. 734-487-1174 FAX 734-487-9235 E-mail: bio_kurta@online.emich.edu

Editor for Recent Literature
Thomas A. Griffiths, Department of Biology, Illinois Wesleyan University, Bloomington, IL 61702
Tel. 309-556-3230 FAX 309-556-3411 E-mail: tgriff@titan.iwu.edu

Editor for Conservation Education and Book Reviews
Patricia Morton, Texas Parks and Wildlife Department, Suite 100, 3000 IH 35 South, Austin, TX 78704
Tel. 512-912-7046 FAX 512-912-7058 E-mail: patricia.morton@tpwd.state.tx.us

Instructions to Contributors and Subscribers:

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 to Kurta (address above). 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.

Subscriptions to individuals per volume (year) are in United States, Mexico and Canada, $18.00 [U.S. funds] , all other countries are $20.00 per volume(year). All issues are sent surface mail, postage paid by ***Bat Research News*** to all addresses world-wide. **Air Mail** is $10.00 per volume extra.

Subscriptions to institutions are $ 30.00 per volume(year).

Please make all checks payable to; ***Bat Research News.*** Subscribers outside the United States can pay by checks in U.S. dollars, drawn on banks with an affiliated office in the United States. Payment can also be by **VISA, MASTERCHARGE**, or **DISCOVER** card (no American Express) by sending in letter from or by e-mail (to Horst) your credit card account number, name exactly as it appears on your card, the expiration date, and the amount you wish to charge to your card.

Your credit card data is safely **destroyed** as soon as our account is credited with your payment.

Bat Research News is : ISSN 0005-6227

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

BAT RESEARCH NEWS

Volume 40: No. 2 **Summer 1999**

E-mail Directory

compiled by G. Roy Horst

This directory includes all individuals and organizations who have submitted their e-mail addresses for inclusion. These addresses are as of May 25, 1999. Some of the addresses in this directory may no longer be correct. If an address is not up to date and non-functional, please e-mail me and I will forward on to you a new address, if one was provided to me. If your e-mail changes, please send me your new address. Any e-mail changes which are sent to me will appear in an update in each of the following issues of Bat Research News.

G. Roy Horst

Name	e mail	country
Horst, G. Roy	**horstgr@potsdam.edu**	**USA, (New York)**
Bat Research News	**horstgr@potsdam.edu**	**USA, (New York)**
Abdullah, Taj	tabdullha@zoology.uq.edu.au	Australia
Adam, Michael	adamm@ccmail.orst.edu	USA, (Oregon)
Adams, Rick	adamsr@uwwvax.uww.edu	USA, (Wisconsin)
Agoramoorthy, G. .	agoram@mail.nsysu.edu.tw	Taiwan
Aguiar, Ludmilla	lms.aguiar@uol.com.br	Brazil
Aguirre, Luis F.	coroagui@caoba.entelnet.bo	Bolivia
Ahlen, Ingemar	Ingemar.Ahlen@nvb.slu.se	Sweden
Alberico, Michael	alberico@biologia.univalle.edu.co	Columbia
Albuja, Luis	lalbuja@SIS.POLI.EDU.EC	Equador
Almeida, Marilen Fernandez	mfde_alm@uol.co.br	Brazil
Altenbach, Scott	batmine@unm.edu	USA, (New Mexico)
Ammerman, Loren	loren@uta.edu.	USA, (Texas)
Anderka, Fred	info@holohil.com	Canada, (Ontario)
Anderson, Kenneth W.	andersen@gannon.edu	USA, (Pennsylvania)
Andrews, Peter T.	pandrews@hep.ph.liv.ac.uk	United Kingdom
Anthony, Edythe	Eanthony@grog.ric.edu	USA, (Rhode Island)
Arita, Hector	arita@ate.oikos.unam.mx	Mexico
Arlettez, Raphael (1)	raphael.arlettaz@izea.unil.ch	Switzerland
Arlettez, Raphael (2)	rarletta@ulys.unil.ch	Switzerland
Armstrong, David M.	armstrod@stripe.colorado.edu	USA, (Colorado)
Armstrong, Kyle	kyle@cyllene.uwa.edu.au	Australia
Arnold, Andreas	arnold.a@primus-online.de	Germany
Arroyo-Cabrales, Joaquin	arromatu@df1.telmex.net.mx	Mexico
Atkinson, Sylvia	80kinsos@health.qld.gov.au	Australia
Augee, Michael	m.augee@unsw.edu.au	Australia

August, Peter	pete@edc.uri.edu	USA, (Massachusetts)
Aulagnier, Stephane	aulagnie@teleirgm.toulouse.inra.fr	France
Avilla, Leonardo S.	lavilla@sv.compuland.com.bre	Brazil
Azzali, Giacomo	anatnor@ipruniv.cce.unipr.it	Italy
Baagøe, Hans	hjbaagoe@zmuc.ku.dk	Denmark
Baker, Barry	barry.baker@ea.gov.au	Australia
Baker, Robert J.	bakerrj@ttu.edu	USA, (Texas)
Baker, Rollin	rbaker@elc.net.	USA, (Texas)
Baker, Suzzane C.	bakersc@jmu.edu	???
Baldino, Cristi	cbaldino@concentric.net	USA, (California)
Banack, Sandra	sabanack@acd1.byu.edu	USA, (California)
Banks, Don	donbanks@magnolia.net>	USA, (Missiissippi)
Baptista, Tony	96tlb@whatonma.edu	???
Barber, Diana	Diana.Barber@QMS1.life.uiuc.edu	USA, (Illinois)
Barbosa, Pat	wildlife@epix.net	USA, (Pennsylvania)
Barclay, Robert	barclay@acs.ucalgary.ca	Canada, (Alberta)
Barnard, Sue	batcons@mindspring.com	USA, (Georgia)
Baron, George	barong@ere.umontreal.ca	Canada, (Quebec)
Barratt, Elizabeth	suaaemb@UCL.AC.UK	United Kingdom
Bassett, John	microman@U.WASHINGTON.EDU	USA, (Washington)
Bat Conservaion of Michigan	76011.663@compuserve.com	USA, (Michigan)
Bat Conservation Internat.	batinfo@batcon.org.	USA, (Texas)
Bat House	bathouse@altnews.com.au	Australia
Bat Research News	horstgr@potsdam.edu	USA, (New York)
Bat World	batworld@aol.com	???
Battersby, Jessa	j.e.battersby@sussex.ac.uk	United Kingdom
Baumgarten, Julio	morcegos@bitsnet.com.br	Brazil
Beasley, Rebecca	beca54@forbin.com	USA, (Iowa)
Beck, Rolf	Rolf.Beck@unsw.edu.au	Australia
Bell, Mitchell	ageo@aol.com	USA, (Florida)
Belwood, Jackie	OhioBats@aol.com	USA, (Ohio)
Bender, Robert	robertb@angliss.vic.edu.au	Australia
Bergmans, Wim (1)	bergmans@nciucn.nl	Netherlands
Bernard, Enrico	ebernard@lavras.uemg.br	Brazil
Bernard, R.T.F.	ZORB@warthog.ru.ac.za	South Africa
Bernard, Richard	zorb@kudu.ru.ac.za	South Africa
Betts, Burr	bbetts@eou.edu	USA, (Oregon)
Bhatnagar, Kunwar	kpbhat01@ulkyvm.louisville.edu	USA, (Kentucky)
Bhatti, Brenda	BHAT3@aol.com	USA, (New Hampshire)
Bhiwgade, Dayanand	biwgade@life.bu.net.in	India
Bihari, Zoltan	bihari@fs2.date.hu	Hungary
Billington, G.E.	GEBillCumb@aol.com.	United Kingdom
Birney, Elmer C.	ecbirney@biosci.cbs.umn.edu	USA, (Minnesota)
Birt, Patrina	s023082@student.uq.edu.au	Australia
Birt, Patrina	patrina.birt@env.qld.gov.au	Australia

Blanchette, Richard	richblan@hotmail.com	Canada, (Quebec)
Blencoe, Eric	eurobats@uno.de	Germany
Bleveans, Luanna B.	luannab@galenalink.com	USA, (Illinois)
Bloss, Joanna	jbloss@bio.bu.edu	USA, (Massachusetts)
Boada-Teran, Carlos Esteban	vsFlores@gaurany.unb.br	Brazil
Bodvinkin, Alexander	irina@ptichi.irkutsk.su	Russia
Bogan, Michael	mbogan@mail.unm.edu	USA, (New Mexico)
Bogdanowicz, Wieslaw	wieslaw@bison.zbs.bialowieza.pl	Poland
Bohn, Kirsten M.	bohnkirs@cwis.isu.edu	USA, (Idaho)
Bolster, Betsy C.	BBolster@compuserve.com	USA, (California)
Bonaccorso, Frank	pngmuseum@global.net.pg	Papua New Guinea
Boughman, Janette	boughman@zoology.ubc.ca	Canada, (British Columbia)
Bounds, Dixie Louise	dbounds@umes-bird.umd.edu	USA, (Maryland)
Bowen, Tina	TinaBowen@mailcity.com	USA, (Arkansas)
Bowles, John	bowlesjb@centuryinter.net	USA, (Texas)
Bradbury, Jack W.	jwb25@cornell.edu	USA, (New York)
Brandon, Carl	cbrandon@vtc.vsc.edu	USA, (Vermont)
Braun, Monika	100734.361@compuserve.com	Germany
Brigham, R. Mark	mark.brigham@uregina.ca	Canada, (Saskatchewan)
Brito, Bernardo	bbrito@guarany.unb.br	Brazil
Britton, Adam	BZARCB@SSA.BRISTOL.AC.UK	United Kingdom
Brooke, Anne P.	abrooke@nh.ultranet.com	USA, (New Hampshire)
Brown, Caroline Bourque	7351.1773@compuserv.com	USA, (California)
Brown, Nikolle	black-catnik@worldnet.att.net	USA, (California)
Brown, Patricia	PATBOBBAT@AOL.COM	USA, (California)
Buck, Anita	aajbuck@ix.netcom.com	USA, (Ohio)
Bumeururgsri, Sara	bsara@ratree.psu.ac.th.	Thailand
Bunch, Bill and Mary	billandmary@alltel.net	USA, (Georgia)
Bunch, M. Strayer	mbunch@innova.net	USA, (South Carolina)
Burke, Harold S.	burke_short@fuse.net	USA, (Kentucky)
Burland, Tamsin	suaatmb@ucl.ac.uk	United Kingdom
Burles, Douglas W.	dburles@pop.UVic.CA	Canada, (British Columbia)
Burneo, Santiago	sburneo@uio.satnet.net	Equador
Burnett, Stephen C.	burnett.33@osu.edu	USA, (Ohio)
Butts, Thomas	tbutts@initco.net	USA, (Montana)
Buzato, Silvana	sbuzato@ib.usp.br	Brazil
Byrnes, Deanna	dpbyrnes@students.wisc.edu	USA, (Wisconsin)
Cabrera, Theresa	tcabrera@zoogate.zoo.hawaii.edu	USA, (Hawaii)
Caceres, Carolina	mccacere@acs.ucalgary.ca	Canada, (Alberta)
Cadena, Alberto	acadena@ciencias.ciencias.unal.edu.co	Columbia
Caetano Junior, Jorge	icaetnao@tba.com.br	Brazil
Caire, William	wcaire@ucok.edu	USA, (Oklahoma)
Cairns, Sara	SCAIRNS@MIDD.CC.MIDDLEBURY.EDU	USA, (Vermont)
Campbell, Karen	karenc@joe.alb.edu	USA, (Pennsylvania)
Campbell, Lori A.	lacampbell@ucdavis.edu	USA, (California)

Capell, Susan	scapell@sugnet.com	USA, (California)
Carpenter, Roger	eidolon@pop.azstarnet.com	USA, (California)
Carter, Timothy	TCC4454@owl.forestry.uga.edu	USA, (Georgia)
Carter, Timothy C.	tcarter@siu.edu	USA, (Illinois)
Cartwright, Anne	cartwrig@eos.net	USA, (Ohio)
Casseday, John H.	casseday@u.washington.edu	USA, (Washington)
Castillo V., Guillermo E.	e908@hotmail.com	Mexico
Catto, Colin	Gatcontrust@qr.apc.org	United Kingdom
Cavelier, Jaime	jcavelie@cdcnet.uniandes.edu.co	???
Chapman, Brian R.	chapman@smokey.forestry.uga.edu	USA, (Georgia)
Chapman, Sandra S.	schapman@smokey.forestry.uga.edu	USA, (Georgia)
Chelsvig, Jim	jchelsvig@aol.com.	???
Chick, Ryan	r.chick@dce.vic.gov.au	Australia
Choate, Jerry	jchoate@fhsu.edu	USA, (Kansas)
Christensen, Linda	Linda.Christensen@sci.monash.edu.au	Australia
Chung-Maccoubrey, Alice	achung/rmrs_albq@fs.fed.us	USA, (New Mexico)
Churchill, Sue	bilge-rat@msn.com	Australia
Clague, Chris	Phoniscus@internetnorth.com.au	Australia
Clark, Brenda	bsclark@sosu.edu	USA, (Oklahoma)
Clark, Don	drclark@tamu.edu	USA, (Texas)
Clark, Mary Kay	mkclark@ncdial.net	USA, (North Carolina)
Clarke, John	John.Clarke@env.qld.gov.au	Australia
Clawson, Rick	clawsr@mail.conservation.state.mo.us	USA, (Missouri)
Clem, Phillip D.	pclem@uchaswv.edu	USA, (West Virginia)
Coen, Claudia	cec6@cornell.edu	USA, (New York)
Coleman, Brent	BLC32@email.byu.edu	USA, (Utah)
Coles, Roger	R.Coles@vthrc.uq.edu.au	Australia
Collins, Linda	LindaCollins@bigpond.com.au	Australia
Comeaux, Lisa	comeaux@utkux.utcc.utk.edu	USA, (Tennessee)
Cook, Lizette	Lizcook@aol.com	USA, (California)
Corben, Chris	corben@delphi.com	USA, (?)
Cosson, Jean Francois	cosson@roazhon.inra.fr	France
Costa, Deborah Peres de	debpc@hotmail.com	Brazil
Covey, Ellen	ecovey@u.washington.edu	USA, (Washington)
Crampton, Lisa	lcrampto@acs.ucalgary.ca	Canada, (Alberta)
Cross, Steve	scross@sou.edu	USA, (Oregon)
Cruz-Neto, Ariovaldo P.	neto@ms.rc.unesp.br	Brazil
Cryan, Paul	pcryan@UNM.EDU	USA, (New Mexico)
Cullen, Max	zephyr@southlights.gen.nz	New Zealand
Currie, Robert	RRCurie@aol.com	USA, (?)
Currie, Robert R.	Robert_Currie@fws.gov	USA, (N. Carolina)
Currie, Robert R.	rrcurrie@ioa.com	USA, (N. Carolina)
Czaplewski, Nick	nczaplewski@ou.edu	USA, (Oklahoma)
Dalton, Virginia [Ginny]	Plecotus@aol.com	USA, (Arizona)
Davidson, Susan	susand@umich.edu	USA, (Michigan)

Davis, Kathy	tegan@ozemail.com.au	Australia
Dávalos, Luis Ignacio	liniguez@fisher.autlan.udg.mx Typo	Mexico
De Oliveira, Maritca	deolivm@dnr.qld.gov.au	Australia
de Wijs, Rombout	R.deWijs@Natuurmonumenten.nl	Netherlands
Delahaye, Laurence	delahaye.l@fsagx.ac.be Typo	Belgium
Dempsey, Janet L.	dempsey@stlzoo.org	USA, (Missouri)
Denault, Lisa K.	ldenault@iastate.edu	USA, (Iowa)
Denzinger, Annette	annette.denzinger@uni-tuebingen.de	Germany
Desch, Clifford	desch@uconnvm.uconn.edu Typo	USA, (Connecticut)
Dickson, Jenny	jcizik@snet.net	USA, (Connecticut)
DiSalvo, Arthur F.	afdisalvo@juno.com	USA, (Neveda)
Ditchfield, Albert D.	trachops@amnh.org	USA, (New York)
Dixon, Mike	dixonm@txwes.edu	USA, (Texas)
Dobbyn, Jon(Sandy)	sdobbyn@bmts.com	???
Druecker, Jay	jdruecker@csc1.csc.edu	USA, (Nebraska)
Ducummon, Sheryl	sducummon@batcon.org	USA, (Texas)
Duffy, Angela	A.Duffy@nre.vic.gov.au	Australia
Dumont, Betsy	erd@riker.neoucom.edu	USA, (Ohio)
Dunlop, Jenna	YFSC0115@VM1.YORKU.CA	Canada, (Ontario)
Dunning, Dorothy	dunning@wvnvm.wvnet.edu	USA, (West Virginia)
Dutko, Rick	rdutko@dep.state.nj.us	USA, (New Jersey)
Dybek, Andre	uzs058@ibm.rhrz.uni-bonn.ck	Czech Republic
Eby, Peggy	peby@ozemail.com.au	Australia
Egar, Judith	judithe@rom.on.ca	Canada, (Ontario)
Elliot, Paul	Typo serae@cvs.warwick.ac.uk	United Kingdom
Ellis, Susan	sellis@jersey.net	USA, (New Jersey)
England, Angela	aengland@batcon.org	USA, (Texas)
Ennis, Tish	tishe@amsg.austmus.gov.au	Australia
Entwistle, Abigail	a.entwistle@abdn.ac.uk	United Kingdom
Erkinaro, Mikko Johannes	mjerkina@cc.jyu.fi	Finland
Esberard, Carlos E.	celesb@uol.com.be	Brazil
Eskow, Jessica	Typo Jessica_Eskowj@champint.com	???
Esser, Karl-Heinz	kalle.esser@biologie.uni-ulm.de	Germany
Evelyn, Michelle	Typo mevelyn@leland.stanford.edu	USA, (California)
Fabian, Marta Elena	mfabian@vortex.ugrs.br	Brazil
Faria, Deborah	morcegos@bitsnet.com.br	Brazil
Fascione, Nina	nfascio@defenders.org	USA, (Maryland)
Fauna and Flora Internat.	info@fauna-flora.org	???
Faure, Paul A.	paf2@cornell.edu	USA, (New York)
Fellers, Gary	Gary_Fellers@usgs.gov	USA, (California)
Fenton, M. Brock	bfenton@monkey.circus.yorku.ca	Canada, (Ontario)
Field, Hume	fieldh@prose.dpi.qld.gov.au	Australia
Findley, James S.	103322.2511@compuserve.com.	USA, (New Mexico)
Finn, Laura S.	lsfinn@aol.com another Email	USA, (Florida)
Firth, Ron	Typo Ronald.Firth@sci.monash.ed.au	Australia

Fischer, Erich A.	efischer@nin.ufms.br	Brazil
Flavel, Stanley	Flavel_S@usp.ac.fj	Fiji
Fleming, Ted	tfleming@fig.cox.miami.edu	USA, (Florida)
Floyd, Randy	rfloyd@teleport.com	USA, (Oregon)
Forbes, Graham	forbes@unb.ca	Canada(New Brunswick)
Forbes, Peter	prforbes/r6pnw_wenatchee@fs.fed.us	???
Ford, Greg	gford@mail.connect.usq.edu.au	Australia
Forman, Larry	GFORMAN@ROCKFORD.edu	USA, (Illinois)
Francis, Charles	cfrancis@bsc-eoc.org	Canada, (Ontario)
Freeman, Patricia	pfreeman@UNLINFO.UNL.EDU	USA, (Nebraska)
French, Barbara	french@batcon.org	USA, (Texas)
Fuhrmann, Malte	Fuhrmann@BGNATUR.de	Germany
Fullard, James	jfullard@credit.erin.utoronto.ca	Canada, (Ontario)
Funakoshi, Kimitake	funakoshi@kkis.ac.jp	Japan
Gaisler, Jiri	gaisler@sci.muni.cz	Czech Republic
Galli, Joan	joan.galli@dnr.state.mn.us	USA, (Minnesota)
Gannon, Michael	mrg5@psuvm.psu.edu	USA, (Pennsylvania)
Gannon, William	wgannon@unm.edu	USA, (New Mexico)
Gardner, Alfred	GARDNER.ALFRED@NMNH.SI.EDU	USA, (Wash., D.C.)
Gaspari, Margaret	batnfoto@mindspring.com	USA, (Washington)
Gaspari, Robert	batnfoto@mindspring.com	USA, (Washington)
Gee, David	dgee@mildura.net.au	Australia
Geisel, Rachel	R.Geisel@uq.edu.au	Australia
Geiselman, Cullen	cgeiselman@batcon.org	USA, (Texas)
Geluso, Kenneth	kngeluso@cwis.unomaha.edu	USA, (Nebraska)
Genter, Dave	dgenter@desktop.org	USA, (Montana)
Genthe, Steffen D.	genthes@river.it.gvsu.edu	USA, (Michigan)
Gerell, Rune	rune.gerell@swipnet.se	Sweden
Giannini, Norberto	pidba@upida.satlink.net	Argentina
Giovengo, Karen	keren_giovengo@mail.fws.gov	USA, (?)
Glick-Bauer, Marian	MABMGB@aol.com	USA, (New York)
Godawa, Joanne	negodawa@cyf-kr.edu.pl	Poland
Gonzalez Bordon, Gloria	teju-cites@sce.cnc.una.py	Paraguay
Gordon, Lori	bcllg@ttacs.ttu.edu	USA, (Texas)
Gordon, Thomas	trux1964@life.bio.sunysb.edu	USA, (New York)
Gore, Jeffrey A.	GoreJ@gfc.state.fl.us	USA, (Florida)
Gornstein, Eric	egorn@acs.bu.edu	USA, (Massachusetts)
Gould, Edwin	edgould@erols.com	USA, (Wash., D.C.)
Graciolli, Gustavo	mingua@garoupa.bio.ufpr.br	Brazil
Graves, Shannon M.	smgraves@aol.com	USA, (Georgia)
Greg Richards & Assoc.	batman@atrax.net.au	Australia
Gregorin, Renato	gregorin@usp.br	Brazil
Griffin, Donald R.	cfs@oeb.harvard.edu	USA, (Massachusetts)
Griffiths, Thomas	tgriff@titan.iwu.edu	USA, (Illinois)
Grsegorski, Michelle	minkystar@hotmail.com	Australia

Gustafson, Alvar	AGustafson@infonet.tufts.edu	USA, (Massachusetts)
Gutiérrez, Eliécer	eliecer@ula.ve	Venezuela
Güttinger, René	rene.guettinger@bluewin.ch	Switzerland
Habersetzer, Joerg	jhaberse@sng.uni-frankfurt.de	Germany
Hall, John	jlahall@aol.com	USA, (Pennsylvania)
Hall, Leslie S.	l.hall@mailbox.uq.edu.au	Australia
Hamilton, Ian	inhamilt@acs.ucalgary.ca	Canada, (Alberta)
Hand, Suzzane	s.hand@unsw.edu.au	Australia
Handley, Charles	handleyc@nmnh.si.edu	USA, (Wash., D.C.)
Haraden, Tom	Tom_Haraden@nps.gov	USA, (Utah)
Harmata, Wincenty	harmata@eko.uj.edu.pl	Poland
Harnish, Harry	devden@arkansas.net	USA, (Arkansas)
Harnish, Harry	devdenatarkansas.net	USA, (Arkansas)
Harris, Arthur H.	aharris@utep.edu	USA, (Texas)
Hart, Aimee	AHart247@aol.com	USA, (Florida)
Hart, James A.	JAHART@ARK.Ship.edu.	USA, (Pennsylvania)
Hartmann, Rainer	RHartmann.Goettingen@t-online.de	Germany
Harvey, Michael, J.	mharvey@tntech.edu	USA, (Tennessee)
Haukkovaara, Olli (1)	olli.haukkovaara@vlk.fi	Finland
Haukkovaara, Olli (2)	olhaukko@freenet.hut.fi	Finland
Hayes, John P.	hayesj@fsl.orst.edu	USA, (Oregon)
Hayes, Robin L.	jhh2@belgarath.cl.msu.edu	USA, (Michigan)
Hayssen, Virginia	vhayssen@science.smith.edu).	USA, (Massachusetts)
Hazam, Bruce	bhazam@ACS.BU.EDU ?	???
Heffner, Ricky	FAC2623@UOFT01 incorrect	USA, (Ohio)
Heideman, Paul D.	pdheid@facstaff.wm.edu	USA, (Virginia)
Heller, Klaus-Gerhard	kheller@biologie.uni-erlangen.de	Germany
Helverson, Otto	helver@biologie.uni-erlangen.de	Germany
Hendricks, William	myotis@ldd.net	USA, (Kentucky)
Henricks, Jolie	BattyCat@aol.com	USA, (Oregon)
Henry, Travis H.	thhenry@tva.gov	USA, (Tennessee)
Henson, O.W.(Bill)	owh@med.unc.edu	USA, (North Carolina)
Herder, Michael	mherder@az.blm.gov	USA, (Utah)
Hermanson, John	jwh6@cornell.edu	USA, (New York)
Hernandes, Alessandra R.	alexbats@music.pucrs.br	Brazil
Hickey, M. Brian C.	bats@glen-net.ca	Canada, (Ontario)
Hill, David A.	d.a.hill@sussex.ac.uk	United Kingdom
Hillman, Adrian	ahillman@hotbot.com	Thailand
Hinman, Katherine	khinman@life.bio.sunysb.edu	USA, (New York)
Hitoshi Murai	rumbat@tym.fitweb.or.jp	Japan
Hoagland, Buzz	bhoagland@foma.wsc.mass.edu	USA, (Massachusetts)
Hobbs, Donna	Hobbs@sjc.cc.nm.us	USA, (New Mexico)
Hogan, Bronwyn	bchogan@ucdavis.edu	USA, (California)
Hogan, Luke	hoganl@dnr.qld.gov.au	Australia
Holcer, Drasko	Drasko.Holcer@hpm.hr	Croatia

Holland, Julian N.	jholland@fig.cox.maimi.edu	USA, (Florida)
Holloway, Gillian	ghollowa@acs.ucalgany.ca	Canada, (Alberta)
Holohil Systems, Ltd.	info@holohil.com	Canada, (Ontario)
Holroyd, Jeffrey L.	gholroyd@compusmart.ab.ca	Canada, (Alberta)
Hood, Craig	chood@loyno.edu	USA, (Louisiana)
Horner, Margaret	peggy.horner@tpwd.state.tx.us	USA, (Texas)
Horst, G. Roy	horstgr@potsdam.edu	USA, (New York)
Hosken, David	hosken@zoolmus.unich.ch	Switzerland
Houck, Becky	houck@uofport.edu	USA, (Oregon)
Houston, Robert D.	R.D.Houston@bristol.ac.uk	United Kingdom
Hovis, Julie	hovisj@gfc.state.fl.us	USA, (Florida)
Hovis, Julie	hovisj@gfc.state.fl.us	USA, (Florida)
Howard, Peter	P.Howard@ens.qu.edu.au	Australia
Howell, Daryl	dhowell@max.state.ia.us	USA, (Iowa)
Hoye, Glenn	bigah@CCNewcastle.edu.au	Australia
Hoye, Margaret	bigah@CCNewcastle.edu.au	Australia
Hsu, Minna J.	hsumin@mail.nsysu.edu.tw	Taiwan
Hubbell, Joselyn	hubblej%cherryvale@boulder.lib.co.us	USA, (Colorado)
Humes, Marcia	humesm@CCMAIL.ORST.EDU	USA, (Oregon)
Hurt, Mollie	Hurt_Mollie/r5_tahoe@fs.fed.us	USA, (California)
Hutcheon, James	hutcheon@students.wisc.edu	USA, (Wisconsin)
Hutchinson, Jeff	jthutc0@ukcc.uky.edu	USA, (Kentucky)
Hutson, Tony	thutson@bats.org.uk	United Kingdom
Hutterer, Rainer	R.Hutterer.ZFMK@Uni-Bonn.De	Germany
Ingle, Nina R.	nri2@cornell.edu	Phillipines
Ingleby, Sandy	Sandyi@amsg.austmus.gov.au	Australia
Irvine, Robert	robert.irvine@asc.gov.au	Australia
Irwin, Nancy	uoinri@abdn.ac.uk	United Kingdom
Iudica, Carlos	casaiud@flmnh.ufl.edu	USA, (Florida)
Ivanova, Teodora	Rabbits@main.infotel.bg	Bulgaria
Jackson, David	david.jackson@ea.gov.au	Australia
Jacobs, David	djacobs@botzoo.uct.ac.za	South Africa
Jarrín-V., Pablo,	ernesto@uio.satnet.net	Ecuador
Jarzembowski, Tomasz	doktj@univ.gda.pl	Poland
Johnson, Heather	sac27916@saclink.csus.edu	USA, (California)
Johnston, David	djohnston8@AOL.com	USA, (California)
Johnston, Georgann B.	gbatty@ix.netcom.com	USA, (California)
Jolly, Simon	JOLLYS@OZEMAIL.COM.AU	Australia
Jones, Gareth	Gareth.Jones@bristol.ac.uk	United Kingdom
Jones, Kate	k.jones@netcomuk.co.uk.	United Kingdom
Juedes, Ulrich	buw@ipn.uni-kiel.de	Germany
Juste, Javier	BCJJB@ttacs.ttu.edu	USA, (Texas)
Kaipf, Ingrid	ingrid.kaipf@uni-tuebingen.de	Germany
Kaipf, Ingrid	ingrid.kaipf@uni-tuebingen.de	Germany
Kalko, Elisabeth	kalkok@nmnh.si.edu	USA, (Wash., D.C.)

Kasper, Stephen	Y6KAS@ttacs.ttu.edu	USA, (Texas)
Kath, Joe	jkath@dnrmail.state.il.us	USA, (Illinois)
Kazial, Karry	kazial.1@osu.edu	USA, (Ohio)
Kazial, Karry	kazial.1@osu.edu	USA, (Oregon)
Kearney, T.	kearneyt@biology.und.ac.za	South Africa
Keegan, D. J.	djk@mweb.co.za	South Africa
Keeley, Brian	bkeeley@batcon.org	???
Kelleher, Conor F.	conorkelleher@tinet.ie	Ireland
Keller, Barry	kellerbarr@isu.edu	USA, (Idaho)
Ken O. Bowman	guano@chorus.net	USA, (Wisconsin)
Kennedy, Jim	jkennedy@batcon.org	USA, (Texas)
Kern, William	whk@gnv.ifas.ufl.edu	USA, (Florida)
Kervyn, Thierry	delahaye.l@fsagx.ac.be	Belgium
Khabilov, Tolibjon	tolib@khgu.khj.td.silk.org	Tajikistan
Kilburn, Kerry	KILBURN@WVSVAX.WVNET.EDU	USA, (West Virginia)
Kilpatrick, Wm. C.	wkilpatr@moose.uvm.edu.	USA, (Vermont)
Kindermann, Darlene	dkinderm@hornet.livnet.edu	USA, (New York)
King, Kerensa	KerensaK@premier1.net;	USA, (Washington)
King, Mark	Mark.a.King@me.state.us	USA, (Maine)
Kirkpatrick, Ralph D.	osagerdk@comteck.com	USA, (Indiana)
Kirsch, John	wuzm@macc.wisc.edu Typo	USA, (Wisconsin)
Kiser, Mark	mkiser@batcon.org	USA, (Texas)
Kiser, Selena	skiser@batcon.org	USA, (Texas)
Klinghammer, Kirsten	klingham@SAGE.CC.PURDUE.EDU	USA, (Indiana)
Knight, Richard	r.Knight@cqu.edu.au Typo	Australia
Kock, Dieter	dkock@sng.uni-frankfurt.de	Germany
Kowalski, Rachel	rkowalski@batcon.org	USA, (Texas)
Krishna, Amitabh	akrishna@banaras.ernet.in	India
Krutzsch, Philip H.	krutzsch@aruba.ccit.arizona.edu	USA, (Arizona)
Kunz, Thomas H.	kunz@bu.edu	USA, (Massachusetts)
Kurta, Allen	bio_kurta@online.emich.edu	USA, (Michigan)
Kwiecinski, Gray G.	GGK301@UOFS.edu	USA, (Pennsylvania)
Laborda, Jeffrey	lslabord@scifac.indstate.edu Typo	USA, (Indiana)
Lacki, Michael	mlacki@pop.uky.edu	USA, (Kentucky)
Lancaster, Winston	wlancast@pc.edu	USA, (Kentucky)
Lance, Richard	rfl5640@usl.edu	USA, (Louisana)
Larsen, Eric	larseeml@dfw.wa.gov	USA, (Washington)
Larson, Paula	Typo Larson_Paula/r5_stanislaus@fs.fed.us	USA, (California)
LaVal, Richard	rlaval@sol.racsa.co.cr	Costa Rica
Law, Brad	bradl@ironbark.forest.nsw.gov.au	Australia
Layne, James N.	jlayne@strato.net	USA, (Florida)
Lee, Ya-fu	abramus@utkux.utcc.utk.edu	USA, (Kentucky)
Leffler, John W.	jleffler@ferrum.edu	USA, (Virginia)
Leitner, Phil	leitner@jong.com	USA, (California)
Lemson, Julie	Typo lemsonju@pilot.msu.edu	USA, (Michigan)

Lengas, Brad	SLXZ6@CC.USU.EDU	USA, (Utah)
Leuthold, Caroline	Caroline.Leuthold@zool.unine.ch	Switzerland
Lewis, Robert E.	relewis@iastate.edu	USA, (Iowa)
Lewis, Stephen W.	tsswl@uas.alaska.edu	USA, (Alaska)
Lewis, Susan E.	lewiss@carroll1.cc.edu	USA, (Wisconsin)
Lidicker, William	lidicker@socrates.berkeley.edu	USA, (California)
Lim, Burton K.	burtonl@rom.on.ca	Canada, (Ontario)
Limpens, Herman	liever.limpens@knoware.nl	Netherlands
Lina, Peter H.C.	p.h.c.lina@ecnc.nl	Netherlands
Lindhard, Birgitte J.	birgitte.lindhard@post3.tele.dk	Denmark
Lippert, Heidi	hlippert@ualberta.ca	Canada, (Alberta)
Lollar, Amanda	batworld@wf.net	USA, (Texas)
Long, Glenis	long@physics.purdue.edu	USA, (Indiana)
Long, Emma	nhi665@abdn.ac.uk	United Kingdom
Long, Jennifer	74721.3477@compuserve.com	USA, (Massachusetts)
Lopes, Ariadna	avflopes@npd.ufpe.br	Brazil
Lumsden, Lindy	Lindy.Lumsden@nre.vic.gov.au	Australia, (Victoria)
Lunde, Darrin	lunde@amnh.org	USA, (New York)
Lunney, Dan	dan.lunney@npws.nsw.gov.au	Australia
Lynn Kershnar, Rebecca	rlk207@is8.nyu.edu	USA, (New York)
Machado, Ricardo Bomfim	rpacheco@guarany.cpd.unb.br	Brazil
MacLeod, Brent	batboy@cadvision.com	???
Maeda, Kishio	maedak@nara-edu.ac.jp Typo	Japan
Marco A. Ribeiro de Mello	marm@acd.ufrg.br	Brazil
Marimuthu, G.	mari@pronet.xlweb.com	India
Marinho-Filho, Jader	jmarinho@guarany.unb.br	Brazil
Marks, Cynthia	flabats@aol.com	USA, (Florida)
Markus, Nicola	n.markus@mailbox.uq.edu.au	Australia
Marques, Rosane Vera	rosenbat@music.pucrs.br	Brazil
Marshall, Charlene	charlene.marshall@npws.nsw.gov.au	Australia
Martin, Len	martin@plpk.uq.edu.au	Australia
Mashburn, Kris	BatsRGr8@aol.com	USA, (California)
Masters, W. Mitchell	masters.2@osu.edu	USA, (Ohio)
Matt, Felix	fxmatt@BIOLOGIE.UNI-ERLANGEN.DE	Germany
Matthews, Alison	alison.matthews@npws.nsw.gov.au	Australia
Matthews, Dennis	d2m.nmdl02.ncom.nt.gov.au	Australia
Mayer, Frieder	fmayer@server.biologie.uni-erlangen.de	Germany
McAney, Kate	mcaney@iol.ie	Ireland
McCarthy, Timothy	mccarthyt@cplgh.org	USA, (Pennsylvania)
McCowat, Tom (home)	tmcowat@clara.net	Wales, UK
McCowat, Tom (work)	tommo@ceredigion.gov.uk	Wales, UK
McCracken, Gary	gmccrack@utk.edu	USA, (Tennessee)
McDaniel, V. Rick	vrmcdanl@Quapaw.astate.edu Typo	???
McDonnell, Jo	jmmcdonn@unity.ncsu.edu	USA, (North Carolina)
McFarlane, Donald A.	dmcfarla@JSD.CLAREMONT.EDU	USA, (California)

McGowan, Emily	emmcg@ix.netcom.com	USA, (Texas)
McNiell, Doreen Parker	Doreen_Parker@fishgame.state.ak.us	USA, (Alaska)
Meada, Kishio	maedak@nara-edu.ac.jp	Japan
Medellin, Rodrigo	medellin@miranda.ecologia.unam.mx	Mexico
Menzel, Michael	MAM6648@owl.forestry.uga.edu	USA, (Georgia)
Meritt, Dennis	dmeritt@condor.depaul.edu	USA, (?)
Merriman, Cathy	cmerriman@wwfcanada.org Typo	Canada, (Ontario)
Mickleburgh, Simon	info@fauna-flora.org	United Kingdom
Mies, Rob	OBCBats@aol.com	USA, (Michigan)
Milam, Mindy	Eptesicus@aol.com	USA, (Alabama)
Miller, Bruce W.	galljug@btl.net Typo	Belize
Miller, Jack W.	75372,475@compuserve.com Typo	USA, (California)
Miller, Peter	Peter_Miller_at_CAS-ADMIN@casmail.calacademy.org	
Miller, Ray	rmmbats@snowcrest.net	USA, (California)
Miner, Karen	kminer@parks.ca.gov	USA, (California)
Mistry, Shahroukh	smistry@olg.com	USA, (Wash. D.C.)
Mitchel-Jones, Tony	tony.mitchell-jones@english-nature.org.uk	United Kingdom
Mitchell, Tony	t.mitchell@nre.vic.gov.au	Australia
Mobley, Emily	oldbat@albany.net	USA, (New York)
Moeschler, Pascal	pascal.moeschler@mhn.ville-ge.ch	Switzerland
Molinari, Jesus	molinari@ciens.ula.ve	Venezuela
Montana, Susan	susanm@petschoice.com	USA, (?)
Montgomery, Narelle	narelle.montgomery@ea.gov.au	Australia
Morell, Tom	tmorrell@wp.bsu.edu Typo	USA, (Indiana)
Morris, Karen	Karen.Morris@state.me.us	USA, (Maine)
Morton, Patricia	patricia.morton@tpwd.state.tx.us	USA, (Texas)
Muller, Eileen	Epmuller@aol.com	USA, (Pennsylvania)
Munoz, Mariana	mariana@ciens.ula.ve	Venezuela
Murai, Hitoshi	rumbat@tym.fitweb.or.jp	Japan
Myers, Phil	pmyers@umich.edu	USA, (Michigan)
Navo, Kirk	kirk.navo@state.co.us	USA, (Colorado)
Neilly, Brendon	critter@IDX.com.au	Australia
Nelson, John	john.nelson@sci.monash.edu.au	Australia
Neuweiler, Gerhard	neuweil@zi.biologie.uni-muenchen.de	Germany
Nogueira, Marcelo R.	mrn@ufrrj.br	Brazil
Nogueira, Marcelo Rod.	mrnogueira@rionet.com.br	Brazil
Nordquist, Gerda	gerda.nordquist@dnr.state.mn.us	USA, (Minnesota)
O'Donnell, Colin	mohua@voyager.co.nz	New Zealand
O'Farrell, Michael J.	mikeof@accessnv.com	USA, (Neveda)
O'Shea, James E.	jeoshea@cyllene.uwa.edu.au	Australia
Ochoa, Jose	jochoa@reacciun.ve	Venezuela
Oh, Yung Keun	batmanoh@dragon.yonsei.ac.kr	Korea
Ohio Bat Program	OhioBats@aol.com	USA, (Ohio)
Okimoto, Ben	hnzoovet@hgea.org	USA, (Hawaii)
Oliveira, Edny Rocha de	eros@acd.ufrj.br	Brazil

Oliveira, Paulo E.	poliveira@ufu.br	Brazil
Org. for Bat Conservation	obcbats@aol.com	USA (Michigan)
Ormsbee, Pat	orms@rio.com	USA, (Oregon)
Owen, Robert (1)	LAQUINO-CITES@SCE.CNC.UNA.PY	Paraguay
Owen, Robert (2)	BCRDO@TTACS.TTU.edu	USA, (Texas)
Pagels, John	jpagels@saturn.vcu.edu	USA, (Virginia)
Pallin, Nancy	pallin@bigpond.au	Australia
Palmeirin, Jorge	palmeirim@fc.ul.pt	Portugal
Park, Shi-Ryong	srpark@cc.knue.ac.kr	Korea
Parker, Doreen	Doreen_Parker@fishgame.state.ak.us	USA, (Alaska)
Parry-Jones, Kerryn	wambina@ozemail.com.au	Australia
Parsons, Stuart	stuart.parsons@bristol.ac.uk	United Kingdom
Pauza, Dainius H.	daipau@kma.lt	Lithuania
Pavey, Chris	pavey@zi.biologie.uni-muenchen.de	Germany
Pease, Charles	cpease@mwaz.com	USA, (Arizona)
Pedersen, Scott	Bathead@u.washington.edu	USA, (Washington)
Pedro, Wagnar Andre	wagnerpedro@regra.com.br	Brazil
Perkins, J. Mark	batsrus1@stsna.com	USA, (Utah)
Perlmeter, Stuart	sperlmet@sps.lane.edu	USA, (Oregon)
Petersen, Christine	PetersenCA@aol.com	USA, (Minnesota)
Pettersson, Lars	pettersson@bahnhof.se	Sweden
Pettersson, Lars	pettersson@bahnhof.se	Sweden
Philpott, Wendy	Amoenus@aol.com	USA, (California)
Pierson, Elizabeth (Dixie)	edpierson@aol.com	USA, (California)
Pine, Ron	pine@imsa.edu	USA, (Illinois)
Pinheiro, Eliana C.	liapinhe@unb.br	Brazil
Pir, Jacques B.	eherjpir@pt.lu	Luxembourg
Pirie, Lucia de la Ossa	priba@cariari.ucr.ac.cr	Costa Rica
Pozo de la Tijera, Carmen	cpozo@nicte-ha.ecosur-qroo.mx Typo	Mexico
Prevett, Patrick	p.prevett@ballarat.edu.au	Australia
Racey, Paul A.	nhi173@abdn.ac.uk	United Kingdom
Racine, Denyse	denyseracine@compuserve.com.	USA, (California)
Radermacher, Heinz	3200613442042-0001@t-online.de	Germany
Rainey, Wm. (Bill)	weredp@aol.com	USA, (California)
Rainho, Ana	dep@icn.pt	Portugal
Ramsey, Marikay A.	ramseyma@juno.com	USA, (New Mexico)
Ramsey, Marikay A.	mramsey@zianet.com	USA, (New Mexico)
Ratnasooriya, W. D.	PVR92.UOC@mail.cmb.ac.lk	Sri Lanka
Rayner, Jeremy M. V.	J.M.V.Rayner@bristol.ac.uk	United Kingdom
Reardon, Terry	treardon@zoology.adelaide.edu.au	Australia
Redondo, Rodrigo A.F.	redondo@mono.ufmg.br Typo	Brazil
Rehak, Zdenek	rehak@sci.muni.cz	Czech Republic
Reinhold, Linda	Linda.Reinhold@dnr.qld.gov.au	Australia
Reis, Nelio Roberto dos	nrreis@sercomtel.com.br	Brazil

Reiter, Guido	Guido.Reiter@sbg.ac.at	Austria
Rensel, Eric	parkerdam.sp@DCNR.state.pa.us	USA, (Pennsylvania)
Revelo, Igor Castro	museon@isacha.ecx.ec	Equador
Reyes, Jorge Ortega	jortega@miranda.ecologia.unam.mx	Mexico
Reynolds, Scott	smbdsr@worldnet.att.net	USA, (Massachusetts)
Rhodes, Monika	anl86027@student.uq.edu.au	Australia
Riba, Pablo	priba@cariari.ucr.ac.cr	Costa Rica
Ribeiro de Mello, Marco A	marmello@biologia.ufrj.br	Brazil
Ribeiro, Tatiana Texeira	bergallo@uerj.br	Brazil
Richards, Greg	batman@atrax.net.au	Australia
Richardson, Bruce	BruceR2738@aol.com	USA, (?)
Ritzi, Chris	cmritzi@hotmail.com	USA, (Texas)
Robinson, Mark F.	mark.robinson23@virgin.net Typo	United Kingdom
Rodriguez-Moran, Armando	arodrig@ns.inter.edu	USA, (Puerto Rico)
Rodriquez-H, Bernal	bernalr@cariari.ucr.ac.cr Typo	Costa Rica
Romero-A, MA.Lourdes	romero@cib.uaem.mx	Mexico
Romijn, Phyllis C. (1)	phyllis.lba@pesagro.com	Brazil
Romijn, Phyllis C. (2)	phyllis@openlink.com.br	Brazil
Roth, Stan	jroth@falcon.cc.ukans.edu	USA, (Kansas)
Rowe, Maureen	rowem@dnr.state.wi.us	USA, (Wisconsin)
Ruedas, Luis A.	lruedas@sevilleta.unm.edu	USA, (New Mexico)
Ruedi, Manuel	manuel.ruedi@izea.unil.ch	Switzerland
Rupprecht, Charles	cyr5@cdc.gov	USA, (Georgia)
Russ, Jon	j.russ@qub.ac.uk	United Kingdom
Russ, Stephen	sruss@ix.netcom.com	USA, (California)
Russell, Amy L.	russella@utkux.utcc.utk.edu	USA, (Kentucky)
Sanchez-Hernandez, Corn.	cornelio@servidor.unam.mx	Mexico
~~Sasse, Blake~~	blakes@flinet.com	USA, (Florida)
Saugey, David	dsaugey@swbell.com	USA, (Arkansas)
Schedvin, Natasha	n.schedvin@nre.vic.gov.au	Australia
Schilling, Stephen	schilling@hypernet.com	USA, (Maine)
Schmidt, Sarah	sschmidt@u.arizona.edu Typo	USA, (Arizona)
Schmidt, Uwe	uwe.schmidt@uni-bonn.de	Germany
Schultz, Martin	Martin.Schulz@dnr.qld.gov.au	Australia
Schulz, Martin	shulzm@dnr.qld.gov.au	Australia
Schum, Michael	mschum@ix.netcom.com	USA, (California)
Schutt, William	desmodus@yahoo.com	USA, (New York)
Schwellenbach, Kathy	kathy.schwellenbach@stpaul.gov	USA, (Minnesota)
Scott, Christine	forbats@batnet.com	USA, (California)
Scott, Mike	mgscott@utk.edu	USA, (Tennessee)
Sedgeley, Jane	mohua@voyager.co.nz	New Zealand
Seidman, Victoria	victoria@humboldt1.com	USA, (California)
Selvey, Linda	selveyl@health.qld.gov.au	Australia
Senulis, Joe	senulis@acm.org	USA, (Wisconsin)
Seyjagat, John	lubee@aol.com	USA, (Florida)

Sheppard, Jessica	batwoman@misfit.com	USA, (California)
Sherwin, Rick	ressh@utw.com	???
Shilton, Louise	Louise.Shilton@anu.edu.au	Australia
Sidner, Rhonda M.	sidner@u.arizona.edu	USA, (Arizona)
Sigé, Bernard	sige@univ-lyon1.fr	France
Simmons, James	james_simmons@brown.edu.	USA, (Rhode Island)
Simmons, Nancy B.	simmons@amnh.org	USA, (New York)
Simons, Diana	batflap@aol.com	USA, (California)
Singer, Stephen W.	SWSingerMS@aol.com	USA, (California)
Singh, Udai Pratap	akrishna@banaras.ernet.in	India
Slough, Brian G.	bslough@yknet.yk.ca	Canada, (Ontario)
Smissen, Joanne	jsmiss.en@deakin.edu.au	Australia
Smith, Elizabeth	libby@nvi.nvi.net	USA, (Ohio)
Smith, Jerome	caspyr@aristotle.net	???
Smith, Leslie	leslies@pronet.net.au	Australia
Smith, Macklin	Macklin.Smith@UM.CC.UMICH.EDU	USA, (Michigan)
Smith, Suzanne E.	ses4@axe.humboldt.edu	USA, (California)
Smuts-Kennedy, Chris	c.smuts-kennedy@doc.govt.nz	New Zealand
Snow, Tim K.	tsnow@gf.state.az.us.	USA, (Arizona)
Soroka, Doug	DSOROKA@ARSeRRC.GOV	USA, (Pennsylvania)
Soubihe, Edmon Antonio R.	edmon@base.com.be	Brazil
Spaulding, Raymond (Rick)	RLSpaulding@OEES.com	USA, (California)
Speakman, John	nhi158@ABERDEEN.AC.UK	United Kingdom
Spears, Fran	FYBSpears@aol.com	USA, (California)
Spears, Ronnie	rspears@mindspring.com	USA, (Georgia)
Spencer, Hugh	Hugh@austrop.org.au	Australia
Stanford, James	caijim@hotmail.com	USA, (Pennsylvania)
Stanvic, Sonya	770-788-9709	Australia
Stern, April	rspears@mindspring.com	???
Stevenson, Lynda	Koalahos@tpgi.com.au	Australia
Stewart, Joanne	jostew1234@aol.com	???
Stihler, Craig	cstihler@dnr.state.wv.us	USA, (West Virginia)
Stoddard, John	gstoddar@UXA.ECN.BGU.EDU	USA, (Illinois)
Stoner, Kathryn	kstoner@cariari.ucr.ac.cr	Costa Rica
Storch, Gerhard	gstorch@sng.uni.frankfurt.de	Germany
Storz, Jay	storz@bio.bu.edu	USA, (Massachusetts)
Strickler, Timothy	stricklt@gvsu.edu	USA, (Michigan)
Stroo, Arjan	stroo@rulrhb.leidenuniv.nl	Netherlands
Studier, Eugene	myotis@umich.edu	USA, (Michigan)
Surlykke, Annemarie	ams@dou.dk	Denmark
Swanson, David A.	dave.swanson@dnr.state.oh.us	USA, (Ohio)
Swartz, Sharon	Sharon_Swartz@BROWN.EDU	USA, (Rhode Island)
Szabo, Erika	szaboe@fs2.date.hu	Hungary
Szewczak, Joeseph M	joe@wmrs.edu	USA, (California)
Tague, Thomas	104774.565@compuserv.com	USA, (Pennsylvania)

Tatarian, Gregory & Trish	tatarian@pacbell.net	USA, (California)
Tavares, Valeria da Cunha	valtabat@mono.icb.ufmg.br	Brazil
Taylor, Peter	petert@durban.gov.za Typo	South Africa
Taylor, Roscoe	taylorer@health.qld.gov.au on leave	Australia
Teeling, Emma	e.teeling@qub.ac.uk	United Kingdom
Thierry, Kervyne	thierry.kervyn@student.ulg.ac.be	Belgium
Thomas, Don	d.thomas.courrier@usherb.ca	Canada, (Quebec)
Thomas, Heather A.	heathet@mail.clemson.edu	USA, (South Carolina)
Thomas, Steven P.	thomas@duq3.cc.duq.edu Typo	USA, (Pennsylvania)
Thompson, Elizabeth	elizabetht@sgccvb.sunygenesee.cc.ny.us	USA, (New York)
Thompson, Laureen	lthompso@delta.dfg.ca.gov	USA, (California)
Thompson, Neville	n.thompson@dial.pipex.com	United Kingdom
Thomson, Bruce	bruce.thomson@env.qld.gov.au	Australia
Tidemann, Chris	chris.tideman@anu.edu.au	Australia
Tigner, Joel	tigner@gwtc.net	USA, (S. Dakota)
Tirhi, Michelle	tirhimjt@dfw.wa.gov	USA, (Washington St)
Titley, David	titley@nor.com.au	Australia
Toomey, Rickard S. III	toomey@museum.state.il.us	USA, (Illinois)
Toop, John	John.Toop@env.qld.gov.au	Australia
Tracy, Dianna	dtracy@oakland.edu	USA, (Michigan)
Tranjano, Eleonara	etrajano@usp.br	Brazil
Trierveler, Fernanda	trier@prp.via-rs.com.br	Brazil
Trimarchi, Charles	trimarch@wadsworth.org	USA, (New York)
Trombulak, Steve	trombulak@midd.cc.middlebury.edu	USA, (Vermont)
Tschapka, Marco	motschap@biologie.uni-erlangen.de	Germany
Tupinier, Yves	Yves.Tupinier@wanadoo.fr	France
Turton, Margaret	turtonm@acay.com.au	Australia
Turton, Margaret	turtonm@acay.com.au	Australia
Tuttle, Merlin	mtuttle@batcon.org	USA, (Texas)
Twente, John	JohnTwente@webtv.net	USA, (Missouri)
Tyburec, Janet	jtyburec@batcon.org	USA, (Arizona)
Tyrell, Karen	karen_tyrell@msn.com	USA, (Tennessee)
Uieda, Wilson (1)	uieda@botunet.com.br	Brazil
Uieda, Wilson (2)	wuieda@ibb.unesp.br	Brazil
Utzurrum, Ruth	utzurrum@bio.bu.edu	USA, (Massachusetts)
Vann, Cynthia	cvann@goodnet.com	USA, (?)
Vaughan, Nancy	nancy.vaughan@bristol.ac.uk Typo	Unitd Kingdom
Vavryn, Dianne	vavryn@networx.com.au	Australia
Venable, Morgan	cruzbat@aol.com	USA, (California)
Verbeek, Joost	verbeekj@wxs.nl	Netherlands
Verkem, Sven	verkem@ruca.ua.ac.be	Belgium
Vernier, Edoardo	giulini@civ.bio.unipd.it	Italy
Villa-R., Bernardo	bvilla@planet.com.mx	Mexico
Vogel, Stefan	roland.eberwein.univie.ac.at	Austria
Vonhof, Martin	mvonhof@acs.ucalgary.ca Jan 1 DIC	Canada, (Alberta)

Walker, Steven M.	swalker@batcon.org	USA, (Texas)
Walsh, Allyson	enquines@bats.org.uk	United Kingdom
Webb, J. Warren	web@ornl.gov	USA, (Tennessee)
Webb, Peter	peter.webb@stonebow.otago.ac.nz	New Zealand
Webster, David	webste@uncwil.edu	USA, (N.Carolina)
Weinstein, Bret	fruitbat@biology.LSA.umich.edu	USA, (Michigan)
Weller, Ted	tweller/psw_rsl@Fs.Fed.US	USA, (California)
Wenzel, Mary	mary.wenzel@mindspring.com	USA, (California)
Wethington, Traci A.	traci.wethington@mail.state.ky.us	USA, (Kentucky)
Whitaker, John	LSWHITAK@SCIFAC.INDSTATE.EDU	USA, (Indiana)
Whiteman, Joseph	bats@cdsnet.net	USA, (Oregon)
Whitman, Kimberly	whitman.kimberly@phillyzoo.org.	USA, (Pennsylvania)
Wiles, Gary J.	gwiles@ns.gov.gu	USA, (Guam,)
Wilhide, J.D.	JDWil@Osage.astate.edu	USA, (Arkansas)
Wilkes, Melody Bell	Mwilkes@MODS.org	USA, (Florida)
Wilkinson, Jerry	wilkinson@zool.umd.edu	USA, (Maryland)
Williams, Daniel F.	dwilliam@s2.sonnet.com	USA, (California)
Williams, Terry	Terry.WilliaMs.@qcl.com.au	Australia
Wilson, Don E.	WILSON.DON@NMNH.SI.EDU	USA, (Wash., D.C.)
Wilson, Heather	hw_chickaree@hotmail.com	USA, (Florida)
Wilson, Nixon	Nixon.Wilson@uni.edu	USA, (Iowa)
Winchell, Jane	Janey_Winchell@PEM.org	USA, (Massachusetts)
Wing, Steven M.	swing@scsn.net	USA, (South Carolina)
Winklemann, John	jwinkelm@gettysburg.edu	USA, (Pennsylvania)
Winnington, Andrew	apwinnington@hotmail.com	New Zealand
Winter, York	ywinter@biologie.uni-erlangen.de	Germany
Winters, Patricia	batmam@aol.com>	USA, (California)
Woloszyn, Bronislaw	WOLOSZBR@isez.pan.krakow.pl	Poland
Woodford, Michael	mwood@sun.science.wayne.edu	USA, (Michigan)
Worthington, David	dave_worthington@nps.gov	USA, (Utah)
Wunder, Laurie	wundelaw@dfw.wa.gov	USA, (Washington)
Wyatt, Dave	dwyatt@concentric.net	USA, (California)
Yamamoto, Terumasa	CXJ13576@niftyserve.or.JP	Japan
Young, Bob	BCSC@cadvision.com	Canada, (Alberta)
Zahn, Andreas	Andreas.Zahn@iiv.de	Germany
Zbinden, Karl	karl.zbinden@phil.unibe.ch	Switzerland
Zippilli, Gail	gailbat@email.msn.com	USA, (Pennsylvania)
Zortea, Marlon (1)	mzortea@sigma.tropical.com.br	Brazil
Zortea, Marlon (2)	mzortea@npd.ufes.br	Brazil

If you know that any of the above addresses is incorrect, and <u>are certain</u> of the correct address, please forward it to me at: horstgr@potsdam.edu **Thank you in advance for your kind assistance. GRH**

Notes on a Colony of *Peropteryx leucoptera* (Emballonuridae) in Brazil

Enrico Bernard
Biological Dynamics of Forest Fragments Project--INPA/SI, Caixa Postal 478,
Manaus, Amazonas 69011-970, Brazil ebernard@inpa.gov.br

The white-winged bat, *Peropteryx leucoptera*, is one of only three species in the emballonurid genus *Peropteryx*. *P. leucoptera* is confined to the Amazon Basin in eastern Colombia, Venezuela, the Guianas, eastern Peru, and Brazil (Koopman, 1993). Species of *Peropteryx* are exclusively insectivorous. Handley (1976) reports capturing some *Peropteryx* (but not *P. leucoptera*) in forests, swamps, savannas, and cultivated areas and states that roosts of *Peropteryx* include shallow caves, rock crevices, human constructions, and dead trees.

On 6 May 1998, during a survey of the bat fauna of Alter do Chão, near Santarém, Pará State, Brazil (2°31'S, 55°00'W), I found a roost of *P. leucoptera*. Alter do Chão is in a relatively dry area dominated by Amazonian savannas (Sanaiotti, 1991). The dry season runs from July to November, and average annual rainfall is 2,200 mm. Savanna vegetation is dominated by grasses and clumps of shrubs composed mainly of species of Myrtaceae and Melastomataceae (Miranda, 1993). Small ($\leq$125 ha) fragments of tropical forest occur within the savannas, and I found the colony of *P. leucoptera* in one of those fragments.

Twelve white-winged bats (Table 1) were roosting in an unidentified, dead, hollow tree that was lying on the ground in an 8-ha forested area. The trunk of the tree was 10 m long and ca. 1.5 m in diameter. There was one main entrance at the base of the fallen tree and three smaller openings along the trunk.

Age of each bat was estimated by closure of phalangeal epiphyses. Those with open epiphyses were classified as young, and those in an intermediate stage were classified as subadults. Nipples of females were examined for lactation, and bellies were palpated to detect embryos.

The colony consisted of three adult females (one carrying a young), three adult males, and five subadults, all grouped together. This grouping suggests the lack of harems, and the presence of several subadults, as well as pregnant females, may indicate that the colony was a maternity roost. Simmons and Voss (1998) report groups of 2-8 *P. leucoptera* in primary forests of French Guiana. Studies on *P. kappleri* in Costa Rica indicate colonies of 1-6 individuals, with several adults of each sex present (Bradbury and Vehrencamp, 1977), suggesting a lack of harems in *P. kappleri* as well. However, Willig (1983), working in east-central Brazil, found aggregations of *P. macrotis* containing up to 10 individuals, with only a single adult male in each group, which suggests the maintenance of harems.

The presence of two pregnant females and subadults (Table 1) suggests that births began 2-3 months earlier. This is in accordance with reproductive data for *P. macrotis*; pregnant females of that species were captured in April in Mexico, February-April in Guatemala, July in Colombia, and August in Peru (Nowak, 1994). Two of the subadults captured by me had darker fur than the others, possibly indicating changes in coloration with age.

Charles O. Handley and staff at the United States National Museum of Natural History, Washington, D. C., helped identify the bats. Work in Alter do Chão was possible due to grants from CNPq and INPA PPI to W. E. Magnusson. A. Albernaz provided logistical support, and E. Farias helped with field collections.

Literature Cited

Bradbury, J. W. and S. L. Vehrencamp. 1977. Social organization and foraging in emballonurid bats. I. Field studies. Behavioral Ecology and Sociobiology, 1:337-81.

Handley, C. O., Jr. 1976. Mammals of the Smithsonian Venezuelan Project. Brigham Young University, Science Bulletin, Biological Series, 20:1-89.

Koopman, K. F. 1993. Chiroptera. Pp. 137-241, in Mammalian species of the world (D. E. Wilson and D. M. Reeder, eds.). Smithsonian Institution Press, Washington, D. C.

Miranda, I. 1993. Estrutura do estrato arbóreo do cerrado amazônico em Alter do Chão, Pará, Brasil. Revista Brasileira de Botânica, 16:143-150.

Nowak, R. M. 1994. Walker's Bats of the World. The John Hopkins University Press, Baltimore, Maryland.

Sanaiotti, T. M. 1991. Ecologia de Paisagens: savanas amazônicas. Pp. 77-81, in Bases Científicas para Estratégias de Preservação e Desenvolvimento da Amazônia: fatos e perspectivas. Vol. 1 (Val et al., eds.). Manaus, Brazil.

Simmons, N. B. and R. S. Voss. 1998. The mammals of Paracou, French Guiana: a neotropical lowland rainforest fauna. Part 1, bats. Bulletin of the American Museum of Natural History, 237:28-36.

Willig, M. R. 1983. Composition, microgeographic variation, and sexual dimorphism in caatingas and cerrado bat communities from northeast Brazil. Bulletin of the Carnegie Museum of Natural History, 23:1-131.

Bernard continued...

Bernard continued...

Table 1. Characteristics of 12 *Peropteryx leucoptera* captured in a forest fragment in Alter do Chão, Brazil.

Sex	Body mass (g)	Forearm length (mm)	Age	Reproductive condition
F	8	47	adult	lactating
F	9	45	adult	pregnant
F	10	45	adult	pregnant
M	6	36	young	nonreproductive
M	7	43	subadult	nonreproductive
M	7	45	subadult	nonreproductive
M	8	45	subadult	nonreproductive
M	8	45	subadult	nonreproductive
M	8	45	adult	nonreproductive
M	8	45	adult	nonreproductive
M	8	45	adult	nonreproductive
M	8	46	adult	nonreproductive

* * * * *

A Safe and Effective Method to Remove Bats From Abandoned Water Wells

Daniel R. England[1] and David A. Saugey[2]
[1]Department of Biology, Southern Arkansas University, Magnolia, AR 71753 and
[2]United States Forest Service, Ouachita National Forest, Jessieville, AR 71949

Abandoned water wells and cisterns may constitute pit-fall dangers to humans and animals, particularly if the uppermost portion of the well's casing is at or near ground level. This potential danger, along with an increased propensity for lawsuits and focus on landowner liability, has increased the rate of filling and closure of wells. In addition, state and federal environmental agencies concerned with contamination of ground water have stepped up efforts to close abandoned wells. This trend is unfortunate for bats because a number of species use these or similar manmade structures during the hibernation period (Saugey et al., 1993; Schmidly, 1991; Tumlison et al., 1992), and wells and cisterns may constitute critical winter habitat in areas devoid of caves or mines.

The technique described here was developed during a long-term study of Rafinesque's big-eared bat *Corynorhinus rafinesquii* in the Gulf Coastal Plain of southern Arkansas. Wells used by bats in our study ranged in depth up to 10 meters, depending upon fluctuating water levels, and provided an interesting challenge in capturing and removing bats. Inside diameters of all wells that we measured were about 1 m. Wells most likely to be used by bats were those with casings constructed of 1-m-tall concrete tiles stacked on end to the desired height or those of mortar and brick. The inside surfaces of these types of casings were sufficiently rough to provide good footing for roosting bats. Wells with casings constructed of smooth-walled, brown, ceramic tile material never harbored bats.

To remove bats from wells, we manufactured a device from a standard umbrella fitted with two control cords and two hardened edges. Modifications to the umbrella included removing the lock-latch normally used to maintain the umbrella in an "open" position and covering the tips of the struts that support the fabric. Duct tape, wrapped several layers thick around these tips, not only helped secure the fabric to struts, but also helped the tips slide along the casing more easily. This greatly reduced the potential of the umbrella to become snagged on roughened areas of the wall or in joints between tiles.

Control cords consisted of heavy-duty twine or parachute cord attached to the umbrella at one end and to short sections of wooden dowels or polyvinylchloride (PVC) pipe at the other. One control cord was firmly attached to the central shaft of the umbrella, just above the handle, and secured with several knots and an abundance of duct tape. This cord was used to raise and lower the umbrella inside the well. A second cord was attached near the tip of a fabric-support strut. This cord was tied to the umbrella's frame where it could not slip off the end of the strut and secured with duct tape. The function of this cord was to rotate the

umbrella for positioning one of two, hardened, collecting edges beneath roosting bats. Control cords were rolled onto the dowel or pipe when not in use. The hardened collecting edges may be constructed from virtually any material that will not absorb water or harm bats. We chose smooth, flexible, plastic material that is used to make signs ("For Sale," "No Trespassing," etc.) and available at any hardware store. An edge was made from two pieces of plastic that were cut to fit the outside curve of the umbrella. The two pieces were placed on each side of the umbrella's material and fastened securely, sandwich style, with aluminum pop rivets. The outside edges of these surfaces were filed smooth and then covered with several layers of duct tape, as were rivets, to prevent sharp edges from harming bats. Two of these hardened surfaces were needed, and each extended about 0.3 m along the edge of the umbrella, with members of the pair positioned opposite one another. This placement was important because it provided balance and allowed for two collecting areas; if one side of the catch basin was full of bats, the device could be rotated and additional collections made without having to remove the umbrella from the well. A weight was secured on the outside of the umbrella basin, at the center point of the shaft, to provide stability and prevent excessive tipping during collection.

During use, the device is lowered in a collapsed position until it is located below the level of roosting bats. Opening is accomplished by a tug on the central cord that allows the frame to expand to the inside diameter of the well. Once expanded, the second cord rotates the umbrella until a hardened edge is positioned beneath individuals or a cluster of bats. The central cord is then used to raise the device. Bats in torpor are gently lifted away from the casing by the hardened edge and fall into the catch basin formed by the soft material of the umbrella. The umbrella must be raised slowly to prevent damage to toes and claws as the edge removes bats from the casing's surface. If active bats are encountered, the expanded umbrella effectively seals off downward escape and forces bats to fly toward the surface where they may be captured with hand nets or allowed to exit the well. A veil of lightweight bird-netting draped over researchers and the well opening will reduce the number of bats that escape.

To date, we have removed over 2,000 bats from wells with few injuries to the bat's feet, and we have never observed broken leg or wing bones as a result of using this device. Certainly, use of this device during the hibernation period constitutes a temporary, and possibly significant, disturbance to hibernating bats, especially in areas where winters are harsh and protracted and energy stores typically marginal. In those areas, this technique probably should be used only to save bats from entombment pending closure of a well or removal of individuals to establish identity.

Literature Cited

Saugey, D. A., V. R. McDaniel, D. R. England, M. C. Rowe, L. R. Chandler-Mozisek, and B. G. Cochran. 1993. Arkansas range extensions of the eastern small-footed bat *Myotis leibii* and northern long-eared bat *Myotis septentrionalis* and additional county records for the silver-haired bat *Lasionycteris noctivagans*, hoary bat *Lasiurus cinereus*, southeastern myotis *Myotis austroriparius*, and Rafinesque's big-eared bat *Plecotus rafinesquii*. Proceedings of the Arkansas Academy of Science, 47:102-106.

Schmidly, D. J. 1991. The bats of Texas. Texas A&M University Press, College Station, Texas, 188 pp.

Tumlison, R., M. Karnes, and M. Clark. 1992. New records of vertebrates in southwestern Arkansas. Proceedings of the Arkansas Academy of Science, 46:109-111.

* * * * *

How Often Should Researchers Go to the Field to Conduct Demographic Studies on *Carollia perspicillata* ?

Marco A. Ribeiro de Mello[1], Jorge L. Nascimento[2] and Fernando A. S. Fernandez[3]
Departmento de Ecologia, Instituto de Biologia, Universidade Federal do Rio de Janeiro, CEP: 21941-590 -- CxP: 68020, Brazil
[1]marmello@biologia.ufrj.br, [2]juliao@biologia.ufrj.br, [3]rodentia@biologia.efrj.br

Most demographic studies of bats in South America are simply by-products of studies that do not focus primarily on population dynamics. Consequently, sampling is seldom designed for reliable characterization of demographic patterns. Many researchers go to the field every other month or at even longer intervals. During our work, we wondered whether such a frequency (every other month) would be suitable for detecting some features of the demography of our target species.

Our study took place at the Poço das Antas Biological Reserve, Rio de Janeiro, southeastern Brazil. The area is the largest (5,500 ha) remnant of lowland Atlantic Forest (Mata Atlântica) in the state of Rio de

Ribeiro, et al, continued...

Ribeiro, et al, continued...

Janeiro. We con-centrated on *Carollia perspicillata* (Phyllostomidae: Carollinae) in a small (16-ha) forest fragment. We made monthly capturing sessions, because we hypothesized that we would lose important detail, if we went to the field at two-month intervals. We undertook to test this hypothesis after completing 14 months of continuous field work from November 1997 to December 1998.

Data on the frequency of capture of juveniles and reproductive females were used in this test. In addition to the actual data that we obtained by monthly sampling, we created two hypothetical data sets that simulated capture of bats every other month. One of the hypothetical sets began in November 1997 (odd series), and the other, in December 1997 (even series).

For presence of juveniles, we found that the even series was similar to the real one, whereas the odd series was different. If we had gone to the field every other month starting in November 1997, we would have seen a peak in juvenile abundance one month before the peak in the real series (Fig. 1). Data on frequency of reproductive females also showed an important difference. Although the odd series showed the same pattern as the real series, the even series lacked the secondary peak in reproduction that was present in the other two (Fig. 2).

We conclude that monthly sampling is better that sampling at longer intervals, because the latter protocol may lead to a misinterpretation of the true demographic pattern of *C. perspicillata*. The main reproduction occurs in the wet season, when food is easier to obtain, but some females breed again in the dry season due to a post-partum estrus. Longer sampling intervals would have made us miss the second reproductive season, which, although it is shorter, is still an important demographic feature of this species.

We thank PROBIO/PRONABIO/MMA, Fundação de Amparo à Pesquisa do Rio de Janeiro, and Fundação Univeritária José Bonifácio.

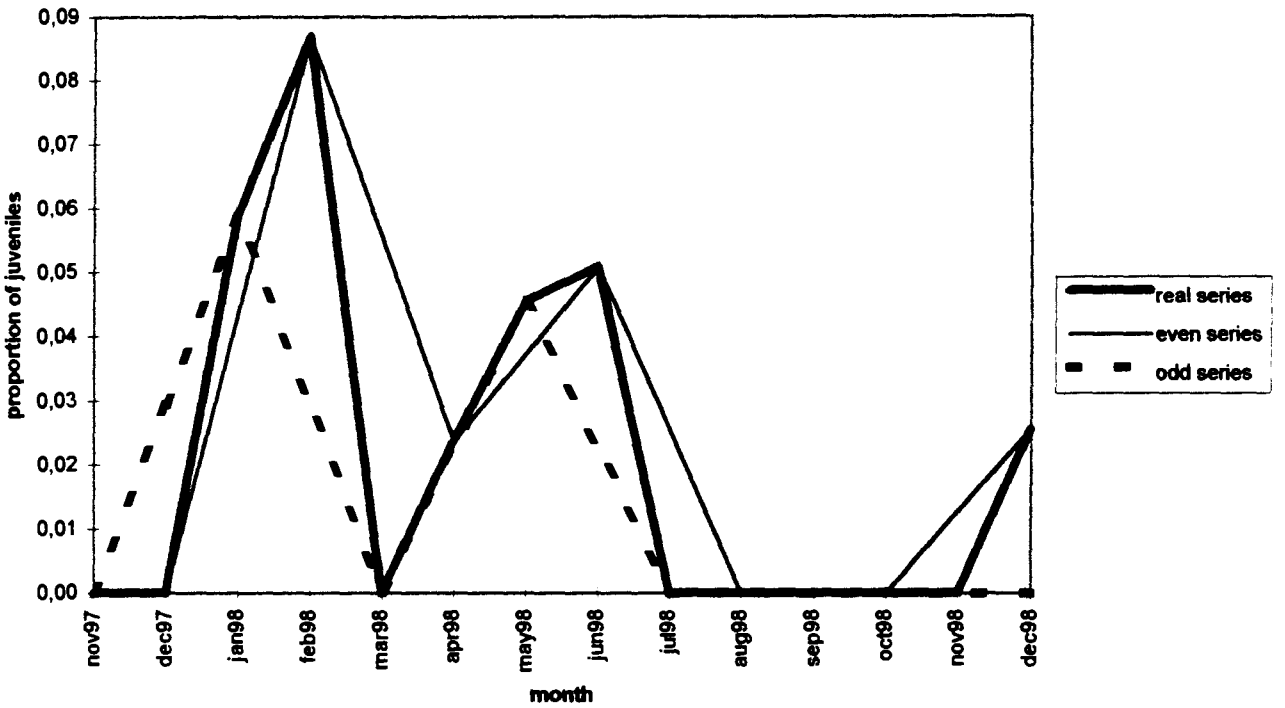


Figure 1: variations in the proportion of juveniles in the population of *Carollia perspicillata*, in a real series and two hypothetical series, the latter ones based on the odd and even months respectively.

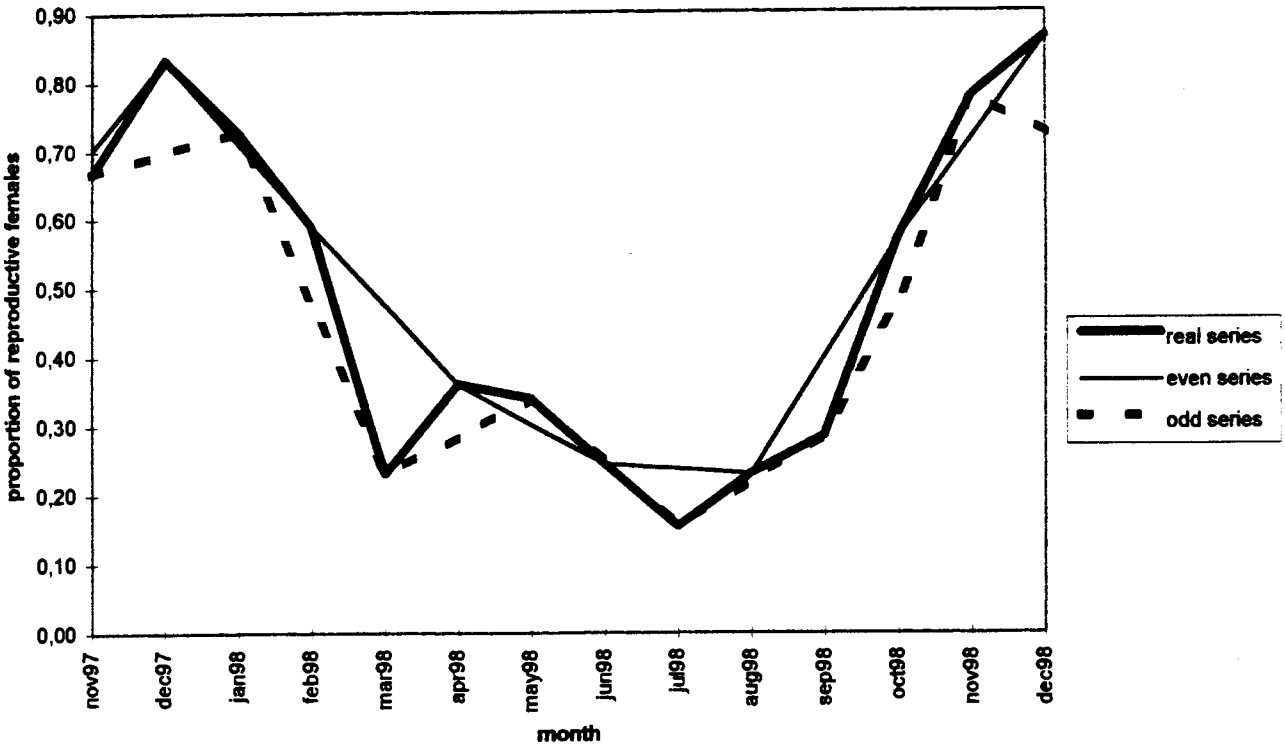


Figure 2: variations in the proportion of reproductive females of *Carollia perspicillata*, in a real series and two hypothetical series, the latter ones based on the odd and even months respectively.

A Computer-downloadable System to Monitor Bat Activity

N. C. Downs and P. A. Racey
Department of Zoology, University of Aberdeen, Aberdeen, Scotland AB24 2TZ

Introduction

The recent development of reliable bat detectors has facilitated the automatic recording of bat activity (Hayes and Hounihan, 1994; Sedgeley and O'Donnell, 1994). Bat detectors, voice-activated tape recorders and speaking clocks, similar to those used by Sedgeley and O'Donnell (1994), have been used in Scotland with some success, allowing the recording of both the number of bat passes and feeding buzzes. However, the tape often ran out at sites with sustained bat activity, output of the detector during light wind triggered the tape recorder, and time required to transcribe tapes was a major drawback. This prompted the development of a new system that coupled a bat detector to a logger that could be downloaded to a computer through an analogue-to-digital (A/D) converter (Fig. 1).

The System

Batbox III Bat Detector.--This detector is a relatively low-cost and effective model that possesses both tuneable bandwidth and volume controls.

Battery.--A rechargeable battery (12 V, 7 amp-h) was used to power the bat detector. It provides constant power for ca. 14 nights, and is, therefore, preferable to the small 9-V batteries for which the Batbox III is designed. These 9-Volt batteries have an effective life span of only ca. 10 hours, and the power they

Downs and Racey continued...

Downs and Racey continued...

provide decreases throughout this time. However, to facilitate the use of a rechargeable battery, a 12-V/9-V voltage regulator must be provided. This was constructed in the electronics workshop at Aberdeen University (Fig. 2).

Skye Analogue-to-digital Signal Converter.--This device converts the analogue signals from the bat detector into digital signals that can be recorded by the datalogger. Every 0.5 second, a positive or negative signal is sent to the logger, indicating the presence or absence of ultrasound, respectively. This device also has a threshold dial, which can be used to filter background ultrasound, such as that produced by light wind.

Gemini Tinytag Count Datalogger.--This datalogger can only be programmed with appropriate software, called Orion Tiny Logger Manager (OTLM). The logger can record at intervals ranging from 1 second to 10 days and has a capacity of 7,900 readings. In our field studies, loggers are set to record every minute. This means that the logger sums the number of positive half-second signals that it has received from the a/d converter every minute.

Connections.--Non-standard jack plugs are required for some connections (Fig. 1).

Operation

This system allows us to record at sites where there is a lot of bat activity. It also provides data that is almost immediately available (Fig. 2) and is less sensitive to extraneous ultrasound than the previous arrangement. When several such systems are deployed on the same night, comparable estimates of bat activity can be obtained with great efficiency, allowing habitat preferences to be determined.

There is some variability in operation of the bat detectors and signal converters. To minimize this, the volume control on the bat detector and the threshold dial on the signal converter were adjusted to the lowest possible settings that detected the sounds of fingers being rubbed together directly in front of the detector microphone.

Acknowledgments.--Financial support was provided by the Natural Environment Research Council and the University of Aberdeen. We are grateful for technical support from the electronics workshop at the University of Aberdeen.

Literature Cited

Hayes, J. P., and P. Hounihan. 1994. Field use of the Anabat II bat detector system to monitor bat activity. Bat Research News, 35:1-3.

Sedgeley, J., and C. O'Donnell. 1994. An automatic monitoring system for recording bat activity. Department of Conservation, Wellington, New Zealand.

Appendix 1. Suppliers and Approximate Costs.

Battery: #597-835 (12 V, 7 amp-h) from RS Components, P.O. Box 99, Corby, Northants, NN17 9RS, United Kingdom (Telephone: 01536-201201). Approximate cost is $34 (£21).

A/D Converter: #SBR 1260 from Skye Instruments, Ltd., Unit 32, Ddole Industrial estate, Llandrindod Wells, Powys, LD1 6DF, U. K. (Tel.: 01597-824811; e-mail: skyemail@skyeinstruments.com). Approximate cost is $157 (£97).

Datalogger and software: Tinytag Count Logger and OTLM Software (313-266 IP68 count). For orders less than 500, contact Alana Ecology, Ltd., Rock Cottage, Sarn, Newtown, Powys, SY16 4HH, U. K. (Tel: 01686-670643; e-mail: alana@dial.pipex.com). For orders over 500, contact Gemini Data Loggers, Ltd., Scientific House, Terminus Road, Chichester, West Sussex, PO19 2UJ, U. K. (Tel.: 01243-783210). Approximate cost is $211 (£130).

Bat Detector: Batbox 111 from Stag Electronics, 4 Esprit Court, New Road, Shoreham-by-sea, West Sussex, BN43 6RB, U. K. Approximate cost is $201 (£124).

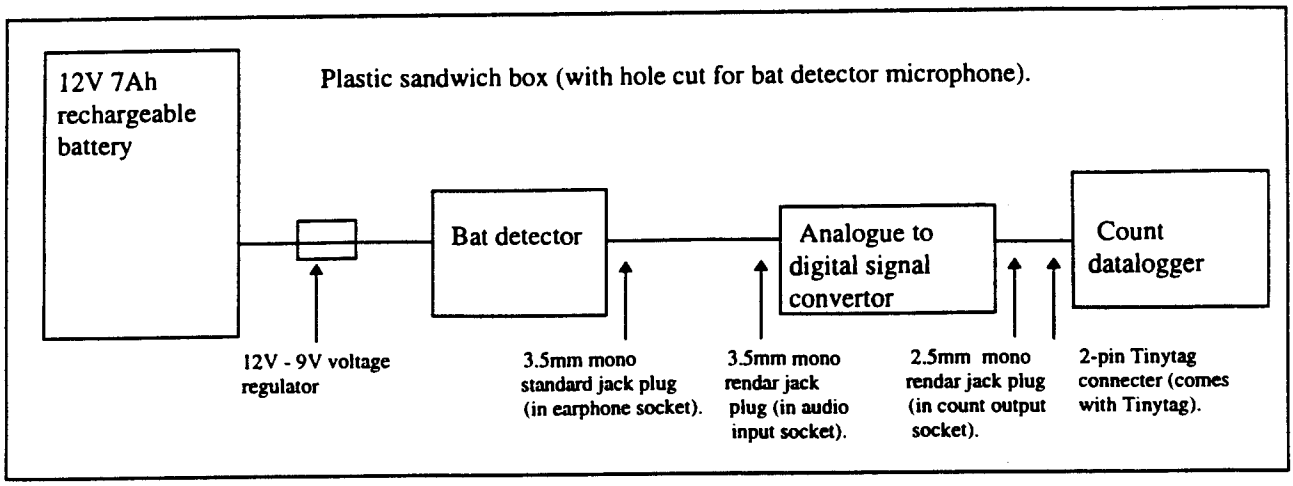


Figure 1. Schematic diagram of the system.

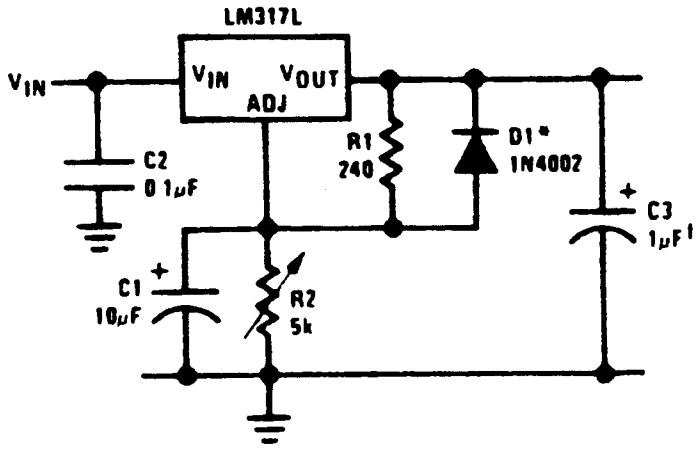


Figure 2. Adjustable voltage regulator with improved ripple rejection (12-V/9-V converter; National Semiconductor Corporation part LM 317).

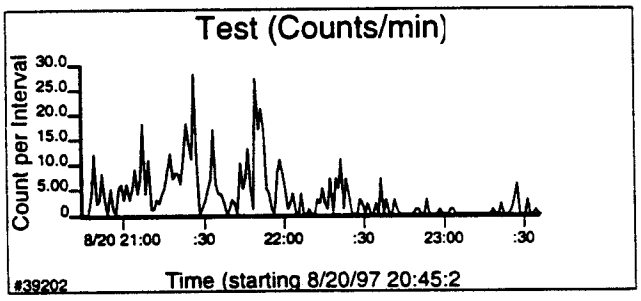


Figure 3. Graphical output of bat activity at dusk using OTLM software. The data can also be obtained in list format.

Blind Test for Ability to Discriminate Vocal Signatures of the Little Brown Bat *Myotis lucifugus* and the Indiana Bat *Myotis sodalis*

Michael J. O'Farrell
O'Farrell Biological Consulting, 2912 North Jones Boulevard, Las Vegas, NV 89108

Introduction

The Anabat II bat detector and associated analysis system has proved capable of generating vocal signatures resulting in reliable identification of many species of bat in the western United States (O'Farrell, 1997). Although Anabat has been used increasingly throughout the United States, there are no other published attempts to provide useful vocal signatures. The eastern half of the country contains several federally listed species of bats that require mandatory surveys for presence and management action for areas where they are found. Standard surveys away from roost sites rely upon established capture methods, primarily use of mist nets. However, surveys relying on capture methods have detected significantly fewer species compared with acoustic methods (Kalko et al., 1996; O'Farrell and Gannon, 1999).

Several governmental agencies have expressed interest in determining the capability of the Anabat system for conducting accurate surveys. Specifically, the Eastern Region of the U. S. Forest Service asked for a blind test for distinguishing the federally endangered Indiana bat (*Myotis sodalis*) from syntopic congeners. The purpose of this study was to test the ability of the Anabat system to obtain diagnostic vocal signatures, allowing accurate identification of free-flying species of *Myotis* in Indiana. Two syntopic species (*M. sodalis* and *M. lucifugus*) were examined.

Materials and Methods

Bats were collected nightly at Ray's Cave, Greene County, Indiana, from 4-6 October 1998. Three separate blind tests were conducted on 4, 5, and 7 October 1998. Bats collected on 6 October were held overnight due to heavy rains that night. Identification of collected bats was made by S. Johnson and S. Pruitt, and the number of each species was withheld from me. A conservative approach to field identification was taken and no *M. sodalis* or *M. lucifugus* with marginal external characters were selected for flight trials. A large, open, grassy slope was selected for hand-release flight trials, approximately 0.8 km south of the cave. Hand-released bats were monitored with an Anabat II detector connected to a zero-crossings analysis interface module (ZCAIM; both from Titley Electronics, Ballina, New South Wales, Australia) and linked to an IBM-compatible laptop computer. Eight Anabat systems, run by operators with widely varying experience, were placed about 40-50 m apart on the perimeter of a rough circle approximately 80 m in diameter. Test bats were released at the center of the circle. For each release, the bat was allowed to take flight on its own. An attempt was made to follow the bat with a spotlight so those operating recording equipment could follow it and be certain it was the source of detected vocalizations. Each released animal was assigned a number that was saved to the hard drive simultaneously with the echolocation calls. More than one bat of the same species was released in nine of 75 flight trials during Test 1 and one of 57 releases during Test 2. During Test 3, the last 24 of 53 released bats had a temporary, chemical light-emitting tag (Mini-light Sticks, Chemical Light, Inc., Wheeling, IL) affixed to the dorsal fur.

All files collected for each test were downloaded from each participating laptop and combined to form a master directory of files. I examined all calls collected and used the qualitative protocol of O'Farrell et al. (1999a) to make identifications. Having never seen *M. sodalis* or its calls, I was allowed access to six sequences of calls from a library of known calls taken from light-tagged individuals in Missouri (E. Britzke, pers. comm.) and from individuals exiting a known roost in Michigan (A. Kurta, pers. comm.). Constraints of time and weather did not permit me to collect a baseline of calls from free-flying bats in natural settings. I chose to be tested each of the three nights rather than using the first two nights for establishing a baseline.

Although three species of *Myotis* frequent the cave, *M. septentrionalis* had swarmed prior to our arrival and was represented only by stragglers. Consequently, there was a single *M. septentrionalis* released during Test 1 along with two *Pipistrellus subflavus*. The remaining tests contained only *M. sodalis* and *M. lucifugus*. Confidence intervals (95%) were derived from the expected probabilities of a binomial probability distribution (Zar, 1984). Thus, confidence intervals were established for the probability of correctly identifying *M. sodalis* and *M. lucifugus* acoustically.

Results and Discussion

Ability to identify correctly each species acoustically increased each night (66.7, 76.4, and 84.3%, respectively (Table 1). For *M. sodalis*, the qualitative method was no better than chance for the first test; however, tests 2 and 3 were better than chance. Although all *M. lucifugus* released during the third test

were identified correctly, sample size was too small to narrow the confidence intervals. The single *M. septentrionalis* and two *P. subflavus* were identified correctly.

Using the qualitative approach, species of *Myotis* may be grouped initially by approximate minimum frequency (O'Farrell et al., 1999a). Calls within a given grouping are then examined for differences in shape. *M. sodalis* and *M. lucifugus* have calls in the 40-kHz range (Fig. 1). To discriminate between these species, it is critical to obtain search calls in an uncluttered environment. Hand releases are one way to obtain vocalizations from known species but often yield calls indicative of roost-exit behavior or flight in high clutter (O'Farrell et al., 1999a). These types of calls tend to be fragmentary, including reduced maximum and minimum frequencies, duration, and time between calls, and they lack diagnostic features necessary for species identification. As an animal moves away from a roost or clutter, frequency range decreases and the characteristic shape develops. Multiple individuals flying in close proximity also produce calls consistent with a cluttered environment. Not only do calls lose their diagnostic structure when individuals are close to each other, minimum frequency for each individual will be offset by several kHz (O'Farrell et al., 1999a)

Commuting and search-phase calls are most useful in discriminating among species (O'Farrell et al., 1999a). Generally, these calls exhibit a reduced range in frequency (i.e., bandwidth of the dominant harmonic); maximum frequency shows the greatest reduction, and minimum frequency and slope reach the lowest values found in the repertoire of the species. I believe that search-phase calls were obtained from *M. sodalis* (Fig. 2a), but based on my observations of *M. lucifugus* elsewhere in North America, I do not believe that well-developed search phase calls of *M. lucifugus* were observed in this study. Search-phase calls of *M. lucifugus* are characteristically longer in duration than I observed in Indiana and terminate at or near 35 kHz. Extremes are not commonly obtained from hand-released animals. Further work with free-flying *M. sodalis* in different habitat settings may reveal further reduction in minimum frequency and change in slope. In general, commuting calls reach the extremes in duration and minimum frequency. However, the more developed calls obtained in this study were readily identifiable (Fig. 2). The single *M. septentrionalis* was correctly based on the structure of its call, which was consistent with that produced by other big-eared *Myotis* (O'Farrell, 1997), i.e. broad in frequency range and short in duration.

Although not exhaustive, the basic features I used for distinguishing *M. sodalis* and *M. lucifugus* are as follows. Minimum frequency of *M. sodalis* search phase calls tended to terminate at 40 kHz but would drift towards 50 kHz as conditions changed (e.g., pursuit, clutter), whereas those of *M. lucifugus* drifted to 35 kHz. There was a common tendency for slightly curvilinear calls of *M. sodalis* to contain a short, flat terminal portion, which was not seen in *M. lucifugus*. Calls of *M. sodalis* tended to be curvilinear in nature and flattest slopes usually approximated 120 octaves per second (OPS). Those of *M. lucifugus* tended to show a steep initial downward sweep, a discrete change in slope in the middle of the call with a slope below 60 OPS, and a terminal steep downward sweep similar to the shape of calls of *M. yumanensis* (figure 1 in O'Farrell et al., 1999a:14).

A qualitative approach to acoustic identification of bats (O'Farrell et al., 1999a) was criticized (Barclay, 1999) for lacking definition and repeatability. Barclay further stated that an objective method such as discriminant function analysis would provide each sequence of calls a probability that it belongs to a given species. Nevertheless, this study demonstrated the efficacy of the qualitative approach, which also provided the probability of correct identification. This, of course, does not negate the future usefulness of a quantitative approach. However, it is imperative to obtain a greater understanding of which structural features to measure and develop a standardized selection process of which calls to measure.

To evaluate properly the results of this study, it is necessary to put it in perspective. Aside from examining a few sequences of light-tagged individuals (E. Britzke, pers. comm.) and individuals exiting a roost (A. Kurta, pers. comm.), Test 1 was the first opportunity I had to observe and record *M. sodalis*. To date, I still have not observed and recorded *M. sodalis* in free flight under natural conditions. Based on five years experience in the southwestern United States, additional experience should yield a greater percentage of correct identifications. Ability to identify accurately this federally endangered species acoustically from other syntopic *Myotis* will provide á powerful management tool. Acoustic surveys usually yield a large number of calls from many individuals, and *M. sodalis* is sufficiently common within its range to expect a similar abundance of calls. The more sequences that can be obtained the better the chance of collecting at least one sequence containing the diagnostic characters necessary for correct identification. As an example for three species of *Myotis* from the southwestern United States, the percentage of non-usable calls obtained during inventories ranged from 19.8 to 34.2 (O'Farrell et al., 1999a). Such calls would be discounted during a normal survey, but attempted use of such calls in the present tests was for the purpose of the tests and would not have been done under actual survey conditions. A protocol that excludes these marginal or unusable calls presumably would eliminate much of the error observed in the present tests.

The summer ecology of *M. sodalis* is not well understood (Thomson, 1982). The large winter colonies disperse, forming smaller maternity groups using tree roosts (Callahan et al., 1997; Kurta et al., 1996).

During this period the species is difficult to capture, with foraging occurring in or under the forest canopy and not over water (LaVal et al., 1977; but see Kurta and Whitaker, 1998). Because calls near clutter are less usable and more likely to overlap with other syntopic species, caution must be exercised in collection and interpretation of data. It is important to avoid acoustic sampling close to clutter whenever possible, but when it is necessary, this should be noted to aid in subsequent interpretation of calls.

Acoustic surveys provide greater coverage of the landscape and detect a greater proportion of species present versus standard capture methods (Kalko et al., 1996; O'Farrell and Gannon, 1999). However, expert use of acoustic surveys requires training field personnel to use a standardized protocol to collect data, recognize poor-quality vocalizations, and modify collection procedures to maximize quantity and quality of recordings. Final determinations must be made by experienced workers because the quality and accuracy of acoustic surveys depend on experience.

Acknowledgments

I thank S. Schmauch for initiating arrangements with the U. S. Forest Service for conducting the test. S. Mighton was responsible for all logistic arrangements, and without him, this test would not have been possible. I appreciate the invaluable assistance and participation of many people including: S. Amelon, K. R. Ennis, S. Reitz, M. Spanel from various forests in the Eastern Region; E. Britzke and K. Murray, Southwest Missouri State University; A. Kurta and C. Unger, Eastern Michigan University; J. Veilleux, Indiana State University, R. Clawson, Missouri Department of Conservation; S. Pruitt, U. S. Fish and Wildlife Service; S. Johnson, Indiana Department of Natural Resources; and V. Brack and A. Henry, 3D/International Environmental Group. A. Kurta, S. Mighton, and J. Scheibe provided helpful comments on an earlier draft of the manuscript.

Literature Cited

Barclay, R. M. R. 1999. Bats are not birds: a cautionary note on using echolocation calls to identify bats. Journal of Mammalogy, 80:290-296.

Callahan, E. V., R. D. Drobney, and R. L. Clawson. 1997. Selection of summer roosting sites by Indiana bats (*Myotis sodalis*) in Missouri. Journal of Mammalogy, 78:818-825.

Kalko, E. K. V., C. O. Handley, Jr., and D. Handley. 1996. Organization, diversity, and long-term dynamics of a neotropical bat community. Pp. 503--553, in Long-term studies of vertebrate communities (M. Cody and J. Smallwood, eds.). Academic Press, New York.

Kurta, A. and J. O. Whitaker, Jr. 1998. Diet of the endangered Indian *bat (Myotis sodalis)* on the northern edge of its range. The American Midland Naturalist, 140:280-286.

Kurta, A., K. J. Williams, and R. Mies. 1996. Ecological, behavioural, and thermal observations of a peripheral population of Indiana bats (*Myotis sodalis*). Pp. 102-117, in Bats and forests symposium (R. M. R. Barclay and R. M. Brigham, eds.). British Columbia Ministry of Forests, Victoria, British Columbia, Canada.

LaVal, R. K., R. L. Clawson, M. L. LaVal, and W. Caire. 1977. Foraging behavior and nocturnal activity patterns of Missouri bats, with emphasis on the endangered species Myotis grisescens and Myotis sodalis. Journal of Mammalogy, 58:592-599.

O'Farrell, M. J. 1997. Use of echolocation calls for the identification of free-flying bats. Transactions of the Western Section of the Wildlife Society, 33:1-8.

O'Farrell, M. J., and W. L Gannon. 1999. A comparison of acoustic versus capture techniques for the inventory of bats. Journal of Mammalogy, 80: 24-30.

O'Farrell, M. J., B. W. Miller, and W. L. Gannon. 1999a. Qualitative identification of free-flying bats using the Anabat detector. Journal of Mammalogy, 80: 11-23.

O'Farrell, M. J., C. Corben, W. L. Gannon, and B. W. Miller. 1999b. Confronting the dogma: a reply. Journal of Mammalogy, 80: 297-302.

Thomson, C. E. Myotis sodalis. Mammalian Species, 163:1-5.

Zar, J. H. 1984. Biostatistical analysis. Second ed. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Table 1. Summary of correct acoustic identifications, total number of hand-releases, and binomial confidence intervals for three tests.

	Number Correct	Total Attemps	Confidence Interval
Test 1			
Myotis sodalis	27	48	0.41 < P < 0.71
Myotis lucifugus	20	24	0.63 < P < 0.95
Test 2			
Myotis sodalis	40	43	0.81 < P < 0.99
Myotis lucifugus	2	12	0.02 < P < 0.48
Test 3			
Myotis sodalis	39	47	0.69 < P < 0.92
Myotis lucifugus	4	4	0.40 < P < 1.0

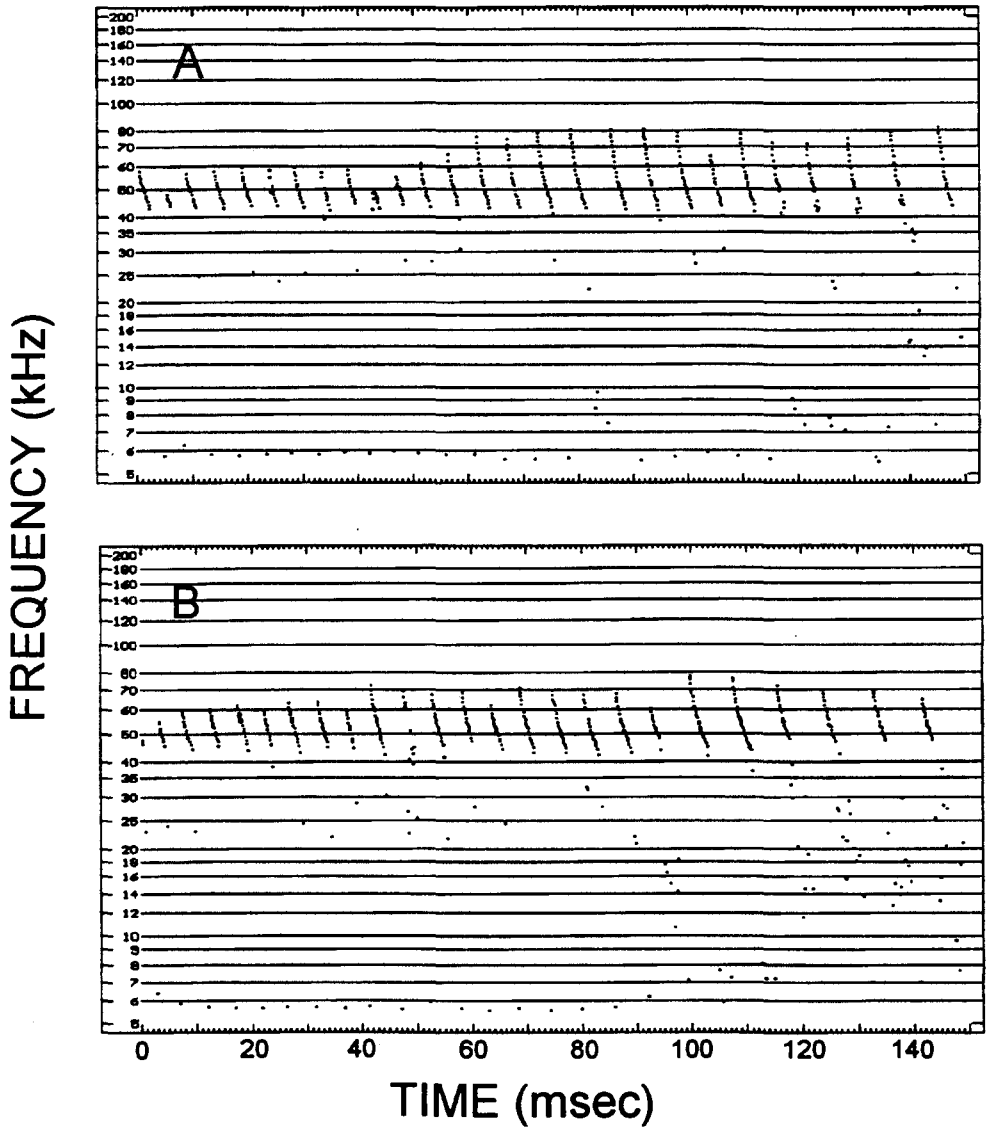


Figure 1. Frequency-time display , using Analook software, of vocal sequences produced by a) *Myotis sodalis* and b) *M. lucifugus*, illustrating calls indicative of initial hand release, exit from a roost, or near to clutter. Time between calls is compressed by the software to allow more calls per screen.

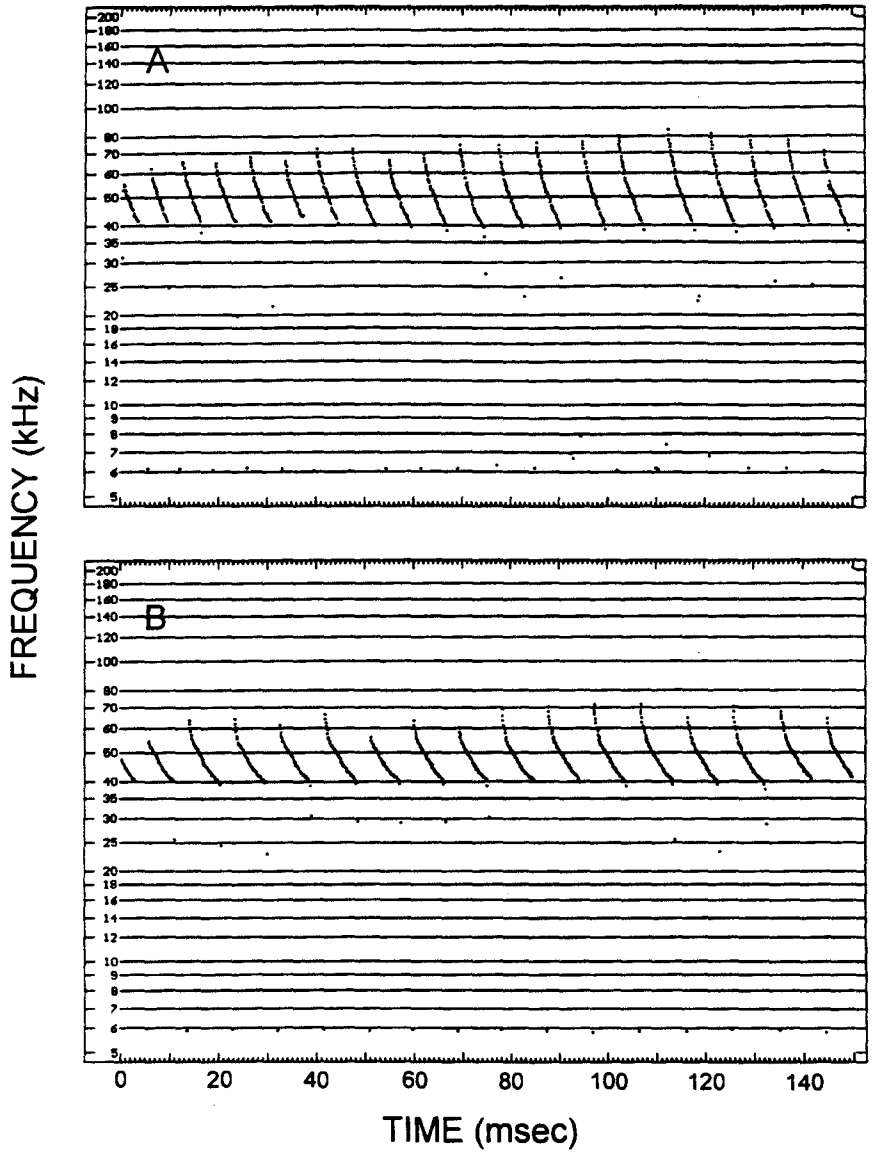


Figure 2. Frequency-time display, using Analook software, of vocal sequences produced by a) *Myotis sodalis* and b) *M. lucifugus*, illustrating search-phase calls away from clutter. Time between calls is compressed by the software to allow more calls per screen.

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 the Feature Editor, Allen Kurta.

Davis' Round-eared Bat *Tonatia evotis* Roosting in a Termitarium Occupied by Ants *Dolichoderus bispinosus* : a Form of Commensalism?

Aaron J. Baker[1], David F. Whitacre[1], Benjamin Gonzalez Cordova[2], and Clayton M. White[3]

[1]The Peregrine Fund, 566 W. Flying Hawk Lane, Boise, ID 83709,

[2]El Fondo Peregrino, Parque Nacional Tikal, Petén, Guatemala, and

[3]Department of Zoology, Brigham Young University, Provo, UT 84602

Present Address of AJB: c/o MUBFS, P.O. Box 409, Fort Portal, Uganda

A major function of a roost or nest site is safety from predators. Numerous vertebrates have well-developed methods for selecting roosts or nests that optimize invisibility, inaccessibility, and impregnability. Roosting or nesting in cavities often effectively maximizes these features more than occupying open sites. Many species of bat roost in caves, crevices, or cavities, capitalizing on reduced predator access and a more stable microclimate afforded by these localities. In addition to cavity nesting, many avian species increase their safety by nesting near and affecting a commensalistic relationship with aggressive insects. For example, dull-colored seedeaters (*Sporophila obscura*---Contino, 1968) and black-throated gerygones (*Gerygone palpebrosa*---Collias and Collias, 1984) consistently nest close to hymenopteran nests. Orange-fronted parakeets (*Aratinga canicularis*) and nearly 25% of all species of kingfishers (Alcedinidae) excavate a nest cavity inside active domes of social termites, which then seal off the bird nest from the rest of the mound (Hindwood, 1959).

On 5 May 1996, we captured 11 Davis' round-eared bats *Tonatia evotis* at a diurnal roost that was inside a hollow termitarium in Tikal National Park, Petén, Guatemala. The termite nest was ca. 2.5 m off the ground and attached to three different trees, forming a tripod-like situation. The nest was ca. 1 m tall by 0.5 m in diameter and had been hollowed out from below, creating a cylindrical cavity 0.25 m in diameter by 0.6 m tall. While capturing bats with a net held below the entrance hole, numerous ants *Dolichoderus bispinosus* began dropping from the nest and inflicting painful bites whenever they landed on our exposed skin. The ants were nesting in the abandoned termitarium, aggressively defending it against intruders, yet apparently tolerating the bats.

Dolichoderus bispinosus occurs from Mexico to Uruguay, southern Brazil, and northern Argentina; it often nests in abandoned termitaria and is considered very aggressive (Shattuck, 1994; J. Longino, pers. comm). T. evotis occupies lowland, semi-deciduous, tropical forests from Veracruz, Mexico, south to northern Honduras (Medellin and Arita, 1989). Though very little is known about the life history of this species, other members of the genus *Tonatia* feed primarily on insects, and at least four other species *T. silvicola, T. brasiliense, T. carrikeri,* and *T. bidens* occasionally roost in termite nests (Goodwin and Greenhall, 1961; Handley, 1976, McCarthy et al., 1992, 1993).

Why do these normally aggressive ants permit bats to roost inside their nest? We suggest two factors that may allow this relationship. First, the stimulus level required to trigger an aggressive response from ants may not be produced by the bats; and second, most bat activity (i.e., coming and going) is nocturnal, whereas most ant activity is diurnal. Davis' round-eared bats weigh ca. 20 g (Medellin and Arita, 1989), probably allowing them to gain purchase on the termitarium without causing much disturbance or significant damage to the fragile surface. The low-impact nature of the bats' activity, concentrated during periods of ant inertia, may explain the ants' tolerance toward the bats. If *T. evotis* is selecting roosts occupied by aggressive ants, thus providing additional protection from predators, we would expect to find this behavior widespread within the species, if not throughout the genus.

We gratefully acknowledge Robert Berry and The Peregrine Fund for financial support, Jack Longino for ant identification, and Lloyd F. Kiff for critical comments on the manuscript.

Baker, et al continued...

Baker, et al continued...

Literature Cited

Collias, N. E., and E. C. Collias. 1984. Nest building and bird behavior. Princeton University Press, Princeton, New Jersey.

Contino, F. 1968. Observations on the nesting of *Sporophila obscura* in association with wasps. Auk, 85:137-138.

Goodwin, G. G., and A. M. Greenhall. 1961. A review of the bats of Trinidad and Tobago. Bulletin of the American Museum of Natural History, 122:187-302.

Handley, C. O., Jr. 1976. Mammals of the Smithsonian Venezuelan project. Brigham Young University Science Bulletin, Biological Series, 20:1-89.

Hindwood, K. A. 1959. The nesting of birds in the nests of social insects. Emu, 59:1-36.

McCarthy, T. J., A. L. Garder, and C. O. Handley, Jr. 1992. *Tonatia carrikeri.* Mammlian Species, 407:1 -4.

McCarthy, T. J., W. B. Davis, J. E. Hill, J. K. Jones, Jr., and G. A. Cruz. 1993. Bat (Mammalia: Chiroptera) records, early collectors, and faunal lists for northern Central America. Annals of the Carnegie Museum, 62:191-228.

Medellin, R. A., & H. T. Arita. 1989.*Tonatia evotis* and *Tonatia silvicola*. Mammalian Species, 334:1 -5.

Shattuck, S. O. 1994. Taxonomic catalog of the ant subfamilies Aneuretinae and Dolichoderineae (Hymenoptera: Formicidae). Entomology, 112:1-241.

Official Regulations for Bat Shipping Containers

Revision to International Air Transport Association (IATA) Container Requirement 77 (CR77) for Bats of all Species

In January 1998, the American Zoo and Aquarium (AZA) Bat Taxon Advisory Group (TAG) took on the project of revising existing airline transport container requirements for bats. The concern was that current requirements did not accommodate the diversity in bat species (i.e. size, behavior, quantity, temperature, materials, etc.). Leader of the working group was Kathy Schwellenbach, who attended on behalf of Como Zoo, but is employed by an affiliate company of Northwest Airlines. Kathy consulted Gregg Pittelkow at Northwest Airlines Cargo, who is on the International Air Transport Association (IATA) Live Animals and Perishables Board (LAPB), and is considered an expert in the field, with regard to presenting proposed changes.

The working group's goal was to revise existing IATA container requirements for bats. This was needed to allow shippers freedom to customize container interiors to meet specific needs of bat species being shipped. The challenge was to remain in compliance with animal and plant/perishable transport requirements for health ministries and airlines worldwide. With assistance and feedback from various research, conservation, and zoo experts with extensive experience in shipping bats, Northwest Airlines and the working group revised CR77. The proposed changes were presented to the **International Air Transport Association - Live Animals and Perishables Board** in October 1998 and the revisions were subsequently approved.

The changes will be published in the October 1999 Live Animal Regulations (LAR) for all airlines that ship animals domestically and internationally. The rules may be used immediately, but airline personnel will not have the new manual/regulations until fall of 1999. If you have access to the Internet, you can view the new regulations online at www.riverbanks.org/battag

ANIMAL CONTAINER REQUIREMENT 77

The illustrations shown in this Container Requirement are examples only. Containers that conform to the principle of written guidelines for the species but look slightly different will still meet the IATA standards. Applicable to: Bats (all species, including flying fox). See USG Exceptions in Chapter 2.

References to "chapters" refers to the Airlines Manual of Regulations to be available to airline personnel in fall, 1999.

1. CONTAINER CONSTRUCTION (see Exception QF-01 in Chapter 3)

Materials

Wood, plywood, wire mesh, non-toxic plastic mesh and screening materials, non-toxic plastic, aluminum, weather-resistant thermoplastic (e.g., Plexiglas).

Principles of Design

The following principles of design must be met in addition to the General Container Requirements outlined at the beginning of this chapter. These species require very specialized handling and the guidelines in this Container Requirement are only the general principles that can be applied to their shipment. Their transport must only be undertaken by those shippers and carriers that can fulfill all the specialized needs of the species concerned. The outer container must be designed to withstand the rigors of transportation, to prevent exposing workers to any animal contact, and to prevent escape of the animal(s) during feeding and/or examination. The inner container should be designed for the safety and well-being of the animal(s), while providing protection from outside elements.

Dimensions

The container must be large enough for the bat(s) to move around freely, and to hang normally from roosting material. The dimensions will vary with the species, but they must allow the animal(s) to hang with their heads extended, to flap their wings sufficiently to dissipate heat, and to position themselves comfortably in groups or separately.

Outer Container

Frame: The frame must be sufficiently strong to withstand the rigors of transportation. It should be impact resistant, non-crushable, and weatherproof. Examples of appropriate outer containers include rigid plastic pet containers, hard plastic coolers, and solid wood frame containers securely fastened with screws. (See General Requirements outlined at the beginning of this chapter, and Ventilation Requirements, below.)

Sides: The sides must be made of wood, plywood, non-toxic plastic, aluminum, or weather-resistant thermoplastic (e.g., Plexiglas).

Floor: The floor must be solid and waterproof.

Roof: The roof must be made of water-resistant wood, plywood, non-toxic plastic, aluminum, or weather-resistant thermoplastic.

Doors: A hinged door (with adequate locks) at one side, or on top of the outer container, must be provided.

Ventilation: Wire mesh ventilation is required on three sides; preferably on all four sides. Mesh covered holes of a minimum 1.3 cm (1/2 in) over a minimum of 1/10th of the surface area are required.

Spacer Bars/Handles: Must be made to a depth of 2.5 cm (1 in), and must be present on three sides of the container as shown in the illustration.

Inner Container

Frame: The inner container must be designed to prevent it from moving about within the outer container during handling. The frame must be made of wood, plywood, wire, or rigid non-toxic plastic mesh or other rigid screening material, non-toxic plastic, aluminum, or weather-resistant thermoplastic. The interior may be subdivided for individual animals or groups of animals, provided feeding and/or examination for all animals in the container can be done safely.

Sides and Roof: The sides and roof must be made of wood, plywood, or screening material such as cloth and wire or non-toxic plastic mesh. Screening material should allow the animals comfortable hanging and roosting positions either together or individually. For species that normally roost in tight crevices, cloth or other safe and non-toxic material may be placed on the inside of the container, providing a padded roosting area for the bats. If necessary, insulation, such as cloth or other safe and non-toxic material may be used between the interior and exterior containers, providing it does not block any ventilation openings.

Floor: The floor may be solid, or wire mesh. Absorbent, non-toxic bedding (e.g., cloth, absorbent paper, newspaper or other similar material) must be provided.

Door: A securely fastened hinged door must be provided.

Ventilation: Unless constructed primarily of wire mesh, ventilation openings must be covered with wire or plastic mesh suitably sized to prevent any part of the animal from protruding out of the opening. All sharp edges must be covered with smooth material.

Feed and Water Containers: Shippers must make provisions and supply equipment for providing food and water when necessary. Water should be given only in the event of a delay, and only in accordance with the instructions accompanying the shipment. Instructions for supplying food and water to the animals (when necessary) must be provided by the shipper and attached to the outside of the container.

2. PREPARATIONS BEFORE DISPATCH(see Chapter 5) No special requirements

3. FEEDING - WATERING GUIDE (for emergency use only)

The need to provide food and/or water should not arise under normal conditions. The water delivery system provided in the container must only be used in the event of a delay and only according to the instructions provided by the shipper. Care must be taken to avoid spilling when using the water delivery system, as hypothermia and death can result if bats become wet. At no time should the outer or inner container be opened to provide food and/or water.

Feeding requirements vary by species. Many bats will not eat dead food items (e.g., dead insects, lizards, or fish) that they themselves have not caught. Fruit-eating bats may also be very fastidious about the quality of the fruit they eat. Additionally, material such as blood, fruit, live or dead insects, and other animals may not be admissible according to agricultural or health ministry regulations.

Many species of bats become torpid (enter deep sleep) during transport and require little or no food or water, so long as they are protected from environmental extremes of heat, cold, and humidity. Rapid transit (less than 24 hours duration) of bats from shipper to consignee is of the utmost importance.

A plentiful food supply (subject to import restrictions at destination) may be placed in the container at the start of the journey for fruit-eating bags. If provided, these materials need to be accessible for removal and destruction by inspectors at the port of entry.

Insectivorous bats require a live insect diet. Due to restrictions on importation of exotic insects, such food generally cannot be supplied.

Vampire bats require fresh mammalian or avian blood. These materials require special permits or other documents for import and must be appropriately contained, therefore they cannot be handled as animal food items.

4. GENERAL CARE AND LOADING (see Chapters 5 and 10)

Most species of bats will huddle together to maintain body heat and for security. If too warm, they will space themselves out and possibly fan themselves, given adequate room in the container. Extremes in temperature can be harmful to bats. Refer to shipper's instructions for acceptable minimum and maximum temperatures, which vary by species. For all species of bats, ambient temperatures should not exceed 29.4 C° (85° F). Because of the limitations for supplying food and water to bats, these animals should not be accepted for transportation if delays extending the itinerary more than 24 hours can be anticipated.

The importer is responsible for supplying experienced personnel at the port of entry to open containers for agriculture and wildlife inspection, and for removing any material that is deemed inadmissible (fruit, blood, fecal material). For unaccompanied shipments, the importer should have expert personnel available to deal with animal emergencies at any intermediate transit points. Cargo personnel must not attempt to make contact with the bats for any reason.

Warning:

Bats can inflict severe bites, and like any wild animal, may transmit rabies and other diseases. This may have serious consequences to humans. Therefore, bat containers must never be opened except by experienced handlers. Public health authorities recommend that persons handling bats be vaccinated against rabies in advance.

The Second Irish Bat Conference

June 4 - 6, 1999

Burren College of Art, Newtown Castle

Ballyvaughan, Co. Clare, Ireland

Following are the abstracts of presentations at the conference in alphabetical order by first author.

Bats of Northern Ireland: Past, Present and Future

Pamela Allen, Honorary Records Secretary, Northern Ireland Bat Group
24 Malone Park, Belfast BT9 6AJ, Northern Ireland

The Northern Ireland Bat Group was formed in 1985. From the onset, it has had the support of the Ulster Museum, which still lends it a permanent address, and of the relevant branch of the Department of the Environment (Northern Ireland), currently known as the Environment and Heritage Service (EHS). Suitably qualified members of the Bat Group give considerable assistance to the latter by making visits on EHS's behalf to concerned members of the public who have bat related problems.

Notes about such visits are made by the visitor on special index cards which are then stored in Bat Group files. The details are entered on the Bat Group computer from which they are copied to CEDaR, Northern Ireland's Centre for Environmental Data and Recording, for safe keeping. Control of access to the records remains with the Bat Group and, in the interests of the bats and their associated people, names and addresses of roost sites are treated as confidential. The majority of these records have been collected by Bat Group members, but some are also contributed by Environment and Heritage staff and by other interested naturalists. There are now nearly 2,500 records of bats relating to over 1,700 sites. This comprises what is possibly the most complete documentation of bat populations of any area of the United Kingdom which is gathered together in a single data bank.

And what is the value of all this documentation? It is, quite simpley, essential if appropriate conservation measures are to be put in place and suitably monitored. The distribution maps compiled by N.I. Bat Group and based solely on bats identified in the hand have been submitted to the Irish Naturalists' Journal for publication and will be presented at the Irish Bat Conference, 1999. For comparison, maps have also been compiled showing distribution as indicated by publications prior to the 1980s.

* * * * *

The Shape of Echolocation Calls and Their Functionality

Arjan Boonman, Stuart Parsons and Gareth Jones
University of Bristol, School of Biological Sciences, Woodland Road
BS8 1UG Bristol, UK

Bat species which hunt in dense environments tend to use short-duration, broadband echolocation calls, whereas bat species which hunt in open environments use long-duration, narrow band echolocation calls, occupying the opposite ends of the range of echolocation call types. Duration and bandwidth together determine the ability of a bat to judge target range. Radar literature, however, suggests that signal curvature could be important in reducing ranging errors due to the bat's own flight speed. By using both ambiguity diagrams and a filter bank model, we investigated all possible ranging errors caused by a wide range of call types and curvature. We found that for most call types, an optimal curvature can be created to minimize ranging errors at all speeds. We hypothesized that all bat species would use this optimum curvature. Our analysis revealed that fast flying bat species use optimum curvature or a stronger curvature than predicted. Slow flying bat species use signals that are less curved than predicted, which can be explained by the different trade offs with which slow- and fast-flying bats are confronted. Flight speed and curvature together influence a bat's image and should be considered as ecological variables determining a bat species' niche.

Social Organisation and Breeding Strategies of the Captive Rodrigues Fruit Bat *Pteropus rodricensis* at Dublin Zoo

Claire Cave and Tom Hayden, Zoology Department, NUI - Dublin, Belfield, Dublin 4, Ireland

The colony of endangered Rodrigues fruit bat, *Pteropus rodricensis*, at Dublin Zoo is part of a captive population management program. The captive population remains an important safeguard against the continued threat of extinction and may provide a valuable reservoir of genetic variability. This study aims to examine the social organization, breeding strategy and activity cycle of the species in captivity. Determining the stability, or lack thereof, of the daily activity cycle may reflect on the animals' annual cycle which would affect such occurrences as the reproductive cycle. Knowledge of the social structure is essential in a captive population management program. This allows the population to be manipulated so that as many individuals as possible contribute their genes to the next generation. The underlying theme of this study is that the feeding behavior and roosting needs are an integral part of social organization and breeding strategy. Territory holding males are presumed to be the predominant sires in the colony. Two types of territories, feeding and roosting are maintained by dominant males.

* * * * *

The Dromore Bat Reserve: Background and Current Situation

Jimmy Dunne[1], Rebecca Cogan[2], Kate McAney[3], Ciára O'Mahony, Elizabeth Byrnes[4] and Martin Byrnes[4]
[1]Wildlife Committee, Kilkeny, [2]Zoology Department, N.U.I., Co.Galway,
[3]Vincent Wildlife Trust, Headford, Co. Galway, & [4]Galway Bat Group, Oranmore, Co. Galway, Ireland

The Lesser Horseshoe Bat *Rhinolophus hipposideros* is both the smallest of the European horseshoe bats and the most northerly. In Ireland it is found in just six regions along the western Atlantic seaboard where it is estimated the population is in the region of 12,000 animals. It also occurs in west and southwest Britain, in France, Belgium, S. Netherlands, Luxembourg, Germany, S. Poland, the Czech Republic, Slovakia and the Ukraine. However, it has become extinct in northern parts of its range within the last fifty years, is threatened with extinction in other areas and is classified as endangered throughout its existing range. One of the primary measures for protecting this species is the specific protection of its summer and winter roosts.

This paper concentrates on one Irish roost located in County Clare which was discovered in the late seventies and has been monitored regularly since 1983. During 1993/94, the building housing the bats became available for purchase. A number of agencies were requested to purchase it to conserve the colony, but the necessary financial resources were not available. The Heritage Council is a statutory independent body which advises the Minister for Arts, Heritage, Gaeltacht and the Islands on policies and priorities in relation to Ireland's heritage. One of its statutory functions is to promote knowledge of, interest in, and pride in the national heritage. Having examined the situation, the Heritage Council purchased the building. In this paper we describe the state of the budding and the repairs which have been carried out. The number of bats using the building have increased steadily from approximately 100 in the mid eighties to over four hundred in 1998. Studies on the foraging behavior during the summer of 1998 revealed that the bats never commute across open pasture. Instead they utilize linear features such as hedgerows, tree lines and stone walls. Where there is a gap between linear features, they tend to use overlying trees and scrub. The roost is adjacent to Dromore Wood, which is a state nature reserve. It has been declared a Special Area of Conservation under the E.U. Habitats Directive. Such designated areas require management plans. It is proposed that the management plan for Dromore should include the retention of linear features such as stone walls and hedgerows.

Different Metabolic Responses to Low Ambient Temperatures in Two Species of Neotropical Fruit Bats, *Artibeus jamaicensis* and *Phyllostomus discolor.*

G. Roy Horst, State University of New Yourk-Potsdam, Potsdam, NY 13676 and
Gary G. Kwiecinski, University of Scranton, Scranton, PA. 18510

Conventional wisdom is that competitive exclusion will occur when two very similar species compete for the same food resources and share the same habitat and behavior patterns. Two species, *Artibeus jamaicensis* and *Phyllostomus discolor* are neotropical frugivores of very similar size (30 to 40 grams), are sympatric and compete for the same food resources in many parts of their ranges. We suspected subtle physiological or behavioral differences which may not be evident when the animals are not challenged, but which during times of stress may bestow a competitive advantage on one species.

Our observations on captive animals are that *A. jamaicensis* is very aggressive when feeding and will not tolerate *P. discolor* at the same feeding site. When food is limited this may bestow a competitive advantage upon *A. jamaicensis*. How can *P. discolor* remain competitive under these conditions?

At normal tropical temperatures the thermoneutral zones and resting metabolic rates are essentially identical for these two species. As ambient temperatures fall below the thermal neutral zone, metabolic rates increase for a short period in both species as the animals attempt to remain homeothermic. After this initial response, P. discolor abandon homeothermy and allow their body temperature to fall approximately parallel with ambient temperature to body temperatures(Tb) as low as 26°. *Phyllostomus discolor* has survived Tb of 30° for as long as 8 hours. *A. jamaicensis* under the same conditions struggle heroically to maintain homeothermy even at ambient temperature(Ta) of 10°, metabolic rates climb ever higher and eventually drop precipitously, and unless Ta is quickly restored to the thermoneutral zone, the animals succumb. It appears that the ability of *P. discolor* to become moderately heterothermic provides a survival advantage on those rare occasions when Ta may drop below the thermoneutral zone for sustained periods.

We have noticed a similar response to limited food resources. When food is limited *A. jamaicensis* continue to search aggressively for food, exhausting their energy reserves; *P. discolor* tends to abandon foraging much sooner, become slightly heterothermic and conserve available energy reserves until conditions improve. *P. discolor* appears to have an advantage when weather conditions (hurricanes) may prevent foraging for extended periods. These subtle adaptations in metabolism and behavior may, over the extended time frame of natural cycles, cancel any short term competitive advantages, allowing for the continuing sympatry of these two species .

* * * * *

Environmental Impact Assessments - Don't Forget the Bats!

Brian Keeley, Dublin Bat Conservation, Merryfalls Cottage,
Harristown Lane, St. Margaret's, Co. Dublin, Ireland

Environmental Impact Assessment - "The process of examining the environmental effects of development- from consideration of environmental aspects at design stage, through to preparation of an Environmental Impact Statement, evaluation of the EIS by a competent authority and the subsequent decision as to whether the development should be permitted to proceed, also encompassing public response to that decision." EPA description, 1995. EIA is a legal requirement for developments of a designated size or of a particular nature, These will be discussed further. The ways in which such developments affect bats will also be discussed. Topics to be addressed within an EIA are:

a. Human Beings b. Flora c. Fauna d. Soils etc.

A survey of the flora and fauna within a catchment area to be affected by development is undertaken and the likely effects of changes to the site are assessed. Recommendations to limit negative effects are drawn up by the ecological consultants and a report is compiled of the findings and mitigation measures. "The data necessary to identify and assess the effectswhich that development is likely to have on the environment" (S.I. No. 349, Part V, Art 25, Second Schedule, (2)(b))

Bat surveys are very often poorly addressed or entirely absent from such studies. This is in spite the fact that bats constitute one quarter of our land mammals and are all protected by Irish and EU law. Analysis of the resident bat fauna and the potential effects on it is a specialized field and this has possibly

led to its exclusion from standard assessment work. In comparing the distribution maps for bats in Ireland with the results from any bat detector survey, it becomes immediately apparent that our knowledge of the actual situation for bat distribution is very much incomplete. This is further exacerbated by our lack of any systematic database for bats. To assess the effects of landscape or land use change on resident bats, it is important to know the whereabouts of:

(i) summer roosting sites, including breeding roosts
(ii) winter hibernation site
(iii) spring/autumn transitional roosts
(iv) autumn mating roosts
(v) feeding perches / night roosts
(vi) feeding areas
(vii) interconnecting vegetation (or other) corridors

This information can be gathered through bat detector work, review of any former roosts and careful investigation of the area most affected by the proposed development. Where trees are shown to be roosts, work on removal of such trees should only be carried out when bats are not breeding or hibernating. Similarly, buildings containing bats must be treated in a careful manner particular to the type of roost. Other bat roost types will provide different challenges but all will be governed by the requirement to avoid unnecessary disturbance to the bats.

* * * * *

Bat Work in Britain – An Irish Perspective

Conor Kelleher
"Northants", Spring Lane, Carrigaguila, Ballinagree, Macroom, Co. Cork, Ireland

Working with the Northant's Bat Group, in Britain, for the last 11 years, the importance of amateur bat work was always apparent. The NBG was one of the first bat groups in existence and had an influence on the others which were to follow. While involved in several, long-term studies on Daubenton's bats, the input of bat workers, of a non-scientific background, showed in the findings and discoveries made by the group. Monitoring weight, sizes, parasite load, breeding, aging and dispersal of bats gave rise to interesting data on behavior, extreme weight changes etc. and the discovery of the 'Chin spot' increased our knowledge of growth and maturity. Further studies were conducted on other species e.g. pipistrelle roost counts and direct conservation methods were employed such as rescuing trapped bats. Hibernation surveys were carried out on a twice yearly basis and bat box schemes were an on-going project in several locations.

Advertising and promotional work involved attending fairs, shows etc. While bat walks and talks were always popular. No opportunity was missed to promote the plight of bats and our local image was heightened by having a unique, eye-catching vehicle.

There is much that can be of use to the growing field of amateur Irish bat work from lessons learned in Britain. Also needed are further detector workshops. Mist net training is also essential to increase our knowledge of the Irish bat fauna. We can learn from our neighbors' past mistakes and so avoid re-inventing the wheel, and British bat workers are only too keen to help! Our task as bat workers is not an easy one; the Irish attitude to wildlife, as a whole, leaves much to be desired. Bat workers are a small, but vocal, minority and it is up to us to help change the widespread apathy which we often encounter. Whether this non-caring attitude is within the general public, judiciary or government, it is we who must exert pressure for change. The present destruction of both the countryside and historic buildings proves that the law, as it stands, is powerless against ignorance, greed and so called progress.

As we encourage new recruits, the Irish bat group network will increase nationwide and so too will our ideas and concerns. It is only to be expected that public opinion, politics and the law will surely follow.

* * * * *

Bats - The Law and Site Designations

Ferdia Marnell, Designations Unit, National Parks and Wildlife,
Dúchas, The Heritage Service, 7 Ely Place, Dublin 2, Ireland

All eight species of bats found in Ireland are protected under the Wildlife Act (1976) and the most important known bat sites are included in proposed NHAS. Approximately 90 pNHAs contain one or more

bat roosts. These sites will be fully protected when the Amendments to the Wildlife Act are passed. The Lesser horseshoe bat is listed under Annex 11 of the E.U. Habitats Directive and consequently the Irish government is obliged to designate SACs for its protection. The selection of these sites has been a collaborative process involving the NPW research staff, NPW regional staff and The Vincent Wildlife Trust. All the best known summer and winter roosts will be included. The designation process will be discussed in detail and the need for hard scientific data to inform the site selection and delimitation processes will be emphasized.

* * * * *

Now We Are Ten! (Years Old)

Donna Mullen, Bat Conservation Group, Dublin Merryfalls Cottage,
Harristown Lane, St. Margaret's. Co. Dublin, Ireland

The Dublin Bat Group was formed in 1989 by Brian Keeley, Regina Mc Devitt, Russell Poole, Greg 0 Corry Crowe and Colette Dooley. Brian has remained as the driving force behind the group with the help of Therese Molyneux (newsletter editor), Shevaun McNally (membership secretary), Joe Dowling (bat bridge building), Susan Flynn (bat rehabilitation), Angela Mason (letter writer/leaflet distributor), Aengus Guckian and Mary Faulkner (legal experts), Phil O'Mahony (school education) and myself (telephone receptionist!). Past activities undertaken by the group include creating one travelling exhibition in conjunction with ENFO and two permanent exhibits in County Dublin, conducting nine all night detector surveys in woods around the country and several winter surveys. We continually monitor the bat life in Dublin's largest park, the Phoenix Park. We were responsible for bringing Irish bats to the attention of The Vincent Wildlife Trust who funded the post of Bat Conservation Officer (in partnership with the National Parks and Wildlife) during the years 1991-1994. We continue to publicize bats by giving about 10 radio and television appearances per year. We are also working on a project with the Gwynedd Bat Group to promote batty holidays. Brian has recently been appointed Conservation Officer for the Finglas and Cabra areas. This year the Heritage Council commissioned us to conduct a Bats in Houses Survey. As for other sources of funding, we receive £300 annually from the National Parks and Wildlife and a small amount from membership fees. On this basis we recently declared ourselves a charity! My hopes for the next ten years? Better funding, Stronger legislation and a Database.

* * * * *

Horseshoes, Leisler's and Barbastelles - The Work Goes On

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

The lesser horseshoe bat population in Ireland is estimated to be in the region of 12,000 animals. This figure is based on survey work conducted during the years 1985- 1988. However, a number of the larger sites discovered during that survey have since been lost and recent survey work suggests that the species is being forced to leave its more traditional summer roosting sites (usually large, unused slated buildings) to take up residence in smaller, corrugated-roofed buildings that are prone to disturbance. The main reasons for this displacement are two-fold: the deterioration of the buildings so that they are no longer suitable for breeding purposes, or their complete renovation, which leads to the exclusion of the bats. Some of the smaller sites are currently under threat from road widening schemes. The Vincent Wildlife Trust, a British registered charity, has been involved in lesser horseshoe conservation in Ireland since 1991, initially carrying out repair work to secure, maintain and improve summer and winter roosts. More recently, The Trust has established reserves by purchasing or leasing old buildings which were becoming increasingly unsuitable for the colonies of bats using them. The improvement work being carried out at the reserves involves replacing roofs, windows and doors, rebuilding walls and erecting ceilings. In one case a building, hitherto unsuitable for lesser horseshoe bats, was modified in early spring to provide an alternative summer site for a nearby colony roosting in sub-optimal conditions. By mid-summer half of the colony had relocated to the new site. The Trust presently has four reserves in Ireland and is negotiating to create three

more. Approximately 1,000 bats have benefited or will do so from the measures taken to date.

In addition to lesser horseshoe conservation, The Trust has assisted in the modification of a roof used by a large nursery colony of Leisler's bats. This was a joint project with the National Parks and Wildlife in an attempt to alleviate the problems of noise, smell and staining created by the colony, numbering over 200. A roof space within a roof space was constructed to contain the bats and facilitate the collection of droppings. The colony quickly adapted to their new roosting site, although modifications are required to improve it further.

In March 1999 The Trust extended its Tree Bat Scheme to Ireland when 162 Schwegler bat boxes were erected in three mixed woodlands. The aim of this study is to confirm the presence of the barbastelle bat (Barbastellus barbastellus) which was recorded in July 1997 at one location in Ireland on time expansion detectors by Professor Ingermar Ahlen and Dr. Hans Baggoe. Detector and mist net studies conducted in the intervening period have failed to find this species.

* * * * *

The Role of the Conservation Ranger in Bat Monitoring and Public Relations

Congella McGuire, Dúchas The Heritage Service, Burren National Park,
2 Riverview, Corofin, Co.Clare, Ireland

To date, in Ireland the emphasis has been on systematic survey work to locate bat roosts. We are now at the stage where a monitoring program is a high priority for bat conservation. Monitoring is an integral part of bat conservation or action plans for bats. Monitoring is a tool to identify bat population changes and relate this to environmental changes. Monitoring is required to meet our obligation under the international treaties to which Ireland has signed up for in recent years.

The number and distribution of individual bat species and their habitat needs to be assessed. The data then has to be collected and collated for conservation decisions and action. At present there is no database to store bat records. A central co-ordination and recording system urgently requires to be put in place. Ireland has much to learn from the British National Monitoring Program, which is up and running since 1996.

There is a long history of bat recording in Co Clare, particularly for lesser horseshoe bats. There are nine hibernation sites for lesser horseshoe bats of international importance (holding 50 to 300 bats each) in seven Proposed candidate Special Areas of Conservation in Co Clare. And there are twelve internationally important maternity roosts for lesser horseshoe bats. These larger lesser horseshoe sites are counted every year, along with other smaller sites and sites designated as Natural Heritage Areas for bats.

The vast majority of bat roosts are in private ownership. The role of the Conservation Ranger in public relations relates mainly to four different groups of people. (1) The householder with bats in the attic of the dwelling house; (2) The farmer with property designated as an Natural Heritage Area or proposed Candidate Special Area of Conservation for bats and all farmers in the Rural Environmental Protection Scheme; (3) Local Authorities, in particular the County Councils; (4) and last but not least, the general public and the myths that still exist about bats,

* * * * *

Lesser Horseshoe Bat Summer Roost Survey, Co. Clare

Ciara O'Mahony, The Vincent Wildlife Trust, Druminacoosaun,
Peterswell, Co. Galway, Ireland

A survey of areas of south Clare for lesser horseshoe bat *Rhinolophus hipposideros* roosts was instigated in the summer of 1998 and continues this year (1999). Initially areas around known winter hibernation sites were searched but subsequently any areas with old records for the bats and/or suitable habitat were searched. In 1998 all unoccupied buildings/structures and any previously unknown caves in an area of 170km2 in south Clare were checked for the presence of lesser horseshoes, where permission could be obtained from landowners to do so. Sites found to have lesser horseshoe bats present were then monitored to establish population size and to attempt to categorize roost use. Two new hibernacula, three new maternity roosts, two further possible maternity roosts and sixteen other roosts of lesser horseshoe bats

were located. Also, two previously known roosts were re-checked and twenty six further buildings were found to have droppings identified as those of lesser horseshoe bats. In 1999, the search area has been extended but fewer lesser horseshoe roosts are being found. To date (May, 1999), one new cave/souterrain roost, likely to be a hibernaculum, and two buildings with small numbers of the bats have been found. A limited number of roosts of other bat species have been discovered. In the case of three internationally important hibernacula, the maximum numbers of lesser horseshoe bats in "summer" roosts within 2km of the hibenaculum closely balance the maximum numbers in the hibernating population. In the case of a fourth internationally important hibernaculum, no roost of significant size has been found nearby. Many of the larger roosts are due for renovation in the near future, one of which is the second largest maternity site found in the search area. The Vincent Wildlife Trust has leased a nearby building, used as a satellite roost, and is conserving the building as a lesser horseshoe bat refuge. Negotiations are ongoing to purchase the largest maternity site found during this survey.

* * * * *

Influences on Activity and Distribution of Bats in the Greater Dublin Area

Noinin Reynolds and Tom Hayden, Zoology Department, NUI - Dublin, Belfield, Dublin , Ireland

The region for this study is Dublin and its hinterland, which comprises an approximate area of four hundred square kilometers. One third of the human population of Ireland lives in this area and numbers are increasing every day. Due to this increase in population, development of the city has spread past the county borders into nearby countryside. Although the diversity of bats is probably greater than the current data suggests, bat fauna is recognized to be under threat due to increased building activity within the city and expanding urbanization of the hinterland.

The aims of the study are:

1) to survey bat numbers and species for Dublin and its hinterland
2) to record habitat preferences
3) to examine the seasonal variation in the activity of bats
4) to determine if the number of species present affect the total bat number (do they exclude each other?)

This survey will enable us to determine where the bats are foraging and will highlight the fundamental habitat requirements of bats. Analysis of different bat activities throughout the year should give an insight into the different behavior that a bat needs to exhibit to survive variable weather conditions.

* * * * *

Niche Differentiation Among Bats in Woodland

Niamh Roche and Paul Elliott,
339 North Circular Road, Phibsborough, Dublin 7, Ireland

Bat activity in four woodlands in Central England in 1995 and one woodland in 1996 was estimated using heterodyne bat detectors. Vegetation cover abundance and density in distinct microhabitats, such as glades, rides, clear-cuts, were assessed. Weather variables from a station in Coventry and also from within the study woodlands were used in analyses. Invertebrate abundance was estimated using several methods (suction, sweep and light traps). Heterodyne detectors can be used in a limited way to distinguish species. *Pipistrellus pipistrellus* (both phonic types combined) and *Myotis* spp. accounted for most bat passes recorded. Activity was significantly correlated with weather variables, although the significantly regressed variables varied between species groups and between woodlands. Pipistrelle activity was often correlated with temperature, while *Myotis* spp. activity was more often correlated with relative humidity or barometric pressure. This may reflect the different feeding niches occupied by species groups. The positive association between pipistrelle activity and temperature reflects these species' reliance on small swarming insects. The weather conditions affecting bat activity differed from one woodland to another depending on woodland structure, situation and aspect. The use of microhabitats was also studied in detail. Pipistrelles were found to avoid dense vegetation from mid to late season but used this microhabitat in proportion to availability early in 1995, before leaf development restricted flight. Both the pipistrelles and *Myotis* spp.

avoided edges in 1995 (a hot dry summer) but pipistrelles used edges in proportion to their availability in 1996 (a cooler, wetter season). The study shows that use of woodlands by bats, may vary from year to year and season to season depending on weather conditions. Habitat use and niche differentiation studies should take into account the possibility that weather and habitat structure could dramatically affect bat activity.

* * * * *

Current Data on Nathusius' Pipistrelle in the British Isles – What Does it All Mean?

Jon Russ, School of Biology & Biochemistry, The Queen's University of Belfast, Lisburn Road, Belfast. BT9 7BL Northern Ireland

Nathusius' pipistrelle, *Pipistrellus nathusii*, has only recently been found breeding within the British Isles, where it was previously thought to be a winter migrant. Since the first record in 1940, observations have been infrequent and usually concern 'grounded' bats, especially in coastal areas and offshore oil platforms. In continental Europe, the species migrates in a south-westerly direction during autumn and winter and returns to traditional breeding areas in Eastern Europe during the late spring. Males establish mating territories along the migration routes and some remain in the areas along the route, where they mate throughout the year.

Here, the records resulting from a recent questionnaire are presented, together with information on breeding colonies and recent bat detector records from the British Isles. These records indicate that numbers of Nathusius' pipistrelle are increasing. However, this may reflect the increase in the number of active bat workers and the advances in the technology used to study them. Records of grounded bats peak during early spring and late autumn, which together with records of individuals from North Sea oil platforms, suggests that Nathusius' pipistrelle is migratory during this part of its range. Conversely, records obtained during the summer and winter months suggest that there is a resident population within the British Isles. It is possible that the British Isles is a transitional area where migrating populations mix with resident populations. The implications of this are discussed in a European context.

Our knowledge of the ecology of this bat in this most westerly extreme of its range is less than complete and further research is urgently needed in order to assess the status of this species. Some priority areas are outlined.

* * * * *

Seasonal Changes in the Foraging Behaviour of Leisler's Bats *Nyctalus leisleri* in Ireland as Revealed by Radio-telemetry

Caroline Shiel, Edenville, Kinlough, Co. Leitrim, Ireland

This study was carried out as part of my Ph.D. research on Leisler's bat. It was the first time that bats were radio-tracked in Ireland. Radio-telemetry was conducted throughout the 1994 and 1995 season at two large nursery roosts in south Co. Wexford - Baldwinstown and Rathangan. The study area is almost all flat and less than 30m asl. Pasture predominates in the district. Three types of radio-transmitter were purchased from Holohil Systems Ltd in Canada: BD-26 (standard model 0.65g), LB-2 (light-weight 0.50g) and LB-2T (temperature-sensitive 0.659). These were tuned between 151.000 and 151.150 MHz with as little overlap in frequency as possible. Other equipment used during tracking included a Mariner 57 receiver, a directional three-element yagi aerial and a non-directional whip aerial, all purchased from Mariner Radar, Suffolk, England.

A total of 35 bats were tracked (30 from Baldwinstown & 5 from Rathangan). These were tracked on a total of 122 overnights and 11 half-nights. Individual bats were tracked for 1-10 nights depending on transmitter performance.

The season was divided into four sections:

1. Preparturition (all bats tagged were adult females)
2. Lactation (all bats tagged were nursing females)
3. Postlaction (all bats tagged were adult females)
4. Juveniles (all bats tagged were juveniles - both male and female)

When analyzing the results from radio-tracking three parameters were considered in detail:

1. Number of flights
2. Percentage of the night spent flying
3. Maximum straight line distance from roost to furthest foraging site.

Seasonal trends were apparent for all three parameters.

Bats were recorded foraging over a large range of habitat types but generally the most important were lights, pasture, pasture/drain and canal. Aerial telemetry was employed to study the dispersal pattern of juvenile bats at the end of the 1995 season. A Cessna 172 aircraft was used to systematically search for signals from dispersed bats. Three juveniles were located in this manner.

I would like to thank the Heritage Council who funded radio-tracking in the 1995 season.

* * * * *

The Rise and Fall of a Late Holocene Bat Roost in South-East Wales

Mike Simms, Department of Geology, Ulster Museum,
Botanic Gardens, Belfast BT9 5AB, Northern Ireland

The Ogof Draenen cave system in south-east Wales contains accumulations of Lesser Horseshoe Bat guano on a scale unmatched by any other British cave, although very few bats now occupy this site. In places the guano covers many square meters to a depth of several centimeters, while elsewhere it forms conical heaps up to 4.5 square meters in area and more than 0.5 m deep. The area has experienced major environmental changes associated with coal mining and iron smelting since the beginning of the Industrial Revolution (c. 1760). However, large-scale abandonment of the roost was much earlier than this, with Carbon-14 analysis indicating a radiocarbon age of 1883 + 45 years. The reasons underlying the large-scale abandonment of this roost remain unknown; was it due to climatic deterioration, habitat change or the catastrophic blocking of access to the system? Preliminary analysis of the guano reveals a rich palynoflora of insect-transported taxa and a more poorly preserved insect fauna. Both pollen and insects provide important data on surface environments when the roost was active. Furthermore, the ingested pollen has preserved a unique record of the insect-pollinated component of the local flora which otherwise is largely unrepresented in pollen spectra derived from blanket peats, lake sediments, etc. Less than 5 km to the north -west lies the Agen Altwedd cave system, which is one of the most important roosts for Lesser Horseshoe Bats *Rhinolophus hipposideros* in Britain today and lies close to the present northern limit of this species. Records show their numbers to have increased to several hundred over the past decade, Understanding the fate of the Ogof Draenen bat roost may have significant implications for the management of the Agen Allwedd roost.

* * * * *

Why Count Bats? The European Bats Agreement, Biodiversity Action Plans and National Bat Monitoring Schemes.

Allyson Walsh and Colin Catto
The Bat Conservation Trust, 15 Cloisters House, 8 Battersea Park Road,
London, SW8 4BG. United Kingdom

Effective bat conservation relies on population monitoring information to identify changes that are of conservation concern at a sufficiently early stage. Funded by the UK government, The Bat Conservation Trust is running a five-year research program to develop effective monitoring techniques for resident UK bat species. The program is helping meet obligations under the Agreement on the Conservation of Bats in Europe (Bonn Convention), in particular by providing a model for developing standard transboundary monitoring techniques for a number of species in Europe. In addition to the Agreement, the monitoring program is beginning to make valuable contributions to the Biodiversity Action Plans for bat species being prepared to fulfil the UKs domestic objectives under the Convention on Biological Diversity. These plans rely on adequate monitoring information to both guide and measure their actions. Studies within the program are focusing on eight species of bat, for which at least two counting methods are being applied from three widely established methods - observation at summer maternity roost sites, observation at winter hibernation sites and summer field survey using bat detectors. Where appropriate, sites are sampled on a random-stratified basis to maximize the precision of national trend estimates. Data collection relies upon a

large network of volunteers and the program has recruited over 1200 members since its start in 1996, with 492 people contributing data during 1998. The monitoring network currently includes 223 hibernation sites, 412 pipistrelle, 123 lesser horseshoe and 44 serotine bat maternity colony sites, plus a total of 687 bat detector field survey sites. Novel bat detector transect techniques have been developed for mixed and single species surveys and studies are in progress to verify the techniques.

[The following titles were presented as posters]

A Multigene Perspective on Microbat Paraphyly.

Teeling, E.[1], Springer, M.[2] and Stanhope, M.[1]

[1]The Queen's University of Belfast, School of Biology and Biochemistry, Belfast BT9 7BL, Northern Ireland. [2]Department of Biology and Interdepartmental Graduate Program in Genetics, University of California, Riverside, California 92521, U.S.A.

The prospect of a paraphyletic Microchiroptera was previously investigated using DNA hybridisation data. We examined this possibility at the DNA sequence level, using a host of nuclear coding genes and 12S-16S mitochondrial loci. Eight species of bat were chosen, two members of the Pteropodidae, six other microbats representing different families and superfamilies.

* * * * *

A Preliminary Bats in Churches Survey

Niamh Roche, Consumers' Association of Ireland, 45 Upper Mount St., Dublin 2, Ireland.

Churches are traditionally considered good roosting sites for several species of bat. Three large roosts of Natterer's bat *Myotis nattereri* have been recorded in Church of Ireland churches in counties Limerick, Mayo and Cavan. The aim of the present study was to examine the importance of Church of Ireland churches for roosting bats. It was also anticipated that Natterer's bats would be found using these structures and that this information would help to improve knowledge of the distribution and abundance of the species in Ireland. The status of the Natterer's bat is listed as "indeterminate". Forty-two randomly selected churches in counties surrounding Dublin were surveyed for bat activity, from May to September 1998. Twenty-seven of these were consecrated Church of Ireland churches, while others were not in use, have been converted or were in a ruinous state. Sixty-two percent of buildings showed signs of use by bats (droppings, insect wings, live and dead specimens). Of these, 67% were identified as roosts of brown long-eared bats *Plecotus auritus* while 27% were roosts of pipistrelles *Pipistrellus pipistrellus*. No confirmed roosts of Natterer's bats were located. Difficulties in accessing attic spaces in some churches could have resulted in this species being under recorded. In order to counteract this problem, evening bat detector visits were made to nine churches. Pipistrelles were the species most commonly observed after dusk in cemeteries, mainly the 55kHz phonic type. Brown long-eared bats, Leisler's bats *Nyctalus leisleri* and the 45 kHz pipistrelle phonic type were also recorded flying in cemeteries. Problems in locating Natterer's bat roosts by surveying buildings indicate that other methods (e.g. mist netting) may be more efficient for determining this bat's distribution and abundance. Church of Ireland churches are particularly important roost sites for brown long eared bats. This project was funded by The Heritage Council.

These abstracts have been generously provided by Kate McAney, convenor of the meeting. If you wish to communicate with any of the authors, and have difficulty reaching them please contact Roy Horst who may have more recent addresses or points of contact.

The Irish Bat Group is planning to meet again in 2001.
The exact dates and venue have not been determined at this date. GRH

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

CONSERVATION

Bergmans, W. 1999. Conservation status of African fruit bats (Mammalia, Megachiroptera). Nederlandsche Commissie Voor Internationale Natuurbescherming, 33: 75-88.

DEVELOPMENT

Kozhurina, E. I. 1999. Early postnatal ontogeny and main periods of the development in parti-coloured bats *Vespertilio murinus* (Chiroptera: Vespertilionidae). Folia Zoologica, 48: 33-48. [Russian Acad. Sci., Severtsov Inst. Ecol. & Evolut., Leninsky Prospect 33, Moscow 117071, Russia]

Vardon, M. J., and C. R. Tidemann. 1998. Reproduction, growth and maturity in the black flying-fox, *Pteropus alecto* (Megachiroptera : Pteropodidae). Australian Journal of Zoology. 46: 329-344. [Tidemann, C. R., Australian Natl. Univ., Sch. Resource Management & Environm. Sci., Canberra, ACT 0200, Australia]

DISTRIBUTION/FAUNAL STUDIES

Abdullah, M. T., M. A. Rahman, and L. S. Hall. 1997. New records for bats in Sarawak, Malaysia. Malayan Nature Journal, 50: 365-367. [Dept. of Zoolog., Univ. of Queensland, St. Lucia, Brisbane 4072, Australia]

Bonaccorso, F. J. 1998. Bats of Papua New Guinea. Conservation International, Washington, D. C., 489 pp. [ISBN 1-881173-26-7]

Goodman, S. M. 1998. Notes on the bats of the Réserve Spéciale d'Anjanaharibe-Sud. Fieldiana: Zoology, new series, 90: 223-226.

Timm, R. M., and R. K. LaVal. 1998. A field key to the bats of Costa Rica. University of Kansas Occasional Publication Series, 22: 1-30. [Natural History Museum, Dept. of Ecol. and Evol. Biol., and Center of Latin American Studies, Univ. of Kansas, Lawrence, Kansas 66045]

ECOLOGY

Boshamer, J. P. C., and P. H. C. Lina. 1999. Mating groups of the pond bat *Myotis dasycneme* in bat and bird boxes. (in Dutch). Lutra, 41: 33-42. [Vogelzand 4250, NL-1788 MP Den Helder]

Foster, R. W., and A. Kurta. 1999. Roosting ecology of the Northern bat (*Myotis septentrionalis*) and comparisons with the endangered Indiana bat (*Myotis sodalis*). Journal of Mammalogy, 80: 659-672. [Dept. Biol., Eastern Michigan Univ., Ypsilanti, MI 48197]

Herrera M., L. G. Preferences for different sugars in Neotropical nectarivorous and frugivorous bats. Journal of Mammalogy, 80: 683-688. [Universidad Nacional Autónoma de México, Instituto de Biología, Departamento de Zoología, Apartado Postal 70-153, 04510 México, Distrito Federal, México]

Jaberg, C., C. Leuthold, and J.-D. Blant. 1998. Foraging habitats and feeding strategy of the parti-coloured bat *Vespertilio murinus* L.,1758 in western Switzerland. Myotis, 36: 51-61. [Centre de coordination ouest, pour l'étude et la protection, des chauves-souris, c/o Musée d'histoire naturelle, CH-2300 La Chaux-de-Fonds, Switzerland]

Kalcounis, M. C., K. A. Hobson, R. M. Brigham, and K. R. Hecker. 1999. Activity in the boreal forest: Importance of stand type and vertical strata. Journal of Mammalogy, 80: 673-682. [Dept. Biol., Univ. of Regina, Regina, Saskatchewan, Canada, S4S 0A2]

Pavey, C. R. 1998. Habitat use by the eastern horseshoe bat, *Rhinolophus megaphyllus*, in a fragmented woodland mosaic. Wildlife Research, 25: 489-498. [Zoology Institut, University of Munich, Luisenstrasse 14, Munich, Germany 80333]

Pavey, C. R., and C. J. Burwell. 1998. Bat predation on eared moths: a test of the allotonic frequency hypothesis. OIKOS, 81: 143-151. [Zoology Institut, University of Munich, Luisenstrasse 14, Munich, Germany 80333]

Pavey, C. R., and C. J. Burwell. 1998. Predation on diurnal insects by the eastern horseshoe bat, *Rhinolophus megaphyllus* Gray (Chiroptera: Rhinolophidae). Memoirs of the Queensland Museum, 42: 555-558. [Zoology Institut, University of Munich, Luisenstrasse 14, Munich, Germany 80333]

Saugey, D. A., B. G. Crump, R. L. Vaughn, and G. A. Heidt. 1998. Notes on the natural history of *Lasiurus borealis* in Arkansas. Journal of the Arkansas Academy of Science, 52: 92-98. [U. S. Forest Service, Jessieville-Winona Ranger District, Jessieville, AR 71949]

Stevens, R. D., and M. R. Willig. 1999. Size assortment in New World bat communities. Journal of Mammalogy, 80: 644-658. [Program in Ecol. and Conserv. Biol., Dept. Biolog. Sci. and The Museum, Texas Tech Univ., Lubbock, TX 79409-3131]

Wilhide, J. D., B. Baker, and D. A. Saugey. 1998. Arkansas range extension of the Seminole bat (*Lasiurus seminolus*). Journal of the Arkansas Academy of Science, 52: 140-141. [Dept. Biol. Sci., Arkansas State Univ., State University, AR 72467]

Wilhide, J. D., M. J. Harvey, V. R. McDaniel, and V. E. Hoffman. 1998. Highland Pond utilization by bays in the Ozark National Forest, Arkansas. Journal of the Arkansas Academy of Science, 52: 110-112. [Dept. Biol. Sci., Arkansas State Univ., State University, AR 72467]

Wilhide, J. D., V. R. McDaniel, M. J. Harvey, and D. R. White. 1998. Telemetric observations of foraging Ozark big-eared bats in Arkansas. Journal of the Arkansas Academy of Science, 52: 113-115. [Dept. Biol. Sci., Arkansas State Univ., State University, AR 72467]

GENETICS

Volleth, M., C. Klett, A. Kollak, C. Dixkens, Y. Winter, W. Just, W. Vogel, and H. Hameister. 1999. ZOO-FISH analysis in a species of the order Chiroptera: *Glossophaga soricina* (Phyllostomidae). Chromosome Research, 7: 57-64. [Hameister, H., Univ. Ulm., Abt. Med. Genet., D-89069 Ulm, Germany]

MAMMALIAN SPECIES ACCOUNTS

To order Mammalian Species Accounts contact Duane Smith at duane@museum.byu.edu or write to: Dr. H. Duane Smith, Monte L. Bean Life Science Museum, Brigham Young University, Provo, UT 84602-0200.

Dunlop, J. 1999. *Mops midas*. Mammalian Species, 615: 1-4.

Gray, P .A., M. B. Fenton, and V. Van Cakenberghe. 1999. *Nycteris thebaica*. Mammalian Species, 612: 1-8.

Kwiecinski, G. G., and T. A. Griffiths. 1999. *Rousettus egyptiacus*. Mammalian Species, 611: 1-9.

Storz, J. F., and T. H. Kunz. 1999. *Cynopterus sphinx*. Mammalian Species, 613 :1-8.

Vonhof, M. J., and M. C. Kalcounis. 1999. *Lavia frons.* Mammalian Species, 614: 1-4.

PHYSIOLOGY

Geiser, F., and D. K. Coburn. 1999. Field metabolic rates and water uptake in the blossom-bat *Syconycteris australis* (Megachiroptera). Journal of Comparative Physiology - B, Biochemical, Systemic, & Environmental Physiology, 169: 133-138. [Univ. New England, Sch. Biol. Sci., Armidale, NSW 2351, Australia]

Hosken, D. J., and P. C. Withers. 1999. Metabolic physiology of euthermic and torpid lesser long-eared bats, *Nyctophilus geoffroyi* (Chiroptera : Vespertilionidae). Journal of Mammalogy, 80: 42-52. [Univ. Zurich Irchel, Zool. Museum, Winterthurerstr 190, CH-8057 Zurich, Switzerland]

Ochoa-Acuna, H., and T. H. Kunz. 1999. Thermoregulatory behavior in the small island flying fox, *Pteropus hypomelanus* (Chiroptera : Pteropodidae). Journal of Thermal Biology, 24: 15-20. [Univ. Florida, Dept. Zool., Gainesville, FL 32611]

POPULATION BIOLOGY

Storz, J. F. 1999. Genetic consequences of mammalian social structure. Journal of Mammalogy, 80: 553-569. [Dept. Biol., Boston Univ., 5 Cummington, Boston, MA 02215]

SYSTEMATICS/TAXONOMY

Liu, F.-G. R., and M. M. Miyamoto. 1999. Phylogenetic assessment of molecular and morphological data for eutherian mammals. Systematic Biology, 48: 54-64. [Dept. Zoolog., Univ. of Florida, Gainesville, FL 32611-8525]

Valdez, E. W., J. R. Choate, M. A. Bogan, and T. L. Yates. 1999. Taxonic status of *Myotis occultus*. Journal of Mammalogy, 80: 545-552. [U. S. Geological Survey, Midcontinent Ecological Sci. Center, Dept. Biol., Univ. of New Mexico, Albuquerque, NM 87131]

Waddell, P. J., N. Okada, and M. Hasegawa. 1999. Towards resolving the interordinal relationships of placental mammals. Systematic Biology, 48: 1-5. [Institute of Statistical Mathematics, 4-6-7 Minami-Azabu, Minato-Ku, Tokyo 106-8569]

TECHNIQUES FOR STUDYING BATS

Mitchell-Jones, A. J., and A. P. McLeis. Bat Workers Manual. JNCC,138 pp. [ISBN 1 86107 462 X]

NEWS from our Colleagues

from Ithaca, New York Submitted by Jack Bradbury

After 25 years in the excessively sunny weather of Southern California,Jack Bradbury and Sandra Vehrencamp are leaving UC San Diego to take new positions at Cornell University's Laboratory of Ornithology. Jack will be assuming the Robert G. Engle Professorship in Ornithology, and Sandy will be Professor of Ornithology. Both will also be members of Cornell's Department of Neurobiology and Behavior. Sandy joins the Bioacoustics group at the Lab of Ornithology, whereas Jack becomes the new Director of the Library of Natural Sounds (LNS), also based at the Lab. Although both have largely worked on birds in recent years, Jack is very keen to expand the LNS sound collection to include both social and sonar calls of bats. He is counting on his many colleagues doing bat research worldwide to help make LNS the major repository of bat vocal signals in the world. The LNS collection will soon go digital with digitization rates and dynamic ranges high enough to store bat sounds with fidelity. The staff at LNS are initiating a program to expand the associated database to include behavioral and contextual information for as many recordings in the collection as possible. The goal is to provide web access to stored digital sounds and corresponding behavioral and contextual information. This should allow a wide variety of comparative studies that up until recently have been impossible. Similar expansions are planned for sounds of other mammals, frogs, fish, and arthropods, and completion of the already excellent collection of avian sounds. The Library will also archive waveforms of electric fish. Jack and Sandy can be reached at Cornell Lab of Ornithology, 159 Sapsucker Woods Road, Ithaca NY 14850-1999 .

emails: Jack Bradbury: jwb25@cornell.edu and Sandy Vehrencamp: slv8@cornell.edu

from York, Ontario, Canada Submitted by M. Brock Fenton.

In the last year, people in the laboratory have been involved with a variety of laboratory and field studies. In the latter part of June and early July, Brock Fenton worked with *Otonycteris hemprichii* in southern Israel, collaborating with Benny Shalmon and David Makin. As a group we worked in Belize in January 1999, using radio-tracking to locate the roosts of *Sturnira lilium*. In June 1999, Brock will join Naas Rautenbach in the field in South Africa to work on a project involving the diversity of African bats in the genus *Scotophilus*. We also were involved with the "Bats: masters of the night" exhibit at the Ontario Science Centre from early October 1998 to mid January 1999. Here are some details about the graduate student projects ongoing in the laboratory:

Sylvie Bouchard expects to finish her Ph.D. dissertation within the next few months. She has been studying olfactory communication in two species of African molossids, *Chaerephon pumila* and *Chaerephon condylura*. This research has involved work with captive animals in the laboratory as well as field studies in South Africa.

Dan Riskin is now in the field in Costa Rica working on his M.Sc. research. His thesis will involve studying the mechanism of operation of the disks of *Thyroptera tricolor*.

Lorraine Standing is about to start the experimental work for her Ph.D. research. Her thesis will involve an investigation of the use bats make of vision and the interface between vision and echolocation. Initially, she will work with captive animals in the laboratory at York.

Jason Taylor expects to finish his Masters of Environmental Studies thesis research by the end of the summer. His work has involved exploring the use of bats in education. He has worked with students in elementary schools as well as more general audiences at conservation areas, parks and camps.

Maarten Vonhof expects to finish his Ph.D. dissertation within the next few months. He has been studying the group dynamics in bats that change roosts, including *Lasionycteris noctivagans, Eptesicus fuscus* and *Thyroptera tricolor*. In addition to tracking marked individuals (radio tags or bands), he also has been doing DNA analysis to assess the genetic relatedness of group members.

Enrico Bernard from Brazil and John Ratcliffe from Ontario will join the laboratory in the fall. Enrico will enter the Ph.D. programme, John, the M.Sc. programme.

Publications from the Department

Fenton, M.B. 1998. The bat: wings in the night sky. Key Porter Books, Toronto.

Fenton, M.B., I.L. Rautenbach, J. Rydell, H.W. Arita, J. Ortega, S. Bouchard, M.D. Hovorka, B.K. Lim, E. Odgren, C.V. Portfors-Yeomans, W. Scully, D.M. Syme, and M.J. Vonhof. 1998. Emergence, echolocation, diet and foraging of *Molossus ater*. Biotropica, 30:314- 320.

York University continued...

Fenton, M.B., D.H.M. Cumming, I.L. Rautenbach, G.S. Cumming, M.S. Cumming, A.G. Ford, R.D. Taylor, J.M. Dunlop, M.D. Hovorka, D.S. Johnston, C.V. Portfors, M.C. Kalcounis & Z. Mahlanga. 1998. Bats and the loss of tree canopy in African woodlands. Conservation Biology, 12:399-407.

Brigham, R.M., M.B. Fenton & H.D.J.N. Aldridge. 1998. Flight speed of foraging common nighthawks *Chordeiles minor*: Does the measurement technique matter? American Midland Naturalist, 139:325-330.

Fenton, M.B., C.V. Portfors, I.L. Rautenbach & J.M. Waterman. 1998. Compromises: sound frequencies used in echolocation by aerial feeding bats. Canadian Journal of Zoology, 76:1174-1182.

Fenton, M.B., J.M. Waterman, J.D. Roth, E. Lopez & S.E. Fienberg. 1998. Tooth breakage and diet: a comparison of bats and carnivores. Journal of Zoology (London), 246:83-88.

Fenton, M.B. and I.L. Rautenbach. 1998. The implications of ignorance, humans and elephants for the conservation of bats in African woodlands, pp 261-270 in Bats: phylogeny, morphology, echolocation and conservation biology (T.H. Kunz and P.A. Racey, editors). Smithsonian Instiution Press, Washington.

Fenton. M.B. 1998. Order Chiroptera - Bats, pp. 28-37. In Wild animals of North America, National Geographic Society, Washington, D.C.

Lim, B.K. and M.D. Engstrom. 1998. Phylogeny of Neotropical short-tailed fruit bats (*Carollia*): phylogenetic analysis of restriction site variation in mtDNA, pp 43-58. In Bats: phylogeny, morphology, echolocation, and conservation biology (T.H. Kunz and P.A. Racey, eds). Smithsonian Institution Press, Washington.

Bouchard, S. 1998. *Chaerophon pumilus*. Mammalian Species, 574:1-6.

Dunlop, J. 1999. *Mops midas*. Mammalian Species, 615:1-4.

Vonhof, M.J. and M.C. Kalcounis. 1999. *Lavia frons*. Mammalian Species, 614:1-4.

Gray, P.A., M.B. Fenton and V. Van Cakenberghe. 1999.*Nycteris thebaica*. Mammalian Species, 612:1-8.

Bogdanowicz, W., M.B. Fenton & K. Daleszcyk. 1999. The dietary consequences of what bats say and what moths hear. Journal of Zoology (London), 247:381-393.

[in press]

Acharya, L. and M.B. Fenton. In press Bat attacks and moth defensive behaviour around street lights. Canadian Journal of Zoology accepted 30 October 1998.

from Brazil Submitted by Claudia Coen

I've just returned from a fantastic month of research, exploration and friendship in Brazil and would like to share it with you who have access to Bat Research News. I am finishing my Ph.D. at Cornell University on the comparative, nutritional physiology of two genera of vampire bats. I work in Colombia but due to civil unrest I've been unable to obtain *Diaemus youngi* in this vast and beautiful country. *Diaemus* occurs in the Department of Arauca but since I am blue-eyed, blond and not a native Spanish speaker, it wasn't safe (or wise) for me to venture there. When my Colombian assistants refused to go on my behalf I realized the extent of the danger and that I would need to downsize my thesis to include only *Desmodus rotundus*. This was most distressing as I am committed to the comparative study of digestion and assimilation of blood by vampire bats and its implications for resource partitioning in these sympatric species. Worse yet, I faced the prospect of being left with the nagging question: "What's going on with these bats, are they chasing the package (mammals vs. birds) or what's in the package (physiological adaptation to mammalian vs. avian blood)"? I have dedicated four years to this question and not being able to see it through would have caused it to linger and present itself in the wee hours of sleepless nights for years to come.

Dr. Wilson Uieda of Universidade Estadual Paulista (UNESP) in Botucatu, Southeastern Brazil, came to my rescue. Bill Schutt introduced me to him in 1995 at the 10th IBRC in Boston, later I had the pleasure of getting to know him and his wife while they were on Sabbatical leave at Cornell. In 1998, he invited me to present my research in the Vampire Bat Symposium at the 11th IBRC in Brazil. During a brief moment when he wasn't organizing and seeing to our needs, I mentioned that I was having difficulty acquiring *Diaemus* for my thesis studies. He immediately offered to help.

Brazil continued...

Inspired, I contacted my dissertation committee at Cornell. Drs. Milo Richmond (chair) and John Hermanson took action to help; applications for funds, protocols and permits were attended to. Wilson put the word out on the bush telegraph and his ear to the ground looking for *Diaemus*. He soon had the bats in captivity, his wife made her lab to available to me and his students pledged time and assistance. I was on my way to a fulfilling and rewarding Brazilian experience.

Wilson has an active laboratory with a number of ongoing projects of immediate importance to bat biology and conservation. As humans continue to encroach on wildlife habitat, biologists and conservationist are increasingly confronted with issues at the human/wildlife interface. These issues most commonly follow a pattern of demise of habitat and wildlife populations due to competition for resources by humans. Few mammals have become livestock pest to the extent of *Desmodus* which feeds exclusively on blood and primarily on the blood of cattle. Human agricultural and mining activities have provided an abundance of food and roosting habitat. As a result, population levels for *Desmodus* may be higher than at any other time in the history of the species. As a direct consequence of their nutritional needs and feeding behavior, *Desmodus* transmit paralytic rabies to cattle, which in turn translates to enormous economic losses throughout Latin America. Work at the human/vampire interface has been limited to controlling vampire bats in order to reduce economic losses and disease transmission. Wilson and his lab have undertaken to work at this interface on two levels.

Their major project takes them to Northern Brazil where they are studying the socio-ecological impact of vampire bat attacks on humans. This study is important because, as in Colombia, *Desmodus* is becoming more urbanized and the incidence of rabies in humans is on the rise. When living in cities, vampire bats adjust their behavior so that they are active during the darkest, quietest urban hours. Wilson's studies of vampire bats feeding on humans in remote and rural areas may offer some insight into the circumstances that drive this species to select humans over other animals.

To complement this work Wilson's graduate student, Marisa Cardoso, is studying food preferences by vampire bats in trials which include human blood. Using a remote video monitoring system, she simultaneously records the behavior of five vampire bats in individual cages and correlates it with the choices they make. It will be interesting to see if the bats sample the blood types by tasting them and rejecting them or if they detect the blood type they prefer by some other means. Perhaps they will like more than one and eat a little of each. Finally, through video monitoring we will know if the bats feed in one bout or sporadically through the night. My data indicate that in captivity there is varaition in feeding behavior between individuals. *Desmodus* is more likely to feed in one bout, while Diaemus mixes short bouts of feeding, grooming and sleeping has been observed feeding 10 hours after blood was first offered.

Wilson and Angelika Bredt have an ongoing study in Brasilia (Mid-Western Brasil) on frugivory and folivory of urban *Artibeus literatus*. They have collected interesting data on folivory in these bats and the species of plants they feed upon. Their photos are fantastic and left me envious of the opportunities they have to get so up close and personal with bats in their natural habitat. In addition, his group have developed an interest in folklore associated with bats and are exploring it further as it relates to two of their projects:

Glaucia Morelli Alves's undergraduate thesis is titled "Survey of bats and folk tales from Fazenda Lageado." Lageado is a large farm that was donated to the university and now is the campus of Agriculture and Agronomy. The campus includes a tract of remnant forest in a protected ecological zone. The public can walk through this beautiful area which is marked with signs describing aspects of the forest, massive leaf-cutter ant colonies and other interesting biological features. Glaucia's work documents the use of this remnant forest by bats. Using netting and banding techniques she looks at species abundance, distribution and diversity within the forest. This study has practical implications for conservationists and resource managers alike as it will shed light on the use of fragmented habitats in urban areas by bats. In conjunction with her species surveys, she is interviewing the local human populations about their knowledge of the bats and the predominant cultural attitudes towards them.

Wilson and Marisa conduct daily surveys of more than 50 horses on another UNESP farm near Botucatu. There, a tree roosting colony of vampire bats is actively bleeding horses and the story goes like this... In Brazilian folklore there is a young boy named Saci Perere. Saci is a forest nymph with only one leg. He has a wonderful, round face with rosy cheeks and laughing eyes which reflect his rye sense of humor. He loves a good joke and plays cheerful pranks on people as he makes his way through the forest in his red cap and smoking his pipe. Rural folk tell that Saci loves to ride horses and make "tranças" in their

Brazil continued...
manes. Tranças are complex mats in the mane, a loose combination of twists and plaits bowed at the distal end. Saci rides along through the forests and pastures at night holding onto the tranças.

But other folk report that tranças are frequently observed on horses bled by vampire bats in the neck region. For more than ten years, field technicians from the vampire bat control program have been telling Wilson about tranças. He first saw one in March 1998 when he responded to an extension call from a farmer who's two horses were being bled by vampire bats. Upon examination he found the horse with a long mane had a trança. Wilson observed tranças again when conducting surveys on a university owned herd actively bled by vampire bats. In all cases tranças were observed in association with vampire bat bites, either in the form of fresh wounds or as scars from old wounds.

Wilson became intrigued! Could a combination of feeding behavior in Desmodus and activity by horses result in tranças? He hypothesized that while feeding on a horse's neck Desmodus hangs from the mane. If the horse moves its head, the bat is forced to cease feeding and cling to, or move around in the mane to secure itself. The combination of the horse's and bat's movements results in the mane rolling up or twisting where the bat is clinging. It appears that tranças are formed over a period of time with repeated activity by both horse and bat causing the mane to become increasingly twisted and plaited. There may be some advantage to *Desmodus* which select to feed on horses that already have tranças. If you have information regarding tranças and vampire bat activity in your country please share it with Wilson via e-mail at uieda@botunet.com.br

While Wilson dedicates some of his time to unraveling the antics and mysteries of the cheeky but delightful Saci, I dedicate my time to analyzing the samples that were so successfully collected in Brazil with the help of Wilson, his family and his energetic group. I encourage you to visit Wilson at his labs in Botucatu and give a seminar. There are 31 recorded species of bats in the area and field sites are easily accessible and safe. Besides, with a guide like Wilson, you're assured of a memorable batting experience. Wilson invites anyone interested in doing work in Brazil to contact him. He currently has *Diaemus youngi* in captivity and is interested in establishing facilities for foreign scientists and students to work on collaborative studies with him. e-mail: cec6@cornell.edu

From Illinois Submitted by Timothy C. Carter

After finishing my Master's degree at the University of Georgia, I accepted an appointment at Southern Illinois University at Carbondale. I am working on my Ph.D. under the guidance of Dr. George Feldhamer. Most of my research will be on *Myotis sodalis*.

The purpose of this Cooperative research project between Southern Illinois University, the Illinois Department of Natural Resources, and the United States Department of Agriculture Forest Service is to study and monitor Indiana bat use of both upland and bottomland forest habitats across the Shawnee National Forest. This project will also test the recent Indiana bat HSI (Habitat Suitability Index) Model for hardwood forests. The project will include surveys of selected hardwood forest and pine plantations on the Shawnee National Forest to determine Indiana bat use of both bottomland and upland forest areas and will attempt to identify roosting habitat parameters. It will also monitor the effects of vegetation management actions including forest timber management and understory burning in both hardwood forest and upland pine plantations.

Project activities will include mist netting for bats at night according to established USFWS guidelines and fitting radio transmitters to captured Indiana bats and possibly other species of forest bats and tracking them to roost sites within the Forest. The project will also include collection of habitat data at each identified roost site. e-mail: tcarter@siu.edu (work), tcarter@globaleyes.net (home)

The 29th Annual North American Symposium on Bat Research

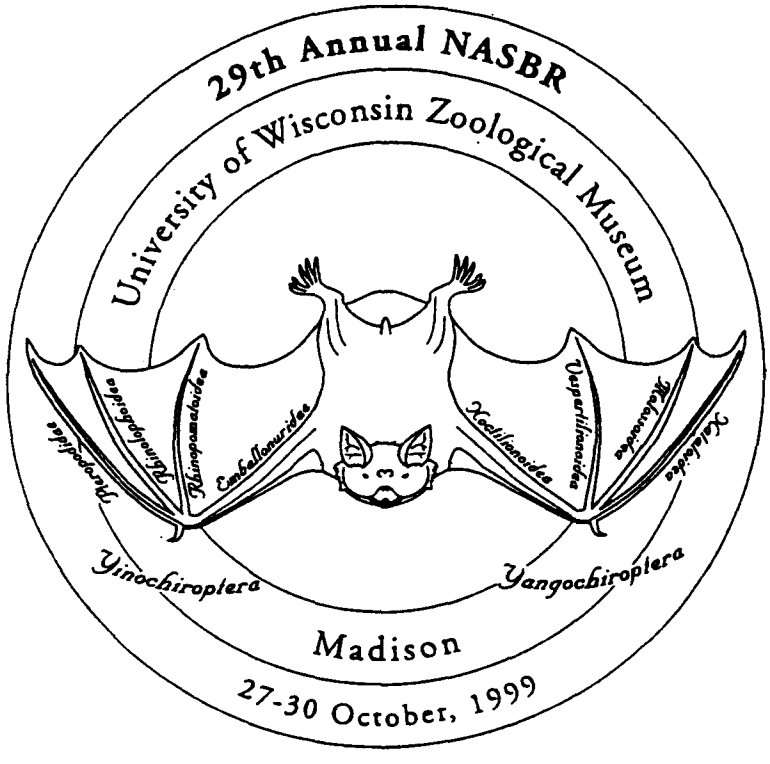
October 27 - 30, 1999

will be hosted by

the University of Wisconsin-Madison Zological Museum, Madison, WI

Conference Host: John Kirsch, University of Wisconsin, Madison, WI

Program Director: Tom Griffiths, Illinois Wesleyan University, Bloominton , IL



The conference logo above, by William Feeny, is a stylized representation of the lessor New Zealand short-tailed bat, *Mystacina velutina*, with spred wings symbolizing the abiding mystery of chiropteran phylogeny.

All North American Subscribers to Bat Research News and all who attended last year's symposium in Hot Springs, Arkansas will receive a registration packet by mail in late spring/early summer of 1999. All others interested in receiving information or registration materials for the symposium, please contact the University of Wisconsin Memorial Union Conference Center at 608-257-6534. Contact: nasbr@macc.wisc.edu if you preferr to use e-mail. This year for the first time, it will be possible to register and/or submit an abstract electronically using a credit card. Details will be included in the registration packet.

We recommend that you reserve a room at the earliest possible date at either of the two conference hotels. the **University Inn** at 800-279-4881 or 608-257-4881 or **Madison Inn** at 608-257-4391.

One can also call: www.travelbase.com/destinations/madison/madison inn.

Special rates have been arranged with these hotels, so be sure to tell the hotel reservation desk that you are participating in the North American Symposium on Bat Research.

Other Future Bat Meeting Announcements

August 1999

VIIIth European Bat Research Symposium
Kracow, Poland in August 23 - 27, 1999.

Address all communications to:
Professor Bronislaw W. Woloszyn, Chiropterological Information Centre,
Institute of Animal Systematics and Evolution, Polish Academy of Sciences,
ul. Slawkowska 17, 30-016 Krakow Poland
e-mail address: woloszbr@ isez.pan.krakow.pl or: VIIIEBRS@isez.pan.krakow.pl
TEL. + 4812/422-64-10 or + 4812/422-19-01 FAX + 4812/422-42-94

* *

September 1999

BCT National Bat Conference - United Kingdom
10 - 12th September 1999

To be held at: The University College of Ripon & York St John (Ripon Campus)

For further information and booking forms contact:

Jill Bradley, The Bat Conservation Trust, 15 Cloisters House, 8 Battersea Park Road, London. SW8 4BG

Tel: +44 171 627 2629
Fax: +44 171 627 2628
E-mail: enquiries@bats.org.uk

* *

April 2000

Australasian Bat Society Conference
25th-28th April 2000

at Tocal College, Paterson New South Wales, Australia.
for further information please contact:
Kerryn Parry-Jones. e-mail wambina@ozemail.com.au
Bat Research News will publish any new announcements as they arrive.
please see Bat Research News Vol.40: No.1, page 18 for more details

* *

June 2000

The American Society of Mammalogists
June 17 - 21

University of New Hampshire, Durham, New Hampshire
for further information contact
H. Duane Smith, Secretary-Treasurer
Monte L. Bean Life Science Museum
Brigham Young University, Provo, UT 84602-0200

More future bat meetings over >>>

More future bat meetings

October 2000

The 30th Annual North American Symposium on Bat Research

September 27 - 30, 2000

University of Miami, Miami, Florida

Convened by Thomas Griffiths and hosted by Ted Fleming

Bat Research News will publish any new announcements as they arrive.

* *

August 2001

The 12th International Bat Research Conference will convene 5 - 9 August, 2001, in Bangi, Malaysia

The Conference will be convened by Dr. Zubaid Akbar

All enquires should be directed to:

Dr. Zubaid Akbar,

Department of Zoology, University Kebangsaan Malaysia

43600 UKM BANGI MALAYSIA.

Tel/Fax: [60] 603-8293827

e-mail: zubaid@ukm.my or zubaid@pop.jaring.my

Website: www.fsh.ukm.my/fsh/dept/bz/zubaid.htm

Bat Research News will publish any new announcements as they arrive.

All subscribers to Bat Research News are on Dr. Akbar's mailing list.

* *

October 2001

The 31st Annual North American Symposium on Bat Research

October (exact dates not yet determined), 2001

Victoria, British Columbia

Convened by Thomas Griffiths and hosted by Mark Brigham

Bat Research News will publish all new announcements as they arrive.

If any one knows of any additional meeting concerning bats and their biology, being planned for the next few year please send the details to Roy Horst for inclusion in future issues.

BAT RESEARCH NEWS

Volume 40 **Summer 1999** **Number 2**

CONTENTS

Front Cover

This is a view of Burren College of Art, a charming combination of a very old tower building and modern new facilities, the venue for the 2nd Irish Bat Conference. The college is located in the scenic "Burrens", a region of vast barren limestone outcroppings several miles in length and rising as high as 700 feet above sea level. The ocean is just over the horizon to the west and the quaint little town of Ballyvaughan is only a few miles north of the site on Galway Bay, County Clare. Everyone should visit this delightful country where the people are very friendly, the scenery is magnificient (and the stout is unsurpassed). GRH

BAT RESEARCH NEWS

VOLUME 40: NO. 3 **FALL 1999**

BAT RESEARCH NEWS

Volume 40: No.3 Fall 1999

Publisher and Managing Editor, G. Roy Horst
Bat Research News, P.O. Box 5068. Potsdam, NY 13676-5068 U.S.A.
Tel. 315-267-2259 FAX 315-267-3170 e-mail: horstgr@potsdam.edu

Editor for Feature Articles, Allen Kurta
Department of Biology, Eastern Michigan University, Ypsilanti, MI 48197
Tel. 734-487-1174 FAX 734-487-9235 e:mail: bio_kurta@online.emich.edu

Editor for Recent Literature, Thomas A. Griffiths
Department of Biology, Illinois Wesleyan University, Bloomngton, IL 61702
Tel. 309-556-3230 FAX 309-56-3411 e-mail tgriff@titan.iwu.edu

Editor for Conservation Education and Book Reviews
Patricia Morton, Texas Parks and wildlife,Suite 100, 3000 IH 35 South, Austin, TX 78704
Tel. 512-912-7020 FAX 512-912-7058 e-mail: patricia.morton@tpwd.tx.us

Research Instructions for Contributors and Subscribers

Bat Research News is published four times each year, consisting of one volume of four issues. Bat Research News publishes short feature articles and general interest notes, which are reviewed by at least two scholars in that field. In addition, Bat Research News includes a "Recent Literature" section which cites many bat related publications in English worldwide, and the abstracts from Bat Conferences around the world. Also included are Letters to the Editors, News Notes submitted by our readers, and "Announcements of Future Bat Meetings, Symposia, and Conferences" worldwide.

Communications concerning feature articles and "Letters to the Editor" should be sent to Kurta; recent literature items should be addressed to Griffiths; book reviews and conservation education items should be submitted to Morton; subscription questions and all other items should be referred to Horst.

Subscriptions to the United States are $18.00 per year, all other individuals are $20.00 per year. Subscriptions to all institutions are $30.00 per year. Airmail outside the United States is $10.00 per year in addition.

Please make all checks payable to Bat Research News.

Payment can also be made using ***Visa, Mastercard, American Express,*** and ***Discover*** cards

Charge card data can be sent to Horst via e-mail, telephone or FAX. Be sure to send the following data. Card company, card expiration date, the 16 digit account number, your name exactly as it appears on your card. If you are concerned about security your data can be sent in two separate messages. We have been using this system for two year and to date have had no losses.

Bat Research News is ISSN 0005-6227
Bat Research News is printed and mailed at the State University of New York-Potsdam
Potsdam, New York 13676 U.S.A.

BAT RESEARCH NEWS

VOLUME 40: No. 3 **FALL 1999**

Letters to the Editors

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 the Feature Editor, Allen Kurta.

The Brown Disc-winged Bat, *Thyroptera discifera*, in the central Amazon, Brazil

Bernal R. Herrera[1], Erica M. Sampaio[2], Charles O. Handley, Jr.[3]

[1]Museo Nacional de Costa Rica, Historia Natural, 749-1000, San José, Costa Rica,

[2]University of Tübingen, Anin.al Physiology, Auf der Morgenstelle 28, D-72076 Tübingen, Germany, and

[3]Smithsonian Institution, National Museum of Natural History, Division of Mammals, MRC-NHB 108, Washington, D. C., 20560, USA

Thyroptera discifera Lichtenstein and Peters has a patchy distribution that includes Nicaragua, Panama, Colombia, the Guianas, the eastern Amazon of Brazil, Peru, and Bolivia (Koopman, 1993). Limits of its range have not yet been defined (Eisenberg, 1989). The species seems to be rare, and little information on its distribution and life history have been published (Wilson, 1978).

We recently captured two *T. discifera* at the Cabo Frio Reserve (59°54'00 W; 2°24'20 S) of the Biological Dynamics of Forest Fragments Project, about 70 km N of Manaus, Amazonas, Brazil. These records extend the known range of *T. discifera* into the central Amazon and provide another example of rarely observed sympatry of *T. discifera* and *T. tricolor* Spix (Voss and Emmons, 1996).

At 1845 h on 27 September 1998, we captured a subadult male *T. discifera* (forearm length = 35 mm; body mass = 4 g) and placed him in a cloth holding bag. This bat was caught about 30 cm above the ground in a mist net that was set in primary forest, about 300 m from an interface with secondary forest composed mainly of *Cecropia*. At 2215 h, we caught a lactating female (forearm length = 35 mm; body mass = 5 g), with naked, pink nipples. She was captured as she flew around the bag containing the male, which periodically uttered audible "pips." She circled the bag several times and landed briefly on it. A similar behavior, i.e., a bat circling a bag containing other bats, has been described for *T. tricolor* in Costa Rica by Findley and Wilson (1974).

The male that we captured was parasitized by a nycteribiid mite. Feces of both bats contained fragments of spider legs and tarsi of the suborder Oribatida. The bats were deposited as specimens in the mammal collection of the National Institute of Research in Amazonia (INPA), with catalog numbers 2703 (male) and 2704 (female).

We thank D. E. Wilson, for helpful suggestions and critical comments, and the Biological Dynamics Forest Fragments Project, for logistical support. E. Sampaio was supported by World Wildlife Fund do Brasil-Fundo Mundial para a Natureza and Fundação Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES).

Literature Cited

Eisenberg, J. F. 1989. Mammals of the Neotropics. The northern Neotropics. The University of Chicago Press, Chicago, Illinois, 85 pp.

Findley, J. S., and D. E. Wilson. 1974. Observations on the neotropical disk-winged bat, *Thyroptera tricolor* Spix. Journal of Mammalogy, 55:562-571.

Koopman, K. F. 1993. Order Chiroptera. Pp. 137-241 *in* Mammal species of world: a taxonomic and geographic reference (D. E. Wilson and D. M. Reeder, eds.). Second ed. Smithsonian Institution Press, Washington, District of Columbia, 1206 pp.

Voss, R. S., and L. H. Emmons. 1996. Mammalian diversity in neotropical lowland rainforests: a preliminary assessment. Bulletin of the American Museum of Natural History, 230:1-115.

Wilson, D. E. 1978. *Thyroptera discifera*. Mammalian Species, 104:1-3.

Bats Roosting in Deciduous Leaf Litter

Christopher E. Moorman[1], Kevin R. Russell[1], Michael A. Menzel[2], Steven M. Lohr[1], Justin E. Ellenberger[1], and D. H. Van Lear[1]
[1]Department of Forest Resources, Clemson University, Clemson, SC 29634 and
[2]Division of Forestry, West Virginia University, Morgantown, WV 26506

Despite the recent surge of information concerning characteristics of roost sites used by tree-roosting bats during summer (e.g., Crampton and Barclay, 1998; Menzel et al., 1998), little is known about roost sites used by bats during winter. During summer, some tree-roosting bats roost within the canopy of hardwood trees (Menzel et al., 1998). However, once leaves fall, deciduous trees may no longer be adequate as roost sites. Herein, we report observations that further support claims concerning use of litter on the forest floor by bats in winter.

We made 10 observations of bats in winter flying from deciduous leaf litter of three upland hardwood stands in the South Carolina Piedmont. The three stands were located on the Clemson University Experimental Forest ca. 4 miles N of Clemson, South Carolina. All observations were made in stands comprised predominately of mixed oaks (*Quercus*) with lesser amounts of yellow poplar (*Liriodendron tulipifera*), hickory (*Carya*), and red maple (*Acer rubrum*). The understory was sparsely vegetated with isolated mountain laurel (*Kalmia latifolia*), red buckeye (*Aesculus sylvatica*), and American holly (*Ilex americana*). Depth of the litter layer in the three stands was ca. 7 cm.

A single bat was flushed from leaf litter on 5 January 1999, as several researchers walked near its location. Nine other observations were made while conducting low-intensity strip-head fires in six 1-ha plots within the three stands. All burns were conducted on clear days. Bats roused during prescribed burns flew as the strip fires approached, and one bat was flushed while raking fire lines. Two or more of the authors viewed each bat. Once bats were roused, they flew over the roost site for several seconds and disappeared into the canopy or smoke created by the fire. Because bats flew out of sight, some observations could have been of the same individual.

On 16 February, we conducted a prescribed fire at two plots bisected by a small perennial stream. The aspects and slope gradients of the two plots were 105° SSW and 280° WNW and 40% and 15%, respectively. At the tome of the burn ambient temperature was 18°C, and minimum temperature the previous night was -2°C. Two bats flew from the forest floor of the SSW-facing slope, and three bats flushed from the WNW-facing slope. One of the bats on the WNW-facing plot flew from a location within 5 m of where the first bat was flushed on 5 January, suggesting the individual may have returned after researchers left the area. On 25 February, we conducted a second prescribed fire at two plots bisected by a different perennial stream. The aspects and slope gradients of the two plots were 45° NE and 216° SSW and 32% and 23%, respectively. Ambient temperature during the prescribed burn was 14°C, and minimum temperature the previous night was 0°C. Two bats were roused from the SSW-facing plot, but no bats were observed while burning the second plot. On 23 March, a third prescribed burn was conducted at two plots bisected by a third small stream. Aspects and slopes of the two plots were 20° NNE and 210° SSW and 30% and 26%, respectively. While burning, ambient temperature was 22°C, and minimum temperature during the previous 24 hours was 4°C. One bat was flushed when fire lines were raked on the SSW-facing slope, and a second bat flew from the forest floor on the NNE-facing slope as the fires approached.

Although we were unable to make definitive identifications, we suggest the bats were eastern red bats (*Lasiurus borealis*. All were relatively large (i.e., larger than *Myotis*), and those seen up close were reddish in color. Saugey et al. (1989) also reported seeing bats "smoked" from their hibernation sites during a prescribed

winter burn in Arkansas, and they believed the bats were eastern red bats resting in leaf litter on the forest floor. In 1993 and 1994, a fema le and male eastern red bat were radiotracked to a single site in hardwood-pine leaf litter on the forest floor (Saugey et al., 1998). Past reports were from the central United States, but our data indicate possible use of leaf litter by eastern red bats is more widespread geographically and may occur throughout the species' range.

Oak leaves dominated the litter layer of plots prior to burns. No bats were flushed from up-slope portions of the stands, which typically contained fewer hardwoods and more pines (*Pinus*). Because of its color, insulatory properties, and resistance to decay, sites with well-developed hardwood litter, especially oak litter, may provide important wintering sites for eastern red bats. However, prescribed fires typically eliminate much forest-floor debris, including leaf litter and small woody debris. Therefore, fire likely renders the burned area temporarily inadequate for ground-roosting bats. Although prescribed fire traditionally has been used for pine management, recent research (Brose and Van Lear, 1998; Brose et al., 1999) indicates that fire is an essential ecological process in management of upland oaks during the regeneration phase. In light of our observations, further investigation of bat use of forest-floor debris is warranted, especially in areas where prescribed burning or other silvicultural manipulations are common.

We thank S. K. Cox, S. Perry, D. B. Vandermast, J. Albiston, and many undergraduates for assistance during prescribed burns. Prescribed fires were conducted for a project funded by McIntire-Stennis through Clemson University.

Literature Cited

Brose, P. H., and D. H. Van Lear. 1998. Response of hardwood advanced regeneration to seasonal prescribed fires in oak-dominated shelterwood stands. Canadian Journal of Forest Research, 28:331-339.

Brose, P. H., D. H. Van Lear, and R. Cooper. 1999. Using shelterwood harvests and prescribed fire to regenerate oaks on productive upland sites. Forest Ecology and Management, 113:125-141.

Crampton, L. H., and R. M. R. Barclay. 1998. Selection of roosting and foraging habitat by bats in different-aged mixed wood stands. Conservation Biology, 12:1347-1358.

Menzel, M. A., T. C. Carter, B. R. Chapman, and J. Laerm. 1998. Quantitative comparison of tree roosts used by red bats (*Lasiurus borealis*) and Seminole bats (*L. seminolus*). Canadian Journal of Zoology, 76:630-634.

Saugey, D. A., D. R. Heath, and G. A. Heidt. 1989. The bats of the Ouachita Mountains. Proceedings of the Arkansas Academy of Science, 43:71-77.

Saugey, D. A., R. L. Vaughn, B. G. Crump, and G. A. Heidt. 1998. Notes on the natural history of *Lasiurus borealis* in Arkansas. Journal of the Arkansas Academy of Science, 52:92-98.

Discriminating *Myotis sodalis* from *Myotis lucifugus* with Anabat—a Critique

Lynn W. Robbins and Eric R. Britzke
Department of Biology, Southwest Missouri State University, Springfield MO, 65804

It is obvious from a series of papers (e.g., O'Farrell, 1999; O'Farrell and Gannon, 1999; O'Farrell et al., 1999) that Mike O'Farrell is arguably the most experienced and probably the most accurate researcher using the Anabat II system for qualitative identification of bats in North America. In a recent paper, O'Farrell (1999) conducted a "blind test" of his ability to distinguish between little brown bats (*Myotis lucifugus*) and the federally endangered Indiana bat (*Myotis sodalis*). Having been involved in the "blind test", we have no doubt that O'Farrell learned to identify and distinguish *M. sodalis* and *M. lucifugus* under the described conditions.

However, we have several concerns related to the procedures of that test and the eventual conclusions.

First is the way in which the accuracy of the identification of the two species was described. The questions he should have answered are what proportion of the *M. sodalis* were correctly identified and what proportion of the *M. lucifugus* were correctly identified? For M. sodalis, O'Farrell correctly identified 56.3% in test 1, 93.0% in test 2, and 83.0% in test 3 (Table 1 in O'Farrell 1999). These results do not support his contention of increased accuracy with increased experience, although this is still impressive given the fact that he had not previously seen calls of *M. sodalis*. Conversely, even though he had extensive experience in identifying calls of *M. lucifugus*, O'Farrell was inconsistent in his ability to identify this species (Table 1 in O'Farrell, 1999).

While the qualitative approach has been used effectively by some researchers, it has been criticized (Barclay 1999) for lacking definition and repeatability. O'Farrell et al. (1999) and Betts (1998) quantified this lack of repeatability among researchers, even those with extensive experience in qualitative identification. The most recent paper (Table 1 in O'Farrell, 1999) suggests that this lack of repeatability may also occur within as well as between individuals, although this maybe due to the limited nature of O'Farrell's test.

O'Farrell (1999) states that the probability of correct identification can be obtained through testing, which is true, but this only applies to a previously completed test. O'Farrell's data (1999) show that the probabilities for a specific test do not translate into probabilities for a previous or subsequent test (Table 1). This fact precludes the use of probabilities of correct identification when qualitatively identifying unknown species of bats under natural conditions.

We realize that the design of this "blind test" was not totally under O'Farrell's control, but the protocol used also should be addressed. It was obvious after test 1 that most bats caught at the cave were *M. sodalis*, with relatively few *M. lucifugus*. The predominance of one species over another could have unconsciously biased identifications in tests 2 and 3. In future tests of this sort, we recommend that the collection of bats and their calls be done in the absence of the person being tested. Individual tests could then be administered with varying proportions of the test species. For repeated testing, the tests should be constructed so that all calls are pooled. This would allow the individual being tested to learn from all previous tests but avoid unintentional bias based on proportions present in previous tests.

We agree with O'Farrell that experience is necessary for accurate identification of species using the Anabat II system. However, the results of the "blind test" (O'Farrell, 1999) do not indicate the repeatability or a measure of accuracy that were described. With increased testing under improved conditions and with the level of expertise shown by O'Farrell, it is possible that the desired results would be obtained. The specific results (O'Farrell, 1999), however, probably could not be repeated by any other researcher in this field. Without some method of species identification that can be used by other experienced workers under natural conditions, the utility of the methods described by O'Farrell (1999) will be limited to studies performed by O'Farrell.

Literature Cited

Barclay, R. M. R. 1999. Bats are not birds: a cautionary note on using echolocation calls to identify bats. Journal of Mammalogy, 80:290-296.

Betts, B. J. 1998. Effects of interindividual variation in echolocation calls on identification of big brown and silver-haired bats. Journal of Wildlife Management, 62:1003-1110.

O'Farrell, M. J. 1999. Blind test for ability to discriminate vocal signatures of the little brown bat (*Myotis lucifugus*) and the Indiana bat (*Myotis sodalis*). Bat Research News, 40:44-48.

O'Farrell, M. J., and W. G. Gannon. 1999. A comparison of acoustic versus capture techniques for the inventory of bats. Journal of Mammalogy, 80:24-30.

O'Farrell, M. J., B. W. Miller, and W. G. Gannon. 1999. Qualitative identification of free-flying bats using the Anabat detector. Journal of Mammalogy, 80:11-23.

Maternity Colony Formation in *Myotis septentrionalis* Using Artificial Roosts The Rocket Box, a habitat enhancement for Woodland Bats?

Harold S. Burke, Jr.
3045 Silver Brook Drive, Burlington, KY 41005-9278

Abstract:

The rocket box is designed specifically to accommodate bats that utilize exfoliating bark. Its structure is such, that it provides a wide range of microclimates while also providing a secure roost. Some early results from Kentucky have been described by Dourson and MacGregor (See, BRN 38:2, A Post Bat House Design). To date, six rocket boxes have been installed at a site in Ohio, and monitored to obtain comparison data of usage patterns in wood lot situations with those obtained from forested areas. A major goal of the project is to discover, and describe the conditions under which the box provides a suitable roost for Indiana bats (*Myotis sodalis*). At the time of writing this article, a maternity colony of ninety-nine adult *M. septentrionalis*, and juveniles to numerous to count inhabit the Ohio boxes.

Methods and Observations:

In March of 1998, three of the boxes were installed on a 28-acre wood lot site in Ohio, approximately 38 miles east of Cincinnati. The surrounding landscape is a mosaic of agricultural, and wood lot residences ranging in size from 25 to 100 acres. The predominant trees in the surrounding area are Ash, Red Oak, Sugar Maple, and Red Cedar followed by small numbers of other hardwoods. The trees at the site range in size from saplings to a large Red Oak forty inches DBH (avg. DBH for all trees 9 – 10 inches). A small pond, approximately three quarters of an acre in size, lies in a field on the property, and is adjacent to the wooded area of the site.

The initial series of boxes were placed as follows; (#1) woods edge, with no canopy cover, (#2) within fifteen feet of an Ash snag, fifty percent canopy cover, and (#3) in a small opening in the trees, ninety five percent canopy cover. During the 1998 season, boxes were checked on a weekly basis beginning May 17, and running through August 17. Bats were first observed using box number two on July 26, at which time an exit count revealed thirty-two bats using the box. On August 2, bats were netted at box number one with three of twenty-two being captured (1 adult female, and 2 juveniles). This confirmed the species as *M. septentrionalis*. Six bats were last observed using box number three on August 13, 1998. During November 1998, three additional boxes with canopy coverage of fifty, eighty, and one hundred percent were installed at the site.

The first check of boxes for the 1999 season was performed on May 2, at which time *M. septentrionalis* were present in the box near the snag. An exit count of the box revealed forty-seven bats using the box. All six of the available boxes were used by June 7, and have been in continuous use since the initial inspection. The movement of the bats from box to box has been quite predictable based on the prevailing weather conditions prior to each visit. The number of bats present fluctuated from a low of one bat found roosting in the box with one hundred percent canopy cover during a week of temperatures in excess of 90 degrees F, to sixty bats on June 14, found in a less shaded box. Of the sixty counted on June 14, three did not leave the box. One of the three was clearly an adult; the status of the other two could not be determined. On June 17, another exit count was performed and video footage taken of the bats leaving the roost (Burke and Belwood). Seventy-seven adults and twelve juveniles were present at this time. A high of ninety-nine adults, and box full of juveniles was reached on June 22, in box number three. Of twelve trips made to the site through June 22, only twice were bats found utilizing the same roost box on consecutive visits, and only once were bats present in more than one box at a time.

Discussion and Conclusions:

With the exception of *M. septentrionalis* being found in more than one box per site, per visit in Kentucky on a more regular basis, the general usage patterns appear to be the same at the Ohio site. The process of maternity colony formation in *M. septentrionalis* appears to be one of interaction between loosely coupled groups of bats that come together, separate, and regroup multiple times, at multiple roosts prior to the young being born. During the period while young were being born, the number of adults present per box increased steadily (i.e., 60, to 77, to 99). This particular activity appears similar to a form of active recruitment of bats using natural roosts by individuals that are utilizing the boxes. Pure chance should predict that on at least some visit(s), all boxes should be empty. This, however, has not occurred.

To date seven species have been identified as using the box (personal communication, Dourson). Noticeably missing from the list of users is *M. sodalis*. The design of the Rocket Box seems adequate for

woodland bats in general. It is, however, the opinion of the author that temperatures reached inside the box may be too warm to sustain a maternity colony of Indiana bats. This aspect of the box will be examined beginning next year.

So, is the box a viable habitat enhancement for woodland bats? I believe the answer is; a definite **YES**.

News

From Lubbock, Texas, Paraguay and California

Submitted by Robert D. Owen and Michael R. Willig
Texas Tech University, Lubbock, TX

Mike Willig has been on Development Leave from Texas Tech Univ. during the past year, at the National Center for Environmental Analysis and Synthesis (NCEAS), at the Univ. of California-Santa Barbara. His research there focuses on modeling gradients of diversity and patterns of body size in New World mammals. In addition, his lab at Texas Tech remains active, with a number of students involved in bat projects. Steve Presley is working on his Ph.D. dissertation, involving ectoparasites of bats, many of which Steve collected during his 1-1/2 years of field work in Paraguay. Richard Stevens is analyzing the results of his extensive collections of bats during 1-1/2 years of fieldwork. Richard's dissertation will evaluate bat community structure in two extensive remnants of Interior Atlantic Rainforest, in Paraguay. Marcos Gorresen, a Master's student in Mike's lab, is evaluating extensive bat data collected during 1-1/2 years of fieldwork in Paraguay. Marcos' thesis will evaluate effects of forest fragmentation on bat community richness, diversity, and structure. Chris Bloch, a doctoral student, is quantifying scale-dependent patterns of body size in Paraguayan bats from the local level to the regional level. Kelley Johnson, a Master's student, is conducting a morphometric analysis of *Sturnira lilium*, evaluating geographic and secondary sexual variation from several extensively-collected sites in Paraguay. Heidi Amarilla, who plans to enter a Master's program this year, has been working both in Willig's lab and in Robert Owen's, learning research techniques.

Robert Owen is beginning a year of Development Leave from Texas Tech, and will spend the coming year in Paraguay, conducting Geographic Information System analyses on Paraguayan small-mammal (including bats, of course) data. He will be working in the Departamento de Ordenamiento Ambiental, in the Paraguayan Ministry of Agriculture. Robert continues to work on several other bat projects, especially in Paraguay and in Michoacan and Colima, Mexico. Back at the lab, George Wang, a Master's student, is developing a thesis project, which will involve G.I.S. analyses of bat distributions in Michoacan, Mexico. Carl Dick and Brian Amman will both be entering Ph.D. programs in Robert's lab, and both will most likely work on bat-related dissertation projects. Carl, who also recently conducted fieldwork in Paraguay, is interested in systematic and co-evolutionary analyses of Neotropical bat ectoparasites. Brian just completed his Master's at the Univ. of Southern Colorado, with a thesis on taxonomic aspects of bat hair structure. Gloria Gonzalez, who plans to enter a Master's program next year in Robert's lab, is currently working with him on an evaluation of morphometric of the three species of *Artibeus* in Paraguay.

Editor's Note:

If Bat Research News is to live up to its name, more of you will have to provide us with a few lines every few years about what you and your co-workers are up to these days. Hordes of you are constantly reminding me about the lack of news from our colleagues. So, why not take a few minutes and let BRN know what interesting things you are doing. The note above from Bob Owens and Mike Willig is a fine model for you to follow. I expect a flood of news items for the next issue! Thanks in advance for your contribution. Yes, you can give me your news items in Wisconsin. Cheers, *Roy*

Book Review

by Patricia A. Morton

Captive Care and Medical Reference for the Rehabilitation of Insectivorous Bats,
Amanda Lollar and Barbara Schmidt-French, 1998,
Bat World Publication, Mineral Wells, Texas, 329 pgs.

If you maintain bats in captivity or are even thinking about doing so, buy this book. *The Captive Care and Medical Reference for the Rehabilitation of Insectivorous Bats* is the most comprehensive and detailed publication of this kind ever produced. It is an essential text for anyone who maintains bats in captivity, from rehabilitators to research professionals and for veterinarians who treat sick and injured bats. Authors Lollar and Schmidt-French have compiled knowledge and experience from over a decade of keeping bats in captivity. Given the scope of the book and the amount of technical detail included here these gals have established themselves as learned professionals and have produced a publication of great value to a variety of disciplines that require keeping captive bats.

The book contains a wide scope of topics and in-depth information I was not expecting to find. Chapters on caging include specific requirements and designs for both crevice roosting and foliage roosting bats as well as special needs for infant bats. Information on feeding has specific instructions for adults, juveniles and infants (formulas and milk replacers) along with directions for maintaining nutritious quantities of mealworms and crickets. For me, the most impressive part of the book is the 130+ pages on illness/injury diagnosis and treatment. Examples to illustrate the range of medical conditions addressed include: membrane tears, compound fractures, respiratory disorders, heat exhaustion, electrical shock, insect stings, gastrointestinal disorders, gum infections, eye and ear problems and pesticide poisoning. Eleven classes of medications are discussed including antibiotics, antifungals, antispasmotics, analgesics and anesthetics.

Rehabilitation issues rarely addressed in print include procedures for the release of rehabilitated bats and care of non-releaseable bats with topics that range from quality of life issues, roost mates, orchiectomy and geriatric bats to methods for euthanasia. Finally, the authors do a nice job of listing guidelines for education programs and live bat exhibits that can provide excellent learning opportunities for the public with no risk to human health. Twelve appendices include state information on wildlife rehabilitation permits, list of veterinary contacts, state bat lists, and an extensive product list.

The publication is a handsome hard-bound book that sells for $45 plus $5 for shipping. Hundreds of descriptive photos, drawings and data tables are distributed throughout the book. It is available through Bat World, 217 N. Oak, Mineral Wells, Texas, 76067. Phone: 940-325-3404.

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

ANATOMY

Wenstrup, J. J., D. H. Mittmann, and C. D. Grose. 1999. Inputs to combination-sensitive neurons of the inferior colliculus. Journal of Comparative Neurology, 409: 509-528. [NE Ohio Univ., Coll. Med., Dept. Neurobiol., 4209 State Route 44, Rootstown, OH 44272]

BAT BOOKS (NEW)

Russ, J. In press. The bats of Britain and Ireland: echolocation calls, sound analysis and species identification. Alana Books, Rock Cottage, Sarn, Newtown, Powys SY16 4HH. [ISBN 0 9536049]

BEHAVIOR

Acharya, L., and M. B. Fenton. 1999. Bat attacks and moth defensive behaviour around street lights. Canadian Journal of Zoology, 77: 27-33. [Fenton: York Univ., Dept. Biol., 4700 Keele St., N. York, ON M3J 1P3, Canada]

Jenkins, E. V., T. Laine, and S. E. Morgan. 1998. Roost selection in the pipistrelle bat, *Pipistrellus pipistrellus* (Chiroptera: Vespertilionidae), in northeast Scotland. Animal Behaviour, 56: 909-917.

Kalko, E. K. V., D. Friemel, C. O. Handley, and H. -U. Schnitzler. 1999. Roosting and foraging behavior of two Neotropical gleaning bats, *Tonatia silvicola* and *Trachops cirrhosus* (Phyllostomidae). Biotropica, 31: 344-353. [Univ. Tubingen, Morgenstelle 28, D-72076 Tubingen, Germany]

Nair, N. G., V. Elangovan, K. Sripathi, G. Marimuthu, and R. Subbaraj. 1999. Foraging behavior of the Indian short-nosed fruit bat *Cynopterus sphinx*. Zeitschrift fur Saugetierkunde, 64: 187-191. [Madurai Kamaraj Univ., Dept. Anim. Behav. & Physiol., Sch. Biol. Sci., Madurai 625021, Tamil Nadu, India]

O'Donnell, C. F. J., and J. A. Sedgeley. 1999. Use of roosts by the long-tailed bat, *Chalinolobus tuberculatus*, in temperate rainforest in New Zealand. Journal of Mammalogy, 80: 913-923. [Science and Res. Unit, Dept. Conservation, Private Bag, Christchurch, New Zealand]

CONSERVATION

Grindal, S. D., and R. M. Brigham. 1999. Impacts of forest harvesting on habitat use by foraging insectivorous bats at different spatial scales. Ecoscience, 6: 25-34. [Suite 600, 555 4th Ave. SW, Calgary, AB T2P 3E7, Canada]

Korine, C., I. Izhaki, and Z. Arad. 1999. Is the Egyptian fruit-bat *Rousettus aegyptiacus* a pest in Israel? An analysis of the bat's diet and implications for its conservation. Biological Conservation, 88: 301-306. [Izhaki: Univ. Haifa, Dept. Biol., IL-36006 Tivon, Israel]

Sedgeley, J. A., and C. F. J. O'Donnell. 1999. Roost selection by the long-tailed bat, *Chalinolobus tuberculatus*, in temperate New Zealand rainforest and its implications for the conservation of bats in managed forests. Biological Conservation, 88: 261-276. [Science and Res. Unit, Dept. Conservation, Private Bag, Christchurch, New Zealand]

Taylor, P. J. 1999. The role of amateurs in the growth of bat conservation and research in South Africa. South African Journal of Zoology, 34: 19-26. [Durban Nat. Sci. Museum, POB 4085, ZA-4000 Durban, South Africa]

DEVELOPMENT

Courts, S. E. 1998. Investigations of infant development and juvenile social interactions in Livingstone's fruit bat *Pteropus livingstonii* at Jersey Wildlife Preservation. Dodo: Journal of the Wildlife Preservation Trusts, 34: 166-167. [Jersey Wildlife Preservat Trust, Dept. Res., Trinity JE3 5BP, Jersey, England]

DISTRIBUTION/FAUNAL STUDIES

Balasingh, J., J. Ronald, P. T. Nathan, and S. S. Isaac. 1999. Occurrence of *Cynopterus brachyotis* (Chiroptera: Pteropodidae) in Kalakad Mundanthurai Tiger Reserve, Southern India. Current Science, 76: 1542. [Wild Life Inst. India Project, Kalakad Mundanthurai Tiger Reserve, Tirunelveli 627551, India]

Csorba, G., S. V. Kruskop, and A. V. Borissenko. 1999. Recent records of bats (Chiroptera) from Nepal, with remarks on their natural history. Mammalia, 63: 61-78. [Hungarian Nat. Hist. Mus., Dept. Zool., Baross 13, H-1088 Budapest, Hungary]

Gargaglioni, L. H., M. E. Batalhão, M. J. Lapenta, M. F. Carvalho, R. V. Rossi, and V. P. Veruli. 1998. Mamíferos da estação ecológica de Jataí, Luiz Antônio, São Paulo. Papéis Avulsos de Zoologia -- Museu de Zoologia da Universidade de São Paulo, 40: 267-287. [Lab. Zool. Vertebrados, Dept. Biol., Univ. de São Paulo, Ave. Bandeirantes, 3.900 CEP 14040-901, São Paulo, Brazil]

Kuenzi, A. J., G. T. Downard, and M. L. Morrison. 1999. Bat distribution and hibernacula use in west-central Nevada. Great Basin Naturalist, 59: 213-220. [Montana Tech, Dept. Biol. Sci., Butte, MT 59701]

López-González, C., S. J. Presley, R. D. Owen, M. R. Willig, and I. Gamarra de Fox. 1998. Noteworthy records of bats (Chiroptera) from Paraguay. Mastozoologia Neotropical, 5: 41-45. [Dept. Biol. Sci., Texas Tech Univ., Lubbock, TX 79409-3131]

Robinson, M. F. 1998. Chiroptera survey: Xe Piane National Biodiversity Conservation Area, Lao P. D. R. Natural History Bulletin of the Siam Society, 46: 155-170. [11 Newton Rd., Little Shelford, Cambridgeshire CB2 5HL, United Kingdom]

Sachanowicz, K., W. Bogdanowicz, and S. Michalak. 1999. First record of *Taphozous nudiventris* Cretzschmar, 1830 (Chiroptera, Emballonuridae) in Turkey. Mammalia. 63: 105-107. [Wincentego Pola 13, PL-08110 Siedlce, Poland]

Sánchez-Hernández, C., M. de L. Romero-Almaraz, R. D. Owen, A. Núñez-Garduño, and R. López-Wilchis. 1999. Noteworthy records of mammals from Michoacán, México. Southwestern Naturalist, 44: 231-235. [Dept. Biol. Sci., Texas Tech Univ., Lubbock, TX 79409-3131]

Shiel, C. B., and J. S. Fairley. 1998. Activity of Leisler's bat *Nyctalus leisleri* (Kuhl) in the field in south-east County Wexford, as revealed by a bat detector. Biology & Environment-Proceedings of the Royal Irish Academy, 98B: 105-112. [Fairley: Natl. Univ. Ireland Univ. Coll. Galway, Dept. Zool., Galway, Ireland.

Tidemann, C. R., M. J. Vardon, R. A. Loughland, and P. J. Brocklehurst. 1999. Dry season camps of flying-foxes (*Pteropus* spp.) in Kakadu World Heritage Area, north Australia. Journal of Zoology, 247: 155-163. [Australian Natl. Univ., School Resource Management & Environmental Science, Canberra, ACT 0200, Australia]

Watson, J. P. 1998. New distributional records for three microchiropteran bats (Vespertillionidae, Rhinolophidae) from the Free State Province, South Africa. South African Journal of Wildlife Research, 28: 127-131. [Natl. Museum, Bloemfontein Dept. Environm. Affairs & Tourism, POB 264, ZA-9300 Bloemfontein, South Africa]

ECHOLOCATION

Britton, A. R. C., and G. Jones. 1999. Echolocation behaviour and prey-capture success in foraging bats: Laboratory and field experiments on *Myotis daubentonii*. Journal of Experimental Biology, 202: 1793-1801. [Jones: Univ. Bristol, Sch. Biol. Sci., Woodland Rd, Bristol BS8 1UG, Avon, England]

Ibáñez, C., A. Guillén, J. Juste B., and J. L. Pérez-Jordá. 1999. Echolocation calls of *Pteronotus davyi* (Chiroptera: Mormoopidae) from Panama. Journal of Mammalogy, 80: 924-928. [Estación Biol. de Doñana, Consejo Superior de Investigaciones Científicas, Aptd 1056, 41080 Sevilla, Spain]

Kössl, M., E. Mora, F. Coro, and M. Vater. 1999. Two-toned echolocation calls from *Molossus molossus* in Cuba. Journal of Mammalogy, 80: 929-932. [Zool. Inst., Luisenstr. 14, 80333 München, Germany]

Rydell, J., L. A. Miller, and M. E. Jensen. 1999. Echolocation constraints of Daubenton's Bat foraging over water. Functional Ecology, 13: 247-255. [Univ. Gothenburg, Dept. Zool., Box 463, SE-40530 Gothenburg, Sweden]

Verboom, B., A. M. Boonman, and H. J. G. A. Limpens. 1999. Acoustic perception of landscape elements by the pond bat (*Myotis dasycneme*). Journal of Zoology, 248: 59-66. [Inst. Forestry & Nat. Resources, POB 23, NL-6700 AA Wageningen, Netherlands]

ECOLOGY

Arlettaz, R. 1999. Habitat selection as a major resource partitioning mechanism between the two sympatric sibling bat species *Myotis myotis* and *Myotis blythii*. Journal of Animal Ecology, 68:460-471. [Rue Paradis 41, CH-1967 Bramois Sion, Switzerland]

Bogdanowicz. W., M. B. Fenton, and K. Daleszczyk. 1999. The relationships between echolocation calls, morphology and diet in insectivorous bats. Journal of Zoology, 247(3): 381-393. [Polish Acad. Sci., Mus. Zool., Wilcza 64, POB 1007, PL-00679 Warsaw, Poland]

Bowie, R. C. K., D. S. Jacobs, and P. J. Taylor. 1999. Resource use by two morphologically similar insectivorous bats (*Nycteris thebaica* and *Hipposideros caffer*). South African Journal of Zoology, 34: 27-33. [Jacobs: Univ. Cape Town, Dept. Zool., ZA-7701, Rondebosch, South Africa]

Brigham, R. M., and F. Geiser. 1998. Seasonal activity patterns of two species of *Nyctophilus* bats based on mist-net captures. Australian Mammalogy, 20: 349-352. [Dept. Biol., Univ. Regina, Regina, SK S4S 0A2, Canada]

Cotterill, F. P. D., and R. A. Fergusson. 1999. Reproductive ecology of Commerson's leaf-nosed bats *Hipposideros commersoni* (Chiroptera : Hipposideridae) in South-Central Africa: interactions between seasonality and large body size; and implications for conservation. South African Journal of Zoology, 34: 53-63. [Biodiversity Foundation Africa, POB FM730, Famona, Bulawayo, Zimbabwe]

Herrera, L. G., T. H. Fleming, and L. S. Sternberg. 1998. Trophic relationships in a neotropical bat community: a preliminary study using carbon and nitrogen isotopic signatures. Tropical Ecology, 39: 23-29. [Universidad Nac. Autónoma Mexico, Inst. Biol., Dept. Zool., Aptd 70-153, 04510 Mexico, D.F. Mexico]

Humes, M. L., J. P. Hayes, and M. W. Collopy. 1999. Bat activity in thinned, unthinned, and old-growth forests in western Oregon. Journal of Wildlife Management, 63: 553-561. [Oregon State Univ., Dept. Fisheries & Wildlife, Corvallis, OR 97331]

Norman, A. P., G. Jones, R. Arlettaz. 1999. Noctuid moths show neural and behavioural responses to sounds made by some bat-marking rings. Animal Behaviour, 57: 829-835. [Univ. Bristol, Sch. Biol. Sci., Woodland Rd., Bristol BS8 1UG, Avon, England]

O'Donnell, C. F. J., J. Christie, C. Corben, J. A. Sedgeley, and W. Simpson. 1999. Rediscovery of short-tailed bats (*Mystacina* sp.) in Fiordland, New Zealand: preliminary observations of taxonomy, echolocation calls, population size, home range, and habitat use. New Zealand Journal of Ecology, 23: 21-30. [Science and Res. Unit, Dept. Conservation, Private Bag, Christchurch, New Zealand]

Shilton, L. A., J. D. Altringham, S. G. Compton, and R. J. Whittaker. 1999. Old World fruit bats can be long-distance seed dispersers through extended retention of viable seeds in the gut. Proceedings of the Royal Society of London - Series B: Biological Sciences, 266(1416): 219-223. [Australian Natl. Univ., Dept. Forestry, Sch. Resource Management & Environmental Sci., Canberra, ACT 0200, Australia]

von Helversen, D., and O. von Helversen. 1999. Acoustic guide in bat-pollinated flower. Nature, 398: 759-760. [Institute of Zoology II, Erlangen University, Staudtstrasse 5, 91058 Erlangen, Germany; electronic reprint at <ftp://server.biologie.uni-erlangen.de/pub/winter-lit/winter-lit.txt>]

Winter, Y. 1999. Flight speed and body mass of nectar-feeding bats (Glossophaginae) during foraging. Journal of Experimental Biology, 202: 1917-1930. [Institute of Zoology II, Erlangen University, Staudtstrasse 5, 91058 Erlangen, Germany; electronic reprint at <ftp://server.biologie.uni-erlangen.de/pub/winter-lit/winter-lit.txt>]

EVOLUTION

Patterson, B. D., J. W. O. Ballard, and R. L. Wenzel. 1998. Distributional evidence for cospeciation between neotropical bats and their bat fly ectoparasites. Studies on Neotropical Fauna & Environment, 33(2-3): 76-84. [Field Museum Nat. Hist., Dept. Zool., Roosevelt Road & Lake Shore Drive, Chicago, IL 60605]

FLIGHT

Webb, P. I., J. A. Sedgeley, and C. F. J. O'Donnell. 1998. Wing shape in New Zealand lesser short-tailed bats (*Mystacina tuberculata*). Journal of Zoology, London, 246: 462-465. [O'Donnell: Science and Res. Unit, Dept. Conservation, Private Bag, Christchurch, New Zealand]

PARASITOLOGY

Beaucornu, J. -C., and J. -F. Noblet. 1998. Les puces de chauves-souris dans les Alpes et les Pré-Alpes françaises (Insecta - Siphonaptera - Ischnopsyllidae). Le Rhinolophe, 13: 29-34. [Lab. Parasitologie et Zoologie appliquée, Fac. Médecine, ave. du Prof. Léon Bernard, 35043 Rennes Cedex, France]

Durette-Desset, M. C., and C. Vaucher. 1999. *Molostrongylus mbopi* n. sp (Nematoda : Trichostrongylina, Molineoidea) parasite of three *Molossops* species (Chiroptera, Molossidae) from Paraguay. Revue Suisse de Zoologie, 106: 407-418. [Museum National d'Hist. Nat., CNRS, Lab Biol. Parasitaire Protozool. Helminthol., 61 Rue Buffon, F-75231 Paris 05, France]

Duszynski, D. W., D. T. Scott, J. Aragon, A. Leach, and T. Perry. 1999. Six new *Eimeria* species from vespertilionid bats of North America. Journal of Parasitology, 85: 496-503. [Univ. New Mexico, Dept. Biol., Albuquerque, NM 87131]

Komeno, C. A., and A. X. Linhares. 1999. Batflies parasitic on some phyllostomid bats in southeastern Brazil: parasitism rates and host-parasite relationships. Memorias do Instituto Oswaldo Cruz, 94: 151-156. [Linhares: Univ. Estadual Campinas, Inst. Biol., Dept. Parasitol., Caixa Postal 6109, BR-13083970 Campinas, SP, Brazil]

Spears, R. E., L. A. Durden, and D. V. Hagan. 1999. Ectoparasites of Brazilian free-tailed bats with emphasis on anatomical site preferences for *Chiroptonyssus robustipes* (Acari : Macronyssidae). Journal of Medical Entomology, 36: 481-485. [Hagan: Georgia Southern Univ., Inst. Arthropodology & Parasitology, Dept. Biol., Statesboro, GA 30460]

Steindel, M., E. C. Grisard, and C. J. de Carvalho Pinto. 1998. Characterization of trypanosomes from the subgenus *Schizotrypanum* isolated from bats, *Eptesicus* sp. (Chiroptera: Vespertilionidae), captured in Florianopolis, Santa Catarina State, Brazil. Journal of Parasitology, 84: 601-607.

PHYSIOLOGY

Kunz, T. H., E. Bicer, W. R. Hood, M. J. Axtell, W. R. Harrington, B. A. Silvia, and E. P. Widmaier. 1999. Plasma leptin decreases during lactation in insectivorous bats. Journal of Comparative Physiology - B, 169: 61-66. [Boston Univ., Dept. Biol., 5 Cummington St., Boston, MA 02215]

Mclean, J. A., and J. R. Speakman. 1999. Energy budgets of lactating and non-reproductive brown long-eared Bats (*Plecotus auritus*) suggest females use compensation in lactation. Functional Ecology, 13: 360-372. [Scottish Agricultural Coll., Dept. Biochem. & Nutr., Auchincruive KA6 5HW, Ayr, Scotland]

Speakman, J. R., and A. Rowland. 1999. Preparing for inactivity: how insectivorous bats deposit a fat store for hibernation. Proceedings of the Nutrition Society, 58: 123-131. [Univ. Aberdeen, Dept. Zool., Aberdeen Ctr. Energy Regulat. & Obesity, Aberdeen AB24 2TZ, Scotland]

Thomson, S. C., and J. R. Speakman. 1999. Absorption of visible spectrum radiation by the wing membranes of living pteropodid bats. Journal of Comparative Physiology - B, 169: 187-194. [Speakman: Univ. Aberdeen, Dept. Zool., Aberdeen Center Energy Regulation & Obesity, Tillydrone Ave, Aberdeen AB24 2TZ, Scotland]

Voigt, C. C., and Y. Winter. 1999. The energetic cost of hovering flight in nectar-feeding bats (Phyllostomidae: Glossophaginae) and its scaling in moths, birds and bats. Journal of Comparative Physiology, B, 169: 38-48. [Institute of Zoology II, Erlangen University, Staudtstrasse 5, 91058 Erlangen, Germany; electronic reprint at <ftp://server.biologie.uni-erlangen.de/pub/winter-lit/winter-lit.txt>]

POPULATION BIOLOGY

Burland, T. M., E. M. Barratt, M. A. Beaumont, and P. A. Racey. 1999. Population genetic structure and gene flow in a gleaning bat, *Plecotus auritus*. Proceedings of the Royal Society of London - Series B, 266:975-980. [Zool. Soc. London, Inst. Zool., Regents Park, London NW1 4RY, England]

REPRODUCTION

Leon-Galvan, M. A., T. Fonseca, R. Lopez-Wilchis, and A. Rosado. 1999. Prolonged storage of spermatozoa in the genital tract of female Mexican big-eared bats (*Corynorhinus mexicanus*): the role of lipid peroxidation. Canadian Journal of Zoology, 77: 7-12. [Univ. Autonoma Metropolitana Iztapalapa, Div. Ciencias Biol. & Salud., Dept. Biol., Unidad Iztapalapa, Avenida Purisima & Michoacan,Colonia Vicentina, Mexico City 09349, DF, Mexico]

Rasweiler, J. J., and N. K. Badwaik. 1999. Relationships between orientation of the blastocyst during implantation, position of the chorioallantoic placenta, and vascularization of the uterus in the noctilionoid bats *Carollia perspicillata* and *Noctilio* sp. Placenta, 20: 241-255. [Cornell Univ., Coll. Med., Dept. Obstetrics & Gynecology, 1300 York Ave., New York, NY 10021]

SYSTEMATICS/TAXONOMY

Csorba, G., and L. L. Lee. 1999. A new species of vespertilionid bat from Taiwan and a revision of the taxonomic status of *Arielulus* and *Thainycteris* (Chiroptera: Vespertilionidae). Journal of Zoology, 248:361-367. [Dept. Zool., Hungarian Nat. Hist. Museum, Dept. Zool., Baross Utca 13, H-1088 Budapest, Hungary]

Kupfermann,.H., Y. Satta, N. Takahata, H. Tichy, and J. Klein. 1999. Evolution of Mhc-DRB introns: Implications for the origin of primates. Journal of Molecular Evolution, 48: 663-674. [Klein: Max Planck Inst. Biol., Immungenet. Abt., Correnssstr. 42, D-72076 Tubingen, Germany]

Lapointe, F. J., J. A. W. Kirsch, and J. M. Hutcheon. 1999. Total evidence, consensus, and bat phylogeny: A distance-based approach. Molecular Phylogenetics and Evolution, 11: 55-66. [Univ. Montreal, Dept. Sci. Biol., CP 6128, Succursale Ctr. Ville, Montreal, PQ H3C 3J7, Canada]

Van Cakenberghe, V., and F. De Vree. 1998. Systematics of African *Nycteris* (Mammalia: Chiroptera) Part III. The *Nycteris thebaica* group. Bonn zool. Beitr., 48: 123-166. [Dept. Biol., UIA, Universiteitsplein 1, B-2610 Wilrijk, Belgium]

Van Den Bussche, R. A., R. J. Baker, J. P. Huelsenbeck, and D. M. Hillis. 1998. Base compositional bias and phylogenetic analyses: A test of the "flying DNA" hypothesis. Molecular Phylogenetics and Evolution, 10: 408-416. [Oklahoma State Univ., Dept. Zool., 430 LSW, Stillwater, OK 74078]

Abstracts on Bat-Related Presentations at the American Society of Mammalogists 79th Annual Meeting in Seattle Washington, June 20 to 24, 1999

Bat Research News is pleased to present the abstracts of those presentations that concerned bat biology at the American Society of Mammalogists Annual Meeting in June 1999 in Seattle Washington. The abstracts of these meetings are not printed except as a booklet of abstracts given only to those who attend the meeting. Printing these abstracts here will enable all those bat biologists who did not attend the meeting to see the data presented by these authors. Bat Research News is grateful to James Richman, President of the Society, for his approval of and support of this worthwhile effort. The abstracts appear in alphabetical order of first authors. G. R. Horst

Bats, Volcanoes, and Worn-out Teeth

Rich A. Adams and Scott C. Pedersen
Dept. Biol. Sciences, Univ. Wisconsin, Whitewater, WI & Dept. Orthod., Univ. Washington, Seattle

The small British Crown Colony of Montserrat has been battered by several hurricanes, and beginning in 1995, pyroclastic flows from its volcano have reduced the southern half of the island to an ecological wasteland, destroying roost sites and 70% of the islands foraging habitat. Six surveys spanning 20 years include 1200 captures of 10 species from 45 locations. The one site common to all six surveys, the Belham River drainage, was reduced to an acidic trickle of water by pyroclasic/mud flows the summer of 1998. If all surveys, species, and locations are considered together, and the data partitioned into three frames [Pre-Hugo][post-Hugo+pre-Volcano][post-Volcano] the population reads: [28.5][2.4][1.5]. Bat captures/net-night (Belham: [49.5][3.4][1.8] BNN). The composition of the frugivore guild has shifted from being dominated two specialists (*Artibeus* and *Monophyllus* – 91% of frugivore captures) to a post-volcano frugivore guild composed predominantly by two 'frugivore-omnivores' (*Ardops* and *Brachyphylla* – 60% of frugivore captures). Hurricanes and volcanic eruptions have been significant impacts on the bat populations of Montserrat, as underlined by the loss of three species: *Chiroderma*, *Sturnira* and *Noctilio*. However, *Brachyphylla* is doing well despite high levels of external parasitism, hair-loss, and exaggerated dental wear due to the constant ingestion of volcanic ash.

Patterns of Cave Use in Bats from Central Mexico

Rafael Avila-Flores and Rodrigo A. Medellin
Instituto de Ecologia, UNAM. Ap. Postal 70-275,04510 Mexico, D.F., Mexico

Roosting places are a key component within the habitat of bats. Although some workers have tried to find patterns of cave use, few of them have explored the limits imposed by intrinsic features and abilities ofspecies to use different roosting environments. In this work, we related body size, taxonomic group, type of food, and the thermoregulatory pattern of species with roost microclimate in cavernicolous bats of Mexico. We selected 18 caves from Central Mexico located in different vegetational zones(tropical semi-evergreen forest, tropical deciduous forest, xerophytic scrub, and coniferous forest). Every cave was visited twice in each season of the year. We collected data on temperature and humidity at sites that were occupied by one or more colonies of bats and also captured some bats for species identification and to take standard measurements. A total of 23 species belonging to five families and eight subfamilies were studied. The most evident pattern obtained was clustering species, all insectivorous Vespertilionids)

moderately hot caves (near 30°C). Homeothermic species (Emballonuridae, Mormoopidae, Phyllostomidae, and Natalidae) occupied caves ranging from temperate near 15°C) to very hot (around 35°C). Homeotherms smaller than 10g occupied roosts above 20°C (mainly above 25°C), except one nectarivorous which was observed on several occasions below 20°C. Only medium and large insectivorous (above 15g) used caves below 20°C. All other homeotherms (medium and large frugivors, nectarivors and sanguivors) were observed in environments ranging from 25 to 35°C. Although the assemblages of the species roosting in caves would be a reflection of the total diversity of surrounding communities, we believe that the caves useful for each species are limited by intrinsic conditions. Because of this, roost availability can be a key factor that influences the geographical distribution of the bats.

Maternal Manipulation of the Sex Ratio in a Reverse Sexually Size Dimorphic Mammal, the Big Brown Bat, *Eptesicus fuscus*

Diana M. Barber
Department of Ecology, Ethnology, and Evolution, University of Illinois, Urbana, IL

Both Trivers and Williar (1973) and Williams (1979) have developed models predicting adaptive individual manipulation of the sex ration. I tested these models in the big brown bat, *Eptesicus fuscus*. Mother-infant pairs were recorded in natural populations to determine if sex ration and size of litters were associated with maternal condition. Mothers in above average conditions produced larger litters and their litter sex ratios were skewed toward females. Maternal manipulation of the sex ration was experimentally tested in a captive colony by altering the mothers' physical condition. Mothers manipulated litter sex ratios in the direction predicted by Williams (1979) if females are more costly than males. Restricted mothers gave birth primarily to singletons, whereas mothers fed an ad libidum diet bore predominantely twins. The cost of producing sons and daughters was measured in a related experiment. Testing individual manipulation of the sex ratio in a reverse sexually size dimorphic mammal will provide a significant advance in the understanding of parental investment.

Role of Urea in the Postprandial Urine Concentration Cycle of Insectivorous Bats

John E. Bassett
Department of Bioengineering, University of Washington, Seattle, WA

Insectivorous bats produce maximally concentrated urine only after feeding. The role of urea in this process was investigated in pallid bats *Antrozous pallidus* maintained on mealworms in a chronic laboratory colony. Bats which were trained to eat when confined and presented with food were fasted for 18-24 hours. Blood and urine samples were collected before and 2 hours after feeding in the postprandial (PP) group and before and 2 hours after confinement without food in the fasting (FA) group. Food consumption was verified by an increase in body weight in the PP group, and weight loss following confinement was determined in both groups. Food consumption by PP animals and confinement of FA animals had no effect on plasma concentration as measured by hematocrit and plasma oncotic pressure. Depending on the pretreatment level of total plasma osmolaity (***P***osm), food consumption increased ***P***osm by as much as 15%. The increase in ***P***osm was accompanied by a similar increase in plasma urea (***P***urea). Food consumption increased total urine osmolality (***U***osm) 50-100% with urine urea (***U***urea) levels increasing by a similar amount. ***U***osm increased with food consumption regardless of the change in ***P***osm, and in all cases the increase in ***U***osm resulted primarily from an increase in ***U***urea. ***P***osm and ***P***urea were unchanged in FA bats, but ***U***osm and ***U***urea increased by 25%. ***U***osm increased in fasted animals, but to a lesser degree, due to increased ***U***urea levels. The postprandial urine concentration cycle in pallid bats resulted from increased urea excretion in response to increased ***P***urea levels. Urea synthesized from

protein in the insectivorous diet was rapidly excreted by the bat at a time during the daily cycle when the level of body water acquired from all sources was the highest.

Patterns of Bodysize in Paraguayan Bats: An Hierarchical Approach

C.P. Bloch[1], M.R. Willig[1,2], S. J. Presley[1], and R.D. Owen[1]

[1]Department of Biological Sciences & The Museum, Texas Tech University, Lubbock, TX 79409

[2]National Center for Ecological Analysis & Synthesis, Univ. Cal. at Santa Barbara, Santa Barbara, CA

Recent research for North America and Australia has suggested the existence of general scale-dependent patterns of body size for terrestrial mammals, but has not included the ecologically diverse and taxonomically rich Chiroptera. At the largest of spatial scales (e.g., continents), the distribution of logarithmic body sizes of terrestrial mammals is characteristically unimodal and leptokurtic, and becomes progressively more platykurtic as spatial scale diminishes. At the scale of local communities species span a similar range of body sizes as characterized by continental distributions, but the distribution of species along the size gradient includes gaps and clusters. We tested the generality of these phenomena for bats based on an intensive and extensive survey of 25 sites representing all major biomes of Paraguay. Our approach was hierarchical, beginning with body size distributions for each site, from which we amalgamated data for each of 7 biomes, mesic eastern and xeric western regions of the country, and at the largest scale, all of Paraguay. At the community level, we assessed body size distributions based on the proportion of individuals as well as on the proportion of species. At the largest scale, the body size distribution of bats is modal but not leptokurtic. At the sale of biomes, the distribution ranges from symmetrical and platykurtic, to leptokurtic. At the scale of sites, the distributions are characterized by gaps and clusters, but the largest four size classes were often absent. Finally, no statistically relationship exists between relative abundance and body mass at each local site. Body size patterns for bats are markedly different than those for terrestrial mammals.

Bats of Ixtlan; Oaxaca, Mexico

Miguel Briones-S., Jaime Calderon, and Antonio Santos-M. Centro
Interdisciplinario de Investigacion para el Desarrollo Integral Regional Unidad Oaxaca, IPN
Calle Hornos No. 1003, Santa Cruz Xoxocotlan, Oaxaca, Oax, Mexico, C.P. 71230

We collected bats from nine localities in the vicinity of Ixtlan de Juarez, Oaxaca, Mexico from July of 1997 to November of 1998. A total of 368,382 meters of net by hours in ten field trips were used. Our results indicate that in the region, phyllostomid bats are a predominant group. Of the 21 species represented in our sample, 19 species belong to this family and represent three subfamilies: Desmodontinae (one species), Vampryinae (one species) and Phyllostominae (17 species). The Phyllostominae was represented by 17 species of three tribes: Glossophagini (five species), Stenodermatini (10 species) and Phyllostomini (two species). The only other family represented in the region was Vespertilionidae with only one genus (*Myotis*) and two species. The 21 species collected represents the 15.33 per cent of the current number of bats' species recognized to Mexico, and the 23.33 per cent of species recognized for the Oaxaca state. We documented the first record of *Tonatia brasiliense* for the state. Ten species were frugivorous, five polinivorous, three insectivorous, and the guilds hematophagous, carnivorous and omnivorous were represented by one species each one. The greatest species richness was found in the evergreen rain forest (15 species). The highest number of species (15) was found at low altitudes (<500 meters). Above 2500 meters, only two species were recorded.

Bat Activity as Measured by the Anabat System

Eric R. Britzke, Kevin L. Murray, Brad M. Hadley, and Lynn W. Robins
Department of Biology, Southwest Missouri State University, Springfield, MO 65804

The knowledge of the factors that influence bat activity is necessary in developing effective monitoring techniques. Ultrasonic detectors (like the Anabat system) allow for the sampling of the bat community activity with fewer biases than capture techniques. In the fall 1998 and spring 1999, we sampled bat activity using the Anabat system. The Anabat systems were set up to passively monitor echolocation calls throughout the entire night. To account for nightly variation, we simultaneously sampled bat activity in different habitats. Echolocation calls were identified to species using Discriminate Function Analysis. We investigated several ways to document bat activities with the Anabat system. We also examined the influence of moon phase and habitat type on general as well as species specific bat activity. In general, the Anabat system proved to be a useful tool in examining the factors that influence bat activity patterns.

Feeding Ecology of the Red *Lasiurus borealis*, Seminole *L. seminolus*, and Evening *Nycticeius humeralis* Bats at the Savannah River Site, SC

Timothy C. Carter[1], Michael A. Menzel[2], Brian R. Chapman[2], and Karl V. Miller[2]
1Department of Zoology, Southern Illinois University, Carbondale, IL 62901
2Daniel B. Warnell School of Forest Resources, university of Georgia, Athens, GA 30602

We collected fecal samples from red (*Lasiurus borealis*), Seminole (*L. seminolus*), and evening (*Nyctieius humeralis*) bats at the Savannah River Site, South Carolina, during summers of 1996 and 1997. Diets were compared to estimates of prey availability which were based on samples of the insect communities in available habitats and the amount of time bats foraged in each habitat. Diets differed among species. All species fed selectively. Red bats consumed mostly Coleoptera in the beginning of the summer and used Lepidoptera more toward the end of the summer. Red bats selectively avoided Lepidoptera and Tricoptera in early summer, Diptera and Tricoptera in the middle, and Diptera, Hymenoptera, and Tricoptera during late summer. Diets of Seminole bats were dominated by Coleoptera and Hymenoptera in early summer. However, they used Coleoptera, Hemiptera, and Tricoptera less as they were available. In mid-summer, Lepidoptera also became an important food item. Hymenoptera was used more than available and Hemiptera, Diptra and Tricoptera were consumed less than they were available. No Seminole bat samples were collected during late summer. Evening bats consumed primarily Coleoptera, Hymenoptera, Hemiptera, and Homoptera during early and mid summer. Lepidoptera, Diptera, and Tricoptera were avoided during early and mid summer. Evening bats consumed mostly Hemiptera, Homoptera, Coleoptera, and Hymenoptera during late summer. They used Hemiptera and Homoptera more than they were available and avoided Coleoptera, Lepidoptera, and Diptera.

Using Acoustic Techniques to Investigate Habitat Utilization in Temperate Bat Communities

Brent L. Coleman, Richard E. Sherwin, and Duke S. Rogers
Depts. of Zoology, Brigham Young Univ., Provo, UT, & Univ. of New Mexico, Albuquerque, NM

Due to limitations and biases of traditional sampling techniques, we propose that acoustic surveys can provide valuable insights about bat community dynamics. Acoustic surveys allow for random placement of survey sites and reduce the biases of traditional techniques (mist netting). Surveys were conducted in a fragmented riparian corridor to investigate utilization of habitat by bats. Acoustic surveys (Anabat II hardware and software) were conducted simultaneously with mist netting and surveys of possible roosts in an effort to evaluate the effectiveness each technique and compensate for biases in each method. Based on

preliminary data, we propose that acoustic surveys provide reliable results for assessing the dynamics of bat communities at the landscape level. We urge caution when attempting to identify bats to the specific level due to the lack of reliable reference library and the undetermined variation of individual calls.

A Comparison of Two Acoustic Survey Designs for Estimating Bat Activity Patterns

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

We examined bat activity patterns using two different acoustic survey designs in northern New Mexico and central Colorado. In New Mexico, we used walking point transects to compare activity levels of bats in four major habitat edge structure at Rocky Mountain Arsenal National Wildlife Refuge. In both cases, we developed models to explain bat activity across the landscape, started a reference library of echolocation calls for the region, and identified free-flying bat calls qualitatively with the use of Anabat II technology. The activity model developed in New Mexico revealed that bat activity was greater in the riparian canyon bottomland compared to upland habitat types. In Colorado, our analysis revealed that bat activity was the highest in area with both tree and water edge features and lowest in areas without habitat edges. Our choice of survey designs for these two areas was community structure. We will discuss advantages and limitations of these two survey designs and review sampling design issues for acoustic surveys of bats.

Effects of Stand Structure and Landscape Heterogeneity on Activity Patterns of Forest-Dwelling Bats

Janet L. Erickson and Stephen D. West
Wildlife Science Group, College of Forest Resources
University of Washington, Seattle, WA 98195

Understanding the processes that underlie bat distribution and activity patterns requires examinations of habitat conditions at multiple scales. We studied the relationship between bat activity and habitat characteristics at both the stand and landscape level. Using Anabat II bat detectors, 48 forested sites in western Oregon and Washington were monitored for bat activity on a least six occasions for each of two field seasons. At the stand-level, bat activity was negatively associated with tree density. The standard deviation of tree density and the density of newly created snags were positively associated with bat activity. In combination, these three variables explained 47% of the total variance in bat activity among sites. Landscape-level variables did not explain any significant variation among a subset of sites (n=22). While landscape-level influences may be important in some situations (e.g., agricultural landscapes), our study suggests that attributes of habitats and the effects of these features on feeding and roosting opportunities.

Analysis and Interpretation of Field Recorded Bat Echolocation Calls Using Anabat

[1]William L. Gannon, [2]Michael J. O'Farrell, [3]G. Corben, and [3]Edward J. Bedrick
[1]Museum of Southwest Biology, University of New Mexico,Albuquerque, NM
[2]O'Farrell Biological Consulting, NV
[3]Department of Statistics, University of New Mexico, Albuquerque, NM

The efficacy of using ultrasonic detectors ("bat detectors") to ascertain presence and allow taxonomic identification of free flying bats recently has been of interest among researchers. Several types of detectors

are available; among them the Anabat system provides for an immediate display of call time-frequency structure allowing for species recognition and subsequent detailed analysis of entire vocal sequences. Possession of a bat detector does not however, imply knowledge of its proper use; providing equipment to a seasonal technician will not suffice to achieve necessary goals. In this paper, we suggest standards for analysis measurement, and interpretation of Anabat output. We describe each step from call collection and measurement to analysis using standard and non-standard classification techniques for a subset of *Myotis* species. As part of this process, we define characters that are useful for analysis as well as criteria for choosing calls that are measurable and classifiable. Standard techniques of call data collection and analysis, combined with the exchange of call files and other data among researchers and wildlife managers will tremendously increase what is known about bats and how best to manage for them, and consequently increase knowledge for their conservation.

Selection of Maternity Roosts by Little Brown Bats *Myotis lucifugus* in Human-made Structures

Keith Geluso and Michael A. Bogan
U.S. Geological Survey, Museum of Southwestern Biology
University of New Mexico, Albuquerque, NM 87131

For many species of bats, little is known about the criteria used by them to select their roosts. Because roosts serve many functions including protection from predators and inclement weather, places to bear and raise young, and areas to digest, rest, groom, copulate, and hibernate, each roost may contain a suite of characteristics that provide bats with advantages for survival and reproductive success. We examined the selection of maternity roosts in little brown bats (*Myotis lucifugus*) in Wyoming and Montana. We compared daily temperatures and the size of roosting space in human-made structures occupied by bats to other structures without bats. After analyzing minimum and maximum temperatures female *M. lucifugus* consistently selected structures with warmer nighttime minimum temperatures and roosting spaces 5cm or less in width. In contrast, no pattern of selection was observed with maximum temperatures in structures. Elucidating the criteria used by little brown bats in selecting maternity roosts may help ameliorate conflict between these bats and building managers. For example, our data suggest that it may be possible to modify structures currently occupied by bats to make them less desirable and, in turn, to build bat houses that provide specific temperatures preferred by these bats.

The Composition and Structure of the Phyllostomid Bat Community in Fragmented Atlantic Forest of Paraguay: A Preliminary Assessment

Marcos Gorresen and Michael R. Willig
Program in Ecology and Conservation Biology, Department of Biological Sciences
and The Museum, Texas Tech University, Lubbock, TX 79409-3131

Habitat loss and fragmentation pose serious threats to the preservation of global biological diversity. The sub-tropical Atlantic forest of eastern Paraguay currently is experiencing exceptionally high rates of both compared to tropical and temperate counterparts. Nonetheless, little is known about the effects of such anthropogenic activities on populations or communities of bats, even though these species provide vital services to the ecosystem via pollination and seed dispersal. This study characterized the local and regional composition and structure of phyllostomid bat communities as part of research concerning the response of bats to the spatial complexity of habitats at the scale of the landscape. More than 1,000 hours of surveys over a 15 month period elucidated the composition and structure of the phyllostomid bat

community in a 3,000 km2 region comprising a range of successional conditions. Rarefaction (random sub-sampling) methods were used to standardize measures of species richness and evenness by accounting for differences in sample size among forest fragments. Indices generated from rarefaction curves were used in determining the structure of the phyllostomid assemblages at 14 sites. Multidimensional correlation tests of ranked species abundance identified indifferences in assemblage structure among sites. Ordination of the assemblages identified species distributions characteristic of fine-grained (small habitat patches, low dispersion), course-grained (large patches, high dispersion), and primary forest dominated landscapes. Together, these analyses provide insight into the long-term effects of continued habitat loss and fragmentation in interior Atlantic forest.

Practical and Experimental Consideration for Designing and Conducting Field Studies Using Anabat Detectors

John P. Hayes
Department of Forest Science, Oregon State University, Corvallis, OR

Anabat II bat detectors are increasingly used in field studies and monitoring activities. The efficacy of using Anabats to achieve research or management objectives depends, in part, on the design of protocols used. In this presentation I discuss behavioral patterns of bats and characteristics of Anabat detectors in relation to protocols for using Anabat detectors. Bat activity varies in both time and space, and this variation has ramifications to the design of data collected using Anabats at two streams in western Oregon indicates that variation both within and among nights is extremely high. Activity varied by several-fold on consecutive nights. These data suggest that at least 6 to 8 nights of data are needed from a site to accurately estimate levels of activity at a site. For comparisons among sites increased sampling efficiency is gained; by simultaneously sampling multiple sites. In addition, although activity of bats frequently exhibited a bimodal pattern, patterns varied substantially among nights. Consequently, comparison of activity based on portions of a night can be misleading. Patterns of activity of bats also vary with height above the ground. As a result, data from ground-based detectors should be interpreted with the recognition that these data may not accurately reflect total levels of activity at a site. Sensitivity of detectors can vary dramatically, necessitating calibration of detectors when multiple detectors are used for comparative studies. Despite limitations of data collected using bat detectors, they remain the most effective tool for collecting some types of information on the behavior and ecology of bats. Attention to experimental design can strengthen inference of data collected using Anabat detectors.

Evaluating Bat Activity Using Acoustic Sampling Along Transects

Shauna Haymond[1] and Duke S. Rogers[2]
[1]Museum of Southwester Biology, University of New Mexico, Albuquerque, NM 87131
[2]Department of Zoology, Brigham Young University, Provo, UT 84602

Acoustic sampling was used to identify bat activity on the Idaho National Engineering and Environmental Laboratory (INEEL) in southeastern Idaho in the summer of 1996 and 1998. A transect was established in each major vegetation type: Juniper woodland, sagebrush, grassland, and riparian habitat along the Big Lost River. The grassland transect was sampled only in 1998. Sampling stations were spaced at regular intervals along each transect and each station was sampled for ten minutes. Each transect

was sampled at one, three, and five hours after sunset for at least three nights. Recordings were used to count the number of echolocation calls logged in each vegetative zone and during each time interval. Calls needed to be composed of at least three pulses to be counted. Juniper woodland had the highest number of echolocation calls both years, more than twice the number of calls sampled in other vegetation types. In 1996, activity was second highest along the Big Lost River and lowest on the sagebrush transect. In 1998, activity was second highest along the sagebrush transect, followed by the Big Lost River and grassland transects, respectively. The number of echolocation calls recorded along the Big Lost River in 1996 (when the river was flowing). The majority of bat activity occurred during samples taken at one and three hours after sunset.

Phylogenetic Assessment of Vespertilionids Based on DNA Sequences of Mitochondrial Ribosomal Genes

Steven R. Hoofer and Ronald A. Van Den Bussche
Department of Zoology, Oklahoma State University, Stillwater, OK

Vespertilionidae is a large and diverse assemblage of small, primarily insectivorous bats (about 350 of 942 bat species) that is nearly cosmopolitan in distribution. Although a considerable amount of information is known about vespertilionids, their phylogenetic relationships remain conjectural at both higher and lower taxonomic levels. Recent studies of higher-level relationships based on diverse data sets such as morphology, karyology, immunology, embryology, and nucleotide sequences have suggested that some members of Vespertilionidae should be removed and either raised to familial rank (e.g., Miniopterinae) or placed with the family Molossidae (e.g., *Antrozous, Tomopeas).* However, different studies have suggested different classifications and no consensus has been reached. We are examining taxonomic relationships of Vespertilionidae with the use of sequence data from three adjacent genes (12SrRNA^{Val},16S rRNA) in the mitochondrial genome (about 2.6kb of contiguous sequence). We have sequenced these genes from 50 vespertilionids (representing 22 genera and all but one subfamily), 15 molossids and several outgroup species. Although our data set is only about one-third complete (i.e. we will sequence about 100 are taxa), preliminary analysis offers support to the traditional classification of vespertilionids. We will discuss the taxonomic implication and utility of these data.

Cranial Morphometrics of the Genus *Sturnia*: A Comparison of Two Techniques

Carlos A. Iudica[1] and Ricardo M. Holdo[2]
[1]Mammalogy – Florida Museum of Natural History and [2]Department of Zoology
University of Florida, Gainesville, FL 32611

The Neotropical fruit bat tribe Stenodermatini consists of about 68 recognized species in 19 genera. Of those 19 genera, 11 are monotypic and only three have 10 or more species. One of those three is the genus Sturnira, which may be recognized by a highly reduced interfemoral membrane and the lack of a tail. This genus inhabits several types of landscape and has a geographical range extending from MW Mexicoto Argentina. As part of an ongoing systematic review of the genus *Sturnira* two morphometric techniques were used and their results compared. Species of the genus *Sturnira* were classified by Hierarchical Cluster Analysis using an average distance method for cluster formation. Two dendrograms were produced, one using traditional cranial morphological measures standardized to account for size differences and one using Elliptical Fourier Analysis on skull and mandible contours. The two trees thus generated are compared and contrasted preliminary results are presented and working hypotheses offered.

Dietary and Foraging Style Differences Between Two Populations of Pallid Bats (*Antrozous pallidus*) at the Populations and Individual Levels

Dave S. Johnston,
H.T. Harvey and Associates, PO Box 1180, Alviso, CA 95002

I analyzed fecal samples from tagged, individual adult make pallid bats for the summer of 1993 and 1994 from a colony on the California coast and from a colony in Death Valley for the summers of 1994 and 1995. Analysis of fecal pellets suggested that the dietary analysis by culled parts was biased with underestimated

numbers of smaller prey and prey with only soft parts. A comparison of pooled dietary data from individuals with the diets of these same bats treated as individuals in the coast populations and a generalist group with generalized individuals in the Death Valley population. Coastal bats did not significantly change their diets temporarily during summer months, but the Death Valley bats did. Both groups ate different prey than arthropods caught in pt traps suggesting both populations are selective forager. I captured 6 of the individually-tagged bats from the coast and 5 of the individually-tagged bats from Death Valley, each with known dietary histories, to test for differences in foraging behavior at the individual and population levels. Two behavioral foraging style types, flyers and crawlers, exist in captives from the coast, which I correlated to field data on their dietary preferences. A weak relationship exists between foraging style and diet in the Death Valley population.

Acoustic Identification of Bats from Time-Expanded Recordings of Echolocation Calls

Gareth Jones, Nancy Vaughan and Stuart Parsons
School of Biological Sciences, University of Bristol, Bristol, England

The echolocation calls of bats are influenced by ecology and morphology. For example, many species which forage close to clutter produce short duration calls to avoid pulse-echo overlap. Large species typically produce calls of lower frequency and at lower repetition rates than do related smaller species. Biologists can use this interspecific variation for species identification in many cases. Species can also sometimes be identified from distinctive social calls. We use broadband, time-expanded recordings of ultrasound and sonographic analysis to extract detailed information from call sequences. We outline how successful this approach has been for identifying British species. We show how multivariate models can be used to assess habitat used by species objectively across habitats in broadband acoustical surveys. We asked whether foraging success can be estimated from the ratios of "feeding buzzes" to bar passes, and whether foraging success can be deduced from variation in the structure of feeding buzzes. Acoustic analyses have also been used for the identification of hitherto undescribed cryptic species that use different echolocation calls. We also consider how analyses can be improved by use of artificial neural networks and by automation.

What Does it Cost to Be a Bat? A Time Energy Approach

Thomas H. Kunz
Boston University, Boston, MA 02215

In this paper I review research over the past ten years, in which we have used a variety of techniques, including doubly labeled water, respirometry, dietary analysis, body composition analysis, calorimetry, proximate analysis of milk, radiotelemetry, PIT tag recordings, infrared thermography, and night vision observations, to explore how bats allocate time and energy roosting, foraging and reproduction. Compared to most other small mammals, bats are unique in how they allocate time and energy to foraging,

reproduction and other life-history events. Foraging activity is generally restricted to the night-time, with one or more intervening night-roosting periods. Bats spend the daylight hours roosting alone, in small social groups, or large aggregations ranging from hundreds upwards to twenty million individuals in a single roost. Females typically give birth annually to a single offspring ranging from 18 to 30 percent of their mother's body mass, and most females suckle their young until the pups are nearly adult size. Temperate species such as *Myotis lucifugus* and *Eptesicus fuscus*, are under strong selection pressure to produce offspring early in a short growing season so that their young have time to deposit fat reserves to survive their first hibernation, and for adult males and females to adequate fat reserves to sustain autumn mating and to survive hibernation, and for females to ovulate and sustain gestation in the following spring. For highly gregarious species, such as *Tadarida brasiliensis*, the expected high energetic costs associated with long nightly commuting flights appear to be compensated for by roosting in a warm thermal environment and the consumption of energy rich insects.

Molecular Systematics of the Mormoopidae and Noctilionidae Using Cytochrome B Sequence Data

Nicole Lewis-Oritt and Robert J. Baker
Department of Biological Sciences, Texas Tech University, Lubbock, TX

Our study used cytochrome *b* sequence data of mitochondrial DNA to infer the phylogenetic relationships among three genera of bats: *Mormoops*, *Pteronotus* and *Noctilio*. Traditionally, the two genera of the family Mormoopidae, *Mormoops* and *Pteronotus* have been grouped together; however immunological data by Honeycutt (1981) suggest that this family may be paraphylletic. Also problematic is the correct phylogenetic position of *Noctilio*, which has been placed within the families Emballonuridae, Mormoopidae, or Phyllostomidae, as well as, elevated to its own family, Noctilionidae. At present, there are eight recognized species belong to the family Mormoopidae and two species belonging to the family Noctilionidae. The primary objective of our project is to resolve the relationships among these three genera of bats. The resolution of the interrelationships among the different taxa of Mormoopidae and Noctilionidae is critical to the understanding the phylogeny of these families and their relationship to Phyllostomidae, especially as it relates to reconstruction of the primitive character states at the bases of their radiations. *Uroderma, Artibeus*, and *Macrotus* which belong to the family Phyllostomidae will be used as outgroups. Several analyses will be performed to assess phylogenetic relationships including parsimony using both Bremmer and bootstrap support and estimation of numerical genetic distances. Preliminary sequence data support positioning *Pteronotus* as a sister taxon to *Noctilio*, excluding *Mormoops*. These data suggest a paraphyletic relationship among these three genera.

Dietary Variation in the Mexican Long-Nosed Bat *Leptonycteris nivals* Revealed by Stable Isotope Analysis

Arnulfo Moreno-Valdez and Thomas W. Boutton
Dep. of Wildlife and Fisheries Sciences, and Dept. of Rangeland Ecology and Management,
Texas A&M University, College Station, TX

We used stable isotope analyses to study individual latitudinal and seasonal variation in Mexican long-nosed bat (*Leptonycteris nivalis*) diet. We used museum and wild-caught specimens covering the species' distribution range. Results indicated that these bats fed extensively on CAM plants (agaves and cacti) through the range. $\delta^{13}C$ values according to sex, age, and reproductive condition. No individual variation in $\delta^{15}N$ was observed except that sub-adults had higher values than adults. Wild-caught specimens were obtained from April-September 1998 from a single locality in northern Mexico. Bats captured in April

showed lower $\delta^{13}C$ values than specimens from September. Despite this seasonal variation in $\delta^{13}C$, all values were within the range of CAM plants. No seasonal variation in $\delta^{15}N$ was detected. Latitudinal variation was observed in $\delta^{13}C$ with bats at southern latitudes showing lower $\delta^{13}C$ than bats at northern latitudes. In general these findings support the presence of a nectar corridor composed primarily of CAM plants and supporting the migration of this endangered species. Based on the distribution of columnar cacti and agave within the Mexican long-nosed bat range, we speculate that north of 24°N this corridor is dominated by agaves and south of 24°N by columnar cacti and some C3 plants.

Activity Patterns of Mexican Free-Tailed Bats *Tadarida brasiliensis mexicana*

Michael P. Mulheisen and Troy L. Best
Department of Zoology and Wildlife Science, Auburn University, AL

Activity patterns of *Tadarida brasiliensis mexicana* from Carlsbad Cavern, Carlsbad Caverns National Park, Eddy Co., New Mexico were recorded using the method described in Mulheisen and Bemis (in litt). They were recorded for 167 days from 1 April through 14 September 1998. Observational data were collected on emergence of bats. Levels of activity were calculated as bat units for each 15 minute period throughout the day. Temporal data, length of emergence, length of return, and time spent away from roost were assessed. Data were presented in tabular form and analyzed to illustrate changes in activity patterns over time and when categorized according to abiotic (weather related) and physiological (reproductive status) variables. Data will be presented to illustrate changes in activity patterns.

A Comparison of Acoustic Sampling and Mist Netting in Assessing Bat Species Presence

Kevin L. Murray, Eric R. Britzke, Brad M. Hadley, and Lynn W. Robbins
Department of Biology, Southwest Missouri State University, Springfield, MO 65804

A survey of bat communities was conducted in Missouri during the summer of 1998 using both mist nets and Anabat. Mist nets provide valuable information about population demographics and species diversity within bat communities. However, they can yield biased samples of bat community activity and may cause undue stress to captured bats. The use of ultrasonic bat detectors like Anabat can ameliorate some of these problems. Bat detectors are relatively easy to set up, require no direct contact with bats and can sample a wider variety of habitats. To test the relative merits of these two methods, we sampled a variety of habitats including ponds, streams, and flyways using Anabat and mist nets in a paired design. This allowed for the simultaneous sampling of bat community activity necessary for direct comparison. Echolocation calls recorded by the Anabat were identified using a discriminate function analysis model based upon a library of know call sequences. Overall, values for species richness were significantly higher for Anabat II than for mist nets ($P = 0.004$). Species richness was consistently higher for Anabat for all habitats, and seven individual species and one species group was detected more frequently with Anabat than with mist nets. The Anabat system provides an effective means of documenting species composition in an area.

Nocturnal Activity of the Endangered Indiana Bat *Myotis sodalis* in Southern Michigan

Susan M. Murray and Allen Kurtaß
Department of Biology, Eastern Michigan University, Ypsilanti, MI 48197

In recent years, a wealth of data has accumulated concerning habitat and roost-site selection by tree-dwelling bats in summer, but relatively little information is available on what these animals do at night. We studied individual Indiana bats (*Myotis sodalis*) to determine how they commuted from their roost to foraging grounds, where and how long they foraged, and whether they used night roosts. We followed radiotagged bats as closely as possible and monitored the strength and direction of the signal every 10 minutes throughout the night. Pregnant (n = 6) and lactating (n = 4) bats foraged mostly in forested areas and typically flew in the cover of trees, following wooded fencelines, forested streambanks, etc. At least eight different foraging areas were used by the group, and individual bats typically used one to four discrete foraging areas each night. Foraging areas were up to 4km (straight-line) from the day roost, and different bats from the same colony foraged in areas up to 6km apart in the same night. Pregnant bats did not return to the day roost before dawn but night-roosted an average 2.8 times each night within a single night, and there was no evidence of a communal night roost such as that used by the building-dwelling little brown bat (*Myotis lucifugus*). Lactating bats returned to the dayroost 2-3 times per night, presumably to feed their young and remained an average of 35 minutes per visit. In addition to using the day roost, lactating bats night-roosted within their foraging areas 1.3 times per night.

Bat Responses to Riparian Buffer Strips in Managed Forests

Margaret A. O'Connell and James G. Hallett
Biology Department, Eastern Washington University, Cheney, WA 99004
Zoology Department, Washington State University, Pullman, WA 99164

To reduce the negative consequences of forest harvest on riparian areas, forest management practices require retention to trees along streams to create riparian buffer strips. We experimentally examined the effects of two prescriptions for such strips on bat activity in NE Washington : current state guidelines and a modified prescription that buffered snags and seeps in the riparian zone. We studied 18 streams including 7 unharvested controls, 6 state harvest sites, and 5 modified harvest sites. Two 800m transects were established parallel to the stream and at 8m (riparian) and 100m (upland) from the stream. Anabat ultrasonic detectors were placed on riparian transects for 2 nights per month in summer 1993-1995 and on riparian and upland transects for 2 nights per month in summer 1996. A total of 451 sample nights yielded 6,402 calls of *Eptesicus fuscus, Lasionycteris noctivagans, Lasurius cinereus, corynorhinus townsendii,* and a *Myotis* group. The number of call of Eptesicus was greater in upland than riparian habitats on cut sites, but did not differ for controls. Activity of *E. fuscus* in the riparian habitat was greater on state sites, but calls per sample night decreased between pre- and post-harvest on state sites. Mean number of calls and feeding buzzes per night were great in riparian than upland habitats on all sites for the *Myotis*. Number of calls per night for *Myotis* in the riparian habitat was greater after harvest on modified sites, which may be due to retention of snags on these sites.

Geographic Variation in the Echolocation Calls of the Hoary Bat *Lasiurus cinereus*

Michael O'Farrell[1], Chris Corben[2] and William L. Gannon[3]
[1,2] Biological Consulting, 2912 North Jones Boulevard, Las Vegas, NV 89108
[2,3] Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM 87131 (WLG)

The use of bat detectors to perform inventories, determine activity, and assess differential use of habitats has become a generally accepted methodology. However, there has been vigorous disagreement as to the level of efficacy, primarily relating to the ability to distinguish certain species and groups of species. The primary explanation suggested for the inability to identify certain species is the magnitude of intraspecific variation resulting in considerable overlap among species, presumably compounded by geographic variation. We find that claims of geographic variation have not been proven due to small sample size and lack of adequate description of methodology, including the behavior of the bat and the context during which bats were recorded. Previous geographical comparisons of species have relied on standard statistical methods that do not allow a comprehensive examination of the range in variation of diagnostic call parameters. We demonstrate a graphical approach to describe variation in structure of calls (i.e., a two-dimension plot of characteristic frequency versus duration). Although we demonstrated a statistical finding of geographic variation in *Lasiurus cinereus*, small sample size, context, and behavior could not be discounted as the proximal cause of observed variation. Most notably, the perceived variation across the geographic range that we sampled did not affect our ability to identify the species by call structure.

Bat Use of High Plains Urban Wildlife Refuge: Species Composition, Foraging, Roosting Habit Use, and Status in Relation to Contaminates

Thomas O'Shea, Lance Everette, Laura Stone, James McCance, and Laura Ellison
U.S. Geological Survey, Mid-continent Ecological Science Center
4512 McMurray Ave, Fort Collins, CO 80525

We studied bat use of Rocky Mountain Arsenal (RMA) National Wildlife Refuge in summers 1997 and 1998. The refuge is located on the urban fringe of Denver, Colorado, adjacent to Denver International Airport and has relatively simple landscape features consisting of short-grass prairie, small reservoirs, and limited patches of mature cottonwood groves. Surveys with mist nets showed that big brown bats (*Eptesicus fuscus*) were the dominant bat species foraging on the refuge, followed by *Lasiurus cinereus* and *Lasionycteris noctivagens*. These findings were consistent with records of bats from surrounding areas documented by museums and public health agencies. Bat activity as measured with ultrasonic sensors was lowest over open prairie and highest at sites with both water and tree edge habitat. Female big brown bats roosted in core urban areas of Denver and commuted to the refuge to forage with 12 maternity colonies discovered by radiotelemetry located from 11 to 18 km from the point of capture at the refuge. RMA was a manufacturing site for chemical weapons during World War II and for pesticides afterwards. Contamination of the site with or organochlorines (especially cyclodienes and DDE) and arsenic and mercury is well known. Concentrations of these contaminates were determined in big brown bats which forage at RMA and their guano. Results are interpreted in comparison with the literature on this topic and with bats and guano from "control" sites in Fort Collins, Colorado.

The Role of the Subordinate Males in the Harem Groups of *Artibeus jamaicensis*

Jorge Ortega R. and Hector T. Arita
Depto. Ecologa de los Recursos Naturales
Instituto de Ecologa, UNAM. Ap. Postal 70-275, 04510, Mexico D.F. Mexico

Several bat species display polygyny as their usual mating system. Harem groups of *Artibeus jamaicensis* are composed of a dominant male and several females, with some exceptions where an extra male is associated (subordinate male). We describe the behavioral defense exhibited by the dominant males when an "outside" bat arrives into the harem territory. We also counted the number of visits that these "outside"bats made into the different harem groups which range between five to 20 females per group with one or two adult males associated. Finally we studied the role of the subordinate males when the dominant males have been removed, and we measured the activity of the dominant males when the subordinate males are absent in the same kind of experiments. Our results showed the medium size groups were the clusters with a higher number of visits, and the largest and smallest groups presented an equal number of visits. The largest groups were the only association with more than one adult male and we realized the experiments in these groups. Subordinate removal produces an increment in the number of visits than the foreign bats done, and the dominant males displayed a great number of agonistic interactions than when they were accompanied. When the dominant males were removed, their places were always quickly taken by the subordinate males who then displayed same agonistic as the dominant males. In contrast, in the more common groups with only one male associated, their places were occupied for a longer time by the satellite males, after a great number of fights among them with the subsequent substitution of the new dominant males.

Cytogeography of Philippine Bats

Eric A. Richart, Jennifer A. Mercier, and Lawrence R. Heaney
Utah Museum of Natural History, University of Utah, Salt Lake City, UT 84112
Field Museum of Natural History, Chicago, IL 60605

Standard karyotypes are available for 27 of the 73 species of bats known to occur in the Philippine Islands. These data reveal an underlying geographic patter karyotypic variation apparent at different taxonomic levels within several independent groups. Pteropodid and rhinolophid species endemic to the Philippines have karyotypes that represent major new arrangements for their families or genera. Some species that are wide spread in Asia are chromosomally polymorphic, exhibiting major differences between populations from within and outside of the Philippines. The historical development of the Philippine Islands and their mammal fauna provides the context for understanding this cytogeographic pattern. The large proportion of unique karyotypes seen among bats from the oceanic Philippines reflects the relative isolation of the archipelago from mainland southeast Asia.

Winter Roost Selection by Eastern Pipistrelles *Pipistrellus subflavus* in Texas

Jody K. Sandel, Grant R. Benetar, Christopher J. Walker, Thomas E. Lacher, Jr., and
Rodney L. Honeycutt [no addresses provided]

In a study designed to determine characteristics associated with winter hibernacula of the eastern pipistrelle (*Pipistrellus subflavus*), microclimate parameters, surrounding land-use patterns, and bat densities were record and compared between four study sites. A preliminary survey revealed that site use by bates was not consistent throughout the year; therefore, population parameters associated with season; changes in the total number, sex ratio, and degree of roost-site fidelity were recorded. No significant differences were found between microclimate parameters measured at any site, occupied or unoccupied.

Analysis of land-use data revealed a significantly higher percentage of urban land-use near the one location without a persistent bat population in an adjacent culvert with comparable criterion. The maximum number of bats peaked in December, with males consistently appearing in higher ratios than females. Bats exhibited variable fidelity to hibernacula during and between seasons. Recaptures ranged from 14 to 73% during both seasons with 24% of the bats captured during the first season returning the following year. These results suggest that selection of winter hibernacula in more temperate regions may not be dependent on microclimate parameters alone.

Bridge Use by Day Roosting Bats in Costa Rica

Richard E. Sherwin, Shauna Haymond and M. Scott Burt
Dept. of Biology, Museum of Southwestern Biology
University of New Mexico, Albuquerque, NM 87131

We surveyed bridges and culverts in Costa Rica for day roosting bats in April-May 1997 and May 1998. We surveyed all bridges along major roadways throughout the country. A suite of microhabitat and microhabitat parameters were collected at each site, including bridge dimensions, construction materials, bat species present, etc. At approximately 75 sites that were surveyed, 60 (80%) were occupied by day roosting bats representing seven species. We analyzed data to determine spatial partitioning, predictability of use, and types of use (i.e. maternity, bachelor). Spatial partitioning among species was maintained throughout the study area in a predictable pattern. Additionally, a correlation was observed between bridge type and species composition. Maternity colonies were common for all species excluding *Artibeus*. Due to the predictability of use and the ease of observation, bridges provide an excellent resource for studying inter and intraspecies interactions. Importance of bridges as day roosts is inferred by the frequent and predictable use by maternity colonies. Recommendations are made regarding future construction of bridges that will provide suitable roosting opportunities for these bat species.

Orientation of Northern Myotis *Myotis septentrionalis* Following Release in Daytime

Dale W. Sparks and Jeffrey A. Laborda
Department of Life Sciences, Indiana State University, Terre Haute, IN

A number of bats have been banded during ongoing studies of the utilization of bat-houses by the northern myotis, *Myotis septentrionalis*, near the Indianapolis International Airport. In 1997, we noticed that bats we captured and released often appeared to flee in the same direction. In addition, when bats were recaptured they were usually co-habiting with many of the same individuals. These observations led us to hypothesize that bats from a specific colony fled to a common point following banding. We tested this hypothesis by capturing and releasing bats from five colonies. All bats from a colony were released individually from a common point. The direction that each animal was released from was rotated systematically. Each animal was observed as long as possible and the last observed direction from the point of release was recorded. Some animals were seen to enter particular roosts, and these data were also recorded. Orientation data were subjected to a Raleigh; bats from four of the five colonies were found to show a significant orientation. Conversely, because bats from three of the five colonies entered more than one roost, we reject our initial hypothesis that the bats were fleeing to one particular roost. Although these data are preliminary, they do indicate that released bats do not randomly orient themselves. Future work will aim at examining which, if any, environmental factors may be associated with the directionality of bats following disturbance.

Life on the Biogeographic Edge:
Tropical Bats, Subtropical Communities and Seasonal Dynamics

R. D. Stevens, M. R. Willig, and R. E. Strauss
Department of Biological Sciences and the Museum
Texas Tech University, Lubbock, TX

Identifying mechanisms that account for general patterns in the composition and structure of natural communities is among the most challenging issues confronting ecology. Independent application of equilibrial and non-equilibrial models has provided only limited insight. For example recent studies involving bat communities have demonstrated considerable variation in the degree to which models of competitively induced structure apply to the New World. Perhaps competitive interactions only induce deterministic structure during narrow windows of time when resources are limiting. Thus in situations where resources are seasonally variable, annual or multiyear species lists may represent inappropriate data for testing models of community organization. Indeed, a better understanding of the effects of seasonality on community composition and structure may provide a vital clue towards identifying broad mechanisms that affect community organization. Paraguay lies at the southern extreme of the tropics, and harbors communities that comprise many species at their distributional and ecological limits. Seasonality may be especially taxing in these systems, and cause large intra-annual fluctuations in community composition and structure. As such we explore seasonal dynamics in the organization of the frugivore guild at two sites in eastern Paraguay (Reserva Natural del bosque Mabaracayu [RNBM] and Yaguarete Forests) by evaluating differences in: (1) species diversity, (2) species evenness, (3) guild composition, (4) density compensation, and (5) size assortment. We captured 5,555 bats representing 10 species of frugivores during this study. At RNBM, we captured 8 species (2,754 individuals) in summer and 7 species (453 individuals) in winter. At Yaguarete Forests we captured 10 species (1,825 individuals) during summer and 7 species (523 individuals) in winter. Taxonomic composition differed consistently between seasons at both sites. Based on randomization tests, both diversity and evenness tended to be higher at each site during winter. Measures of structure also were affected by seasonality, but responses were complex and dependent on site. Competitive interactions were unimportant in structuring the community at RNBM whereas, at Yaguarete forest they elicited structure. In both seasons at Yaguarete forests, species represented a morphologically hyperdispersed subset of the bat fauna. Moreover, changes in abundance coincided with a higher degree of density compensation in the winter. Thus the competitive interactions were more extreme in the winter, controlling which species co-occur as well as their abundances, clearly, a greater knowledge of the ways in which species composition, community structure, and seasonality interact is a prerequisite to a more comprehensive understanding of the organization of communities.

Karst Hydrology and the Selective use of Ephemeral Karst Lake Ecosystems by Bats in Early Spring

Michael Stokes and James Armstrong
Center for Biodiversity Studies, Department of Biology
Western Kentucky University, Bowling Green, KY 42101

The karst Pennyroyal Plain covers a large portion of south central Kentucky and exhibits such unusual features as sinkhole plains, disappearing streams, and ephemeral karst lakes. Ephemeral lakes such as Chaney Lake State Nature preserve are especially important features because natural lentic waters are extremely rare throughout the region. While the hydrology and geology of these lakes is well described,

their ecological importance is largely undetermined. Two unique features of these lakes are their filling patterns and seasonality. During the winter and spring, these lakes fill largely due to the upwelling of warm water from underlying cave systems, followed by complete drying during the summer and fall. Because of their relative warmth and absence of sustained populations of fish, these lakes are hypothesized to provide ideal early breeding sites for aquatic insects and amphibians. Bats are an important part of the mammalian fauna region, of which four are endangered at the state of federal levels. During the spring, when volant insects are relatively rare, we hypothesized that ephemeral karst lakes would provide ideal bat foraging sites due to accelerated development of aquatic insect larvae. In 1998, we compared Chaney Lake to a nearby reference impoundment and found that spring water temperatures were significantly higher in Chaney Lake and that numbers of breeding frogs, based on call counts, were significantly greater in Chaney Lake. Bat foraging effort was evaluated by focal sampling. The number of flights through the field of view of nigh-vision devices was recorded over predefined times with sampling conducted simultaneously at Chaney Lake and the reference impoundment. Statistically more flights were recorded at Chaney Lake. Sampling at Chaney Lake will be continued throughout spring, 1999.

Social Structure of a Polygynous Tent-making Bat, ***Cynopterus sphinx***

Jay F. Storz, Department of Biology, Boston University, Boston, MA

Social structure of an Old World tent-making bat, *Cynopterus sphinx* (Megachiroptera) was investigated in western India over a two-year period (1996-1998). Breeding populations of *C. sphinx* are subdivided into discrete harem groups containing 1 – 38 reproductive females and a single territorial male. A combination of census and mark-recapture data was used to infer the form of mating system, length of breeding tenure of harem males, compositional stability of social groups, rates of dispersal, and mode of new group formation. The operational sex -ratio averaged 1:8.85 (M:F), indicating the potential for an extremely high variance in male mating success. Juveniles of both sexes dispersed after weaning and sexually immature bats were never present in harems at the time of parturition. Adult females often remained associated as roostmates from one parturition period to the next, and group cohesion was unaffected by turnover of harem males. Adult females frequently transferred among tents within the same colony, and harems underwent periodic fissions and fusions. The founding of new harems most often resulted from the fissioning of previously cohesive harems within the same colony. A significant degree of heterogeneity in age composition among harems was evident, but was unrelated to age stratification of tent roosts. I tested predictions about the genetic consequences of harem polygyny using estimates of effective populations sizes based on temporal(adult-progeny) variance in microsatellite allele frequencies over three consecutive reproductive cycles.

Confirmation of Allozyme Distinctness Between ***Myotis lycifugus*** **and** ***Myotis yumanensis*** **in the Pacific Northwest**

Ernest W. Valdez[1] and Aida M. Parkinson[2]

[1]United States Geological Survey, Mid-continent Ecological Science Center, Department of Biology, University of New Mexico, Albuquerque, New Mexico 87131

[2]Redwood National and State Parks, Arcata, CA 95521

In the Pacific Northwest, *Myotis lucifugus carissima* and *Myotis yumanensis sociabilis* can be difficult to distinguish due to similar morphology. Often these two species are found occupying the same roost and are believed by some authors to hybridize. Earlier morphological analyses provided criteria for separating the two species. However, some individual bats remain difficult to identify. We performed an allozyme

analysis on a total of 90 specimens. Fifty-eight of these specimens were regarded as either *M. l. carissima* or *M. y. sociabilis* from northeaster California and south central Oregon. We also used 13 specimens of *M. y. yumanensis* from Bosque Del Apache National Wildlife Refuge, New Mexico, and 19 specimens of *M. l. carissima* from Yellowstone National Park, Wyoming as control samples. We found three fixed allelic differences (GOT, PGI-1, and SOD-1 loci) between *M. yumanensis* and *M. lucifugus*. There was no biochemical evidence of hybridization in any of the specimens we examined despite morphological similarities noted by some authors.

Phylogenetic Affinities of the New Zealand Short-Tailed Bat *Mystacina tuberculata* Based on DNA sequences of Mitochondrial Ribosomal Genes

Ronald A. Van Den Bussche and Steven R. Hoofer
Department of Zoology, Oklahoma State University, Stillwater, OK 74078

The New Zealand short-tailed bat *Mystacina tuberculata* is the sole extant member of Nystacinidae and is one of two endemic mammals in New Zealand. Although *M. tuberculata* is unique ecologically and has several distinguishing morphological adaptations, it shares several derived characters with other families of bats. Based on morphological data, *Mystacina* has been placed in or near families of three of the four traditional superfamilies of Microchiroptera (all except Rhinolophoidea), but the general consensus has been the *Mystacina* shares its closest phylogenetic affinities with Molossidae. However, recent study of immunological data and DNA-DNA hybridization comparisons were interpreted as *Mystacina* sharing its most recent common ancestor with Noctilionoidea. This phylogenetic hypothesis suggests that the most recent common ancestor of *Mystacina* was shared with three families of bats restricted to the New World (Phyllostomidae, Mormoopidae, Noctilionidae) and requires an explanation invoking vicariance, long-distance dispersal, or convergent evolution at least two independent molecular data sets for this phylogenetic relationship. To provide an independent assessment of the phylogenetic affinities of *M. tuberculata* we generated approximately 2.6 kilobase pairs of DNA sequence data from these three mitochondrial genes corroborate previous molecular studies by strongly supporting a *Mystacina*-Noctilionoidea relationship.

Echolocation Calls, Wing Morphology and Foraging Ecology of Bats from the West Indies

Nancy Vaughn[1], Kate E. Barlow[2] and Michael R. Gannon[3]
[1]School of Biological Sciences, University of Bristol, Woodland Road, Bristol BS8 1UG, UK
[2]British Antarctic Survey, High Cross, Madingley Road Cambridge CB3 0ET, UK
[3]Dept. Biology, The Pennsylvania State University, 3000 Ivyside Park, Altoona, PA 16601-3760

Echolocation calls, wing morphology and foraging ecology are closely related in bats. The echolocation calls of 157 bats belonging to 17 subspecies in 4 families from the Antillean islands of Puerto Rico, Dominica and St. Vincent were recorded by using time expansion bat detectors. Sonograms of the echolocation calls and descriptive statistics of six time and frequency variables of calls are presented. The echolocation calls of many of these subspecies (particularly those belonging to the Phyllostomidae) have not yet been described. The wing morphology of each subspecies (described in terms of aspect ratio, wing loading and other aerodynamic parameters) is used to predict its maneuverability and agility. The structure of each subspecies' echolocation calls and its flight behavior are related to what is known of its foraging ecology and to the preception techniques it uses in foraging.

Production and Display of Odor in Courting Male *Saccopteryx bilineata*

Christian C. Voigt
Department of Biology, Boston University, Boston, MA

The role of olfaction in female choice probably is a common and general phenomenon in mammals. Odors could be a reliable cue for female choice if they are costly to produce or impossible to fake. I studied male *Saccopteryx bilineata* with respect to the production and use of scent for courtship display. Colonies of the *polygynous S. bilineata* consist of harem territories that are defended by single males. Although males monopolize territories in which females gather, females seem to be able to choose the father of their progeny freely among the males of a colony. Courting males perform hovering flights in front of females during which odor is displayed from sacs in the wing membrane. A previous study showed that the number of hovering displays and flight maneuvers of a harem male is positively correlated with the harem size, implying that the energetic costs of harem maintenance is increasing with the number of females in a harem. Adult male *Saccopteryx* actively produce the odor of the wing sacs by transferring urine, saliva and secretions from the genital and gular regions in a stereotypic manner into the sacs. I tested whether the displayed odor is costly to produce by comparing the mode of odor production in males with different harem sizes.

Phylogeography of the Big Brown Bat *Eptesicus fuscus* in North America

Bronwyn W. Williams[1], Thomas H. Kunz[2], Viriginia Hayssen[1], and Michael D. Sorenson[2]
[1]Department of Biology, Smith College, Northampton, MA 01063
[2]Department of Biology, Boston University, Boston, MA 02215

The big brown bat (*Eptesicus fuscus*) is widely distributed in North and Central America where it occupies many different habitats and forms relatively discrete breeding colonies in buildings and hollow trees. Strong female site fidelity suggests the potential for significant phylogeographic structure in mitochondrial DNA (mtDNA) and the opportunity to explore the historical relationships among big brown bat populations and subspecies. We extracted DNA from wing and/or muscle biopsies from samples representing various regions across the North American continent and sequenced the hypervariable 5 end of the mtDNA control region. Preliminary analysis of samples from Massachusetts, New York, Wisconsin, Idaho, Kansas, Nebraska and California reveals substantial differences in mtDNA sequences between eastern and western populations and in the number of repeat units (~82 base pairs each) in the control region.

Species-Abundance Distributions and Dominance-Diversity Relationships of Assemblages of Paraguayan Bats

M.R. Willig[1,2], S. J. Presley[1], and R. D. Owen[1]
[1]Department of Biological Sciences and The Museum, Texas Tech University, Lubbock, TX 79409
[2]National Center for Ecological Analysis and Synthesis, Univ. California at Santa Barbara, CA 93101

Geographic patterns in diversity have long intrigued evolutionary biologists. Although a number of metrics (e.g., richness or evenness) are useful as encapsulations of the essence of diversity, empirical species abundance distributions may provide the most insight into broad-scale patterns of diversity. As such, we determined the species abundance distributions for each of three feedings guilds of bats (i.e., frugivores, molossid insectivores, and aerial insectivores) across 25 sites in Paraguay, representing all

major phytogeographic regions of the country. Analyses are based on data from the first 22 months of the expedition and approximately 4000 bat captures representing 44 species. By restricting analyses of data to feeding guilds, we enhanced the likelihood that estimates of relative abundance were meaningful. At each site, we evaluated the hypothesis that each guild exhibited a geometric distribution, and used the slope of that relationship as a measure of dominance. For each guild, we evaluated the hypothesis that dominance was related to richness via regression analyses. In addition, we tested the hypothesis that geographic variation in species abundance distributions was related to phytogeographic considerations through a series of hierarchical G-tests. Our results indicate that the geometric distribution is a good representation of the diversity of bat guilds at the local level, that dominance is related to richness in a guild-specific fashion, and that dominance always increases significantly with decreases in richness regardless of guild. Moreover, considerable geographic heterogeneity characterizes the species abundance distribution of guilds, and a significant portion of that heterogeneity is a consequence of phytogeographic considerations.

Abstracts of Presentations at the VIIIth European Bat Research Symposium August 23-27, 1999 Warsaw, Poland

The following abstracts were made available on a "floppy disc" of poor quality. The best possible efforts were made to copy as nearly as possible all the many variations on the English alphabet commonly used by other languages. In a few cases sentences were modified to correct some very peculiar sentence structure that occasionally occurs when workers are writing in what may be a third or fourth language. Certainly many errors remain, some inadvertently introduced as the abstracts were copied for production here. All such errors are unintentional, and if this changed the context, apologies to the authors. In an effort to conserve space only the addresses of the first authors is provided. The editor also apologizes in advance for any awkward page breaks which may separate a title from its text. The editor thanks all of you for your understanding and patience. G. R. Horst

CONTRIBUTIONS TO THE TROPHIC ECOLOGY OF BATS IN THE UPPER RHINE VALLEY, SOUTHWEST GERMANY

Andreas Arnold, Monika Braun, Norbert Becker & Volker Storch
[1]German Mosquito Control Association (K.A.B.S.), Waldsee.

Though the number of bats in Central Europe has been declining in the past 50 years there is still a large number of bat species and individuals present in the floodplain forests of the Upper Rhine Valley. Over a three year period an investigation was made to assess the potential impact of a large-scale program for biological control of mosquitoes on the local bat population. Besides other studies the droppings of Daubenton's and Nathusius' bats (*Myotis daubentonii* and *Pipistrellus nathusii*) were analysed in order to find out which role the mosquitoes, as well as other insect groups, might play in their diets. The results showed that both species fed mainly on small to medium sized insects belonging to the groups Diptera and Trichoptera. Through the course of the summer the Daubenton's bats showed a significant alteration in their diets' composition. Notable differences were observed between spring and summer indicating a change in the hunting strategy. In spring the prey consisted mainly of waterborne midges whereas in summer the amount of non-waterborne insects increased considerably indicating that the bats more frequently hunted in forests or over land. In the diet of Nathusius' bats, Diptera was of major importance. Seasonal variations in the diet showed for this bat species a highly opportunistic feeding strategy concentrating on insects occurring in high densities. Though despite control measures mosquitoes were present in large numbers throughout the summer and the remnants of these insects were rarely observed in the bats diets. Since mosquitoes prefer to fly near ground and in dense vegetation they so avoided contact with bats. Therefore bats will not be harmed by controlling mosquitoes and, in contrast, can hardly be implemented in the biological control of mosquitoes.

FEEDING ECOLOGY OF A BAT COMMUNITY

Michal Andreas, Antonin Reiter, Petr Benda & Jan Zukal
Agency of Nature Conservation and Landscape Protection of the Czech Republic,
Kaliönická 4-6, CZ-130 23 Praha, Czech Republic

The presented summary shows the results of a long-term study of 16 different species of bats in the Podyji National Park community (SE Czech Republic). The diet composition was studied along with the food supply and spatial distribution. According to dominant food types we distinguished three main

foraging strategies. (1) Foliage gleaners are represented by *Myotis bechsteinii, M. nattereri, M. emarginatus, Plecotus auritus* and *P. austriacus*. These bats feed frequently on wingless arthropods like Lepidoptera larvae, Araneida, and/or on rarely flying Dermaptera. Their food consists also of flying insects foraged probably on the leaf surfaces. (2) Aerial hawkers are *Barbastella barbastellus, Nyctalus noctula, N. leisleri, Myotis mystacinus, M. brandtii, M. daubentonii, Eptesicus serotinus, E. nilssonii, Pipistrellus pipistrellus* and *Rhinolophus hipposideros*. *B. barbastellus* specializes in hunting Lepidoptera adults. *E. serotinus* feeds mainly on Coleoptera (Scarabaeidae) and *Myotis spp.* on small Diptera (Nematocera). (3) Ground gleaners are represented by *M. myotis* feeding on Coleoptera. Not all bats can be divided into specific groups. For example *M. daubentonii* also uses gaffing on water surfaces and *P. austriacus* probably uses aerial hawking. *Eptesicus spp.* and *R. hipposideros* on the other hand display some features of foliage gleaning strategy. Comparing food supply and the diet composition, bats seem to be foraging opportunists. The only one exception is *B. barbastellus* - a
moth-eating specialist. Comparing foliage gleaning and aerial hawking strategies, we noticed higher flexibility of the first one. Foliage gleaning is also a more effective foraging strategy in early spring, before the appearance of prey groups which are important for aerial hawkers (Nematocera, Scarabaeidae, Trichoptera).

THE FRENCH BAT MAPPING PROJECT

Stephane Aulagnier, Patrick Haffner, Gerard Issartel, Francois Leboulenger,
Didier Masson, Francois Moutou & Sebastien Roué
S.F.E.P.M., c/o Service du Patrimoine Naturel, Museum National d' Histoire Naturelle, 57 rue Cuvier, 75231 Paris Cedex 05

In 1998, the French Mammal Society (S.F.E.P.M.) decided to update the atlas of French Mammals issued in 1984 and bats appeared to be the major group to start this work. With 30 species, they represent 30% of terrestial mammals, and after more than one decade of dramatically increasing prospects, they account for our best improvement of mammal populations knowledge. The French Bat Mapping Project was quickly initiated with the help of the regional contacts of the French Bat Group, and the issue of an atlas is planned for 2002. Questionnaires have been supplied to every bat worker, and some local databases are already gathered. For the final document, the mapping committee decided to provide (i) the distribution of the whole data distinguishing between information collected before 1985, hand and bat detector identifications for the period 1985-2000, and (ii) the distribution of breeding indices, as they are defined in the questionnaire. Each species will be supervised by the author of the text analysing the present distribution and recent trends. As a reference for conservation, this atlas will be supplemented with the Red Data List of French bats.

BATS AND LANDSCAPE PLANNING
CONFLICTS BETWEEN BAT FLIGHTPATHS AND MOTORWAYS

Lothar Bach & Herman J.G.A. Limpens. Hamfhofsweg 125 b, D-28357 Bremen, Germany

All over Europe, planning of motorways is a process with serious consequences for nature. In view of European and especially German law, and the circumstance that bats are good indicators for complex landscape relations, it is both necessary and advantageous, for both bat and general nature conservation, to consider bats in planning. We investigated an area in central Germany where a motorway was planned. The aim of our investigation was to assess the landscape use of bats close to the motorway corridor. In 14 nights between May and September we surveyed foraging and commuting bats, mapped their hunting habitats and flight paths and located their roosts. Several flight paths and hunting habitats were found

crossing or overlapping the core planning area. Conflicts between bat landscape use and the motorway corridor were assessed and analyzed and possible solutions in the form of tunnels or bridges for flight paths connecting the landscape on both sides of the motorway were suggested. With these relatively simple constructions it should be possible to keep the ecological infrastructure for bats intact. In addition we point out some ecological questions on bats, which should be studied in the future to enhance the integration of the study of bats in landscape planning.

ACTIVITY PATTERNS AND BEHAVIOUR OF THE BROWN LONG-EARED BAT, *PLECOTUS AURITUS*, INSIDE A ROOST DURING THE BREEDING SEASON

Jessamy Battersby. University of Sussex, School of Biological Sciences

Use of the roost environment by a maternity colony of brown long-eared bats, *Plecotus auritus*, during the breeding season was examined by using a remote infra-red video recording system. Behaviour and activity patterns of the bats and temperatures in various parts of the loft space were continuously recorded between May and September of 1998. External emergence counts were also carried out during this period to correlate the number of emerging bats with activity inside the roost. The roosting position of the bats and movement within the roost was related to circadian rhythms, roost temperature and breeding conditions. The entire colony roosted mainly in the apex of the roof during preparturition and once the juveniles were volant. However, during parturition and until juveniles were volant, pregnant and lactating females used a "creche" area beside a chimney breast, where the temperature was on average 3-8° C. warmer than the rest of the loft space, and had a lower temperature range. Flight activity was greatest during emergence from the roost and when bats were returning from foraging shortly before sunrise. However, bats were observed to use the roost space for flight activity throughout the dial period. Diurnal flight activity was low during preparturition and parturition, and was generally related to bats moving roosting positions within the loft space, but increased significantly once the juveniles were volant with continuous flight activity that had no obvious purpose. Nocturnal flight activity levels were higher than diurnal levels during preparturition and parturition but this changed when the juveniles became more volant outside the roost. Nocturnal flight activity was highest when the juveniles began to emerge from the "creche" area but before they became volant outside the roost. These results show that long-eared bats, particularly juveniles, consistently use the roost space for flight activity. They also show that dial movement within the roost environment is related to temperature. The importance of these results in relation to the ecomorphology and conservation of this species is discussed.

DO DENTAL INCREMENTAL LINES INDICATE ABSOLUTE AGE OF SMALL BATS ?

Darius Batulevicius, Neringa Pauziene & Dainius H. Pauza
Faculty of Environmental Sciences, Vytautas Magnus University, Kaunas, Lithuania
Lithuanian Bat Conservation Society, Lithuania

It is considered that counting the incremental lines (IL) in secondary dentine and cement provides the only method to estimate the absolute age of bats. The aim of this study was to examine the ILs of small bats and to determine whether the number of ILs is related to the actual animal's age. Twenty-six specimens of *Myotis daubentonii, M. nattereri, M. dasycneme, Barbastella barbastellus, Pipistrellus nathusii, Plecotus auritus* and *Vespertilio murinus* were investigated by means of light microscopy. The transverse 1μm sections of 42 canines (C1=20, C1=22), 26 incisors (I1=7, I2=9, I1=3, I2=3, I3=4) and 22 postcanine teeth (P2=4, P3=1, P2=7, P3=3, P4=3, M1=4) were analysed at 1000X magnification. The minimal age of three individuals examined in this study was known according to ringing data. From 10 years old canines and from 3-6 years old postcanine teeth and incisors, dentine lines (DL) were so decreased in width that their accurate counting was impossible to read. On the root level, DLs were the clearest, whereas they were almost obscured from a view at the crown level. Cemental ILs were not

determined in all specimens examined. In conclusion, the number of DLs do vary in different teeth and is dependent on the section level. The formation of DLs in small bats presumably varies from animal to animal. Therefore age determination in small bats by dental ILs is doubtful, especially for animals older than 10 years.

ECOLOGICAL CONDITIONS OF URBANIZATION OF *NYCTALUS NOCTULA*

Zoltan Bihari & Judit Bakos
Agricultural University of Debrecen, 4032 Debrecen Boszormenyi ut 138. Hungary

The *Nyctalus noctula* is the most abundant bat species of Hungary, thanks to its adaptability. It inhabits the crevices of buildings of estate houses in large towns. This paper states an ambitious investigation carried out in a great estate house in the city of Debrecen (Hungary). We explored the inhabited roosts with the help of their acoustic signals and bat droppings on the wall. We found 148 roosts in the 81 ha large area. We examined their roost preference and found that they prefer those roosts that are at the corner of the building at 6-8 m height. The noctule bats choose western walls. We could not find a connection between the placing of roosts and their surrounding vegetation or artificial constructions. We estimated the density of noctule bats in the examined area. The 83 ind./ha is higher than in a natural forest, due to the possibility of dense roosts. About 20-30 individuals stay in one roost. These are used by bats as summer and winter roosts and also in autumn as mating roosts. These bats are threatened by humans. The main reasons are that people are afraid of them and that bats are noisy. Nevertheless, the number of noctule bats is increasing year by year in Hungarian towns, and these types of roosts are the most important.

SEEING DIFFERENTLY: A GEOMETRIC MORPHOMETRICS APPROACH TO WING MORPHOLOGY AND FLIGHT MODE IN RECENT BATS

Wieslaw Bogdanowicz
Museum and Institute of Zoology, Polish Academy of Sciences, Wilcza 64, 00-679 Warszawa, Poland

Previous descriptions of bat wings were based either on univariate or standard multivariate analyses of traditional measures of lengths and areas. Each of these methods has its own strength, but they do not fully describe differences in shape and usually overlook the covariation of points within and among regions of the wing. To avoid these problems, the wings of bats were scanned using a high-resolution camera, and wing morphology was evaluated using thin-plate spline (TPS) analysis of 22 homologous landmarks. The use of partial and relative warps, derived from decomposition of TPS, provided the power to discriminate among various taxa, and segregated recent families of bats into several groups with generalized wing shape and flight characteristics. The relationships between wing morphology and flight behaviour of selected groups of bats were analyzed, and are discussed in the context of phylogenetic constraints on the evolution of flight structures in Chiroptera.

EVOLUTIONARY RELATIONSHIPS AMONG THE AFRICAN FRUIT BATS: REEVALUATION OF PARTIAL WARP SCORES AS CLADISTIC CHARACTERS

Wieslaw Bogdanowicz, Javier Juste B. & Robert D. Owen
Museum and Institute of Zoology, Polish Academy of Sciences,
Wilcza 64, 00-679 Warszawa, Poland

There is a serious disagreement concerning the use of partial warp scores derived from the shape

differences among organisms as cladistic characters for phylogenetic inference. To test this methodology we depicted the skull morphology of the four African megabats *(Rousettus egyptiacus, Eidolon helvum, Myonycteris torquata* and *M. brachycephala*) by means of the thin-plate spline (TPS) of 40 three-dimensional homologous landmarks describing the cranium. The decomposition of TPS by its partial warps resulted in features that can be subjected to cladistic analysis. The most parsimonious tree was compared with the evolutionary hypothesis derived from the genetic literature-based data, and the methodology evaluated and discussed in terms of its effectiveness at retrieving phylogenetic signals from bat morphology. Another test included comparisons between the mainland populations of these bat taxa and some island populations (of presumably known history), to evaluate whether>> phylogeographic information can be extracted from this data as well.

FAUNA OF THE URAL BATS

Vladimir N. Bolshakov & Oleg L. Orlov
Institute of Plant & Animal Ecology, Ekaterinburg, Russia

Studies of bats in the Urals, which began in the middle of the 20th century show that eleven species of bats occur in the region: *Myotis dasycneme, M. daubentonii, M. mystacinus, M. brandtii, M. nattereri, Plecotus auritus, Eptesicus nilssonii, Vespertilio murinus, Pipistrellus nathusii, P. pipistrellus,* and *Nyctalus noctula.* All of them have been found in the Southern Urals. Species found in the Middle Urals were: *M. dasycneme, M. daubentonii, M. mystacinus, M. brandtii, Pl. auritus, E. nilssoni, V. murinus, P. nathusii,* and *N. noctula.* In the Northern Urals, *M. dasycneme, M. daubentonii, M. mystacinus, M. brandtii, Pl. auritus, E. nilssoni,*and *V. murinus* were found. *P. nathusii, P. pipistrellus and N. noctula* are migratory species, the remaining species spend the winter hibernating in the Ural caves. Large winter quarters of bats have been found in the Divya cave in the Northern Urals, in Smolinsskaya, and in the caves of the Middle Urals in Arakaevskaya and Novaya Podkamenskaya. Since the middle of the 20th century, the population of many bat species has been rapidly decreasing. This was caused by the heavy impact of tourism which disturbed the bats during the winter. *M. dasycneme, M. daubentonii, Pl.. auritus* and *E. nilssonii* are listed in the Red Data Book of the Middle Urals.

HABITAT PREFERENCE IN LESSOR HORSESHOE BATS AS REVEALED BY RADIOTRACKING

Fabio Bontadina, Henry Schofield & Beat Naef-Daenzer
The Vincent Wildlife Trust, 10 Lovat Lane, London EC3R 8DN, UK

The lesser horseshoe bat, *Rhinolophus hipposideros*, is one of the most endangered bat species on the Central European scale. It is hypothesized that habitat destruction is one of the main causes of population decline in this species. Several attempts have been made to investigate habitat use in lesser horseshoe bats in different landscapes. However, its very weak and strongly directional echolocation calls make it difficult to detect animals in the field. In addition, the small body mass of this species has precluded the use of radio telemetry as the smallest transmitters exceeded the justifiable surplus weight to add to the flying animals. Recent advances in the miniaturization of circuits have made it possible to build transmitters small and light enough to use with lesser horseshoe bats. The aim of our pilot study was to investigate the performance of a new 0.35 g radiotag with these fragile animals and to compare data on habitat use revealed by radio-tracking with results obtained by other methods. We studied habitat preference on 8 lesser horseshoe bats from a colony of some 300 animals in south Wales, UK. The activity ranges of these animals included significantly more woodland than all other habitat types. We defined key foraging areas by kernel estimations of location densities. Woodlands, hedgerows, riparian vegetation, ranked as the most used habitats, whereas the proportion of locations in settlements and open areas such as arable land and pasture were significantly lower. We observed the animals foraging in vegetative structures such as the

canopies of trees mainly within 2.5 kilometers of their maternity roost, data that cannot be recorded using other methods.

ARE BAT CALLS CURVED TO MATCH THE EMITTERíS FLIGHT SPEED?

Arjan M. Boonman, Stuart Parsons, Gareth Jones & Jeremy M.V. Rayner
School of Biological Sciences, University of Bristol, Woodland Road, Bristol BS8 1 UG, UK

Bats are thought to partition foraging space via interspecific differences in echolocation call design and wing morphology as variables that influence each other indirectly. Echolocation calls are believed to differ mainly in bandwidth and duration, the latter determining the overlap-free window between bat and clutter, in which the bat can detect prey. However, the ability of a bat to resolve the range of a target is also directly affected by the 'shape' of the signal and the flight speed of the bat. It is our hypothesis that accurate range resolution, via echolocation calls, will be correlated with habitat type: the more cluttered the habitat is, the greater the resolution required. We tested our hypothesis by measuring the effect of signal curvature on range resolution over a range of flight speeds using search-phase echolocation calls from 12 species of European bats. Flight speeds were predicted from measurements of wing loading and aspect ratio and, in addition, measured speeds were used. Results of this study show that the curvature of an echolocation call and flight speed together determine a bat's range resolution. Flight speed thus influences partitioning of foraging space by affecting both resolution of echolocation and maneuverability of the bat. Wing morphology only affects echolocation indirectly by defining foraging space to which a bat is adapted in terms of its maneuverability.

NATURE DEVELOPMENT AS A POSITIVE CHANCE FOR BAT CONSERVATION

Jan C. Buys & Herman J. G. A. Limpens
Netherlands Bat Group and Eco Consult & Project Management

Many of our conservation efforts for bats in Europe are typically defensive and directed at the conservation of roost sites and (potential) hunting habitats. We often do so in reaction to acute threats on site level. In regions with a high ecological value this is usually an effective strategy. A significant part of the threats identified so far, concerns the loss of quality and area of habitat. Bat conservation in these areas requires a different strategy. The first experiences with nature restoration in the Netherlands indicate that this can be beneficial for bats. Also when we combine general auto ecological knowledge of bats with the knowledge of natural development processes, we can expect an improvement of bat habitat quality. Nature development can, through the increase of natural dynamics, lead to an increase in a small scale naturally structured landscape, humid vegetation rich of plant species and more natural structured forest providing roost possibilities. Hence nature re-development will, both in terms of insect production and the availability of suitable hunting habitat, lead to an increase of availability and a better distribution of food through the season. An improved ecological infrastructure and a higher availability of tree roosts will develop as well. We therefore recommend to widen the toolbox of bat conservation by utilizing nature re-development techniques through restoration of semi-natural landscapes as well as through enlarging the habitat quality of agricultural and urban landscapes.

GENETIC ESTIMATES OF *M. MYOTIS* MIGRATION ACROSS GIBRALTAR STRAIT

Vincent Castella, Manuel Ruedi, Laurent Excoffier, Carlos Iba´nes & Jacques Hausser
Institute of Ecology, University of Lausanne, Switzerland

Because of their role in limiting gene flow, geographic barriers like mountains or seas often coincide with large genetic discontinuities. Although the Strait of Gibraltar represents such a potential barrier for

terrestrial organisms, no studies have been conducted on its impact on gene flow. Here we tested this effect on a flying mammal Myotis myotis which is distributed on both sides of this Strait. Based on a sample of six populations, mtDNA haplotypes (600 bp of the cytochrome B gene) reveal a complete and ancient isolation between Northern and Southern bats. Results based on six microsatellite loci (nuclear genes) confirm the presence of this strong barrier to gene flow. These results suggest that neither males nor females cross the 17 km of the Gibraltar Strait. This surprising pattern for a species able to cover hundreds of kilometers during dispersal is discussed in a broader zoogeographical perspective. The most likely interpretation is that the Moroccan Mouse-eared bats represent a biological species fully distinct from M. myotis and M. blythii. We therefore provisionally propose to raise the taxon *omari* (Thomas, 1906) to species rank, but a definitive systematic understanding of the whole Mouse-eared bat species complex awaits further genetic sampling, especially in the East Mediterranean areas.

PRESENT STATE OF THE BAT COMMUNITY HIBERNATING IN ARTIFICIAL CAVES NEAR ST. PETERSBURG

Dmitriy V. Chistyakov, Biological Research Institute of St. Petersburg State University, Russia

In two winter seasons, 1998 and 1999, the relative abundance of hibernating bats was estimated in five groups of artificial caves, situated near St. Petersburg. Results of the observations was compared with the data, which was received in preceding decades. The majority of the known caves are significant places for bat hibernation. In 1998 an increase of the common quantity of *Plecotus auritus, Myotis dasycneme* and *Myotis nattereri* was noted in these shelters, in comparison to the middle of 1950's. At the same time a decrease in the number of *Myotis brandtii* was estimated. In 1999 the decrease in number of bats in one group of caves was noted. We could not note any common peculiarities in changes, which took place in artificial caves near St. Petersburg in preceding decades.

FEEDING ECOLOGY OF THE DISC-WINGED BAT *THYROPTERA TRICOLOR*

Dina Dechmann. Dept. of Biology, Swiss Federal School of Polytechnics, Zurich

Thyroptera tricolor is a small bat of the neotropical lowlands and its ecology has been studied very little. Food habits of this species were examined by analysis of droppings. Samples were collected from the bats' day roosts in rolled-up young leaves of musoid plants, mainly from the family Heliconiaceae. The diet consisted of arthropods from 10 different orders and two classes (insects and arachnidae). The favourite prey during the entire study period were: Aranea (occured in 89% of the pellets), followed by Homoptera (79%) and Diptera (62%). The strong presence of wingless or predominantly non-flying prey such as Aranea, larvae, some Coleoptera (Curculionidae) and Dermaptera leads to the conclusion that *T. tricolor* hunts at least a great part of its food by gleaning. Diversity within pellets was generally great (2 - 8 orders) and most of the prey was less than 5 mm big. Isolated larger fragments indicate that bigger prey may be taken, too. The results suggest that *T. tricolor* hunts more or less opportunistically, size being more important than species. Aerial hawking (observed through light - tagging) and gleaning are both being employed as strategies.

DO BATS BELIEVE IN THE WILDLIFE CORRIDORS HYPOTHESIS?

N.C. Downs & P.A. Racey
University of Aberdeen, Department of Zoology, Aberdeen, AB24 2tz, U.K.

Wildlife corridors have been widely promulgated by land managers, often in advance of formal proof of their value. Although the results of the first National Bat Habitat Survey indicate the importance of linear landscape features and connectance between the habitats in which bats feed, reports of the use of

vegetation corridors by bats have often lacked statistical rigour. The aims of this study are 1) to test the hypothesis that bats move between habitats along vegetation corridors, 2) to investigate the extent to which bats exploit feeding habitats such as ponds, and whether this is related to the degree of connectance to nearby habitats and 3) to investigate what resources are provided by corridors: whether bats feed while commuting and the extent to which corridors concentrate insect food. We have made extensive use of automatic bat recording stations to achieve these aims, and have developed the first such station which can provide PC-downloadable data.

THE DIET OF THE GREATER MOUSE-EARED BAT *MYOTIS MYOTIS* IN AN INTENSIVELY USED AGRICULTURAL LANDSCAPE

Christian Drescher
South Tyrolian Museum of Nature

A great nursery of *Myotis myotis* (1300 ad. females), situated in the village of Gargazon (province Bozen, northern Italy), in the valley of the Etsch river, on the southern slope of the Alps, was investigated from 1993 through 1994. Since the colony is surrounded with intensively cultivated orchards, the aim was to gather knowledge of the hunting habitats of this colony. This was a first attempt to investigate and analyze the droppings under the nursery. To document recent changes in the diet (caused by changes in the land use at the same time), we also analyzed a fraction of the droppings, approximately 30 years old. Mole crickets (*Gryllotalpa gryllotalpa*) and carabid beetles (Carabidae) composed the majority of the prey taxa in the droppings. Overall 15 taxa were found. The prey consisted of euryoecious species from park and garden habitats, but there were also stenoecious species from deciduous forests found. The only forests of this kind in the surroundings are submediterranian oak shrub forests. The results are paragoned with the literature and also with observations of *Myotis myotis* from the nursery and the hunting grounds in the orchards. On the basis of this data further investigations on the situation and type of the hunting habitats, together with some advice for the conservation of them are planned for the following years.

BATS AND BIODIVERSITY CONSERVATION IN BULGARIA: AN EDUCATION PROJECT

Elliott,P. and Barker, S., Institute of Education, University of Warwick, Coventry, CV4 7AL., U.K.

The aim of our project is to promote sustainable development through biodiversity education in Bulgaria, one of the most biodiverse countries in Europe. The project is a collaborative one involving people with interests in ecology, conservation and education in Britain and Bulgaria. Bats are one of the main themes of the work. How can children's interest in and concern for bats be promoted in the classroom using stimulating low-cost and no-cost strategies? Draft curriculum materials were used at a series of workshops with teachers, student teachers and NGOs in May 1999. We will consider how the materials were received and what the implications for biodiversity education elsewhere in Europe are. The final version of "Ecological adventures in Bulgaria: from classroom to Karst" will be published later this year. This project is sponsored by the U.K. Darwin Initiative Fund.

BATS OF GUINEA-BISSAU

Cláudia Franco & Ana Rainho
Instituto da Conservaçâo da Natureza, Praça da República, 2900-587 Setúbal, Portugal

The bat fauna of Guinea-Bissau is one of the least known in West Africa, and this lack of information makes it difficult for planning and implementation of conservation measures for this group. With the partial support of IUCN (Guiné-Bissau) and the Portuguese Instituto da Conservaçao da Natureza, this

study went on with the objective of a contribution to the knowledge of bat fauna of Guinea-Bissau and particularly of two National Parks of this country (P.N. Ilhas de Orango and P.N. Tarrafes do Rio Cacheu). Fieldwork took place during October-November of 1997 and February-March of 1998 and consisted of the capture of the specimens in their roosts during the night, with mist-nets. Nine new species were identified, giving a total of 37 species known for this country. It was also possible to extend the known range of some species.

DISTRIUTION OF CAVE DWELLING BAT SPECIES IN NORTHWESTERN TURKEY

Andrzej Furman, Rasit Bilgin, Arpat ozgul
Institute of Environmental Sciences, Bogazici University Bebek-Istanbul, Turkey

The distribution of cave dwelling bat species was studied in a transition region between Europe and Asia (Catalca-Kocaeli region extending 150 km to both sides of Bosphorus). The survey explored five caves in the Asian region (Kocaeli) and seven caves in the European region (Catalca). The ecological factors and physical parameters were recorded outside and within the caves. The cave populations were estimated by counting individuals inside the caves and taking photographs of the large clusters. The species identification was confirmed by direct examination and using the heterodyne detector (batbox 3). Particular individuals were measured and examined for gender and maturity. The main winter roosts and maternity roosts were also identified. In the investigated caves, a total of nine species, belonging to the genus *Rhinolophus, Myotis* and *Miniopterus*, were encountered. In the Catalca region eight species were found, namely *Myotis myotis, M. blythi, M. emarginatus, M. capaccinii, Miniopterus schreibersii , Rhinolophus ferrumequinum, R. hipposideros* and *R. euryale.* In the Kocaeli region, five species were found to be present, namely *Rhinolophus ferrumequinum, R. hipposideros, R. euryale, Miniopterus schreibersii* and *Myotis nattereri.* The genus Rhinolophus was found to be present more dominantly in the caves of the Catalca region and the genus Myotis and Miniopterus were more dominant in the caves of the Kocaeli region.

SYNURBANIZATION OF THE NOCTULE *NYCTALUS NOCTULA*

Jirf Gaisler. Department of Zoology and Ecology, Masaryk University, Brno, Czech Republic

The noctule bat is generally considered to be a forest species. However, its hibernation in urban buildings was recorded as early as in the 19th century, e.g. in Augsburg, Erlangen and Nuremberg (Kolenati 1859). In the 20th century, one of the best documented was the hibernation of up to 1000 individuals in the Frauenkirche Church of Dresden (Meise 1951) which, unfortunately, was destroyed at the end of World War II. Winter colonies of noctules in towns were recorded in most Central European countries, further in Sweden, Holland, Croatia, Ukraine and Kazakhstan. Summer records in towns have been less common. This paper summarizes the records of noctules in buildings, mostly of new housing estates, on the Czech territory within the last decades. In one particular case, more than 1500 bats were recorded. In Brno, the course of hibernation was followed by noctules roosting in a building made from prefabricated panelboards where the bats, (maximum 500 individuals) occupied crevices above windows on the 7th floor. Air temperature was measured in an analogous shelter. In Brno, *N. noctula* occurs all year round and is the third most common foraging bat species in summer. The preference for various urban habitats by this species was studied acoustically. Foraging noctules were most common in riverine habitats and avoided the city centre where only commuting individuals were recorded. Daylight flying on the municipal territory was also recorded. The paper concludes by demonstrating a partial albino noctule obtained from a building of another town. This is the second known case of albinism in this species (cf. Dulic & Mikuska 1968).

FOSSIL BAT FAUNA FROM PLIOCENE/PLEISTOCENE LOCALITIES IN SOUTHERN POLAND

Joanna Godawa-Stormark
Preclinical Division, University of Bergen, Zrstadveien 19, 5009 Bergen, Norway

The Kraków-Wielun Uplands are rich in fossil deposits with the majority of fossil-bearing localities south of Czestochowa. The quarry in Przymilowice is situated in the Upper Jurassic (Oxfordian)limestone hill. The oldest is fauna A (Upper Villarian; Late Pliocene and includes *Plecotus abeli, Myotis helleri*, and *Rhinolophus cf. macrorhinus*. Fauna B (Lower Biharian, Early Pleistocene) *contains M. steiningeri, M. helleri*, and *Rhinolophus sp.* The biostratigraphic position of bat assemblages of fauna C is difficult to determine due to no index species. Species like *Myotis emarginatus, M. bechsteinii* and *Rhinolophus ferrumequinum* suggest however an interglacial character of the fauna. Age of Kielniki I fauna is an Upper Biharian, Early Pleistocene and *M. steiningeri* and *Rh. cf. macrorhinus* were found there. Fauna of bats from Kielniki 3B is dated from the Upper Villanian, Late Pliocene (Biozone MN17) and includes the following species: *Myotis exilis, M. bechsteinii* and *M. steiningeri.* The bat fauna described here consists of a new species for Poland: *Myotis steiningeri,* which is common in Late Pliocene/Early Pleistocene fauna. This species is similar to *M. bechsteinii* which was reported from many Late Pliocene and Early Pleistocene localities.

THE CHIROPTERA OF URBAN CAVES

Lena Godlevsky. International Solomonov University, Biological Department, Kiev, Ukraine

Determined by a number of reasons, there is a rather far-flung net of underground cavities in Kiev, including hydrotechnical constructions, in particular drainage and untilandslide systems drying and reinforcing the right bank of Kiev; natural caves actively used before and representing scientific and historical value at present; constructions concerning the subway system; basement premises and so on. All of these constructions to a certain extent may serve as places for the winter and daytime refuge for bats. Thus, an aim of the study is to learn about the use of the underground shelters by the bats, their species composition and their quantitative evaluation. At the present stage of the work the examination of the rather extensive area of Kiev drainage tunnels has already been made and a number of observations have been obtained making it possible to judge, in some sort, about the bats which use such artificial caves for the winter. I will try to analyze the rather poor species composition of the bats in these potential underground refuges and the small number of the specimens found and also the influence of the ecological and anthropogenic factors on the urban populations of Chiroptera.

CASES OF BAT AND NON-FLYING MAMMAL POLLINATION IN LEGUMES FROM AFRICA AND MADAGASCAR

Regine Grünmeier, Mühlstrafle 23, D-55270 Schwabenheim,Germany

The African legume *Parkia bicolor* (Mimosaceae) is a large canopy tree of the lowland rainforests in West Cameroon. The large inflorescences are reachable for a variety of different flower visitors like bats (Megachiroptera), prosimians, rodents, birds and insects. The main pollinators are bats, but also the non-flying mammals may have a certain effect in the pollination of this plant. In comparison, the African *legume Mucuna flagellipes* (Fabaceae) is a specialized bat flower and tolerates only tiny bats as pollinators. In Madagascar the situation is quite different. The endemic legume *Strongylodon craveniae* (Fabaceae) occurs in the mountain rainforest of East Madagascar. This plant is like the Mucuna - a high growing liana. Its large yellow flowers are found to be visited by various animals including four species of lemurs as well

as birds and insects. The lemurs are seen to be destructive to these flowers but one species, the middle-sized nocturnal Greater dwarf lemur *Cheirogaleus major* (Cheirogalidae), treated them as a pollinator. In all these cases the birds and insects had no effect in the pollination. They only function as nectar and/or pollen robbers. The presented pollination systems are discussed in terms of the evolution and distribution of these species.

ECHOLOCATION BEHAVIOUR ON THE WING AND WHILE HUNTING FLYING PREY IN THE GLEANING BAT, *MEGADERMA LYRA*

Jan E. Grunwald & S. Schmidt
Zoologisches Institut der Ludwig-Maximilians-Universit(t, Luisenstr. 14, D 80333, München, Germany

In a field study in Sri Lanka, sonar calls of Megaderma *lyra* were recorded for bats emerging from and re-entering the roost, passing through dense vegetation and cruising over paddy fields. In all four situations, M. lyra used exclusively short, multi-harmonically structured, downward frequency modulated calls, as are known from laboratory recordings. This call type, however, was adapted to the specific situation. Thus the mean duration of calls emitted in cruising flight was significantly higher than that of signals used in cluttered surroundings. The call repetition rate was significantly increased in the presence of clutter compared to open space situations. Moreover, whereas the second and third harmonics of the calls were most prominent in most situations, higher harmonics were also prominent while the bats re-entered the roost through a small opening. In order to study the echolocation behaviour of *M. lyra* while hunting flying prey, tethered insects were presented to freshly caught, untrained bats in an outdoor flight cage. All bats were spontaneously able to locate and catch flying insects. Prey was usually detected by listening to prey-generated sounds. After detection, however, *M. lyra* immediately started and kept on echolocating throughout the hunting flight. During approach, mean call repetition rates and sweep rates increased, while mean sound durations decreased significantly. In addition, the prominence of harmonics shifted from the third to the second harmonic. During the last 900 ms before capture, the mean call frequency was continuously lowered. Two recordings from *M. lyra* catching tethered insects in the field showed the same echolocation patterns. The systematic changes in the call pattern and the obligatory use of sonar suggest its importance for prey catching in this gleaning bat. Supported by VW-I/73510.

FORAGING HABITATS OF THE GREATER MOUSE-EARED BAT *MYOTIS MYOTIS* OPPORTUNISTIC MACROHABITAT SELECTION BY A MICROHABITAT SPECIALIST

René Güttinger. Group for Wildlife and Conservation Biology,
Zoological Institute University of Zurich-Irchel, CH-8057 Zurich, Switzerland

From 1991 to 1993 45 Greater Mouse-eared bats *Myotis myotis* were radio-tracked in the eastern part of Switzerland to define their hunting grounds. The aim of this study was to examine which macrohabitats (forests, meadows, pastures, etc.) hunting bats prefer and to give possible reasons why they favour certain macrohabitats. All macrohabitats used by the bats had an accessible ground cover. Hunting grounds in forests were generally free of undergrowth and showed only sparse ground vegetation. Intensively cultivated meadows were only used when the grass was either freshly mown or grazed down. The pastures were usually cropped short by livestock and were thus attractive hunting habitats for Greater Mouse-eared bats as well. Likewise, arable fields were only used by the bats in a freshly reaped state when the ground was free of cover. In all these macrohabitats, observations with a night vision scope have shown that Greater Mouse-eared bats picked their food up from the ground. This leads to the assumption that the Greater Mouse-eared bats are more or less dependent on a particular microhabitat structure to catch their prey (mainly larger carabids and tipulids). Due to the observed diversity of hunting macrohabitats, Greater

Mouse-eared bats do not have any trouble finding suitable hunting grounds in the study area. For this reason, it is concluded that the Greater Mouse-eared bats are in no immediate danger at the moment.

CONSERVATION OF MYOTIS CAPACCINII IN CROATIA-ACTION PLAN

Daniela Hamidovic, Branko Jalzic, & Tvrtkovic Nikola,
Croatian Natural History Museum, Demetrova 1, 10000 Zagreb, Croatia.

* This presentation was judged as best poster on species conservation on display at the Conference. The award of U.S.$150 was received by Daniela Hamidovic

Croatia is one of the few countries in Europe in which as many as 30 bat species have been recorded. Scarce knowledge about the ecology of most species and location of nursing colonies present the main obstacle in necessary conservation measurements. While working on a national biodiversity, conservation strategy, four species of vulnerable bats were named, including *Myotis capaccinii.* This species is distributed in the mountains and on the coastal part of Croatia, since it relies on caves and karstic rivers and lakes. A few colonies of 20-300 individuals have been noted, and the biggest two have recently been found: a nursing colony of 2000-4000 individuals in the Miljacka II cave and a mixed colony with *Myotis myotis, M. blythii* and *Miniopterus schreibersii* in the Ulumova cave (approx. 6000 specimens). The disappearance of some colonies has also been recorded. Beside general activities in educating people in bat identification, mist-netting and estimating and monitoring recorded colonies, we have started mapping and making databases. We have made an action plan for *Myotis capaccinii* conservation that consists of 3 parts: 1) estimation and monitoring of cave colonies, 2) research of species ecology in the Miljacka II cave, 3) conservation of the most important colonies and habitats. We will accept any help from abroad because the action plan, which is already in progrress, has essential financial problems and every expert international co-operation, especially on species ecology research, will be more than welcome.

DIFFERENCES IN HIBERNATION OF SYNTOPIC POPULATIONS OF *RHINOLOPHUS FERRUMEQUINUM* AND *R. EURYALE*

Hamidovic Daniela, Kovacic Darko & Djulic Beatrica
Department of Zoology, Faculty of Natural Sciences, University of Zagreb, 10000 Zagreb, Croatia

The former opinion was that *R. euryale* does not hibernate together with *R. ferrumequinum* in the Veternica cave, because no specimen was noted. The cave is situated near the northern border of the *R. euryale* area of distribution. This species is thermophilic which looks for places with the temperature between 11 and 14°C, and relative humidity above 80% to spend the hibernation period. In distinction from *R. euryale, R. ferrumequinum* has a very wide area of distribution and can stand greater variations of both temperature and humidity during the same period of time. It is also the most frequently found cave species in Croatia. In the winter of 1995/1996 the influence of microclimate (primarily temperature) and external climate on the hibernation of these two species was systematically studied. Hibernation started in November of 1995 and ended in May of 1996. The two species were first found together at the same place in the speleological part of the cave. After one week they split into two groups and the rest of the hibernation period they stayed separated. The number of individuals in clusters of *R. ferrumequinum* was between 19 and 300, and the *R. euryale* consisted of 17 to 150 individuals. *R. ferrumequinum* specimens were also found hibernating individually, and those were mostly older females. Our results from the winter of 1995/96 were compared with the results for the same cave given by B. Djulic from 1956 to 1958.

THE DISTRIBUTION OF BATS IN LUXEMBOURG

Christine Harbusch, Jacques Pir & Edmée Engel
Musée national d'histoire naturelle de Luxembourg

The poster presents examples from the new atlas of bat species of Luxembourg published by the National Museum of Natural History, called "Verbreitung der Fledermäuse in Luxemburg". The atlas is mainly the result of a six-year inventory of the summer distribution of bats (methods used: detector work, summer roost checks, mist-netting) and over 10 years of winter roost checks. Maps of the distribution of some of the 19 bat species found in Luxembourg are shown. A short summary gives the main features of the distribution patterns of these species. The maps include summer and winter distribution and historic findings. All data is managed by the database of the Museum called LUXNAT.

ACOUSTIC FLIGHT PATH TRACKING OF ECHOLOCATING BATS IN THE FIELD

Marc Wilhelm Holderied & Otto von Helversen
Institute of Zoology II, Staudtstr. 5, D-91058 Erlangen, Germany

* This presentation was judged as best poster on field research on display at the Conference. The award of U.S.$150 was received by Marc W. Holderied

Combined studies of a bat's flight and echolocation behaviour require, for at least two reasons, knowledge of the flight path of the bat: (i) It is necessary for the calculation of the bat's flight speed (ii) The flight speed of the bat relative to a stationary microphone results in a Doppler shift of the recorded echolocation calls. For calculation of the call frequencies actually produced by the bat, its position, flight speed and direction must be known. For recording a bat's flight path usually optical methods like multiflash photography are employed. Here we use a new acoustic method for tracking the flight paths of echolocating bats in the field. This method localises bats by using their echolocation calls. Each echolocation signal is recorded by eight microphones at known positions. The signal arrives at each microphone with the time delay corresponding to the travelling distance from bat to microphone. The bat's position at the time of the call can then be calculated from these time delays. Depending on the species specific sound pressure of the echolocation signals the method has a maximum range of 50 m. The distance related location error is between 0.2 % and 2 %. When several bats are present all echolocation calls except those that are directly overlapping are reliably assigned to one individual. Flight sequences with a duration up to several minutes can be recorded. We present a comparison of flight speeds and echolocation calls of several european bat species during hunting flight. The question will be addressed: Does a bat alter its echolocation signals in response to the echolocation signals of a conspecifics?

THE BAT FAUNA OF THE BAVARIAN ALPS

Jennifer Holzhaider. Ludwig-Maximilian-University, Luisenstr. 14, 80333 München, Germany

In this study the occurence of bats in the eastern parts of the Bavarian Alps was investigated. Of special interest were species diversity, altitudinal distribution and selection of day roosts in human buildings. Furthermore, bat activity was observed around four caves during 27 nights. From May to September 1997, 500 mountain huts in altitudes between 800 and 1800 m above sea level were studied. 200 bats of nine different species were found with a strong predomination of Myotis mystacinus and M. brandtii. With the exception *of Eptesicus nilssonii*, which was only found above 1100 m, most species showed no preference for special altitudes. The number of occupied roosts as well as the number of observed individuals decreased significantly in altitudes above 1300 m. Buildings were less frequently inhabited by bats with increasing distance from forests. More than 80 % of all animals were adult males which leads to the suggestion that hardly any raising of juveniles takes place at higher altitudes. However,

these habitats seem to be used for hunting and for mating activity since some pairs and mating groups were found. At the caves, 361 bats of 11 species were captured. The species composition differed strongly throughout the summer. The highest diversity and flight activity was recorded in autumn, indicating a period of investigation for winter quarters. Similar to lower altitudes, caves in the Alps also seem to be used as meeting places for mating activity.

BATS OF THE PALEARCTIC REGION: A TAXONOMIC, ZOOGEOGRAPHICAL AND ECOLOGICAL REVIEW

Ivan Horácek, Jiri Gaisler & Vladimír Hanák
Department of Zoology, Charles University, Prague, Czech Republic

Checklists of Palearctic mammals (Corbet 1978, 1984) as well as distributional data on the bats of the world (Koopman 1994, Nowak 1994) reveal about 85 species of 8 families to inhabit the Palearctic region. For about 63 species of 6 families this zoogeographical region is an essential part of their distribution ranges. During the last decades the list has been supplemented with additional taxa: (1) newly described forms such as *Rhinolophus imaizumii, R. kirgisorum, Myotis abei, M. yesoensis, M. pruinosus,* and *Murina silvatica;* (2) forms described earlier but the species status of which has been established as a result of recent taxonomic analyses, e.g. *Myotis schaubi, M. bombinus, Eptesicus gobiensis, Hypsugo alashanicus, Pipistrellus maderensis, Plecotus teneriffae* and *Murina fusca.* In some other taxa (*Rhinolophus ferrumequinum, R. hipposideros, Myotis myotis, M. blythii, M. nattereri, M. daubentonii,* etc.) the patterns of their geographic variation were reinvestigated and new ideas resulted on their intraspecific taxonomy. A particularly complicated situation occurred with the clades for which recent data proved an unexpected cryptic variation, i.e. *Pipistrellus pipistrellus* and *Myotis mystacinus.* Taxonomic and nomenclatoric consequences of these discoveries have not been resolved entirely as yet, while similar problems possibly concern some other clades, e.g. the *Plecotus spp.* In this respect it is promising that the taxonomy of Palearctic bats has increasingly been operated with new tools combining traditional approaches with advanced techniques such as molecular taxonomy and molecular phylogeography. Recent decades provided considerable amount of new distributional records in certain regions the bat fauna of which was insufficiently known (Middle East, Central Asia, Siberia, Far East and China). This data has refined our knowledge of distribution in individual taxa as well as the notion of structure in local Chiropteran communities. Considering earlier approaches to the zoogeography of Palearctic bats (Wallin 1969, DeBlase 1977) and the new information, the following major chorologic units and/or community types can be distinguished: (1) W-Palearctic arboreal, (2) Mediterranean, (3) W-Palearctic eremial, including those of dry habitats in the Middle East, (4) E-Palearctic arboreal, and (5) E-Asiatic transitional. Worth mentioning is that many of the supraspecific taxa with Eupalearctic *distribution (Rhinolophus ferrumequinum* group, *Myotis nattereri* group, *Eptesicus including Amblyotus, Vespertilio, Nyctalus noctula* group, *Plecotus, Barbastella*) exhibit vicariance patterns concordant with the above mentioned chorologic units, e.g. the arboreal-eremial disjunctions in the W-Palearctic and the W-E disjunction of Eupalearctic arboreal in the South. Further implications of these and other patterns will be discussed from the point of view of historical biogeography. Another problem to be dealt with is the degree of endemism. Most species of Palearctic bats hibernate and are insectivorous or feeding on insects and other arthropodes. Only three species of flying foxes, the distribution of which is mostly non-Palearctic, are frugivorous and there are no carnivorous or piscivorous species among the Palearctic bats. However, various foraging strategies such as fast hawking, slow hawking, foliage and ground gleaning, trawling and flycatching have been recorded in Palearctic insectivorous bats (Norberg & Rayner 1987). Other ecological differences among species concern habitat and roost preferences, movements, reproduction strategies and survival. The ecological part of the paper will focus on major ecological characteristics with respect to the phenetic packing of species and communities and the patterns of taxonomy and zoogeography mentioned above.

While a detailed knowledge of their autecology and behaviour is available on certain species, e.g. *Rhinolophus ferrumequinum* (Ransome 1990), *Myotis myotis and M. blythii* (Arlettaz 1995), *Eptesicus serotinus* (Robinson & Stebbings 1997), etc., little has been known concerning the life strategies of many other species. Similarly, the available information on bat assemblages of various habitats in certain regions is incomplete. Thus, one of the aims of our paper is to draw the attention of chiropterologists to the black holes in the knowledge of the Palearctic bat fauna.

COMPARATIVE METABOLIC RESPONSES TO LOW AMBIENT TEMPERATURES IN TWO SPECIES OF NEOTROPICAL FRUIT BATS.

G. Roy Horst & Gary G. Kwiecinski. St. Univ. of N. Y., Potsdam, NY 13676, USA

Artibeus jamaicensis and *Phyllostomus discolor* are neotropical frugivores of very similar size (30 to 40 grams), are sympatric and compete for the same food resources in many parts of their ranges, yet competitive exclusion has not occured. We suspected subtle physiological or behavioural differences which may not be evident when the animals are not challenged, but which during times of stress may bestow a competitive advantage on one species. Our observations on captive animals are that *A. jamaicensis* is very aggressive when feeding and will not tolerate *P. discolor* at the same feeding site. When food is limited this may bestow a competitive advantage upon *A. jamaicensis*. How can *P. discolor* remain competitive under these conditions? At normal tropical temperatures the thermoneutral zones and resting metabolic rates are essentially identical for these two species. As ambient temperatures fall below the thermoneutral zone, metabolic rates increase for a short period in both species as the animals attempt to remain homeothermic. After this initial response, *P. discolor* abandons homeothermy and allow its body temperature to fall approximately parallel with ambient temperature to body temperatures (Tb) as low as 26 °C. *P. discolor* has survived Tb of 30 °C for as long as 8 hours. *A. jamaicensis* under the same conditions struggles heroically to maintain homeothermy even at ambient temperature (Ta) of 10 °C, metabolic rates climb ever higher and eventually drop precipitously, and unless Ta is quickly restored to the thermoneutral zone, the animals succumb. It appears that the ability of *P. discolor* to become moderately heterothermic provides a survival advantage on those rare occasions when Ta may drop below the thermoneutral zone for sustained periods. We have noticed a similar response to limited food resources. When food is limited *A. jamaicensis* continues to search aggressively for food, exhausting their energy reserves; *P. discolor* tends to abandon foraging much sooner, becoming slightly heterothermic and conserves available energy reserves until conditions improve. *P. discolor* appears to have an advantage when weather conditions (hurricanes) may prevent foraging for extended periods. These subtle adaptations in metabolism and behaviour may, over the extended time frame of natural cycles, cancel any short term competitive advantages, allowing for the continuing sympatry of these two species.

THE EFFECT OF CLUTTER ON DETECTION SUCCESS OF PIPISTRELLE BATS

Marianne Egebjerg Jensen

Center for Sound Communication, Inst. of Biology, Odense University, DK-5230 Odense M, Denmark

It has been suggested that bats using FM (Frequency Modulated) signals cannot detect insect echoes if these are overlapped by clutter echoes. 1) However, bats have been observed to attack moths that fly in a presumed clutter overlap zone. 2)Therefore, I wanted to investigate the capabilities of the FM bat *Pipistrellus pipistrellus* to detect and catch prey in the presence of clutter. 2 male pipistrelle bats (P1 and P5) were trained to fly clockwise in a flight cage and catch catapulted mealworms. When their performance was stable, three *Ficus* trees were placed parallel to the bats flight direction to generate extra clutter. For each trial it was noted whether the bat caught, attempted to catch, or missed the prey. Trials involving clutter were recorded on video and the echolocation signals were simultaneously recorded on a

high speed tape recorder. The video was used to estimate the distance from the catapulted mealworm to the clutter object classified in 10 cm intervals, and to investigate the approach behaviour of the bats. The results are preliminary since the experiments are still running. P1 used around 3.3 ms search signals and P5 used 2.9 ms search signals giving clutter overlap zones of 57 cm and 50 cm respectively. If the bats attempted to catch or have caught a mealworm it is defined as a detection of prey. P5 had a detection success of 80 % or higher for all distances except 0 - 9 cm, which has not been tested yet. P1 detected 70 % or more of the catapulted mealworms as close as 30 - 39 cm from the clutter. P1 has not yet been tested at distances closer than 20 - 29 cm to the clutter. However, both bats detect the prey within the clutter overlap zone.

MYSTERIOUS *MYSTACINA*: HOW THE NEW ZEALAND LESSER SHORT-TAILED BAT LOCATES PREY

Gareth Jones, Peter I. Webb, Colin F.J. O'Donnell & Jane A. Sedgeley
School of Biological Sciences, University of Bristol, UK,

The New Zealand lesser short-tailed bat *Mystacina tuberculata* is one of two mammal species indigenous to New Zealand, and evolved in the absence of both mammalian predators and mammals that feed on the ground. It has therefore evolved adaptations for terrestrial locomotion, and is thought to spend considerable time foraging on the ground. *M. tuberculata* is omnivorous, though it eats large numbers of non-volant arthropods. We studied *how M. tuberculata* locates insect prey under controlled laboratory conditions that mimic natural situations, by recording movement patterns (with digital infra-red video) and echolocation behaviour simultaneously. We determined how bats find aerial prey (uncluttered situation), and how they locate prey on the ground (in echo clutter). For the latter we removed visual cues, and isolated olfactory and auditory stimuli. We conclude that *M. tuberculata* uses multimodal sensory behaviours in prey capture.

DIET OF THE MEDITERRANEAN HORSESHOE BAT *RHINOLOPHUS EURYALE* IN SOUTH-EASTERN SLOVENIA

Klemen Koselj & Boris Krystufek
Section for Bat Research and Conservation, Society of Biology Students at University of Ljubljana, Vecna pot 111, SI-1000 Ljubljana, Slovenia

The diet of the Mediterranean horseshoe bat *Rhinolophus euryale* was studied in the Ajdovska Jama cave (low karstic hills of south-eastern Slovenia) where a maternity colony of several hundred individuals live. Faecal pellets and culled parts of preyed insects were collected twice a month. Insects were also collected in the vicinity of the cave using a mercury vapour light trap and a butterfly net. Observations of bat feeding behaviour were with the aid of a bat detector. The predominant food items were long-winged insects, particularly Lepidoptera, Diptera (mainly Tipulidae) and Neuroptera. Our results confirm the correlation between food composition and the type of echolocation used. The Mediterranean horseshoe bat is an FM/CF/FM species that uses the Doppler shift compensation of ultrasonic pulses as a mechanism of prey detection.

BODY MASS AND FAT MASS CHANGES IN MOUSE-EARED BATS *MYOTYIS MYOTIS* DURING HIBERNATION

Pawel Kotejal, Miroslaw Jurczyszyn, and Bronislaw W. Woloszyn
Institute of Environmental Sciences, Jagiellonian University, ul. Ingardena 6, 30-060 Krakow, Poland

We measured body temperature, body mass, lean body mass and fat content in bats hibernating in the Poznan Forts (western Poland) and in a semi-natural cave-mine Miedzianka (south-eastern Poland) during

two winters: 1995/96 and 1998/99. During both of the winters, the body temperature of the bats hibernating in Miedzianka was about 6.5°C. In PoznaÒ, the average body temperatures were more variable, and were lower in 1995/96 (2 to 5°C) than in 1998/99 (3 – 7°C). Both total body mass (BM) and fat mass (FM; estimated with a non-invasive TOBEC method) were lower in males (December: BM=28.6g, FM=5.3g; March/April: BM=24.7g, FM=2.0g) than in females (December: BM=29.7g, FM=5.6g; March/April: BM=26.2g, FM=2.5g). Body mass and fat mass at the beginning of hibernation did not differ significantly between 1995 and 1998 or between Miedzianka and Poznan. However, the pattern of changes of BM and FM differed between the sites and the years. We estimate that over the entire hibernation (assumed 165 days) the bats used 5.8 g fat in 1995/96, but only 3.9g in 1998/99. Because during the 1995/96 winter the bats had much lower body temperatures in Poznan than in Miedzianka, we expected that the cost of hibernation should be also lower in the former place. However, the total cost of hibernation was lower in Poznan (3.7g fat) than in Miedzianka (4.2g fat) in 1998/99 but not in 1995/96. We conclude that variations in the rate of energy expenditure in hibernating bats is not clearly linked to differences in the thermal conditions of the hibernacula.

THE PRENATAL DEVELOPMENT OF LUNGS IN BATS

Irina M. Kovalyova
I.I.Schmalhauzen Institute of Zoology of the National Academy of Sciences of Ukraine, Kiev, Ukraine

The prenatal development of lungs and their definitive structure were studied in representatives of two bats families: plain-nosed bats (Vespertilionidae) and horseshoe bats (Rhinolophidae). The main stages of the lungs embryogenesis in bats were described by means of analysing serial microscopic sections of *Nyctalus noctula, Rhinolophus hipposideros, R. ferrumequinum* embryos and foetuses. The results of the investigation showed that in the studied bats, the laying of lungs begins at the 14th stage of the embryogenesis, as well as their subsequent development right up to the 18th stage were of the same mode. By the 18th stage, the formation of 4 lobes of the right lung and 2-3 lobes of the left lung was predetermined in all studied bats. However after the 18th stage the development of lungs in plain-nosed bats was sharply different from that in horseshoe ones. Thus, for example, the lungs of plain-nosed bats at the 19th stage had the lobe structure clearly expressed, while in horseshoe bats at the 20th stage the lungs were presented as an unbroken structure not having any sign of a division into lobes. The explanation of both the lobe lungs structure and lobeless one was found in connection with distinctions in spatial reciprocal location of the thorax organs, the body, and the head during embryogenesis and also in connection with differences in locomotor adaptations in the course of evolution of these bat families. The supposition about the probable mediated relation between the echo-location (namely methods of radiating signals) and the peculiarities of lungs structures was suggested.

THE EMPIRICAL ESTIMATION OF ADAPTIVE TRANSFORMATIONS IN THE BATS' THORAX USING THE CLUSTER ANALYSIS METHODS

Irina M. Kovalyova & Leonid A.Taraborkin
I.I.Schmalhauzen Institute of Zoology of the National Academy of Sciences of Ukraine, Kiev, Ukraine

We investigated representatives from 9 families of bats and representatives from 3 families of Insectivora. The fundamentals of the investigation were based on the generally used theory about the descent of Chiroptera from ancestors, which were similar to Insectivora by their organization. Hence we obtained a possibility to estimate by means of our special method the degree of the bats evolution advancement according with skeletal changes in the thorax of recent representatives of bats in comparison with the initial plan of the structure of that system in the most generalized form in Insectivora. The

comparative anatomical study on the batsí thorax allowed us to reveal the differences between them in the degree of mobility of its elements. This mobility was characterized as high, medium and low. 17 indices of the thorax skeleton were picked out and measured. The whole set of these indices was conditionally divided into two groups: plesiomorphous indices and apomorphous ones. The estimation of the general evolution advancement in bats was carried out by quantitative correlations of these indices in the skeletal system of the representatives under review by methods of the cluster analysis. We believe that the high mobility of the thoracic elements is an ancestral feature. A decrease in mobility of the thoracic elements and, connected with it, transformations in the morphological structures are the more late acquisition, having been occurred under the influence of changes in both habitat and locomotion modes.

THE ORIGIN OF MEGA- AND MICROCHIROPTERA IN THE LIGHT OF COMPARATIVE ANATOMICAL AND EMBRYOLOGICAL MATERIAL: MONOPHYLY VERSUS DIPHYLY

Michail F. Kovtun. Schmalhausen Institute of Zoology, Academy of Sciences of Ukraine, Kiev

Different concepts were proposed to explain origin and phylogenetic relations of Mega- and Microchiroptera, namely phyletic evolution, monophyly and diphyly. Various authors produced diverse or similar evidences for each of these points of view. Our comparatively morphological and comparatively embryological investigations give new data supporting the concept of bat monophyly. The study of manus construction in all flying vertebrates (Pterosauria, Archaeopteryx, birds, megabats, microbats) shows that this structure is unique in each of these groups. Only in Mega- and Microchiroptera the manus is homologous. Embryological data are contradictory. But the majority of developmental characters is common in mega- and microchiropteran embryos. A number of characters was found in representatives of either some mega- or microchiropteran families. These characters are inconsistent or "errant"; they don't conform to the taxonomical system in their distribution. Differences in dental system contradict the monophyletic concept but milk-teeth are similar in embryos of Mega- and Microchiroptera. Therefore comparative morphological and embryological investigations convince us of the certainty of bat monophyly concepts.

WHAT DOES IT COST TO BE A BAT? A TIME-ENERGY APPROACH

Thomas H. Kunz
Center for Ecology and Conservation Biology, Boston University, Boston, MA, 02215, USA

I reviewed results from over 10 years of research on free-ranging bats, where we had used a variety of field and laboratory techniques, including doubly-labeled water, respirometry, dietary analysis, body composition analysis, calorimetry, proximate analysis of milk, radiotelemetry, PIT tag recordings, infrared thermography, and night-vision recordings, to explore how these volant mammals allocate time and energy to maintenance (roosting and foraging) and reproduction. Compared with most small terrestrial mammals, bats are K-selected and appear to allocate a large portion of their daily energy budget to reproduction. Females of most microchiropterans produce pups averaging 25% of their post-partum body mass, and subsequently they suckle their young until they are almost adult size. Foraging activity of bats most often occurs during the crepuscular periods, when insect abundance is usually highest. Bats may engage in one or more intervening night-roosting periods to digest food and engage in social activities. Most temperate bats are under severe selection pressure to produce large offspring early in the growing season so that they have time to reach adult size and deposit enough fat reserves to sustain them during the mating and hibernation periods, and to promote ovulation in females the following spring. Bats typically spend the daylight hours roosting alone, in small social groups, or in enormous aggregations ranging upwards from hundreds to millions of individuals in a single roost. For some highly gregarious species, such as *Tadarida*

brasiliensis, the high energetic costs associated with long commuting distances and foraging activity may be compensated for by roosting in situations that minimize energy expenditure.

CALCIUM HOMEOSTASIS IN BATS

Gary G. Kwiecinski. Department of Biology, University of Scranton, Scranton, PA, USA.

The calcium homeostatic system in mammals is complex, including variables such as: gastrointestinal intake and losses of calcium, vitamin D status, endocrine regulation by activity of the thyroid and parathyroid glands, kidney conservation of minerals, and bone remodelling. Since most bats are nocturnal, avoid sunlight, and consume mineral poor foods, their calcium homeostatic system might be expected to part from the normal mammalian pattern. Studies in microchiropteran bats demonstrated seasonal calcium and skeletal perturbations, particularly during hibernation and reproduction. These stresses induce extensive bone remodeling, driven by thyroid and parathyroid gland activity. Dorsal skin from *Artibeus jamaicensis* synthesized previtamin-D following exposure to UV radiation, but measurements of circulating 25-dihydroxyvitamin D, the major plasma form of vitamin D, were normally low or non-detectable. Bats fed diets supplemented with or without vitamin D showed no significant variations in plasma calcium. Analyses of milk mineral composition have indicated that calcium is limited and does not meet calculated requirements for neonatal growth and maintaining normal calcium balance of the mother. These animals did not show any signs of vitamin D deficiency or hypocalcemia. Another study has indicated that calcium absorption in the intestines is by a passive mechanism and not by active transport, as in most other mammals. Results to date suggest that bats function optimally at low levels of vitamin D. They rely upon a highly efficient, passive mineral uptake system, and that calcium homeostasis may not be regulated at the level of the intestine, but rather by manipulating bone and teeth reservoirs. Suggestions will be presented to aid in the clarification of the unique calcium homeostatic mechanisms in bats.

DIFFERENCES BETWEEN NATURAL AND CULTIVATED FORESTS USED BY BATS IN THE BIALOWIEZA FOREST

Marta Labocha & Alek Rachwald
Jagiellonian University, The Institute of Environmental Sciences,
Dept. of Zoopsychology end Ethology, Ingardena 6, 30-063 Kraków

In 1996 and 1997 ultrasound recordings of bats were conducted in open areas in the Bialowieza Forest. The recording were carried out in two open areas in the Bialowieza Natural Reserve and in two clearings in a cultivated forest. In every open area recording was conducted on the border of an open area and one hundred meters from the border. The bats were divided into two groups according to their preference either to dense forests or to open areas. The open areas in the natural forest were used more frequently then in the cultivated forest. In the natural forest the border and the centre of open areas were used in a similar degree, while in the cultivated forest the border was used more frequently than the central part. Social calls were observed over ten times more frequently in open areas of natural forests than in cultivated forests.

OBSTACLE AVOIDANCE BEHAVIOUR IN *RHINOLOPHUS FERRUMEQUINUM*: THE ROLE OF THE CF CALL COMPONENT

Esther J. Langeheinecke & Hans-Ulrich Schnitzler
Animal Physiology, University Tuebingen, Auf der Morgenstelle 28, 72076 Tuebingen, Germany

In transfer flights Greater Horseshoe Bats *Rhinolophus ferrumequinum* continuously emit echolocation signals consisting of a long CF and a short terminal FM (tFM) component while flying with high speed (4 - 7 m/s) on stereotyped flight paths along the edges of vegetation. The tFM component is used to localize

targets by estimating range and angle, whereas the CF component so far is only discussed in the context of the perception of fluttering insects. However, it may be possible that bats evaluate acoustical flow field information in the CF component to get spatial information. To understand how these CF-bats cope with unexpected changes in a known environment, bats were trained in a flight room to fly from a starting point to a landing perch. After the animals had adopted individual stereotyped flight paths (60 to 70 cm above ground, 50 to 100 cm off the wall) every tenth flight vertical and horizontal obstacles were introduced in or near that path. The flight behaviour was documented with an infrared strobe and a 3D video system. Synchronously echolocation signals were recorded. Both vertical and horizontal obstacles positioned close to the flight path evoked an increase in the batsí flight altitude as a primary avoidance reaction. Vertical poles that were presented in close distance to the wall did not evoke reactions, indicating that the bats are more tolerant to changes close to the background than to changes at the open side of the flight path. In undisturbed transfer flights the echolocation signals consisted of a distinct CF component and a short less prominent tFM component ('CF dominated mode'). Evasive flight maneuvers were always associated with a switch to the 'FM dominated mode', in which the tFM component was more emphasized by an increase in bandwidth, probably to improve localization of obstacles. The echo information encoded in the long CF component seems to be sufficient to guide the bats on known flight paths and to warn them off unexpected obstacles.

Supported by DFG (Schn 138/20-1) and Graduiertenkolleg Neurobiologie, Tuebingen

ECOLOGY OF BATS ON LOWLANDS OFCENTRAL POLAND: THE USE OF SHELTERS AND FORAGING AREAS

Grzegorz Lesinski, Elzbieta Fuszara, Maciej Fuszara & Marek Kowalski
Dept. of Vertebrate Ecology, Inst. of Ecology PAS, Dziekanów Le_ny, 05-092 _omianki, Poland

This paper summarizes the results of several research projects carried out since the early 80s on the lowlands of central Poland - a region highly transformed by urbanization and mainly deforestation. There are no natural underground hibernacula (caves etc.) while the winters are rather cold. We studied the use of summer roosts, winter shelters and foraging areas by bats. In this paper we attempt to show how and to what extent the life histories of different species are tied to human settlements and land use. In some landscape types we were able to indicate habitats most important for foraging bats. On the basis of distribution patterns, seasonal migrations, shelter and foraging site preferences we divided bat species into ecological groups. The proportion of species belonging to different groups varies between bat communities inhabiting areas changed by human activity.

A EUROPEAN ACTION PLAN FOR THE POND BAT *MYOTIS DASYCNEME* : A CHALLENGE

Herman J.G. A. Limpens, Peter H. C. Lina & Anthony M. Hutson
Eco Consult & Project Management

At the request of the Council of Europe, a Draft Action Plan on the Conservation of the Pond Bat *Myotis dasycneme* in Europe was prepared, based on the experience of the authors with ecology and conservation of bats in general and the pond bat in particular, an intensive survey of available literature, and an overwhelming amount of information presented to us by our European colleagues in reaction to a questionnaire that was circulated among them. General conclusions: On a European scale, the occurrence of both winter and summer populations needs to be studied in more detail. On a regional scale even its distribution needs to be studied more precisely. Accurate methods for monitoring its population trends need to be developed. As for now, its trends, mostly based on counts in hibernacula, are judged to be weakly positive to weakly negative. As a consequence of incomplete knowledge it is difficult to fully

understand [or comprehend] its status and regional differences in this. Nonetheless, a population estimate of 100,000 - 200,000 individuals could be given, and (maternity) roosts were reported from regions where none was known before. Throughout its range, a number of threats, ranging from disturbance and loss of roost sites, decreased quality and availability of food, decreased quality and area of hunting habitat, decreased quality of landscape infrastructure to decreased quality and area of riverine forest, were identified. There is no detailed knowledge on what might be more or less important factors. Many ecological questions relevant to conservation such as on feeding ecology, migration behaviour or the impact of changes in landscape remain unanswered and need attention. Many actions ranging from improvement of its legal status or of the implementation of legislation, the development of conservational procedures in building and landscape management, raising public awareness, to studies of unknown ecological features and of its occurrence and distribution are suggested.

BEHAVIORAL MEASUREMENTS OF SPECTRAL SENSITIVITY IN A FLOWER VISITING BAT *GLOSSOPHAGA SORICINA*

J. Lopez, Y. Winter & O.V. Helversen
Institute of Zoology II, Erlangen University, Staudtstrasse 5, 91058 Erlangen, Germany.

A number of flowers pollinated by bats have retained some coloration, and many have also been noted to have strong UV-reflectivity. Moon and twilight spectra are characterized by a dominance of short wavelengths. This poses the question of functional significance as bats are generally considered to be color-blind and UV-sensitivity is unknown. We studied the spectral sensitivity of the flower visiting bat, *Glossophaga soricina* in behavioral choice experiments. Bats were conditioned to a narrow bandwidth light stimulus in order to receive a nectar reward from a computer controlled nectar feeder. During a behavioral discrimination task a bat had to chose between two feeders only one of which presented the stimulus. An up/down staircase (titration) method was used to determine visual thresholds. The results indicated a spectral sensitivity function with two peaks: one at about 514 nm and a second peak at about 390 nm. In order to evaluate color vision, i.e. the ability to distinguish between wave lenghths, a bat was trained to respond to a violet light (390 nm) for a food reward. In a behavioral test the bats were unable to discriminate this positive stimulus from a green (520 nm) and a yellow (590 nm) light. The results suggests that *Glossophaga soricina* has a visual mechanism which is based on at least one receptor in the visible spectrum. The high sensitivity in the near-ultraviolet range is still unclear.

MINOPTERUS SCHREIBERSII FORAGES CLOSE TO VEGETATION. RESULTS FROM FAECAL ANALYSIS FROM TWO EASTERN FRENCH MATERNITY COLONIES

Alain Lugon & S.Y. Roue
Valais Bat Network, Grand-Rue 50, 2056 Dombresson, Switzerland

The diet of the long-fingered bat, *Minopterus schreibersii*, was investigated in 1998 in two departments of eastern France (Doubs and Haute-Saone) by using faecal analysis. Two maternity colonies were studied, situated in very different environments: 1) cave of Sainte-Catherine: a forested, enclosed valley, bordered by an extensively grazed plateau; 2) cave of Carroussel: a large alluvial, intensively cultivated valley, dotted with woodlands. Droppings were collected every 15 days, from May to October, on plastic sheets installed under the nurseries. 15 faeces from each sample were dissected under a binocular microscope (x10-64). Prey categories were expressed in percentage by volume. The diet of the two colonies is very similar, being largely dominated by moths (94 and 76% by volume for the whole season). Amongst the other prey consumed, one needs to note the presence of Lepidoptera larvae and Aranaeidea, as well as taxa flying close to vegetation (Mycetophilidae, Tipulidae, Brachycera, and Cyclorrhaphae).

The morphology of *M. schreibersii* suggests that it is highly improbable that this species feeds by gleaning. In spring and autumn it seems to specialize on the larvae of lepidopteran species (Tortricidae) which live in trees before descending to the ground on threads, or on spiders which move by ballooning.

SYSTEMATIC RELATIONSHIPS WITHIN CHIROPTERA AS REVEALED BY TAXONOMIC DNA FINGERPRINTING

Vitaliy Matveyev
Biological Faculty, Dept. of Vertebrate Zoology, Moscow State University, 117449 Moscow, Russia

Systematic relationships and the genome divergence extent were investigated by analyzing the distribution of DNA repeats of 17 bat species of both suborders: *Rousettus aegyptiacus, Eonycteris spelaea, Cynopterus sphinx, C. brachiotis* (Pteropodidae), *Rhinolophus ferrumequinum, R. hipposideros* (Rhinolophidae), *Hipposideros larvatus* (Hipposideridae), *Chaerephon plicata* (Molossidae), *Pipistrellus pipistrellus, P. nathusii, P. kuhlii, Myotis daubentonii, M. dasycneme, M. brandtii, M. nattereri, M. muricola* and *Plecotus auritus* (Vespertilionidae). To reveal such sequences the method of taxonomic DNA fingerprinting was applied. The nuclear DNA was hydrolised with short-cutting restriction endonucleases. DNA fragments were marked with [a-P33]dNTP and separated with help of the electrophoresis in polyacrylamide gel. The specificity of these fragments was revealed on specific and generic levels, but not within one species. The phylogenetic trees were constructed by means of neighbour-joining and maximum parsimony methods with the help of a boot-strap analysis on the basis of different number and distribution of repeating DNA fractions. The method of taxonomic DNA fingerprinting had never been used in bat taxonomic studies before.

1) We succeeded in showing, that taxonomic DNA fingerprinting reveals differences between representatives of order Chiroptera on several taxonomic levels: from species to families.

2) This method helps to study both phylogenetic relations of various bat taxa and the extent of the divergence between them.

3) Our results support the association of Rhinolophidae and Hipposideridae into one family, as proposed by some scientists (Koopman, 1993, 1994; Simmons, 1998; etc).

4) The low level of genome divergence was shown for vespertilionid bats, especially for *Myotis* representatives.

5) Examined DNA regions of *Plecotus* and *Myotis* were quite similar.

6) Two of the three European pipistrelle species, *Pipistrellus pipistrellus* and *P. nathusii*, appeared to be more closely related.

None of the used restriction endonucleases revealed any appropriate sequences in the DNA of examined Megachiroptera species. This fact could serve as evidence of a great evolutionary distance between Mega- and Microchiroptera. Different extents of molecular-genetic divergence within certain Chiroptera taxa could be explained from the point of specificity of bat species' evolution process.

PRACTICAL CONSERVATION MEASURES AT LESSER HORSESHOE BAT *RHINOLOPHUS HIPPOSIDEROS* ROOSTS IN IRELAND

Kate McAney
The Vincent Wildlife Trust, 10 Lovat Lane, London, EC3R 8DN.

The lesser horseshoe bat population in Ireland is estimated to be in the region of 12,000 animals. This figure is based on survey work conducted during the years 1985-88. However, a number of the larger sites discovered during that survey have since been lost and recent survey work suggests that the species is being forced to leave its more traditional summer roosting sites (usually large, unused slated buildings) to

take up residence in smaller, corrugated-roofed buildings that are prone to disturbance. The main reasons for this displacement are two-fold: the deterioration of the buildings so that they are no longer suitable for breeding purposes, or the complete renovation of the building which leads to the exclusion of the bats. Some of these smaller sites are currently under threat from renovation or road widening schemes. The Vincent Wildlife Trust has been involved in lesser horseshoe conservation in Ireland since 1991, initially carrying out repair work to secure, maintain and improve summer and winter roosts. More recently, The Trust has established reserves by purchasing or leasing old buildings that were becoming increasingly unsuitable for the colonies of bats using them. The improvement work being carried out at the reserves involves replacing roofs, windows and doors, rebuilding walls and erecting ceilings. In one case a building, hitherto unsuitable for lesser horseshoe bats, was modified in early spring to provide an alternative summer site for a nearby colony roosting in sub-optimal conditions. By mid-summer half of the colony had relocated to the new site. The Trust presently has four reserves in Ireland and is negotiating to create three more. Approximately 1,000 bats have benefited or will do so from the measures taken to date.

VETERINARY TREATMENT OF SICK AND INJURED BATS - CASE REPORTS

Viktor Molnar, Zoltan Molnar & Attila Beregi. Association for Bat Protection, Budapest

The average annual turnover of injured and sick bats at the Association for Bat Protection, Budapest is about 25-30 individuals. These animals are, if feasible, repatriated as soon as possible after proper veterinary treatment. The most frequent pathological condition are the open or simple fractures of the thin finger bones and eventually those of the metacarpal, forearm and arm bones. The success rate of the lege artis surgical intramedullary fixation treatment of the bone fracture and disrupted wing area is currently rather low. Antiarthropodic and anthelminthic drugs must be administered to bats that have been collected during a long time after the injury and therefore have high levels of ecto- and endoparasites. A very rare diagnostic finding (encountered for the first time in a noctule and currently under publication) is spermatocele (retention cyst - secretion stagnancy and secondary calcification in the epididymis) of an unknown initiating factor. Anophthalmia (absence of the eye) was diagnosed in a Daubenton's bat. Until now rabies was not demonstrated by direct or indirect methods in bats in Hungary; immunfluorescence, histopathological and immunoreaction studies of acquired dead or suspiciously behaving animals have all given negative results. A specialised holder vessel has been designed for transferring and keeping the animals. The bats are mostly fed mealworms *Tenebrio mollitor*, crickets *Acheta domestica* and waxmoths *Galleria mellonella*, while extra vitamins are supplied in their drinking water. In case of eventual longer captivity, the animals are appropriately allowed "medical flying" and in winter they artifically hibernate.

PRESENTATION OF BAT RESEARCH AROUND BUDAPEST- ACTIVITY OF THE ASSOCIATION FOR BAT PROTECTION, BUDAPEST (1992-98)

Zoltan Molnar, Viktor Molnar, and David Csanadi1
Association for Bat Protection, Budapest

The first scientific survey and observation of bats in Hungary and in the area surrounding Budapest has been carried out by Lajos M,hely at the turn of the last century. Field observations were performed by Gyîrgy Topl in the 1950s-1970s, and this activity has been continued by Dnes Dobrosi and by the Association for Bat Protection, Budapest. The Association for Bat Protection, Budapest (member of the Hungarian Bat Research Society) has done the bat-fauna examination and protection in four counties of Hungary since 1992. We examined all churches in the area and we control these habitats every 1-3 years with a monitoring system; in case of necessity we make conversions and clean. We check the most significant caves and mining holes of this region at least once every winter. In addition we use a radio monitoring system for detecting bats in the forest habitat. Up to now we have detected the presence of 21

species from this region. There are some species of which we know the parentsí colonies as *well Rhinolophus hipposideros, Myotis myotis, M. blythi, Eptesicus serotinus, Nyctalus noctula* and *Plecotus austriacus*) but there are some others of which we do not know the parents' colonies, but in general these are relatively frequent species *Myotis mystacinus, M. daubentonii, M. emarginatus, M. nattereri, M. bechsteinii, Plecotus auritus* and *Barbastella barbastellus*. Also found were a few rare or sporadic species such as *Rhinolophus ferumequinum, R. euryale, Myotis brandtii, Pipistrellus nathusii, P. kuhli, Vespertilio murinus, Miniopterus schreibersi* and *Nyctalus leisleri*. Once captured, the animals' general data was collected, as well as their ectoparasites, and the eventual presence of endoparasites was investigated through coprological studies.

SEASONAL POPULATION TURNOVER AT A PERMANENT HOUSE-ROOST OF THE NOCTULE *NYCTALUS NOCTULA*

Alfred Nagel & Ursel Häussler. Georg-Hieronymi-Str. 1, D-61440 Oberursel, Germany .

Bat monitoring in Baden-Württemberg in southwest Germany, showed that noctules progressively exploit prominent modern buildings and bridges as transitory roosts or hibernacula. This paper presents a study carried out from February 1997 to June 1998 on changes in size and structure of groups of noctules making use of such a site for permanent shelter throughout the year. The animals hid behind the panelling bordering the roof of a five-story dwelling house, situated in a major river valley, 200 m a.s.l.. Sex, age, mass and reproductive data was collected from samples either picked from the hanging places (1x) or captured by the use of simple bag traps (3x). Emergence counts (18x) and nightly observations were carried out by means of bat detectors and by vision (18x). In addition, roost temperature and bat sonar were recorded by automatic data-logging. Samples (n = 65 ind.) from the winter population (approx. 500 individuals) showed a balanced sex and age class ratio. Until May the number decreased to 40-70 individuals, predominately males: a sample (May 24, 1998, n = 23) was composed of last-year-males (n = 19) besides two old males and one nulliparous female. During the summer no obvious changes occured: a sample from June 18, 1998 (n = 34) consisted of males only (28 from the last year, 6 older ones). Before the middle of August roost activity and social interactions increased significantly due to the influx of young animals as indicated from a sample of exclusively this-year-bats from August 18, 1997 (11 males, 6 females), when 150 bats were counted in all. In conclusion, the roost population turnover reflects the sex-different life histories in migrating noctules. While the philopatric female bats leave as early as in their first spring, males, especially sexually not fully developed yearlings, tend to stay in unisexual groups. There is evidence that bachelor groups are involved in mating when flocks of bats of the year appear in late summer.

DISTRIBUTION OF BATS IN SOUTH TIROL

Oskar Niederfriniger
South Tyrolian Museum of Nature, Italy

From 1995 - 1997 a first attempt was made to gather knowledge about the number of species and population densities of bats in South Tyrol, on the southern slope of the Alps. The results indicate a great number of species and strong populations relative to the restricted area. It seems possible, that no population decline, like in other countries from middle and northern Europe, occurred here, although no data exists from the past. Relying on these results, further monitoring of the population trends can be made.

INFLUENCE OF TEMPERATURE ON BATS HIBERNATING IN THE POLISH TATRA MOUNTAINS

Jakub Nowak
Chiropterological Information Center, ISEZ PAN 31-016 Kraków, ul. Slawkowska 17 Poland

During the winter season of 1998/99 changes in hibernating bat numbers were observed in Jaskinia Zimna (Cold Cave) and Jaskinia Psia (Dog's Cave). Observations were made every two weeks. The maximum number of bats was 71 - in Zimna Cave and 65 - in Psia Cave. The author noticed a minimum of 8 species: *Myotis mystacinus/brandtii, M. myotis, M. nattereri, M. daubentonii, M. dasycneme, Plecotus auritus, P. austriacus and Eptesicus nilssonii.* The most numerous was *Myotis mystacinus*: 75% which were found in Zimna Cave and 80% which were found in Psia Cave. The correlation of bat numbers and minimum outdoor temperatures (mean week temperature before control) was calculated. Correlation was negative. In Zimna Cave R- squared was: R2=51,8% (p=0,0037) - for all species and R2=37,6% (p=0,02) for Myotis mystacinus/brandtii. In Psia Cave R-squared was: R2=72,7% (p=0,00021) for all species and R2=67,1% (p=0,00061) for *Myotis mystacinus/brandtii.* Temperature influence on the number of hibernating bats is substantial. It suggests that bats imigrate from worse thermally isolated hibernacula to better isolated ones.

ANALYSIS OF HOLOCENE BAT FAUNA FROM POD SOKOLA GORA CAVE IN SYSTEMATICS AND ZOOGEOGRAPHICAL ASPECTS

Katarzyna Ochman
Chiropterological Information Center Polish Academy of Sciences, Kraków Slawkowska 17, Poland

The Pod Sokola Góra Cave is situated in the Kraków-Czestochowa Uplands in Southern Poland). 3691 fragments of bat cranial skeletons have been obtained from the bone material of this cave. The Minimal Number of Individuals (MNI) was 1248. In the studied material, 11 bat species subfossil remains were recorded: Ba*rbastella barbastellus* (0,8%), *Myotis bechsteinii* (9,8%), *M.brandtii* (3,3%), *M.dasycneme* (1,2%), *M.daubentonii* (8,9%), *M.emarginatus* (0,2%), *M. myotis* (0,2%),*M.mystacinus* (0,5%), *M.nattereri* (69,2%), *Plecotus auritus* (5,2%), *Pipistrellus pipistrellus* (0,6%). The proportions of several bat species from subfossil material were compared with recent bat fauna hibernating in this cave. Differences between subfossil and recent fauna from Pod Sokola Góra Cave were statistically significant. The comparison of cranial skeleton morphology between recent and subfossil remains of *M.nattereri* showed statistically significant differences in the length of the maxilla toothrow LC-P4, LM1- M3, M3 dimensions (LM3, WM3) and mandible dimensions (LM, HPC). It confirms the tendency towards the reduction of small premolars and molars (especially M3) of this species. This tendency is the result of shortening the rostral part of the skull. On the basis of the species composition of the investigated taphocenosis, the author concludes that the subfossil remains accumulated probably in the middle holocene period.

SPECIES COMPOSITION OF BATS IN WINTER QUARTERS IN CAVES OF THE MIDDLE URALS

Oleg L. Orlov
Institute of Plant & Animal Ecology, Ekaterinburg, Russia

During the winters of 1996-1999, we explored 21 caves in the Middle Urals. The winter quarters were inhabited by 5-6 bat species, namely, *Myotis dasycneme, M. daubentonii, M. mystacinus* and (or) *M. brandtii, Plecotus auritus* and *Eptesicus nilssonii* were found. Individuals of *M. dasycneme* in their winter quarters in caves form large colonies and often hide in crevices. The total number of individuals of this species in 8 caves was about 2,000. *M. daubentonii* is similar to *M. dasycneme* in the character of

wintering and its population in 8 caves is about 100 individuals. There are very few specimens of *M. mystacinus / brandtii* and *P. auritus*, which spend the winter both in crevices, on walls and on the ceiling, and they were found in 5 and 8 caves, respectively. About 170 individuals of *E. nilssonii* were found in 14 caves. They spent the winter side by side, sometimes in small groups of 2-3 bats, as a rule, on the walls and ceiling. Thus, winter quarters of bats were found in 15 caves. The most abundant species *is Myotis dasycneme,* the most widespread is *Eptesicus nilssonii.* The biggest winter quarter is located in the Smolinskaya Cave (80 km south-east of Ekaterinburg) where approximately 1,800 animals were found. According to the data by other authors, showing that there are winter quarters of Vespertilio murinus in the Northern and Southern Urals, we assume that they should be present in the caves of the Middle Urals as well.

HIBERNATION ECOLOGY OF FREE-RANGING GREATER HORSESHOE BATS

Kirsty J. Park, Gareth Jones & Roger D. Ransome
Institute of Biological Sciences, University of Stirling, Stirling FK9 4LA, UK

(1) Patterns of torpor, arousal timing and the duration of activity in free-living greater horseshoe bats, *Rhinolophus ferrumequinum*, were investigated at caves in Cheddar Gorge (south-west England) during the hibernation period by using temperature-sensitive radio-transmitters.

(2) Torpor bouts of continuously monitored bats varied from 1.7 - 282.1 hours (0.1 - 11.8 days). There were no significant differences in torpor bout length among individuals of different age and sex groups. Torpor bout length decreased with increasing climatic temperature.

(3) Activity duration varied from 37 minutes - 54.4 hours. There were no significant differences among individuals of different age and sex groups, but activity duration increased with climatic temperatures above approximately 10°C.

(4) Of 11 bats monitored continuously, ten synchronised their arousals with dusk. The circadian rhythm of one bat showed a free-running pattern over a period of about five weeks. Arousals were more highly synchronised, and closer to dusk in individuals with lower body condition.

(5) Bats roosting in the main study cave often remained there during most or all of their activity in cold weather. During relatively warm weather some individual bats left the Gorge for periods of up to two hours. Foraging takes place in warm weather periods during winter. This view is supported by the strong synchronisation of arousals with dusk, especially in bats with low body condition.

(6) *R. ferrumequinum* appears to have a physiological requirement to arouse from hibernation at frequent intervals: arousals and their subsequent activity cannot always be related to feeding, mating or roosting requirements. Bats do, however, influence the frequency of their arousals by selecting an appropriate cave temperature for roosting, and also alter their activity duration.

IDENTIFICATION OF BATS IN FLIGHT FROM ANALYSIS OF SEARCH-PHASE ECHOLOCATION CALLS BY AN ARTIFICIAL NEURAL NETWORK. CAN ESTIMATES OF CALL SHAPE INCREASECORRECT IDENTIFICATION RATES?

Stuart Parsons & Gareth Jones
School of Biological Sciences, University of Bristol, Woodland Road, Bristol BS8 1UG, U. K.

Several workers have attempted to develop systems capable of identifying bats in the field by analysis of echolocation calls. The techniques employed have included microphones linked to event recorders, manually tuning heterodyne bat detectors, zero-crossing analysis, discriminant function analysis (DFA) of time and frequency characteristics of calls, and synergetic analysis of spectrograms. Most of these

techniques require significant user knowledge, experience, and intervention, are highly subjective, and to date, all have met with limited success. Despite the poor performance of these systems, species with very similar calls can often be distinguished from one another by visual inspection of spectrograms. Although this method requires a viewer with considerable experience and is highly subjective, it does indicate that features do exist that can be used to separate similar calls. We combined estimates of call shape with 'traditional' measures of echolocation calls (duration, start-frequency, end-frequency, frequency with most energy) to increase the precision of species identification. Search-phase echolocation calls were recorded from 14 species of British bats and analysed using a back-propagation neural network and DFA. Preliminary results indicate that a correct identification rate of 96% is possible using the neural network. This compares with a success rate of 80% using the same data analysed by DFA and represents the highest identification rate yet achieved by published (and many unpublished) methods.

BAT FAUNA OF VALJEVO AREA OF WESTERN SERBIA

Milan Paunovic & Branko Karapandza
Natural History Museum, Njegoseva 51, Belgrade, Yugoslavia

During 1991-1998, a research of mammal fauna of the Valjevo area was conducted (CP:99, DP:08, DP:09, DP:19, DP:29, DQ:00, and DQ:10 UTM squares). Surveying elements of mammal fauna, bats in particular were the main goal of this research. Distribution, ecological and conservation status were studied for each bat species of this area. This paper presents data collected during the field research of theValjevo area, along with a complete review of unpublished records from the data bank of the Natural History Museum and the Centre for Animal Marking, Belgrade and relevant literature data. A total of 16 bat species (62 % of bat fauna of Yugoslavia) were recorded. The following seven species are regarded as potentially present: *Pipistrellus pipistrellus P. kuhlii, P. savii, P.†nathusii, Nyctalus leisleri, Barbastella barbastellus and Plecotus auritus.* Data on the total marked species and several most frequently recaptured species are presented. Migration and life span of the following 4 bat species was analyzed: *Rhinolophus ferrumequinum, Myotis capaccinii, M. myotis and Miniopterus schreibersii.* This analysis includes data on abundance, shelter and habitat preference, use of specific shelters according to their function, with comments on the importance of particular shelters for the total of 16 recorded species. Qualitative analyses of bat species in different shelter and habitat types and a review of underground shelters according to their function for each recorded bat species are presented. The IUCN threatened species categories are given for the recorded species, as well as their status on the Preliminary Red List of Vertebrates of Serbia.

THE EMERGENCE ACTIVITY OF SEROTINE BAT AND ITS CHANGES DUE TO PREDATION RISK AND CLIMATIC FACTORS

Klara J. Petrzelková & Jan Zukal
Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic, Czech Republic

A total of 34 observations of emergence activity were made from April to August 1997 and in 1998 at a maternity colony of serotine bats (*Eptesicus serotinus*) in Strelice u Brna, Czech Republic. The time of first emergence and the median of emergence were strongly correlated with sunset. Mean emergence time was 5,2 min after sunset. After parturition the duration of emergence was prolonged and the emergence ended later. Cloud cover, wind speed and relative humidity had no effect on parameters of emergence. The number of emerged bats and the duration of emergence were positively affected by the temperature. The number of emerged bats was significantly negatively correlated with barometric pressure. To study antipredator responses in emergence activity of serotines, a stuffed barn owl (*Tyto alba*) was used as a predator model and placed close to the roost exits on 7 nights in 1997. A stuffed common kestrel (*Falco*

tinnunculus) was used on 7 nights in 1998. Both predator models associated with their calls did not cause changes of any parameter of emergence activity. 91% of emergences were clustered. However, clustering did not increase during the presence of the stuffed owl or kestrel. Finally the emergence pattern of every night was described by the times of emergence of all bats. By the use of MANOVA the influence of reproductive and climatic factors on the variability of emergence pattern was found out.

THE BAT FAUNA OF THE POLISH TATRA CAVES

Krzysztof Piksa & Jakub Nowak
Cracow Pedagogical University, Institute of Biology, Podbrzezie 3, PL.-31-054 KrakÛw, Poland

The Tatra Mountains located in the centre of the Western Carpathians, constitutes the highest moutain massif within the whole Carpathians range. The minor part (about one fourth of the area), located on the northern slopes, lies in Poland. Recently, there are approximately 650 known caves in the Polish part of the Tatras. The investigation of bats was carried out between 1995 and 1999 in 42 localities lying in the altitudunal range between 1,015 m. above sea level(ASL) and 1906 m. ASL. In the caves of the Polish Tatras 12 bats species were reported: *Myotis myotis, M.nattereri, M. dasycneme, M. bechsteinii, M. mystacinus, M. brandtii, M daubentonii, Vespertilio murinus, Eptesicus nilssonii, Plecotus auritus, P. austriacus,* and *Barbastella barbastellus.* The most frequent species are*: M. mystacinus, M. myotis* and *E. nilssonii.* Observed above the tree-line (1550 m ASL.) *were M. myotis, M. nattereri, M. mystacinus, B. barbastellus, P. auritus* ,and *E. Nilssonii.*

INSECT AVAILABILITY IN FORAGING AREAS & PREY SELECTION BY THE GREATER HORSESHOE BAT *RHINOLOPHUS FERRUMEQUINUM*IN LUXEMBOURG

Jacques B. Pir
c/o Natural History Museum Luxembourg; 25, rue M¸nster; L - 2160 Luxembourg

From 1996 to 1998 a pluridisciplinary research project about insect availability in the feeding habitats of two bat species, the serotine (*Eptesicus serotinus*) and the greater horseshoe bat (*Rhinolophus ferrumequinum*) was carried out in the south-east of Luxembourg by chiropterologists and entomologists of the Natural History Museum Luxembourg. The aim of this study was to compare insect availability and food selection within the feeding habitats of these two bat species. Insect availability was especially examined during energetically critical periods in summer: gestation and lactation of the females; - and the time between the young were fully fledged and their weaning from their mothers. Since 1994 the feeding habitats of a nursing colony of the greater horseshoe bat have been investigated by radiotracking more than 20 individuals. The hunting habitats as revealed by this study were analysed concerning their entomofauna during the three physiologically critical periods mentioned above. A quantitative and qualitative investigation of insect availability was done by using different insect trapping methods over several nights during these periods. Droppings collected simultaneously underneath the nursing colony of *R. ferrumequinum* were analysed and the results compared with the available insects. By investigating the insect availability within hunting areas compared with the one in similar habitats known not to serve for hunting, it is hoped to increase the knowledge about the ecology of the main key prey species of the greater horseshoe bat. The obtained results will serve as a base for the biodiversity conservation programme of the Nature Conservation Agency (Water and Forest Administration) to protect and improve feeding areas of the last greater horseshoe bats in Luxembourg.

BATS HIBERNATING IN THE UNDERGROUNDS OF THE UKRAINIAN CARPATHIAN MOUNTAINS

Vasyl Pokynchereda, Carpathian Biosphere Reserve, Ukraine

In the territory of the Ukrainian Carpathians the main underground bat hibernation shelters are the karst and pseudokarst (tectonic) caves and, to a lesser extent, mine shafts. Based on the results of more than fifteen years of investigations, and research of other existing data, it was determined that in the underground cavities of the Ukrainian Carpathians hibernate 16 bat species, belonging to 2 families. They are: Rhinolophidae: *Rhinolophus ferrumequinum, R. hipposideros* and Vespertilionidae: *Miniopterus shreibersii, Myotis blythii, M. myotis, M. bechsteinii, M. nattereri, M. mystacinus, M. brandtii, M. emarginatus, M. daubentonii, Plecotus auritus, P. austriacus, Barbastella barbastellus, Eptesicus serotinus and E. nilssonii.* From them *Rhinolophus ferrumequinum, Miniopterus shreibersii, Myotis blythi, M. nattereri, M. brandtii, M.emarginatus* and *E. nilssonii* were not found in the northern macroslope until now. The dominant species during the hibernation period are: *Myotis myotis* and *M. blythii* (in the northern macroslope only *M. myotis*), subdominant species: *Rhinolophus hipposideros* and *R. ferrumequinum* (in the northern macroslope only *R. hipposideros*). Others belong to the rare but regularly hibernating species. *Eptesicus serotinus and E. nilssonii* were identified hibernating in the caves of this region, respectively, and only two at one time. *Miniopterus shreibersii* has not been recorded here since 1993. The largest hibernation shelters are located in the southern macroslope, where a few shelters with the number of bats numbering from the hundreds to 1.5 thousand individuals ("Druzhba" cave) were found. The underground shelters of the northern macroslope number not more than 100 bats. The majority of underground bat shelters in the territory of the Ukrainian Carpathians is concentrated in the national parks and reserves (Carpathian Biosphere Reserve, Carpathian National Park, National Park "Skolivski Beskydy" and others), which provide protection for them. Underground shelters existing outside these areas need to be protected in innovative ways.

MONITORING CAVE MICROCLIMATES BY EXTERNAL CLIMATE CONDITIONS AND ITS INFLUENCE ON THE POPULATION OF BATS HIBERNATING INSIDE THE CAVE

Tomasz Postawa

Chiropterological Information Center ISEZ PAS Krakow, 31-016 Krakow, Slawkowska 17, Poland

The Pod Sokola Gora (PSG) cave has a pecuilar morphology and microclimate. The author studied the relationship between the climate and microclimate of the PSG cave. The main corridor of the PSG cave has an interesting structure. Its corridor seems to have a concave (u-shaped) shape. For this reason in the winter, cold air enters the cave and deposits in the lowest part of the cave. When the period of cold weather is long, the level of cold air inside the cave rises and can close off the corridor off completely to bats because they do not prefer the cold temperature. The study was carried out from October through May during three years-1993-1994, 1995-1996, and 1996-1997. One visit was made every two weeks and the temperatures were recorded. The results obtained from the cave were compared with the temperature outside the cave. The author used accurate temperature data from the weather station in Czstochowa. The author showed that the temperature inside the cave depends more on the longevity of the cold weather outside the cave instead of the actual low temperature. When the cold period is long, it will create a siphon of cold air, causing the bats not to enter the cave. In such situations, the population of bats hibernating inside the cave may be very low. The author compared winter populations inside the cave and found that during the winter of 1995-1996, the population of hibernating bats was two times lower than in the winter of 1993-1994. Between the winter of 1996-1997, the population of bats was six times lower than in 1995-1996. In different caves in the vicinity during the same winters, such drastic changes in hibernating populations were not observed. During the study the author confirmed 9 different species of bats

hibernating in the PSG cave. They are as follows: *Myotis nattereri, Myotis myotis, Myotis dasycneme, Myotis daubentoni, Myotis brandti, Myotis mystacinus, Plecotus auritus, Plecotus austriacus*, and *Barbastella barbastella.*

DISTRIBUTION AND STATUS OF HORSESHOE BATS*RHINOLOPHUS FERRUMEQUINUM* AND *R. HIPPOSIDEROS* IN THE LOWER WYE VALLEY, U.K.

David J. Priddis
"Norview", Ring Fence, Woolaston Common, Lydney, Glos. GL15 6NX, U.K.

The Lower Wye Valley area of Monmouthshire (formerly Gwent), Wales and Gloucestershire, England is a Candidate Special Area of Conservation (SAC) under the EC Habitats Directive. The study area contains seven Sites of Special Scientific Interest (SSSI) breeding sites of the lesser horseshoe bat *Rhinolophus hipposideros* ("**LHB**"); two SSSI breeding sites of the greater horseshoe bat R. ferrumequinum ("**GHB**") and six hibernacula SSSI's. A detailed database of some 200 sites actually used by horseshoe bats and a further 100 potential sites has been produced by amateur bat workers for English Nature. The study area, approximately 25 km by 45 km, is transected by the limestone cliff-lined River Wye valley and is characterized by its deciduous and coniferous woodland, part under-grazed by sheep; sloping pasture; field hedge boundaries; arable areas and many abandoned mines. The maximum counts of adults at the 18 main breeding roosts of LHBs total 2500 animals, this being some 18% of the estimated mainland U.K. population. The area likewise contains three of the U.K.ís 17 known breeding roosts and 6% of the estimated GHB U.K. population. Both populations are believed to be stable or slightly increasing. Up to 1000 LHBs and 150 GHBs are monitored during Winter in the many underground sites. Most of these sites are abandoned ironstone mines and they are mainly sited in Gloucestershire. Information will be mainly presented in the form of annotated maps but with back-up data available for discussion.

FORAGING BEHAVIOUR AND HABITAT SELECTION IN *MYOTIS MYOTIS*

Ana Rainho & Jorge M. Palmeirim
Instituto da Conservaá o da Natureza. R. Filipe Folque, 46 - 1ß, P-1050 Lisboa, Portugal

The long term conservation of large colonies of cave dwelling bats is only possible if the potential foraging areas are properly managed. In order to plan this management it is necessary to know the foraging behaviour of these bats. Foraging behaviour and habitat selection in *Myotis myotis* were studied in a dry area of Southern Portugal, mostly covered by Mediterranean scrub, stone oak woodlands, olive groves, and cereal steppe. Twelve animals carrying radio tags were followed during the spring of 1998. They were followed with a precision triangulation system from fixed and mobile towers. Both males and females followed and concentrated their foraging activity in specific areas. In the two animals for which this foraging home range was measured, it had about 250 ha. Most of the feeding areas were located within 10 km from the daytime roost. Our data suggest that in general, females forage further from this roost than males. Each animal only used one foraging area, to which it returned every night. Most animals spent all night in the feeding area, but a few males briefly returned to the daytime roost in the middle of the night. None of the animals spent the day in the foraging area. In general bats flew directly from the daytime roost to the foraging area, flying at a speed of about 25 km/h. So far habitat selection has only been analysed for two animals. This limited data suggests a preference for steppe with scattered trees and stone oak woodland.

RESULTS OF THE BAT BANDING IN AZERBAIJAN

Irina Rakhmatulina
Institute of Zoology, Azerbaijanian Academy Of Sciences, Passage 1128, Block 504, 370073 Baku, Azerbaijan Republic

The total number of 5,581 bats of 17 species of 26 registered ones in Azerbaijan have been banded in all characteristic natural regions. Most of them are *Pipistrellus pipistrellus* (1,434 individuals) and *P. kuhli* (975). 757 *Miniopterus schreibersii*, 744 *Myotis blythii* and 391 *Rhinolophus mehelyi* have been banded on the territory of the Lesser Caucasus. 332 individuals of 10 species have been recaptured and most of them were found in the places of the first catches. According to the obtained information, a mass of the bat species makes local movements only between summer and winter roosts. *R. hipposideros, R. ferrumequinum, P. pipistrellus* and *P. kuhli* were recaptured at the distances between several hundred metres to 5 kilometres away from their seasonal shelters. There was a colony of *M. schreibersi*, including 8 - 10 thousands of individuals, inhabiting the Azykh Cave of the Mountain Karabakh during the warm period and the Kilit Cave of the Nakhichevan region during hibernation. The distance between these points is approximately 120 km. *E. Serotinus* was found 50 km to the S-E from his summer roost. Homing experiments and recaptures of the banded animals testify the stationary character of most bat locations in Azerbaijan. *P. nathusii* and *N. Noctula*, most probably, make farther migrations along the Caspian Sea coast.

FORAGING SUCCESS AND MOTHER'S BODY MASS INFLUENCE THE GROWTH ACHIEVED BY FEMALE GREATER HORSESHOE BATS

Roger D. Ransome, University of Bristol, UK

An earlier study on factors influencing the growth of female young showed that radius length is the best field measurement to assess overall growth. Radius early growth rate (between the 4th day and 14 post birth), and the mother's radius length were the two major factors identified which controlled the growth achieved. Together they explained some 49% of the observed variation in growth. In the present study step-down regression of 9 potential factors on growth achieved identified the following additional factors.

1) dawn foraging success and body mass of mothers during very early lactation
2) body mass of mothers after 28 days lactation, just before their young start to forage
3) the early dawn foraging success level of the young aged 48 days.

These factors together explain 86% of the variation observed. Significant mass losses occur in mothers between early and late lactation. These results support the hypothesis that body reserves are accumulated during pregnancy, and are used to subsidize lactation. Body reserves may be combined with nutrients gained from foraging by the mother throughout lactation. However, food deprivation caused by poor weather during the early growth period may be most critical. Foraging levels achieved by the young before weaning also contribute to the final stages of growth, and allows some recovery from earlier deprivation, if it occurs.

FLIGHT ACTIVITY AND HABITAT PREFERENCE OF BATS RECOREDED BY BAT DETECTORS

Zdenek Rehák & Jan Zukal
Department of Zoology and Ecology, Masaryk University, Kotlárska 2 611 37 Brno, Czech Republic

The flight activity of bats was studied at 21 localities in the Moravian Karst (C-Moravia, Czech Republic). Bat detectors were used to record echolocation calls of bats on line transects. The transects were mostly carried out during the first half of the night from April to October and the duration of each transect

was 20 or 30 minutes. The number of minutes with the presence of particular species or a couple of sibling species related to 1 hour of transect (min+/h) was used as a measure of bat activity. Nine habitats were distinguished - fields, meadows, linear landscape elements, villages, rocks, forests, forest edges, streams and ponds. In total, 702 minutes with the presence of flying bats and at least 16 bat species were registered during 3420 transect minutes. *Myotis daubentonii* was the most numerous species (46.2%). Further species with high values of dominance were *Pipistrellus pipistrellus* (12.5%), *Eptesicus serotinus* (8.7%), *M. myotis/blythii* (7.4%) and *Plecotus auritus/austriacus* (5.6%). The number of bat species was highest in rocky habitats (13 species), and lowest in agrocoenoses (3 species). The highest intensity of flight activity of the bat community was observed over ponds (35.0 min+/h) and streams (26.6 min+/h). The interior of villages was also important (10.9 min+/h) while agrocoenoses, without any patches of trees or shrubs, were used little by bats (2.7 min+/h). With respect to habitat preference *M. mystacinus/brandtii, M. myotis/blythii, E. serotinus, Nyctalus noctula, P. pipistrellus* and *P. auritus/austriacus* appear to be eurytopic species and *M. daubentonii, M. nattereri* and *M. emarginatus* to be stenotopic species. While *M. daubentonii* and *M. nattereri* preferred the watersides, *M. emarginatus* was most frequently recorded in the forest. Low number of records made it impossible to evaluate habitat preference of the remaining bat species.

GREATER MOUSE-EARED BAT *MYOTIS MYOTIS* AND LESSER BAT *RHINOLOPHUS HIPPOSIDEROS* IN THE COUNTY OF SALZBURG, AUSTRIA: DISTRIBUTION, ROOST SELECTION AND THREATS DUE TO HUMAN ACTIVITY

Guido Reiter & Ulrich Hüttmeir
Institute of Zoology, University of Salzburg, Hellbrunner Str. 34, 5020 Salzburg, Austria

In the summers of 1997 and 1998, a total of 316 buildings, mainly churches and castles, were investigated. These buildings were checked for the presence of bats, for the characteristics of the roosts, and threats due to human activities were estimated. 13 maternity roosts of the greater mouse-eared bat were found, which were widely distributed over the whole study area, with the sole exception of the mountainous Lungau district. Of the lesser horseshoe-bat 18 maternity roosts were discovered. These were scarce in the lowlands, but comparatively frequent in the mountainous region of the upper Salzach valley. On the whole, the distribution of both species reflects their status in Central Europe. The investigation of roost characteristics revealed, that greater mouse-eared bats use buildings with metal and "eternit" roofs more frequently than expected from a chi-square distribution. As to internal dimensions, more maternity roosts were found in large lofts, solitary individuals of the greater mouse-eared bat, however, were found more often in lofts with well structured shapes. The lesser horseshoe-bats, also, preferred well structured lofts for their roosts. According to the results of this study, maternity roosts of the greater mouse-eared bat are more threatened due to human activities than solitary individuals of this species. Since the lesser horseshoe bats frequently use vicarages for their maternity roosts, they are more often exposed to human disturbance. They are, therefore, even more endangered than the greater mouse-eared bats, whose colonies were found exclusively in churches.

GENETIC VARIATION AND POPULATION STRUCTURE IN THE ENDANGERED GREATER HORSESHOE BAT *RHINOLOPHUS FERRUMEQUINUM*

S. J. Rossiter, Gareth Jone, Roger D. Ransome & Elizabeth M. Barratt
School of Biological Sciences, University of Bristol, Woodland Road, Bristol, BS8 1UG, UK

* This presentation was judged as best presented paper on Ecology and Conservation at the Conference. The award of U.S.$150 was received by Stephen J. Rossiter

Since the 1950s, the numbers of most European bat species have fallen. This study focuses on one

example, the greater horseshoe bat *R. ferrumequinum*, which is endangered throughout most of its European range, having undergone population decline and fragmentation in recent years. Females of the species exhibit strong natal philopatry, forming maternity colonies each summer, while males are more solitary. In Britain, approximately 14 such colonies remain, and ringing has revealed little movement between sites. We used 6 microsatellite loci to examine genetic variability within and differentiation among 7 maternity colonies in England and Wales, and 2 populations from continental Europe. In addition we analysed 5 cohorts born in successive years at one colony, to determine the extent of temporal change. Levels of allelic diversity and heterozygosity varied considerably between sites, but were stable over time. Within Britain the lowest values corresponded to the most isolated colonies, although the total allelic diversity of all bats was lower than that obtained from a sample of 12 individuals from a cave in northern France. We found significant spatial differentiation across Europe, and also among some British colonies, but no temporal differentiation. Pairwise values of differentiation and geographical distance were significantly correlated, indicating gene flow is restricted to neighbouring colonies. Limited dispersal is more likely to be due to male and female fidelity to the natal area, rather than through physiological constraints, and suggests this species is especially vulnerable to the destruction of mating roosts and habitat fragmentation.

ROOSTING SITES OF LEISLER'S BAT *NYCTALUS LEISLERI* IN THE BIALOWIEZA FOREST

Ireneusz Ruczynski & Iwona Ruczynska
Mammal Research Institute, Polish Academy of Sciences, 17-230 Bialowieza, Poland

Roost sites are critical resources for bats as they provide a necessary safe location for day resting with proper thermal and humidity conditions in the vicinity of foraging and drinking areas. Understanding the roosting requirements of bats in old stand forests is probably essential in the conservation and maintenance of all bat species in a changing forest landscape. The Bialwieza Forest (1500 km2) is the largest remnant of the original temperate forest in Europe. Mature stands are dominated by oak *Quercus robur*, hornbeam *Carpinus betulus*, alder *Alnus glutinosa*, spruce *Picea abies*, and pine *Pinus silvestris*. Four lactating females of Leisler's. bat *Nyctalus leisleri* (Kuhl, 1817) were radiotracked for 5 to 14 days during the summer (July-August) of 1998 in the Bialowieza Forest. Twelve roosts were found: 7 in oak trees *Quercus robur*, 4 in ash *Fraxinus excelsior* and one in a maple *Acer platanoides*. Nine of these roosts were situated over 17 m above ground level. All roosts were located close to open areas, which had been caused by forestry management (clearings, roads, forestry lines). Breeding colonies consisted on average of 21 individuals (7-38 bats) in one tree hole. Colonies of *Nyctalus leisleri* occupied roost trees as single species and also with the Noctule bat *Nyctalus noctula*. Low site fidelity of breeding colonies was observed. Our preliminary data suggest that breeding colonies of Leisler's bat require large trees in specific stages of decay situated close to relatively open areas.

MOLECULAR SYSTEMATICS OF EUROPEAN *MYOTIS* REVEAL UNEXPECTED PATTERNS OF MORPHOLOGICAL EVOLUTION

Manuel Ruedi & Frieder Mayer
Institute of Ecology, University of Lausanne, Switzerland

To understand the evolution of species diversification, it is essential to rely on sound phylogenetic backgrounds. The challenge is therefore to reconstruct the history of organisms based on few, if any, fossil records and/or characters issued from contemporaneous species. As speciation events occurred in the past, there is no way to replicate or experiment these reconstructions. The genus *Myotis* is the most widely distributed genus of bats. Yet, its more than eighty species have a rather conservative morphology, making

phylogenetic reconstructions based on phenotypic characters particularly difficult. They have been classified into several subgenera, each subdivided into species groups. Most of these groups of morphologically similar species occupy several continents. If this classification corresponds to real phylogenetic relationships, then it implies that extensive faunal migrations occurred across huge areas. Conversely, if the phenotypic characters used to differentiate them reflect morphological adaptations, then an independent phylogeny would be needed in order to understand how such species radiations may have evolved in different continents. In order to test these alternative scenarios, we used molecular data (complete cytochrome B sequences ; 1140 bp) of most European species, as compared to a subset of African, Asian and American taxa. Not surprizingly, this data demonstrates the existence of several pairs of morphologically similar species (e.g. ***M. daubentonii/M. lucifugus*** or ***M. mystacinus/M. brandtii***) which are phylogenetically not closely related, favoring the hypothesis of a convergent evolution. The converse was also found, that species with distinctive morphology are classified in different subgenera which appears as sister taxa in the molecular phylogeny. Interpretation of these patterns of evolution suggest that adaptive radiation occurred several times in the history of ***Myotis***, leading to recurrent morphological " solutions " which appeared independently in different parts of the World.

THE SOCIAL CALLS OF KUHL'S *PIPISTRELLES PIPISTRELLUS* : STRUCTURE AND VARIATION

Danilo Russo & Gareth Jones
School of Biological Sciences, University of Bristol, Woodland Road, Bristol, BS8 1UG, U.K.

The aim of this study was to describe the structure of social calls produced by Kuhl's pipistrelles *Pipistrellus kuhlii*. Bats foraging around street lamps in the Campania region (Southern Italy) were recorded. Calls were produced by bats during chases and, similarly to those of *Pipistrellus pipistrellus*, were probably used to repel conspecifics from hunting sites. Calls were often constituted by three components, lasted on average 34 ms and contained most energy at about 17 kHz. A positive correlation was found between the frequencies of maximum amplitude of echolocation and social calls. Social calls from two adjacent populations differed in their peak frequencies, and possible hypotheses for this variation are given. The structure of *P. kuhlii* social calls was compared with those of the 45 and 55 kHz P. pipistrellus phonic types. Kuhl's pipistrelle calls lasted longer and showed lower values of minimum and peak frequencies. These differences can help to discriminate between field recordings *of P. kuhlii* and *P. pipistrellus* where the two species occur sympatrically.

THE ITALIAN BAT ROOST ATLAS: A SYNTHESIS OF THE LAST TEN YEARS OF RESEARCH

Danilo Russo & Dino Scaravelli
Italian Chiroptera Research Group c/o Dept. of Structural and Functional Biology,
University of Insubria, Via J.H. Dunant 3, 21100 Varese VA Italy

Bat research in Italy has recently resumed after about 30 years of scarce activity. The last work describing bat roost distribution in Italian territory dates back to the monograph by Lanza (1959). In 1998, a large number of Italian bat researchers decided to create a national research group in order to enhance bat research quality in Italy and to act as a reference point to the research. The first aim of this group was to reassess species distribution on the entire territory, paying particular attention to roosts as key elements for the subsequent development of conservation plans. This work presents a first synthesis based on data collected in the last ten years from many Italian bat researchers. For each known roost data was recorded regarding its location (geographical location, height, roost site characteristics, etc.), function (hibernating

or breeding roosts) and conservation issues such as roost status and interference factors (with humans or other species). Demographic data was also collected recording the number of animals and species of bats present in a roost. All data has been stored in a Geographical Information System, in order to provide a common tool to the Italian (and not only) bat research community. GIS use allowed us to carry out a critical analysis of the ecological factors influencing roosts, producing species richness, species diversity and roost density maps. The comparison of distribution and land use allowed us to reveal preferred habitat types for each studied species. This contribution is the first result of the collective work of the Italian Chiroptera Research Group.

FIRST ACCOUNT ON BATS OF S. MARINO REPUBLIC

D. Scaravelli, A. Suzzi Valli, A. Cecchetti and S. Casali
Onferno Natural Reserve, p. Roma 1, I - 47855 Gemmano (RN)

S. Marino Republic is a small independent state in the mainland of Italy, placed on the slopes of the S. Marino limestone mountain about 25 km from the Adriatic sea coast. Highly populated, this area has a mosaic environment characterised by the contrast between the Mediterranean and continental bioclimate. In 1998 the authors began a project with the aim to increase a better knowledge of the bat fauna of the area and in order to develop a conservation effort for these mammals. There is very scarce published data for this state: some specimens in the collections are from the end of the 19th century and a few sightings were recorded in the 1960ís-1980ís by speleologists. The project is now operating with exploration of cavities, mistnetting and the use of bat detectors. The first data summarised here shows a typical anthropophylous fauna with *Hypsugo savii* and *Pipistrellus kuhlii*. In caves and tunnels few individuals of *Rhinolophus ferrumequinum* and *R. hipposideros* were found, but maternity colonies are unknown. The discovery of a wintering colony of more than 1,000 *Miniopterus schreibersii* in an old railway tunnel, was followed by the necessity to prevent a disturbance to the animals. A special gate was mounted and a monitoring action followed. Probably these specimens go to the Onferno Reserve, 18 km away, for reproduction, from May to October. To help the tree-dwelling species, a bat-box plan was also started. A public campaign, an exposition in the Nature National Centre and new laws are in action to encourage a new approach to this mammals.

THE MICRO-HABITAT PREFERENCES OF BECHSTEIN'S BAT WITHIN WOODLANDS IN SOUTHERN ENGLAND

Henry Schofield & Colin Morris
The Vincent Wildlife Trust, 10 Lovat Lane, London EC3R 8DN, UK

Bechstein's bat, *Myotis bechsteinii*, is a rare tree-dwelling species. Little is known of its ecology but it is generally associated with old broadleaf woodland. Although it is widespread on a European scale records are scarce and it is regarded as rare in all countries where it occurs. Only two maternity colonies have been identified in the UK this century, both of which were discovered in 1998. The first colony of about 50 animals roosts in the loft of a house in south-east England. The second of 54 adults and some 30 juveniles roosts in bat boxes in a woodland in south-west England. The latter is the subject of this study. The aim of this study was to investigate the foraging micro-habitat preferences of Bechstein's bat within woodland and to produce conservation guidelines for woodland managers. The study centres on a 44 ha woodland, which comprises stands of trees of differing age, areas of coppice, riparian trees and conifer plantation. The woodland is surrounded by cattle pasture with boundaries of tree lines and hedgerows. Different areas of the woodland were characterised by recording data such as the age, height, and spatial density. The foraging behaviour of the bats was determined using radio-telemetry. A Geographical Information System was used to analyse the habitat use within the activity range of the bat. Kernel

estimations of foraging location densities were used to determine the key foraging areas within the study site. Compositional analysis was used to determine the micro-habitat preferences of the bats within the study area.

ECHOLOCATION AND FORAGING BEHAVIOUR OF *MYOTIS NIGRICANS*: A "NEOTROPICAL PIPISTRELLE"?

Bjoern M. Siemers, Elisabeth K. V. Kalko & Hans-Ulrich Schnitzler
Animal Physiology, University of Tuebingen, Morgenstelle 28, D-72076 Tuebingen, Germany.

Echolocation behaviour, prey-detection strategies, and foraging performance of the poorly-known neotropical *Myotis nigricans* was studied descriptively in the field and experimentally in a flight cage on Barro Colorado Island (BCI), Panama. The bats flight behaviour was videotaped under infra-red stroboscopic illumination in temporal synchrony with echolocation recordings to asess adaptation of call structure to specific behavioural situations. In the field and flight cage, the bats only performed aerial catches and did not take prey from surfaces. They used echolocation for prey acquisition. In the flight cage, capture performance increased with distance of prey to an experimental "clutter-screen". Performance furthermore depended on the orientation of the "clutter-screen", being better in front of a vertical screen than over a horizontal screen (Fisher's exact test, $p < 0.001$, $n = 78$ for 10 cm distance). The bats preferred prey dummies measuring 9 x 1.6 mm in a prey size selection experiment. In the flight cage as well as in confined habitats in the field, the animals broadcast typical Myotis echolocation calls: comparatively short downward frequency modulated signals providing fair spatial resolution in cluttered environments. However, in the field *M. nigricans* readily and continuously hunted in open space, more then 10 m away from any obstacle. In this search situation, the animals used narrow-band frequency search calls of about 7 ms duration. This call type increases the probability of detecting an insect in open space. Both hunting behaviour and echolocation signals in open space are untypical for the hitherto investigated *Myotis* species as they forage comparatively close to vegetation, the ground, or water surfaces. Behaviour of *M. nigricans* in open space rather resembles a pipistrelle. One might speculate that *M. nigricans* ecologically exploits the Pipistrellus-niche in the Neotropics, given the absence of the genus *Pipistrellus* south of Honduras.

Funded by DFG (SFB 307), Teufel-Stiftung and Studienstiftung des deutschen Volkes.

HABITAT USE BY NATTERER'S BATS *MYOTIS NATTERERI* ON THE WELSH / ENGLISH BORDERS

Peter G. Smith
University of Aberdeen, Dept. of Zoology, Tillydrone Avenue, Aberdeen, Scotland.

* This presentation was judged as best presented paper on field research at the Conference.
The award of U.S.$150 was received by Peter G. Smith

During three summers from 1995, foraging activity of Natterer's bats at four colonies on the borders of England and Wales was studied by radio tracking. Bats were tracked continuously for complete nights. Tracking and habitat data were entered onto a computer on MapInfo Geographic Information System. Typical colony home range area, measured as minimum convex polygon (MCP), was found to be circa 14 sq. km. Percent habitat availability within each colony foraging MCP was compared with percent habitat utilization for 37 bats simultaneously using a method of compositional analysis. This showed that habitat use was significantly non-random (Wilk's lambda = 0.0533, $P < 0.001$ by randomisation) and that semi-natural broad-leaved woodland was significantly selected for over all other habitats ($P < 0.05$). The next most favoured habitats for foraging were river corridors, improved grassland and other woodlands. Arable and coniferous plantation were significantly avoided. A total of more foraging time was spent over

improved grassland, the predominant habitat in the area, than any other habitat category, although it was avoided in the sense that it was used proportionately less than its availability. In contrast, area for area, semi-natural broad-leaved woodland was found to support at least four times the amount of foraging activity by Natterer's bats than was the case for improved grassland. The bats were found to forage actively through most of the night, using night perches only briefly. Although bats changed roosts frequently this was not correlated with changes in foraging areas. Typically they foraged within 2 to 3 kilometres of the roost with a maximum of 6 kilometres being recorded. Evidence from two adjacent colonies included in the study suggests that each colony may occupy an exclusive home range. This study has demonstrated the conservation importance to this species of semi-natural broad-leaved woodland for foraging. *Sponsored by The Peoplefs Trust for Endangered Species, The Endangered British Mammals Fund, The Countryside Council for Wales and English Nature.

FEEDING ECOLOGY OF GREATER MOUSE-EARED BATS *MYOTIS MYOTIS* ONE HUNDRED YEARS AGO: EVIDENCE FROM BAT DROPPINGS AND HISTORICAL LANDSCAPE ANALYSIS

Claude Steck & Rene Güttinger
Group for Wildlife and Conservation Biology, Zoological Institute,
University of Zurich-Irchel CH-8057 Zurich, Switzerland

It was a great surprise when we discovered a considerable amount of old and dusty, but well preserved droppings of Greater mouse-eared bats *Myotis myotis* in an abandoned nursery roost in northern Switzerland (canton of Aargau). Dendrochronological examination of the wooden floor covering the droppings so far, as well as radiocarbon-dating of one skeleton of a young mouse-eared bat revealed that the droppings date from a nursery colony living in the roost about one hundred years ago. First of all, an extensive diet analysis was conducted to get first insights into the dietary niche of the bats at that time. Of particular interest are questions concerning trophic niche breadth and hunting habitat selection of today and one hundred years ago (Was the bat's former diet more diverse than today? Does the former diet indicate that Greater mouse-eared bats were at that time hunting more often in open habitats than today?). To answer these questions the former diet will be compared with the actual diet of two nursery colonies living in the vicinitiy of the ancient roost. In addition, differences in landscape composition between today and one hundred years ago will be studied with a historical landscape analysis. The combination of the two analyses will probably give us some evidence if the contemporary, more or less pronounced selection of Greater mouse-eared bats on forest carabids - a general feeding pattern observed in Central Europe today - could merely be interpreted as an effect of prey availability in today's man made landscape. Some preliminary results revealed by the fecal analysis of old droppings will be presented.

CONSERVATION THROUGH EDUCATION

Shirley A.Thompson
The Bat Conservation Trust, 18 Cloisters House, 8 Battersea Park Road, London SW8 4BG, UK

The term "Education" usually conjures up a picture of children and a teacher. However, the dictionary definition of the word includes the giving of advice and information, as well as training or instructing for a particular purpose. With this in mind, Education in its broadest sense should be recognised as a crucial tool for bat conservation at all levels and for all ages. However, to make the best use of our resources it is essential to look carefully at whom we are trying to educate and plan our strategies carefully.

In order to develop an Education Action Plan, we must consider the following:

What groups do we need to target?

What information do those groups need to further bat conservation?

How do we meet that need?

The main target groups may be summarised as

a). the general public, including adults and young people

b). Professional building and allied industries, including those involved in planning and those likely to come across bats while working, as well as suppliers of material to the industry.

c). Miscellaneous interests, which include, amongst others, major land owners, Government and its agencies, tree organisations, those involved with special structures such as churches, bridges etc.

d). Those already involved with bats - bat workers, general conservation organisations, universities etc.

The various methods available range from posters and leaflets to articles, videos and seminars. Using the wrong medium for the wrong audience is wasteful in time and money. Content of the educational package, too, needs careful ëtargetingí, as does distribution, ensuring that the relevant information actually reaches the right people. Only by taking a broad view of education in this way can bat conservation be built on a strong base.

TAXONOMY OF THE *MYOTIS FRATER* GROUP

Katherina A. Tsytsulina
Zoological Institute, St. Petersburg, Russia

Four subspecies are currently recognized within *Myotis frater* : *M. f. frater* Allen, 1923, *M.f. kaguyae* Imaizumi, 1956, *M. f. longicaudatus* Ognev, 1917, and *M. f. bucharensis* Kuzyakin, 1950. According to our investigation, *M.bucharensis* should be considered a valid species. It is distinguished by a relatively large size, light coloration (of "desert" type) and skull proportions. *M. bucharensis* is a colonial form, living in caves, whereas the remaining longtailed mouse-eared bats are single forest dwellers. *M. bucharensis* (Central Asia) *and M. frater*(Eastern Asia) are separated by the considerabe geographic distance. *M. f. longicaudatus* could be divided into two morphologically distinct forms which are geographically isolated, inhabiting the Far East (type area of *M. f. longicaudatus*) and the Krasnoyarsk region(*M. frater ssp.n.)* respectively. *M. frater ssp.n.* is sufficiently distinct by less bright coloration, longer ears, shorter tail, lacking cartilaginous septa in the lobe(similarity with *M.f.bucharensis*) and also by some craniometrical characters, skull and baculum morphology from the remaining *M. frater* subspecies.

BATS AS TRAFFIC VICTIMS

Peter Twisk
Bat Study Group Noord-Brabant, The Netherlands

Because of their slow reproduction, bats are very susceptible to mortality factors. Killing by traffic is an additional, unnatural mortality factor that may have been largely overlooked. In the last 20 years the author found 33 bats, killed by traffic. These were found in 4 countries in Europe, while traveling by bicycle. They were: 18 *Pipistrellus pipistrellus*, *4 Myotis daubentonii*, 3 *Eptesicus serotinus*, 2 *M. mystacinus*, 1 *M. mystacinus/brandtii*, 1 *M. nattereri*, 1 *M. dasycneme*, 1 *Nyctalus species*, 1 *Barbastella barbastellus* and 1 *Plecotus auritus*. Numbers are between 0.2 and 0.8 per 100 km and expected to be between 1.4 and 24 bats per 100 km annually. Additionally the results of a systematic, weekly search for traffic victims on a 200 km stretch of road in a central part of the Netherlands during one year by W. Jongejan are presented. He found 5 bats per 100 km annually. It is estimated that 0.7 - 1.4% (0.2 - 6.8%) of the Dutch population of bats is killed by traffic. As it is an additional mortality factor, and the reproduction rate of bats is under 50%, this is considerable.

THE IMPORTANCE OF CAVITY-TYPE AND FOREST STRUCTURE FOR THE ROOST-SITE SELECTION OF FOREST DWELLING BATS

Ben Van der Wijden, Sven Verkem, N. Lust & R. Verhagen
Laboratory of Forestry, University of Ghent, Belgium

In recent years, there has been an increasing interest in ecologically based forest management. One of the important issues in promoting biodiversity in woodlands is the retention of sufficient quantities of dead wood and cavity-trees, excavated either by woodpeckers or by natural decay. Despite the importance of cavity trees for fauna, very little is known about their occurrence in natural forests and the implication of their presence for management. We chose to investigate the occurrence of cavities in an Oak *forest Quercus robur* in Belgium and the use of these cavities by forest dwelling bats, because they are considered indicator species for the quality of a forested habitat. To get an idea of the occurrence and distribution of cavities in the study area, 270 cavities were measured of which 80 % was initiated by woodpeckers. The influence of cavity characteristics, tree characteristics and stand characteristics on roost-site selection was assessed by comparing the characteristics of 30 roost trees with 60 randomly selected cavity trees without signs of occupation by bats, using logistic regression. Tree and stand characteristics gave little or no results. The cavity characteristics differed significantly: roost cavities were systematically higher and narrower and had a longer entrance tunnel than reference cavities. Implications for forest management are as follows: to protect bats in oak forests, cavity trees should be retained and woodpecker activity promoted, which is of course also highly beneficial to other forest species. Thinning operations and selective cutting of healthy trees should not directly influence the presence of bats.

LOCATION OF TREE-ROOSTS AND MOVING BEHAVIOUR OF DAUBENTON'S BATS AND LONG-EARED BATS

Sven Verkem, Ben Van der Wijden & R. Verhagen
Research Group of Evolutionary Biology, University of Antwerp, Belgium

Forests play an important role in the conservation of the world's biological diversity. Managing forests and trees in production forest, in such a way as to contribute to the conservation of biological diversity, is therefore increasingly seen as an essential component to conservation. Bats are known to roost in hollow trees, but nevertheless research on roost-site selection of European bats is scarce. During our research we used two methods for locating tree-roosts: radio-telemetry and bat-detectors to detect swarming behaviour. Using these methods we found 30 tree-roosts (22 Daubenton's bat, *Myotis daubentonii* and 8 Common long-eared bat, *Plecotus auritus*). There is no obvious difference in the number of roosts found with the two methods: 18 with bat-detectors and 12 with telemetry (for Daubenton's bat 14/8 and for Long-eared bat 4/4). When the distance between the roost and the road was taken in consideration there was no difference between the two methods for Daubenton's bats (t-test, $p=0.677$), but for Long-eared bats telemetry roosts were located further away from the road (t-test, $p=0.016$). Long-eared bats have a weak sonar and are difficult to hear on bat detectors. Furthermore long-eared bats do not follow obvious flight-paths and they display their swarming behaviour in the very broad surroundings of the roost. This makes us think that for slow-flying species with a weak sonar such as long-eared bats, bat-detectors are not an optimal method for locating roosts. The localization of roosts is also influenced by the moving behaviour of the bats. Radio-tracked Daubenton's bats moved every 3.5 days while long-eared bats moved every 1.6 days. The localization of roosts of long-eared bats will be even more difficult due to this frequent moving.

RECENT RESEARCH ON THE BAT FAUNA OF THE PROVINCE OF TRENTO Edoardo Vernier
Museo civico di Rovereto, Borgo S. Caterina 43, 38068 Rovereto (TN), Italy;
Studio Privato: via delle Palme 20/1, 35137 Padova, Italy

The autonomous province of Trento, in the Trentino-Alto Adige region in Northeastern Italy, covers a surface of 6,207 km^2, of mainly mountainous areas. On many aspects, this area represents an interesting transition area, with Central European and Mediterranean bat species. Actually for the autonomous region of Trento-Alto Adige, there are 26 species of bats recorded (86.6% of Italian species): *Rhinolophus ferrumequinum, R. hipposideros, R. euryale, Miniopterus schreibersii, Myotis mystacinus, M. nattereri, M. emarginatus, M. bechsteinii, M. daubentonii, M. capaccinii, M. dasycneme, M. myotis, M. blythii, Pipistrellus pipistrellus, P. nathusii, P. kuhlii, Hypsugo savii, Eptesicus serotinus, E. nilssonii, Vespertilio murinus, Nyctalus noctula, N. leisleri, Plecotus auritus, P. austriacus, Barbastella barbastellus* and *Tadarida teniotis*. After a lack of studies in the last 50 years, a series of new researches on bat fauna have been carried out in the last years with the regular observation of roosts, collection of bats and monitoring with bat detectors. Recent research, performed with the help of the Museo Civico di Rovereto, has provided much interesting information on rare or less-known bat species, with many new records of *Tadarida teniotis*, the first records for the region of *Myotis bechsteinii*, the southernmost record of *Eptesicus nilssonii* (in August 1996) and the northernmost Italian record of *Rhinolophus euryale* (cave matherials, 1997). The aim of current research is to provide recent information on the status of all the bat species living in this area, and a detailed distribution maps of all known bat species in the province of Trento.

TOWARDS CONSISTENT MONITORING METHODOLOGIES: THE UK NATIONAL BAT MONITORING PROGRAMME

Allyson Walsh & Colin Catto
The Bat Conservation Trust, 15 Cloisters House, 8 Battersea Park Road, London, SW8 4BG U.K.

Effective bat conservation relies on population monitoring information to identify changes that are of conservation concern at a sufficiently early stage. Funded by the UK government, The Bat Conservation Trust is running a five-year research programme to develop effective monitoring techniques for resident UK bat species. The programme is helping meet obligations under the Agreement on the Conservation of Bats in Europe (Bonn Convention), in particular by contributing to recommendations for consistent bat monitoring methodologies in Europe. Studies are focusing on eight species of bats, for which at least two counting methods are being applied from three widely established methods - observation at summer maternity roost sites, observation at winter hibernation sites and summer field survey using bat detectors. Where appropriate, sites are sampled on a random-stratified basis to maximise the precision of national trend estimates. Data collection relies upon a large network of volunteers and the programme has recruited over 1200 members since its start in 1996, with 492 people contributing data during 1998. The monitoring network currently includes 223 hibernation sites, 412 pipistrelle, 123 lesser horseshoe and 44 serotine bat maternity colony sites, plus a total of 687 bat detector field survey sites. Novel bat detector transect techniques have been developed for mixed and single species surveys and studies are in progress to verify the techniques being used and data collected.

THE WALES LESSER HORSESHOE BAT SUMMER ROOST MONITORING

Ruth D. Warren
Countryside Council for Wales, Plas Penrhos, Penrhos Road, Bangor LL57 2LQ

Pre-parturition emergence counts were made from 79 summer roosts of lesser horseshoe bats across Wales over a five year period. Observers were asked to record bat emergence outside of each roost twice in two ten day periods and record information on environmental variables and equipment used. The data has been analysed using a poisson regression with a poisson error distribution and log link function to look at population trends and the effects of the variables. The results showed that this subset of the population of lesser horseshoe bats in Wales was stable and there was no marked increase or decrease in the numbers over time. In addition neither environmental variables nor equipment influenced significantly the emergence counts at roosts. There was no evidence of differential changes over time either between individual roosts or between geographical regions. There was however, missing data in the dataset which reduces the sensitivity of the tests. It was recommended that the most valuable single improvement that could be made to this programme is simply that the observers record all the information requested of them on the proforma. Nevertheless, this programme is providing extremely valuable data on this rare species. Five years is a short period in terms of population monitoring, but already these data provide a valuable baseline against which to monitor changes in abundance, greatly aiding conservation effort.

EDUCATIONAL ACTIVITY OF THE POLISH SOCIETY OF BAT PROTECTION

Andrzej Wegiel & Miroslaw Jurczyszyn
Dept. of Forest Management, Agricultural Univ., Wojsko Polskie St. 71C, 60-625 Poznan, Poland

The Polish Society of Bat Protection (PSBP) made a large project which aimed to popularize bats in the Polish society. The title of the project was: "Gacki 99. Bats -the unknown animals". The project consisted of four parts:

1)artistic competition for children,
2) gallery of compositions,
3) educational exhibition referred to bats,
4) garden party.

Children from the whole country from 500 schools and clubs participated in the competition. We received more than 10, 000 compositions. Every participant of the artistic competition received leaflets concerning bat protection. The most interesting compositions were presented at the Zoological Garden in Poznan. Some of the works were presented on the internet webpage www of PSBP. The educational exhibition was presented at the same place and time while the childrend worked. About 50, 000 people saw the two exhibitions.

ROOSTING ECOLOGY OF *RHINOLOPHUS HIPPOSIDEROS*

Patrizia Weiner & Andreas Zahn
Zoologisches Institut, Universtät München, Luisenstrasse 14, 80333 München, Germany

We studied *Rhinolophus hipposideros* on the island "Herreninsel" in lake Chiemsee, Upper Bavaria. The colony settles in a famous castle of King Ludwig and the population increased between 1992 (12 adults) and 1998 (35 adults). From late April till September the bats roosted in 3 rooms of the attic. Mostly the bats hung scattered around the roost. Only on a cool day (roost temperature: 21°C) at the beginning of the birth period a dense cluster of 6 individuals was observed. The roost temperatures varied between 17.5

and 37°C. The bats used a complicated flight path through the building to move from the attic (where they ignored an open window!) to a window of the cellar where they emerged in an air well and flew up again to leave the castle finally over the roof. The bats started to leave the building on an average of 25 minutes after sunset (minimum 15 minutes). The mean duration of the emergence period was 30 minutes. Since the air well is going to be covered with a roof in the near future, we used a plastic sheet to simulate this change and to study the reaction of the bats to the new emergence situation. While the bats could previously leave the air well everywhere, during the simulation only a space of 70 cm was left between the roof around the air well and the plastic sheet covering the opening. During the first night after the simulation the bats circled about 4 minutes longer in the air well as during the previous nights and they made many attempts before they moved through the narrow opening. When the bats returned they circled up to 15 minutes over the air well instead of entering at once as during the previous nights. However, after three nights their behaviour had normalised. A reduction of the colony size during the simulation was not observed.

THE ENERGETIC BASIS OF GUILD ST RUCTURE IN NEOTROPICAL NECTAR-FEEDING BATS

York Winter
Institute of Zoology II, Erlangen University, Staudtstrasse 5, 91058 Erlangen, Germany,

The high species diversity is one of the outstanding features of tropical communities, yet the mechanisms that maintain this diversity have remained an enigma for ecological theory. Species coexistence under resource limitation should only be possible if interspecific competition coefficients are low (‚classical', deterministic model) or when (possibly stochastic) influences on population abundances prevent the process of competitive exclusion. The goal of this study was to understand the mechanisms of species assembly in a guild of neotropical nectar-feeding bats (Phyllostomidae: Glossophaginae). For this I followed a bottom-up approach. The competitive ability of a nectar-feeding bat is determined by its energetic demands (daily energy expenditure, DEE) for resource availability in its habitat and by its energetic efficiency during foraging for the nectar (and pollen) resources. For the construction of a priori model of species specific competitive ability, I quantified: DEE, cost of forward and hovering flight, flight speeds, flight activity, flight morphology and efficiency of nectar drinking. The model built on this data predicted that in a deterministically structured guild, larger species should use a different type of foraging strategy than smaller species and that smaller species should differ from each other with respect to flight morphology and/or their degree of nectar-specialization. A laboratory experiment of exploitation competition for limited nectar between a small and a large glossophagine bat species confirmed that under food resource limitation, the smaller species is at a competitive advantage. The available field data from a Costa Rican tropical lowland rainforest about food resource use and the spatio-temporal distribution of the different bat species (data from Tschapka & v. Helversen and own obs.) agrees with the model according to which the pattern of species coexistance may be explained by a deterministic equilibrium model.

CIRCADIAN ACTIVITY, BODY TEMPERATURE AND THERMAL PREFERENDUM OF MOUSE-EARED BAT *MYOTIS MYOTIS* IN LABORATORY CONDITIONS PRELIMINARY RESULTS - WINTER SEASON

Michal Wojciechowski, Eugenia Tegowska, Marzena Antas & Joanna Knopik
N. Copernicus University, Institute of General and Molecular Biology, Department of Animal Physiology, PL 87-100 Torun, Poland, Gagarina St. 9

Sleep, daily torpor and hibernation are connected with an animal's reduced activity (circadian or

circannual). Probably the main reason for such behaviours is energy conservation. The aims of our study were: to investigate circadian activity of the heterothermic bat, to determine the animalís thermal preference and to measure changes in body temperature (in intrascapular region) in relation to starvation or satiety state. Experiments were conducted in the winter season (January - March 1999) on 6 individuals male *Myotis myotis*. In our investigations we used a thermal gradient (range: 7°- 43°C) which allowed the animals an optional choice of ambient temperature with the possibility of a simultaneous measure of the animal's activity and its body temperature. We did not find any statistically important differences in ambient temperature chosen by fasted or non-fasted animals. There is, however, a tendency to choose higher ambient temperature by fasted bats. Body temperature was statistically higher in non-fasted animals and the percentage of the total time of the experiment spent in activity was also significantly higher in non-fasted animals.

CHIROPTEROLOGICAL INFORMATION CENTER IN POLAND- 12 YEARS OF ACTIVITY ON BAT RESEARCH AND PROTECTION

Bronislaw W.Woloszyn
Chiropterological Information Center, Institute of Systematics and Evolution of Animals,
Polish Academy of Sciences, ul. Slawkowska 17 31-016 Krakow, Poland

The Chiropterological Information Center (C.I.C.) was established on May 1987 and is now located as a department in the Institute of Systematics and Evolution of Animals, under the Polish Academy of Sciences in Krakow. The main goal of the CIC is to put all information on line regarding bats in Poland, promoting systematic and biogeographical studies on bats, and consulting and co-operating with government and scientific institutions on bat research and protection in Poland. The C.I.C. every year organizes a nation wide census on bats hibernating in caves and cave-like shelters, called Dekady Spisu Nietoperzy" (DSN) and this past year we completed the 12th census. An important goal of C.I.C. is to organize every year a chiropterological school for goverment agencies, private and non-governmental organizations involved in environmental protection in order to distribute pratical knowledge about bats and bat protection. During the past twelve years, over 400 people have participated in these courses. The C.I.C. has students and post-graduate students preparing their masters and doctoral thesis on different biological aspects of bats in Poland. In addition, the C.I.C. edits two journals: 1) The C.I.C. Bulletin (twice a year) and a quarterly annex to the Polish monthly naturalist magazine "Wszechswiat" (The Universe) called "Wszechswiat Nietoperzy" (The Universe of Bats). Both are published in Polish. The C.I.C. also has a publication on the Chiropterological Information Center. Since the autumn of 1995, the C.I.C. has organized International Bat Nights (IBN) which have taken place on the 21st of September. The integration of chiropterologists, their actions and work worldwide on bat protection was the main theme of this event. This year the IBN and European Bat Night (parallel action under the Eurobats Agreement) will be organized on the 28th of August.

PHYSICOCHEMICAL ANALYSIS OF BAT HAIR BY ATOMIC ABSORPTION SPECTROSCOPY AND THERMAL ANALYSIS TECHNIQUES

Bronislaw W.Woloszyn, Katarzyna Kozakiewicz, Krzysztof Pielichowski,
Jan Pielichowski, JanTarkowski andTomasz Postawa
Chiropterological Information Center, Institute of Systematics and Evolution of Animals,
Polish Academy of Sciences, ul. Slawkowska 17 31-016 Krakow, Poland

During the last decade a growing interest towards extracting meaningful information on the basis of bats' hair physicochemical analysis can be observed. The reasons for such studies are connected with non-

destructive possibilities of obtaining valuable data on environmental pollution, specimen and populationís biohistory, as well as the analysis of changes of the whole local ecosystem. The application of modern physicochemical methods makes it possible to determine the amount of metals in batsí hair which are regarded as biological "eco-sensors", sensitive enough to be used in trace analysis. For such studies atomic absorption method (both flame- and electrothermal) and thermal analysis methods (thermogravimetric analysis and differential scanning calorimetry) offer complementary results while a minute sample is used through its display of the thermal event profile to acquire fundamental information about biomaterial under investigation. In our studies we have selected, purified and analysed a series of bats' hair with a well-defined origin to gain fundamental information of the trophic chain in relation to the kind of biotope. Preliminary results indicate certain relationships between the physicochemical properties of batsí hair and environmental aspects of the local ecosystems investigated.

NATIONAL PROGRAM FOR PROTECTION OF BIOLOGICALDIVERSITY: CASUS: BATS

Bronislaw W.Woloszyn and Marian Cieslak
Chiropterological Information Center, Institute of Systematics and Evolution of Animals,
Polish Academy of Sciences, ul. Slawkowska 17 31-016 Krakow, Poland

The strategy for protection of biodiversity should have an outline for future activities concerning this field and prepare a basis for elaborating and implementating this program to specific segments of the environment. It is urgent to prepare the strategy protection of biodiversity, due to the fact that the population increase of one species, Homo sapiens, which is growing rapidly and detoriating the natural resources of the environment. Preparing the national strategy is also an obligation from Poland because it has become a participant of several international agreements and conventions and most importantly a participant of the Convention of Biological Diversity (Article 6). The national strategy of the protection of biodiversity should incllude all living organisms and a good example of this partial strategy is the plan of protection of bats in Poland. Bats are natural predators of insects and occupy the higher level of the food chain and for this reason they are very sensitive to the contamination of the environment.The actual current situation is the result from both positive and negative influences on its population, which are not all recognized by science. The most important factors of environmental threats that decrease bat populations are as follows: loss of habitat, decrease of food resources, contamination of environment and intentional destruction of animals and disturbances. Actions aiming at bat protection should therefore be focused on neutralizing and diminuting anthropegenic dangers. For this reason the strategy of the protection of bats must include all aspects and must be supported by 3 main areas.

1. Protection by law. At present bats are legally protected in Poland and in most European countries. In 1996, Poland joined two international agreements, in which the conservation of bats is included: the Bonn convention and Bonn agreement.

2. Practical protection of bats. There are not many possibilities of directly influencing animals as well as there are few ways of introducing the active protection of bats therefore practical aspects of bat protection deserves actions in three directions.

a) Protection and restoration of winter shelters

b) Protection and restoration of summer shelters.

c) Protection of feeding territories

3. Ecological education. In European culture bats do not have a good reputation, therefore it is very important to educate the general public on bats in order to protect them for the future. We must show people that bats have a very important and useful role in the biodiversity of the eco-system.

ECHOLOCATION CALL PLASTICITY IN AN FM BAT.

Josephine Wong & Dean Waters
School of Biology, University of Leeds, UK

Previous laboratory research on echolocation in FM bats has focused on the bat's ability to detect specific echoes i.e. discrete images produced from single pulse-echo pairs. In addition, the majority of these studies involved stationary bats and do not take into account the motion of the bat. The playback experiments described examines the ability of European pipistrelle bats flying towards a real target to perceive a phantom target closer than expected from the playback of a single self-echo. If the bat can accurately determine range and target information from a single pulse-echo pair, then one would predict an increase in pulse repetition rate in the bat's subsequent echolocation behaviour as it approaches the phantom target. Our results suggest that pipistrelle bats do not respond in the above manner to the playback of a single self-echo at a time delay less than expected from the real echo. Thus the bat seems unable to perceive a phantom target from a single pulse-echo pair. In view of this, future work will test the hypothesis that the bat registers its 'acoustic flow field' of echoes, and therefore integrates information from more than 1 pulse-echo pair, in order to accurately detect and localize a target. Depending on the results obtained in the multiple echo playback experiments, we are also interested in testing whether amplitude changes influence the bat's estimate of echo arrival time, and therefore the perception of target distance; and the extent to which bats can detect echoes modified in time-frequency structure.

SECTION FOR BAT RESEARCH AND CONSERVATION, BIOLOGY STUDENTS SOCIETY, SLOVENIA

Maja Zagmajster
Section for Bat Research and Conservation, Biology Students Society at University of Ljubljana, Vecna pot 111, SI-1000 Ljubljana, Slovenia

The Section for Bat Research and Conservation (SBRC) was founded in January 1998 as a part of the Biology Students Society. So far, it is the only NGO involved in bat research and protection in Slovenia and includes both, professionals and biology students. In spite of its short existence, the SBRC has already performed a number of activities: lectures about the biology of bats for the public, excursions to caves, mist netting, participation in a biology students research camp and organisation of bat research camps on their own. The SBRC also purchased four bat detectors and organized a bat detector workshop. The SBRC gathers data about the distribution of bats in Slovenia, to record important summer and winter colonies and to monitor them. One of its goals is also to develop a Strategy and Action plan for bat conservation in Slovenia and to raise public awareness about bats as an endangered, but important component of our environment. This year the SBRC will cooperate in the Central European Miniopterus Protection Programme and join the International European Bat Night event.

SIBLING SPECIES AMONG EAST-EUROPEAN BATS

Igor V. Zagorodniuk
Institute for Zoology, National Academy of Sciences of Ukraine, Kiev, Ukraine

Among 27 bat species known for the territory of Ukraine and their nearest neighbors there are three species groups, that consist of two morphologically related or sibling species. We will understand the polyspecies as a group of related taxa, that consists of two or more species, that were not identified in all previous investigations of Ukraine fauna, but they are meant in this research. Such polyspecies complexes are known in *Rhinolophus* (*?euryale* among *ferrumequinum* samples), lesser *Myotis* (*brandtii* among

mystacinus or *daubentonii* samples) and *Plecotus* (*austriacus* among *auritus* samples). Traditionally difficult for field diagnostics is the pair of greater *Myotis* (*blythii* and *myotis*). Totals of taxonomic revision of the sibling and morphologically related species and their essential morphological differences are summarized. The principal possibility of species morphological diagnostics and some regularities in their morphological differentiation are shown. In each case, established differences between species deal with the features, that are age-dependent. All of them are determined by heterochronies in the formation as well as in the level of development of initial types of morphological features.

Former species	Category	Component of polyspecies (maturity)
Rhinolophus ferrumequinum	related species	*Ferrumequinum* (sen)+"euryale" (juv)
Myotis myotis	related species	*myotis* (sen) + *blythi* (juv)
Myotis mystacinus	sibling species	*mystacinus* (juv) + *brandti* (sen)
Plecotus auritus	related species	*auritus* (sen) + *austriacus* (juv)

Totally, all registered differences between related species are determined by the fixation of different stages of their maturity in the definitive level. Thus, all diagnostic features have a large onthogenetical component, that should be taken into account in diagnostics.

CRITICAL TIMES OF THE YEAR FOR *MYOTIS MYOTIS* - A COMPARISON BETWEEN SOUTH AND CENTRAL EUROPE

Andreas Zahn, Luìsa Rodrigues, Ana Rainho & Jorge M. Palmeirim
Zoologisches Institut, Universit‰t M¸nchen, Luisenstrasse 14, 80333 M¸nchen, Germany;

The weight of bats is likely to decrease at critical times of the year (e.g. periods of food shortage, hibernation, or mating stress). To determine if climate influences these critical periods we compared curves of seasonal weight changes of Myotis myotis in Southern and Central Europe (Alentejo - Portugal and Upper Bavaria - Germany). Alentejo has dry hot summers and cool winters, whereas in Upper Bavaria it rains throughout the year and the winters are much colder and longer. Bats loose more weight during hibernation in Germany than in Portugal, probably due to the longer winter in the North. In cool springs German bats continue to loose weight in the period immediately after hibernation, whereas those in Portugal get heavier during this time. This seems to be related to food shortage in the early spring in Germany, a time of food abundance in Portugal. In Germany bats gain weight during late spring and summer but in Portugal they loose weight during the summer, probably due to the lack of food associated to the peak of the dry season. Males of both populations and German females loose weight during the mating season (September) but recover in October, in preparation for hibernation. The body condition of juveniles increases faster in Germany than in Portugal. The patterns of weight change during the year are different in the two populations, which suggests that the environment influences them differently. The most parsimonious explanation for the observed differences is that hibernation is less critical in Portugal and that food resources are in fact limiting in early spring in Germany and during the summer in Portugal, forcing bats to loose weight during these critical periods.

E-Mail Directory

Additions or Corrections to E-mail Directory

If your e-mail address is incorrect, new, or has changed recently please forward that information to Horst at horstgr@potsdam.edu Thank you. GRH

Anthony, Edythe	eanthony@ric.edu	USA, (Rhode Island)
Bohn, Kirsten M.	kbohn@wam.umd.edu.	USA, (Idaho)
Bowen, Tina	tinabowen@mailcity.com	USA, (California)
Burke, Harold S.	h.s.burkejr@worldnet.att.net	USA, (Kentucky)
Burkholder, Brad	bholder@delta.dfg.ca.gov	USA, (California)
Burles, Douglas W.	Doug_Burles@pch.gc.ca	Canada, (British Columbia
DePaepe, Veda	vedadepaep@aol.com	USA, (Washington)
Hosken, David	hosken@zoolmus.unizh.ch	Switzerland
Howell, Kim	khowell@twiga.com	Tanzania
Jaberg, Christophe	christophe.jaberg@freesurf.ch	Switzerland
Johnson, Scott	Johnson, Scotta@netscape.net	USA, (Massachusetts)
Johnston, Georgann B.	gbatty@email.msn.com	USA, (California)
Kirsch, Ronan	ronan_kirsch@hotmail.com	France
Makin, David	davmakin@hotmail.com	Israel
Marimuthu, G.	mari@pronet.net. in	India
McCarthy, Timothy	mccarthyt@clpgh.org	USA, (Pennsylvania)
Miller, Lee A.	lee@dou.dk	Denmark
Osborn, Robert G.	rgosborn@hotmail.com	U.S.A (Texas)
Pedersen, Scott	Scott_Pedersen@sdstate.edu	USA, (S. Dakota)
Rainho, Ana	rainhoa@icn.pt	Portugal
Reinbold,Willi	Willi.Reinbold@altmuehlnet.baynet.de	Germany
Rodrigues, Louisa	rodriguesl@icn.pt	Portugal
Rosas, Mario	mrosas@canaldig.com.ar	Argentina
Ruedi, Manuel	manuel.ruedi@mnh.ville-ge.ch	Switzerland
Russell, Amy L.	russella@utkux.utcc.utk.edu	USA, (Tennessee)
Smith, Susan	sandjsmith@earthlink.net	USA, (California)
Sterling, Keir	Kbs1934@cs.com	USA, (New York)
Stoner, Kathryn	kstoner@mail.ibiologia.unam.mx	Mexico
Thomas, Heather A.	hthomas98@aol.com	USA, (South Carolina)
Vonhof, Maarten	mvonhof@yorku.ca	Canada, (Alberta)
Walters, James	james-walters@uiowa.edu	USA, (Iowa)
Wible, John	wiblej@carnegiemuseums.org	USA, (Pennsylvania)
Yamamoto, Terumasa	CXJ13576@nifty.ne.jp	Japan

April 2000

The 9th Australasian Bat Research Conference

will meet in the Hunter Valley, NSW, 25th to 28th April, 2000

for information and registration materials contact:
Kerryn Parry-Jones, Biological Sciences, University of Sydney 2006, NSW, Australia
e-mail kpjones@bio.usyd.edu.au phone/fax 02 43 653 232

* * * * * * * * * * * * * * *

June 2000

The American Society of Mammalogists

will meet at the University of New Hampshire in Durham, NH June 17th to 21st.

for information and registration materials contact:
H. Duane Smith, Monte Bean Life Science Museum, Brigham Young University, Provo, UT 84602-0200

* * * * * * * * * * * * * * *

October 2000

The 30th Annual North American Symposium on Bat Research

will meet at the University of Miami, Miami, FL September 27th to 30th, 2000
for information and registration materials contact:
Thomas A. Griffiths, Department of Biology, Illinois Wesleyan University, Bloomington, IL 61702
e-mail tgriff@titan.iwu.edu tel. 309-556-3230

* * * * * * * * * * * * * * *

More details on the following meetings will appear at least one year in advance of the meeting

June 2001 **The American Society of Mammalogists**, Missoula, MT

August 2001 **The 12th International Bat Research Conference,** Bangi Malaysia

October 2001 **The 31st Annual North American Symposium on Bat Research**, Victoria, BC, Canada

August 2002 **The 9th European Bat Research Symposium,** LaHavre, France

If you know of other meetings, large or small, concerning bats, please send me the details for inclusion in the next issue. Thank you. G. Roy Horst

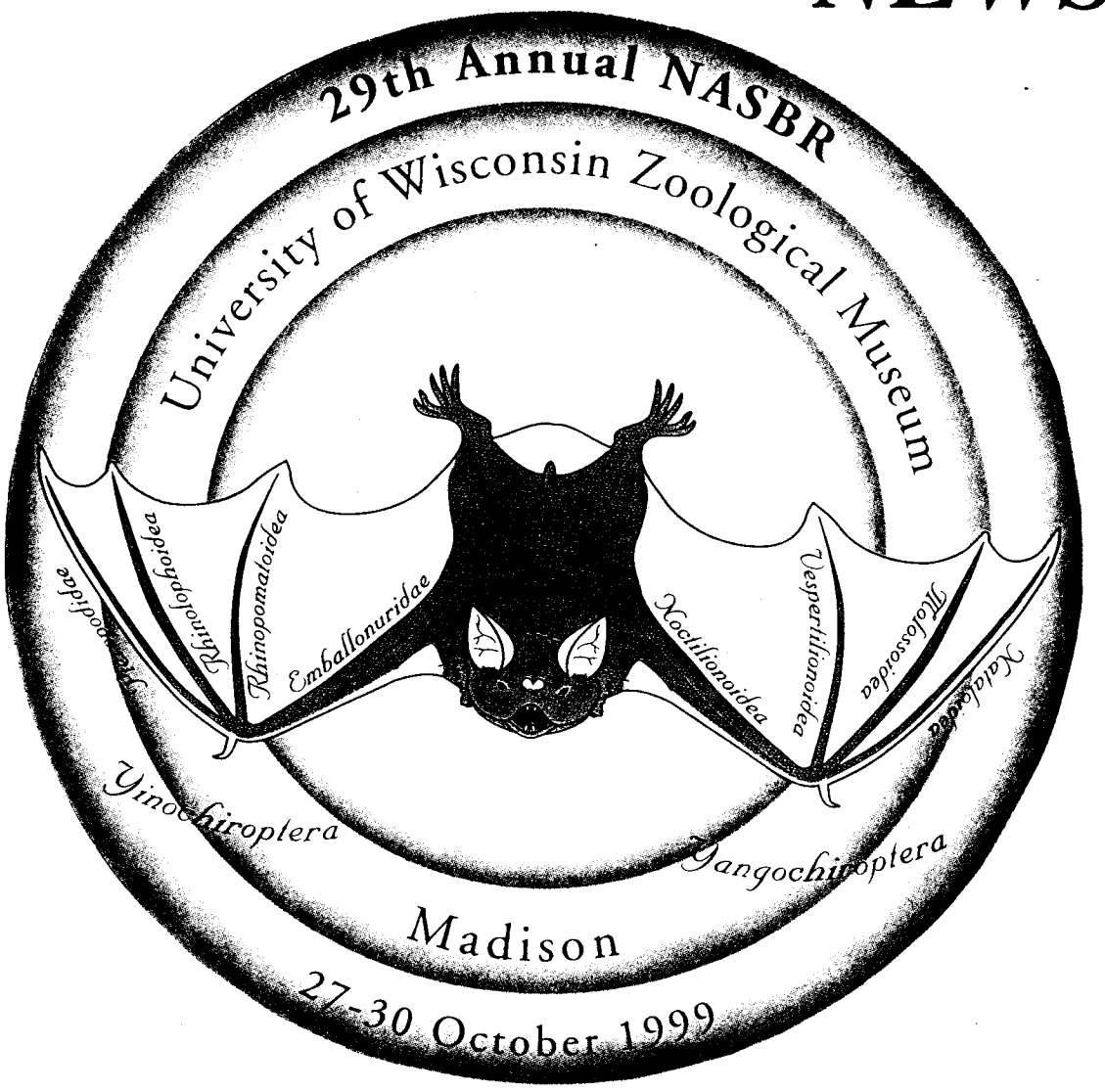
BAT RESEARCH NEWS

Volume 40 **Fall 1999** **Number 3**

Front Cover

The illustration on the front cover was the ensignia of the VIIIth European Bat Research Symposium held in Warsaw, Poland August 23 – 27, 1999. The meeting was convened by Bronislaw W. Woloszyn. The graphic design is the work of Tomasz Postawa.

BAT RESEARCH NEWS



Volume 40 : No. 4 **Winter 1999**

BAT RESEARCH NEWS

Volume 4: No.4 Winter 1999

Publisher and Managing Editor: G. Roy Horst
Bat Research News, P.O. Box 5068. Potsdam, NY 13676-5068 U.S.A.
Tel. 315-267-2259 FAX 315-267-3170 e-mail: horstgr@potsdam.edu

Editor for Feature Articles: Allen Kurta, Department of Biology, Eastern Michigan University, Ypsilanti, MI 48197Tel. 734-487-1174 FAX 734-487-9235 e:mail> bio_kurta@online.emich.edu

Editor for Recent Literature: Thomas A. Griffiths, Department of Biology, Illinois Wesleyan University, Bloomngton, IL 61702, Tel. 309-556-3230 FAX 309-56-3411 e-mail> tgriff@titan.iwu.edu

Editor for Conservation Education: Patricia Morton, Texas Parks and wildlife,Suite 100, 3000 IH 35 South, Austin, TX 78704 Tel. 512-912-7020 FAX 512-912-7058 e-mail> patricia.morton@tpwd.tx.us

Instructions for Contributors and Subscribers

Bat Research News is published four times each year, consisting of one volume of four issues. Bat Research News publishes short feature articles and general interest notes, which are reviewed by at least two scholars in that field. In addition, Bat Research News includes a "Recent Literature" section which cites many bat related publications in English worldwide; the abstracts from Bat Conferences around the world; Letters to the Editors, News Notes submitted by our readers; and "Announcements of Future Bat Meetings, Symposia, and Conferences" worldwide.

Communications concerning feature articles and "Letters to the Editor" should be sent to Kurta; recent literature items should be addressed to Griffiths; book reviews and conservation education items should be submitted to Morton; subscription questions and all other items should be referred to Horst.

The price for is $18.00 per volume(year) to all addresses in the United States, all other individual addresses $20.00. All institutional subscriptions are $30.00 per volume year.

If you wish to pay for both Volume 41 ('00) and 42 ('01), you may do so at the reduced combined price of $32.00 to U.S. addresses, $40.00 to all otheres. This not only relieves you of having to remember to renew again next year but also saves us the extra work of having to submit an additional invoice again. We prefer that U.S. subscribers pay by check, made out to Bat Research News and mailed to the above address. If you wish to pay by credit card, send to Horst via letter, FAX or e-mail the following: card company [Visa, Master Card, Am Ex or Discover]; 16 digit account #; expiration date; amount to be charged; your name eactly as it appears on your card.

Bat Research News is ISSN 0895-6227.
Bat Research News is printed and mailed at the State University of New York-Potsdam
Potsdam, New York 13676 U.S.A.

BAT RESEARCH NEWS

Volume 40:No.4 **Winter 1999**

Do Call Libraries Reflect Reality?

Annie Tibbels
Department of Biology, Eastern Michigan University, Ypsilanti, MI 48197

Introduction

In recent years, the Anabat system has been embraced by a variety of governmental agencies for conducting bat surveys in forested areas (e.g., Humes et al., 1999). Often, a call library is assembled by hand-releasing bats in a large, uncluttered area, recording their calls as they fly away, and using these reference calls to identify future unknowns. Proper use of this technique requires that calls in the library be similar to those of bats later recorded under actual field conditions (Barclay, 1999).

However, surveys are not always conducted at sites similar to areas in which call libraries are assembled. In forested areas, surveys often are performed within small openings or along corridors, such as roads and streams (e.g., Kuenzi and Morrisson, 1998; Jung et al., 1999). Can the added clutter associated with forested corridors induce changes in the structure of an echolocation call (Obrist, 1995), thereby decreasing one's ability to identify the bat? The purpose of this study is to compare quantitatively calls of bats traveling through forested corridors to calls made by bats released in open sites.

Material and Methods

I recorded calls made by light-tagged, adult, little brown bats (*Myotis lucifugus*), using Anabat II detectors. Bats were hand-released in three different situations: an open field, a wide (5 m) road through a forest, and a narrow (2.5 m) road or "two-track" through a forest. For all three treatments, bats were released at least 23 m from the closest detector. At least 25 bats were released in each situation.

I obtained useable call sequences from 9-10 individuals from each site. I defined a "useable" sequence as one that contained at least 8 consecutive, well-formed, search-phase calls. Sequences were edited using Analook software to delete fragmentary calls and extraneous noise. After editing, I used the software to calculate the average value of five variables for each sequence: characteristic slope, maximum frequency, minimum frequency, duration of a call, and time between calls. Each average was treated as a data point, and treatments were compared using analysis of variance followed by Duncan's Multiple Range Test with a protection level of 0.05.

Results

Typical sequences for each treatment are shown in Figure 1. Analysis of variance indicates a significant difference among the three treatments for all variables (Table 1). Multiple comparison tests show that calls from the open area and calls recorded from the large road are statistically identical in all variables. However, all variables for calls recorded on the two-track were statistically different from the other two treatments.

Discussion

Echolocation calls of bats are not static. Instead, echolocation calls are flexible, with the bat matching the call emitted to the amount of clutter in the habitat in which it is flying. Obrist (1995), for example,

showed that size of the foraging area (i.e., an opening) in forested habitats affected both temporal and spectral aspects of the calls in four species of vespertilionids. My results with little brown bats are consistent with those of Obrist (1995). Little brown bats flying along a two-track produced calls that were steeper and shorter in duration and had smaller interpulse intervals and increased bandwith.

With the advent of the Anabat system and accompanying software, many resource managers have viewed it as a tool to allow identification of species of free-flying bats, as well as monitor bat activity in different types of habitats (Krusic et al., 1996; Humes et al., 1999; O'Farrell and Gannon, 1999). Both quantitative and qualitative approaches to species identification using Anabat have been criticized (Barclay, 1999, O'Farrell et al., 1999b), but my goal is not to take sides in this debate. I simply wish to emphasize that it is not sufficient to form call libraries using bats flying in open areas, unless all future work with unknowns also will be in open areas. Variation in call structure induced by change in habitat complicates the species identification problem, especially for species with similar call structure (e.g., *M. lucifugus* vs. *M. sodalis* and *M. septentrionalis* or *Eptesicus fuscus* vs. *Lasionycteris noctivagans*). Although biologists that consistently work with bats realize this (Barclay, 1999; O'Farrell, 1999; O'Farrell et al., 1999a), resource managers, especially those responsible for heavily forested lands, frequently do not. Call libraries of known individuals must be assembled in all habitats of interest. Reliance upon call libraries made in open areas to identify bats flying in real-world situations may result in errors, and studies that largely rely on published descriptions of typical calls for species identification (e.g., Kuenzi and Morrisson, 1998; Jung et al., 1999) should be discouraged.

Acknowledgments

This study was funded through a cooperative agreement between the U.S.D.A. Forest Service (Huron-Manistee National Forest) and Eastern Michigan University and a grant from the Natural Heritage Grants Program of the Michigan Department of Natural Resources awarded to A. Kurta. R. Foster, A. Kurta, S. Murray, and J. Pastula, aided in recording echolocation calls. E. Britzke and M. J. O'Farrell provided helpful tips on the use of Anabat and Analook.

Literature Cited

Barclay, R. M. R. 1999. Bats are not birds--a cautionary note on using echolocation calls to identify bats: a comment. Journal of Mammalogy, 80:290-296.

Humes, M. L., J. P. Hayes, and M. W. Collopy. 1999. Bat activity in thinned, unthinned, and old-growth forests in western Oregon. Journal of Wildlife Management, 63:553-561.

Jung, T. S., I. D. Thompson, R. D. Titman, and A. P. Applejohn. 1999. Habitat selection by forest bats in relation to mixed-wood stand types and structure in central Ontario. Journal of Wildlife Management, 63:1306-1319.

Krusic, R. A., M. Yamasaki, C. D. Neefus, and P. J. Perkins. 1996. Bat habitat use in White Mountain National Forest. Journal of Wildlife Management, 60:625-631.

Kuenzi, A. J. and M. L. Morrison. 1998. Detection of bats by mist-nests and ultrasonic sensors. Wildlife Society Bulletin, 26:307-311.

Obrist, M. K. 1995. Flexible bat echolocation: influence of individual, habitat, and conspecifics on sonar signal design. Behavioral Ecology and Sociobiology, 36:207-219.

O'Farrell, M. J. 1999. Blind test for ability to discriminate vocal signatures of the little brown bat, *Myotis lucifugus*, and the Indiana bat, *Myotis sodalis*. Bat Research News, 40:44-48.

O'Farrell, M. J., and W. L. Gannon. 1999. A comparison of acoustic versus capture techniques for the inventory of bats. Journal of Mammalogy, 80:24-30.

O'Farrell, M. J., B. W. Miller, and W. L. Gannon. 1999a. Qualitative identification of free-flying bats using the Anabat detector. Journal of Mammalogy, 80:11-23.

O'Farrell, M. J., C. Corben, W. L. Gannon and B. W. Miller. 1999b. Confronting the dogma: a reply. Journal of Mammalogy, 80:297-302.

Table 1. Quantitative comparison (mean ± *SE*) of echolocation calls of little brown bats flying in an open area and along two forested corridors.

Variable	Open Field ($n = 9$)	Large Road ($n = 9$)	Two-track ($n = 10$)	ANOVA
Slope (octaves/sec)	111 ± 5	117 ± 10	329 ± 28	$P < 0.0001$
Maximum frequency (kHz)	69.4 ± 1.7	69.1 ± 2.9	80.0 ± 3.5	$P < 0.0169$
Minimum frequency (kHz)	39.6 ± 0.3	38.9 ± 0.5	42.6 ± 0.4	$P < 0.0001$
Duration (msec)	4.8 ± 0.2	4.6 ± 0.3	2.3 ± 0.1	$P < 0.0001$
Time between calls (msec)	120 ± 12	106 ± 2	80 ± 2	$P < 0.0011$

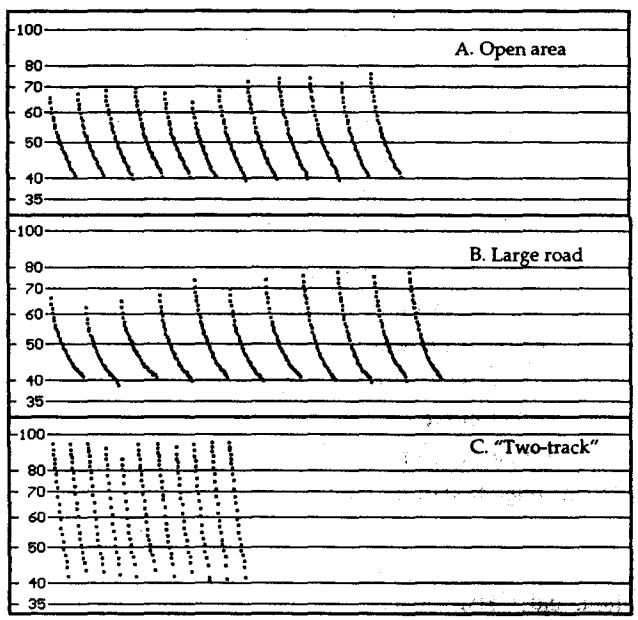


Figure 1. Structure of calls from each site, as drawn by Analook software. Numerals on the Y-axis indicate frequency (kHz). Time (msec) is on the X-axis, although time between calls is compressed by the software to allow more calls per screen.

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 the Feature Editor, Allen Kurta.

Transuterine Migration of the Embryo in the Indian Leaf-nosed Bat, *Hipposideros lankadiva*

Nisar A. Khan, Kamar B. Karim, and Kishor S. Janbandhu
Department of Zoology, Institute of Science, Napur 440 001, India.
Present Address of KBK: I. A. S. Coaching Centre , Old Morris College Building, Nagpur 440 001, India

In most bats, the embryo generally implants in the uterine cornu, ipsilateral to the new corpus luteum (Wimsatt, 1979). In a few species, ovulation occurs from one ovary, and the embryo migrates to the contralateral cornu for implantation, i.e., transuterine migration of the embryo occurs (sensu Boyd et al., 1944). Transuterine migration of the embryo, to some extent, depends on the makeup of the female reproductive tract, especially the corpus uteri (Rasweiler, 1979; Wimsatt, 1979). Transuterine migration has been reported in several vespertilionids (e.g., Gopalakrishna et al, 1981; Wimsatt, 1979) but apparently not in other chiropteran families.

During studies on reproduction in a wild population of the rhinolophid bat, *Hipposideros lankadiva*, we observed six cases of transuterine migration. *H. lankadiva* is a large monotocous hipposiderid, with body mass of adult males ranging between 50 and 65 g and that of adult females between 40 and 55 g. In *H. lankadiva,* the lumina of the two uterine cornua unite to form a corpus uteri. Ovulation usually occurs from the left ovary, with implantation in the ipsilateral uterine cornu at the cranial end of the uterus. However, in five females, the corpus luteum was present in the right ovary but an implanted blastocyst was present in the left uterine cornu. In a single case, the corpus luteum was observed in the left ovary, while a free bilaminar blastocyst was present in the right uterine cornu. Transperitoneal migration of the ovum is ruled out because the ovary is completely surrounded by an ovarian bursa in *H. lankadiva.* This appears to be the first report of transuterine migration of the embryo in a nonvespertilionid.

Literature Cited

Boyd, J. D., W. J. Hamilton, and J. Hammond. 1944. Transuterine ("internal") migration of the ovum in sheep and other mammals. Journal of Anatomy, 78:5-14.

Gopalakrishna, A., G. C. Chari, and K. B.Karim. 1981. Transuterine migration of the embryo in the bat, *Miniopterus schreibersii fuliginosus* (Hodgson). Current Science, 50:152-154.

Rasweiler, J. J. 1979. Early embryonic development and implantation in bats. Journal of Reproduction and Fertility, 56:403-416.

Wimsatt, W. A. 1979. Reproductive asymmetry and unilateral pregnancy in Chiroptera. Journal of Reproduction and Fertility, 56:345-357.

RECENT LITERATURE

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

ANATOMY

Schliemann, H., and E. Schlosser-Sturm. 1999. The shoulder joint of the Chiroptera: Morphological features and functional significance. Zoologischer Anzeiger, 238: 75-86. [Univ. Hamburg, Inst. Zool., Martin Luther King Pl. 3, D-20146 Hamburg, Germany]

Sharma, R. S. K., M. K. Vidyadaran, I. Zulkifli, J. M. Azlan, S. Sumita, A. J. Azilah, and O. K. Ho. 1999. Ecomorphological implications of the microstructures on the tongue of the fawn roundleaf bat, *Hipposideros cervinus* (Chiroptera: Hipposideridae). Australian Journal of Zoology, 47: 405-409. [Univ. Putra Malaysia, Fac. Vet. Med. & Anim. Sci., Serdang 43400, Selangor, Malaysia]

BAT BOOKS (NEW)

Dobson, J. 1999. The Mammals of Essex. Lopinga Books. 229 pp. [ISBN 0 9530362 1 9]

Mitchell-Jones, A. J., et al. 1999. The Atlas of European Mammals. T. and A. D. Poyser, London. 484 pp. [ISBN 0 85661 130 1]

DISTRIBUTION/FAUNAL STUDIES

Boitier, E. 1999. Le Vespère de Savi, *Hypsugo savii*, dans le Puy-de-Dôme. Arvicola, 11: 33. [16 avenue de l'U.R.S.S., 63000 Clermont-Ferrand]

Courtis, J. Y., G. Beuneux, and G. Faggio. 1999. Première observation de la Grande noctule, *Nyctalus lasiopterus*, en Corse. Arvicola, 11: 32. [Groupe Chiroptères Corse, 7 bis rue Colonel Feracci, 20250 Corte]

Diaz, M. M., and R. M. Barquez. 1999. Contributions to the knowledge of the mammals of Jujuy Province, Argentina. Southwestern Naturalist, 44: 324-333. [Univ. Nacl. Tucuman, Fac. Ciencias Nat., CONICET, Miguel Lillo 205, RA-4000 San Miguel De Tucuman, Tucuman, Argentina]

Higginbotham, J. L., L. K. Ammerman, and M. T. Dixon. 1999. First record of *Lasiurus xanthinus* (Chiroptera: Vespertilionidae) in Texas. Southwestern Naturalist, 44: 343-347. [Univ. Texas, Dept. Biol. Arlington, TX 76019]

Jones, C., L. Hedges, and K. Bryan. 1999. The western yellow bat, *Lasiurus xanthinus* (Chiroptera: Vespertilionidae), from the Davis Mountains, Texas. Texas Journal of Science, 51: 267-269. [Texas Tech Univ., Dept. Biol. Sci., Lubbock, TX 79409]

Masson, D. 1999. Histoire naturelle d'une colonie de parturition de Rhinolophe euryale, *Rhinolophus euryale*, (Chiroptera) du sud-ouest de la France. Arvicola, 11: 41-50. [386 rue des Flamboyants, 40600 Biscarrosse]

Moreno-Valdez, A. 1999. The fringed myotis, *Myotis thysanodes* (Chiroptera : Vespertilionidae) in Tamaulipas, Mexico. Southwestern Naturalist, 44: 404-405. [Texas A&M Univ., Dept. Wildlife & Fisheries Sci., College Stn., TX 77843]

Tschapka, M., and G. S. Wilkinson. 1999. Free-ranging vampire bats (*Desmodus rotundus*, Phyllostomidae) survive 15 years in the wild. Zeitschrift fur Saugetierkunde, 64: 239-240. [Univ. Erlangen Nurnberg, Dept. Zool. 2, Staudtstr. 5, D-91058 Erlangen, Germany]

ECHOLOCATION

Barclay, R. M. R., J. H. Fullard, and D. S. Jacobs. 1999. Variation in the echolocation calls of the hoary bat (*Lasiurus cinereus*): Influence of body size, habitat structure, and geographic location. Canadian Journal of Zoology, 77: 530-534. [Univ. Calgary, Dept. Sci. Biol., Calgary, AB T2N 1N4, Canada]

Lustrat, P. 1999. Première mention de Pipistrelle "commune", *Pipistrellus* sp., émettant en fréquence terminale à plus de 50 kHz en France. Arvicola, 11: 34-35. [22 rue Paul Jozon, 77140 Nemours]

Taylor, P. J. 1999. Echolocation calls of twenty southern African bat species. South African Journal of Zoology, 34: 114-124. [Durban Nat. Sci. Museum, POB 4085, ZA-4000 Durban, South Africa]

ECOLOGY

Barataud, M. 1999. Etude qualitative et quantitative de l'activité de chasse des Chiroptères, et mise en évidence de leurs habitats préférentiels: Indications utiles à la rédaction d'un protocole. Arvicola, 11: 38-40. [Vallégeas, 87400 Sauviat sur Vigé]

Burford, L. S., and M. J. Lacki. 1998. Moths consumed by *Corynorhinus townsendii virginianus* in eastern Kentucky. American Midland Naturalist, 139: 141-146. [Kentucky Dept. Fish & Wildlife Resources, #1 Game Farm Road, Frankfort, KY 40601]

Burford, L. S., M. J. Lacki, and C. V. Covell, Jr. 1999. Occurrence of moths among habitats in a mixed mesophytic forest: Implications for management of forest

bats. Forest Science, 45: 323-332. [Lacki: Dept. Forestry, Univ. Kentucky, Lexington, KY 40546]

Grindal, S. D., J. L. Morissette, and R. M. Brigham. 1999. Concentration of bat activity in riparian habitats over an elevational gradient. Canadian Journal of Zoology, 77: 972-977. [Suite 600, 555 Fourth Ave. S. W., Calgary, AB T2P 3E7, Canada]

Lacki, M. J., and J. T. Hutchinson. 1999. Communities of bats (Chiroptera) in the Grayson Lake region, northeastern Kentucky. Journal of the Kentucky Academy of Science, 60: 9-14. [Dept. Forestry, Univ. Kentucky, Lexington, KY 40546]

Palmer, C., and J. C. Z. Woinarski. 1999. Seasonal roosts and foraging movements of the black flying fox (*Pteropus alecto*) in the Northern Territory: Resource tracking in a landscape mosaic. Wildlife Research, 26: 823-838. [World Wide Fund Nat. Int., Trop. Wetlands Oceania Program, GPO Box 1268, Darwin, NT 0801, Australia]

Park, K. J., G. Jones, and R. D. Ransome. 1999. Winter activity of a population of greater horseshoe bats (*Rhinolophus ferrumequinum*). Journal of Zoology, 248 (4): 419-427. [Jones: Univ. Bristol, Sch. Biol. Sci., Woodland Rd., Bristol BS8 1UG, Avon, England]

Petit, E., and F. Mayer. 1999. Male dispersal in the noctule bat (*Nyctalus noctula*): Where are the limits? Proceedings of the Royal Society of London (B), 266: 1717-1722. [Univ. Lausanne, Inst. Ecol. Zool. & Anim. Ecol., Biol. Bldg., CH-1015 Lausanne, Switzerland]

Siemers, B. M., I. Kaipf, and H. -U. Schnitzler. 1999. The use of day roosts and foraging grounds by Natterer' s bats (*Myotis nattereri* Kuhl, 1818) from a colony in southern Germany. Zeitschrift fur Saugetierkunde, 64: 241-245. [Univ. Tubingen, Inst. Zool., Dept. Anim. Physiol., Morgenstelle 28, D-72076 Tubingen, Germany]

Vardon, M. J., and C. R. Tidemann. Flying-foxes (*Pteropus alecto* and *P. scapulatus*) in the Darwin region, north Australia: Patterns in camp size and structure. 1999. Australian Journal of Zoology, 47: 411-423. [Australian Natl. Univ., School of Resource Management & Environm. Sci., Canberra, ACT 0200, Australia]

Waters, D., G. Jones, and M. Furlong. 1999. Foraging ecology of Leisler's bat (*Nyctalus leisleri*) at two sites in southern Britain. Journal of Zoology, 249 (2): 173-180. [Univ. Leeds, Sch. Biol., Louis Compton Miall Bldg., Leeds LS2 9JT, W. Yorkshire, England]

PALEONTOLOGY

Czaplewski, N. J., B. E. Bailey, and R. G. Corner. 1999. Tertiary bats (Mammalia: Chiroptera) from northern Nebraska. Transactions of the Nebraska Academy of Sciences, 25: 83-93. [Dept. Zool, Univ. Oklahoma, Norman, OK 73019]

Czaplewski, N. J., J. I. Mead, C. J. Bell, W. D. Peachey, and T-L. Ku. 1999. Papago Springs Cave revisited, Part II: Vertebrate paleofauna. Occasional Papers of the Oklahoma Museum of Natural History, 5: 1-41.

Czaplewski, N. J., W. D. Peachey, J. I. Mead, T-L. Ku, and C. J. Bell. 1999. Papago Springs Cave revisited, Part I: Geologic setting, cave deposits, and radiometric dates. Occasional Papers of the Oklahoma Museum of Natural History, 3: 1-25.

Sigé, B., J. Habersetzer, and G. Storch. 1998. The deciduous dentition and dental replacement in the Eocene bat *Palaeochiropteryx tupaiodon* from Messel: The primitive condition and beginning of specialization of milk teeth among Chiroptera. Lethaia, 31: 349-358. [Centre de Paléontologie stratigraphique et Paléoécologie, UFR des Sciences de la Terre, Université Claude Bernard - Lyon1, 27-43 boulevard du 11 novembre 1918, F-69622 Villeu rbanne cedex, France]

PARASITOLOGY

Vaucher, C., and M. C. Durette-Desset. 1999. *Histiostrongylus spineus* n. sp (Nematoda: Trichostrongylina), parasite of *Phyllostomus discolor* (Chiroptera: Phyllostomidae), and comments on the genera *Histiostrongylus* Molin, 1861 and *Parahistiostrongylus* Perez Vigueras, 1941. [French] Revue Suisse de Zoologie, 106: 611-620. [Museum Hist. Nat., Case Postale 6434, CH-1211 Geneva 6, Switzerland]

PHYSIOLOGY

Heffner, R. S., G. Koay, and H. E. Heffner. 1999. Sound localization in an Old-World fruit bat (*Rousettus aegyptiacus*): Acuity, use of binaural cues, and relationship to vision. Journal of Comparative Psychology, 113: 297-306. [Univ. Toledo, Dept. Psychol., Toledo, OH 43606]

REPRODUCTION

Lloyd, S., L. S. Hall, and A. J. Bradley. 1999. Reproductive strategies of a warm temperate vespertilionid, the large-footed myotis, *Myotis moluccarum* (Microchiroptera: Vespertilionidae). Australian Journal of Zoology, 47: 261-274. [Univ. Queensland, Dept. Vet. Anat. & Pathol., Brisbane, Qld 4072, Australia]

SYSTEMATICS / TAXONOMY

Alvarez, Y., J. Juste, E. Tabares, A. Garrido-Pertierra, C. Ibanez. and J. M. Bautista. 1999. Molecular phylogeny and morphological homoplasy in fruitbats. Molecular Biology & Evolution, 16: 1061-1067. [Bautista: Univ. Complutense Madrid, Fac. Vet., Dept. Bioquim & Biol. Mol. 4, E-28040 Madrid, Spain]

Lapointe, F. J., G. Baron, and P. Legendre. 1999. Encephalization, adaptation and evolution of Chiroptera: A statistical analysis with further evidence for bat monophyly. Brain, Behavior & Evolution, 54: 119-126. [Univ. Montreal, Dept. Sci. Biol., CP 6128, Succursale Ctr. Ville, Montreal PQ H3C 3J7 Canada]

Mayer, G. C., J. A. W. Kirsch, J. M. Hutcheon, F-J. Lapointe, and J. Gingras. 1999. On the valid name of the lesser New Zealand short-tailed bat (Mammalia: Chiroptera). Proceedings of the Biological Society of Washington, 112: 470-490. [Dept. Biol. Sci., Univ. Wisconsin-Parkside, Kenosha, WI 5314I]

Storch, G. No date. Systematics and classification of extant bats. The Miocene Land Mammals of Europe. pp. 81-90. [Forschungsinstitut Senckenberg, Senckenberganlage 25, D-60325 Frankfurt a.M., Germany]

Tupinier, Y. 1999. Nomenclature des Chiroptères européens. Arvicola, 11: 36-38. [5-B rue Claude Baudrand, 69300 Caluire, France]

ZOOGEOGRAPHY

Rickart, E. A., J. A. Mercier, and L. R. Heaney. 1999. Cytogeography of Philippine bats (Mammalia : Chiroptera). Proceedings of the Biological Society of Washington, 112: 453-469. [Univ. Utah, Utah Museum Nat. Hist., Salt Lake City, UT 84112]

Request for Assistance

Banding Indiana Bats and Gray Bats: a Request for Information

Allen Kurta
Department of Biology, Eastern Michigan University, Ypsilanti, MI 48197

Since the United States Fish and Wildlife Service stopped issuing standardized bat bands in the 1970's, researchers have resorted to a variety of plastic and metal bands. Unfortunately, the majority of these bands do not readily identify the bander, and consequently, information on movements and longevity of bats is potentially being lost. To facilitate communication between bat banders and those who recover a banded bat, the Northeast Bat Working Group is assembling a list of banders and information concerning the bands that are used.

At the present time, we are requesting information **only** from those who have banded the endangered Indiana bat (*Myotis sodalis*) or endangered gray bat (*Myotis grisescens*) with bands obtained from sources other than the U. S. Fish and Wildlife Service. We are requesting information on type of bands, range of numbers, identifying letters or colors, species banded, general location and approximate dates of banding, as well as contact information.

For example: Allen Kurta, Department of Biology, Eastern Michigan University, Ypsilanti, MI 48197, 734-487-1174, bio_kurta@online.emich.edu: Lambourns' lipped metal bands, #1-10,000 with lettering EMU YPSI MI, Indiana bats and others, Michigan, 1994-present. We hope to assemble a list and publish it in Bat Research News by early next year. Information should be sent to Allen Kurta at the address given above.

Abstracts Presented at the 29th North American Symposium on Bat Research

Abstracts are listed alphabetically by first author, who in nearly all cases made the presentation. There were a few errors in the electronic copy received from the local committee, and the Editor attempted to correct as many of these as possible, undoubtedly missed some, and probably introduced a few more, all unintentional. Some abstracts may have received an awkward "page break", but every effort was made to keep such instances to a minimum without too much blank space on the pages. The Editor apologizes to these authors. GRH

Are All Watering Holes Created Equal?

Rick A. Adams[1], Katherine M. Thibault[2], and Brad Petru[3]

[3] Univ.Wisconsin-Whitewater, Whitewater, WI; [2]Univ. New Mexico, Albuquerque, NM

Because most bat species require consumption of free-standing water in order to survive, access to waterholes, especially in xeric environments, is crucial. The importance of waterholes to bat populations is poorly understood, even though these sites serve as sinks by bringing into contact species that normally would not interact due to differential foraging specializations. Over the last four years we have studied water-use patterns of a Coloradan bat assemblage (n = 1250) consisting of 11 species, nine of which are commonly captured. Results indicate that highest species diversity and evenness occur at small-diameter waterholes fed by mountain streams and located in cluttered Douglas-fir/Riparian habitat, sites that are closest to the day roosts of many of the species. Although not surprising that these sites would be of high activity, what is unexpected are the captures of bat species such *as E. fuscus, L. cinereus,* and *L. noctivagans* that normally do not forage in such cluttered habitats. In addition, these species could easily assess large ponds less than 0.7 km away that would predictably better fit their energetic/flight profile based upon wing ecomorphology,. We compare and contrast waterhole parameters (pH, water temperature, turbidity and mineral content) to better understand why bats prefer one site over another.

Size Matters: Scaling and the Evolution of Flight and Echolocation in Bats

Hector T. Arita, Instituto de Ecologia, UNAM, Morelia, Mich.; Mexico

The maximum body mass for bats is three orders of magnitude lower than the weight of the largest terrestrial mammals and one order of magnitude below the theoretical limit for a flying vertebrate. I suggest that three types of constraints could be limiting the size of bats: (1) those associated with flight; (2) those associated with echolocation, especially the coupling of flight and echolocation in aerial-hawking species; (3) phylogenetic constraints. Flight alone might limit the size of megabats, but other constraints (associated with diet, roosting habits or viviparity) could be acting as well. At least in some aerial insectivorous microbats, wing flapping and echolocation sound production are coupled to save energy, so one echolocation call corresponds in time to one wing beat. In theory, pulse repetition rate (PRR) and wing-beat frequency (WBF) should scale with body mass with the same exponent to yield PRR/WBF ratios equal to one. However, the exponents vary among taxa, showing that some bats don't couple the two functions. I traced changes in body mass, PRR, and WBF along N. Simmons' phylogeny of bats to infer the possible effects of diet, echolocation call design, and phylogenetic constraints on body size among different bat lineages. I found three generalized patterns: First, high-intensity echolocation and its coupling with flight constrain size in aerial-feeding insectivores. Second, in lineages with species using low-energy echolocation ("whispering" bats), some species have attained comparatively large sizes, notably among frugivores and carnivores. However, even these bats are much smaller than the largest Megachiroptera. Finally, lineages of bats using high-duty, constant-frequency echolocation calls show a secondary reduction in body size. I conclude that: (1) flight constrains size in all bats, (2) an additional constraint must be limiting the size of Megachiroptera, (3) size in Microchiroptera is constrained by echolocation, (4) aerial insectivores are particularly small, apparently because of energetic constraints, (5) size in frugivores and gleaners are limited to a lower degree by echolocation constraints, and a phylogenetic constraint might be acting, (6) a different mechanism must be limiting body size in bats with high-duty echolocation designs.

Fossil Lineage Reconstruction within the Bat Family Phyllostomidae

Jennifer K. Balch, American Museum of Natural History, New York, NY

Phyllostomidae is a large and diverse family of Neotropical leaf-nosed bats which encompasses a variety of different feeding behaviors from insectivory to sanguinivory. A recent phylogeny of the familial relationships within Phyllostomidae provides a context for investigating the fossil record. By summarizing the fossil record, combining temporal and phylogenetic information, and reconstructing the ghost lineages (missing parts of the tree) it is possible to reconstruct the timing of divergence events in the history of phyllostomids. A total of 134 records of fossil phyllostomids were found in existing literature. A database was created with information on the age, location of find, and bones diagnosed for all fossil accounts. This information on Ancient bats was then superimposed upon the hypothesized phylogenetic tree. Four Miocene fossil finds representing Glossophaginae, Phyllostominae, *Tonatia* sp., *and Notonycteris magdalenensis* suggest a divergence of the major phyllostomid clades around five million years ago which implies that many of the dietary specializations seen in phyllostomids are very old. However, despite the promise of such a fossil record overlay, documented finds are scarce in comparison to the modern diversity of Phyllostomidae. Problems arise from both badly preserved fossils and poorly supported parts of the total evidence phylogeny. For well-supported parts of the tree, such as in Desmodontinae, we can make strong hypotheses about evolutionary history. For other clades we can make only tentative suggestions due to the potential for branch rearrangement. Although we can suggest some interesting hypotheses from the current study, only further fossil finds and improved phylogenies will allow for significant conclusions about the evolutionary history of Phyllostomidae.

The Use and Abuse of Echolocation Data to Infer Patterns of Bat Activity

Ford Ballantyne IV and Richard E. Sherwin, University of New Mexico, Albuquerque, NM

Recent technological advances in acoustic monitoring equipment have led to an increase in the use of this technology to infer patterns of activity and use of habitat by bats. In order to fully understand these patterns, it is important to monitor locations continuously throughout the entire sampling period. Additionally, enough variation may exist within types of habitat that true replication may require that locations are monitored simultaneously. Furthermore, when comparing differential use among available types of habitat, it is also necessary to concurrently monitor activity in all habitats of interest. We collected data in different types of habitat during 1997 and 1998. We compared use within and between habitats allowing us to determine whether significant variation in activity of bats existed within a given habitat. Activity of bats did vary significantly within as well as between types of habitat. This was observed within and among nights. We propose that inferences regarding differential use of habitat may be missed, or overstated unless all points are sampled concurrently through time.

Foraging Behaviour of Male and Female *Myotis adversus* in Queensland, Australia.

[1]Robert M.R. Barclay, [1]Bryan Chruszcz, and [2]Martin Rhodes.

[1]University of Calgary, Calgary, AB, Canada and [2]University of Queensland, Brisbane, Australia.

We used radiotelemetry to study the foraging behaviour of *Myotis adversus* (the large-footed, or fishing bat) near Brisbane, Australia. Individuals roosted in an abandoned railway tunnel and consistently foraged more than 10 kms away over a large reservoir. During the lactation and post-lactation periods, most individuals had one or two relatively long foraging bouts per night. Females foraged for significantly longer than did males (mean 7.5 hrs vs 6.5 hrs), and foraging times were significantly longer during lactation than post-lactation, regardless of gender. The difference between males and females was due to significantly longer second foraging bouts for females, as the first foraging bout was equally long in males and females. The decline in foraging time during the post-lactation stage may be due to the decreased energy demand placed on females, and perhaps the need for males to guard their roost holes in this harem-forming species. Alternatively, prey abundance may have changed through the season and influenced the foraging behaviour of all individuals. There was no evidence of feeding territories as males were not located foraging in the same place every night, and males and females from the same roost (harem) did not forage together.

Structure of Bat Communities in Primary Forests of Central Amazon, Brazil

Enrico Bernard, BDFFP - INPA/SI and Department of Biology, York University, York, Ontario

By grouping species into guilds, and studying their diet, time of activity, use of forest strata, and reproductive patterns, I investigated the structure of bat communities in tree-fall gaps and their surroundings. Between August 1996 and August 1997 (3.398 mistnet-hours), 17 tree-fall gaps and 13 control points were sampled, using mistnets in two strata of the forest: canopy and understory. I captured 936 bats, belonging to 51 species, 27 genera, and 6 families. A sharp vertical stratification between the species was detected. Fecal samples from 36 species were examined, and 25 food categories identified, including seeds, fruits, insects, and spiders. Time of captures indicate a wide variation according the species, but the period between 18:00 and 19:00 presented the highest activity. Three reproductive peaks were observed: October-November; January-February; and July-August. A matrix of guilds composed by 24 cells. Small bats category (4-9 grams) was the richest in species (13), and the highly cluttered/gleaning frugivores presented 19 species. Supported by Brazilian CNPq Masters Program, BDFFP INPA/SI, and Bat Conservation International.

Bat Species Composition in Three Localities in the Amazon Basin

Enrico Bernard[1], Ana L. Albernaz[2], William E. Magnusson[2]

[1]York University, North York, Ontario & [2]Brazilian National Institute for Research in the Amazon (INPA)

We compared the bat species composition of three localities in Brazilian Amazon: continuous forest and fragments at Santarem, an area not previously sampled, and continuos forest in two relatively well known areas, Manaus and Belem. The number of species captured at each site varied between 17 and 46. Most species occurred at high abundance in continuous forest in the three localities, but only a subset was common in the fragments at Santarem. The relative abundance of bat species in Santarem is different from other localities sampled in the Amazon Basin and the presence of forest fragments may be the most important factor contributing to this difference. Multidimensional scaling ordination of sites based on relative abundance indicated distinct assemblages of bat species in the forest fragments in Santarem, and little differentiation of continuous forest sites from sites in other localities. Continuous forests at Santarem and near Belem were more similar to each other than to continuous forest near Manaus, indicating the possibility of an east-west gradient in bat communities in the Amazon. Supported by Brazilian CNPq grant # 521102-95.2 and INPA PPI grant # 2-3540 to W.E. Magnusson.

Software for Mapping Radio Telemetry Data

Robert D. Berry, Brown-Berry Biological Consulting, Bishop, CA 93514

A commercially available mapping program (Topo USA 2.0) was selected to help analyze a large quantity of position/bearing data collected during two radio tracking studies of California leaf-nosed bats *Macrotus californicus* on the Barry M. Goldwater test range in the Arizona Sonoran desert. Software was developed to move the input data (time, frequency, position and bearing) from a spreadsheet to the mapping program’s draw file format for overlay. Bearing data was collected from both ground and airborne receivers. In addition, a data file was collected by the mapping program’s GPS interface while tracking from an aircraft. The software and mapping program have several interactive options that will be demonstrated at the poster session.

Mother-pup Recognition in Big Brown Bats, *Eptesicus fuscus*: The Role of Olfactory and Auditory Cues

Johanna Bloss and Thomas H. Kunz, Boston University, Boston, MA

Female big brown bats *Eptesicus fuscus* form maternity colonies where pups are left behind while adults forage. Upon returning to the roost, a female must locate and identify her offspring for suckling. Using dual choice Y-maze experiments, this study was designed to evaluate the relative importance of olfactory and auditory cues in mother-pup recognition. Female big brown bats successfully identified the scent of their pups from birth until weaning. However, when both auditory (isolation calls) and olfactory cues were available, a female was less likely to choose the arm of the maze that contained her pup than she was when presented solely with olfactory cues. When permitted free interaction with foreign and related pups in a Y-maze, females often approached an unrelated pup first, but a mother was never observed accepting any but her own offspring for suckling. Independent of age, pups did not distinguish between maternal and foreign scent and attempted to suckle from any available female. These results suggest that adult

female big brown bats first orient in the maternity roost in response to isolation calls made by pups and then identify individual offspring based on olfactory cues.

The Effects of a Selective Timber Harvest on Bat Populations in Caribou National Forest

Kirsten M. Bohn[1,2] and Barry L. Keller[1]

[1]Idaho State University, Pocatello, ID. and [2]University of Maryland, College Park, MD

The effects of forest management practices are poorly understood for bats. Timber harvesting may affect two major resources used by bats within the forest canopy: roost sites, in the form of snags, and to a lesser extent, foraging areas. In this study we investigated the effects of a selective timber harvest on bats in Caribou National Forest, Idaho. Anabat bat detectors, with delays and automated tape recorders were used to evaluate bat activity within the forest canopy. Twenty one sites within the forest canopy were sampled in 1996, prior to the harvest, and in 1998, after the harvest. Sites were within, adjacent to, and away from the harvest. The number of bat passes was counted for each site, and each call was categorized as a small species (*Myotis species*) or large species (mostly *Lasionycteris noctivagans*). The number of sites with at least one feeding buzz was also counted. Bat populations were also assessed by capturing bats with mist nets at ponds in 1996 and 1998. The change in the number of bat passes before and after the harvest was different between harvest sites and non-harvest sites. Bat activity decreased in harvest stands but increased in non-harvest stands after the harvest. Proportionately fewer *Myotis* species and more large species calls were recorded in harvest stands after the harvest. The proportion of sites with feeding buzzes did not change after the harvest. The number of bats captured at the pond closest to the harvest area decreased after the harvest. However, the pond away from the harvest also had a decrease in the number of bats captured in 1998. The results of this study indicate that selective harvesting has a negative effect on bat populations. Not only were the number of available roosting sites most likely reduced as a result of snag removal, but the harvest did not increase foraging activity. However, activity did remain high at ponds and forest stands adjacent to the timber harvest. Therefore, the disturbance of the harvest itself did not appear to negatively affect bat activity. The harvest in this study retained a density of 2 snags per acre, which was not adequate for bats, and future harvests should retain more as roosting habitat for bats.

Home Alone in the Land That Time Forgot: Long-term Tracking of the Movements and Home Range of *Dobsonia minor* in Papua New Guinea

Frank Bonaccorso and John Winkelmann

Papua New Guinea National Museum and Art Gallery and Gettysburg College, Gettysburg, PA

Lesser bare-backed bats, *Dobsonia minor* (Pteropodidae), roost as solitary individuals in foliage of understory trees in lowland rainforest at the Kau Wildlife Area in Papua New Guinea. These 70 gram frugivorous bats forage in primary and secondary forest and in abandoned gardens. Movements (n =1,041) of four males and four females fitted with position-sensitive radio-transmitters were monitored for periods spanning 1-18 months. Mean monthly home range was 5.1 ha (n = 12). There was no significant difference in home ranges of males and females, nor was there a dry-wet seasonal difference. However, females had significantly larger mean core use areas than males (1.43 + 0.61 ha, n = 8; and 0.65 + 0.16 ha, n = 4, respectively). There is overlap in both home range and core use areas among simultaneously tracked animals. The long axes of home ranges varied from 150 to 1150 m. Some individuals commuted from day roosts to distant feeding areas resulting in longer, disjunct home ranges. Fruits of *Ficus spp. and Piper aduncum* are the major food items of *D. minor*. *Piper aduncum* shrubs grow in dense clusters within early successional habitats, and individual plants produce a few ripe fruits each night throughout the year. *Ficus spp.* grow in later successional forest, fruit asynchronously, and each tree produces massive fruit set that is ripe for about one week. Three individuals (all females) were tracked over periods spanning from 3-18 months. Although each of these females continued to visit core use areas with *P. aduncum* shrubs, temporal changes in individual home ranges appear to reflect the ephemeral location of fruiting fig trees.

Territorial and Mating Behavior of the Angola Free-tailed Bat, *Mops condylurus*

Sylvie Bouchard, York University, Toronto, ON Canada, M3J 1P3

Although bats are often said to be "the most social" of mammals because they are gregarious and may live in large groups, we know little of the details of the interactions that occur within these groups. I study social interactions and communication within the roost using captive Angola free-tailed bats, a gregarious species in which sexes live together

throughout the year. Individually tagged bats (n=16, 8 females & 8 males) were videotaped using an infrared camera and light source, and the tapes are used for detailed analyses of the interactions between individuals. The purpose of the study was to describe qualitatively and quantitatively *M. condylurus'* territorial and mating behaviors. Males in the flight pen established territories, scent-marked the boundaries and defended them. The a-male was the only male roosting with the females in the protected roost whereas the b-male, roosted beside it, also attracted females from time to time, and constantly challenged the alpha male. Fifty-one territorial displays and forty-eight scent-marking sequences were analyzed, the associated detailed postures and behaviors will be discussed. Analysis of 18 mating attempts, six complete (determined by the male willingly dismounting the female), showed that in three another male (of higher rank) intervened and separated the male from the female. Two recorded attempts lack the beginning, one was outside the field of view (only feet could be seen). Seven attempts were unsuccessful altogether with the female fighting off the male. Again the details of the postures and behaviors leading to and during mating will be discussed. Based on my observations I conclude that the mating system of this species corresponds to resource defense polygyny (stricto sensu Emlen and Oring, 1977). Male M. condylurus defend territories and look for opportunities to mate with the females within them; female movement across territories is not-restricted. The use of the infra-red camera is a non-intrusive manner to collect valuable information about bat behavior, for example the use of these bats' crest and of olfactory signals can easily be "observed" leading to great insights in their communication system.

The Ecology of Torpor and Hibernation by Free-ranging "*feathered bats*".

R.M. Brigham, C.P. Woods, G. Körtner, T.A. Maddocks, & F. Geiser
University of Regina and University of New England

With the exception of scattered anecdotal reports, knowledge about the use of torpor and hibernation by birds is limited. We report the results of recent studies assessing the use of torpor and hibernation by free-ranging caprimulgiform birds in Australia (Australian Owlet-nightjars (50 g) and Tawny Frogmouths (500 g) and North America (Common Poorwills (50 g). Given their proclivity for nocturnal insectivory, parallels with insectivorous bats are natural. Sedentary owlet-nightjars and frogmouths regularly employed shallow torpor during the winter months. Owlet-nightjars allowed T_b to fall about 2°C in bouts lasting up to 5 hr. Surprisingly, torpor was typically used in the morning and rarely at night when birds almost always foraged. Occasionally birds re-entered torpor in the afternoon. Frogmouths allowed T_b to fall to about 29°C in bouts up to 7 hr which occurred after foraging at dusk. Torpid frogmouths always aroused before sunrise. In contrast to Australian birds, poorwills at the northern edge of their breeding range, are migratory, arriving in April and departing in September. They readily enter bouts of deep torpor with T_b falling below 5°C on occasion, typically prior to and after nesting. In southern Arizona, where they occur year-round, poorwills use daily torpor regularly during spring and fall. Torpor was used extensively during the winter months, when poorwills were mostly dormant, although individual behaviour differed markedly, with some foraging frequently while others remained motionless for several weeks at a time. During winter dormancy, T_b for torpid birds typically coincided with T_a at temperatures above 6°C, although passive warming not associated with activity was recorded frequently for all birds. Taken together, we conclude that despite differences in body size, roost sites, and foraging strategies, a number of caprimulgiformes, frequently enter torpor under natural conditions when low T_a would demand high energetic costs for thermoregulation. Moreover, we speculate that convergence in some torpor patterns between them and their Chiropteran counterparts is likely owing to comparable evolutionary forces placed on both groups which subsist on prey that are both predictably and unpredictably irregular in availability.

Bats of Great Smoky Mountains National Park and Nantahala National Forest

Eric R. Britzke[1], Michael J. Harvey[1], Vernon E. Hoffman[2], and Richard M. Mitchell[2]
[1]Tennessee Tech Univ., Cookeville, TN; [2]Arkansas State Univ., State University, AR

During May & August 1999, we surveyed the bat community of Great Smoky Mountains National Park (GSMNP) and Nantahala National Forest (NNF). We mist netted 219 bats representing 11 species, including 5 endangered Indiana bats (Myotis sodalis). Each bat was aged, sexed, banded, and released. Reproductively active female Indiana bats were captured at three locations, 2 in GSMNP and 1 in NNF. A radio transmitter placed on one of the females (NNF) resulted in the location of a maternity colony of 26 bats in a dead hemlock tree. This is the first record of an Indiana bat maternity colony from the southern portion of the range of the species.

Foraging Behavior of the California Leaf-nosed Bat in the Arizona Sonoran Desert

P. Brown[1], R. D. Berry[1], V. Dalton[2], and D. Dalton[2]
[1]Brown-Berry Biological Consulting, CA 93514 and [2]D2 Chiropterology, Tucson, AZ 85745.

Winter and summer radio-telemetry studies of the California leaf-nosed bat *Macrotus californicus* were conducted on the Barry M. Goldwater Range in the Sand Tank Mountains south of Gila Bend, Arizona. Winter roosts were located in mines, while a mine and a natural cave were used during the summer. In addition to fixed station and mobile terrestrial tracking, an airplane was used to track bats on several nights. At both seasons, individual bats had preferred foraging areas that included washes and mountainous terrain within 16 km. of the roost. In previous foraging studies of Macrotus in the California, activity was concentrated among desert trees in dry washes within 9 km. of the roost. In the Arizona desert, trees are found on the hills and flats as well as the washes. A telemetered bat used the same tree in flat terrain on different nights to roost between foraging bouts during the summer survey. The authors thank Robert X. Barry of Luke Air Force Base for the support of this research.

The Use of Neural Networks to Classify Echolocation Calls of Big Brown Bats

Stephen C. Burnett and W. Mitchell Masters, The Ohio State University, Columbus, OH

Attempts to census bats have generally relied on capturing and banding the animals. Some studies have used analysis of echolocation calls to determine the number of species that were recorded. However, these studies have not attempted to determine the number of animals within each species. Because the echolocation calls of bats often contain individual information about the animal producing the call, it might be possible to estimate the number of bats that were recorded. Previous studies have used discriminant function analysis (DFA) to classify calls to individual, to calling situation, to age, and to sex. DFA requires that the number of groups in the sample be known beforehand, and thus it is not suitable for determining the group structure of novel sets of data. We attempted to use artificial neural networks to get around this problem. Neural networks are computer algorithms that can be used to identify patterns in sets of data that might not be found using other techniques. Big brown bat *Eptesicus fuscus* echolocation calls (described by a variety of frequency, time, and amplitude variables) were given as inputs to neural networks. The networks attempted to classify the calls without prior knowledge of group composition. A self-organizing map (SOM) neural network was used to estimate the number of bats that produced the set of calls on the basis of the variables describing the calls. Results suggest that this approach may yield a reasonable estimate of the number of bats in the sample even when a priori information is lacking. This may be useful for estimating the number of bats flying in an area based on recordings of their echolocation calls. Further analyses were conducted to determine the usefulness of using neural networks for other classifications.

AFLP Fingerprinting the Bats of New Britain (Papua New Guinea): Taxonomic, Phylogeographic, and Conservation Applications

Deanna G. P. Byrnes, University of Wisconsin, Madison WI 53706

Using AFLP (amplified fragment length polymorphisms), we have produced fingerprints for individuals from several populations of several species of Megachiroptera from West New Britain, Papua New Guinea, to compare within- and among-population genetic diversity. AFLP uses selective PCR amplification of restriction fragments from a total digest of genomic DNA which can be analyzed to yield a robust and detailed genetic characterization of each population. In addition, we use a novel scanning technique that enables us to visualize more accurately individual markers and distinguish among genotypes within the populations. This method can be applied to many levels of investigation. At the population level, AFLPs can be used to characterize substructure and level of gene flow between neighboring populations. This can aid in the identification of particularly vulnerable species or populations and help in prescribing conservation status to those species and their habitats. Also, by characterizing the basic population substructure of different types of species (for example wide-ranging and restricted, or Colonial and solitary), we may be able to use similar genetic information from species with unknown habits to infer their likely distribution patterns or roosting preferences. At a species/subspecies level, AFLP fingerprinting may help resolve taxonomic questions where the defining characteristics are subtle or questioned, such as small differences body size or geographic range. To such ends, these data can be used to build haplotype trees to examine genealogical relationships among the populations of purported species or subspecies. Combining these phylogenetic trees with geographic distributions may clarify taxonomic ambiguities that exist within many groups of fruit bats by recovering recent evolutionary histories and patterns of such species complexes.

Feeding Ecology of Red, Seminole, and Evening Bats at the Savannah River Site, S.C.

Timothy C. Carter[1], Michael A. Menzel[2], Brian R. Chapman[2], and Karl V. Miller[2]
[1]Southern Illinois University,Carbondale, IL; [2]University of Georgia, Athens, GA

We collected fecal samples from red *Lasiurus borealis*, Seminole *L.seminolus*, and *evening Nycticeius humeralis* bats at the Savannah River Site, South Carolina, during the summers of 1996 and 1997. Diets were compared to estimates of prey availability, which were based on samples of the insect communities in available habitats and the amounts of time the bats foraged in each habitat. Diets differed among species. All species fed selectively. Red bats consumed mostly Coleoptera in the beginning of the summer and used Lepidoptera more toward the end of the summer. Red bats selectively avoided Lepidoptera and Tricoptera in early summer, Diptera and Tricoptera in the middle, and Diptera, Hymenoptera, and Tricoptera during late summer. Diets of Seminole bats were dominated by Coleoptera and Hymenoptera in early summer. However, they used Coleoptera, Hemiptera, and Tricoptera less than they were available. In mid-summer Lepidoptera also became an important food item. Hymenoptera was used more than available, and Hemiptera, Diptera and Tricoptera were consumed less than they were available. No Seminole bats samples were collected during late summer. Evening bats consumed primarily Coleoptera, Hymenoptera, Hemiptera, and Homoptera during early and mid summer. Lepidoptera, Diptera, and Tricoptera were avoided during early and mid summer. Evening bats consumed mostly Hemiptera, Homoptera, Coleoptera, and Hymenoptera during late summer. They used Hemiptera and Homoptera more than they were available and avoided Coleoptera, Lepidoptera, and Diptera.

Patterns of Thermoregulation in the Polygynous Microchiropteran, *Myotis adversus*.

Bryan Chruszcz[1], Robert M. R. Barclay[1], and Martin Rhodes[2]
[1]University of Calgary, Calgary, Canada and [2]University of Queensland, Brisbane, Australia

We radio-tagged 12 female and 10 male bats of the polygynous species, *Myotis adversus*, during November and December of 1997. We captured the bats from a colony located in an abandoned railway tunnel near the town of Samford in southeastern Queensland, Australia. Bats roosted in drainage pipes running into the tunnel. We applied temperature-sensitive tags to pairs of males and females occupying the same roost (of the same harem) at the same time. We considered a bat to be torpid when its body temperature was below its active temperature. During the day, males and females regularly entered shallow torpor, while deeper bouts of torpor seemed to be associated with inclement weather conditions. The mean active, maximum, and minimum temperatures for males were 32.4±0.7 °C, 36.3±0.3 °C, and 28.9±0.4 °C. The mean active, maximum and minimum temperatures for females were 32.2±0.2 °C, 36.5±0.2 °C, and 28.5±0.4 °C. The temperature of the roosts remained stable at 20.0±1.0 °C.

Functional Morphology of Feeding in the Pteropodidae: A Scaling Analysis

Melissa Morales Cogan, University of Chicago and Field Museum, Chicago, IL

The members of the Pteropodidae (Old World fruit bats) have two primary diets: frugivory and nectarivory. These food choices have a strong association with skull morphology especially concerning the apparent lesser robusticity of the nectar feeders. Differences in skull form between nectarivores and frugivores may be correlated with how the skull resists stresses incurred by processing fruit and how aspects of skull morphology can increase the ability to process fruit and procure nectar. Diets that require greater mastication incur greater stresses and thus require an increase in the amount of bone at areas critical to resisting stress. Maximizing effectiveness at procuring and processing food also has an effect upon skull morphology. For a frugivore, increasing the ability to effectively masticate can be accomplished in two ways: either the muscles can be made larger to produce greater forces or the mechanical advantage of those muscles can be increased. Increasing the ability to effectively procure nectar can be accomplished through lengthening of the snout in order to allow better access to nectar resources. This study addressed the question: how much can the effect of diet explain the observed differences in skull form between the frugivores and nectarivores? To answer this question, I tested the following predictions within the Pteropodidae, (1) all frugivores, regardless of type of feeding, have thicker bone in areas important to stress resistance, and maximized effectiveness for mastication as compared to nectarivores when controlling for size and (2) nectarivores will have relatively longer snouts than all frugivores in order to more effectively procure nectar. I used a scaling analysis in order to uncover the effect of size on differences in skull morphology and to facilitate comparisons among bats of different sizes. Results demonstrate that not all frugivores have the same level of stress resistance nor do they all show greater masticatory effectiveness than the nectarivores. Some of the functional groupings among the frugivores correspond to the phylogenetic groupings. Nectarivores, on the other hand, do have relatively longer snouts than most frugivores.

Using Acoustic Surveys to Investigate Use of Fragmented Habitats by a Temperate Bat Community

Brent L. Coleman[1], Richard E. Sherwin[2] and Duke S. Rogers[1]
[1]Brigham Young University, Provo, UT; [2]Univ.New Mexico, Albuquerque, NM

We investigated patterns of habitat use by bats along a fragmented, riparian corridor using the Anabat II bat detection system. Acoustic sampling was employed due to the abundance of water in the area which rendered traditional sampling techniques (mist netting) ineffective. Bat activity in various habitat types was examined to determine the relative importance of existing habitats before the River is altered in a restoration effort. Habitat types were established from information provided by the Utah Mitigation Reclamation Conservation Commission, and two replicates of each habitat type were sampled. Bat activity was defined as the number of echolocation events recorded per hour. Based on data from summer seasons 1998&1999, we propose that acoustic sampling can provide valuable information regarding habitat use patterns of bats along the River corridor.

Acoustic Survey for Western Red Bats *Lasiurus blossevillii*

Chris Corben, Elizabeth D. Pierson, Willam E. Rainey

Many calls of the Western Red Bat Lasiurus blossevillii are sufficiently distinctive that positive identification, using ANABAT, is a simple matter so long as Eastern Red Bat Lasiurus borealis is out of range. Brief call sequences, which could easily be confused with several other species, are often recorded real field situations. Details are provided for recognizing Western Red Bats acoustically and usefulness of the method for Red Bat surveys is discussed. It is concluded that acoustic monitoring is an essential component of a Red Bat survey.

The Relationship Between Body Mass, Phylogeny, Diet, and Basal Metabolic Rate in Phyllostomid Bats: A Computer-Simulation Approach

A. P. Cruz-Neto and A. S. Abè Depto. de Zoologia, IB, UNESP, CP 199, CEP 13506-900, Rio Claro, SP, Brasil

Controversy exists as to what factors affect the basal metabolic rate (BMR) in mammals, once the pervasive effects of body mass have been controlled. For example, various authors have suggested that BMR also varies in relation to diet or phylogeny. We examined these factors in the bat family Phyllostomidae. We first used conventional analysis of covariance (ANCOVA) to test the effects of diet on BMR, while controlling for effects of body mass. This conventional analysis assumes that all species evolved simultaneously from a single common ancestor (i.e., a star phylogeny with equal-length branches) and a Brownian motion model of character evolution. In this analysis, diet exerted a strong effect on mass-corrected BMR. We next used a phylogenetically informed analysis involving Monte Carlo simulations along a specified phylogenetic tree and under different models of character change. The PDSIMUL computer program (Syst. Biol., 1993, 42:265- 292) was used to simulate the evolution of body mass and BMR thousands of times, and these data were then analyzed in the same way as for the one set of real data. The F statistic for the real data set was compared to the distribution of F statistics from the computer-simulated data. In this analysis, no effect of diet on BMR was observed, irrespective of the evolutionary model assumed. In both conventional and phylogenetically informed analyses, body mass exerted a strong effect on BMR: larger-bodied species had lower mass-specific metabolic rates. Owing to the fact that diet is perfectly confounded with phylogeny in the set of 19 species examined, even if diet did exert an effect on BMR in the phylogenetic analysis, it would not be possible to separate this effect from the possibility that these phyllostomid bats differ for some other reason besides diet. This points to the need for careful selection of study species if one hopes to elucidate the effects of ecological or behavioral factors on aspects of bat biology. Supported by Conselho Nacional de Desenvolvimento CientÌfico e TecnolÛgico (CNPq) and FundaÁ„o de Amparo ‡ Pesquisa do Estado de S„o Paulo (FAPESP grant 97/02731-8) to A. P. Cruz-Neto. A. S. Abe was supported by a FAPESP grant (1994/6026-9).

The Mexican Long-Tongued Bat *Choeronycteris mexicana*: A Species at Risk?

Paul M. Cryan and Michael A. Bogan

University of NewMexico, Albuquerque, NM, 87131.Since 1906, fewer than 500 *Choeronycteris mexicana* have been encountered in the United States. Due to these low numbers, the species was listed by Region 2 of the U.S. Fish & Wildlife Service as an information concern under the U.S. Geological Survey Species at Risk Program. In hopes of learning more about the status of *C. mexicana*, we initiated a field survey in the southwestern United States during the summer of 1999. From an initial list of 48 historic localities in Arizona and New Mexico, we were able to find and access 23 sites on public land. Visits coincided with date (month and day) of original observation. We found *C. mexicana* at 74% (n=17) of the sites we visited. Multiple individuals were observed at 82% (n=14) of the occupied sites, and young-of-year were observed at 71% (n=12) of occupied sites. Mean number of years since last recorded visit to occupied sites was 20.8 (n=14, range 3-77). We observed a total of 99 bats and average group size was 3.8 (range 1-15). Young-of-year bats comprised 24% (n=24) of the total number we observed. We found *C. mexicana* roosting in mine adits (n=12), abandoned buildings (n=3), wide rock crevices (n=6), and caves (n=6). Multiple entrances were found in 52% of occupied structures. Bats typically roosted in lighted areas close (mean=2.7m) to entrances. All occupied sites were within 1 km of a reliable water source and, with the exception of a single site, near riparian habitat. Agave species were present in the vicinity of all occupied sites. Sites at which we did not encounter *C. mexicana* were either frequently disturbed, difficult to search, or historically occupied by single individuals. Based on the high rate of bat recurrence, we find no evidence that populations of *C. mexicana* have declined in recent years. The utility of such surveys will be discussed.

Molecular Phylogeny of the New World Bat Genus *Lonchophylla*

Liliana M. Davalos and Sharon A. Jansa. American Museum of Natural History

Phylogenetic relationships among nectar-feeding phyllostomids have been controversial since Griffiths (1982) 1 proposed the subfamily Lonchophyllinae as an early branch of the nectar-feeding group. This subfamiliy comprises the genus *Lonchophylla* plus the monospecific genera *Lionycteris* and *Platalina* . Ensuing morphological, chromosomal, and restriction-site evidence has supported the monophyletic status of the subfamily, but the relationships among these genera, and species therein, remain unresolved. Cytochrome b sequence variation has been found to provide phylogenetically informative data helpful in the resolution of relationships among species for many genera within the family Phyllostomidae. In this study we present a first molecular phylogeny for the genus *Lonchophylla*, and its proposed outgroups, *Lionycteris* and *Platalina* , based on cytochrome b sequence data. Since this gene has been extensively used in phylogenetic studies in bats and other mammal groups, our results can be meaningfully compared to a larger body of work both at supra-specific and sub-specific level. These results will be complemented with morphological data examined from specimens for the purpose of refining our understanding of relationships amongst Lonchophylliines. 1. Griffiths 1982 Systematics of the New World nectar-feeding bats (Mammalia, Phyllostomidae) based on the morphology of the hyoid and lingual regions. American Museum Novitates 2742, 1-45.

Context and Correlates of Vocalizations by Male *Saccopteryx bilineata*

Susan M. Davidson, University of Maryland, College Park, MD

Many male animals have evolved complex vocalizations that function in mate attraction and territorial defense. Male S. bilineata defend roost territories at a colony and produce complex audible vocalizations. Females roost within these territories, and a recent study has found that males having females roosting within their territories have higher reproductive success than males without females. To determine the context in which some of the male calls are given, I recorded male vocalizations on the island of Trinidad and made behavioral observations of the focal male and nearby bats at the time the calls were given. Noisy broad-band (screech) calls were mainly directed at other males and tonal calls were mainly used in interactions with females. Two other call types were not strongly associated with any context and may be involved in territorial defense or conspecific notification. I used Poisson regression to determine how variation in vocalizations relates to the number of females found roosting within the territory of a male. Males that produced more types of composite syllables were associated with more females. In addition, several acoustic features of a common call type significantly correlated with the number of females within a male's territory. Differences in male vocalizations could, therefore, transfer information to colony members about male quality.

Cranial Morphology, Feeding Behavior and the Evolution of Frugivory

Elizabeth R. Dumont, Northeastern Ohio Universities College of Medicine

Frugivory has evolved twice among bats - once in the paleotropical pteropodids, and again in the neotropical phyllostomids. Each of these radiations contains species with diverse ecologies, morphologies, and behaviors. Within individual frugivore communities, these variations are associated with different patterns of fruit resource use. One of the most clear divisions is between bats that make use of a large proportion of figs and bats that utilize other fruits and/or nectar. This study evaluates how each of these two broad classes of frugivores differ in cranial size and shape, and begins to investigate how cranial size, shape, and feeding behavior are associated in the evolution of frugivory. Results of allometric analyses indicate that most elements of fruit bat cranial anatomy do not scale with isometry. Rather, cranial shape changes with shifts in cranial size. Moreover, different patterns of allometry often exist among fig-feeders and other bat species. A recurring question in assessments of dietary adaptation is whether variation in size or shape is more closely associated with variation in food habits and feeding styles. In order to assess this association in an evolutionary context, simple characters summarizing cranial size, shape, diet, and feeding behavior for a subset of ten species are coded and mapped onto existing phyllostomid and pteropodid phylogenies. Although there is a (not unexpected) association between increased body size and dietary emphasis on figs, the lack of congruence among size, shape, and feeding behavior character sets is striking. The pattern of character state distributions do, however, highlight steps in the morphological and behavioral evolution of both pteropodid and phyllostomid lineages. This preliminary assessment indicates that different combinations of morphological and behavioral elements are associated with the evolution of ecological diversity among phyllostomids and pteropodids. Despite the many examples of ecological similarities between individual pteropodid and phyllostomid species, these similarities are convergent and derived through alternative pathways. Further analyses like this one are likely to provide key insights into the relationship between morphology and behavior and their roles in frugivore evolution.

Distribution of the Bats of Eastern North America: Feedback Needed

Angela England, Bat Conservation International, Austin, Texas

The distributional range maps are being updated for the 21 bat species found in the eastern United States and Canada. These maps are intended to complement the maps completed earlier this year for the western United States and Canada. Not since Hall's 1981 Mammals of North America has there been a comprehensive compilation of North America's bat ranges. Such information is much needed by land managers and conservationists. Preliminary data for these maps were obtained from a broad literature survey, supplemented by published and unpublished reports. Information was also requested from state natural heritage agencies. Personal communications from a variety of university, federal, state, and independent biologists have helped to complete the picture. Final input is being solicited at this. Details of sensitive sites will be held confidential. Longitude and latitude were obtained for each record, along with state, county, date, and any other significant features such as location name, capture method, age or sex. Points were then plotted using MapInfo version 4.5 for Windows. A 30-mile radius buffer was computed around each data point, and a polygon for each species was then drawn, following ecoregion boundaries whenever possible. Candidate species maps were compiled in conjunction with the US Geological Survey's "Bat Species of Concern: An Ecological Synthesis for Resource Managers" by Tom O'Shea and Mike Bogan, expected to be published in 1999. Members of the Southeastern Bat Diversity Network and the Northeastern Bat Working Group have provided valuable feedback and refinement of these maps. Persons having knowledge of points near or beyond the periphery of the shown polygons are asked to share their information with the author of this poster, in order to ensure the most accurate representation of the currently known ranges of these species.

Describing the Echolocation Calls of Bats

Brock Fenton, York University, North York, Ontario

Too often biologists use terms such as constant frequency (CF), frequency modulated (FM) to describe the echolocation behaviour of bats or the bats themselves. While CF and FM describe some echolocation calls or their components, they do not accurately depict the bats or their echolocation strategies. By definition, a CF signal has a bandwidth of 0 kHz over some period of time, while an FM signal has a broader bandwidth (>1 kHz) over some period of time. The echolocation calls of a wide range of species reveals that aerial feeding bats (those that use echolocation to detect, track and assess airborne prey, usually flying insects) produce high intensity echolocation calls that may include both CF and FM components. Depending upon the frequencies dominating the echolocataion calls of these bats they

are detectable by most bat detectors at distances of 5 to >10 m. In contrast, gleaning bats (those that take prey from surfaces), species that feed on blood, fruit and at flowers, produce low intensity echolocation calls detectable at distances of <2 m, and, those of many species at <1 m. Each of these general categories of echolocation call intensities appears in a variety of families of bats. While most echolocating bats produce their echolocation calls at low duty cycle (signal on ~10% of the time), separating pulse and echo in time, a few (Rhinolophidae, Hipposideridae and the mormoopid *Pteronotus parnellii*) separate pulse and echo in frequency, producing echolocation calls at high duty cycle (signal on >50% of the time). These bats can broadcast and receive at the same time. The echolocation calls of high duty cycle bats are dominated by CF components and they are widely known as "CF" bats. It is clear that although "CF" accurately describes the components of some echolocation calls, it does not accurately portray the echolocation behaviour or the bats themselves.

Habitat Use by *Corynorhinus rafinesquii* on the Southern Edge of the Species' Range.

Finn,L.S.[1] , T.G. Finn[1] , and T. Bittle[2] [1]Fly By Night, Inc. and [2]University of Central Florida

The Southeastern big-eared bat, Corynorhinus rafinesquii macrotis, is rare throughout its range. The southernmost confirmed maternity colony in Florida is located adjacent to the Disney Wilderness Preserve and Lower Reedy Creek on the Osceola / Polk County line. Research to determine the preferred foraging habitat and alternate roost sites for this population began in April 1999. Bats were radio tracked in April and August. During these sessions, a total of 9 bats were outfitted with transmitters and tracked to 10 roost trees. GIS maps will be presented to illustrate the foraging habitat and locations of roost trees for bats radio tracked during these two sessions. Future tracking dates are scheduled for November 1999 and February 2000.

Why Flower Early? Unusual Response of Organ Pipe Cacti to a Generalist Pollinator.

Theodore H. Fleming, Lyndsay R. Newton, and Helen Hsieh. University of Miami, Coral Gables, FL

Organ Pipe cactus *Stenocereus thurberi* is one of three species of bat-adapted columnar cacti that flower in the spring in the Sonoran Desert. Although peak flowering occurs in mid-June, some individuals begin flowering in April, up to two months earlier than other individuals near Bahia Kino, Sonora, Mexico. Early-flowering individuals are in direct competition with cardon and saguaro cacti for pollination by the bat *Leptonycteris curasoae*. Why flower early if you are a 'minority' species? To see whether *L. curasoae* forages preferentially for organ pipe flowers, we gave captive bats equal numbers of flowers of the three species and scored flower choice. *Leptonycteris* bats visited the three flower types randomly. Since cardon flowers can be up to 100 times more common than organ pipe flowers in April, this behavior suggests that organ pipe flowers will often receive the wrong kind of pollen. What are the consequences of this for fruit set in organ pipe? We hand pollinated flowers of organ pipe with pollen from three sources (self pollen, outcross organ pipe pollen, and cardon pollen) and scored fruit set and measured fruit growth rates. Results of this experiment indicated that fruit set was 0% with self pollen, 74% with cardon pollen, and 84% with organ pipe pollen compared with 37% under open pollination. Organ pipe thus can set fruit with heterospecific pollen. Growth rates of fruits receiving conspecific pollen grew significantly faster than open-pollinated fruits and those receiving cardon pollen. Most open-pollinated fruits produced in April through at least mid-May are heterospecifically pollinated. Although somewhat smaller than conspecifically pollinated fruits, cardon-pollinated fruits contain good numbers of apparently viable seeds. These seeds are not cardon-organ pipe hybrids. Rather, they appear to be asexually produced after stimulation from the 'wrong' pollen. Genetic studies are currently underway to test this hypothesis. Our results indicate that individuals of organ pipe have the ability to produce seeds both asexually and sexually. This unusual reproductive plasticity allows early-flowering individuals to avoid flower abortion after receiving the wrong pollen delivered by a generalist pollinator.

Nudity in the Naked Bulldog Bat *Cheiromeles*

Patricia W. Freeman, University of Nebraska State Museum, Lincoln, NE

Cheiromeles, the Naked Bulldog Bat, is a large aerial insectivore found in Southeast Asia. Its mass is as great as in carnivorous microchiropterans, *Macroderma gigas* and *Vampyrum spectrum*. There is little known about the diet and habits of *Cheiromeles*. There is some evidence that it is a beetle-eater and a termite-eater. It is a fast flyer with thick, leathery ears and low frequency calls that are emitted orally. It is also thought to live in hollow trees, underground, and in caves and can be in large colonies in these places. *Cheiromeles* has flattened nails on its thumbs, calluses at the base

of its thumbs, and sleeves on the sides of its body into which the folded phalanges can be tucked away. I believe these are features that allow *Cheiromeles* to scramble around inside trees and underground where it is probably feeding. Being underground and inside trees in the tropics may be why *Cheiromeles* is naked. Another bats that scrambles around underground is *Mystacina*, but it lives in more temperate New Zealand and is furred.

The Comparative Method and Why Phylogeny Matters

Theodore Garland, Jr., University of Wisconsin-Madison Madison, WI

The last 15 years have witnessed a revolution in the way species differences are studied: the "comparative method" has been revitalized by new analytical tools that use phylogenies and by increased phylogenetic information. Most typically, modern analyses obtain information about one or more phenotypic traits (e.g., wing area, metabolic rate, relative brain size, frequency of echolocation calls, social system, diet, home range area) for a series of species, and then "map" this information onto a phylogenetic tree that has been obtained from independent data (e.g., DNA sequences), analyzed with an appropriate tree-reconstruction algorithm. Usually, to avoid circularity, the traits of interest are not used to construct the phylogeny. Phylogenetically based statistical methods (review in Am. Zool. 39:374-388) attempt to account for the fact that related species tend to resemble each other, and hence that their phenotypes cannot be considered as independent and identically distributed data points for analyses. These techniques allow traditional topics in comparative and ecological physiology, functional morphology, and behavioral ecology to be addressed with greater rigor. Examples include studies of the form of allometric relationships, prediction of values for unmeasured species, correlated character evolution and coadaptation, and whether characteristics of organisms vary consistently in relation to behavior, ecology or environmental characteristics, which can constitute evidence of adaptation (results of natural selection). These methods can also address topics that are unapproachable without phylogenetic information, such as where and when a trait first evolved, its value in hypothetical ancestral species, and whether rates of evolution have differed among evolutionary lineages (clades). Although most powerful with complete phylogenetic information, the procedures can incorporate uncertainty about topology (polytomies: Syst. Biol. 48:547-558), branch lengths, and the way characters have evolved. Three general methods will be discussed: reconstruction of ancestral states (Evolution 51:1699-1711), phylogenetically independent contrasts (Am. Nat. 125:1-15), and Monte Carlo computer simulations to obtain phylogenetically correct null distributions (Syst. Biol. 42:265-292). Free software to implement these techniques is available from the author.

Are Megachiropteran Bats Lunarphilic?

Thomas T. Gordon, S.U.N.Y., Stony Brook, NewYork

Lunarphobia has long been a question of interest among bat researchers and mammalogists in general, although few studies have focused specifically on this anti-predator behavior. Despite a large anecdotal literature supporting lunarphobia, exceptions can be found to this generalization. One problem is that researchers often do not consider the specific ecological conditions of the animals involved. For example, a desert rodent species should demonstrate a higher level of lunar phobic behavior than a species that lives under the leaf litter in a forest. The same should hold true for bats. The Megachiroptera offer a particularly interesting case. Being bats, it could be argued they will show lunar phobic behaviors. Yet, since they do not echolocate, they are more dependent on visual cues for navigation and foraging. As a result, the Megachiropterans should be expected to increase activity during periods of higher moon light levels. However, this activity increase may be partially countered by increased predation risks at increased light levels. If true, I would predict the highest levels of activity to be associated with not the highest light levels, but the more moderate levels seen around the half moon phase. With this prediction in mind, I looked at the capture rates for all the bats I caught at the Parc National de Taï in Côte d'Ivoire in terms of moon phases. I found that the highest capture rates for Megachiroptera were during the half to three quarter phases, with lower levels during the full phase and lowest capture rates during the periods with less than a quarter moon visible. On the other hand, Microchiropteran capture rates remained relative constant for all moon phases. In addition, calling rates for male *Hypsignathus monstrosus* were highest during the half and three quarter moon phases, showing an overall pattern similar to the Megachiropteran capture rates.

The Role of Roosts as Hotspots in Court-displaying *Hypsignathus monstrosus*

Thomas T. Gordon, S.U.N.Y., Stony Brook, New York

The Hammer-headed bat, *Hypsignathus monstrosus*, is probably best known for its classic lek mating system. However, leks have only been reported from a limited region of Central Africa despite the fact the species' range encompasses most of the wet forests of West and Central Africa. Last year, I discussed a non lekking population of *H. monstrosus* from Côte d'Ivoire. I argued this population employs a "resource opportunism polygyny" mating system where males did not defend resources, but advertised with the species stylized mating ritual at fruit trees used by the females. I demonstrated that during the primary calling period, between 2000 hrs. and 0100 hrs., calling activity was centered around fruiting events and the number of males present and duration of the calling events were related to the size/duration of that fruiting event. Further, these ephemeral male calling events were a result not of the fruit directly, but the females present at these fruiting events. I then suggested that these types of associations may be the required precursors needed for the Hotspot model of lek evolution. Here I report on correlates of two added peaks of calling activity: sunset and the hour preceding sunrise. Again, male calling activity was associated with the presence of large numbers of females, but this time the resource involved was roosting sites. The literature states that H. monstrosus tends to roost as singles or in very small groups (<10). At Taï, this was true for individual trees or branches, but often many such individuals and clusters could be found within a restricted area (*H. monstrosus*). I compare my results with those of Bradbury (1977).

Facial Morphology and Echolocation in Chiroptera

A.B. Goudy and P.W. Freeman, University of Nebraska State Museum, Lincoln, NE

Microchiroptera are the only echolocators to use structured frequency signals. Within Microchiroptera there are many echolocation strategies used to exploit a wide variety of habitats and prey types. Some species show remarkable situational flexibility in their echolocating behavior and have much variation within call parameters. Bats also have a wide variety of facial features, some of which have been shown to influence sound emission and reception. We quantified numerous facial features and regressed them against known echolocation call parameters of 69 species, which represented 38 genera and 12 families of bats. Greater widths between paired facial features are negatively correlated with frequency, indicating that facial size plays an important role in the frequencies a bat is able to use. Further, greater widths between the ear canals is negatively correlated with frequency parameters, complimenting the theory that inter-aural distance (distance between the ears divided by the speed of sound) determines the frequencies mammals are able to hear. Measurements of the pinnae and accessory appendages of the pinnae are also correlated with call parameters. The echolocation system is influenced by a number of factors, both morphological and ecological, and how all the factors interact is an area for further research. Recent studies have focused on correlations between echolocation, flight morphology and habitat. This study concerns the predictability of call parameters and sound reception given a particular set of facial features.

Frugivorous Bats Communities of Equatorial Africa (Megachiroptera: Pteropodidae): Comparison of Forest Edge Areas Versus Forest Block Areas.

Mickaîl Paul Henry [1,3], Pierre Formenty [2], Patrick Barrière [3], Perpete Olivier [3], Marc Colyn [3]

[1]Univ. Sherbrooke, Qc, Canada; [2]Project recherche OMS/EBOLA, Abidjan, Côte d'Ivoire; [3]Univ. de Rennes 1, France.

The Paimpont Biological Station (France) undertook several major bat sampling missions in equatorial Africa, from 1994 to 1997 with the ECOFAC/ CEE, BIOFAC/CEE and OMS/EBOLA projects. Thus, frugivorous bat communities (Pteropodidae) have been characterized for 25 localities from 9 regions of Central and West Africa. Mist net captures were made at ground level. Two kinds of areas were sampled: forest block and forest edge (nearby savanna). This study attempted to compare frugivorous bat communities within those different habitats, regarding bat densities and species richness. Unfortunately, too few data are available for variance analyses. Species richness values are rather similar (S=4.7 ±2.3 [n=12] and S=5.8 ±2,5 [n=6], respectively for forest block and forest edge). However, global density is much higher in forest edge than in forest block (respectively 5.82 versus 1.77 captures-night-100 m 2 of net). This difference is mainly explained by the tendency of Micropteropus pusillus to be restricted to forest edge areas (c 2 = 0.009; df=17), where it occurs at high densities. All in all, those two habitats show different global specific compositions. In Central Africa, forest edge communities are largely dominated by 2 species *Micropteropus pusillus*, and *Epomops franqueti*, whereas forest block communities are more diversified, with 4 main species, *Myonycteris*

torquata, Epomops franqueti, Megaloglossus woermanni and *Rousettus egyptiacus*. This result suggests that forest edges and forest blocks provide bats with different environmental conditions, and that the distribution of a species should varying according to its biology. In forest, some species are more associated to edges, e.g. *M. pusillus*, others to blocks, e.g. *M. woermanni, while E. franqueti* is more ubiquitous in equatorial forest. Forest edge and block communities seem to result from two distinct evolutiv lines. Finally, it appears to us that habitat fragmentation (to a small extent) in equatorial Africa may have a positive effect on frugivorous bat densities, but may affect the local community composition and diversity.

Characteristics of Ponderosa Pine Snags Selected as Roosts by the Long-legged Myotis, *Myotis volans*

Herder, M.J. and J.G. Jackson, U.S.D.I. – B.L.M., St. George, UT

This three-year radio telemetry project was to locate and characterize ponderosa pine snags used as bat roosts at Mount Trumbull in northwestern Arizona. Study objectives included characterizing roost preferences in ponderosa pine and oak snags to document the effects of ecosystem restoration work (forest thinning). Over 1,000 bats of 13 different species were captured over open water sources. Among the most abundant species captured over the three year study period were *Myotis volans, M. thysanodes*, and *Corynorhinus townsendii* comprising 40.1%, 22.8%, and 7% respectively of the total. More than 80 net nights of capture effort was conducted in ponderosa pine habitat (71%) and pinyon-juniper habitat (26%). A total of 37 *M. volans* were fitted with radio transmitters. Of those tagged, 10 were lactating, 2 were post lactating, and 14 were non-reproductive females. The remaining 11 bats were non-reproductive males. A total of 59 roost sites were located using radio telemetry tracking and visual inspection methods. Of these, 51 day-roosts of M. volans were located in ponderosa pine snags. Roost snags used by M. volans shared several characteristics including a DBH >28 inches, height >40 feet, elevation >6,480 feet above mean sea level, presence of large fissures and/or exfoliating bark, and distance to water <1.5 miles. Other roost snag characteristics, such as percent slope, position on slope, aspect, canopy cover and basal area, and distance to grazing allotments, treatment areas, or foraging sites showed a high degree of variability. To determine if M. volans arbitrarily selects roost snags from those available, a total of 60 ponderosa pine snags were randomly selected and compared to those of the 51 known roost snags. Snags used by *M. volans* were generally larger in diameter than randomly selected snags and had exfoliating bark and/or crevices or fissures. Forests immediately surrounding roost snags generally had larger basal areas and fewer trees per acre. For roost snags found in areas with high tree densities, the roost opening was most often located above the canopy layer, suggesting a preference for open, uncluttered flight space adjacent to the roost exit.

Pollination of *Agave palmeri* by Nectar-feeding Bats in Southeastern Arizona and the Effects of Alternate Resources on this System

Katharine E. Hinman, State University of New York at Stony Brook, NY

Nectar-feeding bats are frequent visitors to the century plant, Agave palmeri, a long-lived semelparous desert succulent. This plant shows many specializations that are consistent with the bat pollination "syndrome." In the southwestern United States, two species of nectar-feeding bats visit *Agave palmeri* : The lesser long-nosed bat, *Leptonycteris curasoae*, and the Mexican long-tongued bat, *Choeronycteris mexicana*. Both of these species are migratory and visit agaves as part of a "nectar corridor" of blooming plants, which also includes cardon, saguaro, and organ pipe cacti. Understanding the importance of these two bat species to the pollination of *Agave palmeri* requires evaluation of their effects on both the male and female reproductive success of the plants. As well, one must take into account the effect of other resources on the bats' foraging behavior and pollination effectiveness. The presence of large numbers of hummingbird feeders in concentrated areas of southeastern Arizona represents an additional nectar resource for these bats. The possible impacts of this additional resource may be seen as on par with the effects of invasive plant species in other systems. Preliminary results from the study of this system are given. Effects of the hummingbird feeders on the behavior of the bats are evaluated by examining visitation rates to feeders and to agaves, as well as pollen and fecal samples taken from bats captured at different resource sites and from night roosts. These results indicate that the bats are using both agaves and hummingbird feeders as resources during the agave blooming season. As well, they are using feeders during the months of May and June before the agaves are blooming. At this time, they appear to be collecting pollen from other plants in the areas. Visitation rates to feeders are much higher than rates to agaves, but this may simply be a reflection of the higher concentration of the resource. Results from radio tracking

indicate that the bats may restrict their foraging to predictable areas of resources which include both agaves and feeders. Future directions for research will also be discussed.

Phylogenetic Assessment of Vespertilionids Based on DNA Sequences of Mitochondrial Ribosomal Genes

Steven R. Hoofer and Ronald A. Van Den Bussche, Oklahoma State Univ., Stillwater, OK

Vespertilionidae is a large and diverse assemblage of small, primarily insectivorous bats that is nearly cosmopolitan in distribution. Although a considerable amount of information is known about vespertilionids, their phylogenetic relationships remain conjectural, at both higher and lower taxonomic levels. Recent studies of higher-level relationships, based on diverse data sets such as morphology, karyology, immunology, embryology, and nucleotide sequences, have suggested that some members of Vespertilionidae should be removed and either raised to familial rank (e.g., Miniopterinae) or in or near the family Molossidae (e.g., *Antrozous, Tomopeas*). However, different studies have suggested different classifications and no consensus has been reached. We are examining taxonomic relationships of Vespertilionidae with the use of sequence data from three adjacent genes (12S rRNA, tRNA-Valine, 16S rRNA) in the mitochondrial genome (about 2.7 kbp of contiguous sequence). We have sequenced these genes from 65 vespertilionids, 10 molossids, and several outgroup species. Although our data set is only about a third complete (i.e., we will sequence about 100 more taxa), preliminary analysis offers support to the traditional higher-level classification of vespertilionids. Additionally, our analyses indicate that variation in these genes will provide resolution at lower taxonomic levels. We will discuss the taxonomic implications and utility of these data.

Individual Variation in Nightly Time-Budgets of the Little Brown Bat *Myotis lucifugus*

Jason W. Horn, Boston University, Boston, MA

The little brown bat, *Myotis lucifugus* (Chiroptera: Vespertilionidae) is a common and wide-spread insectivorous species in North America. Previous efforts to characterize the daily time-budget of this species have been based on night-vision observations during the day- and night-roosting periods, times of nightly emergence, captures of departing and returning bats, and temperature recordings of roost occupancy. In the present study, I used Passive Integrated Transponders (PIT tags) to monitor the nightly and seasonal behavior of individual bats occupying a maternity colony of M. lucifugus in southern New Hampshire. Over 200 young and adult bats were captured and marked with monel wing bands and PIT tags in 1997 and 1998. All bats were captured as mother-pup pairs and each individual was injected with a glass-encapsulated PIT tag. In 1997, nightly and seasonal activity were monitored at three commonly-used exit/entry holes and two night roosts using a custom-designed antenna coupled with a computer for continuous data acquisition. In 1998 and 1999, nightly and seasonal activity of PIT-tagged bats were monitored at the most commonly used exit/entry hole, after two alternate exit/entry holes were blocked. These data were supplemented with observations using infrared video, and continuous recordings of ambient light, temperature, and humidity, and fecal collection beneath night roosts. Emergence times changed seasonally and were associated with ambient light, temperature, and date. Night-roosting use was significantly associated with minimum nightly ambient temperature. Some bats were characterized by nightly activity patterns that included more than one night-roosting period or more than one foraging period. Use of PIT tags has made it possible to evaluate individual differences in nightly and seasonal activity and order of nightly emergence with respect to age, sex, and reproductive condition, as well as records on roost fidelity and philopatry.

The Phylogeny of Echolocation

James M. Hutcheon, Theodore Garland, Jr, and John A.W. Kirsch. University of Wisconsin, Madison, WI

Ongoing controversies in bat systematics concern not only the interrelationships of chiropteran families,superfamilies, and sub-orders, but also the identity of the nearest likely outgroup of bats. Echolocation is frequently pointed to by all sides in this debate as relevant to their particular phylogenetic hypotheses. Under the standard or "flight first" hypothesis, where powered flight is considered the most general uniting feature of chiropterans, pharyngeal sonar is viewed as a synapomorphy of Microchiroptera, never having evolved in Megachiroptera; the "echolocation first" scenario, in contrast, mandates the loss of this capacity in megabats. Recent molecular work, however, challenges the categorical distinction between microbats and megabats, allying at least Rhinolophoidea with the Pteropodidae, and thus raises the possibility that echolocation evolved twice among

chiropterans. But echolocation is not a unitary anatomical feature nor is it expressed in the same manner in all bats which possess it. The comparative method provides a means of assessing the evolution of traits by taking relationships - as expressed in a phylogenetic tree - into account, thus reducing spurious correlations caused simply by shared ancestry. Body mass, foraging strategy and echolocation call-frequency are considered to be associated. Examining the hypothesis that foraging strategy in bats is related to body mass in a phylogenetic context provides an opportunity to account for what might, in fact, be a phylogenetic constraint. Likewise, although everyone "knows" that megachiropteran bats are larger than many microbats, does variance in body size represent a significant difference, or do mean differences between suborders fall within the expected variance of an evolutionary process? Finally, reference is often made to the large number of extant bat species, with the explicit assumption that echolocation, flight, or both represent a key innovation(s) allowing for the diversification observed in bat species today. However, while the notion of echolocation as a key innovation has been marshaled as an argument to support all of the competing phylogenetic theories, it this hypothesis has not been the subject of a rigorous, statistical assessment.

Bat Life-Histories: Testing Models of Life-History Evolution in Mammals Using a Comparative Phylogenetic Approach.

Kate E. Jones and Ann MacLarnon

School of Life Sciences, Roehampton Institute, London, SW15 3SN, UK

The evolution of bat life-histories (Mammalia: Chiroptera) was examined to investigate patterns of life history covariation and to test Charnov's (1991) mammalian model of life-history evolution. Life-history data was collected from the literature for 308 bat species. Data were transformed into phylogentically independent data using Felsenstein's (1985) method of independent comparisons, modified by Pagel (1992) and implemented by the computer program CAIC (Purvis & Rambaut 1995). As no single estimate of the phylogenetic relationships for all the taxa under investigation was available, we calculated a 'phylogenetic supertree' (Sanderson et al. 1998) from 5 different systematic studies to cover the taxa required. Branch lengths in the phylogeny were set to the same arbitrary value in the CAIC program and the adequate standardization of the contrasts was checked prior to analysis (Garland et al. 1992). With phylogenetically independent contrasts, several of the bat life-history variables investigated were correlated with body mass but others were independent of body mass. The allometric scaling of the life-history variables was not significantly different within the two suborders of bats. Covariation of bat life-history traits was also examined. Although differences were found in the pattern of bat life-history covariation compared to other mammals, fundamental similarities remain; for example, low mortality rates are correlated with late ages at maturity. This means that the 'fast-slow' continuum found to operate in other mammals is also found among bat species. The life-history covariation found within bats supports, or at least not strongly refute, Charnov's (1991) model. Charnov's predicted values for the allometries and interrelationships of juvenile period length (a) and adult mortality (M), and his predicted invariants, are supported for bat species. However, annual fecundity (b) is not significantly correlated with body size as Charnov predicts. A more recent life-history model developed by Kozlowski and Weiner (1997) may explain some of the patterns observed for bat life-histories empirical analyses have yet to be performed. *Current Address: Dept. of Biology, Imperial College at Silwood Park, Ascot, Berkshire, SL5 7PY, UK

Evidence of Use of Echolocation Calls for Sex Recognition in Big Brown Bats

Karry A. Kazial and W. Mitchell Masters, The Ohio State University, Columbus, OH

It has been suggested that a bat's echolocation calls may communicate information about the bat, such as its age, individual identity, or sex. In order for echolocation calls to provide such information, variation in calls must be correlated with the characteristics of the bat producing the calls. Intraspecific variation in echolocation calls linked to age, individual identity, or sex, has been found for a number of species. Few studies, however, have taken the next step and examined whether bats pay attention to this information. In our study, we tested whether information about the sex of an echolocating bat can be perceived by conspecifics. We conducted playback experiments assessing the response of 15 female big brown bats, *Eptesicus fuscus*, to male and female echolocation calls. Bats received playback of 30 seconds of noise, 60 seconds of either male or female echolocation calls, and a final 30 seconds of noise. We measured the bat's vocalization rate during each playback period, and adjusted the rate of the last two periods by Subtracting out vocalization rate during the initial noise period, thereby controlling for activity level of the bat on different testing days. Vocalization rate differed during playbacks of male and female echolocation calls ($p = 0.033$) and after hearing the calls (i.e., during the final noise period) ($p = 0.007$). The female bats vocalized more often during and after male call

playbacks. Female big brown bats were found to respond differentially to echolocation calls based on the sex of the emitter, which supports the possibility of a role for echolocation calls in communication. The results of this study may have important implications for the social lives of bats.

The Mating System of the Mexican Free-tailed Bat *Tadarida brasiliensis* in a Large Highway Bridge Colony

Annika T.H. Keeley[1] and Brian W. Keeley[2]

[1]Texas Parks & Wildlife/ Bat Conservation InternationalPartnership, [2]Bat Conservation International

Mating by Mexican free-tailed bats *Tadarida brasiliensis mexicana* in central Texas was observed between 21 March through 5 April, 1998. Copulations were documented in large day roosts, small day roosts, and temporary night roosts. Focal animal sampling at a highway bridge revealed two distinct male copulation strategies which may function as adaptations to different roost conditions. During aggressive copulation, the male separates a female from a roost cluster, restricting her movements during mating while emitting characteristic calls. During passive copulation, the male moves very slowly onto a female roosting in a tight cluster. Passive copulations occur without resistance from the female and without male vocalizations. Both males and females mate with multiple partners; thus mating is promiscuous. The mating system is characterized as mating aggregations or swarming since mating occurs in large, unstable multi-male / multi-female mating groups, with no apparent male territories or defense of females.

Teasing Apart *Pteropus* : A Preliminary Molecular Phylogeny

Rebecca Kershnar, Nancy Simmons, and Rob DeSalle. American Museum of Natural History, NewYork, NY

The genus *Pteropus* (57 species) compromises nearly one-third of all known Megachiroptera. Over the past decade, research has focused on Pteropus ecology, behavior, and conservation, yet few studies have examined *Pteropus* systematics. To date, there has been no comprehensive cladistic analysis of *Pteropus*, leaving relationships between species largely unresolved. The taxonomy of the genus was last revised in 1912 by K. Andersen who recognized 18 species groups based on morphology and geography. Investigating species relationships using morphology alone can be misleading due to difficulties associated with defining discrete morphological characters, especially in closely related taxa that are distinguished principally by differences in size and/or color. This is a significant problem in *Pteropus*, which includes many island endemics. Therefore we are using sequence data from mitochondrial and nuclear genes to construct a molecular phylogeny for *Pteropus*. The phylogeny generated will be used to investigate the biogeography and monophyly of *Pteropus*, the relationship between widespread and endemic taxa, and the species groups proposed by Andersen. In order to identify gene regions appropriate for species level systematics within *Pteropus*, PCR and sequencing techniques are being employed. The degree of variability observed for different gene regions and their utility in phylogenetic analyses is discussed. Preliminary results concerning relationships within *Pteropus* is also presented. In the future, we hope to combine molecular and morphological data to examine *Pteropus* relationships.

Wing Morphology and Foraging Ecology in a Palaeotropical Bat Community

T. Kingston[1] , R. Hodgkison[2] , G. Jones[3] , A. Zubaid[2] , T.H. Kunz[1]

[1]Boston University, Boston MA, [2]Universiti Kebangsaan Malaysia, 43600 Bangi, Malaysia,

[3]University of Bristol, Bristol BS8 1UG, UK.

In this paper we assess the relationship between wing morphology and foraging ecology in a speciose bat community from Peninsular Malaysia. We looked at three levels of community organization: 1. First, the 49 species were grouped into five foraging strategies based on diet and foraging habitat; three insectivorous strategies defined by the degree of clutter they encountered when foraging (narrow-space, background clutter, and open-space) and two frugivorous strategies. We found good correspondence between wing morphology and foraging strategy, and strategies were distinguished largely by differences in wing loading and wingtip shape, and by aspect ratio. 2. The narrow-space insectivorous species of the forest interior were the dominant foraging strategy of this community and comprised 28 species. We characterized the variation within this group and explored the extent to which it reflects ecological differences between species. Species differed in their wing morphology and were separable by size, wingtip size and wing loading, and aspect ratio. Wing morphology was found to be a good reflection of foraging and roosting ecology for many species, with particular characteristics associated with cave-roosting, hovering, and perch hunting/flycatching. 3. Finally, we tested experimentally whether differences in wing morphology reflect differences in flight performance between those members of the narrow-space insectivorous foraging strategy characterized by frequency modulated

(FM) echolocation calls (the Kerivoulinae and Murininae). Clutter-tolerance in this narrow-space FM guild differed between species and was promoted by low wing loading, a rounded wingtip and low aspect ratio. These findings suggest that resource partitioning in this guild may be effected in part through differences in the foraging microhabitat.

Phylogenies and Where They Come from: Conflict, Concurrence, and the Comparative Method

John A. W. Kirsch, University of Wisconsin, Madison, WI

The types of characters and algorithms used to generate phylogenetic trees bear an intimate, and often unrecognized, relation to each other: not all characters are suited to the same analytical method, and vice versa. Parsimony, for example, has as its first assumption the independence of unit features, an assumption that may at least in principle be met by disparate anatomical characters but rarely by the sequence of bases in a single gene. On the other hand, analogues of the plausible models for DNA evolution - such as those accounting for the influence of transition:tranversion ratios, saturation, base-compositional bias, differential weighting of portions of a gene, etc. – are unknown for anatomy and enhance the power of computer methods appropriate for molecules. Yet, conservative assumptions that base changes are unordered and non-polarized effectively renders sequence analysis "phenetic" (in the sense of "based on overall similarity"). In this, the results resemble those of distance-generating methods (serology, DNA hybridization). As regards bat phylogeny, molecular trees confirm the monophyly of many family-level inferred from anatomy, and appear to "solve" several conundra such as the affinities of *Mystacina*; but they differ from tradition markedly at higher levels, especially concerning the time-honored subordinal dichotomy between megabats and microbats, uniformly recovering a sister-group relation between Pteropodidae and Rhinolophoidea. Because widely-applied combinability tests assess only length differences rather than branching orders among trees, and because few techniques are capable of combining data when taxa or characters differ among studies, it is premature to adopt the results of a global or "total-evidence" analysis until the algorithmic or other reasons for such conflicting results are understood. The more general lesson is that differing trees corresponding to various classes of data may have equal legitimacy. The dilemma this poses for comparative-methodologists is that whereas a single tree can be provided, it may not be the (most) correct one; several phylogenetic hypotheses need to be examined. However, the plausibility or otherwise of the reconstructions of character-evolution on multiple trees may contribute to a considered choice amongst phylogenies.

Behavioral Audiogram of the Neotropical Fruit Bat, *Artibeus jamaicensis*

Gimseong Koay, Rickye S. Heffner, and Henry E. Heffner, University of Toledo, Toledo, OH

Bats present an opportunity to examine the effects of auditory specialization for echolocation upon the basic auditory abilities that are part of the common mammalian plan. As part of a survey of the hearing abilities of bats, we determined the behavioral audiogram of the Jamaican fruit bat, Artibeus jamaicensis. Absolute thresholds were determined for 3 bats using a conditioned avoidance procedure with fruit juice reward. Behavioral thresholds were obtained for frequencies from 1 kHz to 140 kHz. At an intensity of 60 dB SPL, the bats' hearing extended from 2.8 kHz to 131 kHz. The shape of the audiogram is similar to that of other FM bats, showing two regions of good sensitivity with hearing thresholds 15 dB SPL or better. The first broad region of good sensitivity, between 12 kHz and 32 kHz, also includes the frequency of best hearing at 16 kHz, with a mean threshold of 9 dB SPL. A second and narrower region of good sensitivity is seen from 50 kHz to 60 kHz, showing a peak sensitivity of 13 dB SPL at 56 kHz. The distinct decrease in hearing sensitivity at 40 kHz appears to be due to the filtering characteristics of the pinnae. Comparative analysis suggests that the restricted low-frequency sensitivity of A. jamaicensis is common among mammals with good high-frequency hearing.

When and Why Do Plant-visiting Bats Eat Leaves?

T.H. Kunz[1] , J. Balasingh[2] , and G. Marimuthu[3]

[1]Boston University, Boston, Massachusetts, [2]St. John's College, Palayamkottai, India,

[3]Madurai Kamaraj University, Madurai, India

The short-nosed fruit bat, *Cynopterus sphinx* (Chiroptera: Pteropodidae) is a ubiquitous plant-visiting bat that ranges throughout the Indomalayan region. We quantified the foraging behavior of this bat in South India as individuals fed on selected fruits and leaves, and evaluated the chemical composition of these foods. *Cynopterus sphinx* feeds

mostly on fruits following emergence from day roosts and later shifts to feed on leaves later in the night. When feeding on fruits, an individual typically lands directly on a fruit and removes all or part of it with its mouth, and carries it away to a feeding roost. By contrast, bats remove leaves from trees while they are in flight, without either hovering or landing. At feeding roosts, *C. sphinx* chews the leaves and fruits, ingests the soluble contents, and expels the fibrous components as pellets. Results of Principal Components Analysis (PCA) comparing carbohydrates, crude protein, and lipids from selected fruits (n = 5 species) and leaves (n = 6 species) indicate a higher percentage of protein in leaves and a higher percentage of carbohydrates and lipids in fruits. Results of paired t-tests indicated no significant differences between fruits and leaves in these organic nutrients, although the lack of significance probably reflects the high variance in these samples. PCA of selected macrominerals (Ca, Na, K, and P) indicate higher levels of Ca in leaves than in fruits. Results of t-tests comparing these macrominerals revealed a significant difference between fruits and leaves for Ca, but not for the other macrominerals. The relatively high concentrations of protein and calcium in the soluble extracts of leaves ingested by *C. sphinx* supports the hypothesis that leaves are important dietary sources for this plant-visiting bat. Our observations suggest that ripe fruits that are rich in carbohydrates, have a relatively high water content, and are patchy in space and time, may be a limiting resource and thus promote intraspecific competition. By contrast, leaves that are rich in protein and calcium and relatively abundant and dispersed are less likely to promote competition.

Respiratory Muscle Recruitment in Echolocation: Interspecific Variation and Implications for Efficiency

W.C. Lancaster and J.R. Speakman, University of Aberdeen, Scotland

In biosonar vocalization, pressure generation and control of intensity are controlled by respiratory muscles and they incur the major energetic costs associated with echolocation. Biosonar calls used by insectivorous bats vary in frequency content, duration, intensity and duty cycle, and these variations relate to the mode of foraging. Call characteristics may also relate to the energetic costs of producing the calls. We recorded electromyographic activity of respiratory muscles during vocalization in three species of bats, and the energetic costs of echolocation at rest in five species. At rest, *Eptesicus serotinus* produced single calls averaging 2.7 ms (± 0.135, N=145) in duration and a duty cycle of 2.8%. *Pipistrellus pipistrellus* produced single and double calls; first calls averaged 2.1 ms (± 0.12, N=31) and the second were significantly longer at 5.8 ms (± 1.35, N=12). The duty cycle of pipistrelle vocalization was 3.3%. *Myotis myotis* produced multiple calls with a vocal duty cycle of 7.8%. Activity in the flank muscles was consistently associated with vocalization, but patterns of activity varied. The duty cycle for lateral abdominal wall activity in these species (17.4% in serotines, 10.1% in *Myotis* and 31.3% in pipistrelles) was significantly longer than that of the calls. In contrast, the duty cycle of the flank muscle activity in *Pteronotus parnellii* (32%, previously recorded data) was only slightly longer than that of its calls (28%). Interspecific differences were also seen in oxygen consumption recorded during stationary vocalization. *P. parnellii* and *Rhinolophus ferrumequinum* had low costs per call (0.019 and 0.011 J/call respectively). In comparison, the cost per call in vespertilionids was significantly higher (0.247 J/call in serotines, 0.176 J/call in pipistrelles and 0.021 J/call in *Myotis*). The differences in the calling behavior and associated muscular activity in relation to the energetic expenditure per vocalization suggest the existence of morphological and physiological adaptations for the conservation of energy in echolocating stationary bats. Supported by BBSRC 1/SO4245.

Interpopulation mtDNA Diversity in *Corynorhinus rafinesquii*

Lance, R.F. and P.L. Leberg, University of Southwestern Louisiana, Lafayette, LA

Rafinesque's big-eared bat *Corynorhinus rafinesquii* is a potentially threatened species indigenous to the southeastern United States. Analyses of phylogeography in *C. rafinesquii* revealed a high degree of interpopulation mtDNA differentiation relative to co-familial, sympatric species *Nycticeius humeralis* and *Lasiurus seminolus*. Significant differences in haplotype frequencies occurred across distances of less than 50 km; particularly strong divergence in haplotype frequencies was found between Louisiana populations and those from sites east of Louisiana. Factors that might account for the high degree of interpopulation genetic divergence within *C. rafinesquii* include diffuse distribution of colonies and female-philopatry, though data regarding these aspects of the bat's natural history are lacking. Rafinesque's big-eared bats are slow, highly maneuverable flyers, a characteristic that could limit their potential for long-distance movements between populations. The separate influences of isolation-by-distance and of

potential barriers to gene flow on the differentiation between Louisiana populations and those east of Louisiana could not be distinguished. Further research on *C. rafinesquii* social behavior, roost selection, and dispersal will further elucidate the factors underlying these phylogeographic patterns. Because our results indicate that female-mediated gene flow is somewhat limited between *C. rafinesquii* populations, concerns over genetic isolation of populations and the low probability that females will disperse into areas where populations have been lost should impact future conservation efforts.

Characteristsic of Buildings used as Bat roosts in Waukesha County, WI

Susan E. Lewis and Deana N. Pavwoski, Carroll College, Waukesha, WI

Bats are reported to select roosts based on factors such as temperature regimes, humidity, protection from weather and predators, and proximity to water or foraging areas. Roost preferences of bats roosting in buildings should also be influenced by these factors. As landscapes make a transition from rural to suburban or urban, the types of roosts available to building-roosting bats are expected to change. This may have important conservation implications for the bats. We investigated the characteristics of buildings occupied by bats in Waukesha County, WI. We also compared those characteristics to those of a randomly selected subset of buildings within the county by means of questionnaire surveys. Waukesha County is one of the most rapidly developing counties in the state, and thus ideal for an investigation of this nature. Bats most often were reported to roost in uninsulated attics or wall spaces of wooden barns or residential buildings. The majority of roost entrances were on the south and east facing exposures of the buildings, most frequently 3 to 6 m above the ground. Buildings occupied by bats were significantly more likely to be >50 years old, barns or garages, unoccupied by humans, and within 0.5 km of water than were randomly-selected buildings in the county. These results are consistent with our predictions. As the county continues to urbanize, it seems likely that the availability of roosts favored by bats will decrease, potentially leading to a decline or shift in the bat population.

Summer Roost Selection of the Forest Bat Community in the Pocomoke River Watershed, Maryland

Dana L. Limpert[1] and Dixie L. Bounds[2]

[1]Maryland Dept. of Natural Resources, Annapolis, MD [2]University of Maryland Eastern Shore, Princess Anne, MD

Temperate forest bats occupy an important ecological niche as the primary predator of nocturnal flying insects, including many agricultural and garden pests. Yet bats remain one of the least understood mammal groups due to their secretive natures. Concern about declining populations has led researchers to investigate roost selection of many bat species. Few studies have focused on bat selection of natural tree roosts, particularly in the mid-Atlantic states. Radio-transmitters light enough for tracking small insectivorous bats now provide opportunities for biologists to determine the microhabitat and macrohabitat features that bats select when choosing roost trees. Knowledge of these features is critical in understanding how bat habitat needs can be incorporated in conservation plans. This study focuses on using radio telemetry to locate, describe, and quantify summer roost selection at three spatial scales: individual roost tree, forest patch, and landscape using ArcView GIS. In addition, bat roost data will be tested against Geographic Analysis Program (GAP) vertebrate models to determine if habitat needs of more detectable taxa such as birds, reptiles and amphibians can be used to predict the presence of suitable bat roosting habitat. In 1999, 49 bats of 4 species were captured on 24 nights of mist netting. *Lasiurus borealis* was the most common species captured (n=30) followed by *Eptesicus fuscus* (n=11), *Nycticeus humeralis* (n=7) and *Myotis austroriparius* (n=1). Thirteen bats were radiotagged (7 *Lasiurus borealis*, 4 *Eptesicus fuscus*, 2 *Nycticeus humeralis*) and tracked to 17 roosts (16 trees, 1 building). Tree roost characteristics and first year results will be presented.

Predicting Frequency Effects on the Zone of Reception for the Anabat II Bat Detector

Kimberly J. Livengood and Ronald D. Drobney, University of Missouri, Columbia, MO

Anabat bat detectors are becoming a widely used and a valuable tool in bat surveys. The Anabat detector records bat species differentially based on their call characteristics. Some of the factors that affect call detectability include call frequency and intensity, as well as atmospheric attenuation. During the pilot year of this study, we evaluated how changes in frequency alter the shape of the zone of reception. Frequencies were chosen close to logarithmic octaves (41

kHz and 75 kHz) and were tested at a set intensity. We found that the volume of spatial reception changes with frequency. Defining the area of detection for different species of bats will improve the utility of Annabel surveys and provide a frame of reference to compare the activity of different species.

Mercury Levels in Arkansas Bats from Areas Under Fish Consumption Advisories

Steve A. Massa and Richard S. Grippo. Arkansas State University, State University, Arkansas

There is currently great concern about the accumulation of mercury in wildlife, where it may cause neurological and reproductive impairment. It is thought that methylmercury is taken up by aquatic invertebrates from sediment and then bioaccumulates in the food chain, reaching dangerously high levels in top aquatic predators. Forty states have advisories against consuming fish from certain lakes and rivers. Arkansas has advisories against consumption of predatory fish in 13 counties, mainly in the southern and west/central parts of the state. Bats are widely ranging top predators and, because their food items are exposed to many different contaminants, make excellent environmental sentinel species. It is likely that bats consume many of the flying adult stages of the larval aquatic macroinvertebrates consumed by fish. We tested the hypothesis that insectivorous bats from areas under fish consumption advisories for mercury will also contain elevated levels of mercury in their body tissues compared to non-advisory areas. We collected 20 bats from each of two areas of AR under advisories (west/ central region in the Ouachita Mountains. and the south/central region in Felsenthal National Wildlife Refuge) and 20 bats from non-advisory reference areas (White and Cache rivers in northeast AR). Bats were captured by mist-netting or from maternity roosts. Pectoral muscles, kidneys, liver, brain and in some cases fur were removed for determination of mercury levels by cold vapor atomic fluorescence. We found that bats from the Felsenthal region had statistically higher levels of mercury than animals from the Ouachita region and northeast reference region. Young-of-the-year(YOY) bats and juveniles had significantly lower levels of mercury than adults. Two bats had tissue levels that exceeded the hazard criteria set by the U.S.F.W.S and six of the nine bats tested for Hg in fur also exceeded this criteria. Our results indicate that mercury levels in bats are significantly elevated in some of the same areas in which this metal is elevated in fish. Low levels in YOY and juvenile animals suggests mercury elevation occurs after switching to an insectivorous diet. We conclude that mercury accumulation in bats is a significant problem in AR and that further research is warranted.

Insect Harvesting Behavior of Mexican Free-tailed Bats at High Altitiudes

Gary F. McCracken[1], Ya-Fu Lee[1], John K. Westbrook[1], Ben B. Balsley[2], and [3]Michael L. Jensen
[1]Univ. Tennessee, Knoxville, TN, [2]USDA ,College Station, TX: and [3]Univ. Colorado, Boulder, CO.

Mexican free-tailed bats flying at altitudes of 200 to 1200 m above ground level (AGL) scan their environment using long (ca. 20 ms), low frequency (ca. 20 kHz), CF calls that are emitted at a leisurely rate; often less that one call every 350 ms. These echolocation call features differ from those reported for Mexican free-tailed bats at ground-level, and these call features seem well suited for detecting insects at long distances in an obstacle-free environment. Although obstacle-free, the airspace at several hundred meters over central Texas is not insect-free. During periods of insect pest migrations, USDA entomological radars have detected corn earworm-sized insects at altitudes of 200 to 800 m AGL, and at densities of over 1,000 insects/million cubic meters of airspace (i.e. 1 insect per cube of airspace 10 m on a side). Assuming that the insects are evenly distributed at these densities, that a Mexican free-tailed bat flies at speed of 50 km/hr, and (conservatively) that the bat can detect an insect at a distance of 5 m, we calculate that a randomly searching free-tailed bat would encounter an insect approximately every 3 sec. Approximately 10 g of corn earworm-sized insects (1 corn earworm = ca. 250 mg), or more than the bat's daily energy needs, would be encountered every 2 minutes. That high levels of foraging activity and insect harvesting by Mexican free-tailed bats are realized is demonstrated by the high altitude recordings of their echolocation calls. Radiomicrophone detectors suspended from kites have recorded over 1000 search phase calls/minute, and over 10 feeding buzzes/minute, at altitudes of 400 to 600 m AGL.

Use of Bridges by *Corynorhinus rafinesquii* and other Bats in North Carolina's Coastal Plain

Jo McDonnell and Mary K. Clark. N. C. State University and N. C. State Museum of Natural Sciences

During the summers of 1997 and 1998, 977 bridges were surveyed for bats in 27 counties in the Coastal Plain of North Carolina. The goals of this survey were threefold: (1) to gather better information on the distribution of *Corynorhinus rafinesquii* , a species that is listed as threatened in the state and as a Species-at-Risk federally, (2) to learn more about the extent that bats use bridges in N.C. and (3) to gather quantitative information about preferences for bridge-roosting bats. Eight types of bridge structures are found in the region: channel beam, T-beam, slab, concrete multi-beam, steel multi-beam, timber multi-beam, concrete box culvert and pipe culvert. A random sample of each of these bridge types was selected and each bridge was surveyed for bat presence. Information recorded for each bridge included bridge structure and age, average daily traffic, degree of disturbance under the bridge, substrate under the bridge and habitat variables. Several new county records were obtained for *C. rafinesquii* , which was found in 12 of the 27 counties surveyed. Eighty-two bridges in the study were occupied by bats (primarily *C. rafinesquii, Myotis austroparius* and *Pipistrellus subflavus*) and 53 had significant amounts of guano and staining indicating previous use by bats. A generalized linear model was developed with a response variable equal to 1 or 0 (presence or absence of bats). Structure type was the only variable that was significant in bridge choice by bats ($p<5$). With the exception of slab bridges bats used every structure type, but they were most often observed under channel beam bridges.

Integrating Physiological Ecology into the Evolutionary Synthesis: Conversion of Typological to Populational Thinking and Implications for Sample Size

Brian K. McNab. University of Florida, Gainesville, FL

Estimates of the basal rate of metabolism of pigeons and flying foxes obtained from repeated measurements of individuals are compared to those obtained from pooling data within a species. The range in individual basal rates within a species increases by 1-2 % with each individual added. Individual estimates of basal rate are usually within 9 % of each other when four individuals are used. The range in individual basal rates increases with a decrease in the number of measurements made on an individual. The mean of individual basal rates is within 1 % of the basal rate obtained from pooling all measurements when sample size per individual is more than 5 measurements. Repeated measurements on a single individual is usually a good estimate of the basal rate of a species or population as long as the number of measurements is greater than 5, although 10 or more measurements would be preferred. The calculation of individual estimates of basal rate gives information on the degree to which inter-individual variation in this parameter exists, selection for which presumably is the basis for the evolution of basal rate of metabolism. This analysis should apply to all physiological characters.

A Comparison of Bat Activity Above and Below the Forest Canopy

M.A. Menzel[1], J. M. Maness[1], G.F. McCracken[2] , J.W. Edwards[1] , and B.R. Chapman[3]

[1] Div. of Forestry, Morgantown, WV , [2]Univ. of Tennessee, Knoxville, TN, [3]Univ. of Georgia, Athens, GA

We surveyed the vertical distribution of bat activity in the southeastern United States using radiomicrophone ultrasonic detectors to sample bat echolocation calls above and below the forest canopy. During the spring of 1999, a total of 712 calls and 47 feeding buzzes were recorded at 4 sampling heights: 2, 10, 30, and 50 m above ground level (AGL). On a single night, bat activity also was monitored over a pasture at heights of 40, 80, 120, and 160 m AGL. Most flight activity was detected below the forest canopy, however, substantial levels of bat activity including feeding buzzes were also detected above the forest canopy to altitudes of 160 m. Call sequences were classified into 4 species groups based on mean call frequency; low frequency (18-26 kHz), medium low frequency (27-30 kHz), medium high frequency (34-38 kHz), and high frequency (39-45 kHz). The relative activity level of each species group differed among 3 of the 4 height classes. These data demonstrate that bats forage above the forest canopy in the eastern United States and that patterns of bat activity may differ even in a single habitat type depending on the height at which bat detectors are placed. Surveys using bat detectors deployed at a single height to monitor the effects of forest management practices on the distribution and activity of bats may provide incomplete or inaccurate estimates.

Short-term Response of Townsend's Big-eared Bat *Corynorhinus townsendii* Maternity Colony to Wildfire

Markus Mika[1], Richard E. Sherwin[2], and Dave Stricklan[3]
[1]Brigham Young Univ., Provo, UT, [2]Univ.New Mexico, Albuquerque, NM, and [3]USFS, Provo, UT 84602

As part of a study funded by the U.S. Forest Service investigating the habitat affinities of Townsend's Big-eared bats in Utah the Cherry Creek mine complex was identified as significant habitat. Almost all of the 56 mines in this complex (31 shafts and 25 adits) were used by Townsend's Big-eared bats. Three of the mines were maternity roosts used by one maternity colony in succession during a given summer. The last maternity roost was occupied after the young were able to fly and forage on their own (early August). The rest of the mines served as bachelor colonies and/or hibernation sites. In late June 1996, the 'Little Sahara' wild fire burned 46,000 acres in Tooele and Juab counties consuming 75% of all vegetation surrounding the Cherry Creek mine complex. The maternity roost used by approximately 150 mature females at the time of the fire collapsed because of the burning of support timber around the collar. The mine was completely plugged with debris at a depth of 3.5 meters. In addition to the maternity roost two other shafts and three adits collapsed. No bats were observed in the mine complex during surveys conducted immediately following the fire. The following winter the bats returned and the mine use was similar to the year preceding the fire. In the summer of 1997 the maternity colony returned to the area and became established at a site previously unused by this species, but adjacent (40 m) to the collapsed maternity roost. In early August the colony moved out of tracking distance (>10 km) avoiding any possible roost site in the area until dispersal. The maternity colony returned again in 1998. This indicates the effects of the fire may have limited necessary resources to support the maternity colony around the Cherry Creek mine complex in late summer.

Do Visitations Always Lead to Probing? The Pollination of *Heterophragma quadriloculare* by Bats

Shahroukh Mistry, Bryn Mawr College, Bryn Mawr, PA

Bats are known to visit hundreds of plant species for nectar, pollen and fruit. Their role as pollinators and seed dispersers has been well documented. In India, just the three common species of fruit bats (*Cynopterus sphinx*, *Rousettus leschanaulti* and *Pteropus giganteus*) visit 114 species of plants, of which over 24 are visited for their nectar and/or pollen. However, flower visitation does not necessarily mean pollination, and only a handful of studies have been conducted to determine if bats effectively pollinate the flowers that they visit. This study examines the pollination biology of a Bignoniaceae tree, *Heterophragma quadriloculare*, by *Rousettus leschanaulti* to determine the effectiveness of this bat as a pollinator. Heterophragma flowers were self-and out-crossed to determine self-compatability. The fruitset and seedset of hand-pollinated flowers was then compared to that of flowers pollinated by bats. Bat-pollinated flowers exhibited significantly lower fruitset than hand-pollinated flowers, however this value may an underestimate of true bat pollination. Of the fruits that were set by bats, the length of the fruits did not differ from hand-pollinated plants, while the weights were actually higher than hand-pollinated of the fruits. The number of seeds per fruit was also not significantly different between bat and hand-pollination, suggesting that these bats are actually quite effective in the pollination of Heterophragma.

Geographic and Non-geographic Variatio in the Echolocation Calls of Bats in the Genus *Myotis*: A Preliminary Analysis

Kevin L. Murray, John S. Heywood, and Lynn W. Robbins. Southwest Missouri State University, Springfield, MO

Variation in the echolocation call structure of bats from different geographic locations is one potential limitation to the use of ultrasonic detectors in identifying bat species. Unfortunately, the effects of geographic variation on the echolocation call structure of most species remains unknown, making it difficult to estimate the effect on species identification. To assess geographic variation, as well as variation within and among individuals, echolocation call parameters of two species of Myotis from two separate geographic locations were examined. Calls were recorded with an Anabat detector and software directly to a laptop computer and call parameters were calculated by Analook software. *For Myotis lucifugus*, mean call duration, maximum frequency, and minimum frequency differed by I ms, 0.2 kHz, and 1.6 kHz respectively, between geographic locations. For *Myotis grisescens*, the same call parameters differed by 1.3 ms, 3.7 kHz, and 1.5 kHz. A nested ANOVA was performed on each of ten call parameters and resulting

variance components showed that variation within individuals was usually the most common source of variation. Variation due to geographic location was highest for call duration and related time components (17.15%-46.44%). Various frequency components also varied due to geographic location, but to a lesser extent (0%-35.72%). As a direct test of the effect of geographic variation on species identification, calls of each species from both geographic locations were identified by a Discriminate Function Analysis model based on echolocation calls obtained exclusively in Missouri. Geographic variation did not appear to affect species identification, as accuracy rates were comparable for calls from both geographic locations.

Variations in Diet of the Endangered Indiana Bat *Myotis sodalis*

Susan W. Murray[1] and Allen Kurta[2]

[1]Boston University, Boston, MA and [2]Eastern Michigan University, Ypsilanti, MI

Knowledge of an animal's physical and behavioral adaptations for finding, capturing, and consuming prey is essential to help elucidate predator-prey interactions, evolutionary relationships, and partitioning of feeding resources. However, an animal's foraging biology cannot be fully understood without detailed information on its diet. In this study, I examined the diet of the endangered Indiana bat, Myotis sodalis, in southeastern Michigan. Fecal pellets were collected from beneath maternity roosts and grouped into weekly samples from late May to early August 1997 and 1998. On select nights during 1997, pellets also were collected at different times of night to determine if diet differed within a night. Overall diet included 12 arthropod orders, but was dominated by 5 insect orders: Coleoptera (17.4% volume), Diptera (32.9%), Hymenoptera (9.8%), Lepidoptera (22.8%), and Trichoptera (13.3%). Diet differed significantly between summers, across each summer, between pregnancy and lactation, and within nights. In addition, results of the present study were intermediate between another Michigan study and studies from Indiana and Missouri, suggesting that regional differences do not exist; rather, the diet is a continuum across the species range.

Sugar Concentration Preferences of Two Species of Blossom Bats *Syconycteris australis* and *Macroglossus minimus* in Papua New Guinea.

Suzanne L. Nelson, University of Florida, Gainesville, Florida

Syconycteris australis, a feeding generalist, and *Macroglossus minimus*, a nectar specialist, are morphologically similar and coexist in the lowlands of Madang, Papua New Guinea. This study was designed to characterize the feeding preferences and differences between these two species through captive preference tests with honey solutions of differing concentrations. Five *Macroglossus minimus* and eighteen *Syconycteris australis* bats were presented with a choice of either 15% "nectar" (in sucrose equivalents) or 30% nectar in the first trial and a choice between 15% nectar and 7% nectar in the second trial. Overall, the 15% nectar solution was slightly preferred over 30% (55% preference), but highly preferred over 7% nectar (68%). Also, *Syconycteris australis* consumed more volume of nectar per feeding than Macroglossus minimus, and females of both species consumed more than males. Next, I attempted to describe the nectar concentrations that were available to the blossom bats from their preferred food, domesticated banana flowers (*Musa* spp.). All-night monitoring of 20 banana flowers revealed a similar pattern of nectar concentrations of proximate plants, which favors a trap-lining foraging pattern in these blossom bats. Nectar concentrations ranged from 5- 23% sucrose, and varied intra-specifically in their sucrose concentration. Blossom bats in New Guinea appear to subsist on relatively low nectar concentrations due to their low metabolic rates and their tendency to enter torpor when they are energy stressed (Bonaccorso and McNab 1997). *Syconycteris australis* may consume more nectar volume per night and feed more generally due to its higher metabolic rate, as compared to *Macroglossus minimus*.

Nectar Feeding Performance in *Glossophaga soricina*

C.W. Nicolay[1] , E.R. Dumont[1] and Y. Winter[2]

[1]NEOUCOM, Rootstown OH and [2]Erlangen University, Germany

Experiments were conducted to quantify the effect of feeder shape on nectar feeding performance for Glossophaga soricina soricina (Phyllostomidae: Glossophaginae). Rate of nectar extraction (g/s) was chosen as the measure of performance. Rate of nectar extraction may be subject to natural selection in the wild, because it is likely associated with the number of flowers a bat can visit per unit of time and the risk of predation at a flower. The study sample consisted of (n=6) individuals housed at Erlangen University. Six feeders with clear plastic corollas of three lengths (20, 30, 40mm) and two diameters (18, 26mm) were introduced to each bat in the study. A large nectar (17% sugar

water) reservoir ensured that the level of nectar in the corolla changed minimally over the experimental period and provided the bat with an unlimited supply of nectar per visit. The feeders were placed on a digital balance connected to a computer to record the mass of nectar taken per visit. The duration of each visit (ms) was measured by the interruption of a light beam positioned at the front edge of the corolla. A swinging curtain limited visitation by the bats to allow balance readings to stabilize between visits. Before the experiments, bats were allowed access to honey-water in the feeder until they had fed for at least one hour. This reduced the effect of hunger on feeding performance and helped the bats locate the nectar supply. Bats were then allowed access to each feeder for a minimum of one hour, which could be continued until 30 visits occurred. Across all feeders, the average visit lasted 0.8 (±0.033 SE) seconds and 0.068 (±0.0062 SE) grams of nectar were consumed. Wilcoxon matched-pairs tests using mean values for each individual at each feeder demonstrated significant differences in feeding performance among feeder lengths, but not feeder diameters. Rate of nectar extraction was greater at 20mm than 30mm ($Z=2.85$, $p=0.016$) and at 30mm compared to 40mm ($Z=2.19$, $p=0.028$). Rate was not significantly different between the two diameters ($Z=1.293$, $p=0.196$), indicating that the diameter of the narrow feeder was not small enough to inhibit feeding performance. The results indicate that flower dimensions, especially length, do have the potential to affect feeding performance in *Glossophaga soricina*.

Contribution of Acoustic Methods to the Study of Insectivorous Bat Diversity in Protected Areas from Northern Venezuela

Jose Ochoa-G[1]., Michael J. O'Farrell[2] and Bruce W. Miller[3]

[1]AsociaciÛn Venezolana para la ConservaciÛn de ¡reas Naturales, Caracas 1063-A, Venezuela

[2]O'Farrell Biological Consulting, Las Vegas, NV, and [3]Wildlife Conservation Society, Bronx, NY

We present the results of an acoustic survey of insectivorous bats conducted in four protected areas from northern Venezuela (Andean Mountains and coastal region). These areas represent the group of localities in this country with relatively high levels of information on taxonomic composition of bat communities. Field surveys were conducted using the Anabat II detector and analysis system. Acoustic inventories were compared with previous lists obtained with conventional sampling methods (principally mist nets). Twenty species were identified acoustically (grouped in 16 genera of the families Emballonuridae, Noctilionidae, Mormoopidae, Vespertilionidae, and Molossidae) on the basis of vocal signatures verified by capture and subsequent recordation of released animals or comparison of verified vocalizations from other localities. An additional 15 morpho-acoustic species were proposed based on call structure similarities to known species. At three of the localities, the number of species detected by acoustic surveys was higher than previous lists recorded using conventional methods. A range of 5-17 species were added to previous inventories at all localities, with Emballonuridae, Vespertilionidae and Molossidae showing the most important contributions. We demonstrate the importance of acoustic methods as a supplementary tool for field inventories of Neotropical bat communities, in addition to the study of distributional and ecological patterns of free-flying insectivorous species.

Are the Species in the Feces?

Pat Ormsbee and Jan Zinck, U.S. Forest Service Portland State University Eugene, OR

Completing surveys to determine species and numbers of bats can be problematic and eluding for the captor, and intrusive to bats. Developing survey methods that minimize the need to capture and handle bats could be beneficial to investigators and bats alike. We are investigating the possibility of identifying species-specific genetic markers using DNA extracted from guano, with wing-biopsy derived DNA serving as a standard to confirm the isolation of bat DNA from all other DNA present in guano. We captured different species of bats at 4 sites in Oregon and Washington using mist nets, harp traps, or hand nets. Each bat was identified to species and held in an individual container approximately 10 minutes to collect guano. We sampled a 3 mm wing punch from each bat prior to release. Wing and guano samples were collected and stored under standard field conditions, no special treatments, such as refrigeration, were used. We ran simultaneous experiments on DNA extracted from wing biopsies and from guano. Extracted DNA was amplified by polymerase chain reaction (PCR) using mitochondrial primers. Restriction fragment length polymorphism (RFLP) analysis of the PCR product was used to confirm the isolation of bat DNA from guano as compared to the wing biopsy standard.

The Effects of Fire and Logging on Forest Dwelling Bats

Krista Patriquin-Meldrum, University of Calgary, Calgary, Alberta.

Bats inhabiting Canada are primarily dependent on forests for both roosting and foraging habitat. Disturbances such as forest fire and logging clearly affect habitat availability to forest dwelling bats. Several studies are currently aiming to establish a harvesting regime that will minimize the impacts of logging on the ecosystem. Among these studies is EMEND (Ecosystem Management by Emulating Natural Disturbance) which affords researchers the opportunity to investigate the impacts of various logging treatments on a diverse array of organisms. The overall objective of this study is to determine whether a harvesting regime can mimic a natural disturbance, namely fire. This is based on the premise that organisms within an ecosystem are adapted to disturbances historical to the area. The EMEND study area is located in northwestern Alberta (5°40'N 11°W), and it encompasses several cover types, all of which are pyrogenic in nature. During the summer of 1999, I tested several predictions pertaining to the effects of logging on the foraging behaviour of bats in the area. I measured foraging activity with AnabatII detectors in three cover types (conifer dominant, aspen dominant, and aspen/conifer mixedwood). Within each of the three stand types I sampled the edge and centre of four harvesting treatment compartments (clearcut, 20 and 50% retention, and control). As little is known of bats in more northern ranges, I also captured bats using mist nets and harp traps to determine which species inhabit the area. In addition, I assessed reproductive condition of females. Overall activity was low throughout the season and females caught in the area did not show any evidence of reproducing. This may be attributed to unfavourable weather this summer as evenings were rarely above 10∞C and there was often some precipitation. As expected, in all stand types, more passes were detected along the edge of clearcuts than in the centre. In addition to 2 *Myotis septentrionalis* and 1 *Lasionycteris noctivagans*, the majority (20 of 23) of individuals caught were *M. lucifugus*. To determine whether any of the above mentioned treatments can mimic a natural disturbance, fire treatments are currently in progress. I will then be able to measure foraging activity in the burn treatments and compare them to harvest treatments.

Foraging Ecology of an Old World Leafnosed Bat, *Hipposideros speoris*

Chris Pavey[1], Jan Grunwald [1], Chris Burwell[2]

[1]Zoology Institute, University of Munich, Germany and [2]Queensland Museum, South Brisbane, Australia

We studied the foraging ecology of *Hipposideros speoris*, a medium-sized (forearm 45.6-54 mm; mass 9-14.5 g) Old World leafnosed bat (Hipposideridae) at Sigiriya, central Sri Lanka. Our aim was to determine how the species foraged within a human-modified landscape that included rainforest, agricultural land, human settlement, and the grounds of a major tourist site. The study colony of >1000 individuals roosted in two small caves at the base of Sigiriya Rock. We attached radio transmitters to 8 bats (5 adult males, 3 lactating females) and tracked them for a total of 17 bat nights (including >36 h of foraging) and observed foraging by unmarked bats on 18 nights. Radio-tagged *H. speoris* left their roosts at or just before sunset and foraged within 2 km of the roosts. These bats spent on average 165 mins (range 69-242 mins) foraging per night with peaks of activity within 2 h of sunset and within 3 h of sunrise. Radio-tagged and unmarked bats foraged in continuous flight and captured prey by aerial pursuit. Foraging bats used relatively long duration echolocation calls (mean of 6.87 secs) consisting of a constant frequency component followed by a shorter, downward frequency-modulated component. A wide range of habitats were occupied by foraging bats including continuous forest, isolated groups of trees and patches of forest, parkland, and the space above water bodies (streams, large ponds). We did not record bats foraging over agricultural fields. Foraging bats usually flew within 50 cm of surfaces such as foliage or water, but were not observed to glean prey. We identified nine insect orders and spiders among faeces (n = 20 pellets) and prey remains (n = 103) of the study colony, with beetles being the main prey item. Our results indicate that *H. speoris* is flexible in its use of foraging habitat and can successfully forage in human-modified landscapes. These observations explain why the species continues to be common in Sri Lanka despite the huge amount of deforestation that has occurred on the island over the past 70 years. In contrast, the closely related horseshoe bat, *Rhinolophus rouxi*, which is dependent on areas of continuous forest, has undergone a decline in population size.

Is This My Bridge? A Study of Night Roost Fidelity on the Willamette National Forest.

Stuart Perlmeter, Echolocation, Inc.

Eight species of bats have been documented to use concrete bridges as night roosts on the Willamette National Forest. These bridges have become important refuges for many of these species during their nightly activity cycle and a convenient location for studying the behavior and ecology of some bat. This presentation will discuss the preliminary results of a study comparing night roost fidelity on three drainages in the Willamette National Forest. Bats were captured at bridges on 3 drainages in the Forest and data was collected on species, gender, age and reproductive condition. Two captures were conducted nightly (01:00 & 04:00) at each bridge to account for temporal differences in species use of the night roosts. Each bat was tagged with a numbered band and released immediately. Levels of night roost fidelity were compared within and across seasons for species, gender and age class. Overall, a total of 637 bats were banded between 1997-1998 and another 83 bats were recaptured at least once following after they were banded. Overall recapture rate in the "same-session/same-season" category across the 2 seasons was 7.5% (n=48). Within this category bats switched night roosts 43.8% of the time and with the exception of one individual, these switches occurred between adjacent bridges. Recapture rates in the "different-session/same-season" category was <2%. Of the 368 individuals banded in 1997, 27 were caught in 1998 for a "between-seasons" recapture rate of 7.3%. All "between-season" recaptures occurred on the drainage where they were initially captured and 92% of these individuals were found at the night roost where they were first captured. Males and females return rates "between-seasons" were not significantly different from the capture rates in 1997. Recapture rates were significantly lower "between-seasons" for juveniles, with only 1 of the 40 juveniles being recaptured in 1998. While it appears that a large number of bats switched roost after they were first banded, adults returning from the previous season showed a high degree of fidelity to bridges where they were first encountered.

The "Flying Primate" Hypothesis Faces the New Millennium

Pettigrew, J.D., VTHRC, University of Queensland 4072 Australia

Despite Twainesque claims to the contrary, the hypothesis is still very much alive, with a number of new lines of support, not to mention the lingering problems with interpretation of the DNA sequence data. Increasing neural data from non-visual systems provide more shared derived primate-megabat and make it increasingly unlikely that such features are the result of convergence, in contrast to the majority of shared microbat-megabat features that can be attributed to flight. A new suite of serum protein epitopes has also provided strong support for "flying primates", to the consternation of the investigator! One important prediction of the "flying primate" hypothesis was that colugos would prove to share a more recent common ancestor with both megabats and primates than with microbats. This prediction has been fulfilled from a number of diverse lines of evidence. Cranio-skeletal, reproductive, endonuclease, behavioural and neural characters all strongly support a megabat-colugo link, to the exclusion of the microbats, while new molecular data have increased the older immunological support for a primate-colugo link. Despite the molecular support for the primate-colugo link, DNA data fail to link megabats either to primates or to colugos. This anomaly may be related to the extreme modifications of the megabat genome, such as its much reduced size and extreme A+T bias. These changes make the megabat genome unique among vertebrates and may also make the recognition of homology difficult. I will conclude with a comparison between the bat controversy and three notable cases where DNA analysis led to conflicting phylogenies and irreconcilable problems of interpretation (*Dictyostelium, Amphioxus, Plasmodium*). The conflicts could not be settled by the DNA data themselves, even though orders of magnitude more DNA sequence data had been collected compared with the comparatively small amount of DNA sequence data so far available on the bat problem. Significantly, in all three cases, resolution required, or may in future require (Plasmodium), insights from other sources outside the DNA data themselves. If this also proves true for the bats, the "flying primate" hypothesis may yet emerge a clear winner in the new milennium, both in heuristics and parsimony.

Taxonomy of *Myotis occultus* Inferred from Sequences of Two Mitochondrial Genes

Antoinette J. Piaggio[1], Ernest W. Valdez[2], Michael A. Bogan[2], and Greg S. Spicer[1]

[1]San Francisco State University, San Francisco, CA

[2]U.S.G.S Mid-continent Ecological Science Center, University of New Mexico, Albuquerque, NM

The taxonomic status of *Myotis lucifugus carissima* and *M. occultus* has been revised several times. *M. occultus* was first described as a distinct species and supported as such by some authors. Currently, *M. occultus* is recognized as

a subspecies *of M. lucifugus*, based on electrophoretic data. Our objective was to resolve the phylogenetic relationships of these two taxa using direct sequencing techniques. We sequenced the mitochondrial cytochrome*b* (cyt b) and cytochrome oxidase II (COII) genes of specimens from the previous electrophoretic study, and specimens of *M. yumanensis* and *M. velifer* as outgroups. Our results indicate that *M. occultus* and *M. lucifugus* are genetically distinct from each other. Therefore, we suggest that *Myotis occultus* be regarded as a distinct species.

The Western Red Bat, *Lasiurus blossevillii* - Implications of Distribution for Conservation.

Elizabeth D. Pierson[1] , William E. Rainey[2] and Chris J. Corben[3]

[1]2556 Hilgard Ave., Berkeley, CA, [2]Univ. of California-Berkeley, Berkeley CA,[3]PO Box 2323, Rohnert Park, CA 94927 3

The range of *Lasiurus blossevillii* includes much of western North America, but museum records suggest distribution is extremely patchy. The only areas with multiple localities for breeding females are California river valleys west of the Sierra Nevada crest, particularly the large Central Valley. Our study has added multiple new localities in California and is consistent with prior records in documenting a summer association with lower elevation broadleaf trees - large diameter, riparian cottonwoods and sycamores, and older orchards (particularly walnut). Using primarily acoustic techniques, we obtained substantially more red bat activity (at emergence and throughout the foraging period) in areas with high quality riparian habitat (mature tree stands, extending >50 m back from the river) than in areas with less extensive or degraded habitat. More than 90% of California riparian forests have been lost to agricultural conversion or water retention projects, so that - along with other better studied riparian vertebrates - populations of western red bats have likely declined over the last century. Mature orchards with dense canopies offer alternative roosting and possibly foraging habitat. However, some of these crops are frequently sprayed with pesticides, and the direct and indirect effects on red bats are unknown. Our results suggest that riparian restoration projects that reinstate naturalistic flood regimes and foster regeneration of cottonwood and sycamore would benefit this species. Assessing the status of non-colonial, foliage roosting bat species is challenging, but examining seasonal patterns of distribution and association with habitat features that may be remotely identified, offer ways to delineate, monitor, and possibly protect populations.

Roosting Ecology in Naturally Disturbed Habitats in the Central Interior of British Columbia, Canada

Jennifer M. Psyllakis, University of Regina

I will present preliminary results of an investigation of bat roosting ecology in naturally disturbed habitats in the central interior of British Columbia, Canada. Current forestry management practices in British Columbia have moved towards harvesting regimes which mimic natural regimes (e.g., fire). The theory behind this practice is that the flora and fauna of a region will have adapted to these disturbances and the landscapes that are left behind. Therefore, understanding the ecology of bats within the context of natural landscape disturbances is necessary in order to effectively incorporate their management needs into forest harvesting prescriptions. My study focuses on the role and value of remnant, isolated forest patches left behind by a wildfire as compared to continuous forests in both riparian and upland stands. I am collecting relative abundance data using Anabat II detectors as well as roost tree characteristics from radio tagged female *Myotis lucifugus* and *M. volans*. Roost trees located thus far have been in older (greater than 120 years) continuous stands under exfoliating lodgepole pine bark (*Pinus contorta* var. *latifolia*), in cracks and cavities of aspen (*Populus tremuloides*) and in a single standing remnant black *cottonwood (Populus trichocarpa*).

Movement of Gray Bat, *Myotis grisescens*, in and around Pittsburg, Kansas as determined by Radio Telemetry

Barry M. Rabe, Scott M. Robertson and Lynn W. Robbins. Southwest Missouri State University, Springfield, MO

Pittsburg, Kansas, has one of the only known populations of gray bats, *Myotis grisescens*, to inhabit a man made structure, and the only breeding population of gray bats in Kansas. For this reason, a study of the status, population characteristics and critical habitat was initiated in 1998. As part of this study, radio tags were attached to six gray bats

to determine critical foraging habitat. Habitat near Pittsburg varies from rural riparian to urban parks and ponds and reclaimed strip mine ponds. Radio tracking allowed estimates of home range which varied from 2.07 to 11.53 square kilometers. An adult female used the largest area, with male territories varying from 2.07 to 4.88 square kilometers. Maximum distance from roost was found to be greatest for a juvenile female that flew to a point 14 km. from the roost in 28 minutes. Activity periods ranged from 48 minutes to 3 hours and 45 minutes. In comparison, a gray bat was radio tagged at an urban cave in Springfield Missouri. Habitat used included urban ponds, open storm drainage areas, and neighborhoods with mature trees. Distance traveled and size of range was intermediate compared to the Kansas bats.

Mechanisms of Sticking Employed by Spix's Disk-winged Bat *Thyroptera tricolor*

Daniel K. Riskin, York University, North York, Ontario

I measured the ability of 31 disk-winged bats *Thyroptera tricolor* to adhere to four different substrates. The substrates were: sandpaper, Plexiglas, sheet metal, and sheet metal with small holes. Analysis of performance supports the widely held hypothesis from microanatomical studies that these bats adhere by suction. I also detected the use of wet adhesion which is used by other tetrapods such as tree frogs, but which has not been described for bats. *T. tricolor* sometimes used its thumb claws to cling to sandpaper and sheet metal with holes. I compared the sticking ability of *T. tricolor* with those of bats from 14 other species that lacked prominent disks (Emballonuridae: 1, Phyllostomidae: 12, Vespertilionidae: 1). None of these bats showed patterns of sticking ability at all similar to those of *T. tricolor*.

Molecular and Morphological Evolution in the Rousettine Bats (Pteropodidae)

Luis A. Ruedas[1] and Juan Carlos Morales[2]

[1]University of New Mexico, Albuquerque, NM and [2]CERC,Columbia University-MC New York, NY

A previously undertaken morphological analysis *of Rousettus amplexicaudatus* and *R. celebensis* (Chiroptera: Pteropodidae) underscored the morphological identity between these two *Rousettus* species. In order to ascertain indubitably the identities of these highly similar bats, as well as to determine the extent of molecular variation within and between the species, we sequenced in toto the 12S rRNA gene of the mtDNA for 19 individuals in 8 taxa of Pteropodidae, as well as two outgroup vespertilionids. The new sequences were integrated with data for the same gene previously published by Mark Springer and co workers (17 individuals in as many taxa). Inclusion of the latter indicates that *Rousettus* as currently understood is paraphyletic: *R. amplexicaudatus* is a basal taxon within the rousettine radiation; *R. celebensis*, in contrast, represents a highly derived genus within the same group. The sister taxon to *R. celebensis* is not another *Rousettus*, but rather a group comprising the unquestioned *genera Megaloglossus, Lissonycteris,* and *Epomophorus*. Based on the molecular data, it is quite likely that *R. celebensis* constitutes a new genus of rousettine bat which has retained the characters plesiomorphic for rousettines. The biogeographic picture derived from our data indicates that the evolutionary origin of pteropodids lies in Asia; that rousettines colonized Africa from Asia; and that *'Rousettus' celebensis* is the remnant of a back-migration from Africa to Asia or, alternatively, could simply be the sedentary representative of the common, albeit Rousettus-like, ancestor to both *'R.' celebensis* and the African clade. As part of this study, we also addressed (based on the same genetic data) the putative subfamilial status of *Harpyionycteris:* we fail to find support for a subfamilial scheme including a monotypic *Harpyionycterinae*.

Phylogeography of the Brazilian Free-tailed Bats *Tadarida brasiliensis mexicana* and *T. b. cynocephala* as determined by mitochondrial DNA sequencing

Amy L. Russell, University of Tennessee, Knoxville, TN

Brazilian free-tailed bats, *Tadarida brasiliensis*, are common throughout the southern United States and Mexico. Within the United States and north-central Mexico, *T. brasiliensis* is presently divided into two subspecies: *T. b. cynocephala* which is located east of Texas to Florida and the Carolinas, and *T. b. mexicana* which is located from Texas west to the Pacific coast and south into Mexico. The main basis for this division is behavioral differences in migration, hibernation, and roosting habits. *T. b. mexicana* generally roosts in caves in colonies of several million individuals and migrates to winter roosts in Mexico. *T. b. cynocephala* roosts primarily in trees and man-made structures in colonies not exceeding several thousand individuals and spends the winter months in hibernation. Because of these differences, *T. b. mexicana and T. b. cynocephala* have been classified as subspecies. Although the putative taxa are not clearly differentiated by morphology, *T. b. cynocephala* is, on average, slightly larger than *T. b. mexicana*

and some authors have suggested that they may warrant recognition as separate species. Studies using both morphological and genetic (allozyme) information have indicated that the taxa may be hybridizing in the area of Texas, Louisiana, and Arkansas. DNA sequence data from a hypervariable region of the mitochondrial DNA d-loop is being collected for individuals from ten locations throughout the American continents. A nested cladistic analysis will test the null hypothesis of no geographical association between haplotypes and a hypothesis of significant geographical association due to either historical events or to restricted gene flow. Possible impacts of the Pleistocene glaciations on the phylogeography of this species will be explored. Although an abundant species, the life history and demography of the Brazilian free-tailed bat make their populations highly vulnerable. In order to intelligently manage this fragile species, we must have a clear understanding of the genetic structuring and phylogeographic interrelationships of their populations.

Indiana Bat *Myotis sodalis* Population Genetic Study

Leslie R. Saidak[1] , Gary F. McCracken[1] , and Robert R. Currie[2]
[1]The University of Tennessee, Knoxville, TN and [2]U.S. Fish and Wildlife Service

Since being listed as an endangered species 32 years ago, populations of Indiana bat *Myotis sodalis* have continued to decline. Despite an overall pattern of decreasing numbers, however, some colonies in hibernacula have remained stable or increased. Because most major hibernacula are now protected, variability in summer foraging and roosting habitat is suspected as the cause of the variable success of hibernaculum colonies. It also has been suggested in the literature that gene flow among Indiana bat hibernacula may be restricted, which could result in detectable partitioning of genetic variation among colonies. Federal, state, and private researchers are cooperating to capture Indiana bats from hibernacula and summer foraging sites for this study. Tissue samples have been obtained from 402 bats from 15 hibernacula and several foraging sites in eight states. Microsatellite DNA markers are being used to characterize the population genetic structure of the species and to possibly associate summer roosting and foraging sites with specific hibernacula. To date a total of 185 individuals have been examined at one to three highly variable loci, comprising about 15% of the potentially available data. Overall observed heterozygosity of all populations examined so far is 0.84, with 16 to 22 alleles per locus. The high variability of the microsatellite markers, coupled with the large sample sizes available for this study, will allow a thorough characterization of the population genetic structure of this species as research continues. Preliminary analyses using data currently available show some evidence for geographical genetic structure.

Web-based Echolocation Call Voucher System: Interactive Session

Timothy Sanchez-Brown, William L. Gannon, and Michael J. Herder.
University of New Mexico, Albuquerque, NM and B.L.M. Arizona Strip Field Office, St. George, UT

The dramatic increase in the use of portable echolocation detectors –particularly Anabat - has underscored the need for the development of an effective call voucher archival and retrieval system. The World Wide Web has offered a vehicle to promote data organization and sharing. We have created a web site to meet the need to allow researchers to post calls and to make those calls available for download and analysis. Here we demonstrate the utility and function of the Southwestern US Bat Call Library (http://talpa.unm.edu/ batcall). Through this site we also urge other bat researchers to donate and use this resource in their analyses. Not only does the Library support call exchange, echolocation software, and ecological information in the form of species accounts, reference citations are also provided. This project was developed to provide a comprehensive, interactive web network where users can exchange information and even ideas for the conservation and long-term survival of bat species. We emphasize the concept of a call voucher, and of call record verification. Future plans include converting the Anabat software package to Windows platform, complete documentation, and live video clips demonstrating the use of different techniques of utilization and analysis.

Winter Roost Selection By Eastern Pipistrelle Bats *Pipistrellus subflavus* In Texas

Sandel, J. K., G. R. Benatar, K. M. Burke, C. W. Walker, T. E. Lacher, and R. L. Honeycutt
Texas A&M University, College Station, TX

In a study designed to determine characteristics associated with winter hibernacula of the eastern pipistrelle (*Pipistrellus subflavus*), microclimate parameters, land-use patterns, and bat densities were recorded and compared

among four study sites. A preliminary survey revealed that the presence of bats in hibernacula varied throughout the year. Population parameters that were associated with seasonal changes in the total number, sex, and degree of roost site fidelity were recorded. Our results suggest that selection of winter hibernacula in temperate regions may not be dependent on microclimate parameters alone. Minimum temperature was the only significant microclimate predictor of bat abundance, and reflects seasonal use of hibernacula during the winter months. Analyses of land-use data revealed a significant correlation between the number of bats present at each roost and the amount of agriculture and forestland surrounding each site. Distance from the culvert opening to forestland was also correlated with the number of bats. Occupancy of hibernacula by *P. subflavus* was greatest for December and January with males consistently appearing in higher ratios than females. Fidelity of bats to hibernacula was highly variable both during and between seasons. Recaptures ranged from 14 to 73% during both seasons with 24% of the bats marked during the first season returning the following year.

Bat Phylogeny: Refinements in the Morphological Perspective

William A. Schutt, Jr.[1,2] and Nancy B. Simmons[1]

[1]American Museum of Natural History, New York, NY and [2]Long Island University, Southampton, NY

Although much recent systematic work has been based on molecular data, analysis of morphology continues to provide considerable insight into bat relationships. Recently published studies of higher-level bat phylogeny by Simmons and her colleagues have provided strong support for monophyly of many traditionally recognized groupings. However, the level of taxonomic sampling in these studies, which used families and subfamilies as the terminal taxa, resulted in significant polymorphism in the data set. Particularly problematic taxa include many of the large and diverse families (e.g., Pteropodidae, Phyllostomidae, Molossidae, and Vespertilionidae). Sampling at the family/subfamily level has also made combining morphological and molecular data sets difficult since in many cases, molecular data are sampled at the species level. To address these problems, we are assembling a new morphological data set designed to test higher-level bat relationships using multiple species-level exemplars. Taxa have been chosen so as to insure availability of morphological specimens (i.e., skins, skulls, and fluid-preserved specimens) and tissue samples from the same species. Our data set presently includes over 350 morphological characters sampled, as far as possible, in over 50 species representing all chiropteran families. Characters have been drawn from multiple anatomical systems including the musculoskeletal system, tongue, face and ears, pelage and patagia, reproductive tract, respiratory and digestive systems, and brain. Preliminary phylogenetic results are broadly congruent with previous studies, with some interesting exceptions. Future work on this project will include addition of data from more species, filling in data gaps in many hard-to-study anatomical systems, and investigation of new characters. In collaboration with the Van Den Bussche lab, we are also working to analyze our morphological data in the context of combined analysis with molecular sequence data from the same species.

Mechanisms of Coexistence and the Oragnization of a Philippine Microchiropteran Community

Jodi L. Sedlock, University of Illinois at Chicago, Chicago, IL

A mechanism of coexistence approach was used to investigate the organization of a Philippine insectivorous bat community. By identifying axes of environmental heterogeneity and potential ecological trade-offs that may promote the coexistence of species along that axis, a mechanism of coexistence approach provides a systematic framework for hypothesis testing. Additionally, this approach results in data that have direct implications for the monitoring and management of bat communities, rather than individual species. I investigated three potential mechanisms that may work to promote local insect-bat diversity on Mt. Makiling, namely: habitat selection in a mosaic, temporal variation in insect abundance and spatial variation in insect abundance. These mechanisms were tested by monitoring bat and insect activity along transects in three distinct and adjacent habitat types (forest, agro-forest and creek), during three time intervals over the course of 69 nights. Bat activity was monitored with an Annabat II bat detector. The calls of the species present were determined by capturing bats in either mist nets, a harp trap or using a new method I have developed - a tunnel trap, and then recorded upon release. The Rhinolophids and Vespertillionids recorded seem to separate along axes of habitat structure, the former being found in more closed habitats than the later, and along an axes of spatial variation in insect abundance, Vespertillionids taking advantage of areas of higher spatial variance than Rhinolophids. Within the Rhinolophids, larger species such as *Hipposideros diadema* were more likely to forage in

more open habitats than smaller species. Within the Vespertillionds, species seemed to separate along axis of temporal and spatial insect abundance. For example, *Myotis horsfieldii* takes advantage of times (i.e. early evening) and places of high insect abundance, whereas the smaller *Myotis muricola* seems to forage efficiently during times and in places of relatively low insect abundance. Identifying the axes of variation in the environment that promote the coexistence of species may allow us to better understand species declines and assess the impact of environmental change on particular species before population declines can get underway.

Oral Microbiota of Bats

Jenise Segarra Desoto, Rafael Vazquez Torres, and Armando Rodrìguez- Duran,
Interamerican University, Bayamon, P.R

Bats possess a diverse array of salivary chemistries that are associated variation in dietary habits. These differences in oral pH may influence mycotic flora. Previous studies have identified fungi of the *genera Candida, Trichosporon, Torulopsis, Kluyveromyces* and *Geotrichum* associated with bats. We examined *six Artibeus jamaicensis* (frugivorous) and six *Pteronotus parnellii* (insectivorous) captured at Cueva Bonita, Puerto Rico. A sample from the mouth was obtained using a sterile swab, which we proceeded to place in a test tube with sterile saline solution at 0.85%. We prepared two dilutions (1ml) and (0.1ml) of the sample, which were inoculated in Potato Dextrose Agar (PDA), incubated at 30oC for one week, and counted. Each species of yeast and mold was purified in a petri-dish with PDA and identified with a battery 30 chemical tests. The pH of each bat's saliva was determined using mikro.pHyrion paper ranging from 0.0 to 6.0. Molds were identified using taxonomic keys by microscopic examination on trypan-blue wet mounts and Analytical Profile Index (API) yeast 20. *Penicillium, Aspergillus, Aerobacillium, Curvularia, Dreshlera* and *Serratia marcescens* were isolated from the mouth of *Pteronotus parnellii* (pH 4.5 ± 0.1). *Penicillium spp., Enterobacter aerogenes, Corynebacterium* and *Klebsiella pneumoniae* were isolated from *Artibeus jamaicensis* (pH 5.5 ± 0.2). *Candida, Penicillium, Aspergillus* and *Klebsiella pneumoniae* are known opportunistic pathogens. The diet and salivary pH are factors that may influence the differences in oral microbiota.

Differential Mortality, Primary Sex Ratio, and Survivorship in a Natural Population of Neonate Mexican Freetail Bats, *Tadarida brasiliensis mexicana*

Richard E. Sherwin and William L. Gannon
Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM

Differential mortality, primary sex ratio, maternal condition and survivorship of young were evaluated for a southwestern population (Carlsbad Caverns, Eddy County, New Mexico) of Mexican free-tailed bats, *Tadarida brasiliensis mexicana*. Initial results indicate a significant correlation ($r^* = 0.80$, $P = <0.005$) between maternal condition (mass) and sex of offspring, with lighter females more likely to produce sons. Primary sex ratios were not significantly different ($X^* = 0.31$, d.f. = 89, $P > 0.24$). Mortality ratios of neonates began equal, but as the season progressed, a male biased 3:1 mortality ratio was observed. Survivorship of young (defined as developing flight capabilities and exiting roost site) was equal. Results indicate that females may be manipulating offspring sex ratios based on maternal condition. Explanations are given that may explain correlation of female condition and offspring sex. Recommendations are made for further investigation.

Thermal-Imaging Infrared Cameras: Seeing What Bats Are Really Doing

James A. Simmons[1] and Michael J. O'Farrell[2]
[1]Brown University, Providence, RI and O'Farrell Biological Consulting, Las Vegas, NV

In our experience, neither light-amplifying night-vision equipment nor video cameras with short-wavelength infrared floodlights effectively overcome the low visual reflectivity of bats well enough to routinely observe details of the behavior of flying bats in the dark. We recently have initiated field observations of bats using a NIGHTSIGHT PalmIR 250 long-wavelength body-heat imaging infrared camera (Raytheon Systems Corp.) and Sony Video Walkman 8-mm VCR, with an Ultrasound-Advice Mini-3 bat detector to provide a sound track. This system shows "hot" bats as bright objects against a cooler, and thus darker, background, even at long distances. Fine details of foraging behavior can be observed at distances exceeding 50 m. From observations in Rhode Island, *Eptesicus* exhibits great foraging versatility over periods of only tens of seconds-aerial captures are interspersed with captures of insects on vegetation,

and fast dives to catch insects on the ground. In southern Nevada and Utah we have observed large numbers of *Pipistrellus* in virtual "feeding frenzies" on clusters of insects gathered over scarce water sources. It is hard to reconcile the bats' evident success with the potential interference caused by the density of echolocation sounds recorded in these situations. We also have observed a variety of behaviors in *Myotis* and *Tadarida* that have previously been thought to be uncommon or else suspected as a common behavior but only rarely seen and never actually recorded. Acoustically-guided aerial bat-to-bat chases, or "dogfights," sometimes lasting for several minutes and involving two or three bats, are common at most sites. As an accompaniment to acoustic methods, thermal imaging provides not only details of each behavior but allows a more comprehensive assessment of the number of individuals that are active at any given site and time.

Interaction Effects of Structural Clutter and Prey Abundance on Activity by Insectivorous Bats.

Darren Sleep, University of Regina, Regina, SK S4S 0A2, Canada

Brigham et al. (1997; Can. J. Zool. 75:131) assessed the ability of insectivorous bats to negotiate clutter by constructing "clutter boxes" and monitoring bat activity within them. Activity of small bats (e.g., Myotis lucifugus) was significantly reduced in such constructions, but there was no indication of an effect on larger bats (e.g., Eptesicus fuscus). Due to the difference in size and flight capabilities, these results appear counter intuitive. The authors suggested this may be due to larger bats using lower echolocation frequencies which travel further (attenuate more slowly), therefore allowing the bats to fly outside the clutter boxes but yet still register on bat detectors. I propose to adjust the experimental design and place bat detectors at the top of a large cone construction to eliminate the potential experimental artifact. Additionally, I will place small lights at the center of each cone, effectively creating a prey patch. By manipulating light (yes or no) and the amount of structural clutter, I can determine the amount of clutter which first deters bats (reduces activity), and what amount effectively reduces net foraging gain to zero. These findings may be of practical significance, as several studies suggest that the creation of edge habitat through forestry practices may provide high quality foraging sites for clutter tolerant species, assuming that prey sources are not compromised. However, should secondary regeneration at these edges reduce the value of these locations, then edges may be only of short term benefit to foraging bats.

Foraging Range and Urban Habitat Use by the Big Brown Bat, *Eptesicus fuscus*, as Determined by Radiotelemetry

Lisa M. Solberg, Sarah J. Robertson (Hartje), and Lynn W. Robbins
Southwest Missouri State University, Springfield, MO

Six big brown bats, *Eptesicus fuscus*, were radio-tracked to assess their roosting sites and foraging areas in an urban environment. Bats were hand collected or captured with a mist net and a 1.05 g radio transmitter was attached to their dorsal side. The distance from roosting sites to foraging areas ranged from 0.1 miles to 4 miles. Foraging areas for the six individuals ranged from 0.0001 mi^2 to 6.7 mi^2 . Some individuals from different roost sites had overlapping foraging ranges but used approximately the same foraging area on consecutive nights. However, foraging areas varied nightly for two individuals from the same roost. The foraging areas ranged from 0.08 mi^2 and 6.7 mi^2 for the male and 0.06 mi^2 to 0.23 mi^2 for the female. In general, foraging areas were close to the roost site with bats remaining active from 20 to 150 minutes. One newly volant individual foraged consistently for 20 minutes each night. All monitored activity was within the urban habitat and activity was monitored for the first four hours after sunset.

Fungi Related to Bat Guano at Los Culebrones Cave

Julio Angel Soto-Centeno and Armando Rodrìguez-Duran
Interamerican University of Puerto Rico, Bayamon,PR

In the neotropics, hot caves are used year round by different species of bats. A single and reduced entrance, high humidity mostly exceeding 90%, high population densities of bats, minimum circulation of air, and a range of temperatures from 25°C to 40°C, characterize these hot caves. Ten of the 13 species of bats in Puerto Rico use caves as preferred roosting sites; each of these species have different feeding habits. The study was conducted at Los Culebrones Cave, in Arecibo, Puerto Rico. We took temperature measurements of the entrance, and three of the cave's chambers that have different microclimatic characteristics. Samples of guano of each chamber were taken to the laboratory to

verify its composition and its percentage of water. Duplicated guano samples were taken and cultivated on petri dishes containing potato dextrose agar. These samples were incubated at 25°C and 30°C. The fungi isolates were identified on the basis of the macroscopic characteristics of the colony and microscopic characteristics of its structures. Although we can find different species of bats occupying a single cave, they often maintain spatial separation within the roost; we noticed that the composition of the guano might vary depending on the number of different species that occupy each chamber of the cave. Our study showed that there is an inverse relation between the number and density of different species of fungi and the increasing temperature of the chambers. The most prevalent mold in the samples was *Penicillium*; we found it in almost every chamber.

Orientation of Northern *Myotis septentrionalis* Following Release in Daytime

Dale W. Sparks and Jeffery A. Laborda, Indiana State University; Terre Haute, IN

Many bats have been banded during ongoing studies of the utilization of bathouses by northern myotis (*Myotis septentrionalis*) near the Indianapolis International Airport. In 1997 we noticed that bats we captured and released often appeared to flee in the same direction. When we recaptured some these bats, they were again living with many of the same bats as before. These observations led us to hypothesize that bats from a colony fled to a common point following banding. We tested this hypothesis by capturing and releasing bats from five colonies. All bats from a colony were released individually from a common point. Each animal was watched as long as possible, and the last observed direction from the point of release was recorded. Some animals were seen to enter particular roosts, and these data were also recorded. Orientation data were subjected to a Raleigh test for significant orientation. Bats from four of the five colonies were found to show a significant unidirectional orientation. The fifth colony was significantly bi-directional in its orientation. Conversely, because bats from four of the five colonies examined were seen to enter more than one roost, we reject our initial hypothesis that the bats were fleeing to a particular roost.

Contrast Sensitivity of the Jamaican Fruit Bat,*Artibeus jamaicensis* : Preliminary Results

K. Lorraine Standing, York University, Toronto, ON

Much of what we know about Microchiropteran perception concerns echolocation, while comparatively little is known about their visual capabilities. This, despite the fact that bats have well developed eyes. Moreover, for species that produce relatively faint echolocation calls (i.e. whispering bats - e.g. *Artibeus jamaicensis*), it is unlikely that echolocation supplants vision as the sensory system used in foraging and orientation. Using food rewards, four captive *A. jamaicensis* were trained to select a black and white striped panel when simultaneously presented with two visual stimuli: a striped panel and a homogeneous grey panel. In the Cambridge Low Contrast Gratings panel series the contrast between the stripes differs among displays so that the contrast threshold can be determined. My goal is to determine the Contrast Sensitivity Function, the contrast threshold at various spatial frequencies (i.e. widths of stripes), to better understand the visual capabilities of these bats.

Changes in Pitch Stability with Variation in Bat Wing and Body Morphology: Results from "Virtual" Experiments

Elizabeth F. Stockwell, Brown University

In studies of maneuverable flight in bats, considerable attention has been given to the analysis of rolling turns. However, a bat's stability about the pitch axis varies with wing and body morphology and may also affect flight maneuverability. A bat in flight moves its wings through a broad range of positions which alter the direction and magnitude of forces and moments produced by the wings and body. In order to better understand how morphology and kinematics interact to affect flight performance, I developed a computer model which uses parameters based on morphological measurements from actual bats and wind tunnel measurements with physical models to predict the path of a flapping bat. I used the computer model to predict changes in flight trajectory and body angle in "virtual" experiments in which I varied body and wing morphology and the position of the center of mass. In general, "virtual" bats with higher pitch moments of inertia were more stable but required more extreme, corrective wing kinematics if they deviated from a stable configuration. These results have important implications for maneuverability under natural conditions such as during pregnancy or during flight with large fruits or prey.

Wing Dimensions in Bats

Eugene H. Studier and Dennis P. Viele, University of Michigan – Flint

We measured body mass (range = 4.9 to 1078 g) in 179 individuals of 16 species of micro- and megachiropteran bats collected near Madang in Papua New Guinea and in northeastern Australia. From the ventral aspect, with the left wing fully extended, lengths were measured (forearm, midline to digit V, wrist to wing tip, width at digit V, and head and body) as was wing thickness at 8 locations. They were the propatagium anterior to the elbow, at two equally spaced sites in the plagiopatagium posterior to the elbow, at three equally spaced anterio-posterior sites at mid-forearm, and in the middle portions of membrane between digits V and IV as well as between digits IV and III. Wing thickness at 1 or 2 sites on the right wing were also determined. We attempted to measure thickness where muscle bands, blood vessels, etc. were absent. For all sites, wing thickness, while quite variable, increases rapidly in bats with masses below 100 g, increases progressively more slowly to masses around 500 g and then remains constant in heavier bats. Left and right wing thickness at comparable sites differ. Thickness of 2 sites in the inner plagiopatagium (medial to digit V) is constant and larger than the outer portion between digits V and IV and IV and III. At mid-forearm, the wing is thinner at its leading and trailing edges than in the middle. Wing spans and areas follow similar patterns except that values continue to rise slowly in bats with masses exceeding 500 g. Wing loading (g/cm2) is directly and linearly related to mass and no relationship was found for aspect ratio (wingspan/width at digit V) and mass.

3-D Animation of a Computational Model of a Flying Bat

Sharon Swartz, P. Watts, and L. Thomas, Brown University, Providence, RI

To better understand bat wing mechanics, we have developed a computer model that accurately estimates wing stresses from details of kinematics, mass distribution, structural geometry of wing skeleton and muscles, and mechanical properties of tissues. Interpreting the results of a model of this complexity, however, is a challenge to both expert and general scientific audiences. We have therefore constructed a 3-D animation of flying bats that permits the dynamic display of our model outputs in direct relation to the geometry of the wing and its conformational changes during the wingbeat. This animation allows the user to view the flying bat from any angle and at any zoom level, and to control the rate at which each of 40 increments of the wingbeat cycle is displayed. Vectors representing the individual component forces (drag, gravity, membrane tension, etc.) exerted on each of 14 chordwise wing segments can be displayed independently, or in summation with any of the other forces. The resulting dynamic graphical display allows viewers of diverse backgrounds to better understand the functional requirements of bat wings, and more generally, wing mechanics and aerodynamics. This animation facilitates understanding of both readily-grasped and non-intuitive aspects of flight mechanics, and is a powerful tool for our studies and for more general education.

The Role of the Fruit Bat, *Eidolon helvum*, in Seed Survivorship and Germination in *Milicia excelsa*, a Threatened West African Hardwood.

Daniel A. Taylor[1], Bright O. Kankam[2], and Michael R. Wagner[1]

[1]Northern Arizona University and [2]Forestry Reseach Institute of Ghana

Milicia excelsa, a tropical hardwood from West Africa, is threatened with extinction from over-harvest and poor natural regeneration. Seed dispersal by animals plays an important role in tropical forest dynamics. Limited research suggests that *Milicia* may rely almost exclusively on bats-especially *Eidolon*- for seed dispersal. We conducted focal tree observations, measured seed rain, and conducted germination and predation trials on *Eidolon* dispersed seeds in a tropical forest in Ghana. We conducted 300 hours of diurnal and nocturnal observations from the ground and canopy at 5 fruiting *Milicia* trees. We measured seed rain using 56, 2-6 m 2 seed traps totaling 200 m 2 for a total of 5,800 m 2 trap days/ nights. Traps were placed in canopy gaps in a 2 ha. circular array at 3 distances from the focal tree and checked twice daily. To determine the effects of seed dispersal on germination rates we conducted 7 trials placing in petri-dishes 50 seeds each of four treatments; passed through the digestive tract, spit-out in rejecta pellets, extracted from fruit with pulp attached, and extracted, rinsed and dried. We recorded temporal and total germination rates by treatment. We conducted 56 seed predation trials in canopy gaps at two distances from the parent tree to test if predation rates differed significantly by distance, seed density, or treatment category as described above. A trial consisted of 4 groups of 12 seeds and 1 group of 2 seeds representing each of the 4 treatment categories. Seed groups were placed on the forest floor and removal rates recorded hourly. Bats, especially *Eidolon*, were the most important seed dispersers. We recorded 280 bat seed rain hits in 5,800 m 2 trap days/nights. No avian seed rain was recorded.

Eidolon visitation increased nightly seed trap hits by 200%. Eidolon-dispersed seeds appear to germinate quicker and escape predation longer than non-dispersed seeds and seeds dispersed in larger clumps. Fruit bats may also increase *Milicia* reproductive fitness by differentially ingesting and dispersing viable versus less-viable seeds. Bat dispersal, especially by *Eidolon*, may be essential to the long-term viability of *Milicia excelsa*.

The Neda Mine: A Collaborative Effort to Protect Wisconsin's Largest Bat Colony

Daniel Taylor[1], and Maureen Rowe.[2] [1]B. C. I. and [2]Wisconsin Department of Natural Resources

Abandoned since 1914, the four miles of underground tunnels at Wisconsin's Neda Mine eventually became an important bat hibernaculum. But the Neda was also a potential deathtrap due to collapsing ceilings. In 1976, the mine was acquired by the University of Wisconsin-Milwaukee (UWM) for geologic field studies. Around the same time, at least 75,000 bats of 4 species were discovered hibernating in the mine. But the mine's fate was a point of debate between biologists and administrators at the University. Administrators were concerned about the liability risk of leaving the dangerous mine entrances open while Field Station managers and biologists were concerned about the bats. Through collaboration between Bat Conservation International's (BCI) Bats and Mines Project, UWM, the Wisconsin Department of Natural Resources (WIDNR), the U.S. Fish and Wildlife Service, and the Friends of the Neda Mine led by BCI trustee Verne Read, a two-year effort to safeguard the mine was initiated. The first task was to re-census the bats. During the winter of 1994-95 several biologists surveyed the mine finding that the population had grown from 75,000 in the 1970s to between 300,000 and 500,000. These bats likely migrate to the Neda Mine each fall from many thousands of square miles. Over the past 20 years, many old mines in the Great Lakes Region have been closed, leaving bats few habitat options. Now the challenge became stabilizing and protecting the entrances required for bat entry and exit and maintaining airflow necessary for the stable, low temperatures required by hibernating bats. The UWM field station conducted a survey of airflow patterns to decide which entrances were essential to keep open. Thirteen entrances were closed with large rocks that excluded people but permitted maximum airflow and the remaining 5 were stabilized and gated with bat-compatible structures. The Neda Mine Bat Sanctuary now protects one of the three largest hibernating bat populations remaining in North America and is an excellent example of wildlife conservation through collaboration and partnership. WIDNR biologists and the UWM Field Station are now experimenting with remote monitoring systems at the Neda's entrances to determine bat use, temperature regimes, microclimate, and airflow patterns.

Bats, Science, and Environmental Education

Jason Taylor, York University, North York, Ont., Canada

The purpose of this project was to take an in-depth look at the science and technology curriculum, the pedagogical ideals behind both environmental and science education, and the social creation of animals. Science and technology curricula are being introduced throughout schools in North America. Using qualitative research methods, I have examined how experiences with animals can help to expand the cultural, historical, and environmental context of elementary school science. To narrow the scope of the design, and because of their interconnected natural and cultural history, I focused on bats as a case study. The research was based on responses of elementary students and teachers following a bat talk. The qualitative methods consisted of participant observation of students, semi-structured interviews with teachers, and the examination of current Ontario science and technology curriculum documents. Results indicate that experiences with animals help to promote an interdisciplinary approach to elementary school science and technology education. Animals in general (Morgan, 1993), and bats in particular, rank high in the favorite interests of children. Using animals as an environmental education experience helps to advance both science and environmental literacy in elementary students. Morgan, Mark J. (1993). A theoretical basis for evaluating wildlife-related education programs. American Biology Teacher, 54, 153-157.

Evaluating the Effectiveness of Bat Compatible Gates

J.Taylor[1], K.W. Grandison[1], M.J. Herder[2], M.R. Mesch[3], K. Day[4], P.Durrant[1], and J.G. Jackson[2]

[1]Southern Utah University, Cedar City, UT, [2]BLM, Arizona Strip, St. George, UT,

[3]Utah Div. of Oil, Gas & Mining, Salt Lake City, UT, [4]Utah Div. of Wildlife Resources,Cedar City, UT

Over 140 abandoned underground mines have been closed with bat compatible gates or grates on public and private lands in southwestern Utah. While some follow-up studies of the effectiveness of bat compatible closures have

shown that some bats will use gates, little monitoring has been done to document long-term impacts on bat populations. This study is the initial step in evaluating the effectiveness of bat gates in protecting bat colonies and minimizing public safety hazards at abandoned mine closure sites at Silver Reef, Utah. Objectives for the study include evaluating and ranking the effectiveness of active infrared event counters (Trailmaster 500M), infrared video, night vision assisted exit counts, and ultrasonic detection equipment (Anabat) to document changes in numbers of bats using roosts fitted with bat-compatible gates. Six gated and four ungated sites were selected for the suitability of these methodologies. In addition, this study establishes long-term monitoring sites at Silver Reef, Utah, for evaluating impacts of bat compatible gates on bat populations. Active infrared event counters are well suited to counting bats entering and exiting mines, assuming the devices are properly deployed and cover all possible exits. Infrared event counters used in conjunction with night vision assisted exit counts proved of limited value due to the potential for disturbance caused by presence of an observer. Infrared video cameras provided the most information with the highest degree of flexibility of the monitoring systems evaluated. Infrared video provides a permanent record which can be retrieved, analyzed, and edited at any time for a fraction of the cost of night vision equipment. Limitations of video systems include short tape and battery life and low resolution. Monitoring systems which combine the most practical and reliable of these components will be evaluated in the future.

Trophic Structure in a Sonoran Desert BatCommunity: Clues from Stable Isotope Analyses

Adrian Tejedor, J. Nathaniel Holland, Theodore H. Fleming, and Leonel da S. L. Sternberg
University of Miami, Miami, FL

The Sonoran Desert of the American southwest contains one of the most rich and ecologically diverse bat faunas in the continental United States. However, little is known about the trophic structure of such a rich assembly that includes gleaning, open air and vegetation-aerial insectivores as well as nectarivores/frugivores. This study is part of a larger investigation into the trophic and ecomorphological structure of a Sonoran Desert bat community. The major questions of the study were addressed through stable isotope analysis of bat feces. Delta 13C and delta 15N values were obtained from 62 fecal specimens belonging to eleven bat species (3 molossids, 2 phyllostomids, and 6 vespertilionids) that were captured during the spring and summer of 1997. Also, the results were compared to isotopic values from the background vegetation. In general, the community showed considerable variation in both isotopic indicators. *Leptonycteris* specimens had relatively high delta 13C values, which indicate a large degree of CAM-derived carbon in their diet. This is an indication of the species' extensive utilization of CAM plants, such as Cataceae and Agavaceae, at this time of the year. *Antrozous* and *Pipistrellus* showed a mixture of CAM and C3 delta carbon. A second group of species (e.g. *Tadarida, Myotis, Plecotus, Eptesicus*) was markedly C3 in delta carbon values. Additionally, delta 13C and delta 15N were used to determine the trophic level occupied by each species in the studied ecosystem.

Extrapolation of Anabat Call Libraries to Calls Recorded under Typical Survey Conditions.

Annie Tibbels and Allen Kurta, Eastern Michigan University, Ypsilanti, MI

In recent years, the Anabat system has been embraced by a variety of governmental agencies for conducting bat surveys in forested areas. Typically, a call library is assembled by hand-releasing bats in a large, uncluttered area, recording their calls as they fly away, and using these reference calls to identify unknowns. Proper use of this technique requires that calls in the library be similar to those of bats recorded under actual field conditions. However, surveys are not always conducted at sites similar to the areas in which call libraries were assembled. In forested areas, surveys often are performed within small openings or along corridors, such as roads and streams. How similar are calls of bats traveling through forested corridors to calls made by bats released in open sites? To examine this question, we recorded calls of adult little brown bats (*Myotis lucifugus*) that were hand released in three situations-in an open field, along a 5-m-wide road through a forest, and along a 2.5-m-wide road (two-track) through a forest. We measured the minimum frequency, duration, time between calls, and slope of calls for a minimum of seven calls from sequences produced by 10 different bats per treatment. Preliminary analyses using ANOVAs and multiple comparison tests indicate that calls of bats flying down the two-track are significantly different from those released in an open area. This suggests that extrapolation of call libraries to calls recorded in typical survey areas should be done with caution.

How Rabies Propaganda Threatens Bats

M.D. Tuttle, Bat Conservation International, Austin, Texas

The risk of human rabies is extremely low in North America, accounting for just one human death per 150 million persons annually in the United States. In fact, the annual risk is less than that incurred from driving a single mile in a motor vehicle! Nevertheless, leading public health agencies, apparently eager to expand rabies research and prevention budgets, are now promoting the idea that undetected bat bites pose important threats to humans. They base their scary hypothesis on highly biased reports that a majority of the rare, but apparently bat-transmitted rabies cases, occur in humans "for which there is no bite history." To reach this conclusion, they ignore that this is true only because a large proportion of human rabies deaths occur prior to diagnosis, making the questioning required to document a bite history virtually impossible. The new scare tactic was summed up in a March 16, 1999, New York Times headline, "A bat's swift bite, unfelt, that could bring rabies." Such stories are creating a new era of public panic and intolerance that already is accounting for deliberate killing of thousands of bats, state and federal agency mandated eradication, and a return to use of long outlawed poisons for bat control. A self-perpetuating cycle of hysteria has already begun, one that cannot be ignored by those who care about the future of bats.

Ed. Note: This abstract (above) received considerable discussion and after major revision, has been referred to the Board of Directors of NASBR, and to legal council, to determine whether this amounts to an act of political lobbying, thus in violation of NASBR's charter. When these determinations have been made it will appear in this publication as an official resolution of NASBR.

Phylogenetic Analysis of Multiple Independent Data Sets: To Combine or Not?

Ronald A. Van Den Bussche[1], Steven R. Hoofer[1], William A. Schutt, Jr.[2,3], and Nancy B. Simmons[3]
[1]Oklahoma State University, Stillwater, OK; [2]Southampton University ,
Southampton, NY; and American Museum of Natural History, New York, NY

With multiple independent data sets being generated for phylogenetic analyses, several questions are emerging regarding how they should be analyzed. For example, is it necessary for data sets to have similar numbers of characters to prevent "swamping out" the phylogenetic information in smaller data sets? Controversy also exists regarding how different data partitions should be analyzed. Three approaches (total evidence, separate analyses, and conditional combination) have been proposed for elucidating phylogenetic hypotheses for organisms based on multiple data partitions. Although several statistical methods exist for testing whether different data partitions can be combined as well as for testing congruence among phylogenetic hypotheses resulting from separate analyses, the performance of these tests has not been thoroughly examined nor have these tests been applied on a broad taxonomic scale. Therefore, little information is available regarding the prevalence of significant heterogeneity among data partitions. To elucidate higher-level phylogenetic relationships within Microchiroptera, for all taxa under study we are generating approximately 2.7 kb of DNA sequences from three adjacent mitochondrial genes and 350 morphological characters. Because our goal is to provide a well resolved, well-supported phylogenetic tree for Microchiroptera, it is necessary to compare the phylogenetic information present in each of these data sets. The specific purpose of this study was to evaluate the phylogenetic affinities of the New Zealand short-tailed bat (*Mystacina tuberculata*) based on molecular and morphological characters. Toward this end we (1) performed separate phylogenetic analyses and evaluated congruence among different data sets, (2) utilized three statistical tests of homogeneity for determining whether a "total evidence" approach could be utilized, and (3) examined the effect of data partitions of different size and evolutionary constraints on the resulting phylogenetic trees.

Phylogenetic Affinities of the New Zealand Short-tailed bat *Mystacina tuberculata* Based on Molecular and Morphological Characters.

Ronald A. Van Den Bussche[1], Steven R. Hoofer[1], William A. Schutt, Jr.[2,3], and Nancy B. Simmons[3]
[1]Oklahoma State University, Stillwater, OK; [2]Southampton University ,
Southampton, NY; and American Museum of Natural History, New York, NY

Since its description, the phylogenetic affinities of the New Zealand short-tailed bat (*Mystacina tuberculata*) have been difficult to determine. Although previous morphological studies have aligned Mystacina with several microchiropteran families, the general consensus has been that it is nearest to Molossidae. In contrast, immunological

and DNA hybridization data support the inclusion of Mystacina within the New World Noctilionoidea, although these data failed to provide resolution for relationships within the superfamily. The purpose of this study was to elucidate the phylogenetic position of Mystacina based on approximately 2.7 kb of DNA sequences from three adjacent genes (12S rRNA, tRNA Val , 16S rRNA) in the mitochondrial genome and 350 morphological characters. Results from parsimony and distance analyses of the molecular characters strongly support conclusions of previous molecular studies that *Mystacina* is a member of Noctilionoidea. Additionally, these data provide resolution for relationships within the superfamily. Congruence among phylogenetic hypothesis based on molecular and morphological data as well as results of a combined molecular and morphological analysis will be discussed.

Food Habits of *Artibeus jamaicensis* in Puerto Rico

Rafael Vazquez Torres, Armando Rodriguez-Duran . Interamerican University, Bayamon P.R. 00957

Bats are important seed dispersal-agents and have been considered keystone species of some tropical forest. This investigation is focused on studying the foraging behavior and diet habits of the neotropical bat *Artibeus jamaicensis* (Phyllostomidae) and compare the results with those obtained from continental populations. Three 5000 cm 2 wood and plastic fecal traps were set under bat clusters with the purpose of collecting the feces and identifying food items used by the bats. We made nocturnal observations with a night vision scope to examine behavior and patterns of activity. Seed and fruits from thirteen plants have been identified as food resources of *A. jamaicensis* from November of 1997 through September of 1999. We recorded seasonal variations in diet before and after hurricane Georges. Fruits of *Piper adumcun* was the favorite food of *A. jamaicensis* at Convento Cave in Puerto Rico, comprising 50% of the fruits that were found in the traps. *Andria inermis* and *Calophyllum brasiliense* represent the second most important food item from October through December and *Terminalia catappa* during January and February. Leaves of *Erytrina poeppigiana* and fruits of were eaten by this bat throughout the year. Fruits of other species including *Eugenia malacensis, Ficus trigonata, Carica papaya, Columbrina arboricens, Mutingia calabura, Melicoca bujigatus* and *Maga gandinflora* were consumed at different times during the year. Patterns of resource exploitation by *A. jamaicensis* in Puerto Rico are similar to those reported in Panama , although the fruits of choice vary, possibly as a results of differences in fruit availability. *A. jamaicensis* was negatively affected by hurricane Georges with a marked decrease in numbers which could be related to food shortages after the hurricane.

Identification of Lepidopteran Genetic Markers in Fecal Samples of *Tadarida brasiliensis*

Sunitha Vege, University of Tennessee, Knoxville, TN

Every spring, billions of corn earworms, fall armyworms, and other insect pests migrate from the Lower Rio Grande Valley into south central Texas. The huge populations of Mexican free-tailed bats *Tadarida brasiliensis* that inhabit central Texas appear to be major predators of these migratory insect populations, but it is difficult or impossible to identify degraded insect remains from guano below the family level. In our research, we are employing genetic tests (Polymerase Chain Reaction, PCR) to distinguish DNA sequence differences between moth species in the bat fecal samples. The target moth species in this project are corn earworms *Helicoverpa zea*, tobacco budworms *Heliothis virescens*, beet armyworms *Spodoptera exigua*, and fall armyworms *S. frugiderpa.* Primers designed for *H. zea* from a neuropeptide gene (PBAN) sequence consistently amplify the expected marker from the DNA of *H. zea* but not from the DNA of the other moth species. Intron and exon sequences from a triose-phosphate gene have been used to generate primers which amplify a 100bp and 200bp fragments from the DNA of H. virescens. Species-specific primers for *H. virescens* also have been designed from the mitochondrial p63 gene. The species-specific primers are being tested with the DNA isolated from feces obtained from feedings of captive big brown bats *Eptesicus fuscus* and from field samples collected from *T. brasiliensis* from Frio Cave in central Texas. The *H. zea* primers amplified the expected product from DNA isolated from fecal samples collected from controlled feedings. These primers have been tested against DNA isolated from ten field samples that were suspected to contain *H. zea*. All ten samples amplified the expected *H. zea* product. Additional controlled feeding studies and field testing of these primers are in progress and these results will be reported.

Preliminary Report of Roosting Habits of the Eastern Pipistrelle, *Pipistrellus subflavus*

Jacques Pierre Veilleux, Indiana State University

Little is known of the roosting ecology of the eastern pipistrelle, *Pipistrellus subflavus* (Chiroptera:Vespertilionidae), though the species is relatively common over its range. Pipistrelles have been most commonly found roosting in man-made structures (i.e. barns, porches), but because these roosts are seldom found we hypothesize that the majority of roosts are located in trees. Most researchers have assumed pipistrelles roost in tree hollows due to their roosting habits in buildings, while anecdotal accounts list pipistrelles roosting in Spanish moss and dead leaves. The objective of this study is to describe the roosting habits of this poorly understood species under natural conditions. Research was conducted in the bottomland forests along the Wabash River in southwestern Vigo Co., Indiana. Prairie Creek is a tributary bisecting a forest of approximately 650 ha. We mist-netted for bats along this creek and one of its small tributaries. Data were collected mainly in 1999, although additional data were collected in both 1997 and 1998. Seventeen adult, female pipistrelles were radio-tagged, 12 of which were tracked to roost trees. Forty-six roost trees were located of which 22 were verified by counting bats as they emerged in the evening. Nineteen roosts were located in clusters of dead leaves and 3 were located in live foliage. Pipistrelles commonly made use of multiple roost trees during the time they were observed.

Patterns of Tree Use, Group Composition, and Group Stability in Silver-Haired Bats: Implications for Forest Management

Vonhof, Maarten J., York University, Toronto, Ontario

A common feature of studies on forest-dwelling bats is that roost trees are used for only short periods before bats move to another roost-site. However, we know very little about the use of individual roost trees over time, or the group dynamics of bats using these trees. Between 1995-98 I examined tree use, group composition, and group stability of silver-haired bats *Lasionycteris noctivagans* in the Pend d'Oreille Valley in southeastern British Columbia. Bats switched roosts often (mean ± SD: 6.6 ± 8.28 days, N = 18), regardless of whether of whether they were caring for non-volant young. The average horizontal distance between subsequent roost trees used by the same bat varied over a relatively small range relative to the distances typically flown by foraging bats (based on means for each individual: 105 – 941 m, 311 ± 245.5 m, N=10). Roost trees were reused both within and between years, and as more bats were radio-tagged, I found fewer and fewer new roost trees relative to the cumulative number of trees found. To examine the composition, stability, and genetic structure of groups of silver-haired bats, I captured three groups at their roost tree, marked all individuals with aluminum split-ring bands, and collected small pieces of wing membrane for genetic analysis. All individuals from two of these groups were outfitted with radio-transmitters, and tracked on each subsequent day to determine whether they stayed together. Roosting groups were composed entirely of adult females and their young. Banded individuals of one group were captured together in all three years, and were tracked to roost trees that had been used in previous years, as well as to new trees in the same restricted area of forest. The tracking of radio-tagged groups also showed that group membership did not change during the lifetime of the radio-transmitters. Based on the analysis of seven microsatellite loci, groups of silver-haired bats were largely composed of either mother-offspring or full-sibling pairs, and significant genetic differences between groups were evident. These results suggest that stable groups of related individuals return to the same patch of forest and use the same trees between years, and that populations of silver-haired bats are composed of genetically distinct social units.

Timing is Everything: Monthly Variation in Abundance of Pteropodid Bats over One Year on Mt. Kitanglad, Philippines

Emily K. Walker[1] and Nina R. Ingle[1,2]. [1]The Field Museum, Chicago IL and [2]Cornell University, Ithaca NY

We mist-netted bats in residual montane rainforest on Mt. Kitanglad, Philippines, monthly between August 1998 and July 1999. Bats were released after processing and tagging with a numbered band on a ball-chain necklace. Species caught were: *Ptenochirus jagori* (43% of about 330 captures), *Ptenochirus minor* (24%), *Macroglossus minimus* (12%), *Haplonycteris fischeri* (9%), *Cynopterus brachyotis* (6%), *Harpyionycteris whiteheadi* (6%), and *Alionycteris paucidentata, Rousettus amplexicaudatus, and Dyacopterus spadiceus* (1 individual each). This was the first record of *D. spadiceus* from Mt. Kitanglad, and only the third from the Philippines. The species abundance ranking tended to be consistent throughout the study, but in two months uncommon species made up an unusually large proportion of captures. In October 1998, *Haplonycteris fischeri* was the most abundant bat (27% of 45 captures), though it never

accounted for more than 13% of captures in other months. In the same month, *Macroglossus minimus* was also surprisingly frequently netted, following *H. fischeri* in abundance and making up 22% of captures. In April 1999, *Harpyionycteris whiteheadi* showed a similar pattern, comprising 37% of 27 captures, but no more than 5% of captures in any other month. These results may be due to differential catchability of different age and sex classes or to local population movements. While several other studies of Philippine fruit bats found much less monthly variation, our data show that caution is needed in interpreting bat abundance studies. Age and sex classes should be considered when analyzing capture rates, and netting should be carried out over several months in order to get a representative sample.

A Unique Roost Location for Indiana Bats

J. D. Wilhide[1], M. J. Harvey[2], V. E. Hoffman[1], and R. M. Mitchell[1]

[1]Arkansas State University, State University and [2]Tennessee Technological University, Cookville, TN

Indiana bats (*Myotis sodalis*) occupy a variety of summer habitats throughout the eastern United States. Typical roost locations for Indiana bats are under exfoliating bark of dead trees. In the Ozark National Forest, roosts have been located in several tree species including oaks, hickories, and pines. During May 1999, while researching foraging habitats of Indiana bats in the Sylamore Ranger District, a unique roost site was encountered. A male Indiana bat fitted with a 0.5 g transmitter and monitored for several nights, roosted under metal brackets near the top of utility poles. Four different poles were used during eight nights of monitoring. Roosts were located along a gravel road, and were fully exposed to direct sunlight during most of the day. It was also noted that other bats were using utility poles as roost sites.

Bats and Balls: Sexual Selection and Sperm Competition in Bats

Jerry Wilkinson and Gary McCracken

University of Maryland, College Park, MD and University of Tennessee, Knoxville, TN

Sperm competition has received little study in bats compared to other mammals, despite the fact that bats appear to be predisposed for sperm competition due to sperm storage and evidence of multiple mating by females. While there is information on the mating systems of many bats, as yet, no one has tested if mating system influences testes size. We obtained testes measurements for 102 species of bats using published sources, unpublished records and measurements of museum specimens. Testes mass covaries with body mass in other mammals, and we document that the allometric relationship between testes mass and body mass is steeper in bats than in other mammals. We categorize species by male-female association and potential for female promiscuity to test directly for sexual selection on bat testes size. We predict larger testes when females have opportunities to mate with multiple males and smaller testes in monogamous or highly polygynous species in which one male controls access to a female or group of females. In addition, we consider several alternative explanations for testes size including phylogenetic effects, colony size, breeding seasonality, sperm storage, and genetic potential for gametic dysfunction. We also compare testes size between populations for two species of bats to determine if intraspecific differences exist and could be consistent with sexual selection. We find extraordinary variation in testes size, with combined testes mass ranging from 0.12% to 9% of body mass, which exceeds any other mammalian order. Sexual selection provides the best explanation for this variation as both the mating system and the opportunity for female remating explain significant amounts of variation in testes size between species, even after effects of body mass and family are removed. Colony size and sperm storage exhibit weak effects that disappear when phylogenetic pattern is included, while seasonality and potential for gametic dysfunction are unrelated to testes size. Testes size can provide valuable clues about mating systems in species which have not yet been studied in the field.

Temporal and Spatial Patterns in the Movements of the Least Blossom Bat, *Macroglossus minimus* in Papua New Guinea

John Winkelmann and Frank Bonaccorso

Gettysburg College, Gettysburg, PA, and Papua New Guinea National Museum and Art Gallery

Eleven least blossom bats, *Macroglossus minimus* (Pteropodidae) fitted with position-sensitive radio-collars were monitored in lowland rainforest for up to 18 days at Kau Wildlife Area, Madang Province, Papua New Guinea. For 3 females and 7 males, the mean home range is 5.98 hectares and mean core use area 1.67 hectares (30% of mean home range). Of five adult males simultaneously tracked and having contiguous home ranges only two showed slight overlap

in home range. The mean long axis across home ranges was 541 m (233 to 1020 m range, n = 10). All bats roosted each day singly in understory or subcanopy vegetation within old growth forest and showed fidelity to a small day roost area. There was no overlap in day roost area between any simultaneously tracked bats (n=6). Mean day roost area for 10 bats was 0.38 hectares or 6.3% of the mean home range. Activity centers within core use areas all proved to be forest light gaps, riparian light gaps, or open garden areas with inflorescing bananas. Total activity within a night was monitored for two individual adult males: the duration and number of flights and cumulative flight time were tracked for each animal.

The Use of Molecular Tools to Track Gene Diversityand to Evaluate the Mating System of Straw-colored Fruit Bats *Eidolon helvum*

Jan M. Zinck, Portland State University, Portland,OR

The determination of parentage based on genetic data is of considerable significance to basic population and conservation biology because it relates directly to mating behavior, population subdivision, effective population size, and species management. In captive breeding populations, it is useful to know the relatedness of mating individuals in order to avoid the deleterious effects of inbreeding, to minimize damage caused by random catastrophic events, and to monitor the loss of gene diversity due to genetic drift. An Understanding of population substructure, gene flow, mating and reproductive behavior is valuable both when developing management plans in captivity and when managing wild populations. Genetic techniques, such as microsatellite analysis and mtDNA RFLP analysis, make parentage exclusion and determination possible. The American Zoological Association population of *Eidolon helvum* is an ideal population for microsatellite and mitochondrial DNA analysis because of its great breeding success, possession of nearly all the original founding individuals, and overlapping generations. In this study of more than 200 captive straw-colored fruit bats (*Eidolon helvum*, Kerr, 1792), relatedness, parentage, gene diversity over time, and the captive mating system are evaluated using microsatellite and mitochondrial DNA (mtDNA) analysis. Microsatellite primers developed by Dr. Gary McCracken and Lisa Comeaux for bats of the genus *Pteropus* (University of Tennessee: unpublished) were used to determine parentage by exclusion. Mitochondrial DNA primers developed by Wilkinson and Chapman (1991) for the evening bat *Nycticeius humeralis* were used to amplify a region of the D-loop between the proline tRNA gene and a conserved region downstream. Restriction fragment length polymorphism (RFLP) analysis was used to confirm and/or determine maternity by exclusion for the captive born *Eidolon*. Results from the current study, which represent the first genetic study of this species, will be presented.

Erratum

In the Fall 1999 issue [Volume 40: No.3] of Bat Research News the title of the abstract on page 139 (Danilo Russo and Gareth Jones) is incorrect and should read: "The Social Calls of Kuhl's Pipistrelles *Pipistrellus kuhlii* (Kuhl, 1819): Structure and Variation (Chiroptera: Vespertilionidae).

Summary of the Twenty-ninth Annual North American Symposium on Bat Research

Thomas A. Griffiths, Program Director, NASBR
Dept. of Biology, Illinois Wesleyan University, Bloomington, IL 61702

The twenty-ninth annual North American Symposium on Bat Research met at the University of Wisconsin-Madison Memorial Union from October 27-30, 1999, sponsored by the University of Wisconsin Zoological Museum. John Kirsch was the conference host, ably assisted by the members of his Local Committee: Deanna G. P. Byrnes, James M. Hutcheon, Holly I. McIntee, and E. Elizabeth Pillaert. There were 259 registered participants, not counting the educators who attended the special Bat Conservation Workshop on Saturday morning. In terms of numbers of participants, the 29th annual symposium is the second largest regular (non-international) North American meeting ever held (Horst, 1995; Griffiths, 1996, 1997, 1998). Only the 27th annual meeting in Tucson, with 269 registered participants, has been larger. One hundred and eleven scientific papers were presented at the Wisconsin meeting, not counting the special presentations for teachers made during the Saturday morning workshop. Thirty-four of these were poster presentations. According to the official records of the symposium (Horst, 1995; Griffiths, 1996, 1997, 1998), this number of presentations is the largest number ever given at a regular (non-international) meeting.

Once again this year, graduate and undergraduate student participants were invited to enter their platform papers and poster presentations in a competition which judged their merits. A special committee headed by Roy Horst judged twenty-six student platform papers and fifteen student posters. Four cash prizes of $250 each were awarded at the Friday evening banquet. **Michael A. Menzel** of West Virginia University won the Bat Conservation International prize, **Chris W. Nicolay** of Northeastern Ohio Universities College of Medicine won the *Bat Research News* prize, **Daniel A. Taylor** of Northern Arizona University won the LuBee Foundation prize, and **Jodi L. Sedlock** of the University of Illinois at Chicago won the Karl F. Koopman prize. The special SPELEOBOOKS merchandise prize was awarded to **Jenise Segarra Desoto** of the Interamerican University of Puerto Rico for the best poster. Generous monetary donations from Bat Conservation International, from Roy Horst at *Bat Research News,* Roger Haagenson and John Seyjagat of The Lubee Foundation, and Emily Davis Mobley of SPELEOBOOKS made the first three prizes possible. Donations from a number of individuals made the Karl F. Koopman Prize possible.

The North American Symposium on Bat Research has always prided itself on its lack of formal organization. Since its inception, it has simply been an annual gathering of people who meet to discuss the latest research on bats. Times change, and the organization has grown to the point where, financially speaking, it has become of greater interest to federal and state taxing agencies. It has become necessary to adopt a minimal level of organization, in order to become recognized as an official tax-exempt organization. At the 1999 business meeting, participants unanimously adopted a new Constitution and By-Laws which took effect at the close of the 1999 meeting. These documents are printed elsewhere in this number of *Bat Research News.* A Board of Directors was also elected. As specified by the Constitution and By-Laws, the Board serving at the Miami meeting in 2000 will be as follows.

		Term of Office
Mark Brigham	*ex officio* as Local Host in 2001	2000, 2001, 2002
Ted Fleming	*ex officio* as Local Host in 2000	2000, 2001
John Kirsch	*ex officio* as Local Host in 1999	2000
Tom Griffiths	Program Director	*determined by Board*
Hector Arita	elected by membership	2000, 2001, 2002
Robert Barclay	elected by membership	2000, 2001, 2002
Patricia Freeman	elected by membership	2000, 2001
Tom Kunz	elected by membership	2000, 2001
Roy Horst	elected by membership	2000
Pat Morton	elected by membership	2000

Pat Morton of Texas Parks and Wildlife once again organized and ran a special bat education workshop on Saturday morning of the conference. She was assisted this year by Rebecca Christoffel of the University of Wisconsin - Madison, Dennis Yockers of the University of Wisconsin - Stevens Point, Dolly Ledin of the University of Wisconsin - Madison, and Ann Burgess of the University of Wisconsin - Madison. The workshop was very well attended by Wisconsin teachers, conservation workers, and other local persons interested in the conservation of bats. This was the fourth year in a row that Pat has organized and run this workshop in conjunction with the NASBR. I hope she will do this again in the fall at Miami, Florida and annually thereafter. I thank Pat and her co-organizers for their efforts which made the workshop possible.

Finally, let me extend my special thanks to John Kirsch, Deanna G. P. Byrnes, Margaret Griffiths (my wife), and Roy Horst for all the hard work they did to make this meeting a success.

Literature Cited

Griffiths, T. A. 1996. Twenty-sixth annual North American Symposium on Bat Research. Bat Research News, 37: 157.

------. 1997. Twenty-seventh annual North American Symposium on Bat Research. Bat Research News, 38: 145-146.

------. 1998. Twenty-eighth annual North American Symposium on Bat Research. Bat Research News, 39: 194.

Horst, G. R. 1995. A brief history of the annual North American Symposia on Bat Research. Bat Research News, 36: 129-132.

Constitution of the North American Symposium on Bat Research (NASBR)

(adopted October 30, 1999 at the 29th Annual NASBR business meeting)

ARTICLE I. ***Name and Object***

Section 1. The name of the organization is the North American Symposium on Bat Research (abbreviated name: NASBR).

Section 2. The objectives of NASBR shall be exclusively educational and charitable and in furtherance of those objectives:

A. To promote and develop the scientific study of bats in all its branches, including conservation and public education,

B. To disseminate the results of bat research to interested persons,

C. To facilitate an annual meeting of professional bat researchers from throughout North America, and

D. To be involved in international meetings every few years.

Section 3. The organization shall not be organized or operated for profit. No part of the net earnings or other funds of NASBR shall inure to the benefit of or be distributable to its members, Board of Directors members, officers or other private persons except that NASBR shall be authorized and empowered to pay reasonable compensation for services rendered.

Section 4. Notwithstanding any other provision of this Constitution, NASBR shall not carry on any other activities not permitted to be carried on (a) by an organization exempt from federal income tax under Section 501 (c) (3) of the Internal Revenue Code of 1986 (or the corresponding provisions of any future United States Internal Revenue Law) or (b) by a corporation, contributions to which are deductible under Section 170 (c) (2) of the Internal Revenue Code of 1986 (or corresponding provisions of any future United States Internal Revenue Law).

Section 5. No substantial part of NASBR's activities will consist of carrying on propaganda or otherwise attempting to influence legislation, and NASBR shall not participate in or intervene in (including the publishing or distribution of statements) any political campaign on behalf of any candidate for public office.

ARTICLE II. ***Membership***

Section 1. Membership is open to all persons interested in the scientific study of bats (Chiroptera) including scientists, candidates for an academic degree, and/or persons involved in bat research or education about bats, including their conservation. Categories of membership are defined in the By-Laws of NASBR.

ARTICLE III. ***Administrative Organization***

Section 1. The officers of NASBR shall be the Program Director, the immediate past year's Local Host, the Local Host for the present year, the next year's Local Host, and a six person Board of Directors who are elected by the membership.

Section 2. The *Program Director* serves at the will and pleasure of the Board of Directors, and is selected by the Board for an indeterminate, mutually-agreed upon period. The job of the Program Director is to produce the annual symposium in conjunction with a Local Host and his/her Local Committee. The Program Director is an *ex officio* member of the Board, nominally without voting privileges except in the case of a tie vote in which case the Program Director may cast the tie-breaking vote. The Program Director may, without approval of the Board, appoint Associate or Assistant Program Directors, or other persons to assist in the production of the annual meeting. The Program Director is empowered to enter into contracts on behalf of NASBR with hotels, civic centers, university conference sites, audiovisual equipment suppliers, banquet facilities, printing firms, and all and any other organizations with goods or services necessary to the production of a conference.

Section 3. The *Board of Directors* shall be elected from a slate of at least three candidates, no more than one of whom shall be from any single state, province, etc., compiled and presented by the incumbent Board at the annual business meeting of NASBR. Additional candidates may be added to the slate by a nomination and a second from the floor of the business meeting. Two Directors will be elected each year, and will serve for a three-year term beginning with the close of the conference in which they were elected. The Board will be convened annually by the Program Director who will preside until a Chair is elected from among the members of the Board. The Chair will then preside over the election of a Recording Secretary to take minutes of the Director's meeting(s) and the regular business meeting(s) and a Treasurer who will oversee the funds and keep financial records of NASBR for the following year.

Section 4. The *Local Host* is an individual selected to host a meeting three years in advance. He/she generally selects a Local Committee to assist in the planning and execution of the symposium. The Local Committee is an *ad hoc* assembly of persons who undertake to organize a single annual or international meeting. The Local Host becomes an *ex officio* member of the Board of Directors in the year prior to his/her conference, and remains a member of the Board until the close of the conference the year after his/her conference ends. The Local Host is a non-voting member of the Board, unless he/she is also serving as a regular (elected) Board member.

Section 5. An officer of NASBR shall perform his or her duties, including those associated with service on the Local or other committees established from time to time, in good faith, in a manner he or she reasonably believes to be in the best interests of NASBR, and with such judgment as an ordinarily prudent person in a like position would use under similar circumstances.

ARTICLE IV. ***Meetings***

Section 1. NASBR conducts an annual meeting, the venue for which is decided by majority vote of attendees at an annual meeting three years in advance. In the event of no decision, or in case of emergency, the Board of Directors is empowered to select the time and place of an annual meeting. When an international meeting of bat researchers is held in North America, NASBR may be

responsible for planning and administering the meeting and its own annual event may be suspended or held in concert with the international meeting.

Section 2. A special meeting of the Board of Directors may be called at any time by the Program Director, by the Chair of the Board elected at the previous annual meeting, or by the Treasurer. A special meeting of NASBR may be called at any time by a majority of the Board of Directors, provided that notice of the purpose, place, and date of the meeting be given to the membership at least thirty (30) days in advance.

Section 3. Fifty voting members shall constitute a quorum of NASBR at the annual business meeting of NASBR. Action by a quorum at the annual meeting or at a special meeting shall constitute action by NASBR. Four elected members of the Board of Directors shall constitute a quorum of that body.

ARTICLE V. ***Amendments to the Constitution***

Section 1. Amendments to the Constitution may be initiated by a signed, written petition to the Board of Directors by any ten (10) individual members of NASBR or by action by a majority of the Board of Directors. Amendments must be acted upon by the attending members at the next annual meeting held after submission of such proposed amendments. Approval of a two-thirds majority of attendees is required for further consideration of an amendment, which must then be presented to the full membership by mail ballot within six months of approval and must be ratified by a majority of those members of NASBR voting.

ARTICLE VI. ***Dissolution of NASBR***

Section 1. Upon dissolution of NASBR, the Board of Directors shall, after paying or making provisions for the payment of all of the liabilities of NASBR, dispose of all of the assets of NASBR exclusively for the purposes of NASBR in such manner, or to such organization or organizations organized and operated exclusively for charitable, educational, religious or scientific purposes as shall at the time qualify as an exempt organization or organizations under Section 501 (c) (3) of the Internal Revenue Code of 1986 (or the corresponding provisions of any future United States Internal Revenue Law), as the Board of Directors shall determine. Any of such assets not so disposed of shall be disposed of by the Circuit Court of the county in which the principal office of NASBR is then located, exclusively for such purposes or to such organization or organizations as said court shall determine, which are organized and operated exclusively for such purposes.

By-Laws of the North American Symposium on Bat Research (NASBR)

(adopted October 30, 1999 at the 29th Annual NASBR business meeting)

ARTICLE I. *Membership*

Section 1. Membership is open to all persons interested in the scientific study of bats (Chiroptera) including scientists, candidates for an academic degree, and/or persons involved in bat research or education about bats, including their conservation. Categories of membership shall include Regular Members, Student Members, Institutional Members, and Lifetime (Emeritus) Members as defined below.

Section 2. *Regular Member.* Regular members are eligible to vote and may be elected to office in NASBR. Any person may become a Regular Member upon registering for and attending the annual meeting of the NASBR. Membership shall continue for one year following the close of the annual meeting, or until the start of the next meeting, whichever term is greater.

Section 3. *Student Member.* A Student Member must be a candidate in good standing for an academic degree. Evidence for such standing may be provided by endorsement of the student's research advisor or departmental chair, or by official documents asserting student status. Student Members are eligible to vote, but may not be elected to office. Any person may become a Student Member upon registering for and attending the annual meeting of the NASBR at the student registration rate. Student membership shall continue for one year following the close of the annual meeting, or until the start of the next meeting, whichever term is greater.

Section 4. *Institutional Member.* An association, organization, corporation, or institution desiring to support bat research conservation, or education may apply as an Institutional Member. Institutional membership does not, however, include voting privileges or eligibility for office. Institutional memberships shall continue for one year following the close of the annual meeting, or until the start of the next meeting, whichever term is greater.

Section 5. *Lifetime (Emeritus) Member.* Lifetime membership is conferred by the NASBR in recognition of a long and distinguished career in bat research or education about bats. Lifetime members shall be elected by at least a 75 per cent vote of members of the Board of Directors at the annual meeting. Lifetime members are entitled to all the benefits of Regular Membership, but shall be exempt from payment of the annual registration fee for all annual meetings thereafter.

ARTICLE II. *Duties of the Board of Directors*

Section 1. The Board of Directors shall serve as the governing board of the NASBR and shall review and establish policies and procedures of the NASBR in line with the provisions of the Constitution and By-Laws. The Board of Directors shall meet at the time of each regular meeting of the NASBR to conduct such business as may properly come before it. In particular, the Board of Directors oversees the actions of the Program Director as he/she functions to produce the annual meeting.

Section 2. The *Chair* of the Board of Directors presides over the Directors Meeting and co-presides with the Program Director over the general business meeting(s) of the NASBR. He/she assumes overall concerns for the general affairs of the NASBR. The Chair will be elected annually by members of the Board from within their ranks, and will serve from the time of election until the start of the next annual Directors meeting. Neither the Program Director nor a Local Host may serve as Chair of the Board of Directors. A Chair may be re-elected and serve an unlimited number of years, provided he/she continues to be a *bona fide* elected member of the Board.

Section 3. The *Recording Secretary* assumes responsibility for taking minutes of the Directors Meeting and the business meeting(s) of the NASBR, and for ensuring that the minutes are added to the NASBR archives. The Secretary will be elected annually by members of the Board from within their ranks and will serve until the start of the next annual Directors meeting. Any member of the Board, including *ex officio* members, may serve as Recording Secretary.

Section 4. The *Treasurer* of the NASBR assumes overall responsibility and oversight over the financial affairs of the NASBR. The Treasurer will be elected annually by members of the Board from within their ranks and will serve until the start of the next annual Directors meeting. Neither the Program Director nor a Local Host may serve as Treasurer of the NASBR. A Treasurer may be re-elected and serve an unlimited number of years, provided he/she continues to be a *bona fide* elected member of the Board.

Section 5. In the event a member of the Board of Directors cannot serve the remainder of his/her term, the vacancy may be filled by appointment by the Chair of the Board.

ARTICLE III. *Awards*

Section 1. Subject to the availability of funds, the NASBR may, from time to time, make awards to undergraduate and graduate students at the annual meeting, in recognition of an outstanding platform or poster presentation of their research. Winners of student awards are selected by an *ad hoc* committee of members selected by the Program Director of the NASBR each year prior to the start of the annual meeting.

ARTICLE IV. *Amendments to the Bylaws*

Section 1. Amendments to these Bylaws may be initiated by individual members of NASBR at the annual business meeting. Amendments require a second to be considered valid. Amendments may be acted upon by the attending members at that meeting, or may be postponed for action by a majority vote until the next annual meeting held after submission of such proposed amendments. Approval of a two-thirds majority of attendees is required for approval of an amendment.

Future Meetings, Symposia, Conferences, Workshops, etc.

April, 2000

The 9th Australasian Bat Research Conference

will meet in the Hunter Valley, NSW, 25th to 28th April, 2000

for information and registration materials contact:
Kerryn Parry-Jones, Biological Sciences, University of Sydney 2006, NSW, Australia
e-mail: kpjones@bio.usyd.edu.au phone/fax 02 43 653 232

June, 2000

The American Society of Mammalogists

will meet at the University of New Hampshire in Durham, NH June 17th to 21st.
for information and registration materials contact:
H. Duane Smith, Monte Bean Life Science Museum, Brigham Young University, Provo, UT 84602-0200

September, 2000

The Bat Conservation Trust -National Bat Conference

Will meet 1st - 3rd September, 2000 at The Queen's University, Belfast, Northern Ireland.
For information and registration materials contact:
Marie-Claire Edwards,
The Bat Conservation Trust, 15 Cloisters House, 8 Battersea Park Road, London, SW8 4BG.
Tel: +44 171 627 2629 FAX: +44 171 627 2628 E-mail: enquiries@bats.org.uk

September, 2000

The 30th Annual North American Symposium on Bat Research

will meet at the University of Miami, Miami, FL September 27th to 30th, 2000

for information and registration materials contact:
Thomas A. Griffiths, Department of Biology, Illinois Wesleyan University, Bloomington, IL 61702
E-mail tgriff@titan.iwu.edu tel. 309-556-3230

All subscribers to Bat Research News are already on the Symposium mailing list
and will receive registration forms by June 1, 2,000.

Continued>>>

March, 2001

A Special Conference

The Indiana Bat: Biology and Management of an Endangered Species
29 March to 1 April 2001

The ***Northeast Bat Working Group*** and the ***Southeastern Bat Diversity Network*** will host a symposium on the biology and management of the Indiana bat, from 29 March to 1 April 2001, at the Radisson Hotel, in Lexington, Kentucky. The purpose of the Symposium is to aid in recovery of the species by fostering dissemination of information among academic biologists, environmental consultants, and resource managers. The Symposium will consist of invited papers, as well as submitted papers and posters, dealing with any aspect of the ecology, behavior, and natural history of the Indiana bat, in summer or winter. The proceedings of the symposium will be published with Allen Kurta as editor.

The meeting will begin with arrival of attendees and informal social activities on Thursday, 29 March, and end with an optional field trip to the Daniel Boone National Forest on Sunday, 1 April. Oral presentations will be given on Friday and Saturday, and a poster session and social will be held on Friday evening. The local host is Michael Lacki, and the organizing committee consists of Sybil Amelon (U. S. Forest Service), Bob Currie (U. S. Fish and Wildlife Service), Alan Hicks (New York Sate Department of Environmental Conservation), Jim Kennedy (Bat Conservation International), Dennis Krusac (U. S. Forest Service), Allen Kurta (Eastern Michigan University), Michael Lacki (University of Kentucky), and Annette Scherer (U. S. Fish and Wildlife Service). The call for papers will be issued, along with more detailed information on registration, housing, etc., in spring 2000.

More details on the following meetings in 2001 will appear at least one year in advance of the meeting

June 2001	The American Society of Mammalogists, Missoula, MT
August 2001	12th International Bat Research Conference, Bangi Malaysia
October 2001	31st Annual North American Symposium on Bat Research, Victoria, BC, Canada
August 2002	9th European Bat Research Symposium, LaHavre, France
October 2002	31st Annual North American Symposium on Bat Research, Burlington, Vermont

If you know of other meetings, large or small, concerning bats, please send us the details for inclusion in the next issue. Thank you. G. Roy Horst

Corrections, changes or new additions to the E-mail Directory

Bander, Kathleen	kbwm@whidbey.net	USA (WA)
Braun, Monika	monikabraun@cs.com.	Germany
Bretagnolle, Francois	francois.bretagnolle@bota.unine.ch	Switzerland
Butchkoski, Calvin	cmbutchk@penn.com	USA, (Pennsylvania)
Christenson, Keith	christenson@codetel.net.do	USA (military)
Cohen, Keith	batkeith@kcohen.fsnet.co.uk	United Kingdom
Cohen, Keith	batkeith@hotmail.com	United Kingdom
Fankhauser, Toni	toni.fankhauser@wildark.ch	Switzerland
Hays, Mark	marcus_bat@hotmail.com	USA, (Colorado)
Hollis, Lydia	lmhollis@ucalgary.ca	Canada,(Alberta)
Hutchinson, Jeffrey	jhutch@bellsouth.net	USA, (Florida)
Iñiguez Davalos, Luis Ignacio	liniguez@fisher.autlan.udg.mx	Mexico
Leitner, Phil	pleitner@pacbell.net	USA, (California)
Lindhe, Ulla	U.norberg@zool.gu.se	Sweden
Lunnum, Margaret	elfwyn@gateway.net	USA, (Washington)
Lyons, Leslie A.	lalyons@ucdavis.edu	USA, (California)
Norberg, Ulla(see Lindhe)	U.norberg@zool.gu.se	Sweden
Parry-Jones, Kerryn	kpjones@bio.usyd.edu.au	Australia
Reis, Stephen	kcsreis@icx.net	USA, (Tennessee)
Riger, Pete	PRIGER@email.msn.com	USA, (New York)
Russo, Danilo	dan.russo@mbox.netway.it	Italy
Saugey, David	dsaugey@swbell.net	USA, (Arkansas)
Sigé,Bernard	bernard.sige@wanadoo.fr	France
Stanback, Mark T.	mstanback@davidson.edu	USA, (North Carolina)
Stoner, Katherine	kstoner@ibiologia.unam.mx	Mexico
Thompson, Neville	nevillethompson@nationwideisp.net	United Kingdom
Thompson, Shirley	shirleythompson@nationwideisp.net	United Kingdom
Wilson, Heather	hw_chickaree@hotmail.com	USA, (California)

Would you please check the E-mail directory in Volume 40:No 2 to be certain your e-mail address is correct. Please send any corrections, additions or changes to horstgr@potsdam.edu thank you. G.R.Horst

The French Bat Mapping Project

In 1998, the French Mammal Society (S.F.E.P.M.) decided to update the atlas of French Mammals issued in 1984 and bats appeared to be the major group to start this work. With 31 species, they represent 30% of terrestrial mammals. Moreover, after more than a decade of dramatically increasing prospecting, they account for our most improvemed Knowledge of mammal populations. The French Bat Mapping Project was quickly initiated with the help of the regional contacts of the French Bat Group, and 2002.

Data collecting

Questionnaires have been supplied to every French bat workers (± 300), and some local data bases are already gathered. Foreign and French bat workers are requested to provide information on :

- the species - using preferably the latin name;
- the location - this should be as precise as possible (department, parish, U.T.M. or other system coordinates), a 10 x 7.1 km National Geographic Institute grid is a maximum;
- the altitude - mainly for mountain areas;
- the date - the main period covered by the atlas will be 1985 to 2000, but former data are welcome, whenever the season (this will help to identify the status of the species);
- the number of observed individuals;
- the type of contact - hand identification (requiring a licence) or observation of alive animals, fresh carcass or skulls, bat detector identification (useful for checking procedure);
- the biotope - main types of landscape features (pond, river, urban area, deciduous forest, ...).
- reproduction indices - breeding colonies, gestating or lactating females, early juveniles;
- comments - useful to ascertain some identifications for example, references of published data, etc.

Publication

For the final document, the editors decided to provide:
(i) the distribution (on a 20 x 14.3 km I.G.N. grid) of the whole data distinguishing between * information collected before 1985, * hand and * bat detector identifications for the period 1985-2000,
(ii) the distribution (on a 20 x 28.6 km I.G.N. grid) of reproduction indices (defined in the questionnaire).

Each species will be supervised by one (or two) author(s). Each author will be in charge of checking the data and writing down a peer-reviewed text analysing the present distribution and recent trends.

As a reference for conservation, this atlas will be supplemented with the Red Data List of French bats according to the last I.U.C.N. categories.

A comprehensive bibliography will be tentatively published too (please send copy of your papers dealing with some French bats).

Editors

Stéphane AULAGNIER, Patrick HAFFNER, Gérard ISSARTEL, François LEBOULENGER, Didier MASSON, François MOUTOU & Sébastien ROUE

Correspondence

Stéphane AULAGNIER, Place de la Mairie, F-47470 Beauville, France
Didier MASSON, 386 rue des Flamboyants, F-40600 Biscarosse, France

STUDENT SCHOLARSHIPS FOR BAT CONSERVATION RESEARCH

Bat Conservation International hereby announces the availability of student research scholarships. Approximately 15 grants ranging from $500 to $2,500 will be made in 2000. Grants will go to research that best helps document the roosting and feeding habitat requirements of bats, their ecological or economic roles, or their conservation needs. Students enrolled in any college or university worldwide are eligible to apply. Projects must have bat conservation relevance. The application deadline for 2000 scholarships is 15 January 2000.

Application information and forms are available on our web page at
http://www.batcon.org/schol/schol.html
or write to: Bat Conservation International, Student Scholarship Program,
P.O. Box 162603, Austin, TX 78716
or email: aengland@batcon.org

BAT RESEARCH NEWS

Volume 40 **Winter 1999** **Number 4**