BAT RESEARCH NEWS

How are bats and people alike? We go to work each day, find food, protect ourselves from danger, defend our home, attract a mate, and raise a family.

(credits, see rear cover)

VOLUME 42: NO. 1 **SPRING 2001**

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BAT RESEARCH NEWS

Volume 42 Number 1 **Spring 2001**

Contents

The front cover of this issue is from Bats and the Rainforest, a curriculum guide for teachers written by Patricia Morton

BAT RESEARCH NEWS

Volume 42 Number 2 **Summer 2001**

Contents

Front Cover

The front cover for this issue is a copy of a plate taken from:

Traite de L' Ostéologie et de LaMyologie du *Vespertilio murinus*

by P. Maisonneuve, Paris 1878

This illustration is one (plate II) of eleven plates in this delightful old monograph. If any of our readers can find an earlier published illustration of a bat (or bats) that would make an interesting cover for a future issue. If so please include as much information as possible, and send it to me. The original volume is part of my collection. G. Roy Horst

BAT RESEARCH NEWS

Volume 42 Number 3 **Fall 2001**

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Front Cover

The front cover artwork was provided by Kunwar Bhatnagar.

Cynocephalus volans, the flying lemur. Head and body 16 inches, tail 9 inches, weight up to 1.75 kg. These small animals which are like a small cat can glide up to 136 meters between trees. (Almost a bat and it almost flies)

BAT RESEARCH NEWS

VOLUME 42 **Winter 2001** **Number 4**

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Front Cover

The front cover illustration of *Rhinolophus ferrumquinum* is the work of Philippe Penicard. Mr. Penicard is the creator of an excellent series of illustrations of the bats of France. He is an artist who specializes in illustrations of animals for educational purposes. He is active in bat protection and conservation activities in Brittany. His address is 16 bis, route du Port, F-29252, Plouezoch, France. We reproduce his handsome art with his kind and generous permission.

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

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

Editor for Recent Literature: Thomas A. Griffiths: Dept. of Biology, Illinois Wesleyan University, Bloomington, IL 61702 Tel. 309-56-3230 e-mail: tgriff@titan.iwu.edu

Editor for Conservation and Education: Patricia Morton, Texas Parks and Wildlife, Suite 100, 3000, IH 35 Austin, TX 78704 Tel. 512-912-7020 e-Mail: patricia.morton@tpwd.tx.us

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BAT RESEARCH NEWS

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Bats and forest management in Germany: a research and development project (R & D) of the Federal Agency for Nature Conservation, Bonn (1996-1998)

Angelika Meschede[1] and Klaus-Gerhard Heller[2]
[1]6374 Crest View Court, Riverside, CA 92506, USA and
[2]Institut für Zoologie II, Universität Erlangen, Staudtstr. 5, D-91058 Erlangen, Germany

This report on "Bats and Forests" encompasses the results of a 3-year research and development project, involving more than 100 experts and bat workers, between 1996 and 1998. The project was initiated and funded by the Federal Agency for Nature Conservation (Bundesamt für Naturschutz) and carried out by the German Association for Landscape Conservation (Deutscher Verband für Landschaftspflege e.V.). The aim was to develop recommendations for forest management based on the special needs of bats, and the report is addressed mainly to forest owners and foresters.

Besides a thorough search of relevant literature, we also studied the occurrence and ecology of several bat species in forests. The focus was on radiotracking species for which little ecological data was available, including the barbastelle (*Barbastella barbastellus*), Brandt's bat (*Myotis brandtii*), Leisler's bat (*Nyctalus leisleri*), Natterer's bat (*Myotis nattereri*), Bechstein's bat (*Myotis bechsteinii*), and Nathusius' pipistrelle (*Pipistrellus nathusii*). The bat faunas of a set of different forests were determined using a variety of approaches (netting, bat detectors, and checking roost sites, including nest boxes and tree holes). One subproject dealt with riverine forests and their relevance for the migratory species, the noctule (*Nyctalus noctula*) and Nathusius' pipistrelle. Additional information on use of riverine forests during migration was gathered through direct observation of migrating bats and by banding and recapture of bats. A forester was part of the project team and mapped stands in several investigated areas according to a specially developed key. The resulting distributions of forest types were overlaid with radiotracking data of the various bats.

The results of this project corroborated that all 20 bat species that regularly occur in Germany make use of the habitat "forest" in some way. The following species regularly rear young in forests: Bechstein's bat, Natterer's bat, brown long-eared bat (*Plecotus auritus*), noctule, Leisler's bat, Brandt's bat, Daubenton's bat (*Myotis daubentonii*), barbastelle, and Nathusius' pipistrelle. The whiskered bat (*Myotis mystacinus*), Geoffroy's bat (*Myotis emarginatus*), greater mouse-eared bat (*Myotis myotis*), and the common pipistrelle (*Pipistrellus pipistrellus*—including the 55-kHz type) only occasionally use natural tree holes or nest boxes. In most cases, only single males were found, and nursery colonies of these four species rarely have been observed in forests.

Holes in trees and spaces behind bark represent the most important roost sites for bats in forests. Holes may be caused by rotting and/or the work of woodpeckers. While use of tree holes often is obvious, it is very difficult to detect bats roosting behind bark. A new and very significant finding for forest management is that barbastelles almost exclusively use cracks behind bark as a roost site. All levels from the base of the tree up to the crown may be used as roost sites. Bats very often, sometimes daily, move from one roost site to the next, indicating a need for a high density of potential roost sites. We estimated that the minimum required number of available roost sites for a nursery colony of Bechstein's bat was 50 roosts within an area of a few hundred hectares. For other species, e.g., Leisler's bats and barbastelles, a similarly high number of required roost sites has been documented. Although a large number of artificial breeding boxes has been distributed in German forests, they rarely have initiated colonization of a forest by bats.

For almost all species, the forest, forest edge, and canopy gaps are a regular part of the hunting grounds. In decreasing order of intensity of usage, we find Bechstein's bat, which

forages almost nowhere else, greater mouse-eared bat, barbastelle, brown long-eared bat, Nathusius' pipistrelle, Natterer's bat, Brandt's bat, lesser horseshoe bat (*Rhinolophus hipposideros*), greater horseshoe bat (*Rhinolophus ferrumequinum*), whiskered bat, Leisler's bat, Geoffroy's bat, serotine (*Eptesicus serotinus*), Daubenton's bat, grey long-eared bat (*Plecotus austriacus*)northern bat (*Eptesicus nilssonii*), common pipistrelle, noctule, pond bat (*Myotis dasycneme*), aparticolored bat (*Vespertilio murinus*). Depending on their flight behavior and hunting strategy, bats use all strata of the forest, from the space above the canopy down to the open forest floor. For example, Leisler's bats hunt above the canopy, Bechstein's bats fly close to the vegetation, and greater mouse-eared bats forage over and on the open floor. In addition, different species of bat favor different developmental stages of forest stands. Some species target high insect densities, such as those in canopy gaps and small clearings. Ponds, moist areas, forest meadows, areas not intended for wood production (e.g., timber storage sites), waysides, forest edges rich in flowers, and the natural system of canopy gaps are part of these important hunting grounds.

Depending on species, the size of the hunting grounds and the area used by an individual bat range from a few hectares to more than one hundred. Individual Bechstein's bats very faithfully returned to the same hunting grounds, even over several years. Therefore, the long-term availability of a forest habitat is an important conservation issue. The minimum area and the optimal biotope for a breeding colony of 20 Bechstein's bats was calculated to be 250-300 ha of deciduous forest that is rich in structure and with little undergrowth (ca. 20-30 %). Most likely, a colony hunting in a less-structured forest, e.g., a coniferous forest, must disperse over a larger area. Corresponding data were available from a study in the Fläming, south of Berlin, where the hunting area was more than four times as large. The minimum area for a breeding colony of 270 greater mouse-eared bats, which find 75 % of their food in the forest, was estimated to be 70-80 km^2. The most important type of stands for greater mouse-eared bats has an open forest floor, where these bats forage for ground beetles (carabids).

We made several recommendations for forest management, which are intended to serve bat conservation:

1. The type of cultivation and forest management should not include clearings or clearcuts larger than 0.5-1 ha.

2. Develop a network of roost sites at two levels, with the aim of permanently supplying 25-30 tree holes per hectare of old stand, corresponding to 7-10 trees. Level 1 involves securing a network of trees that already show holes due to rotting or made by woodpeckers, cracks in the trunk, or loose bark. Distances between hole hot spots should not exceed 1,000 m. Level 2 involves developing a network of successors for trees of level 1. If possible, chosen trees should already show signs of holes or ecological qualities like a fungus infestation.

3. Mark and protect known roost trees (summer and winter roosts).

4. Change coniferous monocultures into mixed stands of indigenous tree species typical for the site; increase harvest time.

5. If trees must be cut for safety reasons or because of pest infestation, trees or tree branches inhabited by bats should be secured.

6. Artificial breeding boxes cannot substitute for the lack of natural roost sites in the long term. Deployment of a new array of breeding boxes, e.g., in a spruce or pine monoculture, is useful only in connection with a simultaneous change in forest management, with the aim of permanently supplying a sufficient number of hole trees.

7. Depending on type of forest and species of bats occurring in a given forest, several supportive measures for the protection of hunting habitats may be considered:

a. For species that forage in open air space, provide clearings and gaps by harvesting trees in clusters.

b. For species that hunt inside the forest, increase the substratum and intermediate layer up to 20-30 % coverage by partial thinning of the canopy to increase light intensity and thus promote undergrowth.

c. For species hunting close to the forest floor, on the other hand, improve the free air space about 1 m above the ground by reducing undergrowth.

d. Support a canopy with high food production by not harvesting old trees and by enhancing the amount of light incident on such trees and their surroundings.

e. Increase sources of food by establishing tall perennial herbs along waysides and margins of forests (minimum 30 m at outer margins) by natural development and by establishing ponds (100-200 m^2 minimum) and forest meadows; re-establish wet forests by closing drainages and/or diverting waters; restore riparian forests and old river beds. Do not use pesticides, especially insecticides in case of pest infestation, but rely on preventive steps.

8. For protection of bats in forests, we further recommend the mapping of bats and periodical mapping of tree holes, e.g., as part of forest management plans and forest biotope inventories; providing seminars for forest owners, foresters, lumberjacks, and rangers; and developing a net of advisors.

The entire report of 374 pp is published in German: Meschede, A., and K.-G. Heller. 2000. Ökologie und Schutz von Fledermäusen in Wäldern (English translation: Ecology and conservation of bats in forests), Schriftenreihe für Landschaftspflege und Naturschutz, Heft 66, Germany, 374 pp., ISBN 3-7843-3605-1. The report can be purchased from BfN-Schriftenvertrieb im Landwirtschaftsverlag GmbH, D-48084 Münster, Germany, [phone +(0)2501/801-300, fax +(0)2501/801-204] for 39.80 DM.

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A Portable Mist-netting System for the Tropics and a Useful Handling Technique

Rebecca L. Shapley[1], A. A. Barnett[2], E. Henry[3], P. Benjamin[4], and M. McGarrill[5]
[1]Akodon Ecological Consulting, Suite 111A, 951 Bancroft Road, Concord, CA 94518;
[2]School of Life Sciences, University of Surrey Roehampton, London SW 15 3SN, England; [3]Evo's Ecological Touring Company, Georgetown, Guyana;
[4]Chenapou Primary School, Chenapou, Potaro, Section 8, Guyana; and
[5]Chenapou Village, Potaro, Section 8, Guyana [e-mail for RLS: infovore@wombat.net]

Although there are many mechanisms for erecting mist nets (Kunz and Kurta, 1988), few are suitable for sustained backpacking and use in remote areas. During recent fieldwork in Guyana (Barnett and Shapley, 1999), we used a modification of Gardner et al. (1989)'s mistnetting system that allowed for greater portability in environments where thin, tall saplings are readily available. We also developed a simple handling technique that reduces stress for captured bats during processing. The technique can also be used for other small mammals.

The Basic System

Gardner et al. (1989) describe a technique that allows nets to be raised to heights of 10 m on a rope-and-pulley system, similar to that used to run flags up a flagpole. The system consists of ropes, pulleys, and metal antenna poles that are stacked together. It allows mist-netting at heights greater than one can reach, while permitting nets to be brought down easily when a bat is caught but without lowering the poles that support the net. The net then easily is raised again to continue netting. However, the antenna poles suggested by Gardner et al. (1989) are heavy, each ca. 3 m long before stacking, making them unsuitable for work in remote areas or in rugged terrain. Additionally, they or their equivalent may be difficult to find in developing countries and awkward to carry on airplanes and through customs.

Our modification to this system involves "rope stations" (Figs. 1-2) that can be clamped to the top and bottom of saplings, providing attachments for the same flag-type rig, but without the necessity of carrying metal poles to the study site. The modifications use simple and inexpensive materials, available from a hardware store and easily transportable both internationally and by backpack. Nets can be raised to the height of sapling poles, often 4-6 m.

All four rope stations for a given netting rig consist of a marine-type adjustable clamp, with a diameter of 1-3 inches, and D-rings. Rope stations for the top of the saplings (Fig. 1) use two D-rings—one for guy lines coming off the sides of the rig and one on the opposite side of the sapling for the top-line and rope-pulley systems. Shims and smaller diameter clamps may be needed to ensure that the top clamps fit snugly on slender-topped saplings. Guy-ropes and rope-pulley systems are attached to the D-rings using spring-lock style mini-carabiners, providing for easy dismantling into components. Bottom rope stations (Fig. 2) are located several inches from the bottom end of the sapling, and each uses one D-ring to provide tension for the rope-pulley system, as well as a tie-off place for the top-line. The bottom of the sapling is shaved to a point to facilitate pushing it into the ground for added stability. Machetes are adequate for cutting and shaping the saplings. With adequate lengths of rope and saplings cut to appropriate heights, this system allows for raising either one or two nets (6 m by 2.6 m or 9 m by 2.6 m) to heights of ca. 6-7 m meters.

Modifications to the Rope-pulley System

Our experience has suggested a few improvements in the flag-rig rope-pulley system. First, the varying heights of saplings requires that some of the rope be tied or untied to make the resulting rope system an appropriate length. We started with a rope system appropriate for setting nets at heights of 10 m and doubled up extra rope below the snap-hook to shorten the whole system as needed (Fig. 3).

Second, use of a safety line with the loop and snap-hook section allows nets to be put onto the flag rig without fear of losing hold of the loop and finding it has whizzed out of reach to the top of the sapling. A good safety line consists of a short piece (15-30 cm) of thin rope with spring-locks on one or both ends. One spring-lock holds onto the rope loop, while the other holds onto the closed eye at the bottom of the snap-hook. Putting nets onto the flag rig now consists of two steps. First, open the snap-hook and loop connection as before, and then thread the loops of the net onto it. They will remain gathered up. Re-hook the snap-heads on the loop. Second, open one spring-lock on the safety-catch to allow all but the first netting loops to distribute themselves down the remainder of the rope. The extra step is worth the time saved by not having to bring down a pole or sapling and reset it (Fig. 3).

Finally, for added flexibility, an eye-bolt can be used to replace a rope station by screwing the eye-bolt into the sapling or tree. It is quite easy to do this for the bottom rope station when using a live tree as one side of the mist-net rig. Note that when using a live tree, to get either a marine-clamp with D-rings or an eye-bolt to serve as the top rope station above about 2 m requires either two people and some acrobatic actions, or some tree-climbing.

Protective Hammock

We devised a kind of "hammock" for the canopy nets out of a strip of tarpaulin. We recommend a black tarpaulin or other all-weather material, cut about 1.5 m longer than the canopy net is wide, and about 0.5 m wide. The tarpaulin should have grommet holes in all four corners so that it can be suspended underneath a deployed canopy net, thus providing a surface other than the ground for lowering the canopy net onto when a bat is captured and needs to be removed (Fig. 4). Additional holes in the middle of the tarpaulin would provide for water drainage.

In addition, the net may be stored in the hammock to prevent tangling and make re-deployment easier. Begin by lowering the net into the hammock. Bring the sides of the hammock together all along its length, and tie it closed with string. Disconnect the canopy net from the lines that pull it up. Once you have a system for where each rope is tied off (small, spring-lock carabiners can be very helpful for this), simply tie-up the hammock at your new location, attach the canopy net to the lines that will pull it up, and the net will go up easily. Finally, while netting, use of glow-in-the-dark-tape can help identify which rope will lower the canopy net for removing captured bats.

Handling after Capture

Once a bat is captured, many sources (Kunz and Kurta, 1988; Barlow, 1999) recommend that small cages of wood and wire mesh or cloth drawstring bags be used to contain bats until they can be processed and released. Again, sometimes it may not be practical to carry a small cage for captured bats, and this is when the bags work well. Drawstring bags can be made of cotton/polyester (or other material that is robust, breathable, washable, and lightweight) and be ca. 20 cm by 30 cm in finished size. Take care that the tops are tied off, that only one bat is kept per bag, if possible, and that adequate air is around the bag for the bats to breathe. We found that, following the rather traumatic event of being captured in a mist net, bats were frequently much calmer after being in the cloth bags.

Techniques for handling netted bats while processing them (making identifications and taking measurements, etc.) generally involve holding the bat with a hand. This is typically done by holding the bat by the nape of its neck, by containing the bat loosely in one's fist with a finger under its jaw to avoid being bitten, or by placing the back of one's index finger along the back of the bat and pinning its wings between the index finger and thumb and index finger and second finger, on the left and right side, respectively (Karen Campbell and Cal Butchkoski, pers. comm.). Each method is foreign and unsettling to the bat and provides many opportunities for the bat to take fright from headlamps or other visual or tactile stimulation.

Our modified technique involves keeping bats in bags during processing and removing only that portion of the bat that is needed at the moment. By keeping them in the bags as much as possible during processing, we were able to maintain calmer bats and reduce their apparent stress levels. Weight was taken inclusive of the bag, and the bag weighed separately once the bat was released. Measurements of body dimensions and observations on the bat's characters for species identification were conducted by gently exposing the necessary portion of the bat through the opening of the bag. Obviously, although the animal must be handled firmly, take care not to suffocate or crush it in the bag. This handling method is particularly useful whenever longer handling times are required.

Acknowledgments

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Literature Cited

Barnett, A. and R. Shapley. 1999. Final Report of the Potaro Plateau Zoological Expedition. Unpublished report to the Royal Geographical Society London, Linnean Society, and International Otter Survival Fund, 82 pp.

Barlow, K. E. 1999. Expedition field techniques. Bats. Expedition Advisory Center at the Royal Geographical Society, London, 69 pp.

Gardner, J. E., J. D. Garner, and J. E. Hoffman. 1989. A portable mist netting system for capturing bats with emphasis on *Myotis sodalis* (Indiana bat). Bat Research News, 30:1-8.

Kunz, T. H., and A. Kurta. 1988. Capture methods and holding devices. Pp. 1-29 *in* Ecological and behavioral methods for the study of bats (T. H. Kunz, ed.). Smithsonian Institution Press, Washington, D.C., 533 pp.

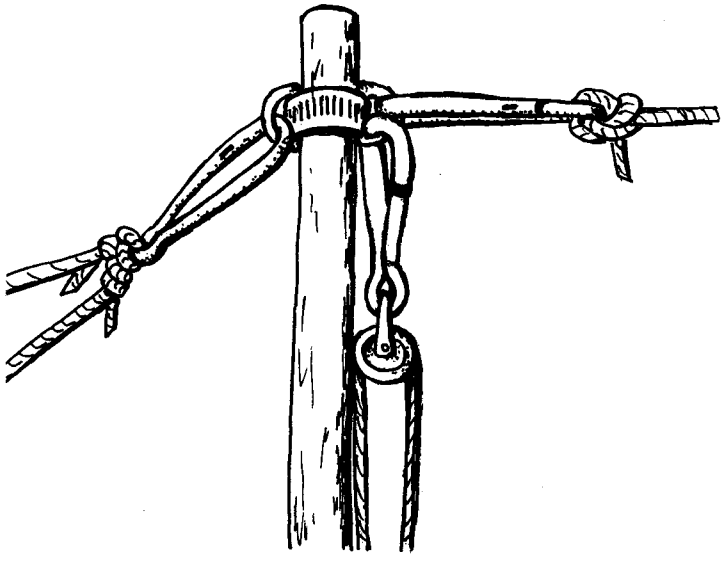

FIG. 1

FIG. 2

Figure 1. Rope station clamped to the top of a sapling. Rope station consists of an adjustable marine clamp and two D-rings. From top, clockwise, are attached the top line, which goes between the two sapling-poles, the pulley rig for raising the mist-net, and the guy-lines, which stabilize the poles.

Figure 2. Rope station at the bottom of a sapling. The station consists of an adjustable marine clamp and one D-ring. The bottom of the pulley rig for raising the mist-net is shown tied to the D-ring. On one pole, the top-line can be run through the top rope station and down to this bottom rope station where it is tied off (not shown). The bottom rope station alternatively could consist of an eye-bolt screwed into the sapling (not shown).

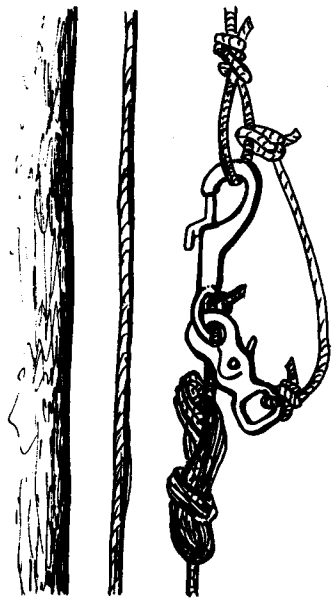

FIG. 3

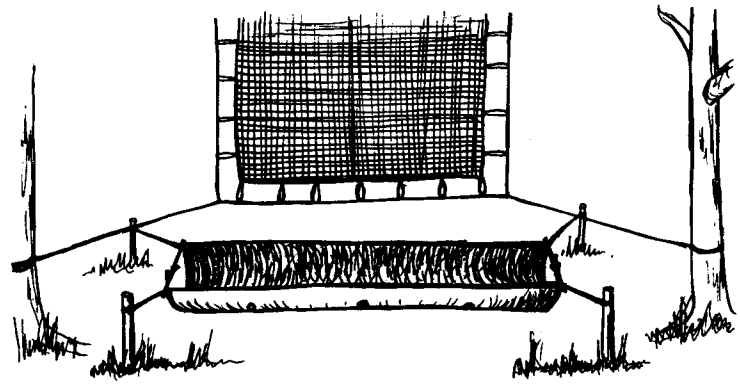

FIG. 4

Figure 3. Netting system showing the snap-hook and safety line where the mist-net is mounted onto the rig.

Figure 4. Canopy net shown with hammock to protect the net when it is lowered.

All figures by Donna Barthelemy - Reeder

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.

An Update on Human Rabies and Silver-haired Bats in the United States

Lawrence A. Hunt[1] and Kunwar P. Bhatnagar[2]
[1]Department of Microbiology and Immunology, and [2]Department of Anatomical Sciences and Neurobiology, University of Louisville School of Medicine, Louisville, Kentucky 40292
e-mails: lahunt01@gwise.louisville.edu & bhatnagar@louisville.edu

Additional information on human rabies and silver-haired bats, *Lasionycteris noctivagans*, is available since an earlier review of this subject in Bat Research News (Hunt and Bhatnagar, 1997). That review emphasized that 21 of 24 indigenous cases of human rabies in the United States from 1980-1997 had variants of rabies virus associated with insectivorous bats, although only one had a documented history of a bat bite. Also, 15 of 21 bat-associated cases had a rabies variant characteristic of the silver-haired bat.

Since our earlier report, the variant of rabies associated with *L. noctivagans* also has been reported by researchers at the CDC (Centers for Disease Control and Prevention) to be associated with the eastern pipistrelle, *Pipistrellus subflavus* (CDC, 1998, 1999a; Noah et al., 1998). Although this variant is the one most commonly associated with human rabies, neither species of bat commonly comes in contact with humans. Among all bats in the United States that tested positive for rabies and were identified to species or genus, *L. noctivagans* represented only 2-4.2% from 1997 to 1999, and *P. subflavus* represented an even smaller percentage (Krebs et al., 1998, 1999, 2000).

A single case of human rabies occurred in 1998 in the United States (CDC, 1999a). As with three of four human cases in 1997 (Krebs et al., 1998), genetic analysis indicated an association with the *L. noctivagans P. subflavus* variant, although there was no history of an animal bite or direct contact with any bat. Four additional cases were reported in 2000—two involving the *L. noctivagans P. subflavus* variant and two with the free-tailed bat, *Tadarida brasiliensis*, variant (CDC, 2000a). A bite by a bat was reported for only one of these four cases, although contact with bats was reported for the other three. Thus, 18 of 26 bat variant-associated human cases since 1980 were associated with bat species that are uncommon and rarely encountered by humans. In contrast, only five cases were associated with the *T. brasiliensis* variant and one with the big brown bat, *Eptesicus fuscus*, even though both species represent a large percentage of bats that tested positive for rabies in the United States in 1997-1999 (17.7-30.0% for *T. brasiliensis* and 42.4-56.6% for *E. fuscus*—Krebs et al., 1998, 1999, 2000). The *L. noctivagans P. subflavus* variant also was responsible for the death of a 9-year-old boy in Quebec in October 2000, the first reported human rabies case in Canada since 1985 (CDC, 2000b). The continued occurrence of these rare cases of bat-associated human rabies in the United States emphasizes the importance of prompt post-exposure prophylaxis after direct contact with a bat, unless the bat is tested and shown to be negative for rabies (CDC, 1999b).

Although terrestrial mammals, such as unvaccinated cats, have been proposed as possible intermediate hosts for transmission of bat-associated rabies virus to humans (Austin, 1998), variants of rabies virus from wild terrestrial animals (raccoons, skunks, or foxes) are presumed to be the major source of rabies in domestic animals (Krebs et al., 1998, 1999, 2000). Despite antigenic differences between the G protein of the *L. noctivagans P. subflavus* variant and human vaccine strains of rabies, both the human diploid cell culture vaccine and the purified

chick embryo cell culture vaccine protected mice against lethal infection with this bat variant of rabies (Dietzschold and Hooper, 1998). Therefore, one can assume that rabies vaccines for domestic animals also would protect against the *L. noctivagans P. subflavus* variant.

Literature Cited

Austin, C. C. Bats and rabies. 1998. Journal of the American Veterinary Medical Association, 213:1323-1325.

Centers for Disease Control and Prevention. 1998. Human rabies—Texas and New Jersey, 1997. Morbidity and Mortality Weekly Report, 47:1-5.

------. 1999a. Human rabies—Virginia, 1998. Morbidity and Mortality Weekly Report, 48:95-97.

------. 1999b. Human rabies prevention—United States, 1999: recommendations of the Advisory Committee on Immunization Practices (ACIP). Morbidity and Mortality Weekly Report, 48(RR-1):1-21.

------. 2000a. Human rabies—California, Georgia, Minnesota, New York, and Wisconsin, 2000. Morbidity and Mortality Weekly Report, 49:1111-1115.

------. 2000b. Human rabies—Quebec, Canada, 2000. Morbidity and Mortality Weekly Report, 49:1115-1116.

Dietzschold, B., and D. C. Hooper. 1998. Human diploid cell culture rabies vaccine (HDCV) and purified chick embryo cell culture rabies vaccine (PCECV) both confer protective immunity against infection with the silver-haired bat rabies virus strain (SHBRV). Vaccine, 16:1656-1659.

Hunt, L. A., and K. P. Bhatnagar. 1997. Human rabies and silver-haired bats in the United States. Bat Research News, 38:85-89.

Krebs, J. W., C. E. Rupprecht and J. E. Childs. 2000. Rabies surveillance in the United States during 1999. Journal of the American Veterinary Medical Association, 217:1799-1811.

Krebs, J. W., J. S. Smith, C. E. Rupprecht, and J. E. Childs. 1998. Rabies surveillance in the United States during 1997. Journal of the American Veterinary Medical Association, 213:1713-1728 [corrections to this article appear in Journal of the American Veterinary Medical Association, 214:1025].

------. 1999. Rabies surveillance in the United States during 1998. Journal of the American Veterinary Medical Association, 215:1786-1798.

Noah, D. L., et al. 1998. Epidemiology of human rabies in the United States, 1980 to 1996. Annals of Internal Medicine, 128:922-930.

Table 1. Human rabies associated with bats from 1998 to 2000 (CDC, 1999a, 2000a). Ln/Ps = *L. noctivagans P. subflavus* and Tb = *T. brasiliensis*.

Date of death	Locality	Age, gender	Viral variant	Known or suspected exposure
11 Nov 2000	Wisconsin	69, male	Ln/Ps	removed bats from house
25 Oct 2000	Minnesota	47, male	Ln/Ps	bitten by bat in house in August
10 Oct 2000	Georgia	26, male	Tb	bats in house, landed on patient
20 Sept 2000	Wisconsin	49, male	Tb	removed bat from house in June or July
31 Dec 1998	Virginia	29, male	Ln/Ps	none, worked on farm and road

Unusual Coloration in a Short-tailed Fruit Bat, *Carollia perspicillata*

José Enrique Escobedo-Cabrera[1], Álvaro F. Ramírez Santamaría[1], Carmen Pozo[1], and Livia León Paniagua[2]
[1] El Colegio de la Frontera Sur, Museo de Zoología-ECOSUR, Carr. Chetumal-Bacalar km 2, Zona Ind. 2, A.P. 424, C.P. 77000, Chetumal, Quintana Roo, México
e-mail: escobedo@ecosur-qroo.mx
[2] Universidad Nacional Autónoma de México. Museo de Zoología, Alfonso L. Herrera, Facultad de Ciencias, A.P. 70-399, C.P. 04510, México D.F., México

The short-tailed fruit bat, *Carollia perspicillata,* normally appears gray-brown overall, although individual hairs are tricolored—brown at the base, whitish in the middle and gray-brown at the tip. On 15 November 1998, we collected a beige-colored adult male, 10 km N of Chetumal (N18° 35'06" , W 88° 14'25") in the state of Quintana Roo, México. In this specimen, hairs were tricolored, but they were beige at the base, white in the middle and beige at the tips. The iris was normal in appearance (brown), flight membranes and uropatagium were beige, and ears and nose leaf were yellowish white. Naked areas were pinkish beige, and claws were whitish. The animal weighed 45 g at the time of collection and had a forearm length of 46 mm. The bat was prepared as a study skin and skull, with the body stored in 70% ethanol, and the specimen was deposited in the collection of El Colegio de la Frontera Sur (ECOSUR—#ECO CHM1690). We collected other specimens of *C. perspicillata* at the same time, but they had the typical grayish-brown color; hence, we believe that the coloration of our specimen was not due to geographic variation or intraspecific color variation. This is the first report of abnormal coloration in the genus *Carollia*.

The Use of Microscopic Hair Characters to Aid in Identification of a Bat Involved in a Damaging Aircraft Strike

Carla J. Dove and Suzanne C. Peurach
Dept. Vertebrate Zoology, National Museum of Natural History, Washington, D.C. 20560
Patuxent Wildlife Research Center, N.M.N.H., NHB 378, MRC 111 Washington, D.C. 20560

On 18 November 1999, a U.S. Air Force T-37-B aircraft sustained a damaging wildlife strike during a night flight (2100 hours) out of Randolph Air Force Base, Texas (29.20 N, 98.10W). Damage to the aircraft required replacement of the entire air conditioning pack at a cost approximating $10,000. While wildlife strikes (mainly involving birds) are known to cause millions of dollars of damage to aircraft each year (Burney 1999), bats have not been considered damaging threats. The damage to this aircraft is significant considering the average cost of a damaging bird strike to a T-37 is less than $200 (Trent Edwards, Randolph Air Force Base, pers. comm.).

The remains of the animal were recovered from the air conditioning intake and sent to the Smithsonian Institution, Division of Birds, for identification (case number 7402). The sample consisted of hairs, a section of forearm (41.5 mm) with a thumb (approx. 5.3 mm) and attached patagium of a bat. Hair was removed from the forearm to aid in identification.

A microslide of the unknown hair sample was prepared according to techniques described for feathers by Laybourne and Dove (1994). We examined the sample at low (100X), mid- (200X) and high (400X) power on a Zeiss comparison light microscope. From hair micro-

structure characters alone, we narrowed the identification possibilities to the family Molossidae based on comparisons with scalation patterns illustrated in Nason (1948) and the unique characters of long spine-like scales along the axis of the hair (Moore and Braun, 1983). We then prepared hair samples from museum specimens at the Smithsonian Institution of all molossid bat species that are known to occur in the vicinity of Randolph Air Force Base, Texas. These species are: *Tadarida brasiliensis*, *Nyctinomops macrotis*, *N. femorosaccus* and *Eumops perotis*. (Koopman, 1993, Hall, 1981). Although the material available from the air strike was limited, we were able to obtain several hairs for microscopic comparisons. The unknown hairs were dark in pigmentation and coronal and dentate in structure matching the description of *Tadarida* by Nason (1948). We agree with Nason (1948) that the scales are closer together in *Eumops* and that the dentate prongs of this genus are not as long as those of *Tadarida*. Although *Nyctinomops* was similar to the unknown sample in overall micro-structure, the hair was wider and the dentate structures were longer than our sample. Furthermore, based on information in Hall (1981), the possible species of *Nyctinomops* do not fit the forearm measurements (*Nyctinomops femorosaccus*, 45.5 - 49.2 mm; *N. macrotis*, 58.0-63.8mm) of the unknown sample. The unknown hair sample best matched *Tadarida brasiliensis* (Brazilian free-tailed bat) according to microscopic characters, macroscopic examination, and geographic distribution.

According to the database maintained by the U.S. Air Force at Kirtland Air Force Base, New Mexico, this represents the first documented damaging bat strike to a U.S. Air Force military aircraft in this country and may become an issue for concern when planning times and routes of aircraft flights. Additionally, the same method of identification was used here as is commonly applied to bird strike identifications and involves the use of microscopic characters to help determine species identification.

We thank A. L. Gardner (USGS-Mammals) for permission to sample museum specimens and for translating the summary into Spanish. Lt. Curt Burney queried the BASH database at Kirtland Air Force Base, N.M. A. L. Gardner, R. P. Reynolds and R. D. Fisher provided helpful comments on the manuscript.

Literature Cited

Burney, C. 1999. BASH 1998. Flying Safety. 55(4): 4-7.

Hall, E. R. 1981. The mammals of North America. Vol. I, second edition. John Wiley & Sons, New York, 600 pp.

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

Laybourne, R. C. and C. J. Dove. 1994. Preparation of birdstrike remains for identification, pp. 531-534 *in* Proceedings and working papers of the Bird Strike Committee Meeting Europe 22, Vienna 1994.

Moore, D. W. and J. K. Braun. 1983. Keys to the hairs of the families Soricidae, Vespertilionidae, and Muridae within Tennessee. Journal of the Tennessee Academy of Science, 58 (3 & 4): 40-43.

Nason, E. S. 1948. Morphology of hair of eastern North American bats. American Midland Naturalist. 39 (2): 345-361.

News From around the World

From Bristol, England

Research in Gareth Jones' laboratory at Bristol University continues with the following projects. Dr Colin O'Donnell and Jane Sedgeley are spending sabbatical time in the lab, writing up their findings on New Zealand bats. I hope to spend some time writing up my prey detection experiments on *Mystacina tuberculata* with them soon. Another Kiwi, Dr Stuart Parsons, has recently written up his work on acoustic identification of bats by using neural networks, and is in the first year of a 3-year study relating signal design to flight speed in echolocating bats, using stereo videogrammetry and acoustic localization methods. We received funding for another 3 years study on genetic structure and paternity in greater horseshoe bats. This work will be performed by Dr Steve Rossiter, and also involves Dr Chris Faulkes of Queen Mary College, University of London, and the long-term studies of Dr Roger Ransome. We are building up long term pictures of genetic relatedness, and relating relatedness to behavioural interactions. Dr Rob Houston is developing a website about biosonar, which will hopefully soon be online at http://www.biosonar.bris.ac.uk/. Arjan Boonman has migrated to Tübingen, and is writing up his thesis on signal design and intensity compensation by echolocating bats. Danilo Russo is completing his thesis on habitat use of Italian bats studied by acoustic methods and also involving a radio-tracking study of Mediterranean horseshoe bats *Rhinolophus euryale*. Katie Parsons is in the second year of a study looking at swarming in bats, and has been covering many miles following Natterer's bats from swarming sites. Adora Thabah has started a project on bats in northeast India, and Pia Wohland completed a Diplomarbeit on parasite loads and grooming behaviour in greater horseshoe bats. I have projects running with Dr Wieslaw Bogdanowicz (Warsaw), on skull morphology of pipistrelles, and Dr Shuyi Zhang (Beijing) on bats in China. I have been supervising further work on habitat use by the two cryptic pipistrelle species (Ian Davidson-Watts), and on winter ecology of lesser horseshoe bats (Carol Williams). I've also got interested in problems of discrimination between echolocating bats and mates by moths that emit ultrasound for courtship.

Submitted by Gareth Jones, Bristol University, Bristol, U.K.

For more details see: http://www.biosonar.bris.ac.uk/batlab/.

e-mail:

From Alice Springs, Australia

In 2000 I returned to Australia after completing a two-year Humboldt Foundation research fellowship at the University of Munich, Germany. My time in Germany was spent in the laboratory of Professor Gerhard Neuweiler, where I enjoyed successful collaboration with Neuweiler, Jan Grunwald and Gerd Schuller. My research examined the foraging and echolocation ecology of leaf-nosed and horseshoe bats. In particular, I carried out a project on a wild population of Schneider's leaf-nosed bat, *Hipposideros speoris*, at Sigiriya a World Heritage Cultural site in central Sri Lanka.

In January 2001 I moved to Alice Springs in central Australia to take up a research scientist position in the Conservation Management section of the Parks and Wildlife Commission of the Northern Territory. For those who are not familiar with Australia, Alice Springs is a moderate sized town (population 28,000) which serves an important function as a service centre for a booming tourist industry centred on national parks including Uluru-Kata Tjuta (Ayers Rock- The Olgas), Watarrka (Kings Canyon) and West MacDonnell. My research will cover a range of threatened animal species, mostly endangered marsupials. To provide some background to my research; about one third of the mammal species that occurred in central Australia have gone extinct over the past 60 to 70 years. These species include the ghost bat, *Macroderma gigas*, which is now present only in northern Australia. Other species are critically endangered and are actively managed to ensure their survival.

Initially I do not expect to be able to devote too much time to bats, but I hope to phase in a project looking at roost availability for hollow-roosting species. In the meantime, I have several papers from my Sri Lankan research to finish off. Also I will travel to Sri Lanka in October this year to run a workshop on

bat conservation and research with Gerd Schuller and Jan Grunwald from the University of Munich. The workshop will primarily be for staff of the Sri Lankan Department of Wildlife Research. Our primary aim will be to further the interest of the research and conservation staff in bats in a country where large mammals, especially the Asian Elephant, are the primary focus of conservation efforts.
Submitted by Chris Pavey, e – mail: chris.pavey@nt.gov.au

From France and French Overseas Territories

This is a progress report summary for the French Overseas Territories Bat Conservation Specialist Group. Created last year within the French Mammal Society, the aim of the group is to promote bat conservation in the overseas territories of France (which are Guadeloupe & Martinique Islands in the Caribbeans, French Guiana in South America, Reunion & Mayotte Islands in the Indian Ocean, New Caledonia Archipelago, and Wallis & Futuna Islands in the Pacific Ocean) and develop regional cooperation in reseach, conservation and environment education programs. Our current main work is to develop a bat-oriented GAP analysis for all territories and collect inventory data towards an atlas and Action Plan for bats of the French overseas territories. So far, we had team fieldworking in Martinique and Guadeloupe, French Guiana and I spent 2 month in the rainforests and savanas of New Caledonia to search for rare endemic species of *Notopteris, Chalinolobus, Nyctophylus, Pteropus* and *Miniopterus*. We are looking forward to any collaboration with bat researchers and conservation NGOs in the regions cited above, and welcome comments or support of any kind.

Submitted by Ronan Kirsch, National Natural History Museum, Paris, and Coordinator, French Overseas Territories Bat Conservation Specialist Group. Email : kirsch@mnhn.fr

From Regina, Saskatchewan, Canada

My research of late has been concentrated on the goatsucker front but there is some bat work in the pipeline. My research this upcoming summer will be to continue a project begun by an honours student (Quinn Fletcher) on the use of torpor by Common Nighthawks in the Cypress Hills of SW Saskatchewan. About a decade ago I found evidence that nighthawks would use torpor in the Okanagan Valley of British Columbia, but Quinn found some good evidence that these birds may be physiologically capable in Saskatchewan.

I currently have 5 graduate students heading into the home stretch re writing up theses. Chris Woods is finishing his Ph.D. on torpor and hibernation by Common Poorwills, Darren Sleep is writing up his M. Sc. on an experimental test of clutter tolerance by bats and Jennifer Psyllakis is writing her M. Sc. on bats used of remnant (post fire) landscapes in northern British Columbia. Two other students in my lab are also finishing up; Danielle Todd is completing her M. Sc. on post-fledgling dispersal by Burrowing Owls and Janna Foster whose M. Sc. project concerned survey methods and use of native prairie by Long-billed Curlews. All and all there shoud be a few thesis defenses around here in the near future. Once all those folks are done, the lab is going to seem rather empty. Left behind will be Craig Willis (Ph.D.) who is studying the use of torpor by big brown and hoary bats, Ray Poulin (Ph.D.) who is working on Burrowing Owl reproductive success in relation to population cycles of small mammals, Steve Davis (Ph.D.) who is evaluating the effect of native prairie fragmentation on grassland songbirds and Jeff Lane (M. Sc.) who has begun his M. Sc. project on the use of torpor by Whip-poor-wills in South Dakota.

Submitted by Mark Brigham, University of Saskatchewan, Regina, SK Canada.
E-mail: mark.brigham@uregina.ca

From New York, NY, U.S.A.

Current research programs in the Department of Mammalogy at the American Museum of Natural History include the following projects.

Rob Voss, Nancy Simmons, and David Fleck are continuing work on an inventory project in the Río Galvez drainage of Peru, a remote region that is today inhabited only by a small population of Matses Indians. Over 500 bats were captured in the first three seasons of fieldwork, including over 40 species.

David, who is a linguist and ethnozoologist, has been investigating indigenous knowledge of bats and the ways in which they are described in the Matses language. With the help of Matses men trained to search for bats and record information, they have identified roost sites of many bat species, including some for which such data were previously unavailable.

In addition to fieldwork, other accomplishments include the recent publication of a monograph on the phylogeny of mormoopids by Nancy and Tenley Conway. Tenley is now off in graduate school at Rutgers (studying patterns of land use, not bats), and we miss her. Nancy has also been collaborating with Elisabeth Kalko (University of Ulm) on a study of the evolution of echolocation calls and utility of call features as phylogenetic characters. A pilot study focussing on noctilionoids is going well and (with luck!) they will present the results at upcoming bat meetings. In her spare time, Nancy has been preparing the Chiroptera chapter for the next edition of Mammal Species of the World.

Scientific Assistant, Eric Stiner is continuing his work on the phylogeny of Megadermatidae. Eric and Nancy presented some preliminary results at the North American Symposium on Bat Research in Miami last fall.. Eric is now working on new dental characters to add into their data matrix.

Nancy and Bill Schutt (Southampton College) are collaborating with Ron Van Den Bussche (Oklahoma State University) on a NSF funded project to resolve higher-level bat phylogeny using molecular sequences and morphological data, coded at the species level. While Ron and his graduate student Steve Hoofer have already sequenced most of the necessary taxa, much morphological data remains to be collected. Jonathan Geisler has been brought onto the project as Nancy's postdoctoral research assistant, to assist in the collection and analysis of morphological data. He has returned to researching bat phylogeny after a 3 year hiatus, in which he completed his Ph.D. at Columbia University. Nancy, Jonathan, and Bill hope to start analyzing some of the data this summer.

Bill Schutt is exploring the functional morphology of, and convergence between, the quadrupedal bats *Desmodus* and *Mystacina*. Bill plans to present the results of this research at the International Bat Meetings in Malaysia. He and Nancy are also working on the functional morphology of the hindlimb and calcar in *Cheiromeles*. Bill Schutt is collaborating with two of his undergraduate students from Southampton College, Heather Knapp and Crystal Aquaviva. Heather and Bill will look for more hindlimb characters that are useful for resolving interfamilial relationships. He is also working with Crystal Aquaviva on modifications to the tendon sheath in the hindlimb digits of phyllostomines. The tendon sheath in phyllostomines may function like the digital lock described in other bats and in Dermoptera.

In addition to staff and postdoctoral fellows, the Department of Mammalogy has an energetic and productive group of graduate students who are pursuing degrees at several universities: Andrea Wetterer, Liliana Dávalos, Valeria da Cunha Tavares, Adrian Tejedor, and Heather Peckham. Andrea Wetterer (Columbia University) is completing her dissertation on the evolution and ecological diversification of phyllostomid bats. She is currently analyzing a data set that includes more than 200 morphological characters and 2,000 base pairs of sequence data. Andrea expects to finish her work this summer. Among her major accomplishments for the previous year is a monograph with Matthew Rockman and Nancy Simmons on the phylogeny of phyllostomid bats.

In 1999 Liliana Dávalos (Columbia University) surveyed the understory bats of the cloud forests of Tambito (southwest Colombia), with grants from Bat Conservation International, the Royal Geographic Society, and the Institute of Latin American and Iberian Studies at Columbia University. Tissue samples were gathered from some bats and are being used in a joint project with Sharon Jansa (Smithsonian Insitution). They have sequenced the complete cytochrome *b* gene for several phyllostomids, most notably *Platalina*. Liliana has also received a Theodore Roosevelt Grant and support from the Explorer's Fund to research the patterns of geographical differentiation of cytochrome *b* of Antillean endemic bats (part of her dissertation)

Valeria da Cunha Tavares (City University of New York) has been working with Nancy on the phylogeny and biogeography of the phyllostomid subtribe Stenodermatina. Preliminary results were presented at the North American Symposium on Bat Research in Miami last year. Valeria is also working on the phylogenetic relationships within the*Vampyressa* complex of phyllostomids (part of her dissertation). This project includes a revision of *Vampyressa* (sensu Koopman 1994), with a reevaluation of the number and diagnosis of species in this genus. She is also working on the biology of *Pygoderma bilabiatum*, based on previous fieldwork in Brazil and museum specimens.

Adrian Tejedor, who joined the program last fall, is working on the diet of *Phyllostomus elongatus*, *P. latifolius*, and two other species of South American bats using fecal pellets. He is also starting a pilot project on the cranial evidence for the phylogeny of the genus *Kerivoula*. Heather

Peckham (Yale University) will be conducting a pilot study this summer for her dissertation. She is studying the role of frugivorous bats in the regeneration of degraded tropical ecosystems in the Panama Canal watershed, and she hopes that the results of her research can be used to manage particular native species in local reforestation projects.

Submitted by Jonathan Geisler and Nancy Simmons
emails: geislerj@amnh.org and simmons@amnh.org

From Calgary, Alberta, Canada

A brief synopsis of what is going on in the bat lab at the University of Calgary. Krista Patriquin has completed her M. Sc. field work and is writing her thesis for a spring defence. She worked as part of a huge, multidisciplinary team investigating the effects of different harvest regimes (thinning vs. clearcutting) in boreal mixedwood forests in northern Alberta. Monitoring foraging activity in different treatment patches, Krista predicted that thinning and clearcutting would have different effects on foraging bats with different flight styles. She is thrilled to find that preliminary analyses suggest the bats agree with her predictions!

Working with Krista amongst the blackflies and mosquitoes, Laureen Hogberg conducted her B. Sc. honours project. She investigated whether bats use small remnant patches of forest, left in clearcuts, as foraging areas. Despite low numbers of bats, Laureen has found that such patches do serve as foraging habitat while bats avoid the centre of clearcuts.

Cori Lausen has also finished her M. Sc. fieldwork on roost selection, roost microclimate, and use of torpor by big brown bats (*Eptesicus fuscus*). She studied female bats roosting in rock crevices in southern Alberta and has some intriguing data showing that pregnant, lactating and post-lactating individuals use roosts with different thermal dynamics. Cori is writing her thesis and will be starting a PHD this summer. She will be using molecular techniques to examine the effect of naturally fragmented habitat in the prairies on the genetic structure of bat populations.

Lydia Hollis has completed the first year of her PHD in which she is investigating the ontogeny of thermoregulation of big brown bats. She worked with Cori last summer and used radio-telemetry to monitor the use of torpor by pups and flying juveniles. She will continue that work this summer and conduct various feeding experiments to test predictions regarding the influence of diet on the use of torpor.

Two new graduate students joined our research group last September. Tanya Luszcz actually started field work last summer and is busily fighting with computer programs to analyze her data and prepare for the coming field season. Tanya is measuring the foraging habitat preferences of bats in the complex forests of southwestern British Columbia. The project is being conducted in collaboration with forest companies and has obvious management implications for an area in which forestry is a major land use.

Donald Solick emigrated from the developing country immediately to the south of us and has quickly learned how to spell colour and behaviour, and measure things in metric like most of the world does. For his M. Sc. research he will be testing predictions regarding the morphological, physiological, and behavioural differences in populations of *Myotis evotis* occupying very different habitats (cool, wet forests in the mountains versus hot, dry, treeless prairie).

Abbie Dennis also worked with us last summer. She found time after her full-time day job to survey the bats and their habitat preferences in the city of Calgary. She is analyzing those data for her B. Sc. thesis and trying to convince skeptics that there really are lots of bats in the city!

As for me, I spend the summers trying not to impede the progress of my students too much. Mark Brigham and I also continue to combine research with family holidays and amaze our colleagues that we can actually get that stuff published. I am still writing papers from my last sabbatical (Australia) and dreaming of the next one. In the meantime I have 12 years of population dynamics and survival data on big brown bat colonies to analyze!

Submitted by Robert M. R. Barclay, Department of Zology, Calgary,Alberta, Canada
e-mail: barclay@ucalgary.ca http://www.ucalgary.ca/UofC/faculties

From Knoxville, Tennessee, U.S.A.

Our lab at the University of Tennessee in Knoxville, is involved in a variety of ecological, behavioral and genetic studies of bats.

Continuing the lab's long-term studies on Brazilian free-tailed bats (*Tadarida brasiliensis*) Amy Russell's PhD research involves analyzing mitochondrial DNA sequence data and developing microsatellite loci that will be used to determine population size, population structure, and the phylogeography of this species throughout its range in North, Central, and South America.

Lisa Bailey (known to many of you as Lisa Comeaux - new name, same person) is involved in her PhD research determining parentage of captive-bred Rodrigues Island fruit bats (*Pteropus rodricensis*) in order to reconstruct the species studbook. This information is being obtained utilizing microsatellite and mitochondrial analyses. The results of this study will be used to design breeding programs for this highly endangered and inbred species in order to maintain maximum levels of genetic variability. Lisa and Gary McCracken are continuing to work with the Lubee Foundation to provide genetic information on parentage to assist the conservation of genetic diversity in the captive breeding colonies of other Old World fruit bats at Lubee.

Jenny Holmes is in Australia where she is conducting field research and collecting samples for microsatellite DNA analysis to investigate the social structure and mating behavior of the Grey-headed flying fox (*Pteropus policephalus*).

Leslie Saidak and Gary are continuing studies on the population genetic structure of the endangered Indiana bat (*Myotis sodalis*). In this project, gene flow among both winter and summer colonies is being assessed using mitochondrial DNA sequences and nuclear microsatellite markers. Research to date indicates that high levels of gene flow occur among colonies both in winter and summer habitat. No genetically isolated colonies have been identified. Weak genetic structuring among females in maternity colonies is attributed to recruitment of female offspring into natal colonies. High levels of gene flow are attributed to the movements of individuals, and possibly to mating during fall swarming events at hibernacula.

Sunitha Vege's project involves the use of molecular techniques (PCR) to identify DNA sequences of target moth species, corn earworm (*Helicoverpa zea*), tobacco budworm (*Heliothis virescens*), beet armyworm (*Spodoptera exigua*), and fall armyworm (*S. frugiperda*), in the feces of bats that have eaten these agricultural pests. Sunitha completed her MS in December 2000, and is continuing this work in the lab, the difference being she is now being paid to do it. As a side project, Sunitha also has demonstrated that the microsatellite genotypes of bats can be obtained from the bats' DNA in their feces.

In addition to Sunitha's work, our research on the foraging behavior of Mexican free-tailed bats (*Tadarida brasiliensis mexicana*) and their impact on major agricultural pest insects is ongoing in a variety of directions. Gary is continuing his collaborative research with Dr. John Westbrook, USDA, College Station, TX on foraging behavior of free-tailed bats on agricultural pests in Texas, with a new project (just submitted to the USDA, Biological Pest Control Program) that will quantify the agricultural effects of insect-eating by bats in experimental field plots. The first workshop on assessing the agricultural and economic impact of insect-eating by the huge bat populations in Texas was held in Texas in December 1999, and was followed by a second workshop in Monterrey, Mexico in September 2000. Along with Gary and Ya-Fu Lee (who completed his PhD at Tennessee in 1999), a group of ecologists, economists, agricultural researchers and modelers (including Tom Kunz, Rodrigo Medellin, Arnulfo Moreno, Merlin Tuttle, Steve Walker, John Westbrook, and others) participated in one or both of these workshops. Tom Kunz and his colleagues at Boston, Gary and his colleagues at Tennessee, and others, have collaborated on a proposal to the National Center for Ecosystem Analysis to continue efforts to evaluate the ecosystem services provided by the bats. The same group of characters (i.e the mafias from Boston, Tennessee, Mexico, and BCI - spearheaded by Godfather Kunz) are collaborating as I write this on a proposal to the NSF Biocomplexity Program.

Having some free time, in the fall 2000, Gary participated in the Pan American Rabies Conference in Lima, Peru, and, just after the meeting in Peru, Gary, Steve Walker, and Arturo Mann conducted a workshop on bats and public health issues for the Chilian Ministry Health in Santiago, Chile.

Submitted by Gary McCracken e-mail: gmccrack@utk.edu

Notes

Mini - cameras

There is a website that offers miniature digital cameras and video cameras, many of them as cheap as $40.00, including some that are infrared sensitive - they are great for night photos of wild bats. Available from www.supercircuits.com and are intended for surveillence use. See some of our results on BATCAM at www.cloudforestalive.org. We have a great video but can't put it on the web from here. The guy who actually designed the setup and adapted these miniature cameras to it is named Jason Roberts, and would probably be glad to answer questions, even though he has just left the position here in Costa Rica to return to the U.S. His address is: jasonkroberts@yahoo.com.

Submitted by Dick Laval

Eighty mile range extension for *Leptonycteris nivalis.*

On September 6, 2000, Mark Hakkila (BLM, Las Cruces) and Lyle Lewis (USFWS) placed mist nets across and adjacent to the Gila Lower Box in Hidalgo County, New Mexico. At 10:43 P.M., an adult male Mexican long-nosed bat (Leptonycteris nivalis) was captured in a 7' x 30' mist net placed across the Gila River. After a forearm measurement was taken, the bat was released. Sixteen other bats, *including Myotis yumanensis, Pipistrellus hesperus, Lasiurus cinereus, Tadarida brasiliensis, M. ciliolabrum,* and *M. volans* were also captured the same night. In discussions with Mike Bogan (University of New Mexico), suggest that this captured Mexican long-nosed bat represents an 80-100 mile range extension north of previously documented animals of this species. Submitted by Lyle Lewis

ANNOUNCEMENTS

SUMMER WORK

Bat Conservation and Management of Mechanicsburg & Carlisle, Pennsylvania is accepting letters of interest for summer 2001 work in NW and central Pennsylvania, Ohio, New York, and possibly Virginia and West Virginia. A number of full time Team Member positions are available for the period of between May 14 (or earlier) through August 15. A Team Member position may also be available (previous mist net, bat ID experience, references required).

Flexible schedule; Should have own vehicle and valid license; Must work late into the night on uneven terrain; Must have rabies pre exposure vaccination, or be willing to obtain; Approximate work times are 4 PM - 2 AM; Only field work is available. Travel is a must; Must be willing to operate out of field camps; Will train.

Serious parties should reply directly to: John Chenger (john@batmanagement.com) or call 717-795-7527. Please feel free to pass this message along where appropriate.

Submitted by John Chenger http://www.batmanagement.com

THREE FIELD TECHNICIANS

Three field technicians are needed from May 10 – August 31, 2001 to assist with radiotelemetry study of red bats (*Lasiurus borealis*) in east-central Mississippi. Duties will include capturing and radio-tagging red bats, all-night telemetry, locating day roosts, and habitat sampling of day roosts. Two technicians will have primary duty of all-night telemetry and 1 technician will have primary duty of locating day roosts. Individuals with previous mist-netting (bats or birds) and telemetry experience are preferred. Applicants must be willing to work in the hot, humid, and buggy Southeast. $7.00/hr., housing and field vehicles provided while conducting field work. Please send a cover letter, resume, and name, phone number, address, and e-mail of 3 references to:

Leslie Welch, Mississippi Cooperative Fish and Wildlife Research Unit, MSU, Box 9690, Mississippi State, MS 39762 Tel. 662-325-7778; welchleslie@hotmail.com

Contact Leslie Welch or Dr. Darren Miller, Weyerhaeuser Co., Columbus, MS 39704 (662-245-5249; darren.miller@weyerhaeuser.com) or Dr. Francisco Vilella, Mississippi Cooperative Fish and Wildlife Research Unit (662-325-0784; fvilella@cfr.msstate.edu) for more information.

GRADUATE RESEARCH ASSISTANTSHIP

One M.S. graduate research assistantship is available in the Department of Forest Resources, Clemson University for a 2-year study of the effects of fuels management (thinning and burning) on forest bat community composition and activity. Previous experience working with bats is preferred. Additional qualifications include a B.S. in wildlife biology, zoology, forestry, or related field, GPA >= 3.0, and GRE>=1500 (V+Q+A). Starting date is June 2001 or earlier.

Interested students should submit a letter of interest, CV, a transcript unofficial is fine for now), a summary of GRE scores, and the names and phone numbers of three references to:

Susan Loeb, Department of Forest Resources, Clemson University, Clemson SC, 29634 - 1003 **Deadline: 3/21/2001.**

Email: sloeb@clemson.edu Tel. (864) 656-4865 Fax: (864) 656-1407

THREE GRADUATE ASSISTANTSHIPS

Three (3) Ph.D. assistantships are available to study the effects of land use and landscape fragmentation on biotic assemblages of the central hardwood region, U.S.A. These assistantships are available as part of a larger consortium project involving Purdue University, University of Missouri-Columbia, and University of Tennessee-Knoxville. One assistantship in fragmentation will be provided by each university. Successful applicants will investigate the impacts of agriculture, forestry, and urbanization on the distribution and viability of one or more of the following groups: granivorous rodents, mesocarnivores, vespertilionid bats, forest passerines, salamanders, anurans, prairie wildflowers, forest

herbs, or fine hardwoods. Students will be expected to participate in a large, interdisciplinary team and to work collaboratively with their counterparts at the other consortium universities in all stages of research, resulting in an enhanced understanding of species ecology and predictive models of occurrence or abundance at spatial scales ranging from local to regional. Results also will be integrated with data from contemporaneously conducted socio-economic research to create decision tools for guiding land-use decisions. Numerous opportunities exist for coordinating research efforts to investigate effects of habitat management or ecological interactions at a finer scale, including response to burning, timber harvest, and agroforestry practices, indirect interspecific effects, behavioral effects of habitat edges, or trophic cascades.

Start dates for assistantships are flexible, beginning as early as 1 May or

as late as 31 December 2001. Applications will be reviewed beginning on 6 March and continuing until suitable candidates are identified for all positions. Successful applicants will receive the stipend and associated benefits for graduate research assistants at each of the respective institutions. Please email or arrange to have the following application materials sent to one of the principal investigators listed below:

1. Statement of purpose, indicating your research interests and long-term goals;
2. The order of preference for the three universities, if you are interested in having your application considered by more than one member of the consortium;
3. A resume containing relevant courses and work experience, as

well as GPA and GRE scores;

4. Letters of reference from three individuals (an email letter is preferable, followed by postal delivery of a signed version)

Application information will be shared among the institutions during the initial screening process to ensure equitable treatment of applications and to achieve the most appropriate balance of research interests and capabilities.

Send application materials to one of the following:

Dr. Robert K. Swihart, Department of Forestry and Natural Resources, Purdue University, W. Lafayette, IN 47907-1159 e – mail: rswihart@fnr.purdue.edu Tel.765-494-3566

Dr. J. Mark Fly, P.O. Box 1071, University of Tennessee-Knoxville, Knoxville, TN 37901 e – mail markfly@utk.edu Tel. 865-974-7979

Dr. William B. Kurtz, 124-A BNR Building, University of Missouri-Columbia, Columbia, MO 65211 e – mail: kurtzw@missouri.edu Tel. 573-882-4567

Search for a Bat Biologist Texas Parks and Wildlife, Austin, TX.

Job Description: (Program Specialist III). Biologist in the Wildlife Diversity Program with primary responsibilities for implementing the Texas State Bat Conservation Plan in cooperation with Bat Conservation International. Works directly with field staff, state and federal land managers, private landowners, corporate land managers, and others in the formulation of bat monitoring and management recommendations and other conservation planning in Texas. Coordinates education and outreach efforts, monitoring, and habitat enhancement activities throughout Texas. Conducts workshops and training activities. Disseminates information to the general public through public outreach, education opportunities, news releases, radio/TV interviews, and other programs and presentations. Prepares reports and management brochures /publications.

Education: Graduation from an accredited college or university with a B.S. degree in wildlife, wildlife management, wildlife ecology, zoology, or closely related natural resource discipline with course work in bat research, habitat conservation and/or management.

Experience: Three year's experience in the wildlife conservation profession. A master's degree may be substituted for one year's experience and a Ph.D. may be substituted for two year's experience.

Salary: $3,471 per month (pending approval from the TPW reclassification procedure).

More Information: A complete job announcement and application form are available at: www.tpwd.state.tx.us (choose "Jobs" and "Wildlife Division").

Also contact Paul Robertson, (512-912-7044), e – mail: paul.robertson@tpwd.state.tx.us

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.

BAT BOOKS

Hutson, T. 2000. Bats. Colin Baxter Photography, Grantown-on-Spey, 72 pp. ISBN 1900455676

ANATOMY

Reep, R. L. 2000. Cortical layer VII and persistent subplate cells in mammalian brains. Brain, Behavior & Evolution, 56: 212-234. [Univ. Florida, Coll. Vet. Med., HSC, Dept. Phys. Sci., Box 100144, Gainesville, FL 32610; reep@ufbi.ufl.edu]

DISTRIBUTION/FAUNAL STUDIES

Brant, J. G., and R. C. Dowler. 2000. Noteworthy record of the seminole bat, *Lasiurus seminolus* (Chiroptera: Vespertilionidae), in Val Verde County, Texas. Texas Journal of Science, 52: 353-355. [Texas Tech Univ., Dept. Sci. Biol., Lubbock, TX 79409; robert.dowler@angelo.edu]

Solari, S., V. Pacheco, and E. Vivar. 1999. New distribution records of Peruvian bats. Rev. Peru. Biol., 6: 152-159. [Dept. Mastozoología, Museo de Historia Natural-UNMSM, Aptdo. 14 0434 Lima 14, Perú]

Timm, R. M., R. K. LaVal, and B. Rodríguez-H. 1999. Clave de campo para los murciélagos de Costa Rica. Brenesia, 52: 1-32. [btimm@falcon.cc.ukans.edu]

ECHOLOCATION

Parsons, S., A. M. Boonman, and M. K. Obrist. 2000. Advantages and disadvantages of techniques for transforming and analyzing chiropteran echolocation calls. Journal of Mammalogy, 81: 927-938. [Univ. Bristol, Sch. Biol. Sci., Woodland Rd., Bristol BS8 1UG, Avon; stuart.parsons@bristol.ac.uk]

Schmidt, S., S. Hanke, and J. Pillat. 2000. The role of echolocation in the hunting of terrestrial prey - new evidence for an underestimated strategy in the gleaning bat, *Megaderma lyra*. Journal of Comparative Physiology A, 186: 975-988. [Tierarztliche Hsch. Hannover, Inst. Zool., Bunteweg 17, Haus 218, D-30559 Hannover, Germany; sabisch@zoologie.tiho-hannover.de]

ECOLOGY

Elangovan, V., G. Marimuthu, and T. H. Kunz. 2001. Temporal patterns of resource use by the short-nosed fruit bat, *Cynopterus sphinx* (Megachiroptera: Pteropodidae). Journal of Mammalogy, 82: 161-165. [Kunz: Boston Univ., Dept. Biol., 5 Cummington St., Boston, MA 02215; kunz@bu.edu]

Fellers, G. M. 2000. Predation on *Corynorhinus townsendii* by *Rattus rattus*. Southwestern Naturalist, 45: 524-527. [Western Ecological Res. Center, U. S. G. S., Point Reyes National Seashore, Point Reyes, CA 94956]

Fenton, M. B., M. J. Vonhof, S. Bouchard, S. A. Gill, D. S. Johnston, F. A. Reid, D. K. Riskin, K. L. Standing, J. R. Taylor, and R. Wagner. 2000. Roosts used by *Sturnira lilium* (Chiroptera: Phyllostomidae) in Belize. Biotropica, 32: 729-733. [York Univ., Dept. Biol., 4700 Keele St., N. York, ON M3J 1P3, Canada]

Kerth, G., K. Weissmann, and B. Konig. 2001. Day roost selection in female Bechstein's bats (*Myotis bechsteinii*): A field experiment to determine the influence of roost temperature. Oecologia, 126: 1-9. [Univ. Zurich, Inst. Zool., Winterthurerstr 190, CH-8057 Zurich, Switzerland; kerth@zool.unizh.ch]

Lance, R. F., B. T. Hardcastle, A. Talley, and P. L. Leberg. 2001. Day-roost selection by Rafinesque's big-eared bats (*Corynorhinus rafinesquii*). Journal of Mammalogy, 82: 166-172. [Analyt. Serv., Inc. Envir. Lab, Engin. Res. Devel. Center, U. S. Army Corps of Engineers, Vicksburg, MS 39180; lancer@wes.army.mil]

de Mello, M. A. R., and F. A. S. Fernandez. 2000. Reproductive ecology of the bat *Carollia perspicillata* (Chiroptera: Phyllostomidae) in a fragment of the Brazilian Atlantic coastal forest. Zeitschrift fur Saugetierkunde, 65: 340-349. [Univ. Estado Rio de Janeiro, IBRAG, Setor Ecol., Rua Sao Francisco Xavier 524, BR-20599900 Rio De Janeiro, Brazil; mellomarco@ig.com.br]

Ruby, J., P. T. Nathan, J. Balasingh, and T. H. Kunz. 2000. Chemical composition of fruits and leaves eaten by short-nosed fruit bat, *Cynopterus sphinx*. Journal of Chemical Ecology, 26: 2825-2841. [Kunz: Boston Univ., Dept. Biol., 5 Cummington St., Boston, MA 02215; kunz@bu.edu]

Sandel, J. K., G. R. Benatar, K. M. Burke, C. W. Walker, T. E. Lacher, Jr., and R. L. Honeycutt. 2001. Use and selection of winter hibernacula by the eastern pipistrelle (*Pipistrellus subflavus*) in Texas. Journal of Mammalogy, 82: 173-178. [Dept. Wildlife and Fisheries, 210 Nagle Hall, 2258 TAMUS, Texas A&M Univ., College Station, TX 77843-2248; rhoneycutt@tamu.edu]

Sano, A. 2000. Regulation of creche size by intercolonial migrations in the Japanese greater horseshoe bat, *Rhinolophus ferrumequinum nippon*. Mammal Study, 25: 95-105. [Mie Prefectural Sci. and Technol. Promotion Ctr., Hakusan, Mie 515-2602, Japan; CZR01205@nifty.ne.jp]

Schulz, M. 2000. Diet and foraging behavior of the golden-tipped bat, *Kerivoula papuensis*: A spider specialist? Journal of Mammalogy, 81: 948-957. [So. Cross Univ., Grad. Res. Coll., POB 157, Lismore, NSW 2480, Australia; nanuk40@hotmail.com]

Srinivasulu, B., and C. Srinivasulu. 2001. Magnitude of depredation on grapes by short-nosed fruit bats *Cynopterus sphinx* Vahl, 1797 in Secunderabad, India. Current Science, 80: 14-15. [Osmania Univ., Dept. Zool., Wildlife Biol. Sect., Hyderabad 500007, Andhra Pradesh, India; masawa@satyam.net.in]

GENETICS

Storz, J. F. 2000. Variation at tri- and tetranucleotide repeat microsatellite loci in the fruit bat genus *Cynopterus* (Chiroptera: Pteropodidae). Molecular Ecology, 9: 2198-2200. [Duke Univ., Dept. Biol., Box 90338, Durham, NC 27708; storz@duke.edu]

Mayer, F., C. Schlotterer, and D. Tautz. 2000. Polymorphic microsatellite loci in vespertilionid bats isolated from the noctule bat *Nyctalus noctula*. Molecular Ecology, 9: 2208-2212. [Univ. Erlangen Nurnberg, Inst. Zool. 2, Staudtstr. 5, D-91058 Erlangen, Germany; fmayer@biologie.uni-erlangen.de]

PALEONTOLOGY

Czaplewski, N. J., and G. S. Morgan. 2000 A new vespertilionid bat (Mammalia: Chiroptera) from the Early Miocene (Hemingfordian) of Florida, U. S. A. Journal of Vertebrate Paleontology, 20: 736-742. [Univ. Oklahoma, Oklahoma Museum Nat. Hist., Norman, OK 73019]

PHYSIOLOGY

Codd, J. R., N. C. Slocombe, C. B. Daniels, P. G. Wood, and S. Orgeig. 2000. Periodic fluctuations in the pulmonary surfactant system in Gould's wattled bat (*Chalinolobus gouldii*). Physiological & Biochemical Zoology, 73: 605-612. [Univ. Adelaide, Dept. Environm. Biol., Adelaide, SA 5005, Australia; jonathan.codd@adelaide.edu.au]

POPULATION BIOLOGY

Castella, V., M. Ruedi, L. Excoffier, C. Ibanez, R. Arlettaz, and J. Hausser. 2000. Is the Gibraltar Strait a barrier to gene flow for the bat *Myotis myotis* (Chiroptera: Vespertilionidae)? Molecular Ecology, 9: 1761-1772. [Ruedi: Museum Hist. Nat., CP 6434, CH-1211 Geneva 6, Switzerland; manucl.ruedi@mhn.ville-ge.ch]

SYSTEMATICS

Cao, Y., M. Fujiwara, M. Nikaido, N. Okada, and M. Hasegawa. 2000. Interordinal relationships and timescale of eutherian evolution as inferred from mitochondrial genome data. Gene, 259(SI): 149-158. [Hasegawa: Inst. Stat. Math, Minato Ku, 4-6-7 Minami Azaabu, Tokyo 1068569, Japan; hasegawa@ism.ac.jp]

Hoofer, S. R., and R. A. Van Den Bussche. 2001. Phylogenetic relationships of plecotine bats and allies based on mitochondrial ribosomal sequences. Journal of Mammalogy, 82: 131-137. [Dept. Zool. and Oklahoma Cooperative Fish and Wildlife Res. Unit, Oklahoma State Univ., Stillwater, OK 74078; ravd@okstate.edu]

López-González, C., S. J. Presley, R. D. Owen, and M. R. Willig. 2001. Taxonomic status of *Myotis* (Chiroptera: Vespertilionidae) in Paraguay. Journal of Mammalogy, 82: 138-160. [Dept. Biol. Sci., Texas Tech Univ., Lubbock, TX 79409-3131; celialg@prodigy.net.mx]

Rodrigues, L. R. R., R. M. S. Barros,.M. D. L. Assis, S. A. Marques-Aguiar , J. C. Pieczarka, and C. Y. Nagamachi. 2000. Chromosome comparison between two species of Phyllostomus (Chiroptera Phyllostomidae) from Eastern Amazonia, with some phylogenetic insights. Genetics & Molecular Biology, 23: 595-599. [Fed. Univ. Para, Dept. Genet., CCB, BR-66075900 Belem, Para, Brazil; ribeiro@ufpa.br]

Soriano, P. J., M. R. Farinas, and M. E. Naranjo. 2000. A new subspecies of Miller's long-tongued bat (*Glossophaga longirostris*) from a semiarid enclave of the Venezuelan Andes. Zeitschrift fur Saugetierkunde, 65: 369-374. [Univ. Los Andes, Fac. Ciencias, Dept. Biol., Merida 5101, Venezuela]

Volleth, M., G. Bronner, M. C. Gopfert, K. G. Heller, O. von Helversen, and H. S. Yong. 2001. Karyotype comparison and phylogenetic relationships of Pipistrellus-like bats (Vespertilionidae; Chiroptera; Mammalia). Chromosome Research, 9: 25-46. [Univ. Klinikum, Inst. Humangenet, Leipzigerstr 44, D-39120 Magdeburg, Germany; Marianne.Volleth@medizin.uni-magdeburg.de]

Future Meetings, Symposia, Conferences, etc.

June 18th - 22nd, 2001

The American Society of Mammalogists will meet at the University of Montana, Missoula, Montana, U.S.A.

August 5 to 9, 2001

The 12th International Bat Research Conference will meet in Bangi, Malaysia.
All information concerning the conference can be obtained at :
http://www.ukm.my/ukm/seminar/bat/index.html

August 12 to 17, 2001

The 8TH International Theriological Congress will meet in Sun City, South Africa. The Organizing Committee is chaired by Professor John Skinner in conjunction with Event Dynamics as the professional Congress organizers. For additional information contact: Sandra Collier, 8th ITC Congress, c/o Event Dynamics, PO Box 411177, Craighall, 2024, Johannesburg, South Africa Tel: +27-11-442-6111. Fax:+27-11-442-5927 E-mail: DonaPlotz at: www.sandra@eventdynamics.co.za Visit the web-site at: www.eventdynamics.co.za/itc

August 31 to September 2, 2001

The British Bat Conservation Trust will hold its annual meeting in Nottingham, England at Nottingham University. Conor Kelleher is the organizer and can provide information about registration and hotel accommodations. For additional information and registration contact Marie-Claire Edwards at: mcedwards@bats.org.uk
or contact The Bat Conservation Trust, 15 Cloisters House, 8 Battersea Park Road, London SW8 4BG Tel: 020 7627 2629 Fax: 020 7627 2628

October 24 to 27, 2001

The 31st Annual North American Symposium on Bat Research will meet in the beautiful city of Victoria, British Columbia, Canada, October 24 - 27, 2001, hosted by Mark Brigham of the University of Regina. All formal sessions of the 31st Symposium will be held at the Victoria Conference Center, which is immediately adjacent (and connected) to The Empress Hotel, one of the grandest, most spectacular hotels in the world. We have obtained outstandingly good room rates for conference attendees at the Empress. Mark has also arranged that our conference banquet will be held in the Crystal Garden. This promises to be a truly memorable symposium. For details see our website at: www.nasbr.com

August, 2002

The 9th European Bat Research Symposium will convene in Le Havre, France. The Symposium Convenor will be Stephane Aulagnier, I.R.G.M., C.R.A. Toulouse, B.P. 27, 31326 Castenet-Tolosan Cedex,France. Aulagnier's e-mail is: aulagnie@teleirgm.toulouse.inra.fr

November 6-9, 2002

The **32nd Annual North American Symposium on Bat Research** will convene in Burlington, Vermont hosted by William Kilpatrick (University of Vermont) and Roy Horst (State University of New York at Potsdam) Arrangements have been made for participants in the symposium to stay at the Radisson Hotel at very reasonable rates. All symposium session, displays, etc., will be in the Radisson which overlooks Lake Champlain only a 5 minute walk away. Just 5 minutes away are historic St.Paul Street and Church Street, both famous for the great number of fine restaurants and the 'Burlington Brew Pub'. Unfortunately the spectacular fall foliage season

will be past (which incidentally is why we can get such reasonable room rates). For details see our web-site at www.nasbr.com

October 23-26, 2003

The **33rd Annual North American Symposium on Bat Research** is tentatively scheduled to meet in San Juan, Puerto Rico. The local host will be Armando Rodriquez-Moran. For details see our web-site at: www.nasbr.com

If you know of other meetings, large or small, concerning any aspect of biology please send us the details for inclusion in the next issue of Bat Research News.
Thank you. GRH

* * * * * * * * * * *

A new book of interest to our readers

Bats of Southern Africa

Guide to Biology, Identification, and Conservation

Peter John Taylor

Public appreciation of the ecological value and remarkable biological adaptations of bats is rapidly growing. Bat watching is one of the world's fastest growing specialist wildlife interests, and bat conservation groups have sprung up all over the world. This book was written to raise public awareness of bats in southern Africa and to dispel some popular myths about them. It provides the prospective bat-watcher with both an authoritative species identification guide and a practical handbook.

Bats of Southern Africa contains species accounts for all the region's 74 species of bats, with descriptions and diagnostic features, as well as information on habitat, social and roosting habits, diet, reproduction, echolocation calls, distribution, and conservation status. Superb photographs and illustrations are supplemented by distribution maps and sonograms of echolocation.

Dr. Taylor, who is curator of Mammals at the Durban Natural Science Museum, also provides practical guidance for those eager to get started with bat-watching, and 'hands on' conservation projects such as bat groups, bat houses and bat detectors.

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BAT RESEARCH NEWS

Volume 42 Number 1 **Spring 2001**

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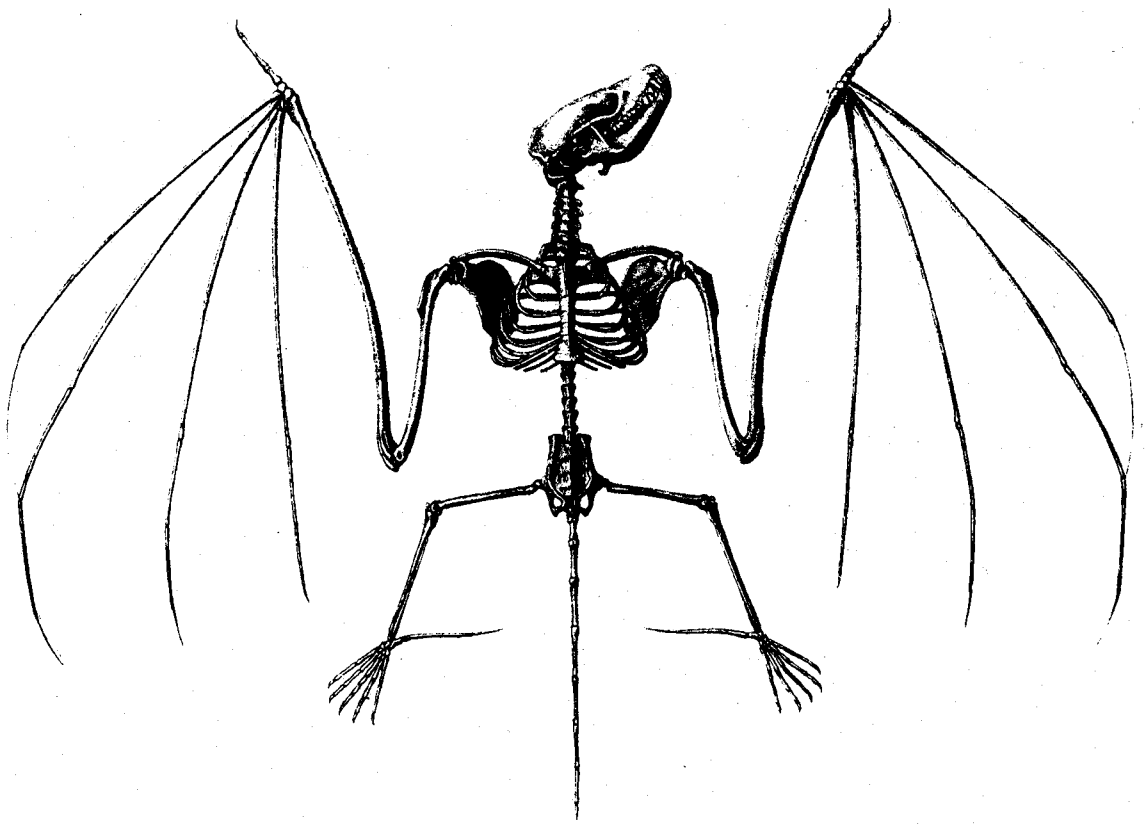
The front cover of this issue is from Bats and the Rainforest, a curriculum guide for teachers written by Patricia Morton

BAT RESEARCH NEWS



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BAT RESEARCH NEWS

Volume 42: No 2 Summer 2001

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Tel. 315-267-2259 FAX 315-267-3170 e-mail horstgr@potsdam.edu

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

Editor for Recent Literature: Thomas A. Griffiths: Dept. of Biology, Illinois Wesleyan University, Bloomington, IL 61702 Tel. 309-56-3230 e-mail: tgriff@titan.iwu.edu

Editor for Conservation and Education: Patricia Morton, Texas Parks and Wildlife, Suite 100, 3000, IH 35 Austin, TX 78704 Tel. 512-912-7020 e-Mail: patricia.morton@tpwd.tx.us

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 an extensive recent literature citation list covering nearly all the recent bat-related literature in English. It also publishes the programs and abstracts of bat-related meetings and symposia world-wide. It publishes letters to the editors, news submitted by our readers, notices, letters of request and the announcements of all scheduled future meetings concerning the biology of bats world-wide. Communication concerning feature articles and Letters to the Editor should be referred to Kurta. Communication concerning recent literature should be addressed to Griffiths. Issues dealing with conservation and education should be addressed to Morton. All other business should be referred to Horst.

Bat Research News also has an electronic edition of exactly the same content as the printed edition. The current prices(through 2001) are: (we pay all mailing costs)

Printed edition to U.S.A.	$20.00	mailed [bulk mail rates]
Printed edition to all other countries	$25.00	mailed surface to all addresses
Electronic edition worldwide	$15.00	
Institutional subscriptions	$35.00	

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BAT RESEARCH NEWS

VOLUME 42:NO.2 SUMMER 2001

From the Publisher and Managing Editor

Every so often the subscribers to Bat Research News are entitled to the Publisher's point of view concerning the well being and future of this publication (and perhaps that of the publisher as well). Bat Research News now has approximately 780 subscribers. Of these 510 subscribe to the printed edition, 170 subscribe to the electronic edition, and about 50 subscribe to both editions. The journal is in good financial condition, showing a small surplus at the end of each volume year. This small surplus is held over to meet unforeseen fiscal contingencies and the rest is used to support the ***Bat Research News Award*** to the most outstanding presentation by a student at our annual symposium. An equal amount is pledged to support the Teacher's Bat Education Workshop by Patricia Morton, which has become a very worthwhile addition to our annual research symposium.

A continuing cause of anxiety for our fiscal affairs is the very late payments of many subscribers. The good fiscal health projected above is based on my faith that nearly 100 outstanding late dues (as of this moment) will be paid before this fiscal year ends. If this faith is unjustified, then one or both of the worthwhile programs mentioned above may sadly need to be discontinued.

BRN has expanded in size, and I trust improved in quality as well. The electronic issue is well received, especially by those subscribes outside of the United States. Many of those people have asked how they can retrieve back issues. This is a new problem as the printed version was easy to store and retrieve (if one can remember where it was thrown after it was read). But the electronic version "does away" with each new issue and retrieval of previous issues becomes a problem. I am working with a computer expert on this retrieval problem and we are now in the process of setting up a PDF retrieval system for electronic subscribers. The back issues will be stored in an electronic bank, and can be accessed (by electronic subscribers) by using your present user address and password, with perhaps one more additional code word. This system will be established by summer's end and all issues since volume 42: No1, Spring 2001 will be available to all electronic subscribers. All the electronic subscribers will be kept notified of the progress and final status of this service.

A new feature, which appears to be well received, is *News* from our subscribers, as seen in the last several issues. Most of these have until this point been fairly detailed descriptions of the work being carried out by professional bat scientists, generally associated with universities. We are eager to include in this section many more reports from a variety of bat workers, about projects in progress or even in the planning stages. There are a great many individuals doing very good work under the auspices of federal, state and local agencies, as well as private organizations. Many good things are being done in the area of conservation, for example, by non-university, non-governmental individuals. These are good people devoted to a good cause: Helping all of us learn more about bats. We would like to hear more from all of you.

I realize that all of you are busy, but why not take a little time and tell the rest of us about your projects, large or small. I really enjoy working on Bat Research News: it keeps this retired old biologist "off the street" and gainfully occupied. So make my day! Overload my mailbox with "stuff"! Force me to quit begging for material, and I will eagerly serve BRN and all of you yet a little while longer.

I thank all of you and look forward to hearing more from you. Sincerely, Roy

The Indiana Bat: Biology and Management of an Endangered Species

A Symposium Held in Lexington, Kentucky

29 March to 1 April, 2001

The Indiana bat, *Myotis sodalis,* is one of the most endangered mammals in North America, with populations in some areas declining by over 80% in the last 15 years. The goal of this symposium was to aid in recovery of the Indiana Bat by fostering dissemination of information among academic biologists, environmental consultants, and resource managers. The local host was Michael Lacki, of the University of Kentucky, and additional sponsors of the conference were the U. S. Fish and Wildlife Service, U. S. Forest Service, Bat Conservation International, Northeast Bat Working Group, and Southeast Bat Diversity Network. Over 200 registrants heard 28 invited papers and examined eight submitted posters that dealt with numerous aspects of the ecology, behavior, natural history, and management of the Indiana bat, in both summer and winter. The proceedings of the symposium will be published later in 2001 by Bat Conservation International, with Allen Kurta and Jim Kennedy as editors.

Abstracts of the Indiana Bat Conservation Symposium

Since all the abstracts concern only the Indiana Bat, *Myotis sodalis*, to avoid redundancy we have removed the generic name *Myotis sodalis* from all titles. Any errors in transcription are the responsibility of the editors and are totally unintentional; our apologies. AK and RH The abstracts appear in alphabetical order by first author.

An Indiana Bat Roost in Suburbia: Important Observations and Concerns for the Future

Jacqueline J. Belwood
Cincinnati Nature Center, Milford, Ohio 45150

Ohio's first Indiana Bat maternity colony was discovered in July 1996 in a 60-acre woodlot that is now a residential subdivision. It was located in a dead maple tree that was felled to avoid hitting a house. A dead female and 33 non-volant juvenile (16 male, 17 female) were retrieved near the tree. No other adult was seen at the time. The pups varied in size (FA: 16 to 35 mm) and weight (2.5 to 5.8 g)indicating asynchronous births. At dusk the juveniles were placed in a bat house for temporary shelter and were retrieved within minutes by bats believed to be their mothers. They were not seen again for three weeks when the same animals, presumably, were observed exiting another dead tree 20 m from the original roost. Despite considerable efforts and the observation that the bats remain in the area after the catastrophic loss of their roost, Indiana Bats were not captured again at the site until the summer of 2000 when two lactating females were netted in two other homeowners' yards. In the future, it is likely that accelerating urbanization will increase the occurrence of Indiana Bats in residential neighborhoods and the potential for contact with people, as evidenced by at least on "urban" Indiana Bat that has been submitted to the Ohio Department of Health for rabies testing. Such findings will necessitate the development of strategies designed to address the competing goals related to public health concerns, "nuisance" bat control, and management of endangered bats.

Distribution, Abundance, and Reproduction by the Indiana Bat in the Appalachian Mountains of the Eastern United States: Affect of Elevation

Virgil Brack, Jr[1]., Craig W. Stihler [2], Richard J. Reynolds[3], and Calvin Butchkoski[4]
[1]Environmental Solutions & Innovations, LLC781 Neeb Road, Cincinnati, OH 45233
[2]West Virginia Division of Natural Resources, Wildlife Resources Operations Center, P.O. Box 67, Elkins WV 26241-0067, [3]Virginia Department of Game and Inland Fisherie, Wildlife Information and Enhancement Division, P.O. Box 996, Verona, Virginia, 24482 and [4]Pennsylvania Game Commission, Wildlife Diversity Section, 2001 Elmerton Avenue, Harrisburg, PA 17110-9797

Late spring and early autumn weather extremes, and cool and wet weather during summer months likely add significantly to the cost of reproduction for many species of bats. Higher latitudes and altitudes typically are cooler and often wetter, and areas at higher elevations often experience greater seasonal variability. The distribution of many species of animals (most notably birds) has been clearly associated with elevation in the Appalachian Mountains of the eastern U.S. In the Black Hills of South Dakota, elevation clearly affects the distribution of reproductive females of most or all species of bats during the summer reproductive season. This paper will look for an association between elevation (in West Virginia, Virginia, and Pennsylvania) and (1) species of capture, (2) number of bats captured per unit effort, and (3) reproductive females. A better understanding of the distribution of the Indiana bat (*Myotis sodalis*), and its likelihood of occurrence, in the eastern U.S. could significantly affect regulatory requirements for this endangered species, and it could help explain the paradox that a "tree bat" is relatively uncommon in the portion of its range that is most heavily forested.

The Acoustic Identification of the Indiana Bat

Eric R. Britzke[1], Kevin L. Murray[2], and Lynn W. Robbins[2]
[1]Dept. of Biology, Tennessee Technological Univ., Cookeville, TN 38505
[2]Dept. of Biology, Southwest Missouri State University, Springfield, MO 65804

The Anabat system has been extensively used for the study of bat activity in recent years, but there has been debate over its use to acoustically identify species. Early research seemed to indicate that species with similar echolocation calls (i.e., members of the genus *Myotis*) could not be differentiated using Anabat. This led to the grouping of similar species in acoustic surveys. However, in the last couple of years, researchers have promoted the ability to identify *Myotis* species using acoustic techniques. In the eastern United States, the population of the Indiana bat, *Myotis sodalis*, is in severe decline. The use of acoustic techniques would greatly increase our knowledge of the life history of the species, but there is still doubt regarding the use of the Anabat to correctly identify the calls of the Indiana bat. During 4 years of research with the Anabat system, we have collected a large data set on the echolocation calls of *M. sodalis*. We will discuss the different sources of variation in the calls (intra-individual, inter-individual, geographic, and interspecific) and the effects of this variation on identification. We will also discuss the implications of this research and provide guidelines for the prudent use of this technology in the surveying and inventorying of bats in the eastern United States.

First Documented Maternity Colony of the Indiana Bat in Greene County, Ohio

R. Jeffrey Brown, R. Andrew King, and Russell Rommé
B.H.E. Environmental, Inc., Cincinnati, Ohio

During a mist-net survey (25 July – 5 August 2000) of Wright-Patterson Air Force Base (WPAFB) in Greene County, Ohio, B H E Environmental, Inc. identified the first confirmed

Indiana bat (*Myotis sodalis*) maternity roost in Greene County, Ohio. A post-lactating female and a juvenile Indiana bat were tracked via radiotelemetry to a dead slippery elm (*Ulmus rubra*) on 2 – 4 August 2000. Exfoliating bark was present on approximately 20% of the 64.0 cm (25.2 in) dbh tree. The roost tree was approximately 20 m (66 ft) from a moderately traveled roadway and parking lot on the campus of Wright State University. Up to approximately 38 bats were observed emerging from a split in the bark on three consecutive evening emergence counts. The juvenile bat also was found using another roost tree (white ash; *Fraxinus americana*; dbh = 29.9 cm (11.8 in) in the same 181 acre (73 ha) woodlot approximately 0.8 km from the slippery elm. Sixteen bats were observed emerging from beneath loose bark on the white ash on 1 August 2000. Based upon application of an existing Indiana Bat Habitat Suitability Index Model, the woodlot provided high quality roosting habitat. Assuming the Life Requisite Suitability Index (LRSI) for foraging exceeds the LRSI for roosting the overall HSI value for the woodlot was 0.88 on a scale of 0.0 – 1.0. The calculated HSI value appropriately approximates qualitative field estimates.

The Ecology of the Indiana Bat Using a Building as a Maternity Site

Calvin M. Butchkoski and Jerry D. Hassinger
Wildlife Diversity Section, Penna. Game Commission, 2001 Elmerton Avenue, Harrisburg, PA

On July 14, 1997, two lactating Indiana bats, *Myotis sodalis*, were found in the attic of an old wood frame country church that is also a maternity site for approximately twenty thousand little brown bats, *Myotis lucifugus*. Follow-up visits during the summers of 1998 and 1999 verified the presence of an Indiana bat maternity colony. From June 8, 1999, to July 18, 2000, twenty-nine different Indiana bats were found using the attic roost, with the potential of more individuals. Specific capture site surface temperatures ranged from 26.7°C to 38.3°C. Weights of adult females ranged from 8.2 grams several days prior to birth to 5.9 grams after birth. In the year 2000, parturition of observed animals occurred after June 8 but before June 24. From May 16 through August 6, 2000, seven Indiana bats (six females and one male) were tracked using radiotelemetry after capture in the attic. A pregnant female with a transmitter attached gave birth in the church on June 13. Major activity areas of tracked bats were mapped using GIS. Tracked bats ranged as far as 4.5 km from the church, primarily using deciduous forest. Seven alternate day roost trees were confirmed. This paper reports on the first discovery of an Indiana bat maternity colony in the northeastern United States and the first ever known maternity colony in a building.

Preliminary Work on Maternity Colonies of Indiana Bats in Illinois

Timothy C. Carter, Steven K. Carroll and George A. Feldhamer
Department of Zoology, Southern Illinois University, Carbondale, IL 62901-6501

Preliminary work on maternity colonies of Indiana bats (*Myotis sodalis*) during summers of 1998 and 1999 yielded 23 roosts from three localities in Southern Illinois. All roost trees were located in bottomland, floodplain, or swamp habitats. Roosting areas for two maternity colonies were 11.72 ha and 146.5 ha using the minimum convex polygon method. The average distance traveled between consecutively used roosts was 578 m (max 2.14 km, min 10 m). All roosts were associated with areas that were more open than the surrounding forest. Open areas were usually created by one or more trees dying that created an opening in the forest canopy. Roosts also were located along man-made openings such as roads or ditches. Percent canopy closure at the roosts averaged 26% (max 65%, min 0%). The species of snag used did not differ from those previously reported. Species used included green ash (*Fraxinus pennsylvanica*), American elm (*Ulmus*

americana), silver maple (*Acer saccharinum*), pin oak (*Quercus palustris*), and shagbark hickory (*Carya ovata*). The average decay class of the snags containing roosts was 4.25 (most branches gone with exfoliating bark). The average diameter of roost trees was 35 cm (max 58 cm, min 18.5 cm) with an average height of 17.5 m (max 34.5 m, min 10 m). The average height of the actual roosts was 8.5 m (max 18.6 m, min 2.5 m). All roosts were located on the bole of the snags. Of these, 22 roosts were located under exfoliating bark; one roost was located in a crack covered by exfoliating bark. Bats averaged 1.5 nights per roost.

The History and Current Status of the Indiana Bat

Richard L. Clawson
Missouri Dept. of Conservation, 1110 South College Avenue, Columbia, Missouri 65201

Indiana bat populations were first surveyed in the late 1950s. In the decades since then, additional colonies of hibernating Indiana bats were discovered and our knowledge of the distribution and status of the species has expanded. The Indiana bat (*Myotis sodalis*) has been listed officially as endangered since 1967. The species was listed due to documented population losses and because it is vulnerable to disturbance and destruction during the winter hibernation season, when a high proportion of its population congregates in a small number of caves and mines. Despite protection of many of these hibernacula, the overall population has continued to decline. Population losses, however, are not universal throughout the range of the species. The population in the southern portion of the Indiana bat's range has suffered disproportionately and declined while that in the northern Midwest and Northeast has maintained or increased numbers during the same time period. Many hibernacula populations, especially in Kentucky and Missouri, have decreased in number since monitoring began. More than half of the current population of the Indiana bat hibernates in the nine Priority One hibernacula. Eight of the nine have been surveyed every two years from 1983 to the present (one is unsafe to enter). During the period 1983 through 1997, the total population in these caves has declined by 38%. Based on censuses taken at hibernacula throughout the species' range, the total, known Indiana bat population in 1997 was estimated to number about 350,000 bats. Surveys during January and February, 2001 will give us an up-to-date picture of the status of the species.

The Response of the Indiana Bat to Gates

Robert R. Currie
U.S. Fish and Wildlife Service, Asheville Field Office, 160 Zillicoa St., Asheville, NC 28801

The Indiana bat (*Myotis sodalis*) was among the first species in the United States recognized at the Federal level as being in danger of extinction. At the time the species was added to the Federal list of Endangered Species, it was believed that human disturbance during hibernation was the primary factor in this decline. Early efforts to protect and recover the species concentrated on reducing or eliminating this disturbance by constructing gates at the entrances to the most important hibernation sites. The design and structural materials used to build these gates has evolved over time. Some early efforts did not recognize the importance of maintaining adequate airflow to the cave nor did they always provide adequate spacing for unrestricted bat movement. Materials used have included flat-bar steel, round steel bars, and various sizes of angle-iron steel. Spacing between the horizontal and vertical bars has varied significantly over time and this variation may have been a factor in the response of Indiana bats to gates. Successful gates are those constructed in a manner that eliminates human disturbance, provides for unimpeded bat movement, and maintains appropriate microclimate within the hibernation

site. Gates are an essential tool in conservation of the Indiana bat and other cave-dependent species. Future gate construction activities must use the information gained from past efforts and carefully experiment with new designs and materials that may provide more effective protection for declining cave and mine dependent bats.

Distribution of Indiana Bat Summer Habitat in the Eastern United States, Including Techniques to Quantify Range-wide Potential Summer Habitat

James E. (Gene) Gardner
Missouri Highway and Transportation Department, P.O. Box 270, Jefferson City, M0 65102

Resource and regulatory officials and bat specialists in all of the United States where the Indiana bat has been reported were contacted during development of the Revised Draft Recovery Plan for the Indiana Bat (*Myotis sodalis*) and asked to submit occurrence and distribution data. A myriad of data were submitted to the Recovery Team by representatives in twenty-eight states with permission to use the data in revising the range map for the species. Using Geographic Information System (GIS) applications, these data were compiled and integrated with other spatial information in an attempt to more accurately identify the known range of the species and quantify potential summer habitat. The historic distribution of the species, a revised distribution scheme, and a quantitative analysis of U.S. Forest cover types will be presented for the most up-to-date and accurate depiction of the range-wide distribution of the Indiana bat.

Roost-site Fidelity by the Indiana Bat in Kentucky

Mark W. Gumbert[1], J. M. O'Keefe[1], and J. R. MacGregor[2]
[1]Eastern Kentucky University, Richmond KY 40475 and
[2]USDA Forest Service, Daniel Boone National Forest, 1700 ByPass Rd, Winchester KY 40391

From 1996-2000, we attached radiotransmitters and radio-tracked a total of 64 Indiana bats (*Myotis sodalis*) captured near a hibernaculum in the Daniel Boone National Forest, Pulaski County, Kentucky and located the trees used as day roosts by these bats. This study included nine different tracking periods: two in early spring (April), two in mid-summer (June-July), and five during autumn (September-October). To gain insight into the fidelity of particular Indiana bats to specific roost trees and roosting areas, previously transmittered bats which were recaptured during later tracking periods and refitted with new transmitters (n=16) whenever possible. Thirteen bats were tracked for two periods, two for three periods, and one bat for four tracking periods. During the study, we documented Indiana bats using 275 different roost trees, and 44 of these were either used by multiple transmittered bats or were used by individual bats during more than one tracking period. Some trees were used by the same bats during two or more year. In addition, the accumulation of roost tree information over successive tracking periods showed that there were distinct areas scattered across the local landscape that were used repeatedly by transmittered bats, while other areas received little or no roosting use by these bats. Our analysis will focus on defining bat fidelity to particular roost trees and roosting areas, describing bat use for roost trees in which transmittered bats were found during multiple periods, and characterizing important areas of repeated use. The results of this study have yielded some new information concerning the roosting ecology of Indiana bats and should aid in the development of future habitat management plans for areas near known hibernacula.

Status and Ecology of Indiana Bats in the Southern United States

Michael J. Harvey
Department of Biology, Tennessee Technological University, Cookeville, TN 38505

The Draft Indiana Bat Recovery Plan (March 1999) lists nine southern states, herein defined as Oklahoma, Arkansas, Tennessee, North Carolina, and southward, with records of Indiana bat hibernating populations. Only three of these states list more than 100 bats; Tennessee, 16,500; Arkansas, 2,700; and Alabama, 300. Indiana bats are no longer known to exist in most of the remaining six states. Priority 2 hibernacula (500 – 30,000 bats) occur only in Tennessee (N = 6) and Arkansas (N = 3). White Oak Blowhole Cave in Great Smoky Mountains National Park (TN), houses the largest hibernating population in the region, usually in excess of 5,000. Recent surveys in Tennessee and Arkansas show population declines at most hibernacula. Although there were several summer records of male Indiana bats, and a few females, from the region, maternity colonies were not discovered until 1999 and 2000. During the summer of 1999 a maternity colony (N = 26 bats) was found in the Nantahala National Forest in western North Carolina; in 2000 a maternity colony (N = 23 bats) was found in Great Smoky Mountains National Park in eastern Tennessee. Reproductive females and/or juveniles were also captured at other locations in Tennessee during both summers. Extensive mist-netting at numerous sites in Arkansas during the past several summers resulted in the capture of only male Indiana bats.

Observations of Hibernating Indiana Bats in the Northeast

Alan Hicks
N. Y. State Dept. of Environmental Conservation, Wildlife Resources Center, Delmar NY 12054

The Indiana bat, *Myotis sodalis,* has been reported in the Northeast region since the 1930's and its status has been regularly monitored since the early 1980's. Most caves and mines in New Jersey, New York, and New England have been searched. The species has been reported hibernating in 24 sites, although it is currently found in just 11. Most of the populations initially reported with few (< 250) individuals have disappeared, are ephemeral, or tend to remain at low levels. Larger populations (>1,000) have increased substantially in number since regular monitoring began. All but 20 of the nearly 22,000 *M. sodalis* currently known to winter in the region are found in New York State. The largest of these sites contains roughly 9,500 individuals. I discuss population changes, cluster density, and cluster sizes at these New York sites. I also report on roughly 2,500 hours of video monitoring of 2 clusters of hibernating *M. sodalis* in a New York cave conducted between January and May 1985. This includes observations of cluster formation and break up, and the response of *M. sodalis* to human activity.

Management of Indiana Bat Winter Hibernacula in Indiana

Scott A. Johnson[1], Virgil Brack, Jr.[2], and R. Keith Dunlap[3]
[1]Indiana Department of Natural Resources, [2]Environmental Solutions & Innovations,
[3]Indiana Karst Conservancy

Protection of winter hibernacula has been a fundamental recovery strategy for the Indiana bat (*Myotis sodalis*) since the species was listed as endangered in 1967. Human disturbance, vandalism, and human and natural modification of hibernacula that alters the cave microclimate are primary factors in the decline of winter populations. More than 97% of the known population wintering in Indiana hibernates in seven caves. Opportunities to protect these hibernacula depend on several factors (e.g., ownership, accessibility, cave morphology, human use) and include landowner outreach, cooperative agreements, interpretive signs, fences, angle-iron gates, and

simulated electronic alarm systems. We present case studies of six hibernacula and describe research and management activities since 1987 to reduce human visitation and maintain temperatures suitable for hibernation. Efficacy of management activities was evaluated through visitor counters and temperature data loggers at three caves, and biennial hibernacula censuses. Counters detected an average of five visitations (range: 0-9) during each seasonal closure period. Visitation levels, however, declined sharply (mean = 0.4 per closure period) after deployment of simulated alarm systems in 1996. Although the statewide winter population increased 31% between 1987 and 1999, trends at individual hibernacula varied and were inconsistent among management strategies (e.g., no action, fences, gates). Increases at two hibernacula and the discovery of a previously unknown site accounted for most of the observed population increase. Long-term monitoring of human visitation and temperature profiles is needed to ascertain if, and how, management activities affect winter populations of Indiana bats.

The UNIMIN Specialty Minerals Corporation - Magazine Mine: A Novel Indiana Bat Hibernaculum in Southern Illinois

Joseph A. Kath
Illinois Department of Natural Resources, Division of Natural Heritage, Springfield, IL 62701

Bats continue to rank among the world's most endangered wildlife despite extensive conservation efforts. Effective education, research, and conservation initiatives at the local, community, and corporate levels are essential to the long-term understanding and survival of these often neglected animals. Promoting bat conservation by changing attitudes, not by confrontation, has enabled professional resource managers throughout Illinois and the Midwest to work directly with citizen groups, schools, and businesses. Extracting solutions to complex environmental problems through the power of community and industry partnerships has proven to be quite successful throughout rural Illinois. Recent efforts at the UNIMIN Corporation's "Magazine Mine" to directly protect resources critical to bat reproduction and hibernation have both strengthened and promoted a conservation ethic benefiting not only bats, but the fragile Shawnee National Forest ecosystem as a whole. Magazine Mine currently supports >9,000 wintering Indiana bats and is the largest hibernacula of Indiana bats ever documented within the State of Illinois. Because this mine has been abandoned for several years (>15 years), it requires immediate and permanent stabilization at the main entrance in order to prevent catastrophic collapse and eventual closure. Such a collapse at this Federal Priority II hibernacula would not only exterminate the large numbers of Indiana bats hibernating within this mine, but permanently prohibit use of this mine by successive generations of *Myotis sodalis*. Stabilization of the 70 meter long Magazine Mine entrance using specially crafted steel arches and lagging plates will take approximately 14 full work days and cost slightly over $80,000.

Distribution, Abundance and roost-site Fidelity of Hibernating Indiana Bats in Relation to Ceiling Temperature in an Abandoned Mine in Southwestern Ohio

R. Andrew King[1], R. Jeffrey Brown[1], Amy B. Henry[1], Robert Beck[1], Russ C. Rommé[1], Michael J. Bruening[1] and David Swanson[2]
[1]BHE Environmental, Inc.,11733 Chesterdale Road, Cincinnati, Ohio and [2]Ohio Dept. of Natural Resources, Waterloo Wildlife Research Station, 9650 State Route 356, New Marshfield, OH 45766

The Lewisburg Limestone Mine supports the single largest population of hibernating bats in Ohio (>32,000) and the single largest population of hibernating Indiana bats (*Myotis sodalis*) in the state (>9000, Priority II hibernaculum). In 1996, 1998, and 2000, we conducted winter censuses of hibernating bats in the mine for the Ohio Department of Natural Resources, Division

of Wildlife. We identified and counted all observed bats, and mapped each bat/cluster's location along nearly 71 km of mine passages. Ceiling temperatures were measured with Raytec® Raynger® ST2 thermometers. We used ArchView® GIS and Surfer® to plot bat locations and to generate temperature isopleths from digitized, temperature data. Indiana bat numbers appear stable with 9,298 individuals in 1996, 9,292 in 1998, and 9,638 (3.7% increase) in 2000. Indiana bats exhibited strong roost site fidelity by clustering in three distinct areas of the mine each year, despite changes of 3°C within these same areas between survey years. Large concentrations of bats (1000 – 5000 individuals) were all within 1 to 5 m of cement block walls that affected temperature, humidity, and airflow. Although ceiling temperatures at roost sites ranged from 5° to 13°C, most bats roosted in areas from 6° to 11°C. The mine's structural complexity and wide temperature range should allow bats to change roosts to compensate for climatic fluctuation. Dataloggers installed in 2000 will record temperature and relative humidity year round. This data may be used to assess results of future experimental manipulations designed to improve and/or stabilize current temperature and humidity regimes.

The Use of Concrete Bridges as Night Roosts by Indiana Bats in South Central Indiana

[1]James D. Kiser, [2]J. R. MacGregor, [3]H. D. Bryan, and A. Howard[4]
[1]Appalachian Technical Services, Inc., 255 Main Street, P. O. Box 98, Whitesburg, KY 41858, [2]USDA Forest Service, 102 RestK Court, Nicholasville, Kentucky 40356, [3]Eco-Tech, Inc., P.O. Box 8 Frankfort, Kentucky 40602, and [4]Camp Atterbury, Bldg. 224, Edinburgh, Indiana 46124

During a mist-net survey and radiotelemetry study in 1998, we serendipitously discovered Indiana bats (*Myotis sodalis*) night roosting under concrete bridges spanning three streams at Camp Atterbury in south central Indiana. Camp Atterbury is a National Guard training facility, which includes portions of Brown, Bartholomew, and Johnson Counties. Seven bridges at the facility were sporadically checked for roosting bats between 2330 and 0430 h on six different nights in late July and early August, and we observed 82 Indiana bats night roosting under three of these. The bridges used by Indiana bats were concrete girder style (multi-beam), and all were located in open canopy situations over streams ranging from 8-40 m wide. The Indiana bats at two of the bridges were in clusters consisting of lactating and post-lactating females along with newly volant juveniles. Two adult males were observed at the remaining bridge. Subsequent, radiotracking of an adult male and a post-lactating female captured beneath these bridges yielded distances between night roosts and day roosts (in dead trees) of 1.01 km for the male and 1.95 km for the female. Two years later (summer 2000), prior to the parturition period, we placed temperature data loggers (StowAway Tidbit) beneath the bridges at each night roost and on adjacent trees in order to determine if the thermal characteristics of concrete bridges used as night roosts by Indiana bats are similar to those reported in the literature for other bat species. Checking bridges for night roosting bats can complement traditional mist netting when surveys are being conducted for Indiana bats. This information could be useful for land managers and for state transportation cabinets throughout the eastern and midwestern states when projects that involve bridge construction or replacement are being developed.

Indiana Bat Conservation on National Forest Lands: Where We Have Been and Where Should We Be Going

Dennis L. Krusac[1], Steve Mighton[2], and John Palmer[3]
[1]USDA Forest Service, Atlanta, GA, [2]USDA Forest Service, Milwaukee, WI, and [3]USDA Forest Service, Ogden, UT

The Forest Service, like other federal agencies, has recovery responsibilities under the Endangered Species Act. Prior to 1995, our efforts to conserve Indiana bats were mainly focused

on protecting hibernacula and streamside management zones because most researchers and managers familiar with the species believed Indiana bats hibernating in the southern part of their range migrated north and used riparian areas during the summer. Hibernacula protection was accomplished through gating, signage, or keeping locations confidential. Protection of streamside management zones was accomplished through implementing best management practices in riparian areas. In 1994, the first female Indiana bat captured in an upland habitat was mist netted on the Daniel Boone National Forest, Kentucky. Consequently, between 1995 and 2000 our efforts were focused on surveys of forested uplands, Forest Plan revisions to address Indiana bats, formal consultation with U.S. Fish and Wildlife Service, and considerable litigation related to Indiana bats. The Forest Service must move forward and actively conserve forest bats. The Forest Service should continue research efforts to determine habitat use in predominantly forested landscapes and the effects of management, refine acoustic monitoring techniques, standardize sampling protocols and monitoring efforts, survey and protect mines and caves, design forest management strategies that provide roost trees across the landscape which include large diameter dead and hollow trees, utilize timber harvest methods that minimize adverse effects to bats, provide and maintain ridge top water sources, find better solutions to management of forest pests, and increase education efforts with a focus on bat conservation.

The Indiana Bat : Journeys in Space and Time

Allen Kurta[1], Susan W. Murray[2], and David Miller[3]
[1]Department of Biology, Eastern Michigan University, Ypsilanti, MI 48197,
[2]Department of Biology, Boston University, Boston, MA 02215, and
[3]School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI 48109

We studied roosting ecology and movements of a small group of Indiana bats (*Myotis sodalis*) in southern Lower Michigan over a 4-year period. During that time, we used radiotracking to locate 38 roost trees occupied by adult females and young. Thirty-seven roosts were located in wetlands, and most were green or black ash (*Fraxinus pennsylvanica* or *F. nigra*) and silver or red maple (*Acer saccharinum* or *A. rubrum*). Roost trees typically received more than 10 hours of sunlight each day. Bats roosted most often under bark, but a number of frequently used roosts were crevices in dead trunks. The bats changed trees once every 2-3 days, and new roost trees likely are discovered as bats forage or commute between foraging areas. Lactating females changed less often than pregnant adults, and bats roosting in crevices changed less often than bats roosting under bark. Maximum distance moved between trees overnight was 5.8 km, but maximum distance between any two roosts discovered over 4 years was 9.2 km. On three occasions, bats wearing transmitters switched roost trees during the daytime. In 1996, bats spent most of pregnancy in one tree located in a swamp and then moved 122 m to a different tree for lactation. In 1997, they used the same tree for pregnancy as in 1996 but moved 2 km to a new tree, in a different wetland, for lactation. In 1998, both pregnancy and lactation were spent in the second wetland. Frequent roost-switching, large home ranges, and changes in activity center between years create challenges for detection, monitoring, and management of this endangered species.

Philopatry and Migration of Banded Indiana Bats

Allen Kurta[1] and Susan W. Murray[2]
[1]Department of Biology, Eastern Michigan University, Ypsilanti, MI 48197
[2]Department of Biology, Boston University, Boston, MA 02215

From 1995 through 1998, we banded 29 adult females from a maternity colony of Indiana bats (Myotis sodalis) in Michigan, to obtain data pertinent to management of this endangered species

on its summer range. We recaptured 12 adults (41%) in later years; five bats were recaptured in exactly the same location in subsequent years, and all were recaught within the known home range of the colony, indicating strong inter-annual fidelity by females to a highly localized area. Three bats (10%) were recaptured while in hibernation in caves that were 467 ± 46 (SE) km from the maternity location. However, each bat hibernated in a distinctly different geographic area—one in eastern Kentucky, east of Cincinnati, Ohio; one in central Kentucky; and one in southern Indiana, west of Louisville, Kentucky. Hibernation sites for members of the same summer colony were as much as 300 km apart. These winter captures indicated that all members of a summer colony do not necessarily hibernate, and presumably do not mate, in the same location.

Summer Habitat Patterns of the Indiana Bat in Northern Missouri

Nancy Miller, Ronald Drobney, and Richard Clawson
Dept. of Fisheries and Wildlife Sciences, University of Missouri, Columbia, MO 65211 (NM),
U.S. Geological Survey, University of Missouri, Columbia, MO 65211, (RD),
Missouri Dept. of Conservation Columbia, MO 65201 (RC)

Concern arising from large decreases in Indiana bat (*Myotis sodalis*) populations has prompted a number of studies dealing with the habitat requirements of this endangered species. Because of their potential to influence reproductive success, maternity colony sites have been the subject of much of this research activity. Initial studies in the midwest focused primarily on microhabitat features of roost trees used by females and their young. This research determined that maternity colonies utilize 2 types of roost trees (primary and alternate) that differ in a number of respects and in use by bats. More recently, researchers compared landscape and macrohabitat features between occupied and unoccupied sites within the Missouri breeding range to determine whether areas with habitat suitable for Indiana bats could be discriminated by factors other than the characteristics of known roost trees. The results of this work demonstrated that the distribution of the measured landscape features was too variable to significantly discriminate between occupied and unoccupied sites. One forest stand characteristic (tree size), however, did differ ($p<0.05$) significantly as a function of use. Although both site types contained trees within the larger size classes, occupied sites had a significantly higher density of trees in these size classes. These findings suggest that if there are enough large diameter trees in an area, maternity colonies can occur irrespective of the proportion of the landscape in forest cover or other measured variables. This type of research should be conducted in other portions of the Indiana bat maternity range.

Variations in the Diet of the Indiana Bat

Susan W. Murray
Department of Biology, Boston University, Boston, MA 02215

Foraging behavior of bats can be affected by extrinsic factors, such as varying spatial and temporal distribution of prey, which can result in daily, seasonal, yearly, and regional variations in diet. Additionally, diet may shift in response to intrinsic factors such as the increased energetic demands of reproduction. The objective of this study is to determine if there is any variation in the diet of *Myotis sodalis* nightly, between pregnancy and lactation, and inter-annually. I also review the literature on Indiana bat diet to examine the hypothesis that regional dietary differences exist intra-specifically. Fecal pellets were collected beneath Indiana bat maternity roosts from May to August 1997 and 1998 in southern Michigan. Using a dissecting microscope, percent volume of insect orders was visually estimated for each pellet. The diet included twelve

arthropod orders, and 96% of food items consisted of dipterans, lepidopterans, coleopterans, trichopterans, and hymenopterans. There were dietary differences between years, within years, between pregnancy and lactation, and within nights. The results of my study were intermediate to those from another northern population, versus populations from more southern parts of the species range. Therefore, the hypothesis of regional variation in diet was not supported. I propose that the Indiana bat may be flexible in terms of its foraging requirements, with individual bats opportunistically foraging in habitats where insects of the appropriate size and type are abundant. In addition, foraging behavior of bats may be affected by varying bat community composition, which changes across the range of the Indiana bat.

Overview of Impacts of Contaminants on Bats: With Special Reference to the Indiana Bat

Thomas J. O'Shea[1] and Donald R. Clark, Jr.[2]

[1]U.S. Geological Survey, Midcontinent Ecological Science Center, 4512 McMurry Ave., Fort Collins, CO 80525-3400 (TO), and [2]U.S. Geological Survey, Columbia Environmental Research Center, Dept. of Wildlife and Fisheries Sciences, Texas A&M Univ., College Station 77843 (retired)

Little has been published about impacts of environmental contaminants on Indiana bats (*Myotis sodalis*). However, it is well established that life histories of insectivorous bats can render populations susceptible to impacts of environmental contaminants. We review knowledge accrued on this topic over the past 50 years since insecticides were first speculated to be a factor underlying declines in bat populations. Some of the firmest evidence for direct lethal effects of contaminants involves certain neurotoxic organochlorine insecticides and their metabolites. These are persistent, lipophilic, accumulate in food webs, and are deposited in body lipids of bats. Toxic quantities enter the brain when lipids are depleted during energy-demanding events in the annual cycle (hibernation, migration). Young exposed through nursing on lipid-rich milk can be particularly susceptible. Although organochlorine insecticides are little used in the U.S. today, there are pockets of elevated ecosystem contamination which may result in bat mortality. Organochlorines have been replaced by other neurotoxic insecticides with different biochemical modes of action, primarily the pyrethroids, organophosphates, and carbamates. These are less accumulative in food chains or in bats. They are likely to poison bats on exposure, resulting in more cryptic mortality or impairment than that associated with organochlorine poisoning. We discuss evidence for concern that these substances are impacting Indiana bat populations in certain agricultural areas. Possible direct and indirect impacts of other environmental contaminants on bats are also reviewed. We outline potential research approaches that may be useful in assessing environmental contaminants as threats to Indiana bats.

Bat Ectoparasites and other Symbiotic Arthropods from the Trans-Pecos Region of Texas

Christopher M. Ritzi[1], Michael T. Dixon[2], and Jim V. Richerson[3].

[1]Dept. Life Sciences, Indiana State University, Terre Haute, IN 47809; [2]Dept. Biology, Texas Wesleyan University, Fort Worth, TX; and [3]Dept. Biology, Sul Ross State University, Alpine, TX 79830.

A qualitative and quantitative analysis of the ectoparasites from 13 species of Molossid, Mormoopid, and Vespertilionid bats was conducted in the Trans-Pecos region of Texas. The study took place in Brewster, Crockett, Culberson, Hudspeth, Presidio and Reeves Counties, from September 1997 through October 1998. A small sample of bats was also examined from Big Bend National Park during May 1998, encompassing nine bat species. Ectoparasites recovered included fleas, streblids, nycteribiids, cimicids, and acari. A roosting site for *Myotis velifer* in

Presidio Co. was examined and revealed the presence of fleas, cimicids, dermestids, and acari. Mean intensity, prevalence, and site prevalence of ectoparasite on the host are presented for the three most numerous bat species encountered in the study. New host and host locality records are presented.

The Ectoparasites of the Indiana Bat Including New Host Records

C.M. Ritzi,[1] T. A. Wethington[2] and J.O.Whitaker,Jr.[1]
[1]Dept. of Life Sciences, Indiana State University, Terre Haute, IN 47809
[2]Dept. of Fish and Wildlife Resources, 1 Game Farm Road, Frankfort, KY 40601

The ectoparasites of the Indiana bat, *Myotis sodalis*, have been under recent investigation in order to learn more about which species are present, their community dynamics and their effects on *M. sodalis*. In an effort to begin this work, Indiana bats were sampled for ectoparasites using a modification of the collection technique outlined by Whitaker (1993) that allows microscopic examination of live bats followed by subsequent release. A small sample of bats were examined in this manner, and parasites recovered were stored in ethanol until identification was possible. Formal identification was carried out at Indiana State University by either slide-mounting in PVA medium or examining in ethanol while using appropriate keys and literature. Results of this study yielded both commonly associated parasites, as well as several new host records. Ectoparasites recovered included *Macronyssus crosbyi*, *Spinturnix americanus*, *Cryptonyssus desultorius*, *Euschengastria pipistrelli*, and *Basila boardmanni*. A complete listing of ectoparasites associated with the Indiana bat will be presented, along with preliminary site preference information for the parasites collected during the present study. Finally, the importance of ectoparasite awareness and inclusion into conservation management will be addressed.

Spring and Autumn Indiana Bat Activity Areas near Three Missouri Hibernacula

Russ Rommé, Amy Henry, Andy King, and Karen Tyrell
BHE Environmental, Inc., 11733 Chesterdale Road, Cincinnati, OH 45246

Little is known about habitat use by Indiana bats (*Myotis sodalis*) during spring and fall in areas near hibernacula. This situation limits development of strategies to manage this endangered species. In 1994, we used radiotelemetry to characterize the home range of Indiana bats during spring staging and autumn swarming periods. Results were used to describe the activity areas of six bats during the spring and three bats during autumn.

Bioaccumulation of Environmental Contaminants in Bats Collected from Missouri

Angela Schmidt and Karen Tyrell
BHE Environmental, Inc., 11733 Chesterdale Road, Cincinnati, OH 45246

We assessed bioaccumulation of environmental contaminants by the federally endangered Indiana bat (*Myotis sodalis)* and gray bat (*M. grisescens).* Both species occur on Fort Leonard Wood (FLW), Missouri where there are numerous sources of potential environmental contaminants, including military training materials and pesticides used in installation management. Bats may be exposed to environmental contaminants through direct exposure (e.g., consumption of contaminated water, inhalation of aerosols and fumes, and absorption through the skin) and through indirect exposure (e.g., ingestion of contaminated prey by adults and contaminated milk by suckling young). Bats selected as surrogates for the two endangered species were captured during the spring and fall from FLW and the nearby Mark Twain National Forest

in Missouri. Bat tissue and guano samples screened for organochlorine and organophosphate pesticides had detectable amounts of DDE, heptachlor epoxide, dieldrin, and chlordane. Tissue samples were also analyzed to determine PAH content. Two biomarkers were assessed in bat tissue samples: Cytochrome P450 activity via Reporter Gene Induction System in liver samples, and PAH metabolite concentrations in gall bladders of the bats. PAHs were detected in most bats analyzed. Activity of the Cytochrome P450 Reporter Gene Induction System indicated elevated gene activity for those bats that had detectable concentrations of PAH. These same bats were shown to contain small amounts of PAH metabolites in their gallbladders. In this paper, we will discuss implications of these results on the long-term management of Indiana bats.

A Southern Bat beyond the Northern Edge of Its Range - Indiana Bats at Tippy Dam

Annie Tibbels[1], Heidi Rice[1], Rodney Foster[2], Susan Murray[3], and Allen Kurta[1]
[1]Dept. of Biology, Eastern Michigan University, Ypsilanti, MI 48197, [2]Stevenson High School, Livonia, Michigan 48152, [3]Dept. Biology, Boston University, Boston, MA 02215

For many years, the northern edge of the range for the Indiana bat in the midwest was believed to be the city of Lansing, in southern Michigan. In 1993, a single Indiana bat was found hibernating in Tippy Dam, a hydroelectric facility, in Manistee Co., Michigan, about 200 km north of Lansing. Since that time we have captured eight other Indiana bats at the dam. We have captured both males and females and have found them both during swarming and hibernation, indicating that mating is possible. Radiotracking during swarming showed that Indiana bats roosted in trees within a few kilometers of the dam during the day. We also have recaptured banded individuals in subsequent seasons, indicating that the bats are faithful to the dam, despite less-than-optimal environmental conditions. No Indiana bat was captured during an extensive mist-netting survey of bats (>54 nights of netting at 27 sites) in areas surrounding Tippy Dam during summer 1998 and 1999. Where these bats spend the summer is not known, but we speculate that they migrate to southern areas of the state or perhaps to areas near the shore of Lake Michigan, where the climate is more mild.

Paleontological Evaluation of Past Use of Indiana Bat Roosts: A Significant Tool for Roost Restoration

Rickard S. Toomey[1], III, Mona L. Colburn[1], and Rick Olson[2]
[1]Illinois State Museum, 1011 E Ash St., Springfield, IL 62703 and [2]Div. of Science and Resources Management, Mammoth Cave National Park, P.O. Box 7, Mammoth Cave, KY 42259

Paleontological data provide an important tool for evaluating past utilization of caves by Indiana bats. It can also provide an important tool in restoring roosts for future use. Paleontological and historical evidence indicate that prior to 200 years of modification by settlers, the Historic Entrance area of Mammoth Cave (Mammoth Cave National Park, Kentucky, USA) housed the largest known Indiana bat hibernation colony. Conservative estimates place bat numbers in the millions. Analyses of remains and traces indicate that many areas of the Historic Entrance area were used for roosts; however, Vespertilio Hall, Little Bat Avenue, and Audubon Avenue near Rafinesque Hall were the primary roost sites. The presence of winter guano, abundant raccoon feces and radiocarbon dates indicate hibernation use over a long period. The raccoon feces indicate that raccoons were important predators on hibernating Indiana bats. Paleontology provides critical data on pre-disturbance microclimatic conditions in the hibernacula. Paleontological remains in Houchins' Narrows and along parts of Main Cave indicate past fill levels were higher. Establishing past entrance dimensions is critical to understanding past winter airflow in the cave, which, in turn, is crucial for any attempts at re-

establishing past roost conditions. Comparisons between paleontological data and modern meteorological data from one past roost site indicate that a small entrance must have closed in the area during the last 200 years. The National Park Service is evaluating the feasibility of reopening the past entrance in an attempt to re-establish the hibernaculum in that area.

An Evaluation of Indiana Bat Hibernation Requirements

M. D. Tuttle and J. Kennedy
Bat Conservation International, Austin, TX 78716

Over the past 20 years, temperatures and population trends were monitored at nine hibernation caves, designated as critical habitat by the Indiana Bat Recovery Team. Populations grew by 97,339 where temperatures averaged 3.0-7.2 C and fell by 185,083 at locations outside this range. Beginning in July, 1998, forty-six dataloggers were installed at 15 of the most important Indiana bat hibernation caves in Illinois, Indiana, Kentucky, Missouri, Tennessee, and Virginia. At each location, temperatures were simultaneously monitored at roosts, as well as outside. Where populations were falling despite protection, roost temperatures were found to be stressfully warm, cold, or unpredictable. Rocky Hollow Cave, in Virginia, which prior to human disturbance sheltered over a million Indiana bats, provided temperatures ranging from 7.0 to 7.5 C in October and November of 1998-1999 and 5.6-7.4 C from December through February. At the Magazine Mine in Illinois, which supports a rapidly growing population, temperatures for the same periods ranged 6.3-6.9 C and 1.4-6.9 C. In all but the northernmost locations, suitable caves must provide chimney-effect air flow between at least two entrances, buffering and storing sufficient cold air to meet the bats' fall hibernation needs without risk of freezing in winter. Protection of such sites, and restoration of appropriate temperatures in now altered sites, is essential to Indiana bat recovery efforts.

Nightly Emergence Activities of the Endangered Indiana Bat

Dennis P. Viele[1] and Allen Kurta[2]
[1]Department of Biology, University of Michigan-Flint, Flint, MI 48502
[2]Department of Biology, Eastern Michigan University, Ypsilanti, MI 48197

As part of a larger study, observations of *Myotis sodalis* emergence behaviors were made during the summer of 1992 to determine what environmental factors were affecting timing of emergence. We measured ambient roost temperature, external ambient temperature, light levels (full spectrum and red light), cloud cover and occurrence of rain at sundown. Examination of data suggests that most environmental factors have little effect on timing of emergence in *Myotis sodalis*, whereas time of sunset plays an important role in time of emergence. Temporally nonrandom and patchy emergence patterns also suggest these bats may be emerging as socially interacting units.

Comparison of Two Habitat Suitability Index Models for the Indiana Bat at Picatinny Arsenal, New Jersey

Antisa C. Webb[1], Kelly A. Burks[1], John D. Van DeVenter[2], and Darrell E. Evans[1]
[1]Environmental Laboratory, U.S. Army Engineer Research and Development Center, Vicksburg, MS 39180 and [2]Natural Resources Division, U.S. Army TACOM Armament Research, Development, and Engineering Center, Picatinny Arsenal, NJ 07806

The Indiana Bat (*Myotis sodalis*), a federally listed endangered species, was first captured on Picatinny Arsenal, New Jersey in the summer of 1995. As outlined under the Endangered Species Act, U.S. Army installations are required to develop Endangered Species Management Plans and

inventory potentially suitable habitats for federally listed species. Two Habitat Suitability Index (HSI) Models were used to determine suitable summer roosting and foraging habitat for Indiana bats on Picatinny Arsenal. An HSI Model developed for the Indiana Department of Natural Resources was compared with a recently released model developed by the U.S. Fish and Wildlife Service. Both models were developed for the "core" maternity range of the Indiana bat in Indiana, Illinois, Missouri, Kentucky, and Ohio. Similar habitat variables were measured in each model, including density of suitable roost trees and percent area with forest cover. A total of 12 cover types were sampled in three 2-km circles (985.96 ha each). HSI scores and baseline Habitat Units were generated using the EXpert Habitat Evaluation Procedures (EXHEP) software, recently developed by the Environmental Laboratory, U.S. Army Engineer Research and Development Center (ERDC). Results from both HSI Models will be presented as well as recommended future model modifications.

Distribution of the Indiana Bat in Indiana

John O. Whitaker, Jr.
Department of Life Sciences, Indiana State University, Terre Haute, IN 47809

Indiana bats have been found in hibernation in 27 caves in 6 counties in south central Indiana. The hibernacula occur roughly in a north/south line. Mist-netting for bats has been carried out in summer including at least 463 nettings in 77 of the 92 counties of Indiana, and Indiana bats have been found in 52 of these counties. Most adult male Indiana bats spend the summer in the general area of the hibernacula. The females disperse much more widely. Evidence of maternity colonies (reproductively active females or juveniles) has been found in 35 counties to date. It appears that maternity colonies may be found throughout much of the state except that few occur in the counties along the Ohio River.

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A Laptop Computer System for Recording and Analyzing Echolocation Calls

Stephen C. Burnett and W. Mitchell Masters
Department of Evolution, Ecology, and Organismal Biology, The Ohio State University,
Columbus, OH 43210 E-mail: burnett.33@postbox.acs.ohio-state.edu

Introduction

Development of field-portable recording equipment has helped to advance research on animal vocalizations and, in the case of audible sounds (e.g., McGregor and Ranft, 1994; Williams and Slater, 1991), a variety of well-tested analog and digital systems for recording and analysis exist. However, equipment capable of recording ultrasonic calls of bats is more difficult to find. Equipment that does exist is often expensive and lacks portability, making it difficult to record echolocation calls under natural conditions (Fenton, 1988). Fortunately, recent advances in computer software and hardware make it possible to assemble a reasonably priced, portable, ultrasonic recording system.

Using analog-to-digital converter cards designed for the PCMCIA interface, a laptop computer can serve as a digital ultrasonic recording system. Because recordings are stored in digital form, they are immediately ready for analysis and manipulation with a variety of computer programs. With additional programming, calls can be analyzed automatically using such a system. We describe a system that can record ultrasonic frequencies for extended periods of time, extract echolocation calls (ignoring periods of silence or irrelevant noise), and automatically measure a number of variables for each call.

System Components

The software for recording that we use runs under Windows 98 on a laptop computer (Toshiba Satellite 2675DVD), with a 450-MHz Pentium III processor, 128 MB of RAM, and a 6.4 GB hard disk. A fast processor insures that recordings can be stored to the hard disk at high sample rates, and the large hard disk allows for an extended period of recording. Calls are digitized by a type II PCMCIA card (PCM-DAS16/330) from Computer Boards, Inc. (Middleboro, MA) that samples at 333 kHz, with 12-bit resolution over a range of ±10 volts. Our microphone is a U30 bat detector (Ultra Sound Advice, London, United Kingdom), with high-frequency pass through. Our testing indicates that frequency response of the detector is flat (±3 dB) from 15 to 110 kHz. Because the maximum signal strength that this microphone produces is ca. ±2 volts, we amplify its output with a custom-built 6x amplifier (maximum output voltage of ±15 volts) to utilize the entire dynamic range of the recording card.

The software that we use for recording is CBDISK (Engineering Design, Belmont, MA)—a program that allows real-time recording to the hard disk at sample rates up to 333 kHz. The software runs in a DOS window within Windows 98. This program produces a sound file of arbitrary duration, limited only by available space on the hard drive. Individual echolocation calls can be extracted from this file and saved into individual files, using either Event Detector software running under SIGNAL (Engineering Design) or custom programs written in Matlab (Mathworks, Inc., Natick, MA).

To record observations of behaviors and recording conditions, spoken comments are recorded along with the ultrasounds in the file created by CBDISK. We then use custom programs written in Matlab to convert the audible portion of the sound file into a WAV file. In addition, the WAV file can also include a heterodyned version of the ultrasonic signal, producing an audible output similar to that of a heterodyne bat detector. The heterodyning frequency is user-specified, thus allowing one to select a heterodyne frequency appropriate for a given species of bat. Spoken comments can later be transcribed and the information added to the header of the sound file produced by CBDISK. Header information is also saved in the file of each call extracted from the sound file.

After extraction of a call, custom programs written in Matlab determine values of several variables describing the call. These variables are duration (msec); starting, midpoint, and ending frequency of the fundamental (kHz); duration of maximum amplitude (msec); and frequency of maximum amplitude (kHz). We also measure variables describing shape of the call (time-

frequency structure). To do so, the analysis program fits several curves to the time-frequency structure of the call; these curves are based on equations 1-4 from Masters et al. (1991), equation 8 from Parsons and Jones (2000), and a linear equation. The goodness of fit of these curves and values of parameters describing the curves give an indication of call shape. Another variable useful in describing shape is curvature (A. Boonman, pers. comm.). Curvature is a measure of how quickly the call drops from its starting frequency to its middle frequency, compared with a linear curve with the same starting and ending frequencies. Curvature values range from zero (linear sweep) to one. All variables resulting from the analysis are stored in a text file that can be imported into statistical software or spreadsheets for further analysis.

Due to the high sampling rate required for ultrasonic signals, resulting data files are very large (ca. 40 MB/min of recording), and some form of long-term, high-capacity storage is necessary. We transfer recordings to recordable compact disks for permanent storage and backup. Each disk holds ca. 15 min of recording.

Problems and Solutions

Our initial recordings showed a persistent 40-kHz noise, regardless of recording conditions. This noise apparently emanates from the laptop display and is eliminated by turning off the display while recording. An additional, weaker noise is visible at ca. 120 kHz and seems to be electronic noise from the computer's power system.

While recording, CBDISK occasionally is unable to write data to the hard drive as quickly as necessary. When this occurs, data in memory are lost, and the sound file momentarily is interrupted. This problem is dependent on speed of the CPU and hard drive and could be eliminated with faster components. We discovered that the problem also could be eliminated by turning off power-saving features, because these decrease speed of the processor, and by turning off the laptop display while recording.

Because maximum sampling rate of this system is 333 kHz, the theoretical maximum frequency that it can record is 166.5 kHz. Any energy present above this frequency causes aliasing, which may render recordings uninterpretable. This is not a problem for us, because the energy in echolocation calls of bats in North America essentially is always below ca. 100 kHz (e.g., Fenton and Bell, 1981). For calls containing significant energy above 140 kHz, an anti-alias filter is required to restrict bandwidth of the signal, and recording frequencies above 140 kHz requires a faster A/D card (e.g., DAQCard-6062E, National Instruments, Austin, TX).

The U30 microphone, like most transducers sensitive to ultrasonic frequencies, is affected by humidity, and prolonged exposure to high levels of moisture can add noise to recordings. We minimize this problem by storing the detector with desiccating gel whenever the detector is not in use.

Discussion

We assembled a portable system that can record ultrasonic frequencies for extended periods of time and limited only by space on the hard drive. The system automatically extracts recorded echolocation calls from the complete sound file and measures parameters describing the calls. The calls recorded with this system can be analyzed and manipulated by a variety of different programs, so a particular analysis program is not required. The analysis software we have written analyzes calls recorded by any system with only minor modifications. Currently, the analysis program is able to analyze only calls that are fairly short (<50 msec) and frequency modulated; however, modifications would permit analysis of longer and/or constant frequency calls as well.

Our system produces very accurate recordings of echolocation calls up to frequencies of ca. 120 kHz. However, at the high rates of sampling necessary for recording, it is not possible to provide a real-time display of calls as they are recorded. In contrast, the Anabat system (Titley Electronics, Ballina, New South Wales, Australia) provides such a display, which may allow experimenters to discriminate calls from different species of bats while they are being recorded (O'Farrell et al., 1999). Because Anabat uses zero-crossing analysis, it records only the strongest harmonic present in the sound, and consequently, some information is lost (Parsons et al., 2000). Because we record the complete signal, we can analyze aspects of calls

that might be missed by Anabat (e.g., data on amplitude). Pettersson's Batsound Pro software (Pettersson Elektronik AB, Uppsala, Sweden) provides functionality similar to CBDISK; however, at the time that we were assembling our system, the longest duration that Pettersson's software could record was limited by the amount of RAM in the computer (L. Pettersson, pers. comm.). Choice of system to use for studies of bat echolocation depends on the capabilities that the researcher desires, along with considerations of cost. If a researcher understands the limitations of the system, any of the above systems might be appropriate for a particular study.

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Literature Cited

Fenton, M. B. 1988. Detecting, recording, and analyzing vocalizations of bats. Pp. 91-104 *in* Ecological and behavioral methods for the study of bats (T. H. Kunz, ed.). Smithsonian Institution Press, Washington, D.C.

Fenton, M. B., and G. P. Bell. 1981. Recognition of species of insectivorous bats by their echolocation calls. Journal of Mammalogy, 62:233-243.

Masters, W. M., S. C. Jacobs, and J. A. Simmons. 1991. The structure of echolocation sounds used by the big brown bat, *Eptesicus fuscus*: some consequences for echo processing. Journal of the Acoustical Society of America, 89:1402-1413.

McGregor, P. K., and R. D. Ranft. 1994. Equipment for sound analysis and playback: a survey. Bioacoustics, 6:83-86.

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.

Parsons, S., A. M. Boonman, and M. K. Obrist. 2000. Advantages and disadvantages of techniques for transforming and analyzing chiropteran echolocation calls. Journal of Mammalogy, 81:927-938.

Parsons, S., and G. Jones. 2000. Acoustic identification of twelve species of echolocating bat by discriminant function analysis and artificial neural networks. Journal of Experimental Biology, 203:2641-2656.

Williams, J. M., and P. J. B. Slater. 1991. Computer analysis of bird sounds: a guide to current methods. Bioacoustics, 3:121-128.

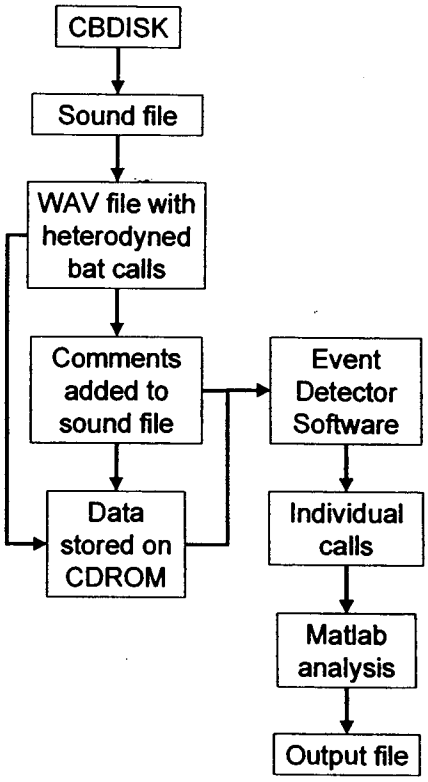

Figure 1. Flowchart of our procedures. Files are recorded in CBDISK. The audible portion of the sound file is filtered, heterodyned and converted to a WAV file. Information on recording conditions is added to the sound file, and the sound file and WAV file are stored on compact disk. Individual echolocation calls are extracted from a sound file, using the Event Detector program, and then analyzed in Matlab.

Observations on Use of Coastal Scrub Habitat by Evening Bats (*Nycticeius humeralis*) in Florida

Jeffrey T. Hutchinson
Department of Environmental Protection, Division of Recreation and Parks, District Administration, 13798 SE Federal Highway, Hobe Sound, FL 33455 E-mail: Jeffrey.Hutchinson@dep.state.fl.us

Introduction

Scrub habitat is a highly pyrogenic ecosystem that occurs almost exclusively in Florida (Myers and Ewel, 1990). In southeast Florida, mature scrub is dominated by a closed canopy of sand pine (*Pinus clausa*) that is 15-18 m high and a dense understory of low shrubby oaks (*Quercus* spp.). Scrub ecosystems are dependent on infrequent, high-intensity canopy fires that occur at intervals of 15-100 years (Kurz, 1942). During these infrequent, catastrophic fires, all sand pines are killed. Additionally, sand pines have a short life expectancy (< 75 years). In the absence of fire, mature scrub typically has an abundance of snags, caused by sand pines succumbing to disease and high winds.

Jennings (1958) and Robson (1989) completed the only known surveys of bats from southeast

Florida. These studies combined general observations, museum collections, mistnetting, and ultrasonic detectors to document locations where bats were found. They noted, however, that bats were essentially absent from the xeric, coastal ridge along Martin, Palm Beach, and Broward counties. Thus, little is known on use of coastal scrub habitat by bats in southeast Florida. However, on several evenings during December 1999, I noticed bats foraging in scrub, in Seabranch Preserve State Park (SPSP) in Martin County, Florida, and I began observations of bats using this unusual habitat.

Study Site

Bats initially were observed along a fireline at the northern boundary of SPSP. Habitat within this area of SPSP is characterized by mid-successional scrub dominated by a canopy of sand pine and an understory of scrub oaks. Average age of sand pines is 34.8 ± 0.87 (*SE*) years, with a range of 26-45 years. Average canopy height is 16.7 m. The canopy is primarily closed with the exception of several gaps in the interior of the forest. Few snags are present in SPSP. The preserve is separated from a low-density residential subdivision by the firebreak, which is mowed periodically and maintained at a width of ca. 5 m to prevent wildfires from spreading from the preserve to the adjacent community. Within the subdivision, small preserves (0.1–1.2 ha) and vacant woodlots (0.13 ha) of scrub exist close to SPSP. Several vacant woodlots adjacent to SPSP have some (3-6) large snags in each, but there are few live sand pines.

Methods

From January to December 2000, I surveyed bat activity along a 400-m section of firebreak at the northern boundary of SPSP. Bat activity was monitored for 3-5 nights/week ($n = 208$), both visually and acoustically (Mini-2 Bat Detector, Ultra Sound Advice, London, United Kingdom). Bats were surveyed by walking the transect ca. 10-15 minutes after sunset when foraging bats could still be observed visually. Average time of survey for the transect was ca. 10-12 min. Mean distance of detection (for visual and acoustic detections) of bats was 41.15 ± 1.23 m, based on 25 measurements of distance from point of detection to known reference points. Total area covered by each survey was an estimated 3.29 ha. Mistnetting for bats also took place on a few nights.

Results and Discussion

During the 12-month period, I detected 732 bats, for an average density of 1.07 ± bats/ha. Number of bats is overestimated because it was not possible to distinguish individuals. The majority of identified bats were evening bats (*Nycticeius humeralis*), though occasional Seminole bats (*Lasiurus seminolus*) also were observed. However, many times it was difficult to distinguish the exact species observed if the distance was greater than 8-10 m from the transect. Northern yellow bats (*Lasiurus intermedius*), Brazilian free-tailed bats (*Tadarida brasiliensis*), and eastern pipistrelles (*Pipistrellus subflavus*) have been captured in Martin County (J. Hutchinson, unpubl. data); thus, it is possible that other species are present in SPSP and the surrounding area. During the survey, bats primarily were observed foraging along the firebreak, but they also were seen in open woodlots adjacent to SPSP, above the sand-pine canopy, and in the interior of the scrub. Activity decreased during periods of cooler weather (ambient temperature < 17.2°C), and no bats were detected when ambient temperatures were < 13.9°C.

Mist-nets were set in scrub habitat on 15 June and 12 October 2000. On 15 June, a pregnant evening bat was captured, < 900 m S of the transect, along a canopy-covered forest road in mature scrub that was ca. 48 years old. On 18 October, three evening bats (two males with descended testes and one adult female) were captured in nets set in a canopy opening in interior scrub, < 20 m W of the transect. Additionally, two male evening bats and a male Seminole bat, each with slightly developed testes, were captured while mistnetting over a blackwater stream on 22 February 2001. The blackwater stream is located < 80 m from scrub habitat.

Due to the abundance of bats observed foraging near the firebreak, I regularly searched for emerging bats at dusk by observing the canopy of mature sand pines and snags. Bats of unknown species regularly were observed flying at canopy level in the scrub, above sand pines, but I never observed a bat emerge from the canopy. On 25 April 2000, I observed an evening bat emerge from the south side (185°) of a dead sand pine at 2010 h EST. After emerging, the evening bat

foraged around the immediate area for ca. 3 min. The bat was roosting in a small vertical slit, ca. 4 by 8 cm, located 8.7 m above the ground. The snag was located in a 0.13-ha undeveloped woodlot adjacent to SPSP. The snag was 32 cm in diameter, 10.4 m in height, and leaning at an angle of 10-15° to the west. No bark was present on the snag, and it was completely exposed to the sun. The snag was snapped in half, possibly during a tropical storm or hurricane within the past 5-10 years.

Within 45 seconds after the evening bat emerged from the roost, an eastern screech owl (*Otus asio*) emerged from a larger cavity on the north side (345°) of the snag, 0.9 m above the fissure from which the bat had emerged. The owl emerged from an oval cavity, with dimensions of 10 by 15 cm. I monitored the snag periodically over the next 2 months, but never observed another bat emerge from the snag. However, bats foraged in the area, and several large snags are in the general vicinity. On 19 May 2000 at dusk, a screech owl flew into the oval cavity, while another screech owl rested at the entrance. Within seconds, an evening bat flew near the cavity and circled the snag several times. It appeared that, as the owl flew towards the cavity, the bat swooped down as if it were "attacking" the screech owl.

This report documents the first use of the pyrogenic coastal-scrub ecosystem in southeast Florida by evening bats for foraging, roosting, and possibly breeding. Based on cursory data reported here, evening bats are common in mid-to-late successional scrub habitat throughout the year in SPSP. Infrequent cold spells may inhibit foraging activity of evening bats when ambient temperature drops below 13.9°C. It is unclear if evening bats or other species of bat are common in scrub habitat elsewhere in southeast Florida. The long interval between fires in scrub habitat, compared with an interval of 2-8 years for other upland ecosystems in southeast Florida, may provide greater roost permanency for tree-roosting bats. In addition, the short life expectancy of sand pines, combined with high-intensity winds from tropical storms, can provide an abundance of suitable snags for roosting by evening bats in mature scrub forests.

Literature Cited

Jennings, W. L. 1958. The ecological distribution of bats in Florida. Ph.D. dissertation, University of Florida, Gainesville Florida.

Kurz, H. 1942. Florida dunes and scrub, vegetation and geology. Florida Geolical Survey Bulletin, 23: 1-154.

Myers, R. L., and J. J. Ewel, eds. 1990. Ecosystems of Florida. University of Central Florida Press, Orlando, Florida.

Robson, M. 1989. Status survey of the Florida mastiff bat. Final Performance Report, Nongame Wildlife Section, Florida Game and Fresh Water Fish Commission, Tallahassee, Florida.

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.

"Buzzless" Insect-catching?

Donald R. Griffin
Concord Field Station, Harvard University, Old Causeway Road, Bedford, MA 01730
Email: griffin@fa.harvard.edu

The aim of this letter is to call attention to a significant challenge and opportunity for students of bat behavior under natural conditions. While foraging, echolocating bats often shorten the interpulse interval to ≤ 0.1 of the duration used when searching for prey, and the output of a typical bat detector changes from a series of clicks to what has come to be called a "feeding buzz." The buzz is so conspicuous that we have come to assume that it occurs whenever a bat attempts to catch a flying insect by echolocation, and buzzes have sometimes been used as quantitative indicators of feeding activity.

However, under some conditions, bats that are presumably hungry fly in early evening for long periods without buzzes. Even in early laboratory studies of the echolocation of flying insects, there were occasional catches or apparent catches when the interpulse interval fell from 90 to only 40-50 msec (Griffin et al., 1960, Animal Behaviour, 8:1431-54). This raises the question of whether some captures occur with only slight reduction in interpulse interval or none at all. If so, it is not safe to assume a 1:1 correlation between feeding buzzes and insect capture. The challenge is to learn how bat echolocation, in general, and changes in pulse repetition rate, in particular, are correlated with captures under various natural conditions.

When no buzz is detected there are three possible explanations. First, buzzes were emitted but not detected, probably because of low frequency and amplitude. Under some conditions, more buzzes are detected from little brown bats (*Myotis lucifugus*) when heterodyne detectors are tuned to 30-35 kHz, rather than the frequency at which signals are strongest, usually 40-45 kHz. For best detection of buzzes, the apparatus should be sensitive to the frequencies in these signals. The second explanation is that the bat was not trying to catch an insect, or third, the bat tried or succeeded in catching an insect without drastically lowering the interpulse interval.

In collaboration with Peter and Gregory Auger and several interested students, we tried to study this question by observing little brown bats feeding over or near a small pond that was 500 m from a large nursery roost in Mashpee, Massachusetts. This is the same site where I banded bats and recovered a few that had migrated considerable distances between caves and nursery colonies (Griffin, 1945, Journal of Mammalogy, 26: 15-23). It is also where Gould (Journal of Mammalogy, 1955, 36: 399-401) collected bats and found that their stomachs were filled with small insects within a short time.

We tape-recorded signals from heterodyne bat detectors (Ultra Sound Advice Mini-3 or Pettersson D100, D120, or D240x) and, to maximize signals and detect bats at the greatest distance, we ordinarily tuned the detector to 40-45 kHz. A sound-analysis program (Canary) was set to display 20-sec samples, because a bat was usually within range of the detector only for one to a few seconds. Analysis was limited to periods when signals were well above noise, so I believed that any buzzes would be detected. Pulses in a buzz could best be detected by ear and then the interpulse interval measured by expanding the display. This selection seemed conservative because some buzzes were detected in recordings that were discarded because of a low signal-to noise ratio in the search-phase signals. In addition to clear and obvious buzzes with

interpulse intervals of 10 msec or less, there were some "semi-buzzes," in which the interpulse intervals of 10 msec or less, there were some "semi-buzzes," in which the interpulse interval was 10-20 msec in duration or the signal-to-noise ratio was too low to be certain that a buzz had occurred. Although two or more bats were sometimes within range, we treated the data as though only one was present. All recordings were made well after dark, during the first 1-2 h after bats emerged from the nursery roost and when we would expect bats to be feeding.

During summer 2000, even when bats were within range with good signal-to-noise ratio, there was considerable variability in frequency of clear buzzes, with interpulse intervals of 10 msec or less, and in spring 2001, there were many isolated buzzes without a gradual decrease in interpulse interval. Between 27 May and 25 June 2000, average number of buzzes/min was 0.7. However, the average increased to 4.8 buzzes/min, between 30 June and 14 July, and decreased to 0.32 buzzes/min, between 22 and 24 July. Did the substantial difference in detected buzzes result from greater demand for food by pregnant or lactating females in late June or early July? Were young bats included in the sample from late July and were they less likely to employ buzzes? Does the ease of detecting buzzes vary due to changes in frequency and intensity? Are buzzes emitted during all attempted captures? These and many other questions about insect-catching behavior cannot be answered without more carefully controlled observations or experiments.

Ideally one would like independent evidence of insect catching, such as weight gain or photographic or video images of insects that actually are captured. This was possible in laboratory studies and also in recent investigations under natural conditions, such as those of Kalko and Schnitzler (Behavioral Ecology and Sociobiology, 35:327-45, 1993) and Britton and Jones (Journal of Experimental Biology, 202:1793-1801, 1999). Newly available apparatus might enable enterprising students of bat behavior to determine whether any insect catches occur without a buzz. I hope that other readers of Bat Research News will be interested in pursuing these questions, and I would be glad to discuss the subject in greater detail.

Observations of Bat Activity during Prescribed Burning in West Virginia

Jane L. Rodrigue[1], Thomas M. Schuler[1], and Michael A. Menzel[2]
[1]USDA Forest Service, Northeastern Research Station, Box 404, Parsons, WV 26287,
[2]Wildlife and Fisheries, Div. of Forestry, West Virginia University, Morgantown, WV 26506

During the week of 30 April 2001, the USDA Forest Service conducted a series of prescribed burns on the Monongahela National Forest, Tucker County, West Virginia, in conjunction with an ongoing study of regeneration of oak (*Quercus* spp.). Burn units were located in the Allegheny Mountain and Plateau physiographic province, at elevations ranging from 615 to 800 m. The forest primarily consisted of chestnut oak (*Q. prinus*), hickory (*Carya* spp.), red maple (*Acer rubrum*), and black locust (*Robinia pseudo-acacia*) in the overstory, with striped maple (*Acer pennsylvanicum*) and mountain laurel (*Kalmia latifolia*) in the shrub layer.

On 30 April, at ca. 1210 h, a myotid bat (*Myotis* sp.) flew from a snag that had ignited at its base, as the fire rapidly moved up the slope. The bat flew ca. 7-10 m to a live serviceberry (*Amelanchier arborea*), where it clung to the uppermost, leafed-out branches. The bat remained in the serviceberry for ca. 30 seconds, before it flew straight to unburned forest across the cleared fireline. Similar behavior was observed on 1 May 2001 on another burn unit in the same general area. At ca. 1330 h, as the prescribed fire moved up a slope, two red bats (*Lasiurus borealis*) flew rapidly out of the burning unit, across a wildlife opening, and into an unburned area of forest.

The short and long-term negative and positive impacts of prescribed burning on bats in forested landscapes of the East are poorly known. Red bats that readily roost in leaf litter on the

forest floor or in tree foliage are subjected to heat and dense smoke (Saugey et al., 1998, J. Arkansas Acad. Sci., 52:92-98; Moorman et al., 1999, Bat Research News, 40:74-75), and other bats roosting in snags consumed by fire undoubtedly are displaced in the short-term. Nonetheless, because most prescribed fires in these Allegheny forests are short in duration and relatively cool, few snags probably are consumed and fire-related mortality of subcanopy, suppressed trees could result in a net gain of potential bat roosts (Menzel et al., in press, Forest Ecology and Management).

Tents in *Pentagonia donnell-smithii* (Rubiaceae) Used by *Vampyressa pusilla* (Phyllostomidae) in Costa Rica

Bernal Rodríguez-H.[1], Sofia Rodríguez-Brenes[2], and María Sagot[2]
[1]Museo Nacional de Costa Rica, Historia Natural, 749-1000 San José, Costa Rica, [2]Escuela de Biología, Universidad de Costa Rica, San José, Costa Rica. E-mail: bernalr@racsa.co.cr.

Fourteen species of neotropical bat use tents made from leaves as refuges, and 80 flowering plants provide tents used by bats (Kunz et al., 1994, J. Mammalian Evol., 2:57-78). Herein, we describe the first report of *Vampyressa pusilla* (Phyllostomidae) using tents in leaves of *Pentagonia donnell-smithii* (Rubiaceae). Tents in *P. donnell-smithii* were first described for *V. nymphaea* (Brooke, 1987, J. Tropical Ecol., 3:171-175), although apparently the species of bat was misidentified (Reid, 1997, A field guide to the mammals of Central America and southeast Mexico). *P. donnell-smithii* occurs in secondary forests below 800 m and reaches heights up to 6 m. Other species of plant used by *V. pusilla* are *Rhodospatha wendlandii*, *Philodendron macrophylla*, *Heliconia spartocircinatha* and *Simira aff. eliezeriana* (Kunz et al., 1994; Zortea and Ferreira Alves De Brito, 2000, J. Tropical Ecol., 16:475-480).

We examined 57 *P. donnell-smithii* in an area of 4,500 m^2, in Estación Biológica Pocosol (10° 21' N, 84° 40' W), Alajuela, Costa Rica, on 20 April 2001. Tents were present on only 5 of the 57 plants. Four tents were unoccupied, and one leaf sheltered three *V. pusilla*. One reproductively active male was collected (length of forearm, 31 mm; body mass, 7 g; MNCR 1105), but the other two escaped.

The tent had an apical design (Kunz et al., 1994) and the same shape and modifications of the leaf described by Brooke (1987) for tents of *V. nymphaea*. Average ($\pm$ *SD*) dimensions of the five tents were: length of blade, 55 $\pm$ 5 cm; width of blade, 39 $\pm$ 3 cm; distance to first cut from petiole-blade intersection, 20 $\pm$ 4 cm; and distance to second cut from petiole-blade intersection, 39 $\pm$ 6 cm. Height from the ground to the tip of the leaf was 267 $\pm$ 90 cm.

It likely would be difficult for *V. pusilla* actually to construct tents on this plant, because of the small size of this bat and the large size and thickness of leaves of *P. donnell-smithii*. Other species of bat that construct tents are also present in the area, including *Artibeus jamaicensis*, *A. phaeotis*, *A. toltecus*, *A. watsoni*, *V. nymphaea*, and *Mesophylla macconnelli*, and it seems more likely that these tents were constructed by one of the larger species. However, more information is needed to determine if *V. pusilla* constructs its own tents, or if it use tents abandoned by other species.

We thank J. Arroyo-Cabrales, G. Barrantes, F. Chinchilla, R. K. LaVal, R. M. Timm, and M. Tshapka for helpful suggestions, and the Asociación Conservacionista Monteverde and the employees at the Estacion Pocosol for their help.

More News continued >>

Second Record of *Eumops hansae* (Molossidae) in Southeastern Brazil

Renato Gregorin
Instituto Hebraico-Brasileiro de Ensino Renascença, São Paulo, SP, Brasil
Present address: Mastozoologia, Museu de Zoologia—USP, São Paulo, SP,
Brasil Cx. Postal 42694; CEP: 04299-970 E-mail: rgregorin@hotmail.com

Many species of molossids are rare, as indicated by collections in museums and records from field work, and this apparent rarity may be due to difficulty in netting molossids and, perhaps, to their low densities. *Eumops* is a genus of free-tailed bat composed of very distinct species, and it is considered one of the most speciose of neotropical molossid genera (Eger, 1977; Freeman, 1981; Ryan, 1991a, 1991b). Within *Eumops*, the species *E. hansae*, *E. dabbenei*, *E. underwoodi*, and *E. maurus* are poorly known in terms of their systematics, geographic distribution, and natural history.

Eumops hansae was described originally by Sanborn (1932), based on a specimen from Colonia Hansa (at present, Curupá), State of Santa Catarina, southern Brazil. To date, it is the only specimen recorded from that region of Brazil, although several individuals were collected from northern Brazil, other areas of northern South America, and Central America (Alvarez and Alvarez-Castañeda, 1990; Anderson, 1997; Gardner et al., 1970; Graham and Barkley, 1984; Simmons and Voss, 1998). Thus, *E. hansae* appears to have a disjunct distribution in South America, with a population in southern Brazil (represented only by the holotype) and others throughout Amazonia and northern Brazil. This led Koopman (1982) to extend the distribution of the species, uniting both forested areas by a broad strip through central Brazil, even though there are no intermediate records.

The Museu de Zoologia has another specimen from southeastern Brasil (MZUSP 15442) that is referred to *E. hansae*. The specimen, an adult male, was collected by F. Novaes in São Paulo city, State of São Paulo (23° 25' S and 46° 39' W), and identified as *E. hansae* by A. L. Gardner in November 1986. The specimen is preserved in alcohol, but the skull is missing. To confirm the identification, I compared the specimen with other *E. hansae* from northern South America and the holotype from Brazil; with *E. bonariensis*, a closely related species from southern South America; and with *Nyctinomops* and *Tadarida*, other genera with external morphology similar to that of *Eumops*. Freeman (1981) pointed out that *Eumops* is phylognetically related to *Molossus* and *Promops*; however, external morphology, primarily facial morphology, of each is very distinctive and a comparison among them is not necessary.

The specimen MZUSP 15442 has rounded ears joined over the head, with several rounded, dermal cushions and warts, upper lips with a few wrinkles, and facial hairs that are thin and pliable. All characters indicate that the specimen belongs to the complex *Eumops hansae-E. bonariensis* (Eger, 1977). The specimen is distinguished from *Tadarida*, which has separated ears, high degree of wrinkling on the upper lips, and hard and thick facial bristles. *Eumops* has nostrils separated by small cushions and spoonlike hairs, whereas *Nyctinomops* has nostrils separated by two parallel rows of large cushions and that region is practically hairless. A comparison among South American species of *Eumops* showed that specimen MZUSP 15442 is easily distinguished by presence of rounded cushions over the anterior surface of the ear and by morphometric characters (Table 1). Thus, this seems to be a valid record of *E. hansae* in southeastern Brazil.

I thank M. de Vivo for permission to analyze the specimens in MZUSP, A. L. Gardner for authorizing the study of the holotypes, and C. J. Galacini for comments on the text. Financial support was provided by FAPESP (grants number 96/02140-7 and 98/5075-7).

Literature Cited

Alvarez, T., and T. S. Alvarez-Castañeda. 1990. Cuatro nuevos registros de mueciélagos (Chiroptera) del Estado de Chiapas, México. Anales de la Escuela Nacional de Ciencias Biologicas, 33:157-161.

Anderson, S. 1997. Mammals of Bolivia, taxonomy and distribution. Bulletin of the American

Museum of Natural History, 231:1-652.

Eger, J. L. 1977. Systematics of the genus Eumops (Chiroptera: Molossidae). Life Science Contributions, Royal Ontario Museum, 110:1-69.

Freeman, P. W. 1981. A multivariate study of the family Molossidae (Mammalia, Chiroptera): morphology, ecology, evolution. Fieldiana, Zoology, new series, 7:1-173.

Gardner, A. L., R. C. LaVal, and D. E. Wilson. 1970. The distributional status of some Costa Rican bats. Journal of Mammalogy, 51:712-720.

Graham, G. L., and L. J. Barkley. 1984. Noteworthy records of bats from Peru. Journal of Mammalogy, 65:709-711.

Koopman, K. F. 1982. Biogeography of the bats of South America. Special Publication, Pymatuning Laboratory of Ecology, 6:273-302.

Ryan, J. M. 1991a. Comparative morphology of the glans penis in Molossus, Promops, and Eumops (Chiroptera, Molossidae). Bulletin of the American Museum of Natural History, 206:122-137.

Ryan, J. M. 1991b. Morphology of the glans penis in four genera of molossid bats (Chiroptera: Molossidae). Journal of Mammalogy, 72:658-668.

Sanborn, C. C. 1932. The bats of the genus *Eumops*. Journal of Mammalogy, 13:348-357.

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.

Table 1. External measurements of species of *Eumops* and *Nyctinomops*. Only males were included.

Species	n	Length of forearm (mm)	Length of 3rd metacarpal (mm)
E. hansae (MZUSP115442)	1	40.7	42.6
E. hansae (holotype)	1	41.7	-
E. hansae (Eger, 1977)	3	41.2	-
E. b. bonariensis	7	46.1 - 48.3	47.0 - 52.5
E. b. beckeri	2	45.8 - 46.0	45.9 - 47.2
E. b. nanus	5	37.3 - 40.3	37.2 - 40.5
N. laticaudatus (from state of Sao Paulo)	8	42.7 - 48.3	45.3 - 47.5

more News continued >>

Visits of Long-tongued Bats, *Glossophaga soricina*, to Hummingbird Feeders in Southeastern Brazil

Wilson Uieda and Carolina Ferreira Santos
Departamento de Zoologia, Instituto de Biociências,
Universidade Estadual Paulista 18618-000 Botucatu, SP, Brazil
E-mails: wuieda@ibb.unesp.br, carolxuranha@hotmail.com

The long-tongued bat, *Glossophaga soricina* (Phyllostomidae), has a wide distribution, from northern Mexico to Paraguay and northern Argentina, and on Jamaica and the Bahamas. This bat is very common in several habitats, including urban areas in many Brazilian cities. We present data on visits of about 50 *G. soricina* to four hummingbird feeders placed in a tree, in a garden, in the city of Botucatu (22°52'S 48°26'W), State of São Paulo, southeastern Brazil.

The solution used in the feeders was prepared with 135 g of cane sugar, dissolved in 2.1 liters of freshwater, and it was offered to the bats on a daily basis. Sugar concentration in this solution was ca. 10%, and sucrose was the main type of sugar. Observations were carried out during 7 nights between August (dry season) and November (wet season) 2000, totaling 23 observation-hours. Each session started at 1800 h and ended around 2200 h.

The first visits started soon after sunset (1840 h), when bats approached the feeders and flew around them. Sometimes we observed several individuals (up to 20) flying around the feeders at the same time. Frequently a bat hovered in front of a feeder and drank the sugar water although we observed bats hanging on a feeder on two occasions. Each visit was brief and lasted only a few seconds. These behaviors are similar to those adopted by *G. soricina* when visiting flowers, as reported by several authors (e.g., Lemke, 1984, Ecology, 65:538-548; Sazima et al., 1999, Annals of Botany, 83:705-712). Between August and October, we counted 7.1 bat visits per minute per feeder, but in November, rate of visitation was reduced drastically to 1 visit per hour per feeder. Also in November, we found nearby several flowering individuals of *Lafoensia pacari* and *Bauhinia* sp., some of which were being visited by *G. soricina*. We hypothesize that use of hummingbird feeders by this bat helps to maintain its urban population during the dry season in Botucatu, when natural food supplies are presumably scarce (Lee and Clark, 1993, Bats, 11:3-5).

According to Sazima et al. (1999), nectars consumed by *G. soricina* and other glossophagine bats in Brazil contain 10-20% sugar. Nectar of bat-pollinated flowers in the New World may contain sucrose, fructose, glucose, or some combination of the three, although glucose tends to dominate (Baker et al., 1998, Biotropica, 30:559-589). Despite the dominance of glucose in natural foods, *G. soricina* readily consumed the sucrose-dominated solution placed in our hummingbird feeders.

We thank the family Cruz for their hospitality, and E. F. Spirandeli Cruz, M. Carolina de Carvalho, and T. Midori Sato for helping in the field, and V. Sanchez Uieda, F. de Assis Ganeo de Mello, I. Sazima, and M. Sazima for critical review of the manuscript.

Notes

To Catch A Bat With A Harp Trap

Harp Traps are used extensively as a technique to catch insectivorous bats during broad-scale surveys and research projects. However, as not all bats that approach a trap are caught, biases may result from this technique, especially in relation to assessing the comparative abundance of species. To assess inter-specific differences in the rate, at which bats were caught, observations were made of the behaviour of bats as they approached a harp trap. Traps were illuminated by infra-red spotlights and filmed with two low light cameras. The echolocation call of each individual that approached the trap was simultaneously recorded using Anabat equipment. 38 hours of observations over 20 nights were recorded between October 1998 and February 1999, at two sites in forested areas of Victoria.

A total of 1750 observations of bats approaching a trap were recorded from ten species. All species were observed to detect and avoid the harp trap. Only 2.6% of the approaches to the trap resulted in capture. As individual bats may have approached the trap a number of times it is not possible to translate this figure into the percentage of individuals caught. The most frequent response for all species was to detect the trap and avoid capture by flying around it, or circling in front if it then flying off in the opposite direction to the trap. 8.3% of observations were of individuals that appeared not to detect the trap, and either bounced off or flew through the fishing lines. Slower flying species tended to avoid the trap, while a higher proportion of faster flying species avoided capture by flying straight through the fishing lines. Inter-specific differences in trappability need to be considered when assessing the relative abundance of each species in an area. An example is provided of how knowledge of the relative trappability altered the perceived abundance of various species.

Submitted by Karen Dobson[1], Lindy Lumsden[2], and John Nelson[1].[1] Department of Biological Sciences, Monash University, Clayton Vic 3168.[2] Arthur Rylah Institute, 123 Brown St. Heidelberg Vic 3084.

Prediction of Large-scale Distribution of Bats: Combination of GIS and Statistical Models.

Thorough knowledge of species distribution is of prime interest for biological conservation as distribution maps are widely used by conservation biologists, e.g. to assess species status, to draw up species red lists or to pinpoint areas of particular biological value. However, identifying species distribution in bats presents a considerable challenge. Intensive surveys of bat populations are difficult to conduct because of the animals' nocturnal behaviour, their wide home range and the problems related to species identification in flight. Consequently, the use of predictive habitat distribution models is an interesting alternative. With such an approach, information about species-habitat relationships can be used to generate statistical models that predict species distribution, based on chosen habitat descriptors.

The Swiss Coordination Centre for the Study and Protection of Bats (CCS), associated with the Swiss Centre for Faunal Cartography (CSCF), conducted a pilot project for constructing predictive spatial models for large-scale bat distribution, based on landscape structure. We constructed two types of models: (i) models for individual species distribution and (ii) models for overall composition of species assemblage. On that purpose, we used an extensive data set comprising about 4'000 bat recordings sampled throughout an area of about 800 km^2 in Switzerland. These data were obtained mainly through mist-net captures above water or in caves entrances and through systematic investigation of public buildings. These data were aggregated per square units of 2.5 x 2.5 km, using an ArcInfo/ArcView GIS. An important data set of environmental descriptors was gathered from several sources (mainly the Federal Office for Statistic). Environmental data were

(CCA) for identifying significant predictors of (i) individual species occurrence or (ii) or (ii) species assemblage composition respectively. Several landscape structure descriptors were selected in the models. They were mainly: altitude, cover of dense forest and of various other woodland elements (hedges, isolated trees, forest patches), cover of lakes and of suburbs. Other descriptors were selected only in few cases (longitude, latitude, cover of pastures). Predicted species occurrence or composition of species assemblage were then mapped over the whole study area by implementing the statistical models into a GIS.

Models for individual species distribution (GLMs) accounted for 21 to 66% of deviance. These percentages differed significantly from a random effect in all cases, as stated by permutations tests. Overall prediction success of the models ranged from 0.71 to 0.87. Several other performance measures were also calculated to assess prediction power of the models.

The results indicated that this modelling approach is highly relevant for predicting bat distribution, although they are mobile organisms with sometimes strong variations in habitat requirements. We thus encourage a more systematic use of similar modelling methods for e.g. drawing large-scale distribution maps of bats or for evaluating chances of species occurrence in remote areas.

Submitted by Christophe Jaberg, Coordination Centre for the Study and Protection of Bats - Neuchâtel, Musée d'histoire naturelle, CH-2300 la Chaux-de-Fonds, christophe.jaberg@rpn.ch

News from our Colleagues

From Springfield, Missouri

Our lab at Southwest Missouri State University is involved in a number of projects pertaining to bat ecology, especially endangered species. Our major emphasis at this time is on the ecology of Indiana bats including roosting and foraging habitat, interactions with other sympatric species, and the use of managed and unmanaged forests on the distribution and activity of these bats. Three students are in the field this summer conducting their research using mist-nets, Anabat II bat detectors, and radiotelemetry in and around the Deer Ridge Conservation area in NE Missouri.

Kevin Murray, who finished his Master's degree this May, is helping us out this summer. His thesis was broken down into two chapters, one, entitled 'Surveying bat communities: a comparison between mist nets and the Anabat II bat detector system' was published in Acta Chiropterologica, and the second chapter entitled 'Variation in search-phase calls of bats' is *in press* in the Journal of Mammalogy.

John Timpone is a second year Master's student studying the roosting and foraging ecology of Indiana bats. He is using mist-nets, radiotelemetry, and GIS technology to characterize and compare these habitats.

Matt Miller is a first year Master's student who is using Anabat II detectors and species identification software to determine habitat use by Indiana bats and associated species. A variety of natural and managed forest habitats will be examined.

Jennifer Erickson will begin her studies this summer, and will start by characterizing the roost habitats of the other species of bats inhabiting the same forest areas as the Indiana bats. She will be using mist-nets, radiotelemetry, and GIS technology.

In addition to these students, Scott Robertson is finishing his thesis on the ecology and habitat use of the gray bat in and around Pittsburg, Kansas, and Sarah Robertson is finishing her thesis on the species composition and habitat use of bats in urban Springfield, and comparing these data with our findings from rural areas.

The Indiana bat study in NE Missouri was funded on a preliminary basis by the Missouri Department of Conservation, U.S. Fish and Wildlife Service, and Bat Conservation International, and it is anticipated that this is the first year of a multi-year project. I am currently looking for one or two Master students who are computer literate, bat enthusiastic, have knowledge or great desire to work with GIS technology, and are available beginning in the summer, 2002 field season. Submitted by Lynn Robbins, Department of Biology, Southwest Missouri State University, Springfield, MO 65804 Email: lwr704f@smsu.edu

From Columbus, Ohio

Research in the bat lab at Ohio State progresses on two main fronts. First, we are continuing our long-standing study of how bats analyze sonar signals. As anyone interested in bats knows, it is an understatement to say that they have a remarkable ability to solve spatial problems using echolocation. We have been trying to dissect this ability in big brown bats (*Eptesicus fuscus*) using electronically synthesized targets (an approach introduced by Jim Simmons nearly 30 years ago). One of our more interesting recent findings is that big brown bats can detect small changes -- on the order of fractions of a millimeter -- in the relative spacing of two or three targets, even as absolute distance to the targets is changing by much larger amounts. Bats might use this ability to pick out moving targets, or perhaps to help determine the three-dimensional arrangement of objects in their sonar field.

The second main area of research concerns whether and how sonar signals might be used in intra-species communication. From recordings in the lab, we have found that it is possible to

identify individual big brown bats fairly successfully by the characteristics of their sonar calls. This finding raises questions about the potential for bats themselves to do the same and thus to recognize other individuals acoustically. Such an ability might, for instance, help a young bat follow its mother to a feeding area, or a colony member follow another member to a new roost. Karry Kazial, a post-doctoral researcher, has found that female bats can evidently determine whether unfamiliar sonar signals come from a male or female bat, which encourages us to think bats might actually make use of other bats, signals. Meanwhile, Steve Burnett, who will be finishing his Ph.D. this summer, has extended the laboratory findings of call individuality to calls from bats in the field. In addition, Steve, using self-organizing neural networks, has made some headway on a question that arises in acoustic surveys of bats, namely, how to tell whether one bat flew over 10 times or 10 bats flew over once. Karry is leaving this summer to assume a Visiting Assistant Professorship at Hope College in Holland, MI. As soon as he finishes his degree, Steve, too, is leaving to take up a tenure-track position at Clayton College and State University in Atlanta, GA. Their absence will be sorely felt, but the arrival this fall of a new doctoral student, Laura Nawojchik from Cornell University, will soften the blow.

In addition to graduate students, a number of undergraduates have made life a lot more interesting and enjoyable in the bat lab. Two of the many I could mention are Heather Handley, who after her stay with us moved on to an internship at the Lubee Foundation in Florida, and Holly Gibbs, who did an honors thesis on the feasibility of releasing lab-reared bats and, after graduation, entered the doctoral program in Natural Resources here at OSU.

Submitted by W. Mitch Masters, Dept. of Evolution, Ecology, & Organismal Biology, 1735 Neil Ave. Ohio State University, Columbus, OH 43210

e-mail: wmasters@pop.service.ohio-state.edu

Announcements

Graduate assistantship in bat ecology

We are seeking one student to begin an M.S. degree this summer in applied bat ecology. The assistantship, split between both teaching and research, includes a $12,630 annual stipend and a full tuition waiver. In addition, three months of summer housing and a research vehicle will be provided. The goal of the two-year project is to determine the influence of wind energy development (turbines) on bat populations at Buffalo Ridge Wind Resource Area (BRWRA) in southwestern Minnesota. BRWRA is the largest single windplant in the world and previous studies have demonstrated that there is considerable mortality of bats, especially the hoary bat, associated with the operation of the wind turbines at the site. However, the influence of wind-turbine related mortalities on populations of bats is unknown. The start date is 11 June 2001. Interested persons should contact Dr. Brock McMillan (brock.mcmillan@mnsu.edu or 507-389-3202) or Dr. John Krenz (john.krenz@mnsu.edu or 507-389-5735) for more information and application procedures as soon as possible. Minnesota State University, Mankato is an Affirmative Action/Equal Opportunity Employer.

Brock R. McMillan, Assistant Professor, Department of Biological Sciences, Minnesota State University, Mankato, MN 56001
Phone: 507-389-3202 Fax: 507-389-2788 e-mail: brock.mcmillan@mnsu.edu

Bat foraging study opportunity

The U.S. Forest Service, in cooperation with the Arkansas Game and Fish Commission, has been conducting a study of bat roosting ecology on the Ouachita National Forest. As part of this study a series of towers used for radiotelemetry reception have been set up around the study area. The USFS would be happy to allow someone to use these towers to monitor foraging bats that were radio-tagged by the USFS as part of the roost study, but there are no funds available to fund this project. If you, or someone you know, is interested in (and can support) this sort of research, please contact me.

Blake Sasse, Nongame Mammal Program Coordinator,
Arkansas Game and Fish Commission,
#2 Natural Resources Drive, Little Rock, AR 72205
Phone: 501-219-4141 Fax: 501-219-4149 e-mail: dbsasse@agfc.state.ar.us

Bat Education Kit for School Children

The American Zoo and Aquarium Bat Taxon Advisory Group and Organization for Bat Conservation have recently constructed an educational tool, The North American Bat Education Kit. The goal is to make this kit available to zoos, teachers, librarians and other educators. The contents offer the educators a fun, interesting way to teach others about the benefits of bats, information about various species of bats, bat habitats, and conservation issues. The North American Bat Education Kit contains many items such as books, videos, games, and slides that make learning about bats fun. Included in this kit are the books: Stellaluna, Understanding Bats, Bats Undercover, A Simple Guide to Bat House Design, and Bats in Question, a video: BATS:The True Story, as well as various handouts containing bat facts, bat house plans, where to see bats, and websites for more information. In addition to the printed literature, many hands-on props and activities are also included in the kit. These include a pair of 6ft wings that a child can try on to demonstrate the largest bat in the worlds wingspan, a stuffed set of tent bats under a leaf, a jar containing 600 plastic insects along with a small finger puppet to show how many insects

one tiny bat can eat every hour, and finally, a Stellaluna puppet with a piece of wooden fruit to demonstrate how fruit bats eat and disperse seeds. The activities included consist of a game to teach children about the differences between Megabats and Microbats, fun masks that they can color and wear and other games that are great educational tools when trying to teach others about the benefits of bats. Finally, the North American Bat Education Kit includes a short slide presentation with a script, a recording of echolocation calls from various insect eating bats and color photos to represent the diversity within the order Chiroptera. All in all, this new kit will prove to be a wonderful educational tool. For more information please contact: The Organization for Bat Conservation at: (e-mail) OBCBATS@aol.com, or the AZA Bat TAG at: www.riverbanks.org/battag/

New E-mail Site

A new information exchange, World Bat Line, has been created on the topic of captive bat care and rehabilitation. Participants include bat caretakers from around the world who are authorities on the care of micro and megabats. Attachments are allowed and useful for diagnostic purposes. To subscribe, send a blank message to : worldbatline-subscribe@yahoogroups.com

Submitted by Amanda Lollar www.batworld.org

New Flying Fox Web-site

There is an excellent new web-site on Grey-headed flying foxes and the situation in the Royal Botanical Gardens in Melbourne, Victoria, Australia.

It is located at: http://www.austrop.org.au/ghff/home.htm

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. This edition of recent literature was prepared by Margaret Griffiths. Thank you Margaret from all of us. GRH

ANATOMY

Manger, P. R., M. G. P. Rosa, and R. Collins. 2001. Somatotopic organization and cortical projections of the ventrobasal complex of the flying fox: An "inverted" wing representation in the thalamus. Somatosensory and Motor Research, 18: 19-30. [Karolinska Inst., Dept. Neurosci., Div. Neuroanat. and Brain Dev., Berzelius Vag 3, Plan 5, S-17177 Stockholm, Sweden; Paul.Manger@neuro.ki.se]

CONSERVATION

Duffy, A. M., L. F. Lumsden, C. R. Caddle, R. R. Chick, and G. R. Newell. 2000. The efficacy of Anabat ultrasonic detectors and harp traps for surveying microchiropterans in south-eastern Australia. Acta Chiropterologica, 2: 127-144. [Lumsden: Arthur Rylah Inst., Dept. Nat. Resources and Environm., POB 137, Heidelberg, Vic 3084, Australia; Lindy.Lumsden@nre.vic.gov.au]

Kurta, A. 2000. Bats in Michigan: An annotated list of scientific publications and theses. Michigan Birds and Natural History, 7: 137-145. [Dept. Biol., Eastern Michigan Univ., Ypsilanti, MI 48197]

Lim, B. K., and M. D. Engstrom. 2001. Species diversity of bats (Mammalia: Chiroptera) in Iwokrama Forest, Guyana, and the Guianan subregion: Implications for conservation. Biodiversity and Conservation, 10: 613-657. [Royal Ontario Museum, Ctr Biodivers. and Conservat. Biol., 100 Queens Pk, Toronto, ON, M5S 2C6, Canada; burtonl@rom.on.ca]

Ochoa, J., M. J. O'Farrell, and B. W. Miller. 2000. Contribution of acoustic methods to the study of insectivorous bat diversity in protected areas from northern Venezuela. Acta Chiropterologica, 2: 171-183. [Wildlife Conservat. Soc., Asociac. Venezolana Conservac. Areas Nat., Apartado 69520, Caracas 1063A, Venezuela; jochoa@reacciun.ve]

DEVELOPMENT

Firzlaff, U., and G. Schuller. 2001. Cortical representation of acoustic motion in the rufous horseshoe bat, *Rhinolophus rouxi*. European Journal of Neuroscience, 13: 1209-1220. [Univ. Munich, Inst. Zool., Luisenstr 14, D-80333 Munich, Germany; firzlaff@zi.biologie.uni-muenchen.de]

DISTRIBUTION/FAUNAL STUDIES

Clague, C.I., R. B. Coles, O. J. Whybird, H. J. Spencer, and P. Flemons. 1999. The occurrence and distribution of the tube-nosed insectivorous bat (*Murina florium*) in Australia. Proceedings of the Linnean Society of New South Wales, 121: 175-191. [Vision Touch and Hearing Res. Ctr., Dept. Physiol. and Pharm., Univ. Queensland, St. Lucia, QLD, 4072, Australia; c.clague@vthrc.uq.edu.au]

Gregorin, R., and V. A. Taddei. 2000. New records of *Molossus* and *Promops* from Brazil (Chiroptera: Molossidae). Mammalia, 64: 471-476. [Univ. Sao Paulo, Inst. Biociencias, Dept. Zool., Museu Zool., Caixa Postal 42694, BR-04299970 Sao Paulo, SP, Brazil; gregorin@usp.br. vataddei@zaz.com.br]

Kruskop, S. V., and K. A. Tsytsulina. 2001. A new big-footed mouse-eared bat *Myotis annamiticus* sp nov (Vespertilionidae, Chiroptera) from Vietnam. Mammalia, 65: 63-72. [Moscow MV Lomonosov State Univ., Museum Zool., Bolshaya Nikitskaya 6, Moscow 103009, Russia; serge@2.zoomus.bio.msu.ru, tsk@cc5792.spb.edu]

Morales-Malacara, J. B., and G. Lopez-Ortega. 2001. A new species of the genus *Periglischrus* (Acari: Mesostigmata: Spinturnicidae) on *Choeronycteris mexicana* (Chiroptera: Phyllostomidae) in central Mexico. Journal of Medical Entomology, 38: 153-160. [Univ. Nacl. Autonoma Mexico, Fac. Ciencias, Dept. Biol., Lab. Acarol., Mexico City 04510, DF, Mexico]

ECHOLOCATION

Burnett, S. C., K. A. Kazial, and W. M. Masters. 2001. Discriminating individual big brown bat (*Eptesicus fuscus*) sonar vocalizations in different recording situations. The International Journal of Animal Sound and its Recording, 11: 189-210. [Dept. Evol., Ecol., and Organismal Biol., Ohio State Univ., 1735 Neil Ave., Columbus, OH 43210; burnett.33@osu.edu]

Fenton, M. B. 2000. Choosing the 'correct' bat detector. Acta Chiropterologica, 2: 215-224. [CBCB, Royal Ontario Mus., 100 Queen's Park, Toronto, ON M5S 2C6, Canada; bfenton@circus.yorku.ca]

Hayes, J. P. 2000. Assumptions and practical considerations in the design and interpretation of echolocation-monitoring studies. Acta Chiropterologica, 2: 225-236. [Dept. For. Sci., 321D Richardson Hall, Oregon State Univ., Corvallis, OR 97331; John.Hayes@orst.edu]

Kazial, K. A., S. C. Burnett, and W. M. Masters. 2001. Individual and group variation in echolocation calls of big brown bats, *Eptesicus fuscus* (Chiroptera: Vespertilionidae). Journal of Mammalogy, 82: 339-351. [Dept. Evol., Ecol., and Organismal Biol., Ohio State Univ., 1735 Neil Ave., Columbus, OH 43210; kazial.1@osu.edu]

Larson, D. J., and J. P. Hayes. 2000. Variability in sensitivity of Anabat II bat detectors and a method of calibration. Acta Chiropterologica, 2: 209-213. [Dept. For. Sci., Oregon State Univ., Corvallis, OR 97331; David.Larson@orst.edu]

Jacobs, D. S. 2000. Community level support for the allotonic frequency hypothesis. Acta Chiropterologica, 2: 197-207. [Dept. Zool., Univ. Cape Town, Private Bag, Rondebosch 7701, South Africa; djacobs@botzoo.uct.ac.za]

Jones, G., N. Vaughan, and S. Parsons. 2000. Acoustic identification of bats from directly sampled and time expanded recordings of vocalizations. Acta Chiropterologica, 2: 155-170. [Sch. Biol. Sci., Univ. Bristol, Woodland Rd., Bristol BS8 1UG, U. K.; Gareth.Jones@bristol.ac.uk]

Parsons, S. 2001. Identification of New Zealand bats (*Chalinolobus tuberculatus* and *Mystacina tuberculata*) in flight from analysis of echolocation calls by artificial neural networks. Journal of Zoology, 253: 447-456. [Univ. Bristol, Sch. Biol. Sci., Woodland Rd., Bristol BS8 1UG, Avon, England]

O'Farrell, M. J., C. Corben, and W. L. Gannon. 2000. Geographic variation in the echolocation calls of the hoary bat (*Lasiurus cinereus*). Acta Chiropterologica, 2: 185-195. [O'Farrell Biol. Consulting, 2912 N. Jones Blvd., Las Vegas, NV 89108; mikeof@accessnv.com]

Wong, J. G., and D. A. Waters. 2001. The synchronisation of signal emission with wingbeat during the approach phase in soprano pipistrelles (*Pipistrellus pygmaeus*). Journal of Experimental Biology, 204: 575-583. [Univ. Leeds, Sch. Biol., Comparat. Physiol. & Biomech. Grp. Miall Bldg., Leeds LS2 9JT, W. Yorkshire, England; bgyjw@leeds.ac.uk]

ECOLOGY

Bernard, E. 2001. Vertical stratification of bat communities in primary forests of Central Amazon, Brazil. Journal of Tropical Ecology, 17: 115-126. [York Univ., Dept. Biol., N. York, ON M3J 1P3, Canada]

Burland, T. M., E. M. Barratt, R. A. Nichols, and P. A. Racey. 2001. Mating patterns, relatedness and the basis of natal philopatry in the brown long-eared bat, *Plecotus auritus*. Molecular Ecology, 10: 1309-1321. [Univ. London Queen Mary Coll., Sch. Biol. Sci., London E1 4NS, England; t.m.burland@qmw.ac.uk]

Cholewa, E., M. J. Vonhof, S. Bouchard, C. A. Peterson, and B. Fenton. 2001. The pathways of water movement in leaves modified into tents by bats. Biological Journal of the Linnean Society, 72: 179-191. [Cholewa: Univ. Waterloo, Dept. Biol., Waterloo, ON N2L 3G1, Canada; cpeterson@uwaterloo.ca]

Elangovan, V., and G. Marimuthu. 2001. Effect of moonlight on the foraging behaviour of a megachiropteran bat, *Cynopterus sphinx*. Journal of Zoology, 253: 347-350. [Marimuthu: Madurai Kamaraj Univ., Sch. Biol. Sci., Dept. Anim. Behav. and Physiol., Madurai 625021, Tamil Nadu, India; gmarimuthu@usa.net]

Flavin, D. A., S. S. Biggane, C. B. Shiel, P. Smiddy, and J. S. Fairley. 2001. Analysis of the diet of Daubenton's bat *Myotis daubentonii* in Ireland. Acta Theriologica, 46: 43-52. [Fairley: 15 Luxor Gardens, Belfast BT5 5NB, Antrim, North Ireland]

Johnston, D. S., and M. B. Fenton. 2001. Individual and population-level variability in diets of pallid bats (*Antrozous pallidus*). Journal of Mammalogy, 82: 362-373. [H. T. Harvey & Assoc., 3150 Almaden Expw., Ste. 145, San Jose, CA 95118; djohnston8@aol.com]

O'Donnell, C. F. J. 2000. Cryptic local populations in a temperate rainforest bat *Chalinolobus tuberculatus* in New Zealand. Animal Conservation, 3: 287-297. [Dept. Conservat, Sci. and Res. Unit, Private Bag Christchurch, New Zealand; mohua@voyager.co.nz]

O'Donnell, C. F. J. 2001. Home range and use of space by *Chalinolobus tuberculatus*, a temperate rainforest bat from New Zealand. Journal of Zoology, 253: 253-264.

Owen, J. G. 2001. Correlations of some climatic variables with mammalian species richness in Texas. Texas Journal of Science, 53: 55-64. [Univ. Salvadorena Alberto Masferrer, Apartado Postal 2053, San Salvador, El Salvador; jgowen@salnet.net]

Parry-Jones, K. A., and M. L. Augee. 2001 Factors affecting the occupation of a colony site in Sydney, New South Wales by the grey-headed flying-fox *Pteropus poliocephalus* (Pteropodidae). Austral Ecology, 26: 47-55. [Univ. Sydney, Sch. Biol. Sci. A08, Sydney, NSW 2006, Australia; kpjones@bio.usyd.edu.au]

Petit, E., F. Balloux, and J. Goudet. 2001. Sex-biased dispersal in a migratory bat: A characterization using sex-specific demographic parameters. Evolution, 55: 635-640. [Univ Rennes 1, UMR 6552, F-35042 Rennes, France; eric.petit@univ-rennes1.fr]

Sedgeley, J. A. 2001. Quality of cavity microclimate as a factor influencing selection of maternity roosts by a tree-dwelling bat, *Chalinolobus tuberculatus*, in New Zealand. Journal of Applied Ecology, 38: 425-438. [Dept. Conservat., Sci. and Res. Unit, Christchurch, New Zealand; mohua@voyager.co.nz]

Sherwin, R. E., W. L. Gannon, and S. Haymond. 2000. The efficacy of acoustic techniques to infer differential use of habitat by bats. Acta Chiropterologica, 2: 145-153. [Univ. New Mexico, Dept. Biol., Albuquerque, NM 87131; rsherwin@unm.edu]

Storz, J. F., J. Balasingh, H. R. Bhat, P. T. Nathan, D. P. S. Doss, A. A. Prakash, T. H. Kunz. 2001. Clinal variation in body size and sexual dimorphism in an Indian fruit bat, *Cynopterus sphinx* (Chiroptera: Pteropodidae). Biological Journal of the Linnean Society, 72: 17-31. [Duke Univ., Dept. Biol., Durham, NC 27708; storz@duke.edu]

Syme, D. M., M. B. Fenton, and J. Zigouris. 2001. Roosts and food supplies ameliorate the impact of a bad summer on reproduction by the bat, *Myotis lucifugus* LeConte (Chiroptera: Vespertilionidae). Ecoscience, 8: 18-25. [York Univ., Dept. Biol., 4700 Keele St., N. York ON M3J 1P3, Canada]

Vardon, M. J., P. S. Brocklehurst, J. C. Z. Woinarski, R. B. Cunningham, C. F. Donnelly, and C. R. Tidemann CR. 2001. Seasonal habitat use by flying-foxes, Pteropus alecto and P. scapulatus (Megachiroptera), in monsoonal Australia. Journal of Zoology, 253: 523-535. [Tidemann: Australian Natl. Univ., Sch. Resource Management and Environm. Sci., Canberra ACT 0200, Australia]

EVOLUTION

Göbbel, L. (2000). The external nasal cartilages in Chiroptera: Significance for intraordinal relationships. Journal of Mammalian Evolution, 7: 167-201. [Dept. Anat. & Cell Biol., Martin Luther Univ. Halle-Wittenberg, Grosse Steinstr. 52, 06097 Halle (Saale), Germany; luminita.goebbel@medizin.uni-halle.de]

Jones, K. E., and A. MacLarnon. 2001. Bat life histories: Testing models of mammalian life-history evolution. Evolutionary Ecology Research, 3: 465-476. [Univ. Virginia, Dept. Biol. Gilmer Hall, Charlottesville, VA 22904; kate.jones@virginia.edu]

Speakman, J. R. 1999. The evolution of flight and echolocation in pre-bats: An evaluation of the energetics of reach hunting. Acta Chiropterologica, 1: 3-15. [Dept. Zoology, Univ. of Aberdeen, Aberdeen, AB24 2TZ, Great Britain; J.Speakman@abdn.ac.uk]

GENETICS

Finato, A. O., M. Varella-Garcia, E. H. Tajara, V. A. Taddei, and E. Morielle-Versute. 2000. Intrachromosomal distribution of telomeric repeats in *Eumops glaucinus* and *Eumops perotis* (Molossidae, Chiroptera). Chromosome Research, 8: 563-569. [Morielle-Versute: IBILCE UNESP, Dept. Zool., BR-15054000 Sao Jose Do Rio Preto, SP, Brazil; Morielle@zoo.ibilce.unesp.br]

PALEONTOLOGY

Morgan, G. S., and N. J. Czaplewski. 1999. First fossil record of *Amorphochilus schnablii* (Chiroptera: Furipteridae), from the late Quaternary of Peru. Acta Chiropterologica, 1: 75-79. [New Mexico Museum of Natural History and Science, 1801 Mountain Rd., NW, Albuquerque, NM 87104; morgan@nmmnh.state.nm.us]

Pardinas, U. F. J., and E. P. Tonni. 2000. A giant vampire (Mammalia, Chiroptera) in the Late Holocene from the Argentinean pampas: Paleoenvironmental significance. Palaeogeography Palaeoclimatology Palaeoecology, 160: 213-221. [Museo La Plata, Dept. Cient. Paleontol. Vertebrados, Paseo Bosque S-N, RA-1900 La Plata, Argentina]

PARASITOLOGY

Lainson, R., and R. D. Naiff. 2000. On *Eimeria bragancaensis* n. sp (Apicomplexa: Eimeriidae) and tissue-cysts of an unidentified protozoan in the bat *Peropteryx macrotis* (Chiroptera : Emballonuridae) from Amazonian Brazil. Parasite-Journal de la Societe Francaise de Parasitologie, 7: 123-129. [Inst. Evandro Chagas, Dept. Parasitol., Caixa Postal 1128, Belem, Para, Brazil]

Reeves, W. K. 2001. Bionomics of *Cimex adjunctus* (Heteroptera: Cimicidae) in a maternity cave of *Myotis austroriparius* (Chiroptera: Vespertilionidae) (South Carolina, USA). Journal of Entomological Science, 36: 74-77. [Clemson Univ., Dept. Entomol. 114 Long Hall, Clemson, SC 29634]

Ritzi, C. M., L. K. Ammerman, M. T. Dixon, and J. V. Richerson. 2001. Bat ectoparasites from the Trans-Pecos region of Texas, including notes from Big Bend National Park. Journal of Medical Entomology, 38: 400-404. [Indiana State Univ., Dept. Life Sci., Terre Haute, IN 47809]

Whitaker, J. O., J. Deunff, and J. J. Belwood. 2000. Ectoparasites of neonate Indiana bats, *Myotis sodalis* (Chiroptera: Vespertilionidae), with description of male of *Paraspinturnix globosa* (Acari : Spinturnicidae). Journal of Medical Entomology, 37: 445-453. [Indiana State Univ., Dept. Life Sci., Terre Haute, IN 47809]

PHYSIOLOGY

Baudinette, R. V., S. K. Churchill, K. A. Christian, J. E. Nelson, and P. J. Hudson. 2000. Energy, water balance and the roost microenvironment in three Australian cave-dwelling bats (Microchiroptera). J. Comparative Physiology - B, Biochem., Systemic, & Environ. Physiol., 170: 439-446. [Univ. Adelaide, Dept. Environm. Biol., Adelaide, SA 5005, Australia]

Craik, J. D., and D. Markovich. 2000. Rapid GLUT-1 mediated glucose transport in erythrocytes from the grey-headed fruit bat (*Pteropus poliocephalus*). Comparative Biochemistry & Physiology Part A, 126(1):45-55. [Kuwait Univ., Fac. Med., Dept. Biochem., POB 24923, Safat 13110, Kuwait]

Dierenfeld, E. S., and J. Seyjagat. 2000. Plasma fat-soluble vitamin and mineral concentrations in relation to diet in captive pteropodid bats. Journal of Zoo and Wildlife Medicine, 31: 315-321. [Wildlife Conservat. Soc., Dept. Nutr., Bronx, NY 10460]

Geiser, F., and R. M. Brigham. 2000. Torpor, thermal biology, and energetics in Australian long-eared bats (Nyctophilus). Journal of Comparative Physiology - B, 170: 153-162. [Univ. New England, Sch. Biol. Sci., Armidale, NSW 2351, Australia]

Herrera M., L. G., K. A. Hobson, L. Mirón M., N. Ramírez P., G. Méndez C., and V. Sánchez-Cordero. 2001. Sources of protein in two species of phytophagous bats in a seasonal dry forest: Evidence from stable-isotope analysis. Journal of Mammalogy, 82: 352-361. [Inst. Biol., Univ. Nac. Autón. México, Apartado Postal 70-153, 04510 México, DF, México; gherrera@mail.ibiologia.unam.mx]

Hood, W. R., T. H. Kunz, O. T. Oftedal, S. J. Iverson, D. LeBlanc, and J. Seyjagat. 2001. Interspecific and intraspecific variation in proximate, mineral, and fatty acid composition of milk in old world fruit bats (Chiroptera: Pteropodidae). Physiological and Biochemical Zoology, 74: 134-146. [Boston Univ., Dept. Biol., 5 Cummington St., Boston, MA 02215; hood@fordham.edu]

Koteja, P., M. Jurczyszyn, and B. W. Woloszyn. 2001. Energy balance of hibernating mouse-eared bat *Myotis myotis*: A study with a TOBEC instrument. Acta Theriologica, 46: 1-12. [Jagiellonian Univ., Inst. Environm. Sci., Krakow, Poland; koteja@eko.uj.edu.pl]

Kwiecinski, G. G., Z. R. Lu, T. C. Chen, and M. F. Holick. 2001. Observations on serum 25-hydroxyvitamin D and calcium concentrations from wild-caught and captive neotropical bats, *Artibeus jamaicensis*. General and Comparative Endocrinology, 122: 225-231. [Univ. Scranton, Dept. Biol., Scranton, PA 18510]

McNab, B. K., and F. J. Bonaccorso. 2001. The metabolism of New Guinean pteropodid bats. Journal of Comparative Physiology B, 171: 201-214. [Univ. Florida, Dept. Zool., Gainesville, FL 32611; mcnab@zoo.ufl.edu]

POPULATION BIOLOGY

Cooper, S. J. B., P. R. Day, T. B. Reardon, and M. Schulz. 2001. Assessment of species boudaries in Australian *Myotis* (Chiroptera: Vespertilionidae) using mitochondrial DNA. Journal of Mammalogy, 82: 328-338. [Ctr. Evol. Biol. and Biodiv., Evol. Biol. Unit, South Australian Mus., North Terrace, Adelaide, South Australia 5000, Australia; cooper.steve@saugov.sa.gov.au]

RABIES AND BATS

Nadin-Davis, S. A., W. Huang, J. Armstrong, G. A. Casey, C. Bahloul, N. Tordo, and A. I. Wandeler. 2001. Antigenic and genetic divergence of rabies viruses from bat species indigenous to Canada. Virus Research, 74: 139-156. [Canadian Food Inspect. Agcy., Anim. Dis. Res. Inst., Rabies Ctr. Expertise, POB 11300, Stn H, 3851 Fallowfield Rd., Nepean ON K2H 8P9, Canada; nadindaviss@em.agr.ca]

REPRODUCTION

Bouchard, S., J. Zigouris, and M. B. Fenton. 2001. Autumn mating and likely resorption of an embryo by a hoary bat, *Lasiurus cinereus* (Chiroptera: Vespertilionidae). American Midland Naturalist, 145: 210-212. [York Univ., Dept. Biol., 4700 Keele St., Toronto, ON M3J 1P3, Canada; sylvie.zoo@mail.com]

Porter, T.A., and G. S. Wilkinson. 2001. Birth synchrony in greater spear-nosed bats (*Phyllostomus hastatus*). Journal of Zoology, 253: 383-390. [Univ. Maryland, Dept. Biol., College Park, MD 20742; tp35@umail.umd.edu]

Recent lit. continued>>

SYSTEMATICS

Onuma, M., Y. Cao, M. Hasegawa, and S. Kusakabe. 2001. A close relationship of Chiroptera with Eulipotyphla (core insectivora) suggested by four mitochondrial genes. Zoological Science, 17: 1327-1332. [Kusakabe: Hiroshima Univ., Fac. Integrated Arts and Sci., Dept. Biol., Higashihiroshima 7398521, Japan; sakusa@hiroshima-u.ac.jp]

Romagnoli, M. L., and M. S. Springer. 2000. Evolutionary relationships among Old World fruitbats (Megachiroptera: Pteropodidae) based on 12S rRNA, tRNA valine, and 16S rRNA gene sequences. Journal of Mammalian Evolution, 7: 259-284. [Dept. Biol., Univ. California, Riverside, CA 92521; mark.springer@ucr.edu]

Simmons, N. B., and T. M. Conway. 2001. Phylogenetic relationships of mormoopid bats (Chiroptera: Mormoopidae) based on morphological data. Bulletin of the American Museum of Natural History, (258): 1-97. [Amer. Museum Nat. Hist., Div. Vertebrate Zool. Mammal., New York, NY 10024]

Van Den Bussche, R. A., and S. R. Hoofer. 2001. Evaluating monophyly of Nataloidea (Chiroptera) with mitochondrial DNA sequences. Journal of Mammalogy, 82: 320-327. [Dept. Zool., Collect. of Vert., and Oklahoma Coop. Fish and Wildlife Res. Unit, Oklahoma State Univ., Stillwater, OK 74078; ravdb@okstate.edu]

From Russia: Titles of articles which appeared in Plecotus. et al # 3 (2000)

Editor; Eugenia I. Kozhurina, A.N. Severstov Institute of Ecology and Evolution, russian Academy of Science, Leninski Prospect 33, Moscow 117071 Russia

These titles all are accompanied by English abstracts. If you wish one (or a few) of these abstracts send me $2.00 and I will copy them and send them to you via e-mail (preferred) or by regular mail if you do not have e-mail facilities. GRH

Bashta, A. T.V. **The lessor horseshoe bat in Ukraine: distribution and present status.** Institute of Ecology of the Carpathians, Koselnytska Str. 4, Lviv 79026 Ukraine

Chistyakov, D.V. **Records of bats in the southwest of Pskov Region.** Biological Research Institute of St. Petersburg State University, Stary Petershoff, Oranienbaumskoe sch. 2, St. Petersburg 198904 Russia

Gazaryan, S.V. **New data on the occurance of the barbastelle in the Western Caucasus.** A.N. Severstov Institute of Ecology and Evolution, russian Academy of Science, Leninski Prospect 33, Moscow 117071 Russia

Ilyin, V.Yu, **Dynamics of the ranges of three bat species in southeasternmost Europe.** The Chair of Zoology, Penza State Pedagogical University, Lermontova Str. 37, Penza 440602 Russia

Ivancheva, E.Yu. and V.P. Ivenchev. **The bats of Ryazane Region.** Biological Research Institute of St. Petersburg State University, Stary Petershoff, Oranienbaumskoe sch.2, St. Petesburg 198904 Russia

Kruskop, S.V. **The bats in caves of the Ke Bang limestone area in central Vietnam.** Zoological Museum of Moscow State University, Bolshaya Nikitskaya str. 6, Moscow 103009 Russia

Kruskop, S.V. **New bat records from central Vietnam.** Zoological Museum of Moscow State University, Bolshaya Nikitskaya str. 6, Moscow 103009 Russia

Kuzman, I.V., A.D. Botvinkin, V.V. Yakimenko and T.S. Afonkova. **Present data on the bats of Omsk Region.** Institute for Natural Foci Infections, Prospect Mira 7, Omsk 644080 Russia

Matveyev, V.A., A.A. Bannikova, and A.A. Lomov, **Sustematic relationships within Chiroptera as revealed by taxonomic DNA fingerprinting.** Laboratory of Evolution of Eucaryotic Genomes, Engelhard Institute of Molecular Biology, Russian Academy of Sciences, Vavilova Str. 32m Moscow 117984 Russia

Rakhmatulina, I.K. **Sex ratios in bat populations of the Eastern Transcaucasia.** Institute of Zoology, Academy of Sciences Azerbiajan, Passage 1128, Block 504, Baku 370602 Azerbaijan Republic

Rossina, V.V. and V.E. Kirilyuk. **Bat records from the Daurian Reserve and the adjacent territories.** Paleontological Institute, Russian Academy Sciences, Profsoyuznaya Str. 123, Moscow 117647 Russia

Smirnov, D.G. **Variation in the baculum of bats from the Middle Volga Basin and the adjacent territories.** The Chair of Zoology, Penza State Pedagogical University, Lermontova Str. 37, Penza 440602 Russia

Tsytsulina, E.A. **Geographic variation of the whiskered bat *Myotis mystacinus* in the Caucasus.** Zoological Institute, Russian Academy of Sciences, Universitetskaya nab. 1, St. Petersburg 199034 Russia

The following abstracts, short articles or titles were presented at the

3rd Irish Bat Conference convened May 18th to 20th at Portumna Castel and Shannon Oaks Hotel in Portumna, Co. Galway, Ireland.

[Some of these abstracts did not include the address of the author.; editor's pologies]

A Study of the Ecology of the Lesser Horseshoe Colony at the Summer Roost in Dromore, Co. Clare

Sinead Biggane and Jimmy Dunne
Department of Zoology, National University of Ireland, Galway, Ireland

The lesser horseshoe bat is the smallest of the European horseshoe bats and the only member of the Rhinolophidae family to occur in Ireland. It is confined to the western side of the country and is found in counties Mayo, Galway, Clare, Limerick, Cork and Kerry. It is considered relatively common in these parts but is classified as endangered in other parts of Europe. The lesser horseshoes maternity roost at Dromore, Co. Clare is extremely important, as it is probably the largest in Ireland. The roost was discovered in the late seventies and has been monitored regularly since 1983, and is now the centre of a PhD study in NUI, Galway. The Heritage Council purchased the building in 1998 with the sole aim of protecting the colony. The bats occupy the hayloft portion of the stables, which date back to the 1900's.

One season's fieldwork, from May through to October, has been completed. Most of this time was spent studying the commuting routes used by the bats. Cogan et al. previously determined these in 1998. This study has found that in the main, the same routes are being used, but additional routes have also been discovered. The bats use linear landscape features such as stone walls, hedgerows and trees in order to commute to their foraging area. Dromore Wood, a predominately broadleaved woodland and national nature reserve, is adjacent to the roost and is their main foraging site; the bats using four different commuting routes to reach the wood. Different habitats in which the colony was suspected of foraging were surveyed for their presence or absence. This study has revealed that the bats showed a preference for foraging in broadleaved areas, as well as along hedgerows and riparian vegetation.

In addition, the behaviour of the colony at their day roosting site was observed, both from within and outside the building. Nightly activity patterns and emergence times were monitored and recorded. A number of dusk to dawn observations were made, allowing different activity patterns to be linked to the pre-parturition, lactation and post-lactation periods. Faecal pellets were collected from within the roost over a twelve-month period and are being analysed. Insects were also collected using malaise traps that were placed next to the roost building and in the nearby woods where the bats forage. It is hoped to attach radio transmitters to a number of bats during the next two years in order to learn more about their movements, particularly their use of satellite and night roosts, and possibly even their hibernation site or sites. At the moment, the maternity site and main foraging grounds of this colony are quite secure, but without knowledge and protection of the roosts in winter, the conservation picture is incomplete.

The Ecology of the Barbastelle Bat in Somerset

Geoff Billington. Greena, North Stainmore, Kirkby Stephen, Cumbria CA17 4 EA U.K.

This paper includes the results of the survey and research work from 1999 & 2000 of a colony of tree roosting barbastelle bats (*Barbastellus barbastellus*) in Horner Woods on the northern side of Exmoor in north Somerset. The colony was located in the second year of a major National Trust bat survey of the woods in 1999. A major research study was commenced out in July 2000. In 1999 four barbastelle bats (two females & two males) were radio tagged and monitored within the limits of the wood, ten tree roosts and several foraging areas were located. In 2000, 17 female bats were radio tagged and tracked to determine: the areas they went to and

the duration they spent in them, behavior, and the roosts used. Tree roosts were climbed to compile data on roost dimensions and collect droppings for analysis. Detailed habitat surveys of the key foraging areas were conducted.

Fifteen tree roosts have been located, 14 in oak trees and one in an ash. 13 of these trees are predominantly of live wood, and the other two are mainly of dead wood. Five of the trees are key breeding sites used by 15-27 bats, with most of the other trees housing two bats (range 1-5), of either males or non-breeding females. Three of these key roosts are in long vertical splits (3-5m in length) in the main trunks or limbs, and the remaining two are in splits in horizontal limbs. In one roost of 24 bats, 23 were caught 16 (70%) of these were breeding females. The core group of breeding females appeared to be mainly divided between two roosts, and frequent movements occurred between them. 54 separate roost occupations of 17 tagged bats were recorded. The occupancy periods ranged from 1-6 days and averaged 1.75 days at each roost. 57% of the records were of single radio tagged bats, in roosts containing 1-5 individuals.

Of the 21 bats that were radio tracked, only three spent more than 30 minutes feeding continuously in the main woodland. The longest duration record for woodland foraging was a non-breeding female for over 90 min. In the first 30 min after emergence some bats would forage over an area of scrub (predominantly gorse and bracken) within the wood before moving away, other bats would head straight off after emergence. They would head rapidly for several km to feeding grounds and were recorded up to 10 km away from the roost.

The bats concentrated on foraging areas for a few days at a time before switching to new ones, on most nights they would visit three or four different areas, some bats traversing over 30 km circuits. Only four instances of bats stationary away from the day roosts was recorded, they feed continuously with feeding beats that are rarely less then 400m in length returning to the day roosts once or twice in a night. They forage in small groups of around half a dozen bats, they meet in socializing places, divide up and feed in adjacent 'patches', they regularly regroup particularly when other bats arrive at the 'meeting place'. They often commute between different areas in groups flying in a line in close formation with only a few meters between each bat.

The key foraging habitats were in scrub dominated "combes" bordering moorland on the north, east and south sides of Exmoor, wooded watercourses, high hedgerows, extensive scrubland areas, the entire moorland including areas predominantly of heather, gardens and low level street lighting, and small areas of ancient wet woodland. The most common plant species found in feeding areas was European gorse.

To date, we have only carried out limited investigation of bat dropping samples, which are dominated by moth (*Lepidoptera*) remains, listed below are the other insect remains identified)

Arachnids (*Arachnida*), Window midges (*Anisopodidae*), Crane-flies (*Tipulidae*)
Lacewings (*Neuroptera*), Bluebottles (*Calliphoridae*), Hover flies (*Syrphidae*).

The UK National Bat Monitoring Programme

Colin Catto & Jules Agate
The Bat Conservation Trust, 15 Cloisters House, 8 Battersea Park Road, London, SW8 4BG, UK

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 monitoring programme for eight 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 providing a model for developing standard transboundary monitoring techniques for a number of species in Europe. Studies within the programme 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 maximise the precision of national trend estimates. Data collection relies upon a large network of volunteers and the programme has

recruited over 1700 members since its start in 1996, with 492 people contributing data to date. The monitoring network currently includes 264 hibernation sites, 684 pipistrelle, 166 lesser horseshoe and 62 serotine bat maternity colony sites, plus a total of 1240 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.

SACs – is Ireland Designating Enough?
Rosaleen Dwyer

Under the conditions of the Habitats Directive (EC Council Directive on the Conservation of Natural Habitats and of Wild Flora and Fauna, Directive 92/43/EEC), the Irish Government has agreed to establish a network of Special Areas of Conservation (SACs). Under this Directive, Ireland has a responsibility to designate SACs for a total of 61 Annex I habitat types and 26 Annex II species. In September 1999, a meeting of the EU's committee for the Atlantic Biogeographical Region deemed that Ireland had proposed an insufficient number of sites for a significant proportion of habitats and species. Since then, Ireland has increased the number of sites that have been proposed to the EU as proposed candidate SACs. To date, the details of 363 sites have been advertised and transmitted to the EU. However, a grouping of five Irish environmental organisations remain concerned that this will not adequately protect Irish habitats and species. A joint report prepared on behalf of this NGO group lists an additional 621 sites that they believe should also be considered for protection as SACs. This list includes an extra 15 sites proposed by the NGOs for the protection of the lesser horseshoe bat.

Care of Injured and Orphaned Bats
Susan Flynn

This presentation will cover the kinds of casualties presenting themselves and the possible causes of injury or abandonment, assessment and handling, the equipment required, and food for adults and pups. Practical suggestions will be given concerning return to the wild, as well as care of the long term resident bats: the speaker will cite examples from her own experience of the problems encountered with bat casualties. Sick or injured bats, especially orphans, are time consuming to care for. The person taking on this responsibility needs to aware of the commitment required. It is definitely better to have a number of people available to share the task. Rehabilitation and return to the wild has a low success rate, but the effort is rewarding.

The Role that Local Authorities Can Play for the Benefit of Bat Conservation
Bernadette Guest

The remit of Local Authorities would not traditionally be seen as including Nature Conservation. However, the appointment of recent positions such as Heritage Officers, Conservation Officers and Environmental Education Officers will have influence on the functions of the various departments and can raise awareness on bats and their conservation needs. The Heritage Officer position is co-funded by the Heritage Council and the role emulates their three objectives of collecting data, promoting pride and raising awareness and proposing policy. Bats are an increasingly vulnerable species threatened by habitat loss, pesticide use and human disturbance. Many departments within the local authority can contribute to the conservation of bats and their habitats by surveying for their presence and considering their needs as may arise through planning applications, housing inspections, demolition of buildings and infrastructural works. Bats need to be considered by local authorities when addressing issues such as building construction, habitat management, hedgerow management and bridge maintenance. Much can be done to conserve these mammals if they are considered during remedial works and development plans. Examples include ensuring that timing of works is sympathetic to the use of bridges by

bats. Installation of artificial roost units should be encouraged on all new concrete and metal bridges to assist in the future conservation of bats. Landscaping work along roads and waterways should consist of mainly native species to ensure good insect populations. Through education and proactive conservation measures local authorities can make a positive and effective contribution towards the conservation of bats.

Nietoperek - Polish Bat Researce and Europe's Greatest Hibernacula.

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

Built by the Germans prior to and during World War II, Nietoperek Bat Reserve is part of the once massive Miedzyrzecz Fortified Front that formed the eastern border of Germany. The fortifications are now in Poland. This series of bunkers and underground tunnels, stretching for 30 kilometres, are now stripped of all they contained.

In the 1980s, the then communist Polish government decided to use the tunnels as a dumping ground for nuclear waste. This prompted a national and international outcry from bat workers, academics and wildlife enthusiasts, for it was known that the tunnels were used by large numbers of bats during the winter months. This however is an understatement, as the tunnels and bunkers are home to some of the rarest European bat species and numbers exceed 30,000 animals.

However, the reserve is constantly under threat from developers who want to increase tourism to the area and there is also much local politics involved as different interests seek to make a living from the fortifications. Therefore the "battle of Nietoperek" is continuing by Polish bat workers to ensure the survival of the bats who have no voice of their own.

During this visit, several studies were being performed on the bats. Members of the group came from two different Polish universities - Wroclaw and Torun and each had their own interest. The above ground bunkers were surveyed for the presence of bats, temperature and body mass details were recorded on bats in the main system and corpses were collected for later study. This work was intensive but rewarding as it led to the observation of many different species.

During our week at the site, the group encountered some of the continent's rarest species including Barbastella barbastellus, Myotis bechsteini, Myotis dasycneme, and Eptesicus nilsonii. It was truly amazing to see congregations of such rarities; the importance of this site is immense and cannot be overstated. Tourists are encouraged to visit the tunnels during the summer months when bats are not present. The use of the system by bats is highlighted to visitors and it forms part of the educational tours organised locally. There is a serious threat to the bat reserve by local tourist groups who want access to the undergrounds throughout the year. This is unrealistic, as there is no tourism to the area in winter however this is not preventing local politicians encroaching on the reserve. These moves are being carefully monitored and local bat workers are contesting any potential threats to the reserve. The ongoing protection of this unique site, both above and below ground, must be ensured. It is difficult to see any good that has ever come out of Hitler's reign but this reserve is one positive result, albeit by default. The indigenous bat workers of Poland should not be left on their own when it comes to providing a voice for the bats whose survival depends on this site.

My thanks to the Polish bat workers and other people that I met during my stay in Nietoperek, in particular, Tomek, Mickal, Gosia, Asia, Peter, Yanuk Anna and Robert. No one could ask for more welcoming or generous hosts.

The Vincent Wildlife Trust Bat Box Study – Portumna and Beyond

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

The Vincent Wildlife Trust has been conducting a tree bat project using concrete bat boxes at a number of sites in England and Wales since 1994. The purpose of the first study, in ancient deciduous woodland in southern England on the Dorset - Wiltshire border, was to see if the rare

Bechstein's bat (*Myotis bechsteinii*) would be attracted to such artificial roost sites. Several species of bats adopted the boxes within one month and the first Bechstein's bat was recorded in 1997. . This discovery subsequently led to a radio telemetry study that has yielded valuable information on this bat's roosting and foraging behaviour.

The VWT tree bat project was extended to Ireland in response to the report that an echolocation call of a barbastelle bat (*Barbastella barbastellus*) had been recorded in Portumna by two visiting bat experts, Professor Ingemar Ahlen and Dr. Hans Baagoe, in July 1997. No specimen of this species, an extremely rare bat throughout its distribution, had ever been recorded in Ireland. In March 1999, 162 concrete boxes were erected in three woods in Ireland, 62 in Portumna Forest Park and the remainder in two nature reserves in Co. Galway; Coole/Garryland and Knockma.

The boxes are checked once a month from April to October. Although bats began using the boxes in Portumna Forest Park within one month of their erection, a barbastelle bat has not yet been found. In fact, the species recorded to date, the pipistrelle (Pipistrellus spp.), Leisler's (*Nyctalus leisleri*) and brown long-eared (*Plecotus auritus*) are the commonest species in Ireland and more associated with roosting in buildings. A fourth species, a whiskered/Brandt's bat (*Myotis mystacinus/brandtii*), was recorded on one occasion in a box in Garryland Wood. The number of bats using the boxes reaches a peak in the autumn and may reflect the dispersal of bats from maternity roosts and the use of the boxes as autumn mating sites. Bats can be quite active on hot days and often fly out of the boxes once they are opened. On a number of these occasions, the bats have been seen to disappear into small cracks on nearby trees. The continuation of the project is reviewed at the end of each season.

Conservation of Bats – A Global Perspective

Simon Mickleburgh. 1 East View Cottages, Marlsford, Woodbridge, Suffolk 1P13 OAT U.K.

In 2001, the publication of '*Microchiropteran Bats A Global Status Survey and Action Plan*' has allowed for a review of the conservation issues facing more than 800 species of bat worldwide. Around 50% of microchiropteran bats are globally threatened or near threatened. Many of the threats facing bats are similar the world over – habitat loss and degradation, loss and disturbance of roosting sites, particularly caves and mines, lack of information and human ignorance. In this talk, I will review these issues using particular species as examples and highlight some of the key conservation measures that need to be initiated. I will also focus specifically on two major issues: 1) Rabies in Latin America and 2) Cave and mine conservation.

The Work of Conservation Rangers in Protecting Bats in the Republic of Ireland

Ciara O'Mahony & Raymond Stephens

Two Conservation Rangers with Dúchas - The Heritage Service will speak about their work in relation to bats. Raymond Stephens works in Connemara and Ciara O'Mahony works in south Galway. Both have been appointed within the last two years. Much of the work in the two areas is similar, involving both dealing with calls from the public about bat roosts and roost monitoring. Raymond visits local schools and organises public events in an effort to increase people's knowledge and interest in bats. Ciara has identified a former lesser horseshoe roost in a Nature Reserve and has worked on a project to renovate the building in the hope the bats will return. The talk will cover dealing with calls from the public, education work, public events, site designation and monitoring, roost surveys and conservation works. The focus will be on these two rangers' personal experience and will aim to outline what has been achieved and what can be achieved in their work.

"Ireland" continued >>

Seasonal Patterns in Activity and Habitat Use by Bats (*Pipistrellus spp.* and *Nyctalus leisleri*) Determined by Using a Driven Transect

Jon Russ & W. I. Montgomery
School of Biology and Chemistry, The Queen's University of Belfast, Road, Belfast, BT9 7BL U.K.

The seasonal activity of Leisler's bat (*Nyctalus leisleri*) and pipistrelle bats (Pipistrellus spp.) with respect to bat numbers and habitat use were investigated using a driven transect. Data were collected in drumlin farmland near Belfast, Northern Ireland in 1998 using two BatBox III bat detectors tuned to detect both species/species groups simultaneously. The number of bats per kilometre increased during April, May and June, peaking in July and tailed off after this period. The main peak in July is assumed to reflect the addition of volant young. An increase in the number of pipistrelle social calls during August and September probably represented mating activity. Bat activity correlated with temperature in both *Nyctalus leisleri* and Pipistrellus spp., although bat numbers were independent of temperature after the middle of June. There was a significant variation in habitat use by pipistrelle bats over the season. Pipistrelle bats were observed in greater numbers in areas of treeline, cut hedge (<1m) and broadleaf woodland, and increased further when these habitats bordered both sides of the road. *Nyctalus leisleri* was found in similar numbers in all habitat types and there was no seasonal variation in its habitat use. The validity of this method for revealing seasonal variation in bat numbers and habitat use is discussed. It is concluded that ambient conditions may affect numbers recorded while some species with long-range echolocation calls, such as *Nyctalus leisleri*, may defy analysis of habitat associations. However, the method is useful with respect to elucidating seasonality of activity and behaviour in certain species.

Habitat Enhancement around Horseshoe Bat Roosts

Henry Schofield

The Vincent Wildlife Trust has 40 bat reserves in Britain and Ireland, mainly for greater and lesser horseshoe bats. Until now our conservation work has centred on renovating and enhancing these buildings for the bats. However, we are aware their foraging habitat is equally important. In many areas habitat has become fragmented as hedgerows and tree lines have been removed. This isolates the bats from suitable foraging habitat. Therefore we have embarked on a habitat enhancement scheme around our reserves. The habitat in a 2 km radius of each roost is mapped onto a Geographical Information System (GIS) using a mixture of aerial photographs and ground surveys. These data allow us to identify the key feeding areas for the colonies. Maps of these key habitat areas can then be passed to planning authorities for consideration in local planning applications. They also allow us to accurately quantify habitat around our reserves and to make comparisons both between different sites and for individual sites over time. We can use these data to assess the habitat surround roosts and to identify areas where landscape features could be improved for the bats. Finally, landowners can be approached with a view to The Trust carrying out management work re-planting important landscape features.

The Use of Ruined Castles by Bats in Southeast Scotland.

Stuart Smith

The first comprehensive survey of a 'ruined castle' in Scotland for bats was started by John Haddow of Central Scotland Bat Group in the early 80's and reported in *Scottish Bats 1 (1992).* The Lothian Bat Group started surveying castles in the late 80's after one of our members was informed (by her mother who worked for 'Historic Scotland'!) that several of 'their' castles were known to be occupied by bats. Regular surveys in subsequent years revealed four species of bat, *Myotis daubentoni, Myotis nattereri, Pipistrellus pipistrellus* and *Plecotus auritis* roosting in these castles at different times of the year in patterns similar to that described by John Haddow at Doune Castle. In 1995 the SE Scotland Bat Groups Committee organised a Scotland-wide survey

of castles by local bat groups, which was funded by a 'Scottish Office Environment Programme' grant. John Haddow coordinated this and the results were subsequently published in *Scottish Bats 4 (1997)*. Here we report briefly on the results of the Lothian surveys carried out since 1987 and the initial results of a more extensive survey started in the Scottish Borders in 1996.

A Better Breed of Bat - in and around the Country Estates of Northern Ireland
Mark Smyth

My paper is all about my travels looking for bats that live in buildings in and around the farms & large houses of country estates. My first clue about bats being here came from my other interest as a self confessed 'plantaholic'. I went to a cottage garden nursery for the first time to discover there was a derelict, traditionally built barn on the property. I asked if there were any bats in it and was told there was, but that they were unidentified. Closer inspection showed they were brown long-eared bats. The plants-person there told me her neighbour had bats who in turn told me her mother had bats who told me ... who told me....! I followed all the leads discovering bats all the way, including many roosts of Ireland's newest species, Nathusius' pipistrelle. The complete list of species recorded is as follows:

Nathusius' pipistrelle – *Pipistrellus nathusii*
Natterer's – *Myotis nattereri*
Brown long-eared – *Plecotus auritus*
Daubenton's – *Myotis daubentonii*
Whiskered – *Myotis mystacinus*

Several additional presentations dealing with bats in houses and other aspects of bat management were also presented. These titles are included here.

Problems with Bats in Houses
Pat Smiddy

Upstairs, Downstairs, Bats in Houses
Brian Keely. Harristown Lane, St. Margaret's, Co. Dublin, Ireland

What Can Coillte do for Bats?
Aileen O'Sullivan, Coillte Research and Development
[Coillte Teoranta is the Gaelic name of The Irish Forestry Board]

The following bat-related abstracts were presented at The 81st Annual Meeting of the American Society of Mammalogists at the University of Montana in Missoula, MT, June 16 -20, 2001

Temporal variation in prey selection and diet breadth by the big brown bat *Eptesicus fuscus* in Pennsylvania

Salvatore J. Agosta and David Morton. Dept of biology, Frostburg State Univ., Frostburg MD 21532

Fecal samples were collected on 21 nights from April to September 2000 at a big brown bat maternity colony in south central Pennsylvania. Insect abundance was measured on corresponding nights with the use of a lack-light trap. Overall, Coleoptera, Hemiptera, and Hymenoptera comprised the greatest percent volume of prey items in the diet. Orthopterans (Tettigoniidae) were important prey items in August and September. We found an inverse relationship between diet breadth and the relative abundance of Coleoptera. In spring and early summer when diet breadth was low scarab beetles (Coleoptera: Scaabaeidae: Melolonthinae) were heavily exploited. As the relative abundance of beetles decreased, *E. fuscus* took a wider variety of prey but still fed heavily on beetles. *E. fuscus* appears to select beetles and take additional types of prey (e.g., ichneumonid wasps, stink bugs, ants) when the relative abundance of beetles is low. The diet of *E. fuscus* in Pennsylvania shows similarities to and differences from the diet in Indiana where this species as been recognized for its beneficial role as a consumer of agricultural pests. Scarab beetles and green stink bugs (Acrosternum hilare), both injurious to crops, were preyed on heavily in this study and in Indiana. *E. fuscus* in this study did not feed substantially on the spotted cucumber *beetle (Diabrotica undecempunctata howardi)* but did take a fairly high proportion of click beetles (Elateridae) in the summer. Click beetle larvae, wireworm, are injurious to a wide variety of crops. This study supports the conclusions of early studies that *Eptesicus fucus* is a highly beneficial species in anthropogenic landscapes.

A Classification for the Family Phyllostomidae Based on the Ribosomal, MTDNA and the RAG-2 Nuclear Genes

Robert J. Baker[1] and Calvin A. Porter[1], Steven R. Hoofer[2] and Ronald A. Van Den Bussche[2]
[1]Texas Tech University, Lubbock, Texas
Oklahoma State University, Stillwater, Oklahoma

We generated a gene tree for all genera of Phyllostomid bats based on DNA sequences from three mitochondrial genes (12s rRNA, $tRNA^{Val}$, and 16s rRNA) and one nuclear gene (RAG-2). We extended our tree into a preliminary Linnean classification with 10 subfamilies. Subfamilies with respective genera in parenthesis are **Macrotinae** (*Macrotus*); **Micronycterinae** (*Lampronycteris, Micronycteris, Neonycteris*); **Desmodontinae** (*Desmodus, Diaemus, Diphylla*); **Lonchorhininae** (*Lonchorhina*); **Phyllostominae** (*Chrotopterus, Macrophyllum, Mimon, Phylloderma, Phyllostomus, Tonatia, Trachops, Vampyrum*); **Glossophaginae** (*Anoura, Brachyphylla, Choeroniscuc, Choeronycteris, Erophylla, Glossophaga, Hylonycteris, Leptonycteris, Lichonycteris, Monophyllus, Musonycteris, Phyllonycteris, Scleronycteris*); **Lonchophyllinae** (*Lionycteris, Lonchophylla, Platalina*); **Carolliinae** (*Carollia, Glyphonycteris, Trinycteris*); **Rhinophyllinae** (*Rhinophylla*), **Stenodermatinae** (*Amertrida, Ardops, Ariteus, Artibeus, Centurio,Chiroderma, Dermanura, Ectophylla, Enchisthenes, Phyllops, Platyrrhinus, Pygoderma, Rhinophylla, Sphaeronycteris, Stenoderma, Sturnira, Uroderma, Vampyressa* (includes *Mesophylla*), *Vampyriscus, Vampyrodes*). Three independent trees exist for this family (total evidence, Wetterer et al., 2000; RAG-2 nuclear gene, Baker et al., 2000 and the mitochondrial ribosomal genes, this poster). Nodes shared by all 3 trees include 1) the Family Phyllostomidae 2) the vampire bats 3) the Stenodermatinae (excluding *Stunira*) 4) Stenodermatina (sensu Weterer et al., 2000 p. 139) 5) a clade including *Anoura, Hylonycteris, Choeroniscus, Choeronycteris* and *Musonycteris* (assuming *Scleronycteris* and *Lichonycteris* are ingroup taxa) plus one, 4 taxon node; four, 3 taxon nodes; and six, 2 taxon nodes. Unfortunately, all data sets do not contain all recognized genera and the above summary is compromised to some extent due to this condition. The data from our gene trees suggest that the last common ancestor of the vampires and a member of the remainder of the Phyllostomidae was a primitive insectivore, i.e., *Macrotus/Micronycteris* morphotype.

Postnatal Development of the Renal Medulla in the Pallid Bat

John E. Bassett
Department of Bioengineering, University of Washington, Seattle, WA 98195-7962

Maximum urine concentrating ability in adult insectivorous bats can be predicted from renal medullary anatomy. Postnatal changes in renal anatomy in bats and their role in the development of maximal urine concentrating ability have not been described. Ontogeny of renal anatomy was determined in pallid bats (*Antrozous pallidus*) born in a captive colony to field-inseminated females. Renal structure was determined on days 1, 21, 42, and 330 after birth in bats born in the laboratory and compared to that of adult bats captured in the field. Bats reared in captivity reached adult body size as measured by forearm (FA) length and body weight (BW) by day 40. Between birth and anatomic maturity, FA length increased 2.6-fold and BW increased 4-fold. Laboratory handling had no effect on growth rate or final body size attained. Total kidney mass in lab-reared bats (day 330) was equal to that of field-caught adults. Total thickness of a midsagittal renal section doubled from 2.75 mm to the adult size of 5.50 mm between days 1 and 42. The 2-fold linear increase in midsagittal renal thickness was comparable to the 2.6-fold linear increase in FA length. The thickness of the functional regions of the kidney (cortex C and medulla (M) with its outer and inner (IM) regions) also increased at the same rate as total thickness with growth. As a result, the anatomic ratios (IM/C, M/C, and PMT) used to predict urine-concentrating ability in adults remained constant with growth. No dramatic changes in the gross structure of the renal medulla with the potential to change maximal urine concentrating ability were observed during ontogeny. However, postnatal changes in plasma urea levels from 32 mM on day 1 to the adult level of 50 mM by day 42 may influence ontogeny of concentrating ability. Also, postnatal changes in other structural components such as nephron heterogeneity, glomerular number and size, tubular diameter and length and in the functional capabilities of tubular epithelial cells may play a role in the ontogeny of maximal urine concentrating ability. These factors are currently under study.

The Species-Area Relationship in Bat Assemblages of Tropical Caves

Anja K. Brunet and Rodrigo Medellin
Dept. of Ecology, Evolution, and Behavior, Univ. Minnesota, St. Paul, MN 55108
Instituto de Ecologia, Universidad de Nacional Autonoma de Mexico 04510 Mexico city, Mexico

We tested for a relationship between number of bat species and surface area of 20 caves in central Mexico and investigated the role of the habitat diversity model as an explanation for this relationship. There was a significant, positive correlation between the logarithm of species richness and the logarithm of cave surface area, evidence of a species-area relationship. Our data suggests that roost-site diversity, as indicated by spatial variation in relative humidity and presence of avons (conical depressions in cave ceilings) is a cause of the species area relationship.

Factors Determining the Abundance of Bats in Southern Illinois: Landscape, Patch and Matrix Scale Relationships

Steve K. Carroll, Tim C. Carter, and George A. Feldhamer
Southern Illinois University, Carbondale, IL

To determine distribution, abundance, habitat selection and patterns of community diversity of bat species in southern Illinois, we conducted 80 nocturnal surveys at 41 locations using mist nets from May to August in 1999 and 2000. Habitat variables were examined at the landscape, patch, and matrix levels to determine if a species were selective at different spatial scaled. Matrix level habitat characteristics were visually recorded at each net site. Patch and landscape level characteristics were determined using the Geographical Information System software ArcView 3.2. During 339 mist net nights we captured 416 bats representing 10 species. *Myotis septentrionalis, Lasiurus borealis,* and *Pipistrellus subflavus* were the most commonly found species accounting for 77% of all observations, *L. borealis* and *P. subflavus* were selective at the matrix level; both foraged in edge habitat most commonly over water. However, neither of these species was selective at the patch or landscape scales. *M. septrionalis* was selective at all three scales.

At the matrix scale, they foraged in interior habitat with a high canopy closure and thick understory.

M. septrionalis selected areas of large contiguous forest but avoided highly fragmented forests and open areas. Nonetheless, type of forest was not significant. Species diversity did not differ among habitats at any level.

Testing Alternative Hypotheses for the Evolution of Sexual Dimorphism in Bats: *Hipposideros armiger terasensis* as a Model Species

Yi-Ju Chen. Dept of Biology, Univ. of New Mexico, Albuquerque, NM 87131

The understanding of the evolution of sexual dimorphism is complicated by the fact that dimorphism depends on other factors such as reproductive strategy, social structure and mating system as well as morphological and physiological constraints. Because physiological and morphological constraints are often the assumption for the evolutionary and ecological hypotheses proposed for mammalian models, and because chiropterans face particularly severe constraints, they are an appropriate group to test these hypotheses. In this study I choose ***Hipposideros armiger terasensis*** as a model species to examine alternative hypotheses for the evolution of sexual dimorphism in animals, especially those proposed for mammalian models. I found that the "big mother hypothesis" and "hot blooded hypothesis" could not account for the sexual dimorphism of my model species. However, results from morphological analysis in this species support the "niche" hypothesis. The causes of sexual dimorphism may involve elements that are not accounted for by a single hypothesis, thus there may be a need for a clade- or taxa-specific hypothesis to explain observed patterns.

Fossil Bats in North America: Faunal Change During the Tertiary Period

Nicholas J. Czapleewski[1] and Gary S. Morgan[2]
[1]Oklahoma Museum of Natural History, University of Oklahoma, Normal, OK 73072
[2]New Mexico Museum of Natural History, 1801 Mountain Rd, NW, Albuquerque, NM 87104

There are major gaps in the Tertiary history of bats in North America but the record is slowly improving. New records being described for the middle-late Tertiary, especially in Florida suggest a preliminary interpretation of North American bat community evolution during the Cenozoic. In the Eocene a handful of scattered records includes specimens referred to 3 families, the archaic Icaronycteridae and extinct members of the extant families Natalidae and Molossidae. Two of the Eocene genera, *Icaronycteris* and ?*Stehlinia*, are possibly shared with Eurasia. Oligocene records are more numerous, but are restricted to Florida except for 2 localities in the Great Plains. The 2 plains sites preserve one vespertilionid each. Vespertilionids are rare in Florida Oligocene faunas, which are dominated instead by extinct genera of Emballonuridae and Mormoopidae and also include species of Natalidae and ?Phyllostomidae. This mix of 'Neotropical' families continued into the early Miocene at which time the Vespertilionidae became more dominant, at least in Florida. The Thomas Farm fauna (early Hemingfordian) may be transitional between Florida late Oligocene faunas dominated by tropical species and middle Miocene and younger faunas that are similar to other North American faunas in consisting almost entirely of vespertilionids. The Thomas Farm fauna contains an extinct genus each of Emballonuridae, Mormoopidae, Natalidae, and Molossidae, but 5 extinct species of Vespertilionidae, one of which is extremely abundant. Later Miocene faunas with bats are spread across the continent and include solely Vespertilionidae; only 1 or 2 species are present in a given locality but these collectively belong to 8 or more genera, some of which are extant. The mid-Miocene disappearance of 'Neotropical' families from Florida and replacement by vespertilionids coincides roughly with the contraction of subtropical woodland and attendant expansion of grassland-savanna as evidence by other paleofloral and paleofaunal evidence. By the Pliocene, widespread localities include a total of 9 vespertilionids, 2 molossids, and 1 phyllostomid (vampire). This Pliocene group probably includes 2 or 3 genera of South American invaders participating in the Great America Interchange.

Phylogeny of Short-nosed Fruit Bats, *Cynopterus ssp* in southeast Asia

Judith L. Eger, Burton Lim and Patricia Ross
Center for Biodiversity and Conservation Biology, Royal Ontario Museum, Toronto, Canada M5S 2C6

With 16 enzymes we used the partial endonuclease digest mapping procedure to map genetic variation in *Cynopterus*. We use 41 individuals of three species *of Cynopterus, C. brachyotis, C. sphinx* and >>

C. titichaecheilus from 18 localities in Laos, Vietnam, Java, Kalimantan, and the Philippines. Outgroup taxa used include eight specimens of *Ptenochirus jagori, P. minor, Sphaerias blanfordi* and three species of *Megaerops.* Previous hypotheses of species boundaries have been confused because of clinal variation in body-size and sexual dimorphism witin species of *Cynopterus.* In addition, generic differentiation within and among populations has been identified in species of *Cynopterus.* We use restriction site mapping to clarify the systematics of south-east Asian *Cynopterus.*

Neotropical Nectar-Feeding Bats (Family Phyllostomidae) Revisited: Hyoid Data Support a Recently-Proposed Molecular Phylogeny

Thomas A. Griffiths, Shawn DeLaMar and Bruce B. Criley
Dept. of Biol., Illinois Wesleyan Univ., Bloomington, IL 61702-2900

The phylogenetic relationships of Neotropical nectar-feeding bats have received much attention over the past forth years. Early in the 20th Century, all New World nectar-feeding bats (except the Antillean genera *Phyllonycteris* and *Erophylla*) were regarded as belonging to a single subfamily Glossophaginae. Analyses of various data sets in the 1960's and 1970's suggested that the taxon Glossophaginae might not be a monophyletic group, and various proposals were made to separate the genera into two (or more) groups. In 1982, on the basis of hyoid and tongue morphological and histological data, T.A. Griffiths proposed that nectarivory arose at least twice in Neotropical bats. He formally separated three genera, *Lonchophylla, Lionycteris,* and *Platalina,* from the subfamily Glossophaginae and placed them into a newly created subfamily, the Lonchophyllinae. This proposal caused considerable controversy at the time. Recently, R.J. Baker and colleagues published a molecular study of the RAG2 gene DNA sequence. Their analysis of the data suggested, among many other things, that the genera *Lonchophylla* and *Lionycteris* are in fact, more closely related to the non-nectarivorous genus *Lonchorhina* than to the Glossophaginae sensu Griffiths (*Platalina* was not available for examination). In this study, we present observations on the hyoid and lingual morphology of *Lonchorhina* that support Baker et al.'s placement of *Lonchorhina* with *Lonchophylla* and *Lionycteris.*

Phylogenetic Affinities of the Nataloid Bats: Evidence from Mitochondrial and Nuclear DNA Sequences

Steven R. Hoofer, Dept. of Zool., Collection of Verts., and Cooperative Fish and Wildlife Unit, Oklahoma State Univ., Stillwater, OK 74078

Although the order Chiroptera has received extensive systematic attention during the past century, due to incongruence among studies and a paucity of synapomorphic characters, many problems associated with higher-level phylogeny of bats still exist. One notable example regards the phylogenetic affinities of the Old World Myzopodiadae and Neotropical Furipteridae, Natalidae, and Thyropteridae. Traditionally these 4 families are thought to have shared a most recent common ancestry, yet, until recently, no study has specifically tested this hypothesis. A recent analysis of morphological characters detected strong support for monophyly of these 4 families and recommended recognition of the superfamily Nataloidea to document this relationship. A subsequent analysis of mitochondrial DNA (mtDNA) sequence data designed to test this hypothesis supported an association of Furipteridae, Natalidae, and Thyropteridae with the New World Noctilionoidea to the exclusion of the Old World Myzopodidae. Differences in phylogeny between these alternative hypotheses have strong implications concerning the origin and early radiation among familial lineages. I examined DNA sequence variation in the nuclear *RAG2* gene (about 1.4 kilobases), which is unlinked and independent from mitochondrial genes, to test these alternative hypotheses. Results from parsimony analysis were markedly congruent with those from mt DNA, refuting monophyly of Nataloidea. Parsimony analysis of the combined *RAG2* and mtDNA sequences provided greater support and resolution concerning these relationships. Whereas the hypothesis derived from morphological data requires the assumption that Old World bats invaded the New World several times independently, *RAG2* and mtDNA sequence data support a single invasion to, and subsequent radiation in, the New World.

Testing the Acoustic Guild Hypothesis: Partitioning of Function Sound Space by Bats

Erin M. Jackson
Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM 87131

The use of acoustic tools to investigate community structure and differential use of habitat by bats has become increasingly common. However, there has been serious debate regarding problems associated with species identification and the repeatability o diagnostic associations. The possible variation in diagnostic call features, coupled with the qualitative approach to species identification has caused question regarding the validity of these methods. In many habitat management projects, specific identifications are not necessary as impacts are affecting functional groups rather than single species. I propose that sound space will be partitioned by these functional groups making identification of group members possible. In this study I will test the hypothesis that temperate bat communities are composed of three functional guilds; aerial hawkers, mixed strategists and gleaners. I propose that these groups will divide sound space by exhibiting variation in call characters such as minimum frequency, slope and duration. Functional guilds were created frm the literature and then tested against calls from known individuals. These results are used to create management recommendations. Management implications are discussed, as are recommendations for application of acoustic techniques.

Feeding Activity in Mines during Hibernation of *Rhinolophus hipposiderum*, *R. ferrumequinum*, and *Barbestella leucomelas* in Tajkistan.

Tolibon K. Khabilov. Khujand State University, 735700 Kujand, Tajikstan

During 1976 - 1993 we studied hibernation of bats in abandoned mines in North Tajikistan placed 720-2700 m above Sol. Activity of Lepidoptera and Diptera was observed in mines beginning from October to April. Regular movements inside and outside of hibernation roosts were recorded for six species of bats (two rhinolophids and four vespertilionids). *Barbastella leucomelas* individuals during all periods of hibernation produced feces that were observed near the anus. Examination of stomachs of *Rhinolophus hipposideros* and *R.. ferrumequinum* revealed remains of food in the winter hibernating period. Thus our investigation proves feeding activity by bats during the hibernation period inside abandoned mines in Tajikistan.

New Bats in the Neotropical Families Mormoopidae & Natalidae from the Oligocene and Miocene of Florida and the Origins of the Tropical North American Chiropteran Fauna

Gary S. Morgan[1] and Nicholas J. Czaplewski[2]
[1]New Mexico Museum of Natural History, 1801 Mountain Rd., NW, Albuquerque, NM 87104
[2]Oklahoma Museum of Natural History, University of Oklahoma, Norman, OK 73019

Fossils representing the endemic Neotropical bat families Mormoopidae and Natalidae are reported from the late Oligocene and early Miocene of northern peninsular Florida. Previously, neither of these two families had a pre-Pleistocene fossil record. A new genus and species of mormoopid is represented by 46 fossils from two late Oligocene (early Arikareean, 24-28 Ma) sites, the I-75 Local Fauna (LF) and the Brooksville 2LF. The fossils share derived characters of the dentition, humerus, and proximal femur with extant mormoopids. Although the fossils are intermediate in certain characters between the two living mormoopid genera, *Mormoops* and *Pteronotus*, they are more similar to *Mormoops* in the lower premolar dentition and distal humerus. A new genus and species of natalid is represented by 32 fossils from the early Miocene (early Hemingfordian, 18-19 ma) Thomas Farm LF. Our phylogenetic analysis of the living and fossil taxa assigned to the Natalidae reveals that the Florida Miocene species is the only extinct taxon that fits within our restricted definition of the family, based on shared-derived osteological and dental characters (reduced orbit with anterior edge far posterior above M2, deep funnel-shaped anteriod orbital fossa, elongated infraorbital canal, dorsally upturned braincase and ascending ramus of dentary, cingular cusp on P4. Several extinct Eocene genera previously referred to the Natalidae (*Honrovits* from Wyoming and *Stehlinia* from Europe) are not members of this family, but may belong to the Nataloidea, which also includes two other small Neotropical families, the Furipteridae and Thyropteridae. Brooksville 2, I-75 and Thomas Farm have the richest middle Tertiary chiropteran faunas in North America. The two Oligocene sites contain a natalid, the new mormoopid, two emballonurids, and a large phyllostomid. Thomas Farm

has the new natalid, one emballonurid, one molossid, and five vespertilionids. These are the earliest New World records of the Emballonuridae, Mormoopidae, Phyllostomidae, and Natalidae, confirming the presence of a tropical North American chiropteran fauna in Florida during the Oligocene and early Miocene.

Bats and their Role as Vectors of Rabies in Pennsylvania

Linsey R. Olnhausen and Michael R. Gannon
Dept. of Biology, The Pennsylvania State University, Altoona College, Altoona, PA 16601

Bats are keystone species in almost all ecosystems in which they are found. Insectivorous bats, such as the 11 species found in Pennsylvania, are major predators of night flying insects, including many that are considered agricultural pests. Bats, and their role as a vector of rabies, have long been in question. Pennsylvania health officials and the CDC have listed bats among high-risk species as rabies vectors for human exposure. Chiroptera is the only group where the entire order is listed, and no distinction is made with regard to individual species. Since 1980, only 26 deaths have been associated with bats as possible rabies vectors in the United States, and only one bat related rabies death has ever been recorded in Pennsylvania. No bat related rabies death has ever been associated with the most common bat in Pennsylvania, the little brown bat (*Myotis lucifugus*). We obtained rabies data for all mammals tested in Pennsylvania from 1943 to present from the Pennsylvania Department of Health. In addition, data relating to cases dealing with human exposure to rabies beginning in 1992 were also available and examined. Data related to bats were compared with other species of mammals, both wild and domestic. Results show that in the past ten years, the number of raccoons found rabid in Pennsylvania has been extremely high. During the same period the numbers of foxes, domestic cats, and bats found to be rabid are each significantly fewer than the number of skunks found to be rabid. Moreover, the combined percent of these rabies cases that resulted in human exposure in Pennsylvania (bats, foxes, and skunks combined) over an eight year period (1992-2000) is again significantly less than the percentage of rabies cases in domestic cats that resulted in human exposure. These data, supplied by the Pennsylvania Department of Health, indicate that domestic cats are a higher risk to humans as a potential vector of rabies than a number of wild species already listed high risk, including bats. Domestic cats are not considered a high-risk species by either the Pennsylvania Department of Health or the CDC.

Dentin Matrix Protein I Gene: A New Nuclear Marker for Inferring Phylogenetic Relationships. Within the Order Chiroptera

Serena A. Reeder, Eric W. Hansen, Steven R. Hoofer, and Ronald A. Van Den Bussche.
Department of Zoology and Collection of Vertebrates,
Oklahoma State University, Stillwater, OK 74078

Due to a limited number of informative morphologic, karyologic, and immunologic characters, it has been difficult to produce a robust phylogeny of Chiropteran families. Molecular data have proven most promising in providing resolution with many studies involving mitochondrial genes. There are two potential problems, however, in that mtDNA is maternally inherited, and all mitochondrial genes are linked. Therefore, considerable effort has focused on identifying nuclear markers for elucidating higher level taxonomic relationships. The Dentin Matrix Protein 1 (DMP1) Gene is involved in some aspect of dentinogenesis, and a previous study with a limited taxonomic sampling concluded that DMP1 was a rapidly evolving nuclear gene. The purpose of this study was to explore the utility of DMP1 for elucidating phylogenetic relationships at several taxonomic levels in bats. We sequenced an approximately 1200 bp fragment of exon six using representatives with well-documented relationships. DMP1 appears to be evolving at a rate suitable for analysis at the family level within Chiroptera and produced a tree similar to that generated by previous mtDNA ribosomal gene trees.

Biological Survey of Bata from Colima, Mexico

Cornelio Sánchez-Hernandez[1], M. Lourdes Romero-Almaraz[2], Gary D. Schnell[3], Michael L. Kennedy[4], and Troy L. Best[5]
[1]Universidad Nacional Autonoma de Mexico, A.P. 70-153, Mexico; [2]Universidad Autonoma del Estado de Morelos, Cuernavaca, Av. Univ. 1001, Mexico; Univ. Oklahoma, [3]Norman, OK 73072, [4]Univ. Memphis, Memphis, TN 38152, and [5]Auburn University, AL 36849

The state of Colima in west central Mexico lies at the interface between Nearctic and neotropical biota. To date 66 (49%) of 135 bat species recorded from Mexico have been found in Colima. Colima topography varies from sea level to a high of 2,200 m. Habitats include pine-oak forest, subdeciduous dry forest, deciduous dry forest and secondary vegetation. In 1997 we began a detailed mammalian survey of Colima, conducting extensive fieldwork and examination of the mammal collections from Mexico and the U.S. Bats have been captured with mist nets placed about 18:00 h and checked until 23:00h as well as by using other types of nets at roosts. We have gathered information of their natural history and reproductive habits from each of the specimens captured, and have preserved skins, skeletons and tissues. We have examined 5,374 bats from 132 principal localities. Specimens represent 7 families, 35 genera, and 62 species. Ten species are endemic of Mexico, 12 are new state records and 12 are second records for Colima. Additional information about reproduction and ecology is provided.

Bat Activity Along Intermittent Streams in Northwestern California

Victoria M. Seidman[1] and Cynthia J. Zabel[2]
Dept. of Wildlife, Humboldt State Univ. Arcata, CA 95521
[1]CA State Parks, Bay Area District, 250 Executive Park Blvd., Suite 4900, San Francisco, CA 94134
[2]U.S. Forest Service, Pacific Southwest Research Station, Redwood Sciences Lab, Arcata, CA 95521

Bats are known to use areas above perennial streams and rivers for foraging and traveling; however, little is known about bat use of smaller streams that flow intermittently. We compared bat activity among three size classes of streams and upland sites in a northwestern California watershed during the summers of 1996 and 1997. Stream size was classified based on channel width. Ultrasonic Anabat II® bat detectors were placed in stream channels and at upland sites, and bat activity was recorded remotely at night. Analysis of bat detector data revealed a significant difference in activity among the four habitat types in both years. In 1996, bat activity was greatest along medium and large intermittent streams, intermediate at small intermittent streams, and least at upland sites. In 1997, there was a similar pattern, but there was no significant difference in bat activity between small streams and upland sites. To determine species presence, bats were captured in mistnets at stream sites with the highest bat activity. Results are presented indicating differences in number of captures by species between medium and large streams.

Reproductive biology of the northern myotis *Myotis spetentrionalis* and comparisons with the little brown bat *Myotis lucifugus* in Indiana

Dale W. Sparks, Aaron R. Krochmal, and William Mitchell.
Dept. Life Sciences, Indiana State Univ. Terre Haute, IN 47809

Detailed studies of the reproductive biology of bats are often limited to these species that form large, easily accessible colonies (such as the little brown myotis, (Myotis lucifugus). The congeneric northern myotis (M. septentrionalis), conversely, is most often found roosting in hollows and under the exfoliating bark trees; little information is available about the birth and development of this bat. We investigated the reproductive biology of this bat at a colony in a barn on the Newport chemical Depot. We collected neonatal bats in this roost from 5 until 10 June 2000. After capture each bat received a uniquely numbered wing band (males on right, females on left) so that we could reexamine these bats at multiple times during the summer. At birth these bats had forearms 12.5 ± 1.1 mm (mean ± sd) long, and weighed 1.9±0.2 g. We also tested the volancy of bats by releasing them from a height of 1 m above a padded surface. Bats began to fly at 18 days and all young bats were flying by 24 days of age. In addition to examining the northern myotis, we also conducted a study using identical techniques on little brown myotis in Poland, Indiana. These bats were born with larger forearms (14.3 ±1.3 mm) and were heavier (2.2±0.4g). We hypothesize that these differences are due to the larger, warmer colonies of little brown myotis.

Taxonomic and Environmenta Determinants of Morphological Diversity Gradients: An Analysis of New World Bat Communities

Richard D. Stevens
Department of Biological Sciences, Texas Tech University, Lubbock, TX 79409-3131

Although latitudinal diversity gradients have been described for many taxa, the empirical characterization of diversity has typically focused on the number and relative abundances of species (i.e., taxonomic diversity). Nonetheless, measures of trophic, genetic, and morphological diversity may exhibit complementary yet more informative geographic gradients. I investigated latitudinal patterns in the morphological diversity of 32 New World bat communities. I used principal components analysis to decompose variation in seven morphological attributes into independent components of size and shape. I then quantified four aspects of the morphological relationships among species within communities on size and shape axes: 1) average pairwise distance among species, 2) average nearest neighbor distance, 3) variance of distances among species, and 4) variance of nearest-neighbor distances. Significant latitudinal gradients exist regarding morphological diversity. Nonetheless, these gradients could be the result of latitudinal increases in taxonomic diversity. I performed simulation analyses to characterize latitudinal gradients in morphological diversity that would be expected from the observed gradient in species richness. A number of morphological-diversity gradients were different from simulated expectations. To the extent that morphological reflects the ecological attributes of organisms, measures of morphological diversity should characterize emergent properties of communities that reflect functional differences among species. Although taxonomic and morphological diversity gradients are complementary, it is likely that mechanisms other than those that affect taxonomic diversity give rise to the morphological composition of species within communities.

Tree Roosting Ecology of Reproductive Female Eastern Pipistrelles *Pipistrellus subflavus*

Jacques Pierre Veilleux
Department of Life Sciences, Indiana State University, Terre Haute, IN 47809

Little is known of the tree roosting ecology of the eastern pipistrelle, *Pipistrellus subflavus*. Previous data suggested that pipistrelles may roost in either tree hollows or in tree foliage. I will present data describing the roosting habits of this poorly understood species, specifically addressing the habits of reproductive females. Research was conducted at the Prairie Creek study site, located in southern Vigo Co., Indiana. Data were collected during May through July 1998-2000. Nineteen reproductive female pipistrelles (15 pregnant; 4 lactating) were radio-tagged. Thirty-seven roost trees were verified by either direct observation or by watching for bats as they emerged in the early evening. All roosts were located in either live (n=12) or dead (n=25) foliage. Oak trees (*Quercus* spp.) were preferred, although a variety of trees were used as roosts. Correspondingly, pipistrelles most often roosted in upland forest habitat (where oaks regularly occurred), rather than in the bottomland, or narrow, stream bank woodland, available in the study area (where few oaks occurred). Pipistrelles roosted in trees and in foliage, that were located below the general canopy height (74.8 and 56.4%, respectively). Canopy closure above roosts averaged 41.4% and bats used leaf roosts with little clutter (foliage or woody material) either above or below the roost. I found it surprising that pipistrelles use foliage as roosts. It appears to be the only North American bat which utilizes foliage as a roost substrate, while maintaining coloniality. Other temperate foliage roosting species (*Lasiurus* spp.) are typically solitary, while colonial species reside in more stable roosts.

Tree Roosting by Female Reproductive Evening Bats *Nycticeius Humeralis* in Indiana.

Sherry L. Veilleux
Department of Life Sciences, Indiana State University, Terre Haute, IN 47809

The evening bata, *Nycticeius humeralis*, is recognized as a common species throughout much of its range. However, it is listed as state-endangered in Indiana, where it is suspected to be declining. Although evening bats are known to roost in trees, the majority of information concerning roosting habits for this species has come from colonies in buildings. The purpose of this study was to describe roosting habits of female reproductive evening bats in a natural environment, specifically to determine characteristics of roost trees and roost sites. Studies on other temperate bat species that roost in tree cavities or under exfoliating bark have revealed general trends in roost selection. Bats tend to use trees in earlier stages of

decay that are tall, usually taller than the height of the overstory canopy, large and uncluttered. These characteristics are presumed to provide thermoregulatory benefits, as well as protection from predators and ease of flight to and from the roost. During May through July 1999 and 2000, 21 female evening bats (12 pregnant, 9 lactating) were captured and radiotagged in a 650 ha bottomland forest of Prairie Creek, which is a tributary of the Wabash River in southern Vigo County, Indiana. Forty roost trees were verified: 35 silver maples (*Acer saccharimum*), 3 green ash (*Fraxinum pennsylvanica*), and 2 dead unidentified trees. Twenty-four trees were live, 14 were declining, and 2 were dead. On average (mean $\pm$ SE), roost trees were 25.4 $\pm$ 0.8 m tall, and 33.6 $\pm$ 2.8 cm dbh. Trees were always situated below the height of the overstory canopy. Evening bats roosted 13.3 $\pm$ 0.8 m above the ground in hollows or cracks on the main trunk and/or broken limbs. Average canopy closure surrounding the roost tree was 57 $\pm$ 20%. Overall, trees used by evening bats are shorter than the overstory canopy height and more cluttered than roost trees of other temperate cavity dwelling bats species. Therefore, some advantages of roosts used by these other species may not apply to roost trees used by evening bats in their northern range.

Activity Patterns of Male Daubenton's Bats *Myotis daubentoni* in Germany

Christa D. Weise[1] and Markus Dietz[2]
[1]Department of Biology, University of New Mexico, Albuquerque, NM 87131
[2]Arbeitskreis Wildbiologie, Justus Liebig-Universitaet, Heinrich-Buff-Ring 25, 35392, Giessen, Germany

The Daubenton's bat *Myotis daubentoni*, (Chiroptera: Vespertilionidae), is a relatively common and widespread insectivorous bat species in Europe, which typically forages over water surfaces. Several studies have addressed activity patterns and foraging strategies in females, but little attention has been devoted to males. We focused on nightly activity cycles and differential use of foraging sites in male Daubenton's bats in a population in central Germany. Nine male individuals of various ages were caught with mist nets, radiotagged and monitored for a total of 46 tracking nights between May and September of 1997. The foraging habits of the studied bats showed high levels of individual variation, but on average were active for 6.2 hours per night, with two to three foraging breaks in night roosts. The maximum radius of activity was 6 km, but most bats stayed within a radius of 4 km from their day roosting area. The most significant factors for the selection of foraging sites are most likely insect density and intraspecific competition. Predation risk was overall low and probably plays an insignificant role in the selection of foraging sites. In comparison with other species, Daubenton's bats appear not to be influenced as strongly by external factors, such as minimum precipitation, which may be related to the foraging strategy of the species.

Habitat Distribution of Bats in a Riparian Corridor in the Mojave Desert of Southern Nevada

Jason A. Williams[1], Michael J. O'Farrell[2], and Brett R. Riddle[1]
[1]Dept. of Biol. Sciences, Univ. of Nevada, Las Vegas, NV 89154
[2]O'Farrell Biological Consulting, Las Vegas, NV 89108

We examined bat species richness and habitat preference among four types of riparian communities (riparian woodland, riparian marsh, mesquite bosque, and riparian shrubland) in the upper Muddy River drainage, southern Nevada. Bat activity was examined using a stratified, replicated sampling design, and sampling techniques included active and passive acoustic monitoring, harp traps and mist nets. Multiple Anabat acoustic detection units sampled replicates of each of the four habitat types simultaneously throughout an entire night for 3-5 successive nights each sampling session. One to 4 sampling sessions were conducted each month other the course of one year. Sixteen of Nevada's 22 known species of bats were identified from e study area. Approximately 67,000 bat passes were recorded from a total of more than 2800 hours of acoustic recording. Collectively, 540 bats were captured with a total 278.75 hours of trapping/netting effort from 30 mights. A substantial species-specific difference in habitat use was observed. While species classified as gleaners (e.g. *Lasiurus blosssevillii, Lasiurus xanthimus, Macrotus californicus)* were found more frequently over riparian marshes and riparian shrublands. Our sampling design enabled the detection of seasonal changes in activity levels among habitat. These changes may reflect seasonal changes in the distribution and abundance of prey, as well as seasonal changes in species composition of the local bat assemblage.

Future Meetings

August 5 to 9, 2001

The 12th International Bat Research Conference will meet in Bangi, Malaysia. All information concerning the conference can be obtained at : http://www.ukm.my/ukm/seminar/bat/index.html

August 12 to 17, 2001

The 8TH International Theriological Congress will meet in Sun City, South Africa. The Organizing Committee is chaired by Professor John Skinner in conjunction with Event Dynamics as the professional Congress organizers. For additional information contact: Sandra Collier, 8th ITC Congress, c/o Event Dynamics, PO Box 411177, Craighall, 2024, Johannesburg, South Africa Tel: +27-11-442-6111. Fax:+27-11-442-5927 E-mail: DonaPlotz at: www.sandra@eventdynamics.co.za Visit the website at: www.eventdynamics.co.za/itc

August 31 to September 2

The British Bat Conservation Trust will hold its annual meeting in Nottingham, England at Nottingham University. Conor Kelleher is the organizer and can provide information about registration and hotel accommodations. His e-mail is: conorkelleher@eircom.net.

October 24 to 27, 2001

The 31st Annual North American Symposium on Bat Research will meet in the beautiful city of Victoria, British Columbia, Canada, October 24 - 27, 2001, hosted by Mark Brigham of the University of Regina. All formal sessions of the 31st Symposium will be held at the Victoria Conference Center, which is immediately adjacent (and connected) to The Empress Hotel, one of the grandest, most spectacular hotels in the world. We have obtained outstandingly good room rates for conference attendees at the Empress. Mark has also arranged that our conference banquet will be held in the Crystal Garden. This promises to be a truly memorable symposium. For details see our web site at: www.nasbr.com

February 2002 (exact dates not yet determined)

The Southeastern Bat Diversity Network (SPDN) will hold its annual meeting in Clemson, S. C. in February 2002. The SBDN meeting will be held in conjunction with the Colloquium on the of Mammals in the Southeastern U. S. Registration and other details will be available later this year. Mary Kay Clark, Curator of Mammals N.C. State Museum of Natural Sciences
E - mail: mkclark1@mindspring.com

April 2 to April 5, 2002

The dates for the Australasian Bat Society conference have been set for the week following the Easter weekend - Tuesday 2 April to Friday 5 April 2002 . There will be pre (Sat. 30th / Sun. 31 March) and post (Sat.6 / Sun.7 April) conference workshops. One will be megabat , the other microbat so that conferencees can attend both if desired . The megabat weekend will include a full day carers' workshop . Ideas for the microbat workshop so far include use of Anabat and gating of mines. Please send in your ideas for the workshops . No decision has been made about which weekend is which yet. It may depend on suitable dates for presenters. The dates are school holidays in Queensland.

The conference is to be held at the Cairns Colonial Club, a great venue and with accommodation that is not excessive. If people are prepared to share then it is very reasonable. A room with 4 people is Aus$135 , or Aus$105 for single/twin share. We are looking for cheaper single accommodation close to the venue but hope as many people as possible can stay onsite. We don't have costings done yet for registration, etc.

Jon Luly has agreed to handle the abstracts for the meeting. The abstracts will also be published in the following issue of Bat Research News. All those wishing to present papers **PLEASE send abstracts** ***300 words or less*** to Jon. [e-mail]: Jonathan.Luly@jcu.edu.au or by snail mail to: Jon Luly, School of Tropical Environemnt Studies and Geography, James Cook University, Townsville, Qld 4811 Australia.

May 15 - 18, 2002

The Lubee Foundation, Inc., the American Zoo and Aquarium Association Bat Taxon Advisory Group and the University of Florida Veterinary Medical Teaching Hospital will host a symposium on *the Medical Management and Captive Care of Chiroptera.*

The venue will be the Holiday Inn, 1250 W. University Ave., Gainesville, Florida 32601 Program includes presentations on medical management, emerging diseases, field programs, conservation, education and captive husbandry and management of Chiroptera. The program will include sessions on Zoo Education, Emerging Diseases, and Ecology and Captive Management. Sessions, workshops, and the banquet dinner will be at the Holiday Inn. On Sunday evening(May 19) A special program *"Rodrigues Fruit Bat Family Extravaganza"* will be held at the Lubee Foundation, Inc., 1309 NW 192nd Avenue, Gainesville, FL 32609.

For further information on this conference or the workshops, please contact one of the following: John Seyjagat, Lubee Foundation at 352 485-1250 or LUBEEBAT@aol.com Peter Riger, Nashville Zoo at 615 746-2526 or priger@email.msn.com or Denise Tomlinson, OBC Florida Bat Center at 941 637-6990 or DRTomlinsn@aol.com

More details will appear in following issues of Bat Research News.

August, 2002

The IXth European Bat Research Symposium will convene 26 - 30 August in Le Havre, France. The Organizing Committee will be chaired by Stephane Aulagnier, I.R.G.M., C.R.A. Toulouse, B.P. 27, 31326 Castenet-Tolosan Cedex,France. Pre-registration deadline is November 1, 2001. Please see the website for additional information.

The website is: http://www.univ-lehavre.fr/actu/9ERBS

Aulagnier's e-mail is: aulagnie@teleirgm.toulouse.inra.fr

November 6-9, 2002

The 32nd Annual North American Symposium on Bat Research will convene in Burlington, Vermont hosted by William Kilpatrick (University of Vermont) and Roy Horst (State University of New York at Potsdam) Arrqngements have been made for participants in the symposium to stay at the Radisson Hotel at very reasonable rates. All symposium session, displays, etc., will be in the Radisson which overlooks Lake Champlain only a 5 minute walk away. Just 5 minutes away are historic St.Paul Street and Church Street, both famous for the great number of fine restaurants and the Burlington Brewpub. Unfortunately the spectacular fall foliage season will be past (which incidentally is why we can get such reasonable room rates). For details see our website at www.nasbr.com

October 23-26, 2003

The 33rd Annual NASBR, is tentatively scheduled to meet in San Juan, Puerto Rico. The local host will be Armando Rodriquez-Moran. For details see our website at: www.nasbr.com

If you know of other meetings, large or small, concerning any aspect of biology please send us the details for inclusion in the next issue. Thank you. G. Roy Horst

E -mail: horstgr@potsdam.edu

BAT RESEARCH NEWS

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Front Cover

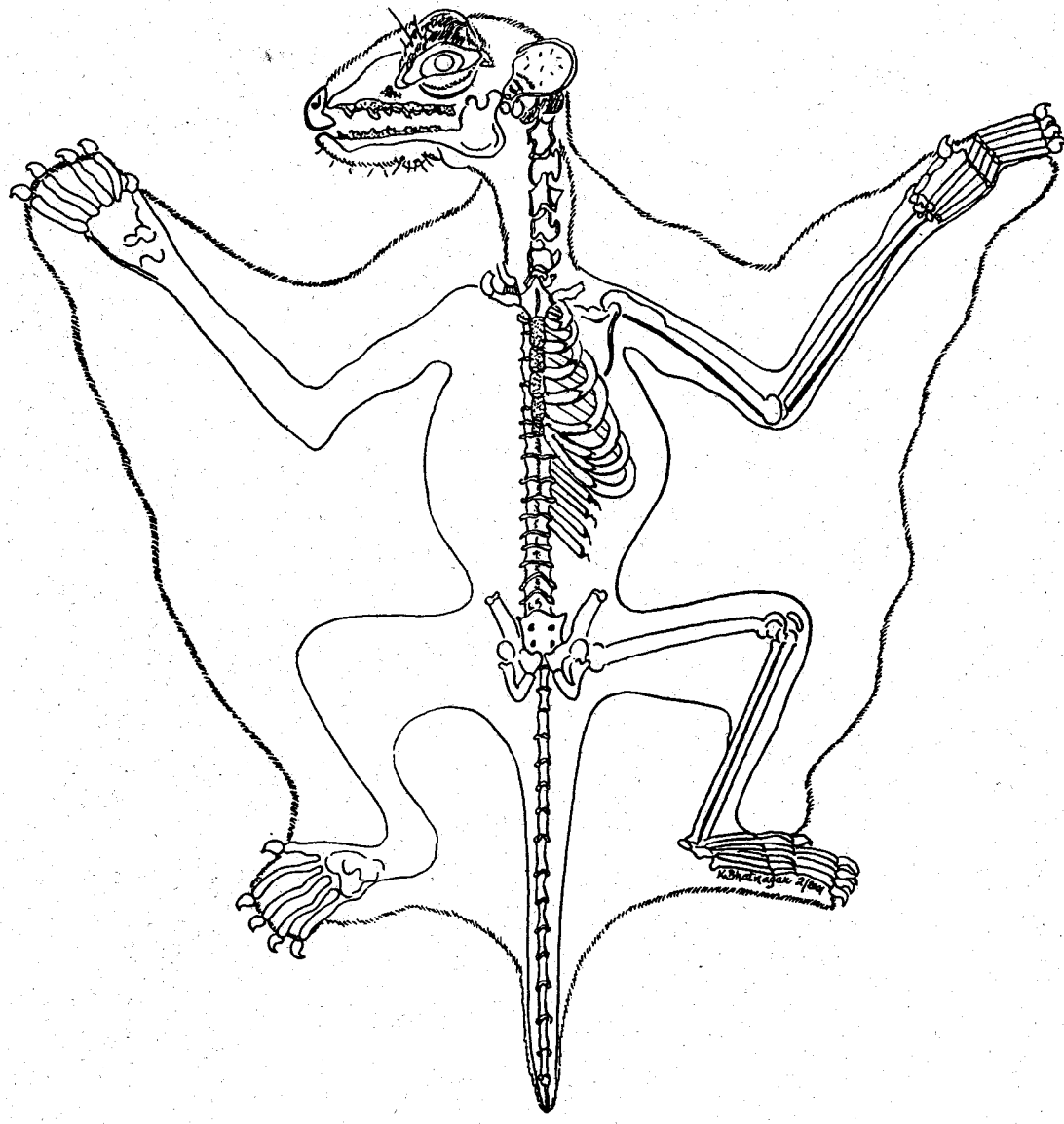
The front cover for this issue is a copy of a plate taken from:

Traite de L' Ostéologie et de LaMyologie du *Vespertilio murinus*

by P. Maisonneuve, Paris 1878

This illustration is one (plate II) of eleven plates in this delightful old monograph. If any of our readers can find an earlier published illustration of a bat (or bats) that would make an interesting cover for a future issue. If so please include as much information as possible, and send it to me. The original volume is part of my collection. G. Roy Horst

BAT RESEARCH NEWS



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

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

Editor for Recent Literature: Thomas A. Griffiths: Dept. of Biology, Illinois Wesleyan University, Bloomington, IL 61702 Tel. 309-56-3230 e-mail: tgriff@titan.iwu.edu

Editor for Conservation and Education: Patricia Morton, Texas Parks and Wildlife, Suite 100, 3000, IH 35 Austin, TX 78704 Tel. 512-912-7020 e-Mail: patricia.morton@tpwd.tx.us

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 an extensive recent literature citation list covering nearly all the recent bat-related literature in English. It also publishes the programs and abstracts of bat-related meetings and symposia world-wide. It publishes letters to the editors, news submitted by our readers, notices, letters of request and the announcements of all scheduled future meetings concerning the biology of bats world-wide. Communication concerning feature articles and Letters to the Editor should be referred to Kurta. Communication concerning recent literature should be addressed to Griffiths. Issues dealing with conservation and education should be addressed to Morton. All other business should be referred to Horst.

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Preparation and Deployment of Canopy Mist Nets Made by Avinet

J. Benjamin Rinehart and Thomas H. Kunz
Department of Biology, Boston University, Boston, MA 02215

Introduction

Some species of bats appear restricted to the canopy and subcanopy of forests and thus are rarely captured in nets set at ground level. Major sampling bias may result unless nets are deployed from the ground into the canopy (Kalko and Handley, 2001). For example, Francis (1994) found that both species richness and relative abundance of Old World plant-visiting bats were markedly higher in the subcanopy than at ground level.

Several methods of sampling the canopy and subcanopy exist (Kunz and Kurta, 1988; Munn, 1991; Simmons and Voss, 1996; Tschapka, 1998). Most include elaborate pulley systems that raise a series of stacked, "horizontal nets" (i.e., those with the long axis of the net positioned parallel to the ground) into the subcanopy. Some methods require installation of permanent supporting structures (Kunz and Kurta, 1988; Simmons and Voss, 1996), each of which may be physically challenging to install, as well as potentially risky to the investigator (but see Tschapka, 1998). Installation of poles and other supporting hardware can be burdensome and time-consuming, especially in difficult terrain or where netting must be done at some distance from a base camp. Thus, a system that relies on cumbersome hardware may limit placement of canopy nets to convenient locations.

For capturing birds, Munn (1991) used a canopy netting system in which standard mist nets were restrung so that shelf strings were perpendicular, rather than parallel, to the long axis of the net. Restringing allowed the net to be positioned vertically, with the long axis perpendicular to the ground. Francis (1994) used a similar system for capturing Old World fruit bats. With this method, the net was supported by poles at the top and bottom, instead of at the sides. Net and supporting poles were suspended from overhead branches by a rope that was positioned initially using a slingshot or crossbow. A major advantage of this portable, vertically positioned net was that it allowed rapid deployment in small forest gaps, high in the canopy, where other methods failed to sample bats. Additionally, the system could be positioned near flowering or fruiting trees to capture plant-visiting bats.

Until recently, a major drawback of canopy netting was that vertically strung nets were not commercially available, and thus, each net had to be restrung manually—a time-consuming procedure. Pre-strung vertical nets, however, are now available from Avinet, (Dryden, NY; www.avinet.com). These nylon canopy nets are available in 6-m (6 shelves) and 12-m (12 shelves) heights, with a standard 3-m width and 38-mm mesh. In addition to cloth (nylon) loops at the top and bottom of the net for attachment to supporting poles, the nets have plastic rings positioned at the lateral edges. These side rings allow more precise positioning and installation of a guideline to allow the net to be opened fully.

We successfully have used canopy nets from Avinet in the northeastern United States and Amazonian Ecuador. Set-up time in the field has been reduced to as little as 15 min and tending these nets is easy. In this paper, we describe a simple procedure for preparation and deployment of these canopy nets.

Required Materials

A number of pieces of rope are required. We use braided nylon or polyester rope that is

6 mm (1/4 in) in diameter. Braided rope is preferred over rope made by twisting three strands together, because braided rope is more resistant to unraveling. Two sections of rope are needed to form the sides of the netting system. For canopy nets that are 12-m high, we use a 10-m length of rope, and for nets that are 6-m high, we use a 5-m length of rope. In addition, a 4-m length of rope is needed to form a "hanger" that will help suspend the system, and finally, a rope that is at least twice the height of desired net placement (40 m is adequate for many situations) is required.

Two poles are needed to support the top and bottom of the net. These should be 3.5-m long, to match the width of the nets, and ca. 1.2-2 cm in diameter. Poles can be made from any stiff, lightweight material, such as electrical conduit or bamboo.

Other required materials include a 25-cm length of thick wire (e.g., a coat hanger), needed for preparation of the system for use, and a metal "figure-8," ca. 5-cm long, that will be used for attaching the pulley and balancing the net. Such figure-8's often are sold in hardware stores as a "closed S-hook." Finally a plastic tarp (3 by 4 m) helps prevent woody debris from becoming entangled in the net.

Preparation of New Nets

This process requires about 0.5 h and should be done prior to deployment in the field. Secure one set of the black, nylon loops of the net to a stationary object (Fig. 1a). Next, cut the retaining string from one set of the lateral, white, plastic guide rings, being careful not to drop the rings (Fig. 1b). Transfer the rings onto the stiff wire and bend into a circle. This secures the rings and prevents them from becoming tangled in the net.

Starting from the secured end, which ultimately will be the top of the net, find the white plastic ring attached at the base of the first, black, cloth loop. Pass one end of a rope through the white plastic ring, leaving 0.5 m of rope extending beyond the ring toward the secured end. Tie an overhand knot in the rope on each side of the white ring (Fig. 1c).

Unfold the net slightly to determine which white ring is next in line, and remove this ring from the wire retaining loop. Pass the free end of the rope through the second white ring, and make a single overhand knot in the rope (Fig. 1c), immediately beyond the ring and 75 cm from the previous knot. This knot will support the shelf string, producing the correct amount of "bag," once the system is in place. Depending on amount of bag desired, distance between knots can be decreased to 70 cm (more bag) or increased to 80 cm (less bag). Repeat this procedure until the last white ring is reached. Secure the last ring with only one knot (to allow easy identification of the top of the net) and leave the excess rope free to secure the net to the lower support of the frame.

Repeat the procedure for the set of white plastic rings on the other side of the net. When finished, return the net, including the newly installed ropes, to the plastic storage bag that originally contained the net. To simplify later deployment, position the net in the bag with the black loops of the double-knotted end on top.

Deployment of Nets

Position a "pulley rope" over a horizontal branch by throwing a rock attached to a rope or use a slingshot to project a weighted object (e.g., 20-50 g lead weight) attached to fishing line. Alternatively, if the targeted branch is not high, a fishing rod and reel can be used to cast the weight and line over the branch. If fishing line is used, tie the loose end of the fishing line to the rope, and pull the rope over the branch. To avoid snagging the line in overhanging vegetation, wrap the knot that joins the rope and fishing line with a small piece of duct tape to give the knot a tapered profile.

Spread a plastic tarp on the ground so that the ends of the pulley rope hang at the center of the tarp. Remove the net's black loops from the bag and spread them to ensure that they are in correct order. Insert one of the poles through the loops and space them along the pole until the

net is slightly taut. Tie the first and last loops in place using the loose ends of the nylon rope that was installed to form the sides of the net panel.

Tie the 4-m section of nylon rope, with the "figure-8" attached, to both ends of the pole to form a hanger (Fig. 1d). Then, position the "figure-8" at the center so that the pole hangs parallel to the ground. Attach a hanging pulley rope to the "figure-8" (Fig. 1e), and hoist the net. When the net is completely above the ground, attach a second pole to the bottom loops in the same manner as the top. Note that it may be necessary to secure one end of either pole to a stationary object to prevent the net from swiveling, especially in windy conditions. Raise the net to the desired height, being careful not to snag the net on tree branches. In cluttered environments, additional ropes may be attached to each end of the lower pole to guide the net while it is being raised.

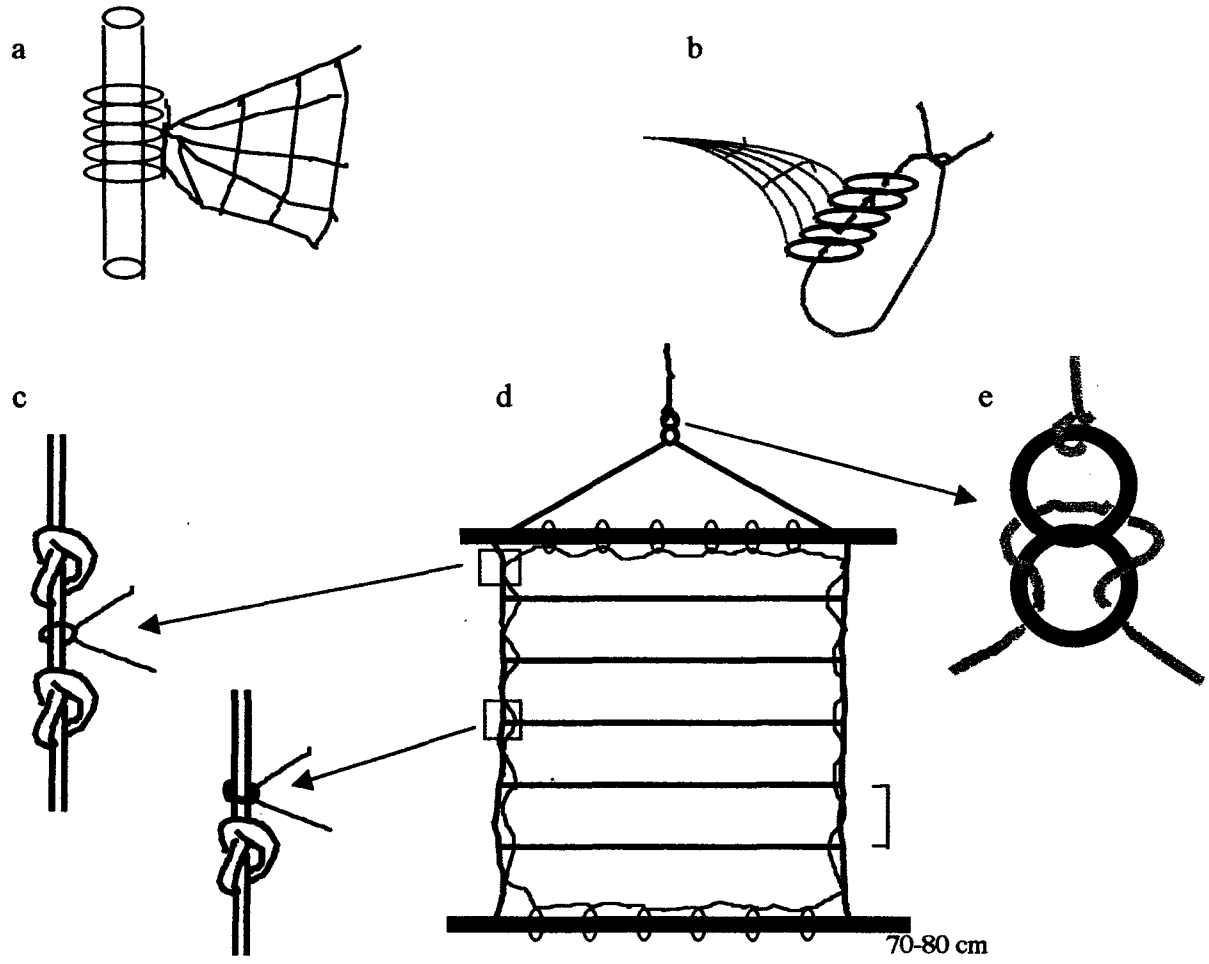

Fig. 1. Preparation and deployment of a canopy mist net: a) attachment of nylon loops to stationary object; b) wire retaining loop holding the lateral, white, plastic rings; c) two knots in guideline, flanking topmost plastic ring, but one knot in guideline below each subsequent ring; d) frontal view of deployed canopy net; e) figure 8 (closed S-hook) assembly used to attach pulley rope and balance net.

Tending Nets

When a bat is captured, one person lowers the net, while another person guides it onto the tarp. Lowering onto a tarp prevents leaves and other debris from becoming tangled in the net. It is possible for one person to operate the system, but this individual must control simultaneously both the net and pulley rope; threading the pulley line through a belt or belt-loop to control speed

of descent can facilitate this. If a net is deployed at the same location for longer than 1 night, it can be lowered onto the plastic tarp and covered, by folding the tarp over the net. This prevents damage from rain, falling leaves, fruits, and other objects.

Acknowledgments

We thank J. Van DeVenter of Picatinny Arsenal (New Jersey) and J. Guerra of Tiputini Biodiversity Station (Ecuador) for helpful suggestions in deployment of nets. Additionally, we thank T. Kingston, S. Murray, and two anonymous reviewers for suggestions on the manuscript.

Literature Cited

Frances, C. M. 1994. Vertical stratification of fruit bats (*Pteropodidae*) in lowland dipterocarp rainforest in Malaysia. Journal of Tropical Ecology, 10:523-530.

Greenlaw, J. S., and J. Swinebroad. 1967. A method for construction and erecting aerial nets in a forest. Bird-Banding, 38:114-119.

Kalko, E. K.V., and C. O. Handley, Jr. 2001. Neotropical bats in the canopy: diversity, community structure and implications for conservation. Plant Ecology, 153:319-333.

Kunz, T. H., and A. Kurta. 1988. Capture methods and holding devices. Pp. 1-29 *in* Ecological and behavioral methods for the study of bats (T. H. Kunz, ed.). Smithsonian Institution Press, Washington. D.C.

Munn, C. A. 1991. Tropical canopy netting and shooting lines over tall trees. Journal of Field Ornithology, 62:454-463.

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.

Tshapka, M. 1998. A compact and flexible method for mist netting bats in the subcanopy and canopy. Bat Research News, 39:140-141.

NEWS

From Germany

Andreas Zahn writes: Here are some of my activities for the "agency for bat conservation in Southern Bavaria" (Koordinationsstelle für Fledermausschutz in Südbayern) - of course conducted together with other researchers and helpers! (However, I am the one who organizes and coordinates the work). Supervision of a "Diplomarbeit" *about Rhinolophus hipposideros* (radio tracking, diet analyses, roosting habits). Supervision of the production of a 45 minute film about bats made by Felix Heidinger (Bavarian Television). We are preparing a ***"Rhinolophus hipposideros"*** - video - observation station" for visitors of the castle of King Ludwig at the island "Herreninsel" in lake Chiemsee.

Luisa Rodrigues, Ana Raino and Jorge Palmeirim from Portugal and I finished a study, **"Myotis in the Original and Recently Colonized Ranges(Portugal and Germany) which in Included Roosting Behaviour, Phenology, Diet and Critical Times of the Year"** It should soon be ready for publication .

From Michigan

Organization for Bat Conservation is pleased to announce that Co-founder, Rob Mies, was awarded an "Outstanding Science Educator Award" at the 13th Annual Metro Detroit Science Teachers Association 's annual banquet on May 15, 2001. Rob was the recipient of the prestigious

" Friend of Science Award," given to one person each year that has contributed greatly to science education in the Metro Detroit school area that is outside of the school system. He was among several teachers who won awards for their continued successful efforts to increase knowledge and excitement about science.

From Toronto

Brock Fenton writes that in the Department of Biology at York University the bat business continues to be good in this part of the world. We have continued to work closely with Judith Eger, Mark Engstrom and Burton Lim at the Royal Ontario Museum, and with James Fullard at the University of Toronto.

In January 2001, a group of us joined colleagues from South Africa in a study of *Otomops martiensseni* in the Durban region. The research included both radio-tracking to monitor patterns of habitat use and work on the bats' vocalizations and the results will be presented at the Victoria meeting. From Durban, **Brock Fenton** went on and joined David Jacobs from the University of Cape Town for a field course operating out of the DeHoop Nature Reserve in South Africa. In May, David Jacobs and Dedee Woodside (from Australia) then worked with Brock on a bat field course in Belize.

As we approach the end of July 2001, people are busy at different stages of graduate projects. **John Ratcliffe** recently completed and defended his M.Sc. thesis ("Taste aversion learning in 4 species of microchiropteran bats.") and is currently into a Ph.D. programme in the Department of Zoology at the University of Toronto where he is working under the joint supervision of James Fullard and Sara Shettleworth. **Sylvie Bouchard** and **Maarten Vonhof** are busy writing their Ph.D. theses and I hope that they will have defended them by the end of 2001. **Enrico Bernard** returned from doing field work in Brazil and is currently analyzing data about bats in forests, forest fragments and savannahs. **Hannah ter Hofstede** is in the processing of finishing up a field season in Belize where she has been working on the grooming behaviour of bats. Meanwhile, **Liz Reddy** is finishing up her field work in southwestern Ontario where she has been studying the foraging behaviour of *Lasiurus borealis*.

Rafael Avila Flores will join the lab in September when he enters the M.Sc. programme. At this point he hopes to study the ecology and distribution of bats in the Mexico City area.

Some 2001 publications from our lab include:

Cholewa, E., M.J. Vonhof, S. Bouchard, C.A. Peterson & M.B. Fenton. 2001. The pathway of water movement in leaves modified into tents by bats. Biological Journal of the Linnean Society, 72:179-191.

Johnston, D.S. & M.B. Fenton. 2001. The diets of pallid bats (*Antrozous pallidus*): variability at individual and population levels. Journal of Mammalogy, 82:362-373.

Fenton, M.B., S. Bouchard, M.J. Vonhof & J. Zigouris. 2001. Time-expansion and zero-crossing period meter systems present significantly different views of echolocation calls of bats. Journal of Mammalogy, accepted September 2000.

Jacobs, D.S. & M.B. Fenton. In press. The status of *Sauromys petrophilus* and *Chaerephon pumilus* (Chiroptera: Molossidae) in the Western Cape Province of South Africa.
African Zoology. accepted November 2000.

Fenton, M.B., E. Bernard, S. Bouchard, L. Hollis, D.S. Johnston, C.L. Lausen, J.M. Ratcliffe, D.K. Riskin, J.R. Taylor and J. Zigouris. 2001. The bat fauna of Lamanai, Belize: roosts and trophic roles. Journal of Tropical Ecology, 17:511-524.

Bouchard, S., J. Zigouris & M.B. Fenton. 2001. Fall mating and resorption of an embryo by a Hoary bat, *Lasiurus cinereus* (Chiroptera: Vespertilionidae). American Midland Naturalist, 145:210-212.

Vonhof, M.J., C.S. Davis, C. Strobek & M.B. Fenton. 2001. Characterization of microsatellite loci in Spix's disk-winged bats (Thyroptera tricolor). Molecular Ecology Notes 1:73-75.

Hickey, M.B.C., M.B. Fenton, K.C. MacDonald & C. Soulliere. 2001. Metal contaminants in the fur of bat (Chiroptera: Vespertilionidae) from Ontario and Quebec. Bulletin of Environmental Contamination and Toxicology, 66:699-706.

Syme, D.M., M.B. Fenton & J. Zigouris. 2001. Roosts and food supplies ameliorate the impact of a bad summer on reproduction by the bat, *Myotis lucifugus* LeConte (Chiroptera : Vespertilionidae). Écoscience, 8:18-25.

Jackson, A.C. & M.B. Fenton. 2001. Human rabies and bat bites. Lancet, 357:1714.

Fenton, M.B. 2001. Bats, revised edition. Facts On File. New York.

Riskin, D.K. 2001. *Pipistrellus bodenheimeri*. Mammalian Species, 651:1-3.

Bouchard, S. 2001. *Chaerophon ansorgei*. Mammalian Species, 660:1-3.

Bouchard, S. 2001. Sex discrimination and roostmate recognition by olfactory cues in the bats, *Mops condylurus* and *Chaerophon pumilus*. Journal of Zoology (London), 254:109-117.

Pape, T., D. Dechmann & M.J. Vonhof. In press. A new species of *Sarcofahrtiopsis* Hall (Diptera Sarcophagidae) living in roosts of Spix's disk-winged bat *Thyroptera tricolor* Chiroptera) in Costa Rica.

12th International Bat Reseach Conference

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Abstracts of Papers Presented at the Conference

These abstracts are arranged in alphabetical order by first authors. Every effort has been made to copy the abstracts as presented in the official program of the conference. Any changes are unintentional and we regret any such errors. The abstracts were compiled by Badrul Munir Md Zain and Norhayati Ahmed and kindly made available by Zubaid Akbar Muktar Ahmad who served as Chairman of the conference. Bat Research News is grateful for their diligent and generous efforts. GRH

PLENARY ADDRESSES

An overview of chiropteran studies in Peninsular Malaysia

Lim Boo Liat
Consultant, Department of Wildlife and National Parks (PERHILITAN)

Bats constitute 43% of the 217 mammalian species recorded in Peninsular Malaysia. Unlike other mammal taxa (comprising of rodents, carnivores and herbivores), which have been given greater zoonotic importance and aesthetic value, research and studies on bats have been relatively low-key until very recently. Having been actively associated with small mammals, including bat studies over the past 60 years, I believe the list of specific studies can be chronologically categorized into three periods. The 1940-60's was the period of description and taxonomy; the 1970-80's focused more on ecological research and strengthening of systematics, and, the 1990's onwards saw the strengthening of knowledge base studies. Bats are a complex group of animals. It is urged that more detail studies be conducted on sympatric species. Rapid development has seen unprecedented land-use changes in Peninsular Malaysia. It is only logical that studies should now focus on effects of habitat loss and conservation of bat populations in the wild. There is only one bat species that is protected in Peninsular Malaysia, and it is hoped that directed bat conservation research in the near future would convince the relevant authorities to protect all bat species. This is the first time that international and local bat specialists are gathering in Peninsular Malaysia

to discuss and exchange information on bats. It is hoped that through this exercise greater prominence and awareness of the critical importance of bat conservation, not only in Malaysia but also throughout the tropics can be realized and publicized.

Seeing in the dark: recent technological advances for the study of free-ranging bats

Kunz, T.H.
Department of Biology, Boston University, Boston, Massachusetts, USA e-mail: kunz@bu.edu

Among the challenges that face biologists who study the ecology, behavior, and physiology of nocturnal animals are the ability to detect and observe their activities without causing undue disturbance. Recent technological advances in infrared thermal imaging, Doppler radar imaging, and integrated passive telemetry, now make it possible to observe and record the behaviors and physiological responses of animals under a wide range of field conditions. In contrast to standard night vision devices and near infrared cameras that can be used effectively in the dark but that must use some source of light, infrared thermal cameras are designed to detect radiated heat from inanimate objects or animals during the day or night and do not require an accessory light source. For the past three years, we have used an advanced infrared thermal imaging system to 1) census Mexican free-tailed bats as they emerge nightly from caves, 2) detect and observe other bat species that roost in foliage (including tent-making bats), 3) assess feeding behavior of vampire bats, 4) observe the foraging behavior of nectarivorous bats, 5) assess social interactions of roosting bats, and 6) and quantify heat flux of flying and roosting bats. At a colony scale, we have used passive integrated transmitters (PIT tags) to assess the nightly and seasonal movements of individual bats as they pass through specially designed antennae placed over exit and entry holes and at roost sites. At a landscape scale, we have used Doppler radar imaging to assess nightly dispersal flights of Mexican free-tailed bats as they depart nightly from maternity roost sites. As with more traditional devices and instruments, these new technologies offer several challenges but great promise for investigating the ecology, behavior, and physiology of free-ranging bats.

Symposium Papers

Nutrient composition of fruits consumed by *Cynopterus brachyotis*

Abd-Hamid, N., A. Zubaid & A. Aminah
Faculty of Science and Technology, Universiti Kebangsaan Malaysia.
e-mail : P18412@mail2.ukm.my

The purpose of this study was to determine the macronutrient content of fruits consumed by the lesser dog faced fruit bat, *Cynopterus brachyotis*. The fruits analysed were *Mimosops elengi* (Sapotacea), *Ficus roxburgi* (Moracea), *Ficus fistulosa* (Moracea), *Livistona rotundifolia* (Palmae) and *Ptycosperma macarthurii* (Palmae). Proximate analysis was done to determine moisture content, crude protein, crude fiber, crude lipid and ash. The results showed a significant difference for all the fruit species. Moisture content was between 7%-2.13% (DM), crude protein 3.6%-0.21% (DM), lipid 10.6%-0.6% (DM) and ash 28.55%-9.91% (DM). The highest value for moisture content and ash was in *Ficus fistulosa*. *Ptycosperma macarthurii* showed the highest value for protein, lipid and fiber. The lowest value for moisture content, crude fiber and ash was in the *Mimosops elengi*. The lowest crude protein was found in *Livistona rotundifolia*. The results suggest that *Cynopterus brachyotis* needs to consume a variety amount of fruits to fulfill nutrient requirements.

Community ecology of bats in a central Brazilian Cerrado area

L. Aguiar[1] & J. Marinho-Filho[2],
[1]PG-Ecologia and [2]Dept. Zoologia, Universidade de Brasília, 70910-900, Brasília, DF jmarinho@unb.br

We studied a bat community at the Jardim Botanico de Brasília and Reserva do Roncador-IBGE, Federal District. A total of 10,800 netting hours resulted in 633 captured individuals belonging to three families and 22 species of medium-sized frugivorous and small insectivorous bats. Most captures (63%) were of fruit/nectar eating Phyllostomidae, the other 37% being insectivorous bats. Omnivores, piscivores and large species of carnivores were not recorded. The bat community is composed of four abundantspecies (64 percent) and many rare or less common species. Gallery forests had higher number of captures where

-as the open formations had mores species, though this difference is not statistically significant. Diversity index is very low, probably due to the dominance of *Artibeus lituratus*. Bats are more active and reproducing in the rainy season. The lower number of captures during the dry season are probably associated with other factor(s) than food, since no food scarcity was detected. Recapture data shows that bats can move as far as 7,8 km from one night to another in the study area. *Artibeus lituratus, A. cinereus* and *Carollia pespicillata* were the most recaptured species. The bats used twenty plant species and seven insect orders as food sources. Piperaceae and Moraceae were the most used plants and Coleoptera the most eaten insect group.

Sex-biased fidelity to natal roosts in the short-nosed fruit bat *Cynopterus sphinx*

J.Balasingh - Research Department of Zoology, St.John's College, Palayamkottai
627 002, Tamil Nadu, INDIA

We investigated the fidelity of *Cynopterus sphinx* to the natal roosts by sampling the tent-roosting groups and censusing the number of pups / juveniles / subadults in each day roost every week (app. 4 – 6 dayroosts were censused every week) in southern India. The results show that the total number of pups were found to be proportional to the total number of adult females in every group; whereas the juveniles and subadults were disproportionate to the number of adult females in more than 70% of groups censused. The ratio of male to female censused during the study was even at the pup stage (1:1.2) which later on skewed heavily towards the females in the juveniles and subadult stage (1:2.2 & 1:3.3 respectively). This indicates that the females may be having a long-term fidelity to natal roosts when compared to males. This long-term fidelity to natal roosts may be advantageous for the females as this favor their survival and their maturation to breeding conditions as females attain maturation far earlier than males.

Bat biodiversity studies in Myanmar (Burma)

P..J..J. Bates & K.M. Swe
Harrison Institute, Bowerwood House, St Botolph's Road, Sevenoaks, Kent, TN13 3AQ, U.K. (PB)
Zoology Department, Yangon University, Yangon, Myanmar (KMS).

Myanmar has been identified by the IUCN as a country whose bat fauna is poorly known. Therefore in November 1999, a joint project was initiated by Yangon University and the Harrison Institute, which had four primary aims: (1) to compile a national checklist of bat species, (2) to identify and conduct bat research in 'priority' habitat types/geographical areas, (3) to promote the conservation of bats in Myanmar, and (4) to conduct training of in-country scientists. Based on a review of the literature, eighty-eight bat species are currently recorded from Myanmar. The geographical scope of past surveys, the majority undertaken between 1863 and 1945, is uneven with extensive areas remaining unstudied. Preliminary researches in 1999-2001 suggest that bats and their guano are extensively utilised by local people for food, medicine and agricultural purposes. In some areas this harvesting is carefully controlled; in others it is piecemeal and unsustainable. Recent joint researches have concentrated on surveys and education programmes in areas whose habitat types are considered priorities elsewhere in S-E Asia, for example the limestone karst region of south-eastern Myanmar and in areas not previously studied, such as the western coastal states.

Roost environment in relation to energy and water balance in Australian bats

R. Baudinette
Department of Environmental Biology, Adelaide University, Adelaide SA, 5005, Australia
russell.baudinette@adelaide.edu.au

Measurements comparing bats with birds and other mammals of similar body mass show high levels of evaporative water loss. Thus, it is likely that selective pressures related to air temperature and humidity influence roost choice in bats. Notwithstanding, there has been little research on the relationships between rates of evaporative water loss and microclimatic conditions of ambient temperature and vapour pressure deficit, the principal factors that influence of water loss. Two previous studies by Webb *et al.* (J. Zool. Lond. 1995. 235, 269-278) and Baudinette *et al.* (J. Comp. Physiol. B, 2000. 170: 439-446) have addressed this problem. The former demonstrated that evaporative water loss in two species of vespertilionid bats directly depends on vapor pressure deficit and metabolic rate, a nd varies inversely with ambient temper -

- ature.The second study generated ratios of metabolic water production to evaporative water loss as a function of humidity and ambient temperature for three Australian bats, and related the derived surface plots to known microclimatic conditions of these species. These studies confirm the importance of both temperature and humidity as variables that may limit the geographic distribution of bats.

Forest fragmentation and habitat use by bats in Central Amazon, Brazil

E. Bernard & M. B. Fenton - Dept. of Biology, York University, Toronto, Canada
ebernard@yorku.ca

Forest fragmentation and habitat loss are consequences of the intense human pressure in the tropics. We investigated habitat use and the effect of forest fragmentation on bat communities at 5 forest sites, 14 natural forest fragments (3 to 360 ha), and 12 savanna sites in Alter do Chão (2°31'S, 55°00' W), in the delta of Tapajós River, Pará State, Brazil, using mist netting (6114 mistnet-hours), accoustic monitoring, and radio-tracking. We captured 3920 bats of 67 species, 37 genera and 7 families. All three techniques indicated that savannas are intensely used by bats and, for most species, were not an ecological barrier. Using Multidimensional Scaling (MS) we investigated the structure of bat communities in each habitat based both on frequencies of captures (FC) and on presence/absence of species (PA). We used MANOVA to test the separation between habitats along MS axes. Multiple Regression analysis was used to investigate the effect of the size and shape of forest areas, and the tree density in those sites on the species ordination. MANOVA indicated significant separation of savanna and forest sites based on FC and PA (Pillai-Trace = 0.002; Pillai-Trace = 0, respectively). Multiple regression indicated that the bat species composition based on PA and FC did not vary significantly in relation to the size of the forest site ($p = 0.243$; $p = 0.309$, respectively) and shape of the forest site ($p = 0.464$; $p = 0.970$, respectively). The density of trees did not affect the structure based on PA ($p = 0.777$) but was significant for FC ($p = 0.009$). Our results indicated that the local bat assemblages were not strongly affected by the forest fragmentation, probably reflecting natural fragmentation processes that have operated for 3000-5000 in our study area.

Geometric morphometrics and cladistics: testing evolutionary relationships among the African bats: *Rousettus egyptiacus, Eidolon helvum, Myonycteris torquata*, and *M. brachycephala*

W. Bogdanowicz[1], J. Juste[2], and R. D. Owen[3]
[1]Museum and Institute of Zoology, Polish Academy of Sciences, Wilcza 64, 00-679 Warszawa, Poland; E-mail wieslawb@miiz.waw.pl ; [2]Estación Biológica de Doñana, Consejo Superior de Investigaciones Científicas, Apartado 1056, 41080 Sevilla, Spain; [3]Dept of Biological Sciences, Texas Tech Univ., Lubbock, TX 74909, USA

There is no agreement concerning the use of partial warp scores derived from the shape differences among organisms as cladistic characters for phylogenetic comparisons. To test this methodology we looked at the morphology of the four African Megachiroptera (*Rousettus egyptiacus, Eidolon helvum, Myonycteris torquata*, and *M. brachycephala*) using 40 three-dimensional homologous landmarks describing the cranium. The resultant features were subjected to cladistic analysis, and the most parsimonious tree compared with an evolutionary hypothesis based on the genetic literature-based data. Another test included comparison between the mainland populations and some island populations (of presumably known history) of these bat taxa. Finally, the linearity between morphometric and phylogenetic distances was tested, and geometric morphometrics is evaluated and discussed in terms of its effectiveness at retrieving phylogenetic signal.

Foraging and roosting behavior of Allen's big-eared bat *Idionycteris phyllotis* in the Arizona Desert as determined by radio-telemetry

P.E. Brown & R.D. Berry
Physiological Science Department, UCLA, Los Angeles, CA 90095-1606; Brown-Beery Biological Consulting, 134 Wilkes Crest Road, Bishop, CA 93514, U.S.A.

Allen's big-eared bat (Idionycteris phyllotis) is one of the rarest North American bat species. Limited information exists about its roosting and foraging habitats. Tumlison (1993) identified two geographically distinct subspecies based on cranial characteristics. The larger nominate subspecies (I. P. phyllotis) occurs

south of the Grand Canyon, with specimens collected along a southeast trending line across the mountains of central and southern Arizona, principally in yellow pine and oak woodland. Recent radio-telemetry of these bats (Rabe et al., 1997) suggests that they roost in tree snags. The only known roosts for the other subspecies (I. P. hualapaiensis) are in five mines in the desert in Mojave County. Two of these colonies are imperiled by renewed mining operations. In August 2000, 0.5g Holohil transmitters were attached to 10 banded Idionycteris (9 adult females and a sub-adult male) that were captured outside the mine as they departed at dusk. The bats were tracked for the next 10 nights to determine foraging habitat and alternate roosts. Most of the bats headed north of the mine into a roadless area of rugged terrain beyond the range of ground-based tracking stations. Night flights with a Cessna 172 provided most of the tracking information and located bats as far as 40 km from the roost. Efficient airborne data collection consisted of a Laptop computer with a moving map program that logged time, position, heading and speed from a GPS receiver while a video camera recorded time, telemetry receiver frequency and signal strength. Some of the tagged bats returned to their home roost nightly, while others would return every second or third night, suggesting an alternate roost to the north. By the end of the study, eight of the bats were recaptured and weighed at the mine where they were banded. No banded bats were ever seen in the other Idionycteris mines (three of the roosts were located within a mile of the home roost), indicating high roost fidelity. This research was supported in part by BCI NABCP and USGS Speciees at Risk grants, and the efforts of many volunteers.

Variations in diet and habitat preferences of sympatric *Cynopterus brachyotis* and *C. sphinx* (Chiroptera: Pteropodidae) in lowland tropical rain forest

S. Bumrungsri and P.A. Racey
Department of Zoology, University of Aberdeen, sarabumrungsri@hotmail.com

Diet and habitat use of two sympatric species of *Cynopterus* were established in lowland dry evergreen forest, Thailand, between March 1998 and March 2000. Faeces were analysed, and the capture and recapture rate of netted bats was determined. Although both species share a set of food plants, and fruits from secondary forest contribute half of their diet, *C. brachyotis*, the smaller of the two species, ate a significantly greater proportion of fruits from secondary forest than *C. sphinx*. The size of fruit eaten is positively correlated with the size of the bats. *C. brachyotis* showed a higher capture rate in secondary forest in almost every month, and *C. sphinx* is more common in primary forest. However, *C. sphinx* increased in secondary forest in the mid-dry season when its preferred fruit is available. The recapture rate in secondary forest of *C. brachyotis* was significantly higher than that of *C. sphinx*, and the reverse situation is observed in primary forest. Male *C. sphinx* had a significantly higher recapture rate in secondary forest than female. Fruit size and habitat use are the major determinants of resources partitioning between these size-overlapping congeners.

Social and population structure in the brown long-eared bat, *Plecotus auritus*

T.M. Burland[1], A.C. Entwistle[2] & P.A. Racey[3]
[1]School of Biological Sciences, Queen Mary, University of London, London E1 4NS, UK [2]Fauna & Flora International, Great Eastern House, Tenison Road, Cambridge CB1 2DT, UK; [3]Department of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen AB24 2TZ, UK t.m.burland@qmw.ac.uk

The brown long-eared bat (*Plecotus auritus*) is a Palaearctic species with low wing loading and low aspect ratio, which feeds primarily by gleaning. Our objective was to determine social organization and population structure in a population located close to the northern border of its distribution. We studied summer colonies using both ecological (mark-release-recapture) and genetic (microsatellite DNA analysis) techniques. Adults of both sexes showed long-term association with the summer colony and juveniles of both sexes were recruited into their natal colony. Minimal interchange among colonies was observed. Despite this, levels of genetic relatedness within and differentiation among colonies was low, suggesting extensive mixing of colonies during mating. This was supported by the finding that males from other colonies fathered over 80% of the colony offspring. The occurrence of genetic isolation by distance within the study area suggests that inter-colony mating only occurs among colonies located nearby. Results, therefore, indicate a spatially structured summer population where each colony can be considered as a discrete sub-population. However, colonies rely on others nearby for mating, with gene flow through the population occurring via a stepping stone model. We propose that the social and population structure of

P. auritus is linked to both the wing morphology and foraging behaviour and the stringent roost requirements in this species at high latitudes.

Contrasted patterns of mitochondrial and nuclear structure among nursery colonies of the bat *Myotis myotis*

V. Castella[1], M. Ruedi[2], L. Excoffier[3]
[1]Laboratory of Zoology, Institute of Ecology,University of Lausanne, CH-1015 Lausanne, Switzerland
Vincent.Castella@ie-zea.unil.ch
[2]Natural History Museum of Geneva, CP 6434, CH-1211 Genève 6, Switzerland
[3]Inst. of Zoology, University of Bern, 6 Baltzerstrasse, CH-3012 Bern, Switzerland

The mating behavior of the greater mouse-eared bat (Myotis myotis) is poorly known. Field studies suggest that females are faithful to their natal site, but few information concerning movements of males are available. Thirteen nursery colonies were sampled in Central Europe in order to investigate the dispersal behavior of this species. Analysis of mitochondrial DNA control region sequences of 260 bats reveals the occurrence of three evolutionary lineages that have probably originated in distinct glacial refugia and meet in a narrow contact zone located near the Alps. In addition, the strong mitochondrial population structure (F_{ST} = 0.540) confirms the philopatry of breeding females. Contrastingly, the study of 15 microsatellite loci reveals a low level of population differentiation (F_{ST} = 0.022). This contrast of structure between both markers suggests the occurrence of male-biased dispersal. Furthermore, because females move rarely to breed in alien colonies, the current distribution of mitochondrial variation is probably highly influenced by historical processes of colonization, while microsatellite loci seem to mainly reflect contemporary levels of gene flow. Finally, because extant movements of both sexes probably occur outside the breeding period, information gathered in nurseries may poorly reflect the metapopulation dynamics of temperate colonial bats.

Energetics of Neotropical bats

A.P. Cruz-Neto[1] & K. Jones[2]
[1]Departamento de Zoologia, IB, UNESP, Rio Claro, Brazil neto@rc.unesp.br
[2]Department of Biology, University of Virginia, Charlottesville, VA USA.

Rates of energy expenditure play a crucial role in shaping the behavior, ecology and physiology of bats. The rate of energy expenditure most often measured is the rate of basal metabolism (BMR). Although body mass is the most pervasive effect determining the magnitude of BMR, a perceptible residual variation exists and several attempts has been made in order to determine the factors responsible for this variation. Chief among these factors are food habits and climate. In this review we scrutinize the effects of diet and climate on the residual variation of BMR within the New World bat family Phyllostomidae. Phyllostomidae has experienced an amazing adaptive radiation, and the diversification of diet within this family is without parallel in any other vertebrate group. Dietary effects are analyzed in terms of continuous (energy content, assimilation efficiency and digestive performance) and discrete (single and multiple food habits categories) categorizations of food habits. The effect of climate is analyzed in terms of correlations between mass-independent BMR and air and roost temperature and latitude. We also analyze the effects of behavior (amount of clustering within a roost) and roost type, as this variable can mitigate much of the direct effects of climate on mass independent BMR. Our analysis is carried out both using species as independent data points and using independent phylogenetic contrasts generated from a recently-developed phylogeny for the whole order. Comparisons are also made between the effects of diet and climate on mass-independent BMR of phyllostomid bats with those obtained for other bat families. We highlight some energetic patterns that may have evolved in tandem with the diversification in the ecology, behavior and physiology observed within phyllostomid bats.

Correlation between morphology and behavior in the evolution of fruit bats

E.R. Dumont
Department of Biology, 221 Morrill Science Center, University of Massachusetts, Amherst, MA 01003, USA
erd@neoucom.edu

The broad goal of functional morphology is to understand the interactions between the form of an organism and the ecological context in which it lives. A long history of functional studies has detailed the morphologies and behaviors that mediate how bats feed and locomote, and has demonstrated how differences among species reflect the ecological diversity of present day bat communities. Many very elegant functional studies describe how animals work, but few aim to discern the evolutionary history behind the complex interactions between morphology, behavior, and ecology. By evaluating functional and behavioral data within a phylogenetic context, we can begin to answer more fundamental questions regarding the integration of morphology and behavior in the evolution of bats. This study employs recent phylogenetic techniques to analyze patterns in the evolution of feeding among frugivorous phyllostomids (New World fruit bats). Specifically, data summarizing craniofacial form and feeding behavior are evaluated using squared-change parsimony analysis. This technique permits the reconstruction of ancestral morphotypes from continuous data and can be used to investigate the correlated evolution of specific characters. Among phyllostomids, many elements of craniofacial form appear to have evolved en suite and can be viewed as an integrated functional complex. Similarly, several aspects of feeding behavior evolved together and are associated with distinct shifts in morphology. This study emphasizes the power of combining functional data and phylogenetic techniques to illuminate the patterns of evolution that gave rise to the morphological, behavioral, and ecological diversity of bats we see today.

Social structure and the dynamics of mixed sex groups in migratory *Pteropus poliocephalus*

P. Eby[1], V. Jones[2], and J. Welbergen[3]
[1]P.O. Box 3229, Tamarama, New South Wales, Australia peby@ozemail.com.au [2]P.O. Box 131, Bellingen, New South Wales, Australia; [3]Department of Zoology, University of Cambridge, Cambridge, CB2 3EJ, UK

Complex migration patterns in *Pteropus poliocephalus* influence the composition and stability of communal day roosts. Roost populations are open, and consist of individuals that remain for several months, although others use roosts as stopover sites and remain less than five days. Roosting bats congregate into groups defined by age, gender, and reproductive status. The locations of these groups within a roost are stable and consistent within and between years. In adult, mixed sex groups, males and females are specific in their roosting positions. During the pre-mating period, the proportion of females is relatively high, and associations between males and females are poorly defined. With the onset of mating, males begin to mark territory boundaries and harems are established. The size and composition of harems vary considerably, and territorial males copulate with short- and long-term harem members. The tendency to migrate is greater in females than in territorial males. Dramatic fluctuations in the size of roost populations during the mating period are related to changes in the size and composition of harems, and mating opportunities of territorial males in day roosts. Predictions of female mate choice and mixed mating systems and strategies in subtropical *P. poliocephalus* are in keeping with trends observed in tropical bats.

Phylogeny of short-nosed fruit bats, *Cynopterus* spp. in South-east Asia

J. Eger, B. Lim & P. Ross
Centre for Biodiversity and Conservation Biology, Royal Ontario Museum, Toronto, ON M5S 2C6 Canada

With 16 enzymes we use the partial endonuclease digest mapping procedure to map genetic variation in *Cynopterus*. We used 41 individuals of three species of *Cynopterus*, *C. brachyotis*, *C. sphinx*, and *C. titichaecheilus* from 18 localities in Laos, Vietnam, Java, Kalimantan, and the Philippines. Outgroup taxa used include eight specimens of *Ptenochirus jagori*, *P. minor*, *Sphaerias blanfordi* and three species of *Megaerops*. Previous hypotheses of species boundaries have been confused because of clinal variation in body-size and sexual dimorphism within species of *Cynopterus*. In addition, genetic differentiation within and among populations has been identified in species of *Cynopterus*. We use restriction site mapping to clarify the systematics of south-east Asian *Cynopterus*.

Precedence of visual cues in the emballonurid bat *Balantiopteryx plicata*

J. Eklof - Zoology Department, Göteborg University, Sweden

Flight and echolocation in the gray sac winged bat (Balantiopteryx plicata) was investigated under different light conditions. The bats were flown at different times of the day in an empty mesh greenhouse. At night they flew smoothly and could easily avoid ceiling and the walls of the greenhouse, but during the day and at dusk and dawn they often tried to fly through the mesh and thereby crashed into it. The bats used echolocation consistently and without any dramatic change in echolocation call structure, that they could be related to the prevailing light conditions. The study indicates that emballonurid bats trust their eyes over their ears when exposed to contradictory auditory and visual cues.

Frugivory, folivory and nectarivory in the short-nosed fruit bat *Cynopterus sphinx* under natural conditions

V. Elangovan[1], G. Marimuthu[1] and T.H. Kunz[2]
[1] Department of Animal Behaviour and Physiology, School of Biological Sciences, Madurai Kamaraj, University, Madurai 625 021, India e-mail: mari@pronet.net.in
[2] Center for Ecology and Conservation Biology, Dept of Biology, Boston University, Boston, MA 02215, USA.

We have studied the foraging behaviour of *Cynopterus sphinx* on 'steady state' fruits (*Annona squamosa, Polyalthia longifolia, P. pendula, Achras sapota, Calophyllum inophyllum, Terminalia catappa* and *Coccinia indica*) and flowers (*Musa paradisiaca*), 'big-bang' fruits (*Ficus religiosa, F. benjamina* and *F. bengalensis*) and flowers (*Bassia latifolia*), leaves of *Cassia fistula, Mimusops elengi* and *Coccinia indica*. There was a temporal distribution with two peaks – the first peak occurred during pre-midnight hours when bats fed upon the steady state fruits and nectar from the two species of flowers. The second peak occurred during post-midnight hours when the bats fed upon the big-bang fruits. During later in night, the bats fed upon leaves by extracting the soluble contents and expelling the bolus under feeding or day roosts. Only solitary bats on steady state fruits and flowers, whereas groups of bats fed on big-bang fruits and flowers. Peak visits to flowers coincided with the maximum nectar production and sugar concentration. It appears that the temporal pattern of foraging behaviour reflects the availability of fruits and nectar as well as their higher water and carbohydrate contents. By extracting the soluble contents of leaves, *C. sphinx* is able to acquire protein and minerals.

Olfactory sensitivity for flower scent constituents in nectar-feeding bat (Glossophaga)

V. Elangovan & Y. Winter
Munich University, Luisenstrasse 14, 80333 München, Germany
and Research Centre for Ornithology of the Max-Planck-Society, 82319 Seewiesen, Germany

A characteristic feature of the pollination syndrome of chiropterophily are the strong odours emitted by the flowers. These odours serve as medium-range attractants to the bats. In this study, absolute olfactory sensitivity of a long-tongued bat, *Glossopha soricina* was determined for five different flower odour components, by using an olfactometer in behavioral discrimination experiments following a two-alternative-forced-choice (2AFC) protocol. Accuracy performance of odour detection was very high at higher concentration of odour molecules and declined linearly corresponding to odour concentration. Lowest olfactory thresholds were observed for dimethyl disulphide and limonene at concentrations of 1.5^{10} molecules / ml air and 9.6^{10} molecules / ml air, respectively. Highest olfactory thresholds (least sensitivity) were observed for benzaldehyde 1.6^{12} molecules / ml air and pinene 9.4^{12} molecules / ml air. The high olfactory sensitivity to dimethyl disulphide corresponds to the spontaneous and innate preference of glossophagine bats to this compound which was demonstrated in laboratory and field experiments. It is also associated with the convergently evolved abundance and volatility of dimethyl disulphide in the floral fragrances of many species of glossophagine visited flowers from diverse plant families.

Understanding bat molar function from first principles

A. R. Evans alistair.evans@sci.monash.edu.au
Department of Biological Sciences, P.O. Box 18, Monash University 3800, Australia

Teeth can be analyzed as tools for the breakdown of food, and tools can be analyzed in terms of basic functional characteristics. It can be shown that the basic dilambdodont molar shape of most microchiropterans (as well as many others such as carnassial and most tribosphenic tooth shapes) can be reconstructed from a few fundamental engineering principles and anatomical constraints. Methodologies for imaging teeth in three dimensions, such as fluorescence laser scanning confocal microscopy, now make it feasible to extend the analysis of tooth shape and function to measure these important functional characteristics. These concepts have been used in a functional analysis of the molars of the microchiropteran Chalinolobus gouldii. Basic functional characters were measured for unworn, lightly worn and heavily worn second molars. This allowed quantitative measurement of how each character changed as wear progressed. Most characters did alter with wear, generally resulting in a tooth that would require greater force and energy to fracture food, but some characters either remained the same or even improved to some extent after a limited amount of wear. Overall, this study has demonstrated the precise changes in morphology of dilambdodont teeth during wear, and lays the foundation for a sound functional interpretation of these changes.

A fresh look at afrotropical bat assemblages: Combining different sampling techniques and spatial scales

J. Fahr Jakob.Fahr@biologie.uni-ulm.de
University of Ulm, Experimental Ecology, Albert-Einstein Allee 11, 89069 Ulm, Germany

Until recently, Afrotropical bat assemblages were considered to show highly impoverished levels of species richness when compared with the Neotropical or Australasian region. This view was held both at the local and regional scale. Contrary to this proposition, I found highly diverse assemblages at two study sites in Ivory Coast, West Africa, using standardised sampling methods including harp traps, mist nets on ground and canopy level, roost search, and acoustic monitoring. Each method produced heavily biased results, both in species composition and relative abundance. Certain species were recorded with a single technique only; consequently complete inventories can only be obtained by combining several techniques. The advantages and shortcomings of each method are compared. I further conclude that previous studies of Afrotropical bat assemblages are far from completion. They suffer from insufficient and non-standardised methods, leading to the previous assumption of impoverished species richness. In this study, I also show that even within a fairly homogeneous habitat some species were exclusively found in particular situations at the micro-scale. I conclude that sampling methods, habitat specificity, and scale dependency strongly influence the results and conclusions of community studies. Further directions in comparing the results obtained at the local scale with patterns at the regional scale are discussed.

Cynopterus brachyotis and *C. horsfieldi* as seed dispersers of tropical rain forest trees

C.D. Fletcher[1], S. Appanah[1], M.N. Normah and [2]A. Zubaid
[1]Natural Forest Division, Forest Research Institute Malaysia, Kepong
[2]Faculty of Science and Technology, University Kebangsaan Malaysia, Bangi.

The diet of *Cynopterus* individuals were studied over a period of 13 months from December 1999 – December 2000 at three different forest types in the Sungai Lalang Forest Reserve, Selangor; i) Compartment 14, a hill dipterocarp Virgin Jungle Reserve, ii) Compartment 50, a logged-over hill dipterocarp forest and iii) Sungai Tekala, a fragmented lowland mixed hill forest and also a plantation and village area. A total of 19 identified plant species from 10 families consumed by both *Cynopterus brachyotis* and *C. horsfieldi* were recorded. Important bat plants identified are Moraceae, which consisted of six identified species, Melastomataceae and Palmaceae with three species each. *Ficus spp.* was observed to be an important food source and probably a keystone species in sustaining *Cynopterus* populations especially during non-fruiting seasons as it was found in their diet every month throughout the study even during months of food scarcity. Seeds have the potential to be dispersed up to 2500m in a secondary hill dipterocarp environment based on the distance between known roost and food source. Ingested seeds had a visibly higher germination percentage of 86.66% as compared to 40.0% for non-ingested seeds. However,

the germination rate of ingested seeds and fresh fruit was not significantly different (11-13 days). Male individuals, in general, were bigger in size (based on forearm length) and heavier at Sungai Tekala followed by Compartment 50 and Compartment 14 suggesting the influence of relative abundance and availability of food source. Most of the bat plants were found to have multiple uses in traditional medicine, forest regeneration, woodwork and food source for human consumption.

Subsidized effect of aquatic insects on bat foraging: Verification using the manipulative field experiment

D. Fukui, M. Murakami & S. Nakano
Tomakomai Research Forest, Takaoka, Tomakomai, Hokkaido, Japan, daif@exfor.agr.hokudai.ac.jp

Stream and forest ecosystems are strongly connected by movement of nutrient or organisms. Allochthonous input of such preys from the outside of a system can allow consumer population in a recipient habitat to increase. In the Tomakomai Experimental Forest (TOEF), five species of bats (*Myotis macrodactylus, Myotis ikonnikovi, Murina ussuriensis, Murina leucogaster, Rhinolophus ferrumequinum*) are observed at riparian forest and to forage on emerged aquatic insects. However, it has never been investigated how important the aquatic insects for bats are. In this research, it aimed to considering whether the feeding activity of bats is affected by suppressing aquatic insect emergence experimentally. A manipulative field experiment was conducted in the Horonai Stream in TOEF in Hokkaido, northern Japan. Green house type cover was installed on 1.2km stretch of the stream for suppress aquatic insect emergence. Three bat detectors were installed for experimental reach and control reach without any cover respectively, and the echolocation calls of bats were recorded. As a result, the feeding frequencies of bats were strongly depressed, which suggest great importance of aquatic insect for bat's resource.

Torpor in Australian Mega- and Microbats

F. Geiser
Zoology, School of Biological Sciences, University of New England, Armidale NSW 2351, Australia
fgeiser@metz.une.edu.au

Australian bats have been separated from other continents for prolonged periods. Although many have to cope with aridity, unpredictability of food supply, and adverse weather, little is known about the physiological adaptations that allow them to survive. The available results suggest that thermal conductance of Australian bats is similar to that of other bats. However, basal metabolism (BMR) of most is lower than that predicted from allometric equations for bats and other placental mammals in general. The difference in diet of Australian mico- and megabats does not appear to affect conductance or BMR. Torpor as an energy conserving strategy is common in Australian bats and has been observed in six of seven families. Australian vespertilionids (and probably other families) have the ability to enter deep and prolonged torpor with minimum body temperatures of 2-5 °C and metabolic rates as low as 3-4% of BMR. Small megabats (e.g. blossom-bats) appear to enter daily torpor exclusively with body temperatures of 17-23 °C and metabolic rates of about half BMR. The comparative analysis suggests that Australian bats are conservative with energy use. However, more information is needed to clearly establish how Australian bats are functionally adapted to the specific challenges of their continent.

Development of foraging behaviour in the short-nosed fruit bat *Cynopterus sphinx*: Radio-telemetry studies

N. Gopukumar
Department of Animal Behaviour & Physiology, School of Biological Sciences, Madurai Kamaraj University, India
gopukumar99@usa.net

We report observation made using radio-telemetry of the foraging behaviour of a male pup and a female pup along with their respective mothers. The body weight and fore arm length of the male and female pups are 25 gm, 59.8mm and 23 gm, 59.5mm respectively. Observations were carried out for 20 days. Both the mother bats prefer to forage at areas closer to their day roost when they carry their young ones with them. The male pup remain attached with its mother for the first five days. On the sixth day it gets separated from its mother, but both bats prefer to forage at the same foraging area till the end of the study despite the mother bat changing its day roost on the 15th day. Similarly, the mother bat with the

female pup foraged in areas closer to the day roost for the first two days. On the third day the mother bat left the female pup in a tree nearer to the day roost and moved to long distant foraging areas. Throughout the night, the female pup remain in the same place while its mother bat makes regular visits. From the 7th day the female pup makes short foraging flights from the tree where it was left by its mother. As the duration of foraging flights of the baby increases, the number of visits by mother decreased. From the 17th day onwards the young female bat commutes to long distant foraging areas. Throughout the study both the mother and its young roosted in the same tent.

Roost selection by the *Myotis* bats in a temperate rain forest

S. D. Grindal
Axys Environmental Consulting Ltd., Suite 600, 555 Fourth Ave. S.W., Calgary, Alberta, Canada, T2P 3E7 (email: sgrindal@axys.net

Forest management alters seral stage distribution which may affect roosting habitat for bats. Roost selection by bats was investigated in a managed forest dominated by second-growth (50-80 yr) and old-growth (200-350+ yr) stands during the summers of 1996-1998 on Vancouver Island, British Columbia, Canada. Roost habitat was characterized by following 54 radio-tagged Myotis bats (40 M. lucifugus, 7 M. californicus, 3 M. yumanensis, 2 M. evotis/keenii, 2 M. volans) to their roosts. Roost selection was assessed by comparing known roost characteristics to their availability, as determined by data collected in random plots in second- and old-growth stands (site level), as well as using a geographical information system applied to digital forest cover information (stand level). Results suggested that bats selected roosts at both site and stand level spatial scales. Bats preferentially selected roost trees that were of large diameter, tall, of moderate decay class, with the majority of the bark remaining, and in old-growth stands. These data suggested that the availability (i.e., number of roosts), as well as the suitability (i.e., characteristics) of roost trees, are important for bats in second- and old-growth forests. Therefore, forest management should include provision of adequate numbers and types of trees to provide appropriate roosting habitat for forest dwelling bats.

Grey-headed flying foxes *Pteropus poliocephalus* in the Melbourne Botanic Gardens

K. Grose
no address given

The grey-headed flying fox is indigenous to Australia. It ranges along the east coast of Australia south of Bundaberg in Queensland to Warrnambool in south west Victoria. It was reported in Victoria as early as 1868. The Botanic Gardens in Melbourne were established in 1846. When the grey-headed flying foxes first roosted there in 1981, they were only 50 in number but by late February 1998 the numbers rose dramatically from around 2,500 to 10,000. While they were there in modest numbers they were tolerated, but by the Year 2000 the Gardens' policy hardened. A statement issued in March of that year by Dr Philip Moors (appointed Director in 1992) said that the culling of bats would begin immediately, as the damage they were causing plants was unsustainable. The long-term goal was not to have flying-foxes in the Gardens at all. The methods to be used were to capture the young, hit roosting bats with tranquilliser darts and catch flying bats in harp traps. All captured bats were to be euthanased. There was widespread opposition to this plan but the Victorian Environment Minister, Sherryl Garbutt, backed Dr Moors. She told the press she would not hesitate to give approval for the bats to be killed if a Forum of Experts (Wed. 24 January 2001) did not come up with practical ways of removing them. They didn't. "The bats must go, one way or the another, to protect the gardens", she said. Culling began before Easter 2001. Two important letters from scientists were sent to the Federal Environment Minister in April 2001. A confidential letter from Professor Michael Archer, Director of the Australian Museum, signed by 35 other scientists also, urged Senator Robert Hill to list the grey-headed fox as a threatened species and halt the cull. Senator Hill subsequently wrote to Mrs Garbutt and the culling stopped. A Task Force is currently trying to succeed where the Forum of Experts failed, to move the bats to sanctuaries along the Yarra River.

Roosting ecology and behaviour of *Pteropus vampyrus natunae* in Sarawak

M. T. Gumal
National Parks and Wildlife Division, Sarawak Forest Department, Sarawak, Malaysia

Field data on the roosting ecology and behaviour of *Pteropus vampyrus natunae* in a peat swamp forest in Sarawak were collected between August 1998 and March 2000. The roost site was not sedentary, and *P. v. Natunae* had a maternity roost home range of about 1120 ha. Two movement phases were seen within the maternity roost home range. The first phase consisted of continuous movement of roost sites each month. The second phase had almost zero or restricted roost site movement each month. Each phase lasted between four and six months. The restricted movement phase was located in the most remote part of the peat swamp forest. This was contrasted with the sites of the continuous movement phase ranging from remote areas to those most easily accessible. The latter phase also coincided with late pregnancy and the birth season each year. This pattern of continuous and restricted movement phases was repeated in the second year of observations. Possible factors causing the movement phases are discussed. The Sarawak Government's strategy of protecting the whole maternity roost home range as well as part of the foraging home range is highlighted.

Echolocation, wing design and flight performance in the long-fingered bat *Myotis capaccinii* (Bonaparte, 1837)

D. Hamidovic[1], M. Jokic[2] & S. Parsons[3]
[1]Senova 10, HR-10000 Zagreb[2]Croatian Waters, Central Water Management Laboratory, Av. Veceslava Holjevca 15, Zagreb, [2] Biological Sciences, Univ.of Bristol, UK, daniela.hamidovic@zg.hinet.hr

The Long-fingered bat (*Myotis capaccinii*) is one of the seven most endangered bat species in Europe and little is known about its biology. Since 1999 a three-year multidisciplinary study (funded by The Whitley Awards Foundation) has investigated aspects of the ecology of this species at its largest nursery colony in Europe (Miljacka II Cave, Croatia). Fundamental to any study of the ecology of a microchiropteran bat, is an understanding of its acoustic ecology and flight morphology. Between May and September 2000, echolocation calls were recorded while bats were exiting the cave, flying through dense foliage, foraging over a river, and on release from the hand after capture. Four spectral and three temporal features of calls were analysed. Measures of theoretic flight performance were also calculated from wing tracings of 160 individuals inhabiting the cave. In this paper we 1) describe and compare the echolocation calls emitted in different habitat types and ecological situations, and compare these results with those published for species with similar ecologies, 2) describe the theoretical flight performance of this species in relation to what is known about its ecology, and 3) discuss our results in terms their relevance to the conservation of *M. capaccinii*.

Vertical stratification of Malaysian fruit bats

R. Hodgkison[1], S. Balding, A. Zubaid[2] and T.H. Kunz[3]
[1]University of Aberdeen, Department of Zoology, Tillydrone Av., Aberdeen, AB9 2TN, U.K[2]Universiti Kebangsaan Malaysia, [3]Boston University rhodgkison@hotmail.com

This project was designed to investigate the influence of body mass, wing morphology, and vegetation clutter on the vertical stratification of fruit bats in a Malaysian dipterocarp forest. The vertical stratification of fruit bats was assessed using mist nets placed in the forest sub-canopy from ground level to up to 28 m. Wing tracings and body masses were recorded for each of the species captured. The vertical distribution of vegetation clutter was assessed throughout the forest profile, by measuring the percentage vegetation cover along a 6 x 60 m forest transect. Four species (*Chironax melanocephalus, Cynopterus brachyotis, Cynopterus horsfieldi,* and *Megaerops ecaudatus*), that were most frequently captured in the middlestorey (10 to 20 m), had capture rates that were negatively correlated with vegetation clutter. One species (*Balionycteris maculata*), that was most frequently captured within the understorey (<10 m), had a capture rate that was positively correlated with vegetation clutter. The latter species also had the lowest aspect ratio and lowest wing loading of all the sub-canopy fruit bats. Since a low aspect ratio and low wing loading are important for manoeuvrable flight, this study demonstrates that small differences in body mass and wing morphology could be of ecological importance in the vertical stratification of structurally complex forest habitats.

Directionality of bat's sound emission during search and pursuit flight measured in the field

M. Holderied & O. von Helversen
Inst. Zool. II, Univ. Erlangen, Germany Staudtstr. 5. 91058 Erlangen mholderi@biologie.uni-erlangen.de

The width of a bat's sound beam has major impact on what it perceives of its surroundings: wide beams cover a wide 'filed of vision" with limited detection range; narrow beams bear increased detection range but cover a smaller segment of the environment. In this study we measured the directionality of sound emission for the vespertilionid Pipistrellus pygmaeus/mediterraneus during search flight and pursuit. Bats were recorded while hunting over a river bed using the method of acoustical flight path tracking (JASA 1996, 100(4): 2709). Pursuit flight was elicited by swinging a small spinning paper propeller circularly on a fishing line. Occasionally a bat took the propeller as a fluttering insect and tried to catch it. Sound pressures (dB peSPL 10 cm distance) were calculated by correcting for distance related attenuation and directionality of the two recording microphones. Source levels in flight direction varied from 107-127dB. In search flight the mean source levels in front and rear direction differed by approximately 20 dB. While pursuing the propeller bats used source levels of up to 121 dB and seemed to focus their echolocation with a somewhat lower front-rear difference. These are the first such measurements ever made in the field, and they make likely that this bat species adapts the width of its echolocation beam to current needs. Possibly the bats achieved this by opening their mouth more or less widely.

Hibernation energetics in relation to latitudinal gradients in bats

M.M. Humpheries[1,2], J.R. Speakman[3], & D.W. Thomas[2]
[1]Department of Biology, McGill University, Montréal, Québec, H3A 1B1, Canada;
[2]Département de Biologie, Université de Sherbrooke, Sherbrooke, Québec, J1K 2R1, Canada
[3]Department of Zoology, University of Aberdeen, Aberdeen, AB24 3TZ, UK

Hibernation permits endotherms to survive prolonged periods of cold temperatures and reduced food supply, through a combination of energy storage, microhabitat selection, and metabolic dormancy. For many mammals simple thermal relationships define both the length of the hibernation period as well energy expenditure during hibernation, facilitating unusually precise prediction of the energetic consequences of microhabitat and latitudinal temperature gradients. Here we develop a quantitative model predicting the effect of ambient temperature on the hibernation energetics of little brown bats (*Myotis lucifugus*), and compare model predictions to the observed distribution of bats across thermal gradients within caves and across the North American continent. Our model predicts pronounced effects of ambient temperature on total winter energy requirements, and a relatively narrow combination of hibernacula temperatures and winter lengths permitting successful hibernation. Empirical distribution patterns of *M. lucifugus* are consistent with the thermal dependence of hibernation energetics severely constraining the cave and continental distribution of this species.

Roosting organisation and breeding behaviour of *Pipistrellus mimus*

S. S. Isaac Res.Dept of Zool. St.John's College, Palayamkottai - 627002, India.

Roosting organization and breeding behavior of the Indian pygmy bat *Pipistrellus mimus* were studied in a colony of 30 bats roosting in crevices of a building at Madurai Kamaraj University, Madurai, India. Periodical tagging and visual observations were made through out the year. The results reveal that P. mimus exhibits female resource polygyny where females are highly social and share their roosting sites. Both parous and non-parous adult females roost in small groups with their pups, where as adult males always roost inside the crevices in singles through out the year. 31.1% of grown-up female pups roost along with the maternity group after weaning, while the rest are dispersed. On the other hand, all grown-up males are dispersed and roosted singly near the maternity roosts or elsewhere. Females gave birth to twins and exhibited postpartum oestrus. Potential females can under go parturition three times a year and thus produce six pups per year. Females born in a breeding season are able to give birth to infants in the next proceeding season. The mean inter-parturition interval for individual females is 98.5 ± 14 days. Grown-up females undergo first parturition at the mean age of 112 ± 10.21 days.

Roost selection in tube-nosed fruit bats (Nyctimeninae)

N. Irwin nirwin@zoology.uq.edu.au
Zoology and Entomology, University of Queensland, St. Lucia, Brisbane, Qld 4072 Australia.
Veterinary Pathology and Anatomy, University of Queensland, St. Lucia, Brisbane, Qld 4072, Australia

The IUCN/SSC Action plan for Old World Fruit bats highlighted the lack of information on the roosting requirements for Tube-nosed Fruit Bats (Nyctimeninae). Radiotelemetry was used to examine the roost-site preferences of three species (*Nyctimene albiventer, N. cyclotis* and *Parancytimene raptor*) in two lowland sites (north (seasonal rainfall) and south coast (aseasonal rainfall)) of Papua New Guinea. 25 bats (over a 10 month period) were radio-tracked to their day roosts. Bats were located 233 times in a total of 135 roost trees. Contact with individual bats was maintained for up to 35 days and 23 roosting occasions. Distance to nearest other roost, tree height, dbh, and epiphyte load were recorded. All roost trees were identified to species level (26 families, 42 genera, 58 species). I conducted a vegetation plot in the northern site and used data from a hyer-diverse vegetation plot in the southern site. Bats roosted in clumps of dense foliage and epiphytes in the sub-canopy. They switched roosts frequently but showed fidelity to an area. The comparison between the roost trees and the vegetation plots will reveal whether the bats were selecting their roosts or if they were merely a random selection of what was available.

Nonshivering thermogenesis in *Myotis daubentonii* at different ambient temperatures

M. Jefimow, M. Wojciehowski & E. Tegowska
N. Copernicus University, Institute of General and Molecular Biology, Department of Animal Physiology, PL 87-100
Toru_, Poland , ul. Gagarina 9 jefimow@biol.uni.torun.pl

Nonshivering thermogenesis (NST) is a primary source of heat for small mammals when exposed to cold and/or during arousal from hibernation and torpor. We tested whether the effect of stimulation of NST in *M. daubentonii* is affected by an ambient temperature. Experiments were performed during the winter season on 6 male bats collected from the hibernacula. Animals were injected with saline (for control) and noradrenaline (0.6 mg/kg) to induce NST, both in laboratory temperature and in the cold (10°C). Changes in the interscapular brown adipose tissue temperature (T_{BAT}) were measured continuously, two hours prior to and two hours after the injection. In laboratory temperature, shortly after the beginning of the experiment, all bats entered torpor, probably due to low cost of arousal. In the cold, three out of six individuals were torpid before the injection, while three others remained euthermic. Different reactions observed in the cold could reflect energy reserves of the bats since animals that were torpid before the injection had lower body mass than euthermic ones. The effects of noradrenaline and saline injections in torpid bats had similar pattern and led to immediate arousal. In saline-injected animals, the increase in T_{BAT} could be an effect of NST activation by endogenous NA released in consequence of the stress of injections. The dose of noradrenaline, that we used, did not induce hyperthermia since after the injections bats returned only to the euthermic level. Hyperthermic action of NA was observed only in animals that were euthermic throughout the experiment. We suggest that an effect of noradrenaline depends primary on body temperature and then on ambient temperature. This work was supported by grant KBN no. 6P04C 020 19

The population status of the Mariana fruit bat (*Pteropus mariannus*) in the Northern Islands of the Mariana Archipelago

N. C. Johnson
PMB #618 PPP, Box 10000, Saipan, MP 96950 (Commonwealth of the Northern Mariana Islands)
nathancjohnson@hotmail.com

Several the remote northern islands in the Mariana archipelago were surveyed for the endemic Mariana fruit bat (*Pteropus mariannus*) between June-August 2000. Many of these islands are subjected to severe feral ungulate damage and fruit bat poaching pressure. Surveys were conducted using direct colony, evening station, and evening departure counts. Fruit bat populations have declined dramatically since 1983 on the islands of Pagan and Anatahan. Evidence of fruit bat poaching was prevalent on Pagan and Anatahan. Increased feral ungulate forest degeneration was also documented. It is believed that the cumulative effects of poaching and feral ungulate destruction are largely responsible for the decline of the Mariana fruit bat population.

Female greater wax moths reduce sexual display behaviour in relation to potential predation risk from echolocating bats

G. Jones, A. Barabas, W. Elliott & S. Parsons
School of Biological Sciences, University of Bristol, UK Gareth.Jones@bris.a.uk

Female greater wax moths *Galleria mellonella* display by wing fanning in response to ultrasound produced by males. Male *G. mellonella* signals show some similarities with calls produced by echolocating bats that emit frequency modulated (FM) signals. Female *G. mellonella* therefore need to distinguish between the attractive signals of male conspecifics, which may lead to mating opportunities, and similar sounds made by predatory bats. We performed playback experiments and predicted:

1) females would display in response to playbacks of male calls
2) females would not display in response to playbacks of the calls of echolocating bats (we used the calls of Daubenton's bat *Myotis daubentonii* as representative of a typical FM bat).
3) When presented with male calls and bat calls simultaneously, females would display more when perceived predation risk was lower.

We manipulated predation risk in two ways. First, we varied the intensity of bat calls to represent a nearby (high risk) or distant (low risk) bat. Second, we broadcast calls of bats searching for (low risk) and attacking prey (high risk). All predictions were supported, suggesting that female *G. mellonella* are able to distinguish conspecific male mating calls from bat calls, and that they modify display rate in relation to predation risk.

How to measure bat diversity and how to test for the quality of data in community studies

E. K. V. Kalko [1,2] and E. M. Sampaio[3]
[1]Experimental Ecology, University of Ulm, Albert-Einstein Allee 11, 89069 Ulm, Germany [2] Smithsonian Tropical Research Institute, P. O. Box 2072, Balboa, Panama; [3]Animal Physiology, University of Tuebingen, Auf der Morgenstelle 28, 72076 Tuebingen, Germany Elisabeth.Kalko@biologie.uni-ulm.de

Assessing species composition, community structure and processes underlying the high diversity of bats (Chiroptera), particularly in the tropics, is a challenging endeavour, particularly due to the lack of well-established sampling and analysis protocols. With increasing anthropogenic pressure on the few remaining natural landscapes, preservation of biodiversity has become one of the most crucial challenges of the millennium. We summarise the current status of community studies in tropical bats with special emphasis on sampling and analytical procedures. We underline the need for standardised methodology by demonstrating how placement and number of mist nets influences capture results. We compare and interpret the results from different sampling methods (ground versus canopy mist-netting, harp traps, acoustic monitoring) and analysis (diversity indices on local and regional scales, species accumulation curves, extrapolation of local species richness) and suggest under which circumstances which method should be used. We further demonstrate that behavioral studies on selected bat species (i.e., home range use and roost selection determined by radiotracking, food choice) are indispensable for understanding the significance of the patterns seen in the community studies. We conclude by proposing uniform sampling protocols to allow for direct comparisons across sites.

Isolation of unknown viruses from fruit bats in Malaysia

A. Karuppaiya, A.R. Sohayati, S.H. Sharifah, Y. Kono, C.M. Zaini, D. Azizah, J. Maria & A.R. Mohd-Ali
Veterinary Research Institute, 59, Jln. Sultan Azlan Shah, 31400, Ipoh, Perak, Malaysia
sohayati@iphvri.po.my

A sequel to the detection of neutralizing antibodies to Nipah virus in bats, trappings of bats were regularly done in attempts to isolate Nipah virus. Tissue samples from 99 fruit bats trapped from around Kinta district, in the state of Perak, Malaysia were subjected to virus isolation. Seventeen viruses exhibited syncytial type of cytopathic effect in cell cultures were isolated from various organs of the bats. All isolates that showed syncytial type of cpe was tested negative by PCR for Nipah virus. The DNA synthesis inhibitor did not inhibit replication of the two selected viruses. The infectivity of the two viruses was not lost after treatment with chloroform and diethyl ether. Characterization work to determine the nucleic acid and envelope of the other viruses were very difficult, as it was a slow growing virus. Two of the viruses were non-enveloped RNA viruses and PCR results indicate that those viruses were not Nipah virus.

Phylogenetic relationships among East Asian vespertilionid bats based on various molecular markers

K. Kawai[1], M. Nikaido[1], M. Harada[2], M. Hasegawa & N. Okada[1]
[1]Graduate School of Biocience and Biotechnology, Tokyo Institute Technology, MidoriKu, NagatsutaCho, Yokohama, Kanagawa 2268501, Japan. [2]Laboratory Animal Center, Osaka City University Medical School, Abeno, Osaka 5458585, JapanKuniko Kawai kkawai@bio.titech.ac.jp

The family Vespertilionidae includes the largest number of species and the members of this family are distributed worldwide. Twenty-five vespertilionid species are distributed in Japan. These species belong to nine genera *Myotis*, *Pipstrellus*, *Eptesicus*, *Nyctalus*, *Vespertilio*, *Barbastella*, *Plecotus*, *Miniopterus* and *Murina*. The phylogenetic relationship among these genera is still unclear. Here, we inferred the phylogenetic relationships among East Asian vespertilionid bats based on various molecular markers. To infer the phylogenetic relationship, we sequenced mitochomdrial sequences (ND1 region; 957bp) and nuclear gene sequences (vWF gene; 657bp). In addition, we used SINE insertion analysis method. The results of these molecular markers suggest that *Nyctalus* was closely related with *Pipstrellus*, and that *Miniopterus* was diverged at the basal position of Vespertilionidae. The SINE insertion analysis and vWF gene sequences indicate that *Murina* and *Myotis* were sister relationships. This sister relationships were not supported by morphologic data and karyotypic data, but the combination of molecular, morphology and karyotypic data will reveal the relationship among Vespertilionidae species in detail.

Impact of artificial bat roosts on the regeneration of Neotropical rainforests

Detlev Kelm & Otto von Helversen
Institute of Zoology 2, University of Erlangen, Germany detkelm@gmx.de

The general loss of habitat, and thus tree-roosts, by logging of tropical forests has resulted in a decrease in bat-species diversity. Because bats are one of the most important pollinators and seed-dispersers in tropical rainforest habitats, the loss of bat species diversity will probably effect forest regeneration. We are currently testing the effectiveness of artificial roosts on bat species diversity in disrupted habitats and primary forests in the Costa Rican Atlantic lowlands. In addition, the impact of artificial roosts on seed input is being measured with seed traps. Forty artificial roosts have been installed in primary forest and in a variety of disrupted habitats. Colonization of these roosts occurs within three weeks after installation. More than 60% of the roosts have been occupied continuously over 18 months in both forest and disrupted habitats. Eight species of bats have been confirmed to spend the daytime in the artificial roosts: three species of Carolliinae, three species of Glossophaginae, and two species of Phyllostominae. The installation of artificial bat roosts could support local bat populations and enhance natural regeneration of disturbed habitats through increased seed input thus restoring biodiversity.

Relatedness, life history and social behavior in the long-lived Bechstein's bat *Myotis bechsteinii*

G. Kerth kerth@zool.unizh.ch
Zoologisches Institut, Universität Zürich, Winterthurerstrrasse 190, CH-8057 Zürich, Switzerland

Bechstein's bats communally rear their pups in maternity colonies that consist of 15-50 adult females. Males are solitary. Individual females do not give birth every year, and on average wean about 0.6 young per year. Thus, colonies comprise reproductive as well as non-reproductive individuals. Low annual individual reproductive success is balanced by a high survival rate of about 80% per year for adult females, which can reach an age of 20 years. Genetic population analysis, using mitochondrial and nuclear markers revealed extreme female natal philopatry. Maternity colonies of the Bechstein's bat are closed societies, comprising closely related as well as genetically rather unrelated females that live together for many years. Maternity colonies are characterized by a fission-fusion type society. Colonies regularly split into several subgroups that occupy different roosts. Individuals switch roosts frequently and composition of subgroups is characterized by strong mixing of colony members. Roost selection is influenced by roost temperature and preferences vary with the season and a female's reproductive status. The social organization of maternity colonies suggests that the long-lived female Bechstein's bats need familiar and perhaps related cooperative partners for raising their young. Mothers and their offspring probably profit from sociality

because of warming by non-reproductive females, babysitting, and information transfer about roost sites, whereas allo-nursing and information transfer about foraging areas are of little or no importance.

Roosting ecology of *Plecotus austriacus* and *Barbastella leucomelas* in Central Asia

T.K. Khabilov tolib@khgu.khj.td.silk.org
Khujand State University, 735700 Khujand, Tajikistan,

Little is known about distribution, biology and roosting ecology of *Plecotus austriacus* and *Barbastella leucomelas* in Central Asia. Both are known until 80th only from a few localities in Turkmenia, Kirgizia and Uzbekistan . In Tajikistan which researched during last 25 years in chiropterological mention better *P. austriacus* and *B. leucomelas* are common in foothills and mountains of Kurama, Turkestan, and Zerafshan. Our investigation conclude that roosting ecology both species are differ from same of all other bat species in Central Asia. *P. austriacus* breeding colony (20-85 females) placed only in abandoned mines that occupied with this species from April to August include. Development of a single embryo take place in the right uterine horn. The length of gestation approximately 1,5-2,5 month, parturition occurs from early June to July. Copulation are in last July until September. In winter less of 10 % from summer population (only males) hibernate in mines. *B. leucomelas* have the same annual pattern, differences are: 1) breeding clusters are 3-10 females in each mine; 2) after parturition cluster are destroyed; 3) in winter both sex hibernate in abandoned mines.

Micro-habitat preference inside mines of several species of bats in Tajikistan

T.K. Khabilov tolib@khgu.khj.td.silk.org
Khujand State University, 735700 Khujand, Tajikistan

Results of our field study during 1976-2000 habitat and micro-habitat preference 14 species of bats in North Tajikistan. Four groups of bats are divided: 1) cave-dwelling species (*Rhinolophus hipposideros, R. ferrumequimum, R.bocharicus, Myotis blythi,* and *M. emarginatus*); 2) rock-dwelling species (*Eptesicus bottae, Hypsugo savii, Otonycteris hemprichi*, and *Tadarida teniotis*); 3) tree-dwelling species *(Nyctalus noctula*), and 4) synantropic species *(Pipistrellus pipistrellus* and *Epesicus serotimus*). During hibernation inside abandoned mines we observed only two micro-habitat preference groups of bats:1) open-hibernate species (all *Rhinolophidae*) and 2) crevice-hibernate species (*Myotis mystacimus, Vespertilio murimus, E. serotinus, H. savii,* and *P. pipistrellus*). *M. emarginatus, Plecotus 632*austriacus, and Barbastella leucomelas* are intermediate species because can hibernate as open and in crevices.

Analysis of community structure based on capture and acoustic information

T. Kingston, A. Zubaid, G. Jones & T.H. Kunz
Department of Biology, Boston University, MA 02215, USA tigga@bio.bu.edu

Spatial distribution patterns are central to understanding richness and rarity in tropical forests but are poorly known for most bat species. We demonstrate the use of individualized, spatially-explicit capture/recapture records to compare the local distribution patterns of species of an insectivorous bat community from the rainforest interior of Peninsular Malaysia. An intensive, standardized, sampling protocol based on harp traps enabled us map capture locations along 14 km of trails in a 1.2 km^2 area and develop a GIS database (Arc/INFO and ArcView) of 34 species and > 2400 records. We characterized local patterns of species distribution using global (Moran's I) and local (Gi*d) tests of spatial autocorrelation, and compared recapture distances across species. Species differed in their spatial distribution patterns and in the mean distances between recaptures, characteristics that indicate differential habitat use and can influence both species interactions and relative extinction risk. Species with small populations and clumped distributions may be particularly susceptible to habitat disturbance. Abundant species that show no spatial structure and have small recapture distances may be less at risk than common species in which large local hotspots and large recaptures distances reflect specific requirements that confer vulnerability.

Bats of New Caledonia: Bioacoustics as a complementary inventory tool for bat conservation planning in a Melanesian biodiversity hotspot

R.A.L. Kirsch, Y. Tupiner & A. Rainho kirsch@mnhn.fr
Mus. Nat. d'Histoire Naturelle, Laboratoire de Conservation des Espèces Animales, Ménagerie, 75005 Paris, France

The Melanesian archipelago of New Caledonia is a biological jewel identified as a rainforest biodiversity hotspot of major conservation importance in the Pacific ocean region and worldwide. The nine bat species occurring on the territory (genus *Pteropus, Notopteris, Chalinolobus, Miniopterus* and *Nyctophylus*) are poorly known and surveys are currently being conducted to improve our knowledge on the species systematics, distribution, and conservation status in the frame of the « *Atlas and Action Plan for the Conservation of Bats and their habitats in the French Overseas Territories* ». We present partial results of a preliminar two months survey in the archipelago, emphasizing the rediscovery of New Caledonia wattled bat *Chalinolobus neocaledonicus* with the help of bioacoustic inventory. Analysis of time-expanded echolocation call spectrograms associated with in-site observation of foraging behavior allowed to produce a description of *C. neocaledonicus* sonar signature, and to differentiate it from *Miniopterus* species. First patterns of occurrence of the species are mapped in a Geographic Information System that will be used as an integrated tool for planning future research and building recommendations for the conservation and sustainable management of fruit bats and vespertilionids in the archipelago.

Roosting ecology and the environmental potential for polygyny in a harem-forming fruit bat *Cynopterus sphinx*

T.H. Kunz[2], J.F. Storz[1], H.R. Bhat[3], J. Balasingh[4] & P.T. Nathan[4]
[1]Dept. Biology, Duke University, Box 90338, Durham, NC, 27708, USA [2]Dept Biology, Boston University, Boston, MA 02215, USA; [3]Nat Inst Virology, Pune 411 001, India, [4]Dept Zoology, St. John's College, Palayamkottai India
storz@duke.edu

Variance in reproductive success is a primary determinant of genetically effective population size (N_e), and thus has important implications for the role of genetic drift in the evolutionary dynamics of animal taxa characterized by polygynous mating systems. Here I report the results of a study designed to test the hypothesis that polygynous mating results in significantly reduced N_e in an age-structured population. This hypothesis was tested in a natural population of a harem-forming fruit bat, Cynopterus sphinx (Chiroptera: Pteropodidae), in western India. The influence of the mating system on the ratio of variance N_e to adult census number (N) was assessed using a mathematical model designed for age-structured populations that incorporated demographic and genetic data. Male mating success was assessed by means of direct and indirect paternity analysis using 10-locus microsatellite genotypes of adults and progeny from two consecutive breeding periods (n = 431 individually marked bats). Combined results from both analyses were used to infer the effective number of male parents in each breeding period. The relative proportion of successfully reproducing males and the size distribution of paternal sibships comprising each offspring cohort revealed an extremely high within-season variance in male mating success (up to 9.2-fold higher than Poisson expectation). The resultant estimate of N_e/N for the C. sphinx study population was 0.42. As a result of polygynous mating, the predicted rate of drift ($1/2N_e$ per generation) was 17.6% higher than expected from a Poisson distribution of male mating success. However, the estimated N_e/N was well within the 0.25-0.75 range expected for age-structured populations under normal demographic conditions. The life-history schedule of C. sphinx is characterized by a disproportionately short sexual maturation period scaled to adult lifespan. Consequently, the influence of polygynous mating on N_e/N is mitigated by the extensive overlap of generations. In C. sphinx, turnover of breeding males between seasons ensures a broader sampling of the adult male gamete pool than expected from the variance in mating success within a single breeding period.

Roosting ecology of the Endangered Indiana Bat (*Myotis sodalis*) in the eastern United States

A. Kurta bio_kurta@online.emich.edu
Department of Biology, Eastern Michigan University, Ypsilanti, MI 48197, USA

We studied roosting ecology of a group of Indiana bats (*Myotis sodalis*) in southern Michigan over 4 years using radiotracking techniques. Thirty-seven of 38 roost trees used by adult females and young were

located in wetlands, and all 37 were elms (*Ulmus* spp.), ashes (*Fraxinus* spp.) or maples (*Acer* spp.). Roost trees had larger diameters than randomly selected trees, and roosting areas typically received >10 h of sunlight each day. Bats changed trees every 2-3 days, and new roost trees likely are discovered as bats forage or commute between foraging areas. Pregnant females switched more often than lactating adults, and bats roosting in crevices changed less often than when the same bats roosted under bark. Maximum distance moved between trees overnight was 5.8 km, but maximum distance between any two roosts discovered over 4 years was 9.2 km. The focal point of roosting activity moved 2 km across the landscape over 3 years. Frequent roost-switching, large home ranges, and changes in activity center between years create challenges for detection, monitoring, and management of this endangered species.

The nutritional ecology of *Pteropus rufus* in S.E. Madagascar

E. Long, P. A. Racey and G. R. Iason e.long@abdn.ac.uk
University of Aberdeen, Department of Zoology, Tillydrone Avenue, Aberdeen, AB24 2TZ, Scotland G. R. Iason – Macaulay Land Use Research Institute, Craigiebuckler, Aberdeen, AB15 8QH, Scotland.

The aim of this study was to document the plant species comprising the diet of *Pteropus rufus*, together with their chemical composition, and to relate these to feeding behaviour. Food samples and corresponding 'ejecta' pellets were collected and air-dried in the field. Samples were oven dried and ground for chemical analysis upon return to the UK. The chemical composition of plant material and feeding remains were compared to determine extraction efficiency of the bats when feeding. The nutritional consequences of the bats' feeding behaviour (ejecta pellet production) is examined. The diet of *P. rufus* at this site is narrow, containing only 13 plant species, and is dominated by the pollen of *Agave sisalana* which occurred in 84% of faecal samples analysed. Many faecal samples consisted only of *Agave* pollen. *P. rufus* was found to have high mean extraction efficiencies for nitrogen (73%), total water soluble carbohydrates (86%), condensed tannins (46%) and phenolics (24%). It is unclear how much of the tannin extracted from plant material is ingested by *P. rufus*. There is a negative correlation between plant tannin content and extraction of nitrogen by the bats, suggesting that tannins are complexing with proteins within plant material (ejecta pellets) and thus are not ingested by the bats.

Behavioural measurements of spectral sensitivity in a flower visiting bat *Glossophaga soricina*

J. Lopez[1], Y. Winter[1,2] & O. von Helversen[1]
[1] Erlangen University, Germany and [2]University of Munich, Germany.

The role of the optical sense in the lives of bats is sparsely known and not well understood. The ability for visual pattern discrimination, however, is well developed in glossophagine bats. In addition, the floral coloration retained by some bat-pollinated plants raises the question if flower visiting bats command over color vision. Here, we studied the spectral sensitivity of the flower visiting bat *Glossophaga soricina* in behavioral experiments. The results indicated a spectral sensitivity function with the main peak at about 514 nm (nanometer), and a second peak in the near UV at about 390 nm. We subsequently tested for the bats' ability to discriminate between these wavelengths which is a prerequisite for color vision. A bat was trained to respond to a violet light (390 nm) for food reward. In a behavioral test the bats were unable to discriminate this positive stimulus from a green (520 nm) or yellow (590 nm) light. Further experiments with chromatic backgrounds failed to produce any evidence for the action of two independent photo pigments. The results suggests that *Glossophaga soricina* has a visual mechanism which is based on a single receptor in the visible spectrum, although the cause of the high sensitivity in the near-ultraviolet range is still unclear. The functional significance of UV-sensitivity may be related to the frequent occurrence of UV-remission from corollas of bat-pollinated plants.

Roosting ecology, social structure and mating system of the fruit bat *Cynopterus brachyotis* (Chiroptera: Pteropodidae) in West Malaysia

U. Lensing ursala.lensing@gmx.de

Zoological Insitute, AG Winter, Ludwig-Maximilians-University Munich, 80333 Munich, Germany

The lesser short-nosed fruit bat *Cynopterus brachyotis* is a small, frugivorous bat species in South-East Asia and is believed to have a harem-polygynous mating system. This study investigates the roosting ecology, social organisation and reproductive strategies of males and females in *C. brachyotis* to identify key parameters for the mating system of the species. Methods used are (1) capture-mark-recapture studies to analyse the population structure, (2) censuses and observations at day roosts to examine the roosting behaviour and group composition as well as interactions within and between groups, (3) radio telemetry for detailed observations of selected individuals and (4) DNA analyses to determine male reproductive success and the kinship of population members. First results show a highly dynamic roosting behaviour with groups regularly changing their compositions and locations. This may indicate a more complex and dynamic structure of the single male/multi females groups in *C. brachyotis* than previously thought. Of special interest is the behaviour of single, unpaired males in the population. These males may have a great influence on adjacent groups and on male and female mating strategies.

Flexibility and specificity in roosting ecology of the lesser long-eared bat *Nyctophilus geoffroyi*: a common and widespread Australian species

L. F. Lumsden[1] and A. F. Bennett[2] lindy.lumsden@nre.vic.gov.au

[1]Arthur Rylah Institute, Dept. Natural Resources and Environment, Heidelberg, Victoria 3084, Australia [2]School of Ecology and Environment, Deakin University, Clayton, Victoria 3168, Australia

An increasing body of literature suggests that tree-hole roosting bats are selective in their use of roosts. By comparing aspects of roosting ecology of bats, where there is a high level of specificity, with those where roost use appears more flexible, we may gain a better understanding of key factors that influence roost selection. We review seven studies on roosting ecology of the Lesser Long-eared Bat, *Nyctophilus geoffroyi*, a common and widespread vespertilionid in Australia, to identify roosting characteristics that appear flexible or specific. *N. geoffroyi* is relatively flexible in its roosting distribution, occurring in urban, rural and a wide range of natural habitats. While predominantly roosting in tree cavities, individuals of this species (especially males) also use other natural and artificial roost sites. Tree roosts include a range of forms and orientations, but roosts under bark and in crevices that frequently have a northerly aspect are common. A strong preference is shown by both sexes to roost in dead trees, where entrance dimensions are consistently narrow (2.5 cm). Males predominantly roost alone, while females form larger colonies, especially while breeding. Significant selection for larger trees is shown for roosts used by females during the maternity period. In all studies, individuals shifted roosts every 1-2 days, and occupied a relatively restricted roost area. We propose that thermal requirements of roosts, risks of predation, and social structure within populations are key factors that influence the roosting ecology of this species.

The conservation status of Malagasy fruit bats

J.L. MacKinnon[1,3], P.A. Racey[1], C.E. Hawkins[1], J. Ranivo[2] & V. Razakarivony[2]

[1]Department of Zoology, University of Aberdeen, Tillydrone Avenue, Aberdeen, United Kingdom, [2] Departement de Biologie Animale, Université d'Antananarivo, Antananarivo 101, Madagascar, [3]*current address:* Wildlife Conservation Society, B.P.8500, Antanannarivo 101, Madagascar

A national survey of the three endemic species of fruit bats in Madagascar was conducted between April 1999 and December 2000. Roost sites were located, the numbers of individuals were counted and threats to the roost were established by interviewing the local communities. The data suggest that of the three species on the island, *Pteropus rufus* and *Eidolon dupreanum* populations are both declining. The main threat to bat populations is hunting and hunting in roost sites with guns is the must destructive method. Detailed studies of hunting of *P. rufus* and *E. dupreanum* and population viability analyses using VORTEX and based on these data suggest that these species should be considered as threatened species and classified as vulnerable according to IUCN criteria. Recommendations for the long-term survival of

these species include protecting them under Malagasy law, establishing a monitoring program at selected sites and ensuring that bats remain on the conservation agenda in Madagascar.

Courtship and mating of the Black flying fox, *Pteropus alecto*, in Australia

N. Markus
Veterinary Pathology and Anatomy, University of Queensland, Australia

The reproductive behaviour of flying foxes occurs during annual mating seasons and is conducted predominantly at the day roosts. Observations of courtship and mating behaviour were conducted at a wild colony of *Pteropus alecto* in Brisbane, Queensland, Australia during the mating seasons of 1999 and 2000. Specific behaviours were categorised in accordance with a previously constructed ethogram for this species (Markus, in prep.). Courtship rituals commenced pre-dawn and occurred in repetitive sequences throughout the day. Each sequence comprised of a pre-copulatory 'male approach' phase, an alignment phase, a copulation phase, a post-copulatory ('male screaming') phase and a resting phase. A total of 69 courtship sequences, incorporating 37 courtship bouts and 135 copulation attempts, were recorded over the two seasons. Courtship bouts involving females attended by the current season's young were of significantly longer duration than those involving non-lactating females. However, duration of copulation attempts did not differ between females of either category. Courtship was always initiated by a male, and females often appeared to resist copulation attempts through struggling and evasion of the male. Consequently, copulation involved the physical restraint of a female by the male and was attempted with varying degrees of success.

High altitude foraging by Brazilian free-tailed bats *Tadarida brasiliensis* on migratory insect pests

G.F. McCracken, J.K. Westbrook, Y.-F. Lee & S. Vege
University of Tennessee, Knoxville, TN, USA; USDA, College Station TX, U.S.A.,
Institute of Zoology, Taipei, Taiwan; American Red Cross, Philadelphia, PA, U.S.A.

Brazilian free-tailed bats are major predators on agricultural insect pests that fly at high altitudes. Radio-microphone bat detectors attached to helium balloons and the tether lines of kites have recorded over 100 hours of bat foraging activity at altitudes of 200 to 1200 meters over South Central Texas. During periods of peak activity by bats, these recordings include over 1000 search phase calls and up to 20 feeding buzzes per minute documenting intense feeding. Examination of over 40,000 bat calls show that 99% of these calls are consistent in acoustic features with the calls of Brazilian free-tailed bats. Intense foraging occurs at the same altitudes and locations as large migratory populations of several of the most destructive agricultural insect pests, including adult moths of corn earworms (*Helicoverpa zea*), tobacco budworms (*Heliothis virescens*), and fall armyworms (*Spodoptera frugiperda*). Fecal analysis documents a dramatic increase in moth consumption by these bats that correlates with the timing of these moth migrations and the availability of the moths to the bats. DNA sequences of corn earworms and tobacco budworms have been amplified from the bats' feces, confirming the consumption of these pests by the bats.

Habitat use of endangered and endemic Philippine flying foxes using radio telemetry

T. Mildenstein, S.C. Stier and L.S. Mills tammphil@hotmail.com
U.S. Peace Corps, Box 7013 Air Mail Distribution Center, N.A.I.A., 1300 Pasay City, Philippines;
School of Forestry, University of Montana, Missoula, MT 59812

In 1992, the U.S. Navy left the Subic Bay Base and turned over one of the country's last remaining lowland forests to the Philippine government. We focused our conservation efforts on a roost of over 30,000 endemic and endangered large fruit bats, the Golden Crowned Flying Fox (*Acerodon jubatus)* and the Philippine Giant Fruit Bat *(Pteropus vampyrus lanensis)*. Essentially no ecological studies have ever been conducted on *Acerodon jubatus* or *Pteropus vampyrus lanensis*. We captured and radio collared thirteen fruit bats (6 *Acerodon jubatus*, 7 *Pteropus vampyrus*). Using triangulation, we plotted the resulting 47 fixed locations and visited them on the ground recording the habitat type and measuring them according to structural and vegetative characteristics biologically important to foraging bats. We recorded the bats across 20,000 hectares of continuous lowland dipterocarp forest of the Subic Bay area and neighboring

provinces. 77% of the fixed locations are found in forests, 19% in beach/mangrove forest, and 4% in rural interface. This habitat use information is being used to develop the Subic Bay Protected Area Management Plan, foster cooperative conservation of the fruit bats by politically separated protected area management offices, and monitor for illegal hunting in the protected area.

Abundance, distribution and conservation status of the large flying fox, *Pteropus vampyrus*, in Peninsular Malaysia

J. Mohd-Azlan[1], A. Zubaid[1] & T.H. Kunz[2] zubaid@ukm.my
[1]School of Environmental and Natural Resource Sciences, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 UKM, Bangi, Malaysia.
[2]Center for Ecology and Conservation Biology, Department of Biology, Boston University, Boston, MA 02215

A survey of the abundance and distribution of the Large Flying Fox, Pteropus vampyrus, in Peninsular Malaysia was undertaken between January and October 1999. A total of 115 sites were investigated based on past records and information obtained from local residents and wildlife and forestry officers. Based on the results of this survey, a severe decline in the abundance of P. vampyrus was observed throughout the peninsula. At almost half of the sites visited, there were no recent records or observations of this bat. Most extant colonies are presumably located deep in isolated and inaccessible forests, and in dense riparian vegetation such as mangrove and freshwater swamps. We suggest that unregulated hunting and habitat loss are the primary reasons for the decline in abundance of this species in Peninsular Malaysia. Inadequacies in existing laws need to be addressed and a public awareness program launched so that an effective conservation and management plan can be formulated to ensure the long-term survival of this ecologically important species.

Genetic population structure and mobility of two Venezuelan desert nectar-feeding bats: Inferences from mitochondrial DNA

L.R. Newton[1], J.Nassar[2] & T.H. Fleming[1] lnewt@fiq.cox.miami.edu
[1]PO Box 249118, Dept. of Biology, University of Miami, Coral Gables, FL, 33124, USA
[2] Laboratorio de Biología de Organismos, Centro de Ecología, Instituto Venezolano de Investigaciones Científicas (IVIC), Apartado Postal 21827, Caracas 1020-A, Venezuela

Glossophaga longirostris and *Leptonycteris curasoae* (Phyllostomidae: Glossophaginae) are two important pollinators of columnar cacti in Northern South America. Despite similarities in feeding behavior, morphological and ecological evidence suggest that movement patterns of the two species are different. We are testing the hypothesis that these two species exhibit different levels of mobility: low mobility in *G. longirostris* and high mobility *in L. curasoae*. We sequenced approximately 330 bp of control region mitochondrial DNA for 41 *G. longirostris* and 42 *L. curasoae* from eleven geographic zones in Venezuela. Results from UPGMA analyses show high levels of population structure in *G. longirostris* but little structure within *L. curasoae*. Measures of population subdivision in *G. longirostris* (F_{ST} = 0.7250, Φ_{ST} = 0.751) were higher than those in *L. curasoae* (F_{ST} = 0.1624, Φ_{ST} = 0.217). Tests for correlation between geographic distance and F_{ST} suggested that movements are geographically restricted in both species; however, *L. curasoae* individuals shared haplotypes between zones with greater separation (812 km between zones) than did *G. longirostris* (592 km between zones). Overall, our results suggest that *L. curasoae* is capable of long-distance flights in Northern South America and, in consequence, could act as a long-distance vector of cacti genes.

Performance analysis as a tool for understanding the ecological morphology of flower-visiting bats

C. W. Nicolay cnicolay@kent.edu
School of Biomedical Sciences, Kent State University and Department of Anatomy, Northeastern Ohio Universities College of Medicine, 4209 State Rt. 44, Rootstown, OH 44272-0095, USA

Although several morphological features related to feeding with the tongue unite nectar-feeding bats, the cranial morphology of flower-visiting species ranges from relatively generalized to highly specialized. Performance analysis provides a tool for interpreting the ecological and the evolutionary significance of

morphological variation. Performance is defined as a quantifiable measure at some behavioral task expected to ultimately influence ecology and reproductive success. The first step in performance analysis is to investigate the association between morphology and performance. Two measures of nectar-feeding performance have been examined for six phyllostomid species-feeding rate and maximal tongue extension. Laboratory experiments demonstrate morphological specialization is clearly associated with maximal tongue extension, but unrelated to feeding rates. The second step in performance analysis assesses the relationship between performance and resource use. Increasing tongue extensibility probably increases effectiveness at visiting long flowers, however the ability to use alternate food sources may be consequently sacrificed. The results from these feeding experiments indicate the need for ecological research to identify situations that potentially favor selection for long tongues. These include times when other, less-specialized bats may rely on different flowers, migrate, or switch diets. To identify such situations, detailed knowledge of annual diets, resource availability, and plant morphology is essential.

Corpus luteum and plasma progesterone concentration in *Hipposideros l. lankadiva*

Nisar A. Khan[1], Sastry, M. S.[2] and Karim, K. B.[1]
[1]Dept. of Zoology, Inst. of Science, Nagpur 440 001, India
[2]Dept of Zoology, Nagpur Univ. Campus, Nagpur 440 010, India

Corpus luteum and its role in pregnancy is known in several Indian bats, however circulating progesterone concentration has not been investigated in any Indian rhinolophid. Present paper deals with these aspects in *Hipposideros lankadiva*, an annual breeder where corpus luteum persists through retarded embryonic development during semitorpor in an unusually long gestation period of 260-270 days. The genitalia were fixed in Alcoholic Bouin's, sections were stained with haematoxylin-eosin and the plasma progesterone levels were estimated by radio immuno assay. The corpus luteum is maximally developed at the time of implantation with plasma progesterone concentration 40.9 ng/ml, the level declines during semitorpor to 12.6 ng/ml coinciding with its decreased volume and defunct appearance. This phase is marked by retarded embryonic and slow placental development. Further increase in plasma progesterone concentration, 41.6 ng/ml was observed at arousal from semitorpor after which the corpus luteum regresses at late limb-bud stage coinciding with the establishment of the chorioallantoic placenta which secretes progesterone required for further maintenance of pregnancy. It is concluded that the extended life of the corpus luteum in the rhinolophid bat is related to semitorpor, long gestation period and retarded embryonic development.

Causes and consequences of tree-cavity roosting in a temperate bat, *Chalinolobus tuberculatus*, from New Zealand

C. F. J. O'Donnell[1] and J. A. Sedgeley[2] codonnell@doc.govt.nz
[1]Science and Research Unit, Department of Conservation, Private Bag, Christchurch, New Zealand
[2]Department of Zoology, University of Otago, P.O. Box 56, Dunedin, New Zealand

Among the ca. 80 taxa of Microchiroptera in Australasia, frequency of tree-cavity roosting increases as mean annual temperature decreases and latitude increases. The latitudinal gradient suggests there may be significant thermal benefits to tree-cavity roosting in cold climates. We explore the causes and consequences of tree-cavity roosting in *Chalinolobus tuberculatus*, which occurs at the southern limit (highest latitude) of this gradient. The characteristics of five geographically distinct populations are compared. *C. tuberculatus* selected the oldest forest trees for breeding and avoided roosting under bark and in caves and buildings, despite relative abundance of these sites. Cavity quality was a major factor influencing selection. We provide evidence that *C. tuberculatus* selected small well-insulated cavities that accrue significant energy conservation benefits compared with other potential roosts (the "thermal hypothesis"). Reproductive females selected roosts that reach maximum temperatures late in the day and retain high temperatures through the night, thus benefiting non-volant young. We propose that selection favours smaller, rather than larger, group sizes in this cold temperate climate. Smaller groups using well-insulated cavities have higher survival rates than larger groups in less insulated cavities. *C. tuberculatus*, formed behaviourally, though not geographically, isolated subgroups. All populations exhibited extreme roost site lability but strong long-term philopatry among pools of >100 roosts. Most were used once per year but date of reuse was similar each year. Strict temporal philopatry suggests bats do not switch roosts in response to daily variability in weather conditions. The thermal hypothesis suggests social group structure

evolved incidentally in response to physiological constraints on thermoregulation and reproduction. Nevertheless, individuals could directly benefit the reproductive success of relatives within the group. Social interdependence would increase the probability that clusters are large enough on any one day to be thermally beneficial. We conclude by discussing the applicability of findings to tree-cavity roosting bats and implications for conservation.

Conservation status of bats in the Fiji Islands

J. Palmeirim, S. Qalavaki, A. Champion, A. Naikatini, M. Tuiwawa, M. Yabaki, & M. Fisher
Dept. Zoologia e Centro de Biologia Ambiental, Faculdade de Ciencias,
Universidade de Lisboa, P-1700 Lisboa, Portugal. Palmeirim@fc.ul.pt

The objective of this project was to study the conservation status of the bats Fiji. In spite of including just six species, the bat fauna of Fiji is of great importance because it includes endemics, near endemics, and globally threatened species. Thirty islands of the archipelago were visited during this survey. Pteropus tonganus has declined in some regions, but may be increasing in others. Pteropus samoensis is still fairly common in some areas of the larger islands, but is threatened in some smaller islands. Fijian populations are critical to the survival of this species, threatened in the Samoas. The known World distribution of Pteralopex acrodonta is still restricted to the forests of the island of Taveuni. Notopteris macdonaldi and Chaerephon bregullae are limited by the number of suitable underground roosts available. Since Fiji is one of the only two countries harbouring populations of these species, it plays an essential role in their protection. Emballonura semicaudata is declining, but the Fijian populations are still probably the best in the species range. Deforestation and cat predation seem to be the main causes for bat population declines. Caves and the remaining areas of forest are critical for the preservation of most Fijian bats.

Age estimation and variations in growth rates of the grey-headed flying-fox *Pteropus poliocephalus*

K. A. Parry-Jones kpjones@bio.usyd.edu.au
University of Sidney, Sidney, NSW, Australia

In studies of population structure and dynamics there is a need for reliable methods of aging wild free-living animals. Two parameters of growth (weight and forearm length) for juvenile *Pteropus poliocephalus* of known age were investigated to determine the growth curves and to assess them for reliability at predicting the age of unknown animals. This method of age estimation can be confounded if there is a basic difference between the growth of wild animals and that of the captive known aged animals on which the estimation is based. Previous studies have shown that the constituents of the milk of *P. poliocephalus* can vary significantly depending on the diet of the lactating female. So the growth rates of juvenile *P. poliocephalus*, from mothers on different diets, were investigated and considerable variation was found. As well the animals reared by captive flying-foxes showed a large range of values in both the size of the infant at birth and its subsequent growth rate. These variations suggest some caution may be required in determining the age of juvenile *P. poliocephalus* from accepted growth parameters such as forearm length.

Autumnal swarming in British bat species

K. N Parsons[1], Gareth Jones[1], F. Greenaway[2] & I. Davidson-Watts[3]
[1]School of Biological Sciences, University of Bristol, UK., [2]Natural History Museum, London, UK.
[3]English Nature, Peterborough, UK. Katie.Parsons@bristol.ac.uk

The community dynamics of bats visiting underground sites in south-west England during late summer and autumn was investigated by using catching and mark-recapture surveys. Information on species diversity, temporal segregation of peak visitation of different species and re-visitation rates are given. Swarming was mainly by Myotis species, and sexually active males predominated in all catches. Considerable numbers of bats considered rare nationally were captured. Activity loggers permitted remote monitoring of communities and correlation of activity with climatic variables. A preliminary estimate of the catchment area of a major swarming site was made. Bats were radio tracked from swarming sites, and their subsequent behaviour documented. Large numbers of bats visit swarming sites, and the conservation of these sites is clearly important. We speculate on the function of autumnal swarming.

Frequency alternation by echolocating bats: signal structure and function

S. Parsons[1], A. Boonman[2], T. Kingston[3] & G. Jones[1]
[1]School of Biological Sciences, University of Bristol, UK. [2]Tierphysiologie, Universitaet Tuebingen, Germany.
[3]Biology Department, Boston University, USA. stuart.parsons@bris.ac.uk

At least 12 species of echolocating bat regularly alternate between short broadband and longer narrowband echolocation calls. The majority of these species are large, fast flying, and alternate only when flying greater than 10 metres above the ground. Recently, researchers have speculated that alternation aids long-range detection. Successive calls differ in frequency and so bats may be able to produce a second call before the echo from the first has returned. This would allow a bat to wait much longer for an echo to return, thus enabling it to detect objects and a much greater range. However, if long-range detection were the ultimate aim of these signals, one would expect bats to produce only narrowband signals with no overlap in frequency. This is not always the case, with bats often alternating between broadband and narrowband pulses, and significant spectral overlap occurring between successive pulses. We analysed successive calls from a number of species in terms of their ranging and object localisation abilities and hypothesise that bats alternate between narrowband and broadband signals to detect objects at long-range (narrowband signals) and obtain more precise ranging and localisation information (broadband signals).

Bats of Djibouti with a discussion of bat migration across the southern Red Sea

Malcolm Pearch
Harrison Institute, Bowerwood House, St. Botolph's Road, Sevenoaks, Kent TN13 3AQ, Great Britain.

In March, 1999, a small mammal survey was undertaken in Djibouti. Ten species of bat were collected including six which have not been recorded previously from the country. As a result, sixteen bat species representing ten families are included currently on the national checklist. This compares to twenty-nine species recorded from Eritrea and seventy-six from Ethiopia. Eleven of the Djibouti bats are essentially savannah species and have pan- or East African distributions. One is a Palaearctic species and four are arid adapted with extensive ranges in the Saharo-Sindian region. A specimen of *Rhinopoma microphyllum* generated particular interest as it compared favourably to specimens of *R. m. asirensis* from Saudi Arabia and differed significantly from the nearest known African populations in eastern Sudan. It is further evidence of bat migration across the southern Red Sea. In some cases, this migration may be a "one-off" translocation of vagrants without subsequent colonisation. In other cases, viable colonies have become established in new territories. This is particularly the case with essentially African species colonising western Saudi Arabia and Yemen. Of the ten bat families found in Djibouti, only one (Megadermatidae) is not found in Arabia.

Systematics of dog-faced bats *Cynomops* based on molecular and morphometric data

S. L. Peters[1], B. K. Lim[2], and M. D. Engstrom[2] burton@rom.on.ca
[1]Department of Zoology, University of Toronto, 25 Harbord Sreet, Toronto, Ontario, Canada M5S 3G5, [2]Centre for Biodiversity and Conservation Biology, Royal Ontario Museum, Toronto, Ontario, Canada M5S 2C6

Cynomops is usually considered a natural monophyletic group at the taxonomic rank of genus, or as a subgenus of *Molossops*. The species limits and phylogenetic relationships within *Cynomops*, however, remain unresolved due primarily to subtle morphological differences and overall similarity in size for the small taxa. We use a combination of morphometric analyses for delineating size variation, and molecular data for reconstructing the evolutionary history within *Cynomops*. Rooting the tree with *Eumops hansae*, a clade of *Molossops neglectus* and *M. temminckii* was the sister lineage to a monophyletic *Cynomops* clade. The most parsimonious topology for *Cynomops* had a phylogeny of (*C. paranus, C. planirostris*), (*C. greenhalli, C. abrasus*), *C. mexicanus*). Molecular analysis supports the synapomorphy of pale venter as diagnostic for *C. planirostris* although it overlaps in size with the similarly small, dark venter *C. paranus*. *Cynomops greenhalli* is also relatively small but it is most closely related to the large-sized *C. abrasus*. *Cynomops mexicanus*, traditionally considered a subspecies of *C. greenhalli*, is the most basal lineage, suggesting its designation as a distinct species.

Diversity of Microchiroptera in a tropical urban environment

S.A. Pottie[1] & D.J.W. Lane[2] david_jwlane@hotmail.com
[1] Dept of Biological Sciences, National University of Singapore, Kent Ridge, SINGAPORE 119260
[2] Department of Biology, Universiti Brunei Darussalam, Jalan Tungku Link, Gadong BE1410, BRUNEI,

The historical mammalian literature for Singapore, dating from the late 19th and early to mid 20th centuries, records a total of 22 microchiropteran species for this small equatorial island. From earliest colonial times through to subsequent nationhood, the landscape of Singapore has been dramatically transformed from one dominated by wetland and dryland forests to a predominantly urban environment. Only remnants of primary forest remain but there are significant areas of secondary forest associated with water catchments, parks and offshore islands. Surveys carried out in the 1990s revealed that, of the 22 species previously recorded, 9 were locally extinct. The status of the remaining 13 is designated as: 5 endangered; 4 common; 1 uncommon; 1 rare; 1 indeterminate; 1 doubtful record. Excluding the doubtful record, this represents a local extinction rate of 42% and of the remaining species, 41% are considered locally endangered. However two new records of bat species in Singapore were made, namely *Nycteris tragata* and *Rhinolophus refulgens*. These are both forest-associated species and are assumed to have been present in the past but not detected in earlier surveys. As expected, surveys showed that forest and urbanized habitats had, respectively, the highest and lowest bat diversities. Some of the locally extinct species are forest specialists and loss of forest habitat is assumed to be the cause of their decline. Other declines may relate to loss of roost sites and deliberate or accidental destruction in a land that has one of the highest human population densities on the planet.

The role of fruit bats in maintaining biodiversity in Malagasy forests

P.A. Racey, C.E. Hawkins[1], E.Long[1], D. Andriafidison[2],R. Andrianaivoarivelo[2],
S. Fidiarisoavoninarino[3], C. Nirina[3], M. Raheriarisena[2], S. Rakamiarison[2],
J.G. Rakotondratsimba[2],R. Ralisoamala[2], J. Ranivo[2], F. Ratrimomanarivo[2],
N. Razadindrakoto[2], V. Razakarivony[2] & J.L. MacKinnon[1]
[1]Dept of Zoology, University of Aberdeen, Scotland, [2]Dept of Animal Biology, University of Antananarivo, Madagascar, & [3]Department of Plant Biology, University of Tulear, Madagascar p.racey@abdn.ac.uk

The objectives of this project were [1] to survey the roosts of the three Malagasy Megachiroptera *Pteropus rufus, Eidolon dupreanum* and *Rousettus madagascariensis* all of which are endemic; [2] to study their feeding ecology by analysis of faeces and ejecta; [3] to evaluate the effects of hunting and [4] to produce a National Action Plan for their conservation. *Pteropus* roosts are found mainly on the coastal lowlands. Twenty six of the hundred and thirty three *Pteropus* roosts surveyed have become deserted within the last ten years, often as a result of hunting with guns and there were only two examples of *Pteropus* establishing new roosts. *Eidolon* roosts in clefts in rock faces and although little forest remains on the central high plateau, it still roosts there. Eighteen out of the forty-one *Eidolon* roosts surveyed have become deserted because of hunting. There were thirty five plants species in the diet of *Eidolon* and thirty eight in the diet of *Pteropus* and a total of fifty different plant species in all, only twenty three of which were consumed by both bat species. Approximately two thirds of the plant species in the diet were fruit and one third was pollen or parts of flowers. Over half the species in *Eidolon's* diet were endemics. The germination rate of seeds passing through bats differed little from that of seeds taken from ripe fruit but is significantly greater than that recovered from the faeces of frugivorous birds. *Eidolon* visits the rare baobab *Adansonia suarezensis* and is likely to be its main pollinator.

Foraging by *Myotis myotis* in a Mediterranean region

A. Rainho and J. Palmeirim rainhoa@icn.pt
Instituto da Conservação da Natureza, Rua Filipe Folque 46-1°, 1050-114 Lisboa, Portugal

The objective of this project was to study the foraging behaviour and habitat selection by *Myotis myotis* in a Mediterranean region. The study area, located in southern Portugal, is covered with Mediterranean scrub, stone oak open woodlands, olive groves and cereal steppe. Forty-two animals were marked with small radio tags and followed mostly by precision triangulation from double fixed and mobile antennas, placed in the highest points of the landscape. The combination of fixed and mobile antennas usually covered an area to about 20km from the roost. The locations were incorporated in a GIS and plotted over digitised aerial photographs. Overall, the animals used more intensively the wooded habitats (stone

oak woodlands and olives groves) than the scrub and open areas. All the animals used fixed foraging areas to which they returned most nights. Although most animals used only one feeding area, some used two or even three feeding areas. Twenty-five feeding areas located up to 19 km from the roost were identified. The great majority of males foraged within a radius of 10km from the roost; the females foraged further away. The median size of the foraging area was 350 ha.

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Occupation of the maternity roost by non-juvenile female greater horseshoe bats throughout the summer

R. D. Ransome.
School of Biological Sciences, Bristol University, Bristol, UK

Monthly captures of the whole colony present within the maternity roost at Woodchester Mansion from early May to early September were made over three summers from 1998 to 2000. Bats were caught from 1 to 5 times each summer, with a maximum of 15 captures possible. Females formed about 75% of all non-juvenile individuals captured in each summer. In 1998 cold weather in early June depressed numbers in the roost, lowering occupancy levels that year. In the other two summers, the weather remained favourable, leading to a similar pattern of occupation. Immature females, aged one or two years, show the highest level of occupancy, with 50% of individuals present on all five occasions in 1999, and also in 2000. Mature, breeding females were next, with 27% present on all five occasions in those summers. Non-breeding mature females, and recent immigrants dominate the lowest level of occupancy (once per summer). Mean age of all females fell by about 1.5 years with each of the other four capture classes (twice to five times each summer). It was about 7 years for bats captured twice each summer, and 2.5 years for those caught five times. Preliminary analyses of the limited data obtained to date suggest that breeding females can be divided into two groups. Firstly, long stayers, (LS), which occupy the roost for four to five months, and secondly, short stayers (SS), which are only present for two to three months of the summer. LS females usually hibernate at major sites (types 1 and 2, Ransome 1991) close to the maternity roost. SS females hibernate in smaller territorial sites (type 3), some of which are much further away. SS females may stay within these widely scattered sites until late pregnancy, only returning too the maternity roost to give birth, lactate and wean their young, before leaving again.

Prey selection by *Myotis myotis* (Vespertilionidae) in a Mediterranean region

M.J. Ramos Pereira, H. Rebelo, A. Rainho & J.M Palmeirim mirayka@hotmail.com
Instituto da Conservação da Natureza, Rua Filipe Folque, n.° 36, 1° 1050-114 Lisboa, Portugal

Prey selection by Myotis myotis was studied between March and November 1999 in a nursing colony located in Southern Portugal. Diet was determined by faecal analysis and food availability through pitfall trapping in eleven habitats around the roost. Overall, Gryllidae (Orthoptera), Carabidae (Coleoptera) and Arachnida dominated the diet. The main taxa consumed were not necessarily the most frequently caught in

the traps, although they were among the most frequent. The composition of the diet varied along the study period. In the spring, it was dominated by Carabidae and Gryllidae, in the summer by Arachnida, and in the autumn by Carabidae. In general, these changes reflected the observed seasonal variations of the availability of the different groups. Food was far more abundant during the spring than in the long and dry summer season and autumn. In the studied region, the preferred prey were most abundant in cork oak woodlands, olive orchards, and cereal steppe, all with short grass cover.

Big reservoir, dam problem

Rebelo, H. & Rainho, A.
ICN. Rua Filipe Folque, 46-1°. P-1050-114 Lisboa. Portugal rebelohu@icn.pt

The Alqueva project is mainly an hydraulic project, that regards the availability of water as a mean of support for regional development in Alentejo, a poor dry region of Southern Portugal. The characteristics of this project, with emphasis on the previous deforestation of the area, and submersion of 250 Km^2, will result in deep changes on the region, particularly at the natural level. As a consequence, the company responsible for the project (EDIA), together with PEDIZA, is funding several studies to evaluate and monitor the impacts. In the first year, the bat study aimed the determination of "important areas for bats", taking in consideration three factors: the species richness, the presence and importance of roosts, and the importance of feeding areas. The deforestation will now proceed, taking in consideration the areas defined in several aspects: in the methods used, in the work schedule, in the areas where the forest will be kept and placing bat-boxes in the surrounding of the most important forests. Other measures, like the partial closing of an important roost, and guaranteeing the survival of isolated individuals found during fieldwork are also being prepared. In 2003, after the flooding, the monitoring phase will start. The global objective of this phase is to evaluate the efficiency of the measures taken, by means of determining changes in bat diversity, changes in numbers of individuals in known roosts, migrations or in-between roosts movements of cave dwelling bats, and the success of bat-boxes in decreasing the impacts on populations of endangered tree-dwelling species.

Bat-boxes for Mediterranean climates

H. Rebelo, M.J. R. Pereira, L. Rodrigues & J.M. Palmeirim hugoreb@hotmail.com
Instituto da Conservação da Natureza, Rua Filipe Folque, n.° 36, 1° 1050-114 Lisboa, Portugal;

It is often desirable to make available alternative roosts for bats using buildings. The objective of this project was to identify ways to manipulate bat-boxes in order to make them suitable for Mediterranean climates. During much of the year the best bat-boxes should absorb environmental heat, but during the very hot summer season it may be necessary to avoid overheating. The thermal behaviour of boxes with various combinations of architectonic variables was studied using dataloggers. Dark coloration was the most efficient way to increase the inner temperature of the boxes. Light colours and double roofing were the best ways to keep them cooler. In parallel with these experiments, three sets of similar bat boxes, differing in colour (black, grey and white), were placed near buildings occupied by colonies of *Pipistrellus pygmaeus* in southern Portugal. In the current spring, two years after the beginning of the experiment, bats are using the three sets of boxes. At this time of the year, black boxes are by far the most used. A few bats have also been found in the grey boxes, but none in the white ones.

Do bats use artificial roost boxes in a subtropical Australian city?

M. Rhodes
Suburban Wildlife Research Group, Australian School of Environmental Studies, Griffith University, Nathan Queensland 4111, Australia. M.Rhodes@mailbox.gu.edu.au

Over half of the 80 species of Australian insectivorous bats roost in trees. Few old trees that may provide suitable roosts for bats and other arboreal vertebrates remain in suburbia due to vegetation clearance on private land and trimming of old trees on public and private land. Brisbane is one of the largest and fastest growing urban areas in the world with the fastest rate of population growth of any Australian region. This has resulted in large losses of important vegetation across the region. Nest boxes are an important wildlife management tool in situations where hollow availability is limited. In Australia the use of bat boxes is at an early stage. In this study I sought people interested in being involved in a long-term bat conservation study by purchasing their own bat box for their property. Since October 2000 forty-

two boxes have been installed in more than thirty gardens. In addition to this, I erected boxes of several sizes to investigate roost requirements of a range of bat species. Six boxes differing in size and configuration have been installed at each of five study sites, giving thirty boxes in total. Box occupation monitoring started in January 2001 with five boxes used by bats in the first three months.

Regional trends in microchiropteran habitat use in southeast Queensland, Australia

M.P. Rhodes
Dept. of Veterinary Pathology, Univ. of Queensland, Queensland 4072 Australia.

I examined regional patterns of habitat use by Microchiroptera in southeast Queensland. Light tagging observations of eight species from this region showed high similarity in use of habitats, and frequent lack of habitat specialisation. These characteristics are evident from raw times in habitats, but are not completely described by means, such as Habitat Use index, or diversity indices, such as Shannon Diversity Index. The breadth or 'evenness' of habitat use, as described by diversity indices, is as strong a characteristic of regional habitat use as mean habitat use. Species that spent more time in the most cluttered habitat had a greater breadth of habitat use. This skewed the habitat use index as a measure of habitat use. I compared habitat use to obstacle negotiation ability, measured in a flight chamber, and to wing morphology. The breadth of habitat use was correlated with obstacle negotiation ability, but was not correlated with the wing morphology descriptors aspect ratio and wing loading. The habitat use index was correlated with aspect ratio and wing loading, but not obstacle negotiation. The stronger relation between habitat use and obstacle negotiation suggests habitat use is related to factors other than wing aspect ratio and wing loading.

Methods for analysing microbat faunal composition and community structure: Case studies from Australia

G. Richards batmanoz@bigpond.com
Wildlife Research and Ecological Assessment Consultant, PO Box 9, Gungahlin, ACT 2912, Australia

This paper reports on various new methods for assessing bat communities in Australia. These methods include the basis for generating the initial species inventory and justification for call detection for the entire night; a method for rapid habitat assessment to target sampling sites, the estimation of species abundance including a concept of "site records," several strategies for monitoring impacts at minesites and other developments with potential impacts, a statistical method for establishing which species in a community are habitat specialists, and a quantitative method for establishing patterns of niche utilization, and differentiating between realized and vacant niches. Case studies are provided from a variety of ecosystems, including semi-arid and temperate woodlands, temperate forests, and a minesite within a dry tropical woodland national park.

Ecology of the West Indian endemic *Erophylla sezekorni* in Puerto Rico

A. Rodríguez-Durán and J. Soto-Centeno
Inter-American University, Bayamón PR 00957 USA

The West Indies is a zoogeographically distinct archipelago within the Neotropics. Levels of endemism at the specific level are about 50%, and at least four genera of bats can be found nowhere outside this region. Given their absence from the mainland Neotropics, the biology of these West Indian endemics is poorly known. *Erophylla sezekorni* (= bombifrons) is considered a fruit/nectar-eating phyllostomid. We examined the diet of *E. sezekorni* at monthly intervals over the course of a year, and performed laboratory experiments to determine temperature preferences. The results of thermopreferendum experiments were compared to observations and measurements made in caves to assess roosting preferences of this bat. In comparison with *Pteronotus quadridens*, a known hot-cave-dweller, *E. sezekorni* selected significantly lower temperatures in the thermopreferendum chamber. These differences correlate with field observations. In addition to seeds and pollen we report the occurrence of large numbers of insect remains in the feces of *E. sezekorni*, especially coleopterans.

Roosting behaviour and phenology of *Myotis myotis* in the original and recently colonized ranges

L. Rodrigues, A. Zahn, A. Rainho & J.M. Palmeirim rodrigues@icn.pt
Instituto da Conservação da Natureza, Rua Filipe Folque 46-1°, 1050-114 Lisboa, Portugal

The availability of new roosts in buildings allowed *Myotis myotis* to expand northward from Southern Europe. This project identified changes in its biology related to this expansion, comparing southern (Portugal) and northern (Germany) populations. The populations of the recently colonized northern ranges differed from those in the south in the following aspects: (1) nurseries use attics instead of underground roosts; (2) temperature in their roosts fluctuated considerably along the day and season; (3) density and location of clusters frequently changed in response to temperature; (4) nurseries tended to be smaller (median= 90 vs 500), and monospecific; (5) males seldom joined these nursery clusters; (6) the nursing season ended two months later, but the onset of the mating season was synchronous; (7) signs of sexual activity ceased with hibernation; (8) hibernation was longer (5 vs 2 months); (9) births took place two months later; (10) young had less time for development; (11) in the first year females did not give birth and males seldom showed signs of sexual maturation (9 vs 84%). Most of these aspects put the northern populations at a disadvantage. However, the fact that *M. myotis* became one of the most successful bats in some parts of Central Europe, suggests that ecological factors are able to compensate for these disadvantages.

Causes and consequences of genetic structure in the greater horseshoe bat (*Rhinolophus ferrumequinum*)

S. J. Rossiter[1], G. Jones[1], R. D. Ransome[2] and E. M. Barratt[3] s.j.rossiter@bristol.ac.uk
[1]School of Biological Sciences, University of Bristol, Woodland Road, Bristol, BS81UG, UK

We studied breeding behaviour and its consequences for social structure and gene flow in the greater horseshoe bat (*Rhinolophus ferrumequinum*) at a colony in southwest Britain. Mother-young pairs and candidate fathers from five successive years were genotyped at seven polymorphic microsatellite loci. Breeding was polygynous, with some females breeding with the same male in different years. A small annual skew in male reproductive success increased over time, due to the repeated success of some individuals. Females mated with males born both within and outside their own natal colony, though did not appear to actively outbreed. Yet male offspring with higher mean d^2 values, a measure of outbreeding based on microsatellite allele divergence within the individual, were also more likely to survive to adulthood, indicating that outbreeding is important for individual fitness. Within the colony, significant structure of relatedness, coupled with elevated relatedness among matrilineal kin, may provide suitable conditions for the evolution of kin-selected behaviours. Indeed, radio-tracking showed that female kin preferentially shared foraging sites and night-roosts. Such associations may result from long-term maternal tutoring, rather than short-term kin-directed cooperation. These findings have important implications for the management of this endangered species.

Population genetic structure of very large populations: the Mexican free-tailed bat, *Tadarida brasiliensis*

A. Russell and G. F. McCracken
Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville, TN 37996, USA
russella@utkux.utcc.utk.edu

Species with restricted distributions or low potential for movement often are characterized by population structures that can be readily defined by geographical distribution. On the other hand, highly vagile or migratory species such as many birds, bats, insects, and marine organisms, are characterized by population structures that are often more difficult to predict. In many cases, the lack of obvious geographical barriers to gene flow can make *a priori* assumptions about geographical population limits misleading. Additionally, males and females may exhibit different patterns of migration or philopatry, and population structure may be inaccurately assessed if such behavioral dimorphism is not recognized. Using data from mitochondrial DNA (mtDNA), we examine the population genetic structure of the Brazilian free-tailed bat, *Tadarida brasiliensis*, a highly vagile mammal that is characterized by extremely large population sizes. DNA sequence data from the D-loop of the mtDNA genome suggests that there is no genetic structure among *T. brasiliensi s* populations throughout North America. However, significant

differences exist between populations in North and South America. This genetic evidence conflicts with the morphological, ecological, and behavioral data upon which current taxonomic divisions are based. However, studies of foraging, diet, roosting habits, and migration demonstrate that this species is behaviorally plastic. The implication that *T. brasiliensis* in North America constitutes a single panmictic population suggests that this species is characterized by extremely large effective populations sizes. Effective population sizes of the magnitude suspected for this species are extremely rare for mammalian species.

A mechanistic approach to the study of bat community structure

J. Sedlock[1,2]
[1]University of Illinois at Chicago, Department of Biological Sciences, Chicago, IL60607 USA;
[2]Correspondence: The Field Museum of Natural History, Division of Mammals, Chicago, IL 60605 USA
jsedlock@fieldmuseum.org

Field investigations of the ecological processes maintaining local bat diversity can appear overwhelming, particularly in the tropics. One possible approach employs the theoretical framework of foraging theory as a basis for deducing and testing mechanisms of coexistence. Using a Philippine insectivorous bat community as a model, I demonstrate how this mechanistic approach yields hypotheses that can be easily tested using acoustic activity data. For those species whose calls are distinct and easily detectable, I show how these acoustic data, systematically collected along spatially and temporally explicit transects, can provide a robust test of habitat selection using log-linear models. Moreover, I demonstrate how dynamic regression models of changes in bat activity and insect abundance over time, on both a habitat- and patch-scale, may provide a test for a novel coexistence mechanism with respect to bats — variance partitioning. Finally, I show how path analysis allows one to investigate the relative direct and indirect effects of structural aspects of the environment and resource availability on a species' foraging activity. These analyses demonstrate the largely unrealized value of systematically collected acoustic activity data, as well as the effectiveness of a mechanistic framework in forming and testing explicit hypotheses in complex systems.

The contact call of *Megaderma lyra* and its social function

S. Schmidt
Institute of Zoology, TiHo-Hannover, 30559 Hannover, Germany sabisch@zoologie.tiho-hannover.de

Indian False Vampire bats, *M.lyra*, from different day roosts meet regularly at certain night perches. In this situation, the bats frequently emit a multi-syllabled, harmonically structured social call, tentatively termed contact call (CC). Discriminant analyses of 304 CC of eight Sri Lankan and 389 CC of nine Indian bats disclosed that the calls carry individual-, sex- and population-specific signatures. The mechanisms involved in establishing contact between bats at the night perch were studied with field playback experiments (N = 1380) using CC and *M.lyra* sonar calls (SC), as well as stimuli without social relevance (cricket and *Taphozous* sonar calls, NS). The bats ($n > 35$) responded specifically to these three stimulus classes, with a significantly (multiple chi_-test, $p < 0.05$) increased number of "no reactions" to NS and significantly stronger responses to CC and SC which included flights towards the speaker and CC emissions. These were never found in response to NS. Interestingly, contact calls were the only social calls elicited by the playback stimuli. Thus, *M.lyra* exploits CC as well as SC to detect and follow its conspecifics. Moreover, CC constitute the specific social call response to indicate the presence at a night perch. Supported by VW-I/75991.

Quadrupedal bats: form, function and phylogeny

W. A. Schutt, Jr.
Natural Science Division, Southampton College of Long Island University, 236 Montauk Highway, Southampton, New York 11968, USA desmodus@yahoo.com

Quadrupedal locomotion varies tremendously in bats-from frantic, clumsy scrambling to incredible feats of agility and speed. However, relatively few researchers have explored this interesting phenomenon from an evolutionary perspective. In this study, the post-cranial morphology of three bats known to exhibit

efficient quadrupedal locomotion (*Cheiromeles* sp., *Desmodus rotundus*, and *Mystacina* sp.) was examined. Skeletal and fluid-preserved specimens were used to study adaptations related to quadrupedal locomotion. Observed similarities and differences were evaluated from a phylogenetic and comparative perspective. Related taxa not known to exhibit efficient quadrupedal locomotion were used for comparison. Convergence was identified in a number of characters (*e.g.* presence of a complete fibula) seen in those bats that exhibit quadrupedal locomotion. Many unique features (*e.g.*, the opposable hallux in *Cheiromeles*) are reported in detail for the first time.

Chances, challenges and limitations of acoustic species identification in the field: mechanisms of co-existence in *Myotis*

B. Siemers and H.U. Schnitzler
Animal Physiology, Zoological Inst., Tübingen University, Morgenstelle 28, 72076 Tübingen, Germany
bjoern.siemers@uni-tuebingen.de

In recent years, acoustic monitoring of echolocation calls has become increasingly used in bat research as a tool for faunal inventories and analyses of community structure. It ideally complements mist-netting as an inventory technique for several groups of bats. We review the methodology and feasibility of acoustic species identification and present data on the genus *Myotis* as a challenging example. We show both technical and biological reasons for the difficulty of identifying an echolocating *Myotis* bat to species level under field conditions. Echolocation signals primarily serve to deliver the echo information that a bat needs to solve the different tasks it encounters while commuting and foraging. Many features of echolocation calls consequently are not species-specific, but rather situation-specific. In an experimental setting, we standardised some situation-specific variables and showed that then frequency parameters but not call duration differed between species. Within six morphologically rather similar European *Myotis* species, several call parameters correlated with prey capture success in our standardised task. We therefore assume that differences in call parameters in this case reflect fine-grained differences in the use of niche space within this community subset. The challenge in acoustic monitoring is to pinpoint the species-specific parameters within the situation-specific variability of the call repertoires.

Diurnal variation in the retinal responses of the tropical bat, *Taphozous nudiventris kachhensis* (Dobson 1872)

K. Sripathi & M.S.G. Abraham
Department of Animal Behaviour and Physiology, School of Biological Sciences,
Madurai Kamaraj University, Madurai 625 021. India sribat@usa.net

Diurnal variation in the electroretinogram of the bat *Taphozous nudiventris kachhensis* was studied. The animals were injected with i.p. with a muscle relaxant (Rompun 7µl/g body weight) and anesthetized with nembutal (0.025 mg/g body weight). After surgery a bolt was fixed on the skull with dental cement. When the recovery from the anesthesia was complete the animal was placed in a holder attached to a stereotaxic device. The local wounds were treated with a local anesthetic (Novocaine). While recording the eye is treated with Xylocaine. The amplitude of the a-wave and the b-wave were measured for 50 lx, 500 lx and 1,700 lx pulses, hourly all day long. The b-wave amplitude showed a clear-cut diurnal variation in the three intensities of white light administered. For 50 lx pulses, the b-wave amplitude response showed a peak from 02^{00} h to 04^{00} h and second peak at 19^{00} h to 22^{00} h. The response was minimal from 10^{00} h to 14^{00} h. For 500 lx pulses, the b-wave amplitude peaked from 02^{00} h to 05^{00} h with a second peak from 19^{00} h to 22^{00} h. Minimal response was seen from 10^{00} h to 12^{00} h. For 1,700 lx, the peak response amplitude was from 02^{00} h to 05^{00} h and a less pronounced peak was from 21^{00} h to 23^{00} h. The minimal response period was from 12^{00} h to 16^{00} h. There was no conceivable diurnal variation in the response amplitude of the a-wave for all the three intensities of light pulses. The variations in the response amplitude could be explained as a consequence of the shedding of the disk in the rods. These bats live in crevices exposing themselves to high light intensities during day. This could induce shedding of the outer disk of rods as has been shown in other vertebrates leading to reduced responses during the day hours.

Have the Asian *Myotis* species a unique or multiple ancestors? A molecular approach

B. Stadelmann*, M. Ruedi, C. M. Francis, T. Guillen, L.K. Lin & H.T. Yu.
*University of Geneva, Station de Zoologie,154, rte de Malagnou, 1224 Chêne-Bougeries, Switzerland
Benoit.Stadelmann@zoo.unige.ch

The pattern of today's diversity and distribution of species is the result of intricate processes mixing dispersal, adaptive radiation, competition and extinction. With about 90 species spread all around the world, the genus *Myotis* is one the most diverse and successful radiation among mammals. The species are generally subdivided into four subgenera, each one typifying a distinct ecomorph. Previous phylogenetic analysis of mitochondrial DNA data have shown that West Palaearctic and American representatives of each ecomorph do not share common ancestors. Rather, all 12 tested American species formed a distinct, monophyletic clade, which radiated independently. Unfortunately, Oriental species were underrepresented and their contribution to the global diversity of *Myotis* species could not be assessed. We filled this gap and present here the phylogenetic evolution of 20 Oriental species, as compared to 28 other *Myotis* and 22 outgroups, using complete cytochrome b sequences. While the monophyly of the American clade is strongly supported, the remaining West Palaearctic and Oriental species form an intricate radiation. However, most Asian species appear at the basis of distinct clades, suggesting that they are close to the ancestral area of the whole genus. The molecular tree further supports that recurrent ecomorphological convergences took place during the species radiation within the genus *Myotis*.

Spatial memory for complex flower distributions in nectar-feeding bats (Glossophaginae): A comparative experimental approach

K. P. Stich & Y. Winter
Munich University, Luisenstrasse 14, 80333 München, Germany and Research,Centre for Ornithology of the Max-Planck-Society, 82319 Seewiesen, Germany

Glossophagine bats visit flowers to feed on nectar and pollen, in a manner comparable to the diurnal hummingbirds. Since a major constituent of daily energy turnover stems from foraging costs arising during commutes between flowers, selection pressure on efficient foraging should be strong. One way to achieve this, is to travel along shortest routes which requires knowledge of the spatial distribution of flowers. Glossophagines obviously possess a well developed spatial memory which allows them to remember the locations of profitable flowers. Within the circa 30 species of glossophagines some diversity has evolved in their reliance on floral rewards and in their strategies of space use. The aim of this study is to examine the influence of ecological factors on the evolutionary development of spatial memory in different species. The bats' ability to remember the locations of previously visited flowers is tested with a computer-controlled array with 64 artificial flowers (8 x 8). The timing and amount of sugar water secretion from these flowers can be programmed individually. During behavioural tests, bats are required to remember the locations of flowers emptied previously in order to forage efficiently. This corresponds to the natural situation. With this experimental setup we can determine precision, complexity and duration of spatial memory in different species of glossophagine bats. Bat-pollinated flowers have characteristic shapes and smells. Thus, the association of flowers with stimuli of different sensory modalities (visual, echoacoustical, or olfactory) may be an important component of spatial memory processes. Such stimuli can be presented automatically from our artificial flowers. This allows us to evaluate the influence of local sensory stimulation on the formation and recall of spatial memory for flower locations by different glossophagine species.

A dietary investigation of the golden crowned flying fox and the Philippine giant fruit bat at Subic Bay, Luzon, Philippines

S.C. Stier and T.L. Mildenstein, samstier@hotmail.com
U.S. Peace Corps, Box 7013 Air Mail Distribution Center, N.A.I.A., 1300 Pasay City, Philippines

The Golden Crowned Flying Fox (*Acerodon jubatus*) is an endangered, Philippine endemic who's diet is virtually unknown. The dietary components of the Golden Crowned Flying Fox and the co-roosting Philippine Giant Fruit Bat (*Pteropus vampyrus lanensis*) were investigated at Subic Bay, Luzon, Philippines, using fecal analysis, bat hunter interviews, and personal observations. Proportion of bat droppings having elements from the *Ficus* genus averaged 74% (76% *A. jubatus*; 71% *P. vampyrus*) over a

seven-month period, suggesting the relatively high importance of species within this single plant genus over at least a large portion of the year. Of all *Ficus* seeds identifiable to the species level, one species, *Ficus variegata*, showed high degrees of representation in bat droppings (31% *A. jubatus*; 55% *P. vampyrus*). Results suggest that a small number of fig species comprise a staple in both species' diets throughout the year, while hunter interviews and personal observations indicate 1) a number of other dietary items are also utilized on a more sequential basis, and 2) these species have overlapping but distinct diets. Results of this research are being utilized to affect protected area planning, reforestation, and hunting practices in the area for improved conservation of these species.

Dynamics and 3-D kinematics of bat flight:
How and why bats are not fixed-wing aircraft

S. M. Swartz, sharon_swartz@brown.edu
Dept of Ecology & Evolutionary Biology, Brown University, Providence, RI 02912, USA

During flight, bat wings move through space in a three-dimensionally complex way. When we quantify wing-beat amplitudes and frequencies, we capture some proportion of that complexity, but neglect some aspects of kinematics that are potentially interesting, and that may influence aerodynamics and mechanics. Here, I present information on 3-D movements of the wings of several bat species flying at a range of velocities, and compare this approach with that of less technically complicated and more easily obtained 2-D kinematics. Full 3-D analysis is substantially more powerful, particularly for parts of the wing-beat cycle other than the middle of downstroke. However, 3-D analyses are costly and challenging to obtain, and the complexity of the results requires novel approaches to data visualization. Dynamic, interactive 3-D graphical animations help to present results in a manner that will greatly facilitates their interpretation by scientists, and also makes our results more readily understandable for more general audiences. Better understanding of the multidimensionality of bat wing motions will provide not only new insights into the functional biology of flight, but may also significantly improve our understanding of the relationship between the interspecific variation in flight performance, and hence ecology, and bat wing architecture.

Gleaning in Natterer's and brown long-eared bats: a comparative study

S.M. Swift and P.A.Racey.
Zoology Department, University of Aberdeen, Aberdeen AB24 2TZ, UK drumore1898@aol.com

Two species which glean prey directly from plant surfaces, the brown long-eared bat, Plecotus auritus, and Natterer's bat, Myotis nattereri, are sympatric in Scotland. However, they eat different arthropods, possibly due to the methods they use to detect prey. The present study aimed to identify the cues used to locate prey and to test the hypothesis that, unlike P.auritus, M.nattereri does not switch off echolocation while gleaning, and this affects its prey composition.. Groups of each species were maintained in a flight room and their foraging behaviour compared. M.nattereri continued to emit echolocation calls throughout gleaning attacks, and feeding buzzes were detected in 79% of capture attempts. Echolocation was the most important cue used during gleaning: bats were able to locate prey using echolocation alone, but not by using only prey-generated sound. In contrast, P.auritus stopped echolocating for up to 1s before gleaning prey, and feeding buzzes were rarely emitted. It was able to locate prey in the absence of all cues except prey-generated sound, and the loudness of this sound significantly affected the ability of P.auritus, but not of M.nattereri, to detect prey. In a habitat where both species occurred, moths constituted 31.8% of the diet of P.auritus during May-September, but only 4.2% of that of M.nattereri. It is likely that M.nattereri does not hunt moths selectively because it cannot glean without echolocating and cannot therefore avoid alerting moths to its presence.

The reproductive pattern of *Cynopterus horsfieldi*: a histological view[1]

T.W. Tay, M.T. Marina, C.H. Wong, [1]A. Zubaid & [2]A.B. Kamis [1]School of Environmental Sciences and Natural Resources, [2]School of Biosciences & Biotechnology, Faculty of Science & Technology, Universiti Kebangsaan Malaysia,43600 Bangi

The reproductive pattern of a frugivorous bat, *Cynopterus horsfieldi*, was described at an agriculture area (Kuala Perlis, 100^0 8.5' E, 6^0 26.2' N). Male and female bats were sampled monthly using mist nets from April 2000 to March 2001. Upon collection, the testes and ovaries were removed and fixed in Bouin's solution. A standard histological method was later performed to review the monthly changes. For staining, Wiegert's hematoxylin was used with eosin as a counter stain. Microscopic observation in the seminiferous tubules and epididymides of male bats showed that they were synchronized in the presence or absence of spermatozoa. Although the presence or absence of spermatozoa was not consistant in consecutive months, the spermatogenesis process however, occurred throughout the study period. Meanwhile in female bats, observation showed that they possessed a bilaterally functional reproductive system, whereby pregnancy can occur on either side of the uterine horn. The formation of a corpus luteum coincided with the observation.

Microbat monophyly, microbat paraphyly, rhinolophoid diphyly: Exactly what is going on?

E. C. Teeling[1,2*], O. Madsen[3], M. J. Stanhope[2,4], W. W. de Jong[5], M. S. Springer[1].
[1]Department of Biology, University of California, Riverside, California 92521 USA[2]Queen's Univ. Belfast, Biology & Biochemistry, 97 Lisburn Road, Belfast BT9 7BL, UK [3]Dept. Biochemistry, Univ. Nijmegen, Box 9101, 6500 HB Nijmegen, The Netherlands [4]Bioinformatics, SmithKline Beecham Pharmaceuticals, 1250 South Collegeville Road, UP1345, Collegeville, Pennsylvania 19426 USA [5] Inst. for Biodiversity and Ecosystem Dynamics, 1090 GT Amsterdam, The Netherlands. emmat@ucrac1.ucr.edu

Never before have systematic controversies been so rife as in bats. Currently both molecular and morphological findings agree that the order is monophyletic, however the monophyly of the suborderMicrochiroptera is still questionable. Independent molecular studies based on phylogenetic analyses of nuclear and mitochondrial genes and on DNA hybridisation results indicate that microbats are paraphyletic with members of the superfamily Rhinolophoidea grouping with the megabats as opposed to other microbats. Both of these molecular results refute morphological findings, all of which support microbat monophyly. However, a recent mutligene molecular study seemingly supported morphological findings. This paper indicated that microbats were monophyletic with a rhinolophoid bat (Nycteris) grouping with the microbats as opposed to the megabats. We evaluated this problem using a 7.1 kb nuclear data set that included portions of five nuclear exons (A2AB, 1.3kb; BRCA1, 2.8kb; RAG1, 1.1kb; RAG2 0.8kb; vWF 1.2kb) for 20 bats and nine outgroups. Phylogenetic analyses with diverse methods all resulted in a well-supported basal split between two groups of bats. The first group, Yinpterochiroptera, includes all of the megabats, the rhinolophoids Rhinolophus, Hipposideros and Megaderma, and the representative rhinopomatid. The second group, Yangochiroptera, comprises the remaining bats, including two species of the rhinolophoid genus Nycteris. Microbats remain paraphyletic, but rhinolophoids are diphyletic. Our results resolve the apparent conflict between molecular data sets and imply that anatomical modifications associated with the nasal-emission of echolocation pulses evolved independently in nycterids versus other rhinolophoids. Our results also have direct implications for the evolution of echolocation and flight in mammals.

Primary and secondary strategies of target localization in flower bats: Spatial memory and cue-directed search

J. Thiele & Y. Winter
University of Munich and Max-Planck-Research Center for Ornithology, Seewiesen, Germany

The reliance on spatial memory to locate food sources can increase foraging efficiency when non-moving and rapidly replenishable food sources are exploited. This is the ecological situation for the neotropical nectarivorous bat *Glossophaga commissarisi*. The major fraction of overall energy consumption in these bats is covered by nectar and pollen gained from flowers that are patchily distributed in tropical forest habitats. As flower nectar is a renewable resource in a distinct location, bats can optimize foraging efficiency by remembering and revisiting flower locations. The reliance of bats on a "memory

strategy" versus a "search strategy" was examined in two behavioral experiments based on a delayed – matching – to – sample protocol. During the learning phase of a trial, bats learnt to obtain food from a single artificial feeder among an array of several, uniquely shaped feeders. For the test phase, the array of feeders was shifted and rearranged so that the spatial cues (absolute location within room and relative position within array of feeders) were dissociated from the object cues (unique shape of feeder). The bats' choice of feeders during the test phase (all feeders unrewarded) was analyzed to deduce the cue types used by the bats for the relocation of the active feeder. The sequential choice of feeders during tests (first six choices evaluated) showed that, initially, bats searched at the absolute location of the formerly rewarding feeder. Subsequently, however, they redirected their visits to the feeder with the shape and hence echoacoustic properties of the formerly rewarding feeder. We conclude that *Glossophaga commissarisi* utilizes spatial memory to relocate flowers. Their search strategy, however, is bimodal, with reliance on spatial memory as the primary and cue-directed search as their secondary strategy to find known flowers.

A Multi-disciplinary Approach To the Conservation of Livingstone's Flying Fox (*Pteropus livingstonii*) in the Comoro archipleago,Western Indian Ocean

W. J. Trewhella will.trewhella@nottingham.ac.uk
Action Comores, c/o IBiS Learning Technology Group, School of Life and Environmental Sciences, University of Nottingham, Nottingham NG7 2 RD, United Kingdom

Livingstone's flying fox (*Pteropus livingstonii*) is an endemic and endangered fruit bat from the Comoro archipelago in the Western Indian Ocean. Conservation goals for this species were outlined in the IUCN Action Plan for Old World Fruit Bats in 1992 and these have been acted on by various organisations. An *in-situ* survey and regular monitoring programme, carried out by trained Comorans, has identified new roost sites and increased the population estimate for this species by an order of magnitude. Research on the ecology of this species shows that it differs from the congeneric *Pteropus seychellensis comorensis*, and is dependent on forest habitat for feeding and roosting. This habitat is threatened by human pressures; however due to political instability and lack of resources, action to protect the forest habitat of this species has been slow to organise. Environmental education programmes to protect the bat and its habitat have been initiated and reviewed, and a captive breeding programme has been successfully started, with bats breeding regularly in Jersey and Bristol Zoos in the United Kingdom. Important lessons for the implementation of conservation programmes can learnt from the last decades work on *P. livingstonii*.

Pattern of torpor use by free-ranging Australian forest bats

C. Turbill, G. Kortner & F. Geiser
School of Biological Sciences, University of New England, Armidale, NSW 2351, Australia

The thermal biology of free-ranging Australian forest microchiropterans is largely unknown, although this information is essential for understanding roost selection according to microclimate. We remotely measured skin temperatures of non-reproductive Nyctophilus geoffroyi (7g) at a cool, high altitude area, and Vespadelus pumilus (4g) at a warm, subtropical, coastal area of south-eastern Australia during summer. Both species roost in trees and entered torpor on 100% of roost-days. Initial torpor bouts usually commenced near sunrise, or earlier during cool nights. On most roost-days, bats used the rise in ambient temperature during the morning for passive re-warming before actively arousing. Bats remained normothermic over the warmest part of the day, but frequently re-entered torpor in the late afternoon when ambient temperatures declined. On cool days, which were more frequent at high altitude, N. geoffroyi could remain torpid throughout the day, whereas on the warmest days torpor was restricted to the morning bout. Final arousals in both species usually occurred around sunset, although N. geoffroyi occasionally remained torpid for up to 40 h. Our study shows that the temporal organization of thermoregulation by these forest bats closely follows the daily cycle in ambient temperature, and darkness acts as a strong cue for arousal from torpor.

The distribution and abundance of insects and Daubenton's bats *Myotis daubentoni* in relation to altitude and small-scale variations in riparian habitat

V. Turner Dept. Biology, Sch. Biol., Univ. Of Leeds, Leeds, North Yorkshire, England

Studies of animal social structure regularly focus on the distribution of fwmales in the population, which are often governed by limited resources such as food and shelter. Male distribution, in turn, is determined by that of the females'. Previous studies have shown marked sexual aggregation in the summer foraging distribution of the temperature-zone insectivorous bat *Myotis daubentonii*. Males forage and roost in the upper river reaches and females lower down. The foraging and prey distribution of this species was studied along a river gradient in relation to variables such as altitude, temperature, water surface state and the presence or absence of bank-side trees. It was significantly colder further up the river with fewer insects and bats than the lower reaches. Volant insects above the water surface were significantly higher in river sections with trees on either one or both banks, as was the abundance of bats. Insect abundance was not related to the water surface condition, but bats avoided rapid and cluttered water, preferring smoother sections. The sexual segregation observed in this species is discussed in terms of temperature-dependent insect distributions, the potential use of torpor in adverse conditions, competitive exclusion of males from the lower reaches by females (and/or dominant adult males) and echolocation constraints.

Local movement patterns in Philippine fruit bats: Who stays, who moves, where, and what then?

R.C.B. Utzurrum josrbu@samoatelco.com
Dept. of Marine & Wildlife Resources (ASG), P.O. Box 3730, Pago Pago, American Samoa 96799, USA

A 14-month mark-release-recapture study of Philippine fruit bats was conducted to 1) estimate home ranges, 2) project habitat requirements, and 3) document patterns of movement among habitats. A total of nine co-existing species were captured in a gradient of continuous habitats ranging from a mosaic of agriculture and secondary growth at 500 m above sea level to mossy forest at 1625 m. Recapture rates ranged from 1% in *Rousettus amplexicaudatus* to 28% in *Haplonycteris fischeri*. In general, recapture and movement patterns revealed: 1) distances moved were not a function of body size; 2) inter-specific differences in habitat use; 3) a general lack of sex- or age-related differences in patterns of habitat affinity; and 4) indications of sex-related behavioral differences in movement. Analysis of patterns suggest that at least three species are already experiencing reduced activity spheres and that habitat degradation differentially impacts endemic species. Results also indicate how sex-based behavioral differences in use of space across habitats may influence social and genetic structuring of local populations. These ecological, social, and genetic correlates of movement patterns could have ultimate ramifications for persistence of and co-existence among species

Variations in wing morphology and flight performance in a few species of South Indian bats

J. Vanitharani[1] & G. Marimuthu[2]
[1]Dept of Zoology, Sarah Tucker College, Affiliated to Manonmaniam Sundaranar University, Tirunelveli – 627 007, India. [2]Dept of Animal Behaviour, Madurai Kamaraj University, Madurai – 625 021, India.

Morphology of an animal reflects its ecology. Flight has enabled bats toexploit a variety of foraging niches inaccessible to other mammals. Observations on wing morphology and flight performance weremade on five species of bats. A frugivore Rousettus leschenaulti, a carnivore Megaderma lyra and three insectivores Taphozous melanopogon, Hipposideros speoris and H. ater were recorded in an area around Tirunelveli (08 44'N lat.77 42'E long) Tamilnadu, South India. The morphological parameters were measured by following the methods described by Norberg and Rayner (1987). The calculations of flight performance were made by following regression equation models given by Rayner (1988) and norberg (1990). The present analysis proves morphological differences among the five species of adult bats results in these species occupying different ecological niches, due to its influence on flight performance, that in turn affects their foraging behaviour and diet. Variations in the wing shape of these bats are due to their different flight demands and the need to minimise flight costs. The results indicate that small difference in wing morphology have significant effects on flight performance.

Habitat use by flying foxes (*Pteropus alecto* and *P. scapulatus*) in monsoonal Australia

M. J. Vardon [1,2] and C. R. Tidemann[1]
[1]Australian National University, School of Resource Management and Environmental Science, Canberra ACT 0200, Australia [2]Present address; Australian Bureau of Statistics, Environment and Energy Section, PO Box 10, Belconnen ACT 2606, Australia

Flying-foxes (*Pteropus alecto* and *P. scapulatus*) are widespread and abundant in monsoonal Australia. The use of camping (=roosting) and foraging habitats were investigated 1992-98. For both species habitat use was strongly seasonal and was linked to food availability, the reproductive cycle, differences in the preferred diets and physical tolerances of the species. Within the species there were differences in habitat use between main (>1,000 occupants) and satellite (<1,000) camps of each species and, for *P. alecto*, between the sexes. The species are partly sympatric, often occurring in mixed species camps, but there were differences in the use of foraging and camping habitats. Both species use essentially the same range of habitats for camps (mangroves, monsoon rainforest, bamboo, *Melaleuca* forest, riparian vegetation) but the frequency and timing of use of each habitat were different. Camp vegetation in the study area was not a limiting factor on the population of either species. A landscape scale analysis of camp patterns found that while there was overlap in the use of habitats, *P. alecto* used a more floristically diverse range of habitats than *P. scapulatus*. Important habitats for *P. alecto* were floodplains, monsoon rainforests, mangroves, Melaleuca forests and *Eucalyptus miniata/E. tetrodonta* woodlands, while for *P. scapulatus* inland habitats were more important, in particular *E. microtheca* and *E. dicrhromophloia* woodlands.

Microsatellite genotypes of big brown bats (*Eptesicus fuscus*) from their feces

S. Vege & G.F. McCracken
American Red Cross, Philadelphia PA, U.S.A. and University of Tennessee,Knoxville,U.S.A.

Big brown bats (*Eptesicus fuscus)* were genotyped from their feces using three sets of microsatellite primers. Genotypes obtained from bat fecal DNA consistently matched the genotypes obtained from DNA extracted from wing membrane tissue of the same bat. Identical microsatellite genotypes were also obtained from multiple fecal DNA samples from the same bat. DNA obtained from feces using a modification to the DNeasy tissue kit (Qiagen) amplified from 92 % (83/90) of the samples upon the first PCR. The use of fecal DNA provides opportunities for addressing ecological and behavioral questions for animals that are difficult to capture, rare, or endangered.

Strategies and conflicts in the harem-polygynous mating system of *Saccopteryx bilineata*

C. C. Voigt[1,2], G. Heckel[1], O. von Helversen[1] [1]Universität Erlangen-Nürnberg, Institut für Zoologie II, Staudtstr. 5, 91058 Erlangen, Germany [2]Lehrstuhl für Verhaltensforschung, Universität Bielefeld, Morgenbreede 45, 33615 Bielefeld, Germany christian.voigt@biologie.uni-bielefeld.de

Daytime roosts of the Neotropical sac-winged bat, *Saccopteryx bilineata* (Emballonuridae) include up to 60 individuals and are located in buttress cavities of trees or in well-illuminated sections of caves. Colonies are structured into harem groups, each of which includes a single male and a varying number of females. In daytime roosts, sac-winged bats do not aggregate into clusters, instead individuals are spaced at least 5–10 cm apart. Agonistic interactions among colony members are frequent. Males are rarely dominant in encounters with females and, as a consequence, harem males are not capable of preventing females from changing between harems. Paternity studies using the DNA-fingerprinting technique have confirmed that males are not able to monopolize the copulations with the females in their harems. However, reproductive success of males correlates, on average, with the size of their harem. Removal experiments of harem males have shown that non-harem males queue for access to harem territories. The need to enter a queue as soon as possible in a male's life may have led to male philopatry in *Saccopteryx bilineata*. We conclude that the mating pattern of *Saccopteryx bilineata* does not resemble a classical harem system. Female choice is probably more important in *Saccopteryx bilineata* than male dominance.

Pollination of the mangrove *Sonneratia caseolaris* (Sonneratiaceae) by nectarivorous fruit bats in a riparian mangrove ecosystem, Peninsular Malaysia – A preliminary study

S. Watzke stwatzke@gmx.de
Zoologisches Inst., AG Winter, Ludwig-Maximilians-Universität München, 80333 München, Germany

The mangrove *Sonneratia caseolaris* is distributed from Ceylon throughout South-East Asia where it grows inland along tidal creeks as far as the influence of salinity extends. Along the river 'Sungai Selangor', Pensinsular Malaysia, this chiropterophilous plant is very common and often referred to as the 'firefly mangrove'. It is pollinated by macroglossine bats, mainly by *Macroglossus minimus*. This study investigates the plant-pollinator interface (analysis of the foraging behaviour of macroglossine bats, pollination efficiency) and the breeding system of *Sonneratia caseolaris* in relation to the flowering phenology and floral rewards (nectar volume and concentration, nectar production rates and rhythms). Flowers are produced asynchronously throughout the year and only open for one night. The flowers produce large amounts of nectar only during the first hours after opening. After that, nectar amounts and concentrations decrease rapidly until first stamens fall from the flowers around 8 hrs after opening. Experimental cross- and self-pollination shows, that *Sonneratia caseolaris* is self-compatible, but fruit set and fruit quality (fruit size, seed numbers) are much higher under natural conditions and experimental cross-pollination. Due to the flower structure, *Sonneratia caseolaris* seems to be mainly dependent on outcrossing.

Foraging patterns, resource utilization and mating system of the nectarivorous fruit bat *Macroglossus* in a riparian mangrove ecosystem, Peninsular Malaysia

S. Watzke stwatzke@gmx.de
Zoological Institute, AG Winter, Ludwig-Maximilians-University Munich, 80333 Munich, Germany

The long-tongued fruit bat *Macroglossus minimus* is a small nectarivorous bat. It is the primary pollinator for numerous plant species. This study is focused on foraging behaviour and the mating system and specifically tries to address the following questions: (1) How are food resources allocated between individuals? (2) Is the social structure and mating system an adaptation to patterns of food resource availability? Methods used are (1) capture-mark-recapture to analyse the population structure, (2) radio telemetry to monitor activity periods and time budgets, to determine home range sizes and core-use areas and to identify roosts, (3) identification of food sources and evaluation of resource quality and quantity, (4) experimental manipulations of food availability in order to study the effect of resource quantity and quality on space use and social interactions. First results show that males and females follow different strategies of resource utilization and habitat use. Reproductively active males tend to have smaller home ranges but a much higher activity budget than females. These males appear to monopolise food resources and seem to defend part of their home ranges as mating territories. Roosts are exclusively used by solitary individuals. No female aggregation occurs.

Daily torpor use by temperate insect-eating bats in natural roosts.

C.K.R. Willis & R.M. Brigham willis1c@uregina.ca
Dept of Biology, University of Regina, Regina, Saskatchewan, S4S 0A2, Canada

Endothermic animals, like temperate insect-eating bats that live in areas where food resources and climate fluctuate may depend on daily torpor to defray thermoregulatory costs. Daily torpor is a short-term reduction in body temperature and metabolic rate that has been studied extensively in mammals. However, until recently, bats have received little research attention in this context. Torpor results in considerable energy savings for bats but is not without costs: predation risk may increase during torpor, and reproductive costs may be considerable. For example, the use of torpor by pregnant bats slows fetal growth and delays parturition, while torpor use during the lactation period slows milk production and juvenile growth. Female bats in temperate areas are typically the sole providers of parental care so these costs likely exert more selection pressure on them than on males, and several studies have confirmed that reproductive female bats use torpor less often than males. A number of adaptations are thought to help females avoid torpor while reproductive, including clustering in maternity colonies. Along these lines, the selection of maternity roost sites by bats, based on characteristics that could optimize microclimate, has been a recent research focus,

especially for bats roosting in natural roosts like tree cavities and rock crevices. We review current research addressing the relationship between gender, use or avoidance of torpor, and roost selection in temperate areas where bats depend on natural roosts. We also present new data comparing use of torpor and roost selection in cavity and foliage roosting, temperate insect-eating bats.

The energy link: from physiology to community ecology of nectar-feeding bat

Y. Winter winter@zi.biologie.uni-muenchen.de
Zoological Institute, University of Munich, 80333 Muenchen, Germany

To secure vertebrate pollination services, a plant must enable its pollinator to maintain a balanced energy budget. The offering of large energy rewards, however, is only one side of the equation. By directly promoting foraging efficiency, plants reduce their pollinators' energetic demands. Floral adaptations in pollination systems of glossophagine bats that reduce the cost of foraging by minimising search time include: i) floral advertisement with an olfactory 'trade-mark' that is specific for bat-pollinated flowers, ii) acoustic nectar-guides that facilitate sonar flower localization and iii) sequential flowering phenology that capitalizes on the excellent special memory of bats. Recent advances in our knowledge of energetics of glossophagine bats (daily energy requirements, energetic cost of foraging flight and hovering flight, flight speeds, nectar extraction efficiencies) now permit, for the different degrees of flower search efficiency, the quantitative prediction of minimum floral nectar production rates that are necessary for maintaining bat pollinator populations. Bat pollination systems thus provide a general model for the effect of food energy distribution on population parameters in multi-species assemblages.

Body mass and thermal environment affect torpor in heterothermic bats

M. Wojciechowski, E. T_gowska, M. Jefimow
N. Copernicus University, Institute of General and Molecular Biology, Department of Animal Physiology, PL 87-100 Toru_, POLAND, ul. Gagarina 9 mwojc@biol.uni.torun.pl

Under natural conditions factors responsible for the induction of the lethargy states in heterothermic bats usually act in common giving no possibility to separate their influence on animal's adaptive strategies. The questions we wanted to answer in our experiments was: to what extent food limitation and thermal environment are responsible for the induction and modulation of lethargy states and how this influence changes due to different body mass of the species studied? The experiments were performed in the winter seasons 1999, 2000 and 2001 (January – March; natural photoperiod) on 6 males of *Myotis myotis* (mean body mass 33g) and on 3 males of *Myotis daubentonii* (mean body mass 6g). In our investigations we used a temperature gradient system that allowed optional selection of ambient temperature. Simultaneously animal's activity and its body temperature (in the interscapular region) were recorded. In 1999 and in 2001 the experiments were performed in a "high gradient" (range 7-43^{o}C) and in 2000 in a "low gradient" (range 0-20^{o}C). Our results indicate that the ability of entering the torpid state is independent of body mass or of thermal environment. However, the pattern (length and depth) of the lethargy states in heterothermic bats depends on the species' body mass and on the thermal environment that informs bats about the food availability. Both those factors highly control the torpor to minimise the costs of survival in the face of unfavourable environmental conditions. [Partially supported by KBN grant no. 6 P04C 02019]

Reproduction status of male *Cynopterus brachyotis* in an agriculture area and a fragmented forest

[1]C. H. Wong, [1]T. W. Tay, [1]M.T.Marina, [1]A. Zubaid & [2]A. B. Kamis
[1]School of Environmental Sciences & Natural Resources, [2]School of Biosciences & Biotechnology, Faculty of Science & Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor

This study was conducted at an agricultural area (Kuala Perlis, Perlis) and a fragmented forest area (UKM Forest Reserve, Selangor) for 12 months from April 2000 to March 2001. The main objective was to gather information on the reproductive status of male *Cynopterus brachyotis*, a frugivorous bat which is considered to be an important seed disperser in paleotropical forests. Sampling on bats was carried out using mist-nets. A standard histological and sperm count method were used to study the changes in the reproductive organ, namely the testes. Male *Cynopterus brachyotis* in Kuala Perlis and U K M Forest

Reserve both most likely experienced two high spermatogenesis seasons annually at different times. Both seasons were coincided with the fruiting seasons in both sites respectively. Reproduction of the species is likely performed seasonal with continuous bimodal polyoestry-males may have some spermatozoa in the testis and epididymis year-round but, like the females, are considered to demonstrate two breeding peaks, as shown by bimodal peaks in testicular weight and size and in the presence of epididymal spermatozoa.

Bat conservation in Malaysia

C.A. Yeap[1] & A. Zubaid[2]
[1]Malaysian Nature Society, JKR 641, Jalan Kelantan, 50480 Kuala Lumpur
[2]Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi

Malaysia is one of the 'hot spots' for bat diversity in the Indo-Malayan region. However, the conservation of bats in the country has not gained much attention compared to other more enigmatic mammals and even birds. The misconceptions of bats still persist within the general public hence their lack of popularity. Despite the current situation, bats are afforded protection through three major wildlife laws while most of their habitats are located under Malaysia;'s protected areas system. Although bats are known to play crucial roles in the ecosystem and even to our economy through ecotourism, bts are still being persecuted. Habitats are increasingly under pressure from various forms of development, resulting in fragmentation and habitat unsuitability. These new developments must be taken into account in bat conservation hence the need to review extant wildlife and habitat protection laws in Malaysia. Apart from these, awareness campaigns may be necessary to dispel all misconceptions before the Malaysian people can appreciate our bat diversity.

National Bat Conference of the Bat Conservation Trust

31 August - 2 September

Nottingham University, Nottingham, UK

The papers presented at the conference did not all have prepared abstracts and quite few of these were of very local interest. Instead of abstracts, the titles are presented here along with the authors' names, addresses and e-mails. Those who wish to learn more on any of these topics are encouraged to contact the authors directly. GRH

Sexual segregation in Daubenton's bat populations on an upland river.

John Altringham, School of Biology, University of Leeds, Leeds,LS2 9JT UK
j.d.altingham@leeds.ac.uk

Habitat use by Italian bats

Danilo Russo and Gareth Jones, School of biological Sciences, University of Bristol, Bristol, BS8 1UG
Gareth.Jones@bris.ac.uk

Bat-tling against tree fellers

Dave Dawson, no address given

The NBMP - Which bat do we want to be?

Colin Cato[1], Jules Agate[1] and Allyson Walsh[2], [1] The Bat Conservation Trust, 15 Cloisters House, 8 Battersea Park Road, London, SW8 4BG nbmp@bats.org.uk , [2] Bat Conservation International, PO Box 162603 Austin, TX 78716 awalsh@batcon.org

Rabies and bats:Public health implications

Anthony Fooks, Rabies Research and Diagnosis Group, Dept. Virology, Veterinary Laboratories Agency (Weybidge) New Haw, Addlestone, Surrey, KT15 3NB UK no e-mail given

The northern Ireland bat survey

Jon Russ and W.I. Montgomery, The Queens University, Lisburn Road, Belfast, BT9 7BL, UK
j.russ@qub.ac.uk

Bat protection and research in the Nietoperek Bat Reserve, West Poland

Tomasz Kokurewicz, Agricultural University of Wroclaw, Wroclaw, Poland
kokur@ozi.ar.wroc.pl

The biology of cave spiders

Peter Smithers, Dept. Biological Science, Universsity of Plymouth, Drake circus, Plymouth, Devon, PL4 8AA UK no e-mail given

Hedgerow architecture and its use by bats

Ruth D. Warren, no address given

The English Nature Horseshoe Bat Project: Securing favourable land management in roost sustenance zones in southwest England

James Diamond, English Nature, Level 2,Renslade House, Bonhay road, Exeter, Devon, EX4 3AW UK. james.diamond@english-nature.org

Hertfordshire Barn Conversion Survey 2000: A Study of Bats in Barn conversions in Hertfordshire

Patty Briggs, Claybury Cottage, 8 Sparrows Herne, Bushey, Herfordshire WD2 3EU, UK
pattybriggs@cwcom.net

The use of historic parkland by forging bats

Miriam Glendell[1] and Nancy Vaughan[2], [1] Birkbeck College, University of London, London WC1B 5DQ, UK and [2]School of biological Sciences, University of Bristol, Bristol, BS8 1UG
No e-mail given

The nutritional ecology of *Pteropus rufus* in S.E. Madegascar

Emma Long[1] P. A. Racey[1] and G. R. Iason[2]. [1] Dept of Zoology, Universtiy of Aberdeen, Aberdeen AB24 2TZ and [2]Macaulay Land Use Research Institute, Craigiebuckler, Aberdeen, AB15 8QH, UK
e.long@abdn.ac.uk

RECENT LITERATURE

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

ANATOMY

Bhatnagar, K. P., T. D. Smith, A. Krishna, U. P. Singh, and J. R. Wible. 2001. The vespertilionid vomeronasal organ: An investigation on the VNO of *Scotophilus* (Chiroptera, Vespertilionidae). Acta Chiropterologica, 3: 119-128. [Univ. Louisville, Sch. Med., Louisville, KY 40292; bhatnagar@louisville.edu]

Makanya, A. N., T. J. Self, C. N. Warui, and D. K. Mwangi. 2001. Gut morphology and morphometry in the epauletted Wahlberg's fruit bat (*Epomophorus wahlbergi*, Sundevall, 1846). Acta Biologica Hungarica, 52: 75-89. [Univ. Bern, Inst. Anat., Buhlstr 26, CH-3000 Bern 9, Switzerland; makanya@ana.unibe.ch]

Manger, P. R., R. Collins, and M. G. P. Rosa. 2001. An architectonic comparison of the ventrobasal complex of two Megachiropteran and one Microchiropteran bat: Implications for the evolution of Chiroptera. Somatosensory & Motor Research, 18: 131-140, 2001. [Karolinska Inst., Dept. Neurosci., Div. Neuroanat. & Brain Dev., Berzelius Vag 3, Plan 5, S-17177 Stockholm, Sweden, Paul.Manger@neuro.ki.se]

Morigaki, T., M. Kurohmaru, Y. Kanai, M. Mukohyama, E. Hondo, J. Yamada, S. Agungpriyono, and Y. Hayashi. 2001. Cycle of the seminiferous epithelium in the Java fruit bat (*Pteropus vampyrus*) and the Japanese lesser horseshoe bat (*Rhinolophus cornutus*). Journal of Veterinary Medical Science, 63: 773-779. [Univ. Tokyo, Dept. Vet. Anat., Tokyo 1138657, Japan]

Stockwell, E. F. 2001. Morphology and flight manoeuvrability in New World leaf-nosed bats (Chiroptera: Phyllostomidae). Journal of Zoology, 254(Part 4): 505-514. [Dalhousie Univ., Dept. Biol., Halifax, NS B3H 4J1, Canada; liz.stockwell@dal.ca]

Watts, P., E. J. Mitchell, and S. M. Swartz. 2001. A computational model for estimating the mechanics of horizontal flapping flight in bats: Model description and validation. Journal of Experimental Biology, 204: 2873-2898. [Swartz: Brown Univ., Dept. Ecol. & Evolutionary Biol., Providence, RI 02912; sharon_swartz@brown.edu]

BEHAVIOR

Baker, G. B., L. F. Lumsden, E. B. Dettmann, N. K. Schedvin, M. Schulz, D. Watkins, and L. Jansen. 2001. The effect of forearm bands on insectivorous bats (Microchiroptera) in Australia. Wildlife Research, 28: 229-237. [Australian Bird & Bat Banding Scheme, GPO Box 8, Canberra, ACT 2601, Australia]

Fullard, J. H. 2001. Auditory sensitivity of Hawaiian moths (Lepidoptera: Noctuidae) and selective predation by the Hawaiian hoary bat (Chiroptera: *Lasiurus cinereus semotus*). Proceedings of the Royal Society of London - Series B: Biological Sciences, 268(1474):1375-1380. [Univ. Toronto, Erindale Coll., Dept. Zool., Mississauga, ON L5L 1C6, Canada; jfullard@credit.erin.utoronto.ca]

Kerth, G., M. Wagner, and B. Konig. 2001. Roosting together, foraging apart: information transfer about food is unlikely to explain sociality in female Bechstein's bats (*Myotis bechsteini*). Behavioral Ecology & Sociobiology, 50: 283-291. [Univ. Wurzburg, Inst. Anim. Ecol. & Trop. Biol., Biozentrum, Hubland, D-97074 Wurzburg, Germany; kerth@zool.unizh.ch]

Pavey, C. R., J. E. Grunwald, and G. Neuweiler. 2001. Foraging habitat and echolocation behaviour of Schneider's leaf nosed bat, *Hipposideros speoris*, in a vegetation mosaic in Sri Lanka. Behavioral

Ecology & Sociobiology, 50: 209-218. [Pk. & Wildlife Commiss. No. Terr., Arid Zone Res. Inst., POB 1046, Alice Springs, NT 0871; chris.pavey@plmbay.pwcnt.nt.gov.au]

Sano, A., and K. Akita. 2001. Burrowing behavior of the Japanese large-footed bat, *Myotis macrodactylus*. Honyurui Kagaku (Mammalian Science), 41: 83-86. [Forestry Res. Div., Mie Prefectural Sci. and Tech. Promotion Ctr., Hakusan, Mie 515-2602, Japan]

CONSERVATION

Clarke, F. M., and J. R. Downie. 2001. A bat (Chiroptera) survey of mora rainforest in Trinidad's Victoria-Mayaro Forest Reserve. Biodiversity & Conservation, 10: 725-736. [Univ. Aberdeen, Dept. Zool., Aberdeen AB24 2TZ, Scotland, UK; f.clarke@abdn.ac.uk]

Hickey, M. B. C., M. B. Fenton, K. C. MacDonald, C. Soulliere. 2001. Trace elements in the fur of bats (Chiroptera: Vespertilionidae) from Ontario and Quebec, Canada. Bulletin of Environmental Contamination & Toxicology, 66: 699-706. [St. Lawrence River Inst. Environm. Sci., 2 Belmont St.,Windmill Point, Cornwall, ON K6H 4Z1]

Lee, Y.-F., and Y.-M. Kuo. 2001. Predation on Mexican free-tailed bats by peregrine falcons and red-tailed hawks. Journal of Raptor Research, 35: 115-123. [Div. Forest Protection, Taiwan Forestry Research Institute, Taipei, Taiwan 10051; abramus@protect.tfri.gov.tw]

Martin, K. W., W. L. Puckette, S. L. Hensley, and D. M. Leslie, Jr. 2000. Internal cave gating as a means of protecting cave-dwelling bat populations in eastern Oklahoma. Proceedings of the Oklahoma Academy of Science, 80: 133-137. [Dept. Math and Sci., Rogers State Univ., Claremore, OK 74017]

DISTRIBUTION/FAUNAL STUDIES

Bates, P. J. J., T. Nwe, K. M. Swe, and S. S. H. Bu. 2001. Further new records of bats from Myanmar (Burma), including *Craseonycteris thonglongyai* Hill 1974 (Chiroptera: Craseonycteridae). Acta Chiropterologica, 3: 33-41. [Harrison Inst., Ctr. Systemat. & Biodivers. Res., Bowerwood House, St. Botolphs Rd., Sevenoaks TN13 3AQ, Kent, England; hzm@btinternet.com]

Bogan, M. A., and P. M. Cryan. 2000. The bats of Wyoming. Fort Hays Studies, Special Issue 1: Pp. 71-94 *in* Reflections of a Naturalist: Papers Honoring Professor Eugene D. Fleharty (J. R. Choate, ed.), Fort Hays State University, Hays, Kansas; 241 pp. [USGS, Midcontinent Ecological Sci. Ctr., Dept. Biol., Univ. New Mexico, Albuquerque, NM 87131]

Bouchard, S. 2001. Sex discrimination and roostmate recognition by olfactory cues in the African bats, *Mops condylurus* and *Chaerephon pumilus* (Chiroptera: Molossidae). Journal of Zoology, 254(Part 1): 109-117. [Zoo Sauvage St. Felicien, CP 90, St. Felicien, PQ G8K 2P8; sylvie.zoo@mail.com]

Hendrichsen, D. K., P. J. J. Bates, and B. D. Hayes. 2001. Recent records of bats (Chiroptera) from Cambodia. Acta Chiropterologica, 3: 21-32. [Harrison Inst., Ctr. Systemat. & Biodivers. Res., Bowerwood House, St. Botolphs Rd., Sevenoaks TN13 3AQ, Kent, England; hzm@btinternet.com]

Higginbotham, J. L., and C. Jones. 2001. The southeastern myotis, *Myotis austroriparius* (Chiroptera: Vespertilionidae), from Comanche County, Texas. Texas Journal of Science, 53: 193-195. [Texas Tech Univ., Dept. Biol. Sci., Lubbock, TX 79409; cjones@packrat.musm.ttu.edu]

Owen, S. F., M. A. Menzel, W. M. Ford, B. R. Chapman, K. V. Miller, J. W. Edwards, and P. B. Wood. 2001. First summer record of a female Indiana bat, *Myotis sodalis*, in West Virginia. Journal of the Elisha Mitchell Scientific Society, 117: 132-134.

Richardson, P. (ed.) 2000. Distribution atlas of bats in Britain and Ireland 1980-1999. The Bat Conservation Trust. [10 Bedford Cottages, Great Brington, Northampton NN7 4JF, £5.50 (checks payable to the Bat Conservation Trust)]

Russ, J. M., A. M. Hutson, W. I. Montgomery, P. A. Racey, and J. R. Speakman. 2001. The status of Nathusius' pipistrelle (*Pipistrellus nathusii* Keyserling & Blasius, 1839) in the British Isles. Journal of Zoology, 254 (Part 1): 91-100. [Queens Univ. Belfast, Sch. Biol. & Biochem., Med. Biol. Ctr., 97 Lisburn Rd., Belfast BT9 7BL, Antrim, North Ireland]

Sparks, D. W., and J. R. Choate. 2000. Distribution, natural history, conservation status, and biogeography of bats in Kansas. Fort Hays Studies, Special Issue 1: Pp. 173-228 *in* Reflections of a Naturalist: Papers Honoring Professor Eugene D. Fleharty (J. R. Choate, ed.), Fort Hays State University, Hays, Kansas; 241 pp. [Dept. Life Sci., Indiana State Univ., Terre Haute, IN 47809]

ECHOLOCATION

Gannon, W. L., R. E. Sherwin, T. N. deCarvalho, and M. J. O'Farrell. 2001. Pinnae and echolocation call differences between *Myotis californicus* and *M. ciliolabrum* (Chiroptera: Vespertilionidae). Acta Chiropterologica, 3: 77-91. [Univ. New Mexico, Museum SW Biol., Div. Mammals, Albuquerque, NM 87131; wgannon@unm.edu]

ECOLOGY

Brooke AP. 2001 Population status and behaviours of the Samoan flying fox (*Pteropus samoensis*) on Tutuila Island, American Samoa. Journal of Zoology, 254(Part 3): 309-319. [POB 102, Newfields, NH 03856; abrooke@nh.ultranet.com]

Bullen, R., and N. L. McKenzie. 2001. Bat airframe design: flight performance, stability and control in relation to foraging ecology. Australian Journal of Zoology, 49: 235-261. [Dept. Conservat. & Land Management, POB 51, Wanneroo, WA 6065, Australia]

Jurczyszyn, M., and R. Bajaczyk. 2001. Departure dynamics of *Myotis daubentonii* (Kuhl, 1817) (Mammalia, Chiroptera) from their hibernaculum. Mammalia, 65: 121-129. [Adam Mickiewicz Univ., Dept. Systemat. Zool., Fredry 10, PL-61701 Poznan, Poland]

Menzel, M. A., T. C. Carter, L. R. Jablonowski, B. L. Mitchell, J. M. Menzel, and B. R. Chapman. 2001. Home range size and habitat use of big brown bats (*Eptesicus fuscus*) in a maternity colony located on a rural-urban interface in the southeast. Journal of the Elisha Mitchell Scientific Society, 117: 36-45.

Quang, P. N., and J. F. Voisin. 2001. Bats and Rodents in swiftlet caves in Vietnam (Chiroptera and Rodentia). Mammalia, 65: 253-257. [Khanh Hoa Salangane Nest Co., 38-40 Tran Quy Cap, Nha Trang, Khanh Hoa]

Rodriguez-Duran, A., and R. Vazquez. 2001. The bat *Artibeus jamaicensis* in Puerto Rico (West Indies): Seasonality of diet, activity, and effect of a hurricane. Acta Chiropterologica, 3: 53-61. [Inter Amer. Univ. Puerto Rico, Dept. Nat. Sci., Bayamon, PR 00957; arodriguez@bc.inter.edu]

Rossiter, S. J., G. Jones, R. D. Ransome, and E. M. Barratt. 2001. Outbreeding increases offspring survival in wild greater horseshoe bats (*Rhinolophus ferrumequinum*). Proceedings of the Royal Society of London - Series B: Biological Sciences, 268: 1055-1061. [Univ. Bristol, Sch. Biol. Sci., Woodland Rd., Bristol BS8 1UG, Avon; s.j.rossiter@qmw.ac.uk]

Siemers, B. M., C. Dietz, D. Nill, and H. U. Schnitzler. 2001. *Myotis daubentonii* is able to catch small fish. Acta Chiropterologica, 3: 71-75. [Univ. Tubingen, Inst. Zool., Dept. Anim. Physiol., Morgenstelle 28, D-72076 Tubingen, Germany; bjoern.siemers@uni-tuebingen.de]

Sparks, D. W., K. J. Roberts, and C. Jones. 2000. Vertebrate predators on bats in North America north of Mexico. Fort Hays Studies, Special Issue 1: Pp. 229-241 *in* Reflections of a Naturalist: Papers Honoring Professor Eugene D. Fleharty (J. R. Choate, ed.), Fort Hays State University, Hays, Kansas; 241 pp. [Dept. Life Sci., Indiana State Univ., Terre Haute, IN 47809]

Waldien, D. L., and J. P. Hayes. 2001 Activity areas of female long-eared myotis in coniferous forests in western Oregon. Northwest Science, 75: 307-314. [Oregon State Univ., Dept. Fisheries & Wildlife, Corvallis, OR 97331; David.Waldien@orst.edu]

EVOLUTION

Juste, J., C. Lopez-Gonzalez, and R. E. Strauss. 2001. Analysis of asymmetries in the African fruit bats *Eidolon helvum* and *Rousettus egyptiacus* (Mammalia: Megachiroptera) from the islands of the Gulf of Guinea. I. Variance and size components of bilateral variation. Journal of Evolutionary Biology, 14: 663-671. [CSIC, Estac. Biol. Donana, Avda Ma Luisa S-N, E-41013 Seville, Spain; juste@ebd.csic.es]

Juste, J., C. Lopez-Gonzalez, and R. E. Strauss. 2001. Analysis of asymmetries in the African fruit bats *Eidolon helvum* and *Rousettus egyptiacus* (Mammalia: Megachiroptera) from the islands of the Gulf of Guinea. II. Integration and levels of multivariate fluctuating asymmetry across a geographical range. Journal of Evolutionary Biology, 14: 672-680.

Kingston, T., M. C. Lara, G. Jones, Z. Akbar, T. H. Kunz, and C. J. Schneider. 2001. Acoustic divergence in two cryptic *Hipposideros* species: A role for social selection? Proceedings of the Royal Society of London - Series B: Biological Sciences, 268: 1381-1386. [Boston Univ., Dept. Biol., 5 Cummington St., Boston, MA 02215; tigga@bio.bu.edu]

Lewis-Oritt, N., R. A. Van Den Bussche, and R. J. Baker. 2001. Molecular evidence for evolution of piscivory in *Noctilio* (Chiroptera: Noctilionidae). Journal of Mammalogy, 82: 748-759. [Baker: Texas Tech Univ., Dept. Biol. Sci., Lubbock, TX 79409 ; rjbaker@ttu.edu]

Storz, J. F., H. R. Bhat, and T. H. Kunz. 2001. Genetic consequences of polygyny and social structure in an Indian fruit bat, *Cynopterus sphinx*. I. Inbreeding, outbreeding, and population subdivision. Evolution, 55: 1215-1223. [Univ. Arizona, Dept. Ecol. & Evolut. Biol., Tucson, AZ 85721; storz@u.arizona.edu]

Storz, J. F., H. R. Bhat, and T. H. Kunz. 2001. Genetic consequences of polygyny and social structure in an Indian fruit bat, *Cynopterus sphinx*. II. Variance in male mating success and effective population size. Evolution, 55: 1224-1232.

NATURAL HISTORY

O'Donnell, C. F. J. 2001. Advances in New Zealand mammalogy 1990-2000: Long-tailed bat. Journal of The Royal Society of New Zealand, 31: 43-57. [Sci. and Res. Unit, Dept. Conservat, Private Bag, Christchurch, New Zealand; codonnell@doc.govt.nz]

PALEONTOLOGY

Springer, M. S., E. C. Teeling, O. Madsen, M. J. Stanhope, and W. W. de Jong. 2001. Integrated fossil and molecular data reconstruct bat echolocation. Proceedings of the National Academy of Sciences of the United States of America, 98: 6241-6246. [Univ. Calif. Riverside, Dept. Biol., Riverside, CA 92521; mark.springer@ucr.edu]

PARASITOLOGY

Esteban, J., G., B. Amengual, and J. S. Cobo. 2001. Composition and structure of helminth communities in two populations of *Pipistrellus pipistrellus* (Chiroptera: Vespertilionidae) from Spain. Folia Parasitologica, 48: 143-148. [Univ. Valencia, Fac. Farm, Dept. Parasitol., Av. Vicente Andres Estelles S-N, Valencia 46100, Spain; Jguillermo.Esteban@uv.es]

Ritzi, C. M. and M. K. Clark. 2001. New ectoparasite records of bats from North Carolina. Journal of the Elisha Mitchell Scientific Society, 117: 135-137.

PHYSIOLOGY

Cruz-Neto, A. P., T. Garland, Jr., and A. S. Abe. 2001. Diet, phylogeny, and basal metabolic rate in phyllostomid bats. Zoology, 104: 49-58. [Dept. Zoolog., IB, Univ. Estadual Paulista, CP 199 13506-900, Rio Claro, SP, Brasil; neto@rc.unesp.br]

Hosken, D. J., and J. E. O'Shea. 2001. Sperm production and immune function in two Australian bats, *Chalinolobus morio* and *Nyctophilus geoffroyi*. Ethology Ecology & Evolution, 13: 173-180. [Univ. Zurich, Zool. Museum, Winterthurerstr 190, CH-8057 Zurich, Switzerland; hosken@zoolmus.unizh.ch]

O'Brien, G. M., E. Ogawa, and N. S. Agar. 2000. Oxidant defence in the red blood cells of the greyheaded flying fox, *Pteropus poliocephalus*. Comparative Haematology International, 10: 200-202. [Univ. New England, Sch. Biol. Sci., Armidale, NSW 2351, Australia; gobrien@metz.une.edu.au]

Simbauni, J. A., and R. T. F. Bernard. 2001. Changes in the abundance of cells in the anterior pituitary gland and the possible roles of luteinizing hormone, prolactin and progesterone in the control of delayed implantation in the straw-coloured fruit bat (*Eidolon helvum*) African Zoology, 36: 63-70, 2001. [Kenyatta Univ., Dept. Zool., POB 43844, Nairobi, Kenya; jsimbauni@avu.org]

REPRODUCTION

Lloyd, S., A. J. Bradley, and L. S. Hall. 2001. Changes in progesterone and testosterone during the breeding season of the large-footed myotis *Myotis moluccarum* (Microchiroptera: Vespertilionidae). Acta Chiropterologica, 3: 107-117. [Univ. Queensland, Dept. Vet. Pathol. & Anat., Brisbane, Qld 4072, Australia; Shan.Lloyd@mailbox.uq.edu.au]

Stevens, R. D. 2001 Twinning in the big fruit-eating bat *Artibeus lituratus* (Chiroptera: Phyllostomidae) from eastern Paraguay. Mammalian Biology, 66: 178-180. [Texas Tech Univ., Dept. Biol. Sci., Lubbock, TX 79409; cmrds@ttacs.ttu.edu]

Vivier, L., and M. van der Merwe. 2001. Aspects of the histology of reproduction in the female Angolan free-tailed bat *Mops condylurus* (Microchiroptera: Molossidae) in Mpumalanga, South Africa. Journal of Zoology, 254 (Part 4): 495-504. [Univ. Zululand, Dept. Zool., ZA-3886 Kwa Dlangezwa, South Africa]

SYSTEMATICS

Eger, J. L., and D. A. Schlitter. 2001. A new species of *Glauconycteris* from West Africa (Chiroptera : Vespertilionidae). Acta Chiropterologica, 3: 1-10. [Royal Ontario Museum, Ctr. Biodivers. & Conservat. Biol., 100 Queens Pk., Toronto, ON M5S 2C6; judithe@rom.on.ca]

Kock, D. 2001. *Pipistrellus africanus meesteri*, nom. nov for *Pipistrellus nanus australis* Roberts, 1913 (Mammalia: Chiroptera: Vespertilionidae). Acta Chiropterologica, 3: 129-130. [Forsch Inst. Senckenberg, Senckenberganlage 25, D-60325 Frankfurt, Germany; dkock@sng.uni-frankfurt.de]

Lopez-Gonzalez, C., and S. J. Presley. 2001. Taxonomic status of *Molossus bondae* J. A. Allen, 1904 (Chiroptera: Molossidae), with description of a new subspecies. Journal of Mammalogy, 82: 760-774. [Inst. Politecn. Nacl., Comis Fomento Act. Acad., Ctr. Interdisciplinario Invest. Desarrollo Integral, Unidad Durango, Sigma S-N Fracc 20 Noviembre 2, Durango 34220, Mexico; celialg@prodigy.net.mx]

Tsytsulina, K. 2001. *Myotis ikonnikovi* (Chiroptera, Vespertilionidae) and its relationships with similar species. Acta Chiropterologica, 3: 11-19. [Russian Acad. Sci., Inst. Zool., Universitetskaya Nab. 1, St. Petersburg 199034, Russia; tsk@ec5792.spb.edu]

VIROLOGY

Badrane, H., and N. Tordo. 2001. Host switching in *Lyssavirus* history from the chiroptera to the carnivora orders. Journal of Virology, 75: 8096-8104. [Tordo: Inst. Pasteur, Lab. Lyssavirus, Dept. Virol., 25 Rue Dr. Roux, F-75724 Paris 15, France; ntordo@pasteur.fr]

Moutou, F., and M. Artois. 2001. Wild mammals as possible reservoir of zoonoses. Medecine et Maladies Infectieuses, 31 (Suppl 2): 159S-167S. [Afssa Lerpaz, Epidemiol. Unit, BP 67, F-94703 Maisons Alfort, France.; f.moutou@alfort.afssa.fr, m.artois@vet-lyon.fr]

Johara, M. Y., H. Field, A. M. Rashdi, C. Morrissy, B. van der Heide, P. Rota, A. bin Adzhar, J. White, P. Daniels, A. Jamaluddin, and T. Ksiazek. 2001. Nipah virus infection in bats (order Chiroptera) in peninsular Malaysia. Emerging Infectious Diseases, 7: 439-441. [Field: Queensland Dept. Primary Ind., Anim. Res. Inst., LMB 4 Moorooka, Brisbane, Qld 4105,; fieldh@prosc.dpi.qld.gov.au]

EQUIPMENT GRANTS PROGRAM

Sandpiper Technologies, Inc. is now accepting Equipment Grant applications for the 2002 field season. The company specializes in electronics for wildlife research and offers free use of its video equipment rental equipment to undergraduate and post graduate students. Implemented in 1997, this program has been used throughout the U.S. and Canada. During the 2001 field season, over 10 students received free use of equipment for a complete field season, and 12 students received $200 cash grants. Equipment discounts to universities are also available.

AVAILABLE EQUIPMENT

* TreeTop Peeper Video System
  - Monitor and b/w camera on a 16, 35 or 50-foot pole
* Basic Sentinel Video System
  - Time-lapse VCR, b/w or color camera, 25m cable and camera set-up kit
* Burrow Video Probe with head mounted video display and one of two video camera probe options:
  - 2.3-inch dia., 3-meter gooseneck (Peeper Video Probe)
  - 1.0-inch dia., 3-meter gooseneck (Peep-A-Roo)

Equipment specifications can be found at: http://www.Sandpipertech.com

HOW TO APPLY

Applications are accepted year-round, but students needing equipment for the spring/summer season should apply by December 1, 2001.

Applicants must

1) Describe their project and how they plan to use the equipment.
2) Describe the size of the critter to be studied and the habitat.
3) Specify the length of the field season, and the preferred equipment schedule.

DEADLINE: December 1, 2001 for the 2002 field season. Decisions are based on the proposal, field survey schedules and equipment availability.

Contact Ann Christensen, Sandpiper Technologies, Inc.
535 W. Yosemite Ave.
Manteca, CA 95337
e-mail: Ann@Sandpipertech.com (209) 239-7460 http://sandpipertech.com

Future Meetings

October 24 to 27, 2001

The 31st Annual North American Symposium on Bat Research will meet in the beautiful city of Victoria, British Columbia, Canada, October 24 - 27, 2001, hosted by Mark Brigham of the University of Regina. All formal sessions of the 31st Symposium will be held at the Victoria Conference Center, which is immediately adjacent (and connected) to The Empress Hotel, one of the grandest, most spectacular hotels in the world. We have obtained outstandingly good room rates for conference attendees at the Empress. Mark has also arranged that our conference banquet will be held in the Crystal Garden. This promises to be a truly memorable symposium. For details see our web site at: www.nasbr.com

February 2002 (exact dates not yet determined)

The Southeastern Bat Diversity Network (SPDN) will hold its annual meeting in Clemson, S. C. in February 2002. The SBDN meeting will be held in conjunction with the Colloquium on the of Mammals in the Southeastern U. S. Registration and other details will be available later this year. Mary Kay Clark, Curator of Mammals N.C. State Museum of Natural Sciences
E - mail: mkclark1@mindspring.com

April 2 to April 5, 2002

The dates for the Australasian Bat Society conference have been set for the week following the Easter weekend - Tuesday 2 April to Friday 5 April 2002 . There will be pre (Sat. 30th / Sun. 31 March) and post (Sat.6 / Sun.7 April) conference workshops. One will be megabat , the other microbat so that conferencees can attend both if desired . The megabat weekend will include a full day carers' workshop . Ideas for the microbat workshop so far include use of Anabat and gating of mines. Please send in your ideas for the workshops . No decision has been made about which weekend is which yet. It may depend on suitable dates for presenters. The dates are school holidays in Queensland.

The conference is to be held at the Cairns Colonial Club, a great venue and with accommodation that is not excessive. If people are prepared to share then it is very reasonable. A room with 4 people is Aus$135 , or Aus$105 for single/twin share. We are looking for cheaper single accommodation close to the venue but hope as many people as possible can stay onsite. We don't have costings done yet for registration, etc.

Jon Luly has agreed to handle the abstracts for the meeting. The abstracts will also be published in the following issue of Bat Research News. All those wishing to present papers
PLEASE send abstracts ***300 words or less*** to Jon. [e-mail]: Jonathan.Luly@jcu.edu.au or by snail mail to: Jon Luly, School of Tropical Environemnt Studies and Geography, James Cook University, Townsville, Qld 4811 Australia.

May 15 - 18, 2002

The Lubee Foundation, Inc., the American Zoo and Aquarium Association Bat Taxon Advisory Group and the University of Florida Veterinary Medical Teaching Hospital will host a symposium on *the Medical Management and Captive Care of Chiroptera.*

The venue will be the Holiday Inn, 1250 W. University Ave., Gainesville, Florida 32601 Program includes presentations on medical management, emerging diseases, field programs, conservation, education and captive husbandry and management of Chiroptera. The program will include sessions on Zoo Education, Emerging Diseases, and Ecology and Captive Management. Sessions, workshops, and the banquet dinner will be at the Holiday Inn. On Sunday evening(May 19) A special program *"Rodrigues Fruit Bat Family Extravaganza"* will be held at the Lubee Foundation, Inc., 1309 NW 192nd Avenue, Gainesville, FL 32609.

For further information on this conference or the workshops, please contact one of the following:

>>

John Seyjagat, Lubee Foundation at 352 485-1250 or LUBEEBAT@aol.com Peter Riger, Nashville Zoo at 615 746-2526 or priger@email.msn.com or Denise Tomlinson, OBC Florida Bat Center at 941 637-6990 or DRTomlinsn@aol.com

More details will appear in following issues of Bat Research News.

August, 2002

The IXth European Bat Research Symposium will convene 26 - 30 August in Le Havre, France. The Organizing Committee will be chaired by Stephane Aulagnier, I.R.G.M., C.R.A. Toulouse, B.P. 27, 31326 Castenet-Tolosan Cedex,France. Pre-registration deadline is November 1, 2001. Please see the website for additional information.

The website is: http://www.univ-lehavre.fr/actu/9ERBS

Aulagnier's e-mail is: aulagnie@teleirgm.toulouse.inra.fr

November 6-9, 2002

The 32nd Annual North American Symposium on Bat Research will convene in Burlington, Vermont hosted by William Kilpatrick (University of Vermont) and Roy Horst (State University of New York at Potsdam) Arrqngements have been made for participants in the symposium to stay at the Radisson Hotel at very reasonable rates. All symposium session, displays, etc., will be in the Radisson which overlooks Lake Champlain only a 5 minute walk away. Just 5 minutes away are historic St.Paul Street and Church Street, both famous for the great number of fine restaurants and the Burlington Brewpub. Unfortunately the spectacular fall foliage season will be past (which incidentally is why we can get such reasonable room rates). For details see our website at www.nasbr.com

October 23-26, 2003

The 33rd Annual NASBR, is tentatively scheduled to meet in San Juan, Puerto Rico. The local host will be Armando Rodriquez-Moran. For details see our website at: www.nasbr.com

If you know of other meetings, large or small, send us the details for inclusion in the next issue. Thank you. G. Roy Horst

E -mail: horstgr@potsdam.edu

BAT RESEARCH NEWS

Volume 42 Number 3 **Fall 2001**

Contents

Front Cover

The front cover artwork was provided by Kunwar Bhatnagar.

Cynocephalus volans, the flying lemur. Head and body 16 inches, tail 9 inches, weight up to 1.75 kg. These small animals which are like a small cat can glide up to 136 meters between trees. (Almost a bat and it almost flies)

BAT RESEARCH NEWS

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e-mail: horstgr@potsdam.edu

Editor for Feature Articles: Allen Kurta, Dept. 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, Dept. 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: Patricia Morton, Texas Parks and Wildlife, Suite 100, 3000 IH 35 South, Austin, TX 78704. Tel. 512-912-7020
e-mail: patricia.morton@tpwd.tx.us

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 nearly all bat-related publications in English worldwide; the abstracts of presentations at bat conferences around the world; letters to the Editors; news submitted by our readers, notices and requests, and announcements of future bat conferences worldwide.

Communications concerning feature articles and "letters to the Editor" should be addressed to Kurta, recent literature items to Griffiths, conservation items to Morton, and all other correspondence to Horst.

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BAT RESEARCH NEWS

VOLUME 42: NO.4 WINTER 2001

From the Editor

With this issue Bat Research News has completed 42 years of publication in 41 volumes which occupies over 40 centimeters of shelf space (or is a stack over a foot high). The first volume consisted of 9 pages; this volume is 211 pages! The present issue, en mass, weighed in at over 400 pounds and cost nearly $600 to mail. Our printing costs have grown nearly exponentially as well. We bring this to your attention in response to several comments about our ever-increasing subscription rates for the printed edition. Happily the costs of our electronic condition are relatively fixed, and we encourage you to take advantage of our electronic edition if costs are a serious concern. We are currently arranging to have the electronic edition produced as a PDF file, which makes recovery of previous issues easier and more satisfactory. Hopefully this project will be completed before the next edition is issued. We have been able to keep our costs within reason because all of us are volunteering our time at no costs. As Managing Editor I remind you that Bat Research News and its readers owe a great debt of gratitude to our Associate Editors, Tom and Margaret Griffiths, Al Kurta, and Pat Morton, who have made my duties very light and enjoyable.

We continue to receive the minor but valid complaint that Bat Research News contains so little about what we as individuals are doing that is bound to be of interest to all the rest of us. We have been asking, even begging, you to send us some small (or large) items of interest, but the response has been minimal. It is interesting to note that when we get together at meetings and conferences we are all in huddles talking about out latest projects and ideas(in addition to our formal presentations) yet so few are interested in sharing their thoughts and ideas with the rest of us. I know that a great many of you have exciting NEWS for us. Share your good NEWS with the rest of us. We are grateful to those of you have been generous with your contributions and we hope you continue to provide us with items of interest. I have received a few suggestions on this topic; one is that we have two subscription rates, one for contributors, and one for consumers! Neither fair nor realistic. but amusing.

On a higher note, I have just learned that the U.S. Postal Service has recently announced that it will issue in September, 2002 a panel depicting four species of bats native to the United States. These are the red bat, the leaf-nosed bat, the spotted bat, and the pallid bat. Interestingly no bat from the genus Myotis is included, even though this is by far the most abundant in the United States. The release reads, "Long misunderstood, bats are essential to nature's balance. They consume farm and forest pests, pollinate flowers, and carry seeds to new locations." However there are no seed dispersers represented in this set of stamps. Even so, this is a long overdue recognition of these important animals. The official first covers will be released by the Postal Service in Austin, Texas. I'm certain that every one of you in the United States will purchase, use and save great numbers of these, and those of you in other countries will purchase them as collectibles. What a tremendous way to "spread the word".

We are ever eager for suggestions for improving the usefulness and value of Bat Research News and welcome all suggestions. Please let us have the benefit of your advice. G. Roy Horst

Abstracts of Presentations at the 31st North American Symposium on Bat Research
Held October 24 to 27, 2001, in Victoria, B.C., Canada

The abstracts are listed in alphabetical order by first author

Flight Control? Directionality of Drinking Passes at Water Holes

Adams, Rick A. and James A. Simmons
University of Wisconsin-Whitewater; Brown University

The question of whether bats are organized in their drinking patterns at water holes has been the focus of an ongoing six-year study of a Colorado bat assemblage. Data have supported differential intraspecific (age and sex) use-patterns of drinking sites as well as interspecific temporal displacement at high-use sites. In 2000 and 2001, we used an Indigo Systems "Merlin" midrange cooled, infrared imaging system with a SONY video Walkman 8-mm VCR, to film the drinking behaviors of bats at high-use water holes in Colorado. We recorded for two hours on each of four nights at two sites [Shadow Canyon (SC) where bats per net per night (bnn) averaged 12.34 among nine species; and Bear Canyon Creek (BC) that averaged 10.52 bnn among eight species]. In reviewing the subsequent video recordings we calculated the number of drinking passes (defined as an individual making contact with its head on the water surface) and noted the directionality of each pass. A total of 387 passes was recorded (SC: n = 199, BC: n = 188). Of these, 355 or 92%, of all drinking passes occurred from a single direction (dominant approach pathway) at each site, with 1% occurring from the immediately opposite direction, and 7% occurring from a direction convergent with, but not opposite to, the dominant approach path. At both sites, the direction of the dominant approach path was against stream-flow. The strict directionality of drinking passes portrayed at the water's surface was in stark contrast to activity above the water hole where no directionality of flight could be discerned, even when dozens of bats were circling together. We hypothesize that because bats cannot echolocate efficiently to avoid one another while drinking, unidirectional coordination of drinking passes where "in-bound" flights come from a single, predictable direction, lessens significantly the chance of collisions among individuals. Further investigations into these behavioral patterns are planned.

Patterns of Cave Use in Bats from Central Mexico: Limits Imposed by Size, Diet, Taxonomic Group and Thermoregulatory Pattern

Avila-Flores, Rafael and Rodrigo A. Medellín,
York University, Toronto, ON; Universidad Nacional Autônoma de México, Mexico City, DF, Mexico

Plasticity of roost use by bats may be primarily a reflection of their water balance and thermoregulatory abilities. To test this hypothesis, we explored the relationship between four species characteristics (body size, general food habits, taxonomic group, and thermoregulatory patterns) associated with their physiological abilities and the microclimate of sites used as roost. We sampled 18 caves from central Mexico located in five contrasting biomes where we recorded roost variables and presence of bats. Little evidence of microclimatic specificity was observed among 23 species studied. Heterothermic species as a whole (Vespertilionidae) were found in the coldest caves and in the widest range of temperature (1.6 – 29.80C), whereas homeothermic species (Emballonuridae, Mormoopidae, Phyllostomidae and Natalidae) occupied warmer roosts (14.5 –37.50C). Within the second group, good homeotherms (keep a narrow range of body temperature) were observed at slightly lower temperatures when compared to regular (wide-range) homeotherms. Body size alone did not determine clear patterns of cave use. However, the smallest homeothermic insectivorous species (<10 g) consistently occupied roost >200C (more often >250C); only the largest homeothermic insectivorous were found near 150C. Frugivorous, nectarivorous and sanguivorous bats were observed in a wide range of temperature (14.5 – 370C), but often <200C. Humidity in roosts was highly variable for most species, and we did not detect any trend regarding this factor. Our data suggest that the complex interaction of body size, type of food, taxonomic group, and thermoregulatory ability impose important limits to bat species with respect to the types of roosts that they can successfully exploit. These data also support the hypothesis that temperature is the most important physical factor for bats in roost selection.

A Classification for the Family Phyllostomidae Based on the Ribosomal mtDNA and the *RAG-2* Nuclear Genes

Baker, Robert J., Calvin A. Porter,Steven Hoofer, and Ronald A. Van Den Bussche. Texas Tech University Lubbock TX; Oklahoma State University, Stillwater, OK

We generated a gene tree from 52 of 57 genera of phyllostomid bats based on DNA sequences. From three mitochondrial genes (12s rRNA, tRNA Val, and 16s rRNA) we studied 51 genera and from the nuclear gene(*RAG-2*) we studied 52 genera. We extended our trees into a preliminary Linnean classification with eleven subfamilies. Recognized subfamilies with respective genera in parentheses are Macrotinae (*Macrotus*); Micronycterinae (*Lampronycteris, Micronycteris, Neonycteris*); Desmondontinae (*Desmodus, Diaemus, Diphylla*); Lonchorhininae (*Lonchorhina*); Phyllostominae (*Chrotopterus, Lophostoma, Macrophyllum, Mimon, Phylloderma, Phyllostomus, Tonatia, Trachops, Vampyrum*); *Glossophaginae (Anoura, Brachyphylla, Choeroniscus, Choeronycteris, Erophylla, Glossophaga, Hylonycteris, Leptonycteris, Lichonycteris, Monophyllus, Musonycteris, Phyllonycteris, Scleronycteris*); Lonchophyllinae (*Lionycteris, Lonchophylla, Platalina*); Carolliinae (*Carollia*); Glyphonycterinae (*Glyphonycteris, Trinycteris*); Rhinophyllinae (*Rhinophylla*); Stenodermatinae (*Ametrida, Ardops, Ariteus, Artibeus, Centurio, Chiroderma, Dermanura, Ectophylla, Enchisthenes, Mesophylla, Phyllops, Platyrrhinus, Pygoderma, Sphaeronycteris, Stenoderma, Sturnira, Uroderma,Vampyressa, Vampyriscus, Vampyrodes*). Three independent tress exit for this family (total evidence, Weterer et al, 2000:RAG-2 nuclear gene, Baker et al,2000 and the mitochondrial ribosomal genes, this poster). Nodes shared by all three trees include 1) the Family Phyllostomidae, 2) the vampire bats, 3) the Stenodermatinae (excluding Sturnira) , 4) Stenodermatina (sensu Weterer et., 2000 p.139) 5) a clade including *Anoura, Hylonycteris, Choerniscus, Choeronycteris* and *Musonycteris* (assuming *Scleronycteris* and *Lichonycteris* are ingroup taxa) plus one, 4 taxon node; four, 3 taxon nodes; and six, 2 taxon nodes. Unfortunately, all data sets do not contain all recognized genera and the above summary is compromised to some extent due to this condition. The data from our gene trees suggest that the last common ancestor of the vampires and a member of the remainder of the Phyllostomidae was a primitive insectivore, i.e., *Macrotus / Micronycteris* morphotype.

Indiana Bat Roosts in Suburbia: Important Observations and Concerns for the Future

Belwood, Jacqueline J., Cincinnati Nature Center, Milford, OH

Ohio's first Indiana bat maternity colony was discovered near Cincinnati in July 1996 in a 60-acre woodlot that is now a residential subdivision. It was located in a dead maple that was felled to avoid hitting a house. The roost contained about 35 females and their young. Since then, two additional lactating females have been netted in other residential backyards, just meters from the original roost. In 1999, a lactating female and juvenile were netted in a city park in Cleveland and an animal rehabilitator, also in Cleveland, obtained an injured Indiana bat that subsequently died. Ohio's second Indiana bat roost was found in 2000, on a busy university campus in Dayton. In Ohio and elsewhere, it is likely that accelerating urbanization in the future will increase the occurrence of Indiana bats in residential neighborhoods and similar areas. More importantly, it will increase the potential for contact between Indiana bats and people. Since 1996, this is evidenced by at least three "urban" Indiana bats that were captured in or near buildings and submitted to the Ohio Department of Health for rabies testing. Such occurrences will necessitate the development of strategies designed to address conflicting goals related to public health concerns, "nuisance" bat control, and the management of endangered bats.

Seasonal Changes in the Structure of a Central Amazonian Bat Assemblage

Bernard, Enrico, York University, Toronto, ON

The structure of bat assemblages may change over seasons in response to environmental factors, such as weather and food availability. Using captures in mist nets and monitoring echolocation calls, I investigated the changes in the structure of a bat assemblage in Alter do Chão, Pará State, Brazil, between the rainy (April to early June) and dry season (late June to early October) in 2000. Alter is in a relatively dry area, receiving ca. 2000 mm of rain annually, but with just 25% of that in the dry season. I captured 3,747 bats, belonging to 67 species. Forty nine species (2,310 bats) were caught in the wet season,

compared to 56 species (1,437 bats) in the dry season, corresponding to 1.06 bat/mnh and 0.40 bat/mnh respectively. The average biomass of the bats captured dropped from 37.6 g in the rainy season to 21.8 g in the dry season. The activity of aerial-feeding insectivorous species, measured by bat passes, did not vary between rainy and dry seasons ($p = 0.208$, $df = 11$), but some frugivorous species just disappeared during the dry season. Two large (> 40 g) frugivores, Artibeus lituratus and Phyllostomus discolor accounted for respectively 25.8% and 10.1% of the total captures in the rainy season, but just 1.8% and 3.7% of the captures in the dry season. Short range migrations (< 300 km) between the study area and large extensions of primary forest, where the food availability is supposed to be continuum along the year, could explain the absence of some species in the dry season. These results emphasize the need for long-term studies when sampling a bat assemblage for species inventory or ecological purposes.

A Field Recording Technique to Passively Collect and Time Tag Echolocation Calls from Free Flying Bats Using Time Expansion Bat Detector and Digital 8 Video Camcorder

Berry, R.D. and J. Szewczak
Brown-Berry Biological Consulting, Bishop, CA; White Mountain Research Station, Bishop, CA

Many bat biologists use the Anabat 6 software for passive monitoring of bat activity using a frequency division bat detector (Anabat II) connected to a laptop computer. Advances in computing technology and availability of full frequency spectrum analysis software (SonoBat) have sparked new interest in a more complete analysis of echolocation signals. A new technique is available to passively record echolocation calls in the field using an automatically resetting time expansion bat detector (Pettersson D240x) with a Sony Digital 8 camcorder. The camcorder automatically time tags every frame of video/audio data and stores the audio in a standard format 32kHz WAVE file. The camera's automatic gain control adjusts the sound level for maximum resolution in a 12 bit format. Sony's DV (i-link) connection to a VAIO laptop allows direct downloading of the wave file with zero distortion. Automatic time-tagging of both Anabat II files and time expansion files allows the investigator to correlate the identical echolocation calls from both systems provided the bat detectors are co-located. The researcher can rapidly scan Anabat files to select which time expansion calls should receive full SonoBat analysis. The technique is particularly well suited for passive recording of mine roost outflights where a visual as well as audio recording is desired

Mexican Free-tailed Bats at Carlsbad Cavern, New Mexico: Where Do They Spend the Winter

Best, Troy L., Lisa A. McWilliams, Celia López-González, David M. Roemer, Gabriel Villegas-Guzmán, John L. Hunt, Luis Guevara-Chumacaro, and Herguin B. Cuevas-Arellano,
Auburn University, AL; Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional, Durango, México; Carlsbad Caverns National Park, NM

Little is known about sites where the Mexican free-tailed bat (Tadarida brasiliensis mexicana) spends the winter. A search of the literature produced only five winter records of bats from the large colony at Carlsbad Caverns National Park, New Mexico; these records were at sites in Mexico. In December 1999, we visited four of these localities to determine if winter colonies were still present. Although we found evidence of Tadarida in each of the caves, we found no large winter colonies. In December 2000, we visited seven caves in central Mexico to determine if they contained large winter colonies of T. brasiliensis. We assessed the size of colonies found, the condition of each cave, and determined if other species of bats shared the caves. We discovered winter colonies in two of the caves, but the total number of bats in these colonies was less than 100,000. Most of the caves we visited had evidence of visitation by humans, but the effects of disturbance by humans is unknown.

Audio-Vocal Matching in Greater Spear-nosed Bats

Bohn, Kirsten M., Cynthia F. Moss, and Gerald S. Wilkinson, Univ. of Maryland, College Park, MD

Greater spear-nosed bats (*Phyllostomus hastatus*) have a large repertoire of social calls with low frequency components as well as broadband echolocation calls in the ultrasonic frequency range. Previous studies have shown that this species learns group specific foraging calls that range from 5–12 kHz. We

expected *P. hastatus* to have relatively high hearing sensitivity in this frequency range. We investigated the relationship between high frequency echolocation call perception and low frequency social call perception by determining auditory thresholds to pure tones from 2.5–100 kHz. Thresholds were determined for four P. hastatus using a go/no go procedure. Sensitivity was highest at 10–20 kHz which corresponds to the range of intraspecific communication rather than echolocation. The highest sensitivity was at 15 kHz. This frequency does not match foraging calls, but does match the frequency range of isolation calls. Isolation calls are produced by pups, have the requirements for individual signatures, and are used in parent-offspring recognition. These findings suggest that isolation calls may be an important component of the vocal repertoire in this species.

Flight Duration and Time Budgets of Three Pteropodid Species: Does Lunarphobia Affect Activity in New Guinea?

Bonaccorso, Frank, John Winkelmann, Carlos Iudica, James Serach, and Timothy Strickler
National Museum & Art Gallery, Waigani, Papua New Guinea; Gettysburg College, Gettysburg, PA; Univ. Florida, Gainesville, FL; Lawrence Academy, Groton, CT; Grand Valley State Univ., Allendale, MI

We recorded time budgets of flight and night-roosting during complete and partial nights for Syconycteris australis, Macroglossus minimus, and Dobsonia minor at Kau Wildlife Area, Madang Province, Papua New Guinea. The duration of bouts of flight and night-roosting were determined using position-sensitive radios collared onto free-roaming bats. A two-fold increase in pulse rate from a radio indicated that a bat was in flight. Mean emergence times were 18, 24, and 31 min after sunset respectively for D. minor, S. australis, and M. minimus. Cumulative flight activity within an activity period of 12 hr ranged from 2.4 to 5.6 hr. All species divided flight activity into a series of intermittent bouts (38-110 per night) each lasting a few seconds to over twenty minutes. Most flight bouts were under 6 minutes in duration and in proximity to food resource plants. In the case of M. minimus, most flight activity was confined to individual core-use areas around flowering bananas where conspecifics seem to be excluded in a classic case of territoriality. A small proportion of flights in these species were longer than ten minutes in duration and appeared to indicate 'scouting activity' over infrequently used portions of the home range. Longer flights by M. minimus occasionally passed through "information centers" where numerous individuals were active simultaneously. There was more spatial overlap in flight activity within populations of S. australis and especially in D. minor. These latter two species fed largely on "big-bang" fruiting trees. S. australis and M. minimus showed a trend toward reduced activity in bright moonlight, however, these pteropodids did not cease flight activity during periods of bright moonlight. The number of bouts of flight, mean duration of flight, and cumulative flight time were reduced during bright moonlight when comparing successive portions of a night relative to moonrise or moonset. We conclude that there is a mild lunarphobia in small pteropodid bats.

Indiana Bat, *Myotis sodalis*, Maternity Colonies in the Southern United States

Britzke, Eric R., Michael J. Harvey, and Susan C. Loeb
Tennessee Technological University, Cookeville, TN; Southern Research Station, Clemson, SC

Mist-netting and radio-telemetry conducted during the summers of 1999 - 2001 resulted in the discovery of three Indiana bat maternity colonies in forested areas of western North Carolina and eastern Tennessee, the first reported from the southern portion of the range. We tracked nine bats for a total of 40-bat days (range 0–9 days / bat). In 1999, we located a primary roost in an eastern hemlock (Tsuga canadensis) snag (109 cm DBH) in the Nantahala National Forest, NC. In 2000, we located a primary roost in a pine (Pinus sp.) snag (39 cm DBH) in Great Smoky Mountains National Park, TN. Another primary roost tree was found in a pine snag (55 cm DBH) in GSMNP in 2001. Exit counts at primary roost trees revealed maximum colony sizes of 28, 23 and 81 bats, respectively. All three primary roost sites were exposed to direct sunlight during most of the day. We also located six alternate roost trees: three pine snags, two red oak (Quercus rubra) snags, and one live black birch (Betula lenta). Primary roosts located in 1999 and 2000 were not used during subsequent summers. The eastern hemlock used in 1999 was still standing as of June 2001, while the roost tree found in 2000 had already fallen when checked in May 2001.

Status of the California Leaf-nosed Bat *Macrotus californicus* in the United States

Brown, P.E., and R.D. Berry
University of California, Los Angeles; Brown-Berry Biological Consulting, Bishop, California

Most of the known colonies of *Macrotus* in the United States occupy abandoned mines. A few relatively small summer roosts occur in natural caves. Banded bats in several mines in California have been studied for over 30 years, and they exhibit a high degree of population stability and roost fidelity if undisturbed. This paper will present the results of a recent survey of historic and newly-discovered Macrotus roosts throughout their range in Nevada and Arizona, conducted as part of a USGS Species at Risk grant. Threats to Macrotus include repeated human entry into roosts (especially in the maternity season), closure of abandoned mines for hazard abatement and renewed mining in historic districts

The Species-area Relationships in Bat Assemblages of Mexican Caves

Brunet, Anja K. and Rodrigo A. Medellín, University of Minnesota, MN; UNAM, México

We tested for a relationship between number of bat species and surface area of 20 caves in central-eastern Mexico and evaluated the role of the habitat diversity model as an explanation for this relationship. We found a significant, positive correlation between the log of species richness and the log of cave internal surface area, which indicates a species-area relationship. Variation in relative humidity was also correlated with species richness and roosting area. Our data suggest that roost-site diversity, as indicated by microhabitat variation in relative humidity and presence of avons (conical depressions in cave ceilings), is an explanatory factor for the observed species-area relationship.

Movement Patterns for Two Sympatric Bare-backed Fruit-bats (Pteropodidae: Dobsonia) on the Island of New Britain, Papua New Guinea: A Preliminary Study

Byrnes, Deanna G. P., Emily Ruell, Frank Bonaccorso, and John Winkelmann,
Univ. Wisconsin, Madison, WI; National Museum & Art Gallery, Waigani, Papua New Guinea;
Gettysburg College, Gettysburg, PA

Five *Dobsonia praedatrix*, and two *D. anderseni* fitted with position-sensitive radio-collars were monitored up to 36 days during June/July of 2001 on the lower slopes (100-300 m elevation) of Mt. Garbuna, West New Britain Province, Papua New Guinea. The feeding areas of these bats included riparian and secondary forest, oil palm plantation, small gardens, and abandoned plantations of coconut and cacao. In this pilot study to examine resource overlap, individual bats were consistent in visiting the same feeding areas throughout the period of our observations. The two *D. anderseni* males (274 g body mass) utilized a mean area of 4.1 ha, slightly smaller than the mean 5.9 ha used by the two male *D. praedatrix* (233 g). The area used by the three female *D. praedatrix* (142 g) ranged from 2.3 ha to 4.1 ha. Three *D. praedatrix* and two *D. anderseni* showed substantial spatial overlap in their feeding areas. Individuals were observed visiting fruiting plants including figs, bananas, breadfruit, and oil palms. The small foraging areas of these two species of the genus *Dobsonia* are linked to a feeding specialization on native fruits that produce very large numbers of fruits per tree (figs) or cultivated species managed by humans to produce a large biomass of fruit in a small area. Two of the female *D. praedatrix* shared an area distinct from the others in a steep forested valley adjacent to primary forest. During the day we found a single sub-adult female *D. praedatrix* roosting in canopy foliage within her feeding area in the forested valley, but were unable to locate the day roosts of the other individuals. Before dawn, individuals of both species flew in direct paths away from the feeding area and beyond the range of our equipment. *Dobsonia anderseni* usually roost in caves in large aggregations. *Dobsonia praedatrix* may roost in caves in fewer numbers than *D. anderseni* but more frequently roost in trees. Our capture ratio in this study and in our previous work on the island suggest that *D. anderseni* are relatively less abundant than *D. praedatrix* on New Britain. The abundance of *D. anderseni* may be constrained by the availability of adequate roosting caves, which may not be a strict requirement of *D. praedatrix*. Efforts to locate a cave roost and to determine commuting distances between roosts and foraging areas were unsuccessful in 2001 but will be continued in future field work.

More Bats and Education: The Public Face of a Colony

Campbell, Karen A., Albright College, Reading PA

Austin's Congress Street Bridge, Bracken Cave, University of Florida's Bat Condo, and The Red Covered Bridge in Reading, PA. Each of these sites is annually visited by crowds of people eager to witness the evening exodus of bats. The PA colony has recently been employed to engage non-scientists in simple research questions, thereby providing a glimpse into the scientific process. Bats readily capture the interest and attention of people of all ages, particularly when they can visit the colony and participate in the experience. As a result, public bat programs can be a window to a larger view of science. Given current concerns over the low level of scientific literacy of the average citizen, these encounters provide an opportunity for us, as scientists, to advance the public understanding of science as a process. It is important to remember that as people who have developed an understanding of the method of scientific discovery, we represent a very small proportion of the general population. Curricular reform at all levels of scientific education involves removing the impression that science learning is a process that sifts from the masses a select few students deemed suitable for scientific inquiry. Initiatives to improve the learning of science include efforts to ensure that science is taught as a process in which all citizens are engaged at some level. Blurring the boundaries between research and education in our casual encounters with school and community groups provides an avenue to model the ways in which scientific research is conducted and used to address real problems. Two adjacent *Myotis lucifugus* maternity colonies, housing an estimated 6000 bats, are sites at which research activities have been incorporated as part of public presentations. These activities are designed to allow the audiences to gain an appreciation for the kinds of questions that science asks, rather than viewing the field as a neat collection of "bat facts." Interactive programs allow people with virtually no scientific background to build an understanding of how a scientist gathers and analyzes data or tests hypotheses in search of answers that give meaning to life. This also allows us to personalize the scientific process, to show how science is work done by people caught up in the process of discovery. In this way, our audiences learn not only about bats, which are admittedly fascinating on their own, but gain some insight into the spirit of scientific inquiry which defines who we are.

The Impact of Ecological and Latitudinal Gradients on the Phylogeographic Structuring of *Cynopterus brachyotis* in Southeast Asia: A Preliminary Analysis

Campbell, Polly, Thomas H. Kunz, Christopher J. Schneider, and Akbar Zubaid
Boston University, Boston, MA; Universiti Kebangsaan Malaysia, Bangi, Selangor

Cynopterus brachyotis is a medium-sized plant-visiting megachiropteran whose broad distribution encompasses much of the Indomalayan region. Common in a wide variety of habitats from primary forest to residential and agricultural areas, this species exhibits both dietary and behavioral flexibility, and substantial morphological variation. Moreover, analysis of mitochondrial (mtDNA) Cytochrome b sequence variation has revealed considerable genetic divergence within *C. brachyotis* across habitat types in peninsular Malaysia. Thus, this species is well suited for phylogeographic analyses of population structure at varying spatial scales. For this study we sequenced the hypervariable 5' end of the mtDNA control region for individuals from over 25 localities, including the Malay peninsula and offshore islands, Thailand, Borneo, Java and Sulawesi. The goal of this preliminary analysis is to compare local genetic and morphological divergence within *C. brachyotis* across habitat types in peninsular Malaysia with phylogeographic structuring of this species along broader latitudinal and longitudinal gradients, and across post-Pleistocene barriers to gene flow.

Is the Glossphaginae Monophyletic? Evaluating Data from Different Sources

Carstens, Bryan C. and Barbara L. Lundrigan, Michigan State University Museum, MI

We present a phylogeny of 35 species of nectar-feeding bats based on 119 morphological characters: 62 from the skull, dentition, skin, and skeleton, and 57 soft tissue characters (the latter from Wetterer et al., 2000). These data strongly support monophyly of the subfamilies Glossophaginae, Phyllonycterinae, and Brachyphyllinae, and the tribes Glossophagini and Lonchophyllini. They contradict the phylogeny identified by DNA sequences from the RAG-2 gene (Baker et al., 2000) in their support for a monophyletic Glossophaginae. Analysis of a combined matrix, including both the morphological characters and DNA sequences from the *RAG-2* gene (taken from Baker et al., 2000), results in a phylogeny with a similar

topology to that produced by the morphological data alone. Support for most major clades is stronger than in the morphological tree, but support for a monophyletic Glossophaginae remains weak. This weak support underscores the historical disagreements regarding relationships among the subfamilies; combining morphological and molecular data has not resolved this issue. Uncertainty regarding basal relationships complicates description of morphological change during the evolution of nectarivory in the Phyllostomidae. The phylogeny we present suggests a progressive reduction of the upper and lower incisors, resulting in increased space at the front of the mouth for the tongue to pass through during feeding. This transition may have opened new feeding niches to glossophagine bats.

Are Indiana Bats and Northern Long-eared Bats Roost Competitors?

Carter, Timothy C. and George A. Feldhamer, Southern Illinois University, Carbondale, IL

During the summer of 2001, the roosting ecology of ten northern long-eared bats (*Myotis septentrionalis*) and seven Indiana bats (*Myotis sodalis*) were examined. All bats tracked were adult females. The roosting areas of the two maternity colonies were parapatric; however, no roost trees were used by both species. This indicates that at least during the summer months these two species may not cohabitate. While there were some similarities between the roosting habits of the two species, northern long-eared bats showed greater roosting niche breadth than the Indiana bat. Northern long-eared bats used a greater number of species of trees. They used both live and dead trees and used cavities as well as exfoliating bark. Indiana bats restricted their use to exfoliating bark on dead trees. The microhabitat characteristics of the roost tree also differed between species. The results of this study indicate that these species are not competing for roosting resources. However, these results may not be applicable to other areas because of the unique habitat characteristics of this study site.

Results of a Bat Survey in the Western Ozark National Forest

Caviness, Michelle L. and Douglas A. James, University of Arkansas, Fayetteville, AR

At present, sixteen species of bats have been found in Arkansas. Most of the available information on the distribution of these species is based on scattered site records and cave surveys. Studies on geographic distribution, status, and ecology of endangered Arkansas bats have been conducted annually since 1978. Although bats are commonly studied in caves, investigations of free-ranging bats in the summer also have been performed. In recent years, such studies have been undertaken primarily in the Sylamore Ranger District of the eastern Ozark National Forest and the Ouachita Ranger District of the Ouachita National Forest, both sites in Arkansas. However, few studies of that type have been conducted in the western Ozarks. Surveys of this northwestern region of Arkansas are needed in order to determine distribution and abundance of different taxa of bats. The Ozarks appear to be an important area for bat biodiversity and the many caves found throughout the Ozarks provide locations for hibernacula, mating colonies, and maternity colonies. A survey of bats was conducted in the western Ozark National Forest from late April 2000 through mid October 2000. Bats were caught in mist nets at 21 ponds and streams or creeks in the Lee Creek and Wedington Units of the Forest. All sites were netted two or more times totaling 46 net nights. This produced 142 bats of six genera and eight species all in the family Vespertilionidae. Species represented include *Eptesicus fuscus, Lasiurus borealis, Lasiurus cinereus, Lasionycteris noctivagans, Myotis lucifugus, Myotis septentrionalis, Nycticeius humeralis,* and *Pipistrellus subflavus.* Bats were identified and sexed, and reproductive status, forearm length, and weight were recorded. Bats were banded and released at the site of capture. Data were analyzed to determine species sex ratios, population levels, activity patterns, habitat usage, and for the two Forest Units, abundance, diversity and species richness. This is the first year of a two-year study.

Morphometric Variation in the Crania of *Hipposideros armiger terasensis*

Chen, Yi-ju (Roni), University of New Mexico, Albuquerque, NM

A total of 174 adult skull specimens of *Hipposideros armiger terasensis*, an endemic subspecies of the island of Taiwan, were examined morphologically. Univariate and multivariate statistical analyses based on 26 cranial characters were utilized to exanimate the differences between sex and geographical groups (central and northern Taiwan). The two-factor analysis of variance showed that 21 skull characters differed significantly between localities, and 14 skull characters were significantly different between sexes. >>

Furthermore, least squared means multiple analysis showed that there are more statistically significant cranial characters in the central populations than in northern populations. MANOVA showed statistical significance on both sex and locality effects, and showed no significance in the interaction. Principle component analysis on k-groups caught less then 55% of the variation in PC1, and indicated a strong shape difference in the samples. More information is needed for a complete understanding of the evolution of sexual dimorphism in *Hipposideros armiger terasensis*.

Analysis of Echolocation Calls with Neural Network Techniques to Identify Bat Species on the Gulf Islands of British Columbia, Canada

Craig, Vanessa, Susan Holroyd, and Steven F. Wilson
EcoLogic Research, Gabriola Island, BC, Canada; Holroyd Consulting, Calgary, AB, Canada

Identification of bat species by echolocation call is the subject of much research and debate. Discriminant function analysis has been the most common method used for objectively identifying bat species from calls; however, recent studies in New Zealand and Britain have used neural network analyses to identify species from data collected with heterodyne or time-expansion bat detectors. As part of a study on the Townsend's big-eared bat (*Corynorhinus [Plecotus] townsendii*), we examined the ability of neural network analysis to distinguish species based on calls recorded with Anabat II™ (frequency-division) detectors at several sites on the northern Gulf Islands of coastal British Columbia. We collected data at 37 locations from which we obtained 846 usable calls. We collected reference calls from hand-released or free-flying bats where possible, and used additional reference calls collected by other researchers in western North America. Call attributes were calculated using Program Analyze. We used call duration, maximum, minimum, and average call frequency, slope at the beginning and end of the call, and an estimate of call curvature in the neural network analysis. A subset of the reference call data was used to develop a series of 3-layer perceptron networks using a second-order conjugate gradient decent training algorithm, a more efficient method than the back-propagation method used in previous studies. We applied the model with the lowest classification error to the remaining reference call data to test the model's ability to correctly identify novel calls. Our final model grouped *Myotis spp.* and identified *C. townsendii, Eptesicus fuscus, Lasiurus cinereus* with 90% accuracy, and *Lasionycteris noctivagans* with 80% accuracy. The model performed significantly better for most species than a discriminant function analysis on the same data. We applied the neural network model to the unknown calls collected in the field with Anabat II™ detectors. Of the 846 calls, 92% could be identified to species (or *Myotis spp.*) with 95% certainty; the remainder were classified as unknown. We expect our models will improve as we collect additional reference calls. Our research demonstrates that Anabat II™ detectors can be used to collect echolocation data suitable for species (or group) identification, and that neural network analysis is a powerful technique that can be used to accurately identify several bat species common to the Pacific Northwest.

Species Limits & Historical Biogeography of the Antillean Endemic Genus Brachyphylla

Dávalos, Liliana M., Columbia University and American Museum of Natural History, New York, NY

Chiropteran subspecies, and to some extent species, have traditionally been described based on geographical variation in pelage and morphometrics. This approach may complicate the delimitation of basal groups, species, which should exhibit a unique fixed combination of characters. Mitochodrial genes are useful in delimiting species insofar as this genome evolves rapidly and haplotypes become fixed quickly. Fixed haplotypes may then constitute unique combinations of characters. To investigate the limits of the basal phylogenetic units and the historical biogeography of the Antillean endemic genus *Brachyphylla*, I sequenced cytochrome b from specimens encompassing most of the range of *Brachyphylla nana* and *B. cavernarum*. Analyses of the sequence data contradict both the species and subspecies limits in use, which are based on morphometrics. More importantly, the results suggest that individuals from a single island population do not necessarily share a most recent common ancestor. This assumption, that island populations of *Brachyphylla* are in fact monophyletic, underlies all morphological analyses to date. A more thorough sampling of the entire geographic range of *Brachyphylla* is necessary to reach definitive conclusions regarding the species and subspecies limits in the genus, and only then can phylogenetic and

biogeographic relationships be elucidated. For now, mitochondrial characters have revealed an intricate pattern of geographic differentiation, similar to that reported for several Antilean birds.

Evaluation of Vampire Incidence on Livestock in the Sierra de Manantlán Biosphere Reserve

Dávalos, Luis Ignacio Iñiguez and Juan Pablo Esparza Carlos, Univ. Guadalajar, Autlán, Jalisco, México

One of the most characteristic of animal health problems in cattle production zones of Latin America is the incidence of vampire attacks by *Desmodus rotundus*. This can constitute a serious problem because of the bite itself and a number of diseases that can be transmitted by the vampires, notably rabies or "derriengue." For this reason, some farmers think of bats as pests that should be eliminated, which sometimes results in destruction of roosts of a number of other bat species. Because of this, it is relevant to evaluate the incidence of vampire bites on cattle, to determine if it is or is not above a threshold to take specific control actions. We did this study along seven communities of the Sierra in the Manantlán Biosphere Reserve in Jalisco, Mexico. We interviewed 72 livestock owners (58% of the total in those towns). The average age was 55 years old, and only 10% were 23 to 39 y.o. In the last three years, 75% of cattlemen observed attacks on their herds. Only one third know that vampires transmit mortal diseases. Two thirds considered vampires as a problem, but only half of those think that it is a serious one. Only 8% of the cattle have been affected with derriengue. All people stated that pig raising is not profitable, because of the damage that vampires do in the nipples that prevents nursing. The period of November–February present fewer attacks. Disturbed areas were identified as more risky for attacks. Only 26% took actions to prevent continuous bites to the same animal. Some vampire control techniques are referred to by 28% of the cattlemen, but only 7% applied any techniques. Seventy percent believe that there is only one bat species. Knowledge of people regarding food items of bats is poor. All the interviewed people recognized blood as an item, of whom 66%, 14% and 8%, identified, respectively, fruits, insects and nectar as items. Only in one town, where five years ago a workshop on vampire control was held, some cattlemen know that the four items are consumed by different species. When some drawings of bats' faces and uropatagia were shown, 25% of the people claimed to recognize the vampire bat, but only half were correct. Presently, vampire problems exist in the zone and should be controlled. Knowledge of bats is poor and not evenly distributed. It is of crucial importance to start a environmental education program and technical training to help solve this problems.

The Nectar-feeding Bat Community Associated with *the Stenocereus queretaroensis* Buxbaum Blooming Cactus

Dávalos, Luis Ignacio Iñiguez and Carlos Ibarra Cerdeña
Universidad de Guadalajara, Autlán, Jalisco, México

Several authors have studied the relationship between nectar-feeding bats and columnar cacti. In this relationship, bats provide effective pollen dispersal while cacti provide high amounts of good quality nectar and pollen for nocturnal visitors. However, there are several cacti species in which reproductive biology has been poorly studied. In this work, we present preliminary data on the reproductive ecology of pitayo *(Stenocereus queretaroensis)*. This work was done in the Autlan valley, in western Mexico, where pitayo has economic importance at regional and state levels for collectors and farmers who sell the fruits in regional markets. We sampled the reproductive behavior of this cactus and the local nectar-feeding bat community during two periods of blooming (late February to late April in 2000 and 2001). Preliminary results suggest that the bats are the most important visitor for the nocturnal flowers of pitayo. This group has the highest visitation rate to the cactus followed by bees and birds. Bats had more pollen adhered to their bodies compared with birds and bees and, consistently, the plants have a higher reward production around midnight, when bats are most active. Pollen of pitayo was found on the bodies of three glossophagine species, *Leptonycteris curasoae, Choeronycteris mexicana,* and *Glossophaga soricina,* and one stenodermatine, *Dermanura phaeotis.* Pollen of *S. queretaroensis* was never found on the other stenodermatine bats captured, *Sturnira ludovici, Artibeus intermedius* and *A. jamaicensis.* The most abundant bat in two years during *S. queretaroensis* blooming was *L. curasoae* (73.7% of captures in 2000 and 71.4% in 2001), most of which were adult males. During the cactus-blooming peak (March) the long-nose bats captured were mostly reproductive males. The pitayo produce abundant flowers which anthesis begins at 21:30 hours Stigma receptivity starts at 23:00 hours, coinciding with the beginning of nectar

production. Nectar had a peak of 0.4 ml with 20% sugar-brix at midnight. After that moment, both volume and concentration slowly decreased. Although the flowers remain open the rest of the day before dying, most visitation by other pollinators takes place in the early morning (6:00-8:00 hours). Diurnal visitors were mostly bees and some birds. We postulated that *Leptonycteris curasoae* is the most important pollinator of *Stenocereus queretaroensis* since it is the most abundant and active visitor. As the species implicated in this relationship are important from both conservation and economic standpoints, research designed to contribute to their management will be relevant in the next years.

The Nasal Cavity of Hypsignathus monstrosus: Adaptations for Sound Production?

Dawson, Alta E. and Elizabeth R. Dumont, University of Massachusetts, Amherst MA

Lekking is a distinct mating behavior in which males gather in a specific area and display or call to attract females. Male hammer-headed fruit *bats (Hypsignathus monstrosus*, Megachiroptera: Pteropodidae) are well known for conspicuous lekking displays that include wing flapping and loud calling. The larynx of male hammer-headed fruit bats is both sexually dimorphic and highly derived in relation to calling. In this study, we document dimorphism in the nasal cavity of this species and investigate its potential role in sound production. Three-D reconstructions of the nasal cavity for 25 pteropodid species (one male and one female per species) were generated from serial CT scans. While the nasal cavity is not dimorphic among pteropodids in general, dimorphism in *Hypsignathus* is marked. Moreover, the nasal cavity of both male and female *Hypsignathus* differs significantly from those of all other pteropodids, including closely-related members of the same subfamily. Elaborated paranasal spaces of *Hypsignathus* are unique and may function as resonating chambers. We suggest that this derived nasal cavity morphology may be driven by the evolution of sound production in relation to lekking behavior.

Visitor Activity and Education Programs on Bats at the Montreal Biodome

Delorme, Michel and Diane Mitchell, Montréal Biodôme, Montréal, Quebec, Canada

They're blood-sucking vampires that entangle themselves in people's hair! Just think of all the myths that make people persecute bats, those charming little creatures so indispensable to the health of ecosystems around the world. Since it opened, in June 1992, the Montréal Biodôme has been constantly striving to dispel such superstitions and protect these misunderstood flying mammals. The different teams working at the Biodôme have designed a series of educational activities, mostly around Halloween, including 1) Our Friend the Bat, a workshop to dispel myths surrounding bats, 2) a cart full of bat-related items and pictures, 3) the Backyard Beasties exhibition, 4) a mini-play, Béüs the Bat, 4) a nighttime activity in the Biodôme's ecosystems, Shivers by Moonlight, 5) information sessions at the bat cave in the Biodôme's Tropical Forest ecosystem, and 6) an exhibition of masks and face-painting. All these activities are designed to help visitors to the Montréal Biodôme to better understand these mysterious nocturnal creatures.

Phylogeography and Systematics of North American Long-eared Myotis

Dewey, Tanya, University of Michigan, Ann Arbor, MI

This research proposes to analyze intra-and inter-specific patterns of genetic variation in the mitochondrial gene cytochrome b of the six long-eared myotis (Vespertilionidae) species of North America (*Myotis auriculus, M. evotis, M. keenii, M. milleri, M. septentrionalis*, and *M. thysanodes*) in order to determine the pattern of evolutionary relationships among species and to identify the boundaries of independently evolving populations. A combination of intra-specific morphological variability and inter-specific morphological similarity makes it difficult to distinguish some long-eared myotis species pairs where they occur in sympatry and there has historically been confusion regarding the pattern of relationships among these species. In addition, it is possible that habitat fragmentation strongly influences population subdivision in these species. These bats are found primarily in coniferous woodlands, which are patchily distributed on mountain ranges throughout western North America. During recent glaciations this boreal habitat was more extensive, occurring continuously between mountain ranges that are now isolated by arid grasslands and desert. These habitat shifts have occurred cyclically throughout the late Quaternary and may have profoundly influenced inter-specific and intra-specific patterns of evolution in associated vertebrate faunas. An analysis of genetic variation within and among long-eared myotis species provides a

unique opportunity to test hypotheses concerning the effect of late Quaternary climate changes on the evolution of western North American mammalian faunas. The identification of independently evolving populations within long-eared myotis species is also essential so that conservation efforts directed at these species can be focused on biologically meaningful units.

Evaluating the Effectiveness of Bat Compatible Gates

Diamond, G.F., J.M. Diamond, V.J. Tyler, K.W. Grandison, and M. Mesch
Southern Utah University; Utah Division of Oil, Gas, and Mining

Populations of many bat species are believed to be declining due to a decrease in historical habitat. Recent studies have shown that abandoned mines are being used by numerous bat species. The Utah Department of Natural Resources, Division of Oil, Gas and Mining Abandoned Mine Reclamation Program is currently authorized to close abandoned mines to protect the public from potential hazards. Abandoned mines are surveyed prior to closure and those providing suitable habitat are sealed with bat-compatible gates. Few post-gate monitoring studies exist to document long-term effects of these techniques for conserving bat populations. This study is the initial step in this process. Long-term objectives include determining daily and seasonal use of mines by bats and evaluating species composition and relative numbers of bats utilizing the mines. Two gated mines in the Silver Reef area, one recently gated mine in the East Reef, and three ungated mines in the Tushar Mountains were monitored during the 2000 and 2001 field season. The Tushar Mountain mines are scheduled for the installation of bat compatible gates in the fall of 2001. Eleven of Utah's 18 bat species have been netted or acoustically recorded at these mine entrances. *Myotis sp.* and Townsend's big-eared bats, *Corynorhinus townsendii pallescens*, were found in highest numbers in the Silver Reef (gated) and East Reef (recently gated) mines. Long-legged myotis, *M. volans*, was the dominant species in the Tushars (un-gated). Bat activity was highest in gated Silver Reef Mines. A combination of monitoring techniques (infrared digital video recorders, night vision goggles, Anabat‰ acoustic detection, and Trail Master‰ event recorders) were used to collect bat behavior data in the 2000 field season. To minimize disturbance to existing bat populations, visual observations were partially eliminated during the 2001 field season. Infrared digital video provided a more accurate analysis of bat behavior and was the primary method for data collection at the mine entrances in the 2001 field season. Circling bats were more frequent at gated than at un-gated mines. Preliminary results indicate that humidity and microclimate fluctuations may contribute to variability in daily activity. External climate does not appear to play a role in bat activity patterns. There is no consistent correlation between observer presence and high or low levels of bat activity.

Fruit Bats, Fig Wasps and the Reproductive Ecology of Figs

Dumont, Elizabeth R., George D. Weiblen, and John Winkelmann
Univ. Massachusetts, Amherst, MA; Univ. of Minnesota, Saint Paul, MN; Gettysburg College, PA

Successful reproduction in plants first requires the transfer of pollen to receptive flowers and later the effective dispersal of viable seeds. Among figs, pollination is accomplished through highly specific and mutualistic relationships between figs and often a single species of pollinating wasp. Seed dispersal is a much less specific phenomenon in that many different species of frugivores may disperse seeds from any particular species of fig. Throughout the tropics bats utilize figs extensively and are credited with being effective and perhaps critical agents of seed dispersal. In all Neotropical figs, pollen and seeds are produced in the same fruit and there is no differentiation between male (pollen-producing) and female (seed-producing) fruits. In contrast, many species of Paleotropical figs are functionally dioecious, with pollen (male) and seeds (female) produced on separate trees called "gall figs" and "seed figs," respectively. Here we show for a dioecious fig that fig wasps and fruit bats exert opposing selective pressures on gall and seed fig morphology and chemistry at pollination and dispersal. Preference experiments demonstrate that fig wasps do not discriminate between gall and seed figs despite the fact that wasps entering seed figs fail to reproduce. Preference experiments with fruit bats demonstrate that bats have an overwhelming preference for seed figs that is associated with their nutrient content. Each of these selection episodes appears to optimize plant fitness. We suggest that the opposing selective pressures imposed by fig wasps at pollination and by fruit bats at dispersal contribute to the maintenance of the unique reproductive strategy of dioecious figs and may have played a role in its evolution.

Acoustic Interactions Between Bats and Arctiid Moths in Papua New Guinea

Dunning, Dorothy C., West Virginia University

Arctiid moths were assayed for sound production in response to bat-like stimuli at two sites in Papua New Guinea: at the Mahonia Na Dari Research and Conservation Centre, near Kimbe, West New Britain and at Ambua Lodge in the highlands overlooking the Tari Valley in Southern Highlands Province. At least nine species clicked in response to tactile stimulation and/or to trains of artificially-generated ultrasonic pulses at two repetition rates: 16.67 pulses/sec (50 msec off, 10 msec on) and 166.67 pulses/sec (5 msec off, 1 msec on). In addition, at least two moths clicked in the lab without any artificial stimulation at all, though the echolocation cries of bats were detected on the recordings. The responses of the moths were recorded with a Pettersson Ultrasound Detector D 240 in time-expansion mode and a Sony stereo cassette recorder model WM-D3. The echolocation cries of bats hunting around electric lights at the two sites and in the forest at one site were similarly recorded. These signals were analyzed using Canary 2.1, a sound analysis program. The interpulse intervals within the FM buzzes of these bats were measured, as were the durations and duty cycles of click bursts from the moths. The probabilities were computed of the clicks occurring at random between buzz pulses, when they might overlap the critical interval at the beginning of an echo and jam the bats' echolocation abilities. However the moths sometimes seem to time their clicks to the intervals between pulses, when the jamming probability would be higher, rather than emitting them at random in response to trains of ultrasonic pulses.

Milk Minerals and Neonatal Mineral Accretion in *Artibeus jamaicensis* and *Phyllostomus discolor*, Two Neotropical Plant-visiting Bats

Falzone, Michelle, Eugene Studier and Gary Kwiecinski,
The University of Scranton, Scranton, PA; University of Michigan-Flint, Flint, MI

Reproduction, growth, and development in Chiroptera are unique in that most species give birth to a single large (ca. 20-30% mother's post-partum weight) young that is weaned at ca. 90-95% adult size and ca.70-80% adult post-partum mass. The need for young to become independent fliers as quickly as possible presumably drives this rapid and burdensome development. We are testing the hypothesis that the ability of the mother to provide nutrients to developing (dependent) young limits reproductive and developmental capacity. Milk samples were collected longitudinally, from birth through weaning, from females with known-aged young from a captive colony of two similarly sized, phyllostomid bats. We also collected physical data from the neonates, including body mass, forearm length, total epiphyseal gaps, aspect ratio, and wing loading. Linear and non-linear regression indicated the logistic growth model best fits neonatal developmental data. Milk samples were analyzed for specific minerals [calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), and Iron (Fe)] and nitrogen (N). Milk mineral and N concentrations varied, but did not significantly change in either species except in *Artibeus jamaicensis* where Na levels declined. By utilizing the logistic growth curve for body mass and known body composition data, we calculated daily accretion, total body mineral values, and the amount of milk required to be ingested each day to meet accretion needs throughout the course of neonatal growth. From these analyses, we determined that milk minerals and N are present in concentrations that exceed the needs of developing young except for Ca. Milk Ca level appears to limit the rate of growth and development in these species.

Excitatory-inhibitory Interactions in the Inferior Colliculus of the Big Brown Bat (*Eptesicus fuscus*) as Revealed by Two-tone Testing of Duration Tuned Neurons

Faure, Paul A., Thane Fremouw, John H. Casseday and Ellen Covey
University of Washington, Seattle, WA

The mammalian inferior colliculus (IC) is the target of multiple parallel inputs originating from lower brainstem auditory nuclei. In echolocating bats, application of antagonists to the inhibitory neurotransmitters GABA or glycine alters the spike count and latency of many IC cells, suggesting that IC neurons receive inhibitory inputs with a different time course and latency from excitatory inputs. The IC is the first nucleus in the central auditory system where neurons tuned to signal duration have been reported, suggesting that duration tuning is created in the IC arising through the convergence and temporal interplay

of excitatory and inhibitory synaptic inputs. To investigate the nature of such interactions, we presented pairs of tones which varied in their temporal relationship while recording extracellular spiking responses from duration tuned neurons in the IC of *Eptesicus fuscus*. One tone in the pair was set at the cell's best duration (short tone), the other tone was set at a long duration that elicited few or no spikes (long tone). The onset time of the long tone was fixed; the onset time of the short tone varied relative to that of the long tone. Because the short tone always elicited spikes when presented alone, response variability when both tones are presented reflects the interaction of inputs evoked by the two signals. Spike counts to the short tone were reduced or eliminated as it approached the long tone, moved through it, and for some time following. In some cells, the interval of reduced spiking (i. e., inhibition) was proportional to the duration of the long tone stimulus, which is consistent with recent conceptual models of the neural mechanisms of duration tuning. Spike counts were reduced even when stimulus energy in the short tone was equated with that of the long tone and regardless of whether the starting phases of the two signals matched. The results indicate that duration tuned neurons receive inhibitory input arriving shortly after stimulus onset and which persists for the duration of the stimulus. Moreover, inhibition evoked by a stimulus to which the neuron is unresponsive can suppress the response to a sound at best duration even when the two signals are noncontiguous. The results support the hypothesis that duration tuned neurons are created by complex temporal patterns of excitation and inhibition within the IC. Research supported by NIH grants NIDCD 00607 and 00287.

Long-term Acoustic Monitoring: How Reliable Are Bat Surveys?

Fellers, Gary M. and Chris Corben,
USGS, Western Ecological Research Center, Point Reyes National Seashore, CA

We have been monitoring bat vocalizations at a single site in Marin County, California continuously since December 1999. Using a permanently mounted Anabat (in a waterproof housing) and a dedicated computer, we have recorded echolocation calls from sunset until sunrise every night. The setup is easy to deploy, relatively cheap (about $2,000 US), and simple to maintain. In 2000, we recorded nearly 340,000 calls that were saved in 32,000 files, a number easily stored on one CD-R disk. Our data have a large night-to-night variation 933 ± 941 SD calls per night. When adjusted for the number of hours of darkness, the numbers are similar, 52.0 ± 54.8 calls per hour. The trend is similar for each of the most commonly recorded species, *Tadarida brasiliensis, Lasionycteris noctivagans, Eptesicus fuscus,* and *Lasiurus blossevillii.* Trends in calling activity do not relate to temperature, wind, rain, or any other weather factor that we have examined. These results have significant implications for biologists conducting bat surveys. Because of the large night-to-night variation in bat activity, it is essential that surveys be conducted over a much longer period of time than is normally assumed. Short-term surveys are likely to greatly over/under estimate both bat activity and species diversity.

Protecting Little-known Species: The African Bat Otomops martiensseni

Fenton, M.B., P.J. Taylor, D.S. Jacobs, E.J. Richardson, E. Bernard, S. Bouchard,., L. Hollis, K.R Debaeremaeker, H. ter Hofstede, C. L. Lausen, J. S. Lister, D. Rambaldini, J. M. Ratcliffe, and E. Reddy,
York University, North York, Ontario

Listed as "vulnerable" by the International Union for the Conservation of Nature, the molossid *Otomops martiensseni* occurs widely in Africa and in Madgascar. Outside of a few known cave roosts, there are few records of *O. martiensseni*, although around Durban, South Africa the species is common and roosts in buildings. Seventeen buildings used as roosts by *O. martiensseni* averaged 34.5 ± 15.8 years old. Originally described as three species, populations of *O. martiensseni* differ significantly in size (forearm length) between east Africa and Durban or Madagascar, but not between Durban and Madagascar. In the Durban area bats entered roosts by landing and crawling. Roost populations there ranged from 7 to 29 individuals, typically consisting of one adult male, several adult females and young, suggesting a harem social structure. The ratio of adult females to young was virtually 1:1, and among young the ratio of males : females averaged 2:1. Radio-tracking showed that individuals used several day roosts and night roosts, and foraged widely in a landscape dominated by sugarcane and urban development. The echolocation and many social calls of *O. martiensseni* are readily audible to human observers, allowing a non-contact, low technology way to monitor the distribution and activity of these bats. Although listed as a species of special concern in Kwa - Zulu Natal, these bats appear to be candidates for inclusion on a "blue" list of

species, ones showing stabilized or increased abundance. We recommend *O. martiensseni* as a "flagship" species in the Durban area, representing the resilience of nature.

New World Nectar-feeding Vertebrates: Community Patterns and Processes

Fleming, Theodore H., Nathan Muchhala, and J. Francisco Ornelas
University of Miami, Coral Gables, FL; Instituto de Ecologia, Xalapa, Mexico

New World nectar-feeding vertebrates occur primarily in the mammalian family Phyllostomidae (subfamilies Glossophaginae and Phyllonycterinae with a total of about 34 species) and the avian family Trochilidae (about 330 species). In this paper we compare and contrast patterns and processes in the community structure of these two groups to identify evolutionary commonalities and differences. Both groups show similar latitudinal trends in regional species diversity with peak diversities occurring in northwestern South America and southern Central America. Diversity at the community level shows parallel trends with species richness increasing as a power function of annual rainfall per site. Nectar bat diversity ranges from 1-6 species per site; hummingbird diversity ranges from 3-28 species per site. Higher per site hummingbird diversity has arisen in part from the evolution of distinct sets of canopy- vs. understory-feeding species. The two groups also show a parallel trend regarding body size and jaw/bill length distributions in different habitats: the largest species tend to occur in dry habitats. We postulate that this trend reflects differences in mean flower sizes among habitats. The density and biomass of both nectar-feeding bats and birds tend to be low at most sites, reflecting the low energy density of nectar compared with other food resources (e.g., fruit). In both groups, seasonal migration is a prominent feature of community organization. Hummingbirds exhibit a more diverse array of foraging strategies than nectar bats. Whereas both groups contain species that forage via trap-lining, only in hummingbirds is resource defense a common foraging strategy. Energy availability probably limits population sizes of both groups in many (but not all) habitats, but a greater array of flower types has promoted higher per site hummingbird diversity.

Bats in Buildings: Private Land Habitat Stewardship on Southern Vancouver Island.

Ford, Adam T., University of Victoria, BC

Many of British Columbia's bat species roost in buildings such as sheds, barns, cabins and unsealed attics. While there is no shortage of these structures across the landscape, landowners that are housing a bat colony may not be aware of the conservation value that their building has. Therefore, efforts should be made by wildlife managers to address private landowners with respect to the conservation of bat habitat on their property. Impeding this effort are issues of liability, cost and the receptivity of landowners. The goal of this study was to assess the receptivity of landowners to bat conservation. A letter was mailed to 597 residences in North Saanich, BC asking if they would like to participate in a bat conservation survey. Once contact was made I first attempted to identify the presence of a bat colony on the site. After my first meeting with landowners I assessed their receptivity to the bat colony (or potential bat colony) on their property using a five-point scale. In a second round of landowner contact I gave participants a questionnaire that established how landowners saw themselves engaging in bat conservation. Participants were asked how receptive they are to bats on their property using the same five-point scale. Additionally, twelve habitat stewardship options were listed and landowners selected those options they would be willing to do. Most participants did not have bats living in their residences but were attempting to encourage bats with artificial roosting structures. The second most common feedback was from homeowners who have resident bats and were either sympathetic to them or did not mind their presence (i. e., "I won't bother them if they won't bother me."). The third most common opinion was held by landowners who either had a roost or foraging area on their property, but did not welcome bats (i. e., "I hate these damn bats, I can't even water my plants at night"). A result of this study suggests that many private landowners are willing to participate in habitat stewardship. Wildlife managers should consider promoting bat conservation through stewardship. Research for this study has also illustrated the absence of a provincial building bat roost directory. Such a directory should be in place to monitor rare and endangered bat populations and to provide research opportunities for wildlife managers and biologists. The creation of this directory would require public outreach that would no doubt raise the public's awareness of bat conservation.

Utilizing Bat Boxes to Relocate Commensal Bat Colonies

Frantz, Stephen C. and Andrew D. Saunders
NYSt. Dept Health, Albany, NY; SUNY College of Environmental Science & Forestry, Syracuse, NY

Following development of the successful birdnetting checkvalve method for excluding commensal bats from buildings, it became apparent that additional management techniques might benefit both bat conservation and public health. A series of studies was initiated to determine how to encourage bats (primarily *Myotis lucifugus*) to utilize alternative roosts (bat boxes), and then how to move such boxes with bats to areas of little (or controlled) human activity. The basic approach was in early spring to locate a bat box(es) near a bat-occupied building. A box was either elevated on poles within several meters of the building; or it was affixed to the building adjacent to the primary bat access hole(s). Over the course of the warm season, bats explored the boxes. After bats had departed for their winter hibernacula, the buildings were batproofed. The following spring, bats occupied bat boxes when they failed to gain entry to the batproofed original roost site. Once the bats established themselves in the bat boxes, the boxes with bats were relocated. Greatest success occurred when relocation occurred shortly before parturition. While more studies are needed, relocations of up to approximately 1.6 km from the original roost site have been successful; stable colonies in relocated houses have been monitored for several years. Most of this work occurred in the Chenango Valley State Park (near Binghamton, NY) and at the SUNY-ESF Adirondack Ecological Center (near Newcomb, NY), but the general techniques should be applicable to other geographic locations and to other species of commensal bats.

The Evolutionary Influence of Bats on the Flight and Sensory Defences of Moths and Butterflies

Fullard, James H., Erindale College, University of Toronto, Mississauga, Ontario, Canada

If bats are significant predators, their presence will effect the activity patterns and sensory defences of the insects that share their night. The flights of 84 Nearctic species of Lepidoptera (moths and butterflies) were measured over their complete 24 hour cycle and the level of nocturnality (the time spent flying when bats are foraging) was used to examine the evolution of flight preferences and anti-bat ultrasonic ears in these insects. These studies suggest that the "best" strategy is mixed day/night flight, used by eared moths. Less "successful" strategies are exclusive day-flight in the earless butterflies and reduced or cryptic night-flight in the earless moths. This evolutionary balance between bats and Lepidoptera is seen in other examples around the world (e.g., night-flying, eared butterflies of Panama; day-flying, bat-deaf moths of Venezuela). It appears that flight preferences, once evolved, do not change easily since certain bat-free habitats (e.g., French Polynesia) have not produced night-flight in butterflies. The danger of exchanging one defence for another may be evident in certain Hawaiian moths that are forced to fly in bat airspace without the benefit of sensitive ears.

Rabies in Pennsylvania: Are Bats a High Risk Species?

Gannon, Michael R. and Linsey R. Olnhausen
The Pennsylvania State University, Altoona College, Altoona, PA

Bats are keystone species in almost all ecosystems in which they are found. Insectivorous bats, such as the 11 species found in Pennsylvania, are major predators of night flying insects, including many that are considered agricultural pests. Bats, and their role as a vector of rabies, have long been in question. Pennsylvania health officials and the CDC have listed bats among high-risk species as rabies vectors for human exposure. Chiroptera is the only group where the entire order is listed, and no distinction is made with regard to individual species. Since 1980, only 26 deaths have been associated with bats as possible rabies vectors in the United States, and only one bat related rabies death has ever been recorded in Pennsylvania. No bat related rabies death has ever been associated with the most common bat in Pennsylvania, the little brown bat *(Myotis lucifugus)*. We obtained rabies data for all mammals tested in Pennsylvania from 1943 to present from the Pennsylvania Department of Health. In addition, data relating to cases dealing with human exposure to rabies beginning in 1992 were also available and examined. Data related to bats were compared with other species of mammals, both wild and domestic. Results show that in the past ten years, the number of raccoons found rabid in Pennsylvania has been extremely high. During the same period the numbers of foxes, skunks, and bats found to be rabid are each significantly fewer than

the number of domestic cats found to be rabid. Moreover, the combined percent of these rabies cases that resulted in human exposure in Pennsylvania (bats, foxes, and skunks combined) over an eight year period (1992 – 2000) is again significantly less than the percentage of rabies cases in domestic cats that resulted in human exposure. These data, supplied by the Pennsylvania Department of Health, indicate that domestic cats are a higher risk to humans as a potential vector of rabies than a number of wild species already listed high risk, including bats. Domestic cats are not considered a high risk species by either the Pennsylvania Department of Health or the CDC.

They Just Keep Calling, But Is Anyone Listening?

Gordon, Thomas T., SUNY Stony Brook, NY

The Hammer-headed Bat, *Hypsignathus monstrosus*, is probably best known for its lek mating system, which includes a loud and highly stereotyped male display. In Taï Forest, in western Côte d'Ivoire, H. monstrosus does not lek and males can be heard calling alone or in small groups across the entire year, regardless of season. Such calling is in stark contrast to the highly seasonal calling reported by Bradbury (1977) where female reproductive patterns closely matched the male calling patterns. This leads to the question of whether or not the female reproductive patterns in Taï Forest were relatively aseasonal, reflecting the male calling patterns, or highly seasonal as reported in Gabon? To address this issue, I estimated the age of all the juvenile and subadult *H. monstrosus* captured to look for seasonal birth peaks. Two distinct birth peaks (6 months apart) were found in this population of *H. monstrosus*. Neither the periods during which these peaks occurred nor the estimated mating (conception) periods correlated to any ecological factor tested or the male calling patterns. However, the time at which the young become volent was significantly related to the estimated levels of fruits available in the forest. The female *H. monstrosus* at Taï Forest appear to follow a reproductive pattern synchronized to levels of fruit availability and the male calling activity is not a reliable cue for female receptivity.

Fruit Bat Conservation in the Comoros Islands: Past Efforts, Current Challenges, and Future Steps

Granek, Elise and Brent J. Sewall, Oregon State Univ., Corvallis, OR; Univ. of Minnesota, St. Paul, MN

Six bat species, including three Megachiropterans, inhabit the Comoros Islands of the West Indian Ocean. Here we examine the conservation of Megachiropterans in the Comoros. *Pteropus seychellensis comorensis* and the endemics, *Pteropus livingstonii* and *Rousettus obliviosus*, all utilize Comoros' rapidly disappearing forests for feeding and roosting habitat. Despite challenges including limited resources, poor infrastructure, and infrequent government enforcement of environmental regulations, various organizations working in the Comoros have undertaken conservation projects targeting bats. Action Comores focuses on *P. livingstonii* conservation through ecological research and roost monitoring. Several organizations developed a Species Action Plan for P. livingstonii. The World Conservation Union (IUCN) and the Comorian Environment Ministry are currently executing a five-year biodiversity conservation project that includes outreach, training, development of a Conservation Action Plan for P. livingstonii, and research on R. obliviosus. To gain local support, any long-term conservation strategy must promote environmental education and conservation-related income generation for rural Comorians. Effective bat conservation must include feeding habitat and roost site protection, long-term monitoring, further research on feeding ecology, population dynamics and reproductive biology of the Megachiropterans, and re-evaluation of the conservation status of *R. obliviosus*. Conservation of the Comorian rainforests may depend on the protection of these keystone bat species.

The Short-term Impacts of Abandoned Mine Reclamation on Townsend's Big-eared Bat (*Corynorhinus townsendii*) in New Mexico and Utah

Greenlee, E. S., R. E. Sherwin, W. L. Gannon, and J. Scott Altenbach
University of New Mexico, Albuquerque, NM

Abandoned mine reclamation programs have become both increasingly common and organized in the western United States. These programs are mandated to close abandoned mines to help assure public safety. As these programs began to gain momentum and start impacting greater numbers of mines, biologists became increasingly concerned about the actual and potential impacts that the large-scale re-

duction of this resource might have on cavernicolous species of bats. As a general response to these concerns, state mine reclamation programs initiated pre-closure survey protocols to identify "significant" roosts. Whenever possible those mines at which important bat colonies were located were protected with bat gates. As a result of these efforts approximately 330 of 5000 identified abandoned mines in Utah and 150 of 3500 in New Mexico have been protected with bat compatible closures. The majority of these bat gates were installed to protect roosts of *Corynorhinus townsendii*. As the responsibility of reclamation agencies generally ends with the closure of mine openings, little effort has been made to determine the effectiveness of current protocols for maintaining populations of bats in the landscape. Few post-closure surveys have been conducted. We conducted surveys at gated mines throughout New Mexico and Utah to determine the short term impacts of abandoned mine reclamation on *C. townsendii*.

Neotropical Nectar-feeding Bats (Family Phyllostomidae) Revisited: Hyoid/lingual Data Support a Recently-proposed Molecular Phylogeny

Griffiths, Thomas A., Shawn DeLaMar Lapetino, and Bruce B. Criley
Illinois Wesleyan University, Bloomington, IL

The phylogenetic relationships of Neotropical nectar-feeding bats have received much attention over the past forty years. Early in the 20th Century, all New World nectar-feeding bats (except the Antillean genera *Phyllonycteris* and *Erophylla*) were regarded as belonging to a single subfamily Glossophaginae. Analyses of various data sets in the 1960's and 1970's suggested that the taxon Glossophaginae might not be a monophyletic group, and various proposals were made to separate the genera into two (or more) groups. In 1982, on the basis of hyoid and tongue morphological and histological data, T. A. Griffiths proposed that nectarivory arose at least twice in Neotropical bats. He formally separated three genera, *Lonchophylla, Lionycteris*, and *Platalina*, from the subfamily Glossophaginae and placed them into a newly created subfamily, the Lonchophyllinae. This proposal caused considerable controversy at the time. Recently, R. J. Baker and colleagues published a molecular study of the RAG2 gene DNA sequence. Their analysis of the data suggested, among many other things, that the genera *Lonchophylla* and *Lionycteris* are, in fact, more closely related to the non-nectarivorous genus *Lonchorhina* than to the Glossophaginae sensu Griffiths (*Platalina* was not available for examination). In this study, we present observations on the hyoid and lingual morphology of *Lonchorhina* that support Baker et al.'s placement of *Lonchorhina* with *Lonchophylla* and *Lionycteris*. *Lonchorhina* does not have the extreme adaptations for nectar-feeding found in the lonchophylline genera, but it does share with lonchophyllines several derived hyoid/lingual character states that are not found in *Macrotus, Micronycteris*, or *Phyllostomus*. In particular, *Lonchorhina* has a permanent, shallow lingual groove in the lateral surface of the posterior tongue in a position similar to the much deeper grooves found in *Lonchophylla, Lionycteris*, and *Platalina*. While this is clearly a work-in-progress, our data collected to date provide some support for Baker et al.'s hypothesis, and thus for Griffiths' original creation of the subfamily Lonchophyllinae in 1982.

Habitat Use by Bats in a Managed Forest

Grindal, Scott, AXYS Environmental Consulting Ltd., Calgary, AB

Forest harvesting alters or fragments habitat, which may impact bat populations. Habitat use by bats was investigated during the summers of 1996 to 1998 in a harvested forest on Vancouver Island, British Columbia, Canada. Roosting habitat was characterized by following radio-tagged bats to their roosts. Roost selection was assessed by comparing known roost characteristics to their availability, as determined by data collected in random plots in second- and old-growth stands (tree and site level), as well as using geographical information systems applied to digital forest cover information (stand level). Bat activity was monitored using ultrasonic bat detectors placed in second- and old-growth stands in four habitat types (riparian, cutblock edges, forestry roads, and interior forest). Prey availability was assessed using fluorescent black light insect traps operated concurrently with the bat detectors in riparian and cutblock edges. Bats selected large diameter tall trees of moderate decay class with the majority of the bark remaining in old-growth stands. Ultrasonic bat activity was greatest in riparian habitats, with reduced activity in cutblock edges, forestry roads, and interior forest. In contrast, insect biomass was greater in cutblock edges than riparian habitat, suggesting that prey availability may not be the primary factor for determining foraging habitat. Bat activity also tended to the greater in old-growth stands, suggesting that proximity of foraging areas to roost sites may be important, as well as the physical complexity of the

habitat. These data suggest that the availability (i.e., number of roosts), as well as the suitability (i.e., characteristics) of roost trees, are important for bats in second- and old-growth forests. Therefore, forest management should include provision of adequate numbers and types of wildlife trees to provide appropriate habitat for roosting bats.

Flight and Echolocation of the Earliest Emballonurid Bat from the Middle Eocene of Messel

Habersetzer, Joerg, Gerhard Storch, and Bernard Sigé
Forschungsinstitut Senckenberg, Frankfurt, Germany; Université Claude Bernard, Villeurbanne, France

The flight apparatus and the inner ear of a new Eocene emballonurid bat species was studied on two specimens of Grube Messel, near Frankfurt, Germany, one being extraordinarily well-preserved. The wing is highly specialized for a rapid and constant flight style. The proportions of the narrow foil and the outline of the flight membranes are almost identical with extant Taphozous species. The external ear, the relative size of the inner ear, and some internal features of the cochlea also appear almost identical with extant *Taphozous* species. The earliest radiation known from an extant bat family thus shows that already during Paleocene time, specilializations in flight style and echolocation obviously compared well with those known from their extant representatives.

The Role of Fixed-wing Aircraft in the Discovery of the First Summer Colonies of Indiana bats *Myotis sodalis* in New England

Hicks, Alan C., Susanna L. von Oettingen, Michael B. Burbank, Marylin F. Ricker, and Franklin C. Cole, NY State Department of Environmental Conservation, Albany, NY; US Fish and Wildlife Service, Concord NH; USDA Forest Service, Middlebury VT; Northfield, VT; NY State Police, Albany, NY

Although nearly 30,000 Indiana bats (*Myotis sodalis*) winter in New York State, summer colonies have never been documented there or in New England. We tested the feasibility of locating summer colonies using fixed-wing aircraft to track radio-tagged animals as they dispersed from their hibernaculum. We also had ground crews to verify locations and to conduct emergence counts. We radio tagged and released five *M. sodalis* (four females, one male) at the Barton Hill Mines, Essex Couny, NY on May 2, 2001. The following day we located two females near Middlebury and North Orwell Vermont, 35 km SE and 36 Km SSE respectively, from the mine. Both remained in the area for the expected life of the transmitters. A third female was located on May 8 in Vergennes, VT, 22 km ENE of the mine in an area that was thoroughly searched during the first flight. The bat was never detected again. To our knowledge, this is the first time that female Indiana bats have been tracked from their winter to summer range. The use of aircraft for finding summer range has the potential of being less expensive, more thorough, and less biased than other search methods, especially when taking full advantage of the plane's ability to simultaneously search for multiple animals.

Nectar-feeding Bats and Agaves in Southeastern Arizona: Obligate Mutualists or Ruthless Opportunists?

Hinman, Katharine E., S U N Y at Stony Brook, Stony Brook, NY

The two species of nectar-feeding bat found in southeastern Arizona, *Leptonycteris curasoae* and *Choeronycteris mexicana*, have long been cited as important visitors to the species of century plants in this area, especially *Agave palmeri*. However, the extent to which visits by these bats are truly vital to the survival of this plant is a matter of some debate. Some authors have claimed that the relationship between *L. curasoae* and *A. palmeri* is an obligate mutualism and that the decline of *L. curasoae* which led to its being placed on the endangered species list has also resulted in extremely low levels of fruit and seed set in *A. palmeri*. Others, however, assert that, while the bat is almost certainly dependent on the plant as a food source, the plant is capable of adequate fruit set without pollination by any nocturnal visitors. Exclusion experiments indicate that, while *Agave palmeri* is capable of setting fruit with only diurnal visitation, higher fruit set occurs when only nocturnal visitors are allowed, and highest fruit set occurs when both nocturnal and diurnal visitors are allowed. However, these exclusion experiments also call into question the claim that *Agave palmeri* are self-incompatible, and thus reliant on animal pollinators for any seed set. As well, analysis of fecal matter from the bats suggests that they may be relying on other sources of protein

beyond Agave pollen. The abundance of alternate nectar sources, primarily in the form of hummingbird feeders, in certain areas of their range also indicates the possibility of a substitute source for carbohydrates. Unfortunately, the longevity and semelparity of *A. palmeri* make manipulative studies very difficult as it does predictions about the effects of inadequate seed set. As well, the migratory nature and large foraging area of *L. curasoae* create difficulties for extensive long-term studies of resource use. However, acknowledgement and confirmation of possible alternative resources for both partners in this mutualism can help better inform management decisions for both species.

Grooming Behaviour and Roosting Preferences of Phyllostomid Bats in Relation to Streblid Load

Hofstede, Hannah M. ter, York University Toronto, ON

Batflies from the family Streblidae spend their entire life on their host, with the exception of the time that female flies deposit their larvae within the roost to pupate. Once the fly has emerged it immediately seeks a host to live on. These flies therefore appear better adapted to living on cavity roosting bats, which provide a stable and protected surface for depositing larvae, than foliage roosting bats, which have less protected and more ephemeral roosts. I captured bats at the Lamanai Archaeological Reserve in Belize from April 4 to August 4, 2001 and collected data on parasite load and grooming behaviour for a variety of species in the family Phyllostomidae. Streblid loads for four cavity roosting bat *species (Carollia brevicauda, Desmodus rotundus, Glossophaga soricina* and *Sturnira lilium*) were significantly higher than those of four foliage roosting bat species *(Artibeus phaeotis, Artibeus watsoni, Uroderma bilobatum* and *Vampyressa pusilla*) (Mann-Whitney U, $p < 0.0001$, $n = 265$). Out of these eight species, grooming behaviour was videotaped and described for *Carollia brevicauda, Glossophaga soricina, Sturnira lilium, Artibeus phaeotis* and *Artibeus watsoni* in order to provide a general description of grooming behaviour and to compare potential differences in grooming based on roosting preferences and streblid load. Grooming behaviour consisted mostly of scratching the fur with the hind claws, licking and chewing the hind claws and licking the wing membranes. Grooming behaviour was compared when Sturnira lilium and Glossophaga soricina had streblids or when they did not.

Development of Thermoregulation and Dietary Influences on Torpor Use by Big Brown Bats, *Eptesicus fuscus*

Hollis, Lydia, University of Calgary, Alberta, Canada

Growth and survival of young animals is affected by their ability to cope with environmental conditions. For example, juvenile survival in homeothermic animals may be affected by the ability to thermoregulate and minimize the costs of thermoregulation. One means of reducing thermoregulatory costs is by making use of torpor. Although there are many extensive studies on growth and development of bats, little is known about the development of torpor in bats. The purpose of my study is to examine the development of thermoregulatory ability in temperature-zone bats from southeastern Alberta, Canada. I determined the use of torpor by 16 prevolant and 28 fledged juvenile big brown bats, *Eptesicus fuscus*, using temperature-sensitive radio transmitters. Preliminary data suggest that although prevolant E. fuscus used torpor more than fledged young, they were able to keep warm while their mothers foraged by clustering together within the roost. I also investigated the influence of diet on torpor use by big brown bats. To test this, subadult *Eptesicus fuscus* were fed mealworms raised on various diets. Mealworm larvae were raised on three diets: (1) bran, as the "control diet", (2) bran with 10% addition by weight of sunflower oil, as the "unsaturated diet" [high in Polyunsaturated Fatty Acids (PUFA)], and (3) bran with 10% by weight of sheep kidney-fat, as the "saturated diet" (low in PUFA). After a two-month period, each group of mealworms was fed to a group of 3–4 captive subadult *E. fuscus*. After a 2-week feeding period on the various diets, use of torpor by the bats was monitored using temperature-sensitive transmitters. Bats were held in a cold chamber at 100C for one week, and length and depth of torpor bouts were determined. Preliminary data suggest that bats fed on mealworms high in PUFA had longer and deeper torpor bouts than *E. fuscus* fed on mealworms low in PUFA and control mealworms. One possibility is that bats fed on mealworms high in PUFA were not limited by reduced membrane fluidity at low temperatures. Since the melting point of mammalian storage fat greatly decreases as the degree of fatty acid unsaturation increases, PUFA acquired through the diet may be essential for maintaining membrane fluidity at the low body temperatures reached during torpor.

Roosting Ecology of the Grey-headed Flying Fox, *Pteropus poliocephalus*: Social Organization in a Summer Camp

Holmes, Jennifer L., University of Tennessee, Knoxville, TN

A colony of grey-headed flying foxes (*Pteropus poliocephalus*) in the Royal Botanic Gardens in Sydney, Australia was studied over a ten-week period before, during and after the mating season to assess spatial distribution and social organization. Ground censusing techniques were used to determine weekly estimates of the numbers of bats in the colony and numbers of bats within each tree. Surveys were used to document genders and ages of bats occupying each tree. Unlike Nelson's (1965) findings, the social structure of the colony was based not on mating strategies of individual bats but on age and gender. Adult and subadult bats clearly segregated themselves within the colony. Within these age groups, bats also segregated themselves to some extent by gender, except during the mating season. Adult bats were found to roost in taller trees while younger bats (subadults and independent juveniles) roosted in shorter trees.

Do Social Interactions Play a Role in the Night-roosting Behavior in the Little Brown Bat, *Myotis lucifugus*?

Horn, Jason W., and Thomas H. Kunz, Boston University, Boston, Massachusetts

A maternity colony of approximately 800 adult little brown bats (*Myotis lucifugus*), located in a small barn in southern New Hampshire, has been the subject of a long-term study of variation in individual activity budgets and roost fidelity. Individuals night roost in small rectangular spaces (mortises) that are unoccupied during daylight hours. For each of the past five years, we have marked 150 to 200 individuals in this colony with subcutaneous transponders (PIT tags) to quantify the use of night roosts and assess nightly activity budgets. The ring antennae of PIT tag readers were placed over the openings to these night-roosts to record the identity of individuals entering and leaving. Additionally, the identity of individuals that departed to forage and later returned to the barn was recorded by positioning an antenna over one of the openings commonly used during emergence. A popular hypothesis for the function of night-roosting behavior in bats is that it serves an important energy-conserving, thermoregulatory role. Night roosts in this barn can be 190 C warmer than ambient temperatures when they are occupied by bats. Interactions during night-roosting behavior may also facilitate communication within the roost, or influence foraging behavior as it does in some species. Non-random use of these spaces may indicate such a role. During summer 2000, 70% of the individuals that visited two monitored night roosts visited one roost at least twice as often as the other. In either case, individuals appear to compete for this important resource. Video observation of these night roosts revealed high rates of visitation and turnover when the roost was fully occupied, suggesting competition for position within the roost. The present study was designed to identify possible social components that may contribute to this night-roosting behavior. During summer 2001, the activity of bats at four frequently used night roosts was monitored during several experiments of ten days each. For the first five days of each experiment, two roosts were blocked to prevent access while two others were monitored for activity. For the second five days, roosts that were either blocked or monitored were switched. Infrared video recordings corroborated the entrance and departure activity at these night-roosts. Temperature probes inside night-roosts monitored the presence of bats in the four experimental roosts, as well as one control roost. Preliminary analysis suggests that individuals may divide their nightly activity into more than one night-roosting session and more than two foraging periods, and may non-randomly associate during night-roosting periods.

A Preliminary Study of Infant Behavior and Communal Care of Young in a Captive Group of Straw-colored Fruit Bats, *Eidolon helvum*

Hull, Rebekah, Jan Zinck, and Debbie Duffield, Portland State University, Portland, OR

A captive group of seven adult females, two juvenile females, and one adult male *Eidolon helvum* was observed for approximately 150 hours over a 6 month period extending from late pregnancy through early weaning of the new young. Communal care behaviors, postpartum matings, and changes in social organization were noted. Forms of allo-parental care, such as allo-grooming and holding of young, were performed by specific "helpers," one adult female and the adult male of the group. Allo-nursing was not observed. An ethogram was developed to record infant behaviors and produce individual time budgets.

Preliminary data from these infant time budgets suggests possible differential rearing of male and female young. Results from this season and research plans for next season will be discussed.

The Preliminary Effects of Wildlife Stand Improvements and Low Intensity Prescribed Burns on Bat Populations on the Buffalo Ranger District, Ozark National Forest, Arkansas

Jackson, Jeremy L., J. D. Wilhide, and Shane Prescott, Arkansas State University, State University, AR

The effects of forest management on bat populations is a concern in many of our National Forests. Wildlife stand improvements (WSI) and low intensity prescribed burns can alter the age and condition of the forest, and this can affect the abundance and diversity of bat species. These management practices were investigated on the Buffalo Ranger District, Ozark National Forest in northwestern Arkansas. The habitat consists primarily of deciduous hardwoods with small compartments of conifers scattered throughout the district. The district is approximately 241,000 acres of which 30,000 acres are designated wilderness areas. For this investigation on the effects of these management practices on the bat population, observations were made in areas where WSI's and low intensity prescribed burns will be conducted in the fall of 2001 and spring of 2002, respectively. Two controls were chosen in areas where WSI's and low intensity prescribed burns have been conducted in the past.

Prey Discrimination by Olfactory Cues in the Pallid Bat (*Antrozous pallidus*)

Johnston, Dave S., H.T. Harvey & Assoc., San Jose, CA; Santa Clara University, Santa Clara, CA

Many carnivores use olfactory cues for prey detection, but little is known about bats' use of olfactory cues to detect animal prey. The pallid bat (*Antrozous pallidus*) is known to detect prey by listening to low-frequency sounds generated by ground-dwelling arthropods. I used a maze to determine if the pallid bat can also distinguish between prey in scent-choice experiments. Preliminary results from the scent-choice maze suggested that captive pallid bats distinguished prey odors (e. g., meal worm, *Tenebrio molitor*, Jerusalem cricket, *Stenopelmatus fuscus*) from controls (i. e., distilled water) and non-prey insects (e. g., stink beetle, *Eleodes sp.*). In addition I used paper balls (1 cm in diameter), each impregnated with fluids from a different prey type, to observe prey recognition by olfactory cues. Captive bats typically captured prey-impregnated paper balls and rejected and recaptured them several times before loosing interest. One female adult, that refused to eat live meal worms, readily "captured" paper balls impregnated with the angular-winged katydid (*Microcentrum rhombifolium*) as well as dead, dried insects (e. g., fork-tailed bush katydid, *Scudderia furcata*) that it ate entirely. Foraging bats never "captured" nor got their nose closer than 12 mm from a ball impregnated with the stink beetle fluid. Additionally, captive bats pursued live stink beetles crawling on a substrate in a flight room and bats didn't loose interest in the beetle until the bat's head was about 1.5 – 2 cm from the insect. These results suggest that pallid bats use chemical signals, and probably not visual cues, to detect and distinguish between prey at short distances (<10 cm).

Bat Extinction Risk: Pattern and Process

Jones, Kate E., Andy Purvis and John L. Gittleman
Imperial College at Silwood Park, Ascot, Berkshire, UK; University of Virginia, Charlottesville, VA

We investigate the pattern and processes influencing extinction (as indicated by IUCN threat categories) in bats using a multivariate phylogenetic comparative approach. Small geographic ranges and low wing aspect ratios are found to independently predict extinction risk in bats, explaining 48 % of the total variance in IUCN assessments of threat. Smaller geographic ranges would decrease the likelihood of recolonization from other populations after local stochastic extinction. Similarly, species with low wing aspect ratios have higher flight costs and this may limit their ability to recolonize patches after local extinctions when habitats are fragmented. The pattern and correlates of extinction risk in the two bat suborders is significantly different: megabats are significantly more currently threatened and have experienced more species-level extinctions in the last 500 years than microbats. While correlates of microbat extinction risk are the same as in the order as a whole, megabat extinction is more correlated with geographic range and life history rather than with wing morphology. Extinction risk is not randomly distributed phylogenetically: closely related species have more similar levels of threat than would be expected if extinction risk were random. Given the unbalanced nature of the evolutionary diversification of

bats, it is likely that the amount of phylogenetic diversity lost if currently threatened taxa disappear may be greater than in other clades with numerically more threatened species.

Preliminary Natural History Aspects of a Bridge-roosting Colony of Southeastern Bats (*Myotis austroriparius*) in Southwest Arkansas

Jones, Tammy R., Drew Reed, J.D. Wilhide, David A. Saugey, and Betty G. Crump
Arkansas State University, State University, AR; United States Forest Service, Jessieville, AR; United States Forest Service, Glenwood, AR

Preliminary data from a colony of southeastern bats (*Myotis austroriparius*), located in Pike County, southwest Arkansas, were collected from May 14 to August 15, 2001. The bats were found roosting in the expansion joints of a large concrete bridge over a northern portion of the U.S Army Corps of Engineers' Lake Greeson. The bridge is located in an area of high disturbance on a heavily traveled state highway adjacent to a busy marina. In early June the colony consisted of approximately 350–400 bats of both sexes. Brazilian free-tailed bats (*Tadarida brasiliensis*) were also observed using the bridge as a day roost. During the maternity period, males and females were found to be utilizing the same expansion joint, as well as being clustered together. Pregnant and lactating females, as well as females with pups, were collected between mid-May and late June. Once juveniles became volant they continued to use the bridge roost along with the adults. The bats seemed to disperse to different joints within the bridge at this time. Invasive survey techniques such as hand capture also caused movement to different joints; these bats are very sensitive to direct roost disturbance. During the winter of 2000/2001, approximately 30 bats were banded from abandoned cinnabar mines on the south end of Lake Greeson, 4.8 km (three miles) from the bridge roost. However, none of these bands were recovered in the summer survey efforts. A total of 258 bats were banded from the bridge roost this summer in order to determine if these bats are using the cinnabar mines as their winter roost. This ongoing research on the natural history aspects and foraging behavior of M. austroriparius, in the Lake Greeson Project Area, will continue monthly throughout the fall and winter of 2001, and continuously throughout the spring and summer of 2002.

Bat Activity and Echolocation in Biomes of Northwestern Argentina

Kalcounis-Rueppell, Matina C., Tim J. Brown, Paul T. Handford, and Ricardo A. Ojeda,
Univ.CA, Berkeley, CA; Univ. Western Ontario, London, ON; CONICET-IADIZA, Mendoza, Argentina

We examined echolocation sequence characteristics and activity of bats in four biomes of northwestern Argentina during the early southern spring of 1997. Our aims were to evaluate the level of bat activity among the four biomes and to investigate whether the acoustic structure of echolocation signals conformed to general predictions. We sampled bat activity in sites representing high Andean Puna desert, lowland Chaco thornscrub, lowland Monte desert, montane Yungas forest (rain forest) and montane Chaco thornscrub. No bats were recorded in the Puna, while of the other biomes the least to the most active were: Monte desert, rain forest, Chaco thornscrub. Echolocation signal structure differed among the biomes. In general, signals recorded from bats in rain forest were of relatively high frequency whereas signals recorded from bats in Monte desert were of relatively long duration. Time between signals was shorter at the montane Chaco site probably reflecting more feeding sequences at this site. Modal frequency of signals and duration of signals differed predictably among the biomes. We show that bats in the less complex biomes tend to be less active. Our results highlight the abundance and diversity of the Chacoan bat community, and we suggest that this region offers opportunity for further study.

Hydroelectric Development and Roost Sites: The Campbell River Story

Kellner, Mandy & Sal Rasheed, Pacific Slope Consulting, Vancouver, BC; Parks Canada Agency, Calgary

The history of the Campbell watershed, on Vancouver Island, British Columbia, has resulted in a highly modified landscape, with interesting consequences for the bat fauna. In 1938, a large (115 sq. mile) fire burned most of the lower watershed, creating the current, even-aged, homogeneous forests. There was also extensive flooding and loss of valley-bottom riparian habitat due to the construction of three dams in the 1950s. These occurrences may have significantly reduced the availability of natural roost sites, such as the large-diameter snags commonly used by bats on northern Vancouver Island. Currently, colonies of bats live in the B C Hydro power-generating stations associated with the dams. These artificial roosts may be

important to the survival of bat populations in this landscape. However, the potential for bats to create unsanitary work conditions and startle people working in the dangerous interior of the stations has led to safety concerns and the desire to remove the bats. In response, the BC Hydro Bridge Coastal Restoration Fund has funded a BC Ministry of Water, Land and Air Protection (WLAP) initiative, the two-year Campbell River Watershed Bat Habitat Enhancement Project. This cooperative project partners BC Hydro and WLAP and has two main components. Firstly, we will study the bats which are using the BC Hydro generating stations. This investigation will determine the species of bats using the stations, locate roosting sites within the stations, and estimate colony sizes. To compliment this work, we will also conduct a comprehensive inventory of bats in the Campbell River watershed and examine natural roosting behavior. Secondly, based on our findings, we will recommend measures to exclude the bats from the generating stations, provide alternate roosts for bats currently using the generating stations, and monitor use of these alternate roosts. This poster presents our results from Year 1, including details of the situation in the generating stations and preliminary information from the watershed inventory. The research will hopefully contribute to the conservation-oriented management of bats in an industrial setting.

Acoustic Divergence in Two Cryptic Hipposideros Species: A Role for Social Selection?

Kingston, Tigga, Marcia Lara, Gareth Jones, Zubaid Akbar, and Christopher Schneider
Boston University, MA; Bristol University, UK; University Kebangsaan Malaysia, Malaysia

The bicolored leaf-nosed bat (*Hipposideros bicolor*) is a widespread and common bat from South East Asia. We demonstrate that a population from Peninsular Malaysia comprises two morphologically cryptic but acoustically divergent species. Echolocation call frequencies were distributed bimodally with peaks in the frequency of maximum energy at ca. 131 kHz and 142 kHz, and the two phonic types are genetically distinct with a cytochrome b sequence divergence of just under 7%. Differences in call frequency are not likley to effect resource partitioning by detectable prey size or functional range. Acoustic divergence in these species may be a consequence of social selection for a clear communication channel, which is mediated by the close link between the acoustic signal and receptor systems imposed by the highly specialized nature of the hipposiderid and rhinolophid echolocation system. Ecological segration may be achieved by differences in microhabitat use; the 131 kHz H. bicolor is characterized by longer forearms, lower wing loading, a lower aspect ratio and more rounded wingtip, features that are associated with greater maneuverability in flight that may enable it to forage in more cluttered environments relative to the 142 kHz phonic type.

Arm Signals: Are Characters of the Humerus Useful for Resolving Phylogenetic Relationships among Bats?

Korobov, Natasha, Jonathan H. Geisler, and Nancy B. Simmons
Barnard College, Columbia University, NY, NY; American Museum of Natural History NY, NY

Despite numerous phylogenetic studies in recent years, higher-level relationships of bats remain controversial. Monophly of some groups thought to be well-supported (e.g., Microchiroptera, Nataloidea) has been questioned, and relationships within and among many families remain poorly resolved. As part of a larger effort to develop new and enhanced data sets to address these problems, we conducted a thorough study of morphology of the humerus to assess its value as a source of phylogenetic characters. As the most proximal skeletal element in the wing, the humerus is the site of attachment of many important flight muscles, and its proximal end forms part of a shoulder-lock mechanism in many species. Morphology of this element has long been known to vary among taxa. We compared the humerus of over 50 bat species and several outgroups, and found extensive variation that we described in over 25 morphological characters. Not surprisingly, parsimony analyses of these data alone indicate that the humerus by itself does not contain enough information to resolve relationships. Combination of these data with other morphological characters (e.g., from the skull, postcranial skeleton, pelage, face, tongue, etc.) yielded more satisfactory results. Inclusion of characters of the humerus improved phylogenetic resolution resulting from analysis of a much larger data set of over 300 characters, and significantly changed topology of some parts of the tree. Humeral characters changed resolution, topology, and/or support for various groupings in Megadermatidae, Mormoopidae, Phyllostomidae, and Emballonuridae, and were important for determining

placement of Noctionidae relative to other families. Resolution of relationships within Vespertionidae remains problematic.

Bat Conservation on Eastern National Forests: Where We Have Been and Where We Should Be Going

Krusac, Dennis L., USDA Forest Service, Atlanta, GA

The Forest Service, like other federal agencies, has recovery responsibilities under the Endangered Species Act. Prior to 1995, our efforts to conserve bats including the endangered Indiana bat, were mainly focused on protecting hibernacula and streamside management zones because most researchers and managers familiar with the species believed Indiana bats hibernating in the southern part of their range migrated north and used riparian areas during the summer. Hibernacula protection was accomplished through gating, signage, or keeping locations confidential. Protection of streamside management zones was accomplished through implementing best management practices in riparian areas. In 1994, the first female Indiana bat captured in an upland habitat was mist netted on the Daniel Boone National Forest in Kentucky. Consequently, between 1995 and 2000 our efforts were focused on surveys of forested uplands, Forest Plan revisions to better address bat conservation, formal consultation with U. S. Fish and Wildlife Service, and considerable litigation related to Indiana bats. The Forest Service must move forward and actively conserve forest bats. The Forest Service should continue research efforts to determine habitat use in predominantly forested landscapes and the effects of management, refine acoustic monitoring techniques, standardize sampling protocols and monitoring efforts, survey and protect mines and caves, design forest management strategies that provide roost trees across the landscape which include large diameter dead and hollow trees, utilize timber harvest methods that minimize adverse effects to bats, provide and maintain ridge top water sources, find better solutions to management of forest pests, and increase education efforts with a focus on bat conservation.

Ecological, Behavioral, and Physiological Applications of Infrared Thermal Imaging for the Study of Bats

Kunz, Thomas H., Jason W. Horn, and Jeff D. Frank
Boston University, Boston, MA; Indigo Systems, Inc., Santa Barbara, CA

One the greatest challenges that face biologists who study the ecology, behavior, and physiology of nocturnal animals is the ability to detect and observe their activities in the dark without causing disturbance. Recent technological advances in infrared thermal imaging now make it possible to observe and record the ecological, behavioral, and physiological responses of animals under a wide range of field conditions. In contrast to standard night vision devices and near infrared cameras, each of which require some source of light, infrared thermal cameras are designed to detect radiated heat from inanimate objects or animals during the day or night without the need for an accessory light source. For the past three years, we have used an advanced infrared thermal imaging system to 1) census Mexican free-tailed bats as they emerge nightly from caves, 2) detect and observe roosting behavior of bats (including tent-making bats), 3) document the feeding behavior of vampire bats, 4) observe and record foraging behavior of insectivorous bats, 5) evaluate the energetic benefits of clustering, and 6) evaluate heat flux of both flying and roosting bats. As with other types of equipment, this new technology offers as many opportunities as it does challenges for investigating the ecology, behavior, and physiology of free-ranging bats.

Journeys in Space and Time: Movements of the Endangered Indiana Bat

Kurta, Allen, Susan W. Murray, and David H. Miller
Eastern Michigan Univ., Ypsilanti, MI; Boston Univ., Boston, MA; Univ. of Michigan, Ann Arbor, MI

We studied movement among roosts by a group of Indiana bats (*Myotis sodalis*) in southern Michigan over four years using radiotracking techniques. Thirty-seven of 38 roost trees used by adult females and young were located in wetlands, and all 37 were elms (*Ulmus spp.*), ashes (*Fraxinus spp.*) or maples (*Acer spp.*). Bats changed trees every 2–3 days, and new roost trees likely were discovered as bats foraged or commuted between foraging areas. Pregnant females switched more often than lactating adults, and bats roosting in crevices changed less often than when the same bats roosted under bark. Maximum distance moved between trees overnight was 5.8 km, but maximum distance between any two roosts discovered

over 4 years was 9.2 km. The focal point of roosting activity moved 2 km across the landscape over 3 years. Frequent roost-switching, large home ranges, and changes in activity center between years create challenges for detection, monitoring, and management of this endangered species.

Scaling of Body Size and the Abdominal Wall in Echolocating Bats

Lancaster, Winston C., Pikeville College, Pikeville, KY

By the principle of Laplace, the pressure generated within a cylindrical muscular organ is related to the stress produced by its walls and its radius. Progressively larger cylinders require greater stress to generate equivalent pressures. Pressure is generated by the stress exerted by muscular walls and is determined by the thickness of the wall. Therefore, generation of equal pressures in progressively larger cylinders requires thicker walls. If applied to bats that produce intense vocalizations, the principle of Laplace would predict that the muscles of the abdominal wall, the generators of pressure for echolocation, should become progressively thicker in larger species. This requirement could then limit the size of high-intensity echolocating bats by the practical limits of the thickness of a muscular body wall. From measurements of 13 species of alcohol-preserved bats from the collections of the Royal Ontario Museum, I estimated body volumes, surface areas and mean body radii. Samples of the abdominal wall were taken to measure thickness and examine the structure of the muscle. Cross sectional area of abdominal wall muscles determines the power available to compress the thoracoabdominal cavity. The cross sectional area corrected for body size has a negative relationship with body volume, indicating that larger bats have relatively smaller cross sectional areas of their abdominal wall muscles. This relationship does not support the hypothesis and is contrary to the principle of Laplace. The principle of Laplace applies well to generation of pressure by vascular structures composed of relatively uniform muscular tissue. It may not, however, apply equally well to complex systems composed of multiple tissues. Additionally, differences in styles of echolocation, pressure volume relationships and musculotendinous architecture complicate this comparison. Further data are needed to substantiate this relationship. Funding provided by PCSOM.

Daily Torpor in Whip-poor-wills (*Caprimulgus Vociferus*): A Comparison to the Bat Model

Lane, Jeffrey E., University of Regina, SK

Although taxonomically disparate, birds within the order Caprimulgiformes (nightjars) and bats have evolved to fill very similar ecological niches. Both groups forage for aerial insects, and are active during crepuscular and nocturnal periods. Recently it has been found that the similarities between nightjars and bats may even extend to include physiological traits. Daily torpor and seasonal hibernation (i.e. temporal heterothermy) are widespread phenomena in temperate insectivorous bat species. During periods of inclement weather, low insect abundance exacerbates the energetic difficulty of maintaining a body temperature well above ambient, and the use of heterothermy provides a mechanism to conserve a large portion of a bat's energy budget. As nightjars are exposed to nearly identical ecological constraints as bats, it is not surprising that they have been shown to use heterothermy as well. Although heterothermy is believed to have arisen independently in the mammalian and avian lineages, Common Poorwills (*Phalaenoptilus nuttalli*), members of the Caprimulgiformes, have been shown to enter prolonged bouts of torpor with body temperatures dropping to within a few degrees of ambient, in a manner parallel to that seen in temperate bat species. Whip-poor-wills (*Caprimulgus vociferus*) are taxonomically related to Common Poorwills and ecologically similar to both Common Poorwills and bats. This study addressed whether Whip-poor-wills also employ heterothermy. I used temperature-sensitive radio transmitters to assess skin temperatures of free ranging Whip-poor-wills from May to September of 2000, and from May to August of 2001. Additionally, a sample of birds were subjected to artificially low temperatures to determine if Whip-poor-wills could be induced to use torpor under laboratory conditions. Lastly the qualitative and quantitative properties of torpor in Whip-poor-wills were compared to those of Common Poorwills and bats. Torpor was observed, under field conditions, during September, 2000 and May, 2001. Torpor bouts typically occurred immediately prior to sunrise, and lasted between 2 and 5 hours. The minimum defended body temperature observed was 180C. Under laboratory conditions, one bird used a torpor bout of equivalent duration and depth as those seen under natural conditions. Although Whip-poor-wills have been shown to use torpor, the parameters of its use differ from those seen in bats and Poorwills. Whip-poor-wills have not been observed to enter prolonged, multi-day, torpor (i. e., hibernation) and

appear to defend a body temperature of at least 8 or 9 degrees above ambient. Observations will continue into the autumn of 2001 to further characterize torpor use in this species.

Comparing Three Methods to Monitor Commensal Bat Populations Roosting in Structures

Laniewicz, Brian R., Stephen C. Frantz, John W. Hermanson, and Paul D. Curtis
Cornell Univ, Ithaca, NY; N Y State Department of Health, Albany, NY; Cornell Univ., Ithaca, NY

Populations of commensal bat species, such as the little brown bat, Myotis lucifugus, and the big brown bat, *Eptesicus fuscus*, are often difficult to monitor. Therefore, it may be difficult to accurately quantify changes in population size over a given period of time. Given the increasing pressure on public health officials and biologists to manage bats living in human-occupied structures, our study was designed to assess three techniques for monitoring initial and experimentally manipulated populations of bats at individual roost sites. Factors contributing to difficulties in monitoring protocols may include: variability in site design, roost accessibility (both for bats and humans), availability and location of adequate roosting surfaces, overall roost site characteristics, population size, and economic feasibility. For scientific studies that require one to effectively determine detailed changes in the size of commensal bat colonies, a monitoring method, or a combination of methods, that takes such factors into consideration, may be required to acquire satisfactory data to conduct valid scientific tests. We evaluated three different monitoring techniques (video exit counts, roost counts, and a guano index count) that could be utilized for obtaining population data for commensal bat roosts located in structures at 19 bat roosts in central New York during the summers of 2000 and 2001. Sixteen of these roosts were primarily *M. lucifugus* roosts and three were primarily *E. fuscus*. Of the 19 roosts, five were monitored with all three techniques, eight with video exit and roost counts only, two with roost count and guano paper index only, three with video exit count only, and one with roost count only. At all roosts in which both roost counts and video exit counts took place, population estimates based on roost counts alone where always lower, and typically more variable, when compared to the video exit counts, but video analysis was a more costly and time intensive monitoring method. The guano paper index provided a reliable index of relative change in bat populations, but is time intensive, does not provide an index of population size, and is limited to sites with open and accessible floor space within the roost. Under most circumstances the video exit count should provide an accurate overall population estimate.

***Thermoregulation and Roost Selection by Reproductive Female Big Brown Bats Roosting in Rock Crevices in the South Saskatchewan River Valley, Alberta**

Lausen, Cori L., University of Calgary, AB, Canada

I studied a maternity colony of big brown bats, *Eptesicus fuscus*, roosting in rock crevices along the South Saskatchewan River in southeastern Alberta. I documented thermoregulatory patterns, and roost microclimate for pregnant, lactating and post-lactating females. I measured relative torpor use using a comprehensive torpor unit (degree-minutes), the area under the active body temperature (Tact) line on a body temperature (Tb) versus time graph. A complete picture of thermoregulatory patterns is presented by combining this comprehensive unit with proportion of bat-days on which torpor was used, minimum Tb and time in torpor. Pregnant and lactating females used torpor (0 Celcius*minutes) to the same extent, and significantly less than post-lactating females, supporting the cost:benefit hypothesis for torpor in reproductive bats. Pregnant E. fuscus used torpor less often than lactating and post-lactating females, but time spent in deep torpor was greater. Post-lactating females, despite experiencing ambient temperatures (Tamb) similar to those present during lactation, achieved the lowest mean minimum Tb's of all three reproductive stages and spent more time in deep torpor than lactating E. fuscus did. Depth and duration of torpor did not change with Tamb during lactation, but varied directly with Tamb during pregnancy and post-lactation, suggesting that the cost:benefit ratio for deep and prolonged periods of torpor may be higher for lactating bats. Rock crevice roosts used during pregnancy, lactation and post-lactation differed thermally, and the microclimate differences mirrored the bats' use of torpor. Roost relative humidity was lower than ambient and did not differ with reproductive stage. Crevice depth and opening size affected microclimate. Lactation roosts (deeper, larger opening size) may promote juvenile growth by being insulative; they were more thermally stable, warming more slowly during the day, and remaining warmer at night than other roosts. The shallow roosts used by pregnant and post-lactating females fluctuated with Tamb allowing for deep torpor at dawn, and passive re-warming during the day. At the onset of post lact-

lactation, females began roosting on the opposite side of the river to that used during pregnancy and lactation. Crevice microclimate differences between the two sides of the river may have explained this sudden shift in behaviour.

*** Cori Lausen was awarded the Bat Conservation International Award for the best presentation on species survival.**

What Will a Detector Detect? A Study of the Anabat's Zone of Reception

Livengood, Kimberly, Ronald Drobney, Chris Corben, and Richard Clawson
Univ. Missouri, Columbia, MO; US Geological Survey, Missouri Cooperative Fish and Wildlife Research Unit, Univ. of Missouri, Columbia, MO; Missouri Dept. Conservation, Columbia, MO

Researchers using bat detectors to assess bat activity need to know how large a volume of space is being sampled. This volume will depend on many factors including: the characteristics of the bat call (frequency and intensity), transmission through the atmosphere (varying with temperature, humidity, and barometric pressure), and bat detector characteristics (microphone and amplifier response characteristics, sensitivity setting, battery voltage, and variation between units). These factors have been explored for the Anabat detector and their effects on the zone of detection will be discussed. It was found that under realistic field conditions the volume of space within which a particular bat could be detected may vary by a factor of more than 20.

Importance of Cattle Pastures and Other Open Areas as Foraging Sites for the Serotine Bat (*Eptesicus serotinus*)

Lubeley, Solveig and Hans-Wilhelm Bohle, Philipps-University of Marburg, Germany

Of all European bat species, the serotine bat, *Eptesicus serotinus* is considered to be the species best adapted to life in European towns and villages. With roosts in buildings, foraging habitats in landscapes transformed by humans, and insects which are associated with cattle pastures as food, serotines are well adapted to humans and their environment and have developed a high degree of synanthropism. In the course of an extensive study on the ecology and habitat use of the serotine bat in an agriculturally dominated lowland area in central Germany, ultrasonic detectors were used to assess flight and foraging activity of bats above different types of agricultural land (arable land, meadows, pastures). Bat detector surveys (n=96) at selected sampling locations (n=83, total n=739) were carried out on 21 nights between April and September 2000. In addition, radio-telemetry was used to locate foraging sites of six neighboring colonies of the serotine bat (n=65 individuals) during the summers of 1997 to 2001 and to determine home range sizes of individual bats and bat colonies. Foraging sites were at a distance of up to 11 km from the day or maternity roost. Nursery colonies were found to have homes ranges (minimum convex polygon) of up to 73 km2. Individual and colonial home ranges as well as core areas overlapped with individuals from different colonies feeding at the same sites. Radio-tracking data indicated that the foraging behavior of female serotines is characterized by a seasonal succession of different preferred foraging habitats which is dependent on the seasonal availability of food resources. Woodland - in particular forest edges - (April to May), meadows (June to July) and pastures (July to September) play a varying role as foraging areas for serotine bats in villages throughout the maternity period. A clear preference for cattle pastures (88%) over meadows (11%) and arable land (1%) was detected via bat detector surveys. In addition to a temperature-dependent use of agricultural land, the frequency of visits to feeding sites in open areas increased over the season. Cattle pastures appeared to be an especially important foraging habitat at the end of the maternity colony period (July to September). The results of this study will aid in developing land management recommendations contributing to the conservation of this bat species.

Habitat Use by Forest-dwelling Bats in the Northern Skagit Watershed, BC

Luszcz, Tanya, University of Calgary, Calgary, AB

The majority of British Columbia's bat species are associated with forest habitats and are important contributors to these ecosystems. The extent of this contribution is still poorly understood in temperate zone ecosystems, and studies of bat habitat use may further clarify these relationships. Factors, which may influence bat habitat use, include forest age, spatial complexity and elevation. Young forests are typically

more dense and homogeneous, thus presenting great amounts of spatial complexity (clutter) to bats. Older forests are often more open, with heterogeneous structural complexity and more suitable roost sites than younger forests. Cluttered habitats require bats to be more maneuverable. Following ecomorphology theory, habitat use by bats can be predicted by differences in their wing morphology, body size and other characteristics that influence maneuverability. Elevation may also affect bat distribution and habitat use due to different life-history strategies and thermoregulatory constraints. The aforementioned factors vary significantly between different biogeoclimatic zones. Biogeoclimatic ecosystem classification integrates climate, soil and vegetation data to classify the various ecosystems of British Columbia. The objectives of this study are to identify bat diversity and distribution in the Skagit watershed in southwestern BC and to compare bat activity levels between forests of different biogeoclimatic zones and ages. In summers 2000 and 2001, I used remote ANABAT II detector systems to measure bat activity levels in young, medium and old forests of three different biogeoclimatic zones. Separating out black cottonwood forests created a fourth habitat type. In 2001, nine replicates of each of the age-habitat combinations were sampled. Detectors were placed in natural gaps within a contiguous habitat type. Nine species of bats were captured or heard in the study area. *Myotis lucifugus* and *M. californicus* were the most commonly captured species. Preliminary analyses showed that bat activity was highest in black cottonwood stands. Bat activity also increased with increasing forest age. There was a significant difference in bat activity between young and old forest stands, probably due to a higher density of trees and a lower density of available roost trees in young stands. There was also a trend for decreasing activity with increasing elevation, possibly due to differences in temperature. Gap size, forest density, available roost tree density, temperature and elevation have been measured to determine their influence on bat activity. Call analysis of activity data will be undertaken using ANABAT software to determine habitat use by species or species groups.

How the Sonar Calls of Big Brown Bats Change as Call Duration Changes

Masters, W. Mitchell, Glenn E. Miracle, Stephen C. Burnett, and Karry A. Kazial
Ohio State University, Columbus, OH

The sonar calls of free-flying big brown bats (*Eptesicus fuscus*) vary in length from under 1 ms to over 15 ms. A bat usually adjusts call duration to avoid overlap between its emitted pulse and returning echoes. How individual bats change call structure as they change pulse duration is unknown, but this information is relevant to the problem of acoustic identification of individual bats in the field, either by researchers or by bats themselves. We recorded 12 lightly-restrained big brown bats as they echolocated at different distances from nearby objects, obtaining calls ranging from less than 1 ms to over 9 ms. A specially written program (Matlab programming language) automatically measured the values of call parameters such as duration, starting frequency, and ending frequency for each of the approximately 2400 calls obtained. In addition, the program determined the frequency of the fundamental over the course of the call and applied non-linear curve fitting to fit six candidate equations to the call's "shape" (i. e., its frequency vs. time structure). Fits were usually good, with the best fits giving an average root-mean-squared error of 0.46 kHz (less than 2% of the call's mid-frequency). The best-fit equation was used to compute the time at which the call's fundamental frequency reached its midpoint, i. e., halfway from starting to ending frequency. The difference between this time and half the call's duration was used to define call "curvature," which varied from zero (a strictly linear frequency sweep) to nearly 1.0 (an L-shaped sweep). Analysis showed that different bats change their calls in different ways as they change duration. For instance, some bats maintained a nearly constant curvature no matter what the call length, while others showed a strong positive correlation between curvature and duration. Idiosyncratic changes in call structure at different durations complicates the problem of identifying individual bats from analysis of their calls. Nevertheless, discriminant function analysis classified 56% of calls to the correct individual using only three parameters (call frequency halfway through the call, call curvature, and the slope of the best-fitting straight line through the fundamental). This percentage is substantially greater than expected by chance (1 in 12, about 8%), and suggests that despite individualistic changes in call structure at different durations, proper identification of the emitting bat may still be feasible.

Temperature Profiles and Elevation of Bat Hibernacula on Northern Vancouver Island, BC.

Mather, Monica, Trudy Chatwin, Martin Davis, and Alisa Vanderberg
Ministry of Water, Land and Air Protection Province of BC

The Weymer Creek drainage on northern Vancouver Island is the site of the only known hibernaculum for *Myotis* species in British Columbia, including the endangered Keen's long-eared myotis (*Myotis keenii*). As little is known about the winter biology of bats in coastal regions where the winters are mild, our objective was to determine physical characteristics of hibernacula in order to help find and protect other bat hibernacula. In 1996, eleven caves ranging in elevation from sea level to 922 m were located. Over the winter of 1996 to 1997, twenty seven temperature data loggers were placed within the caves at depths varying from 0 m to 300 m into the cave. Hibernation and species identification were determined through direct observation, netting of swarming bats and skeletal remains. *Myotis lucifugus, M. yumanensis, M. volans,* and *M. keenii* were using five of the monitored caves for hibernation. The five hibernation sites were characterized as having stable daily winter temperatures of 2.6–3.90C. These sites are deep in caves in the high and mid-elevation range, with the largest concentrations of hibernating bats found between 800–900 m. The lowest elevation hibernaculum was found at 550 m. This information can be used to identify and protect other bat hibernacula in coastal British Columbia

Variation in the Echolocation Calls of Brazilian Free-Tailed Bat

McCracken, Gary F., John K. Westbrook, Paul G. Schleider, and Erin H. Gillam
University of Tennessee, Knoxville, TN; U.S. Department of Agriculture, College Station, TX

As with numerous other characteristics of their ecology, behavior, and physiology, Brazilian free-tailed bats, *Tadarida brasiliensis*, show remarkable variability and plasticity in their echolocation calls. Earlier field and laboratory studies documented that, "With the exception of very long CF signals, Tadarida exhibits the whole range of echolocation signals found, species-by-species, among all other Microchiropteran bats" (Simmons et al. 1978). Recordings from radiomicrophone bat detectors at altitudes of up to 1100 meters over Texas document thousands of QCF (quasi-constant frequency) calls at 19 to 23 kHz that can exceed 20 ms duration. These calls, which from all evidence are those of *T. brasiliensis*, appear to document the exception to the species' call repertoire that was noted by Simmons et al. (1968). Simmons et al.(1968; 1971) also report that the typical search calls of *T. brasiliensis* recorded at ground level are CF (or QCF) at approximately 50 kHz and 10 ms in duration. Our observations and those of numerous other field researchers document that the search calls emitted by these bats near ground level ("search" here defined as calls of at least 10 ms duration emitted at intervals of at least 100 ms) are typically at 32 to 25 kHz. However, many calls recorded at ground level over corn and cotton fields where *T. brasiliensis* forage in great abundance, as well as calls recorded as high as 500 meters above the ground, exceed 10 ms duration, satisfy the above definition of "search" calls and approach 50 kHz. Whether these are also calls of T. brasiliensis, and, if so, their ecological context is being investigated. Calls recorded from 32 light-tagged, hand-released T. brasiliensis document the diverse suite of calls, including short CF/FM, FM with several harmonics, and FM tailing with CF, reported by Simmons et al. (1968, 1971).

The Mexican Free-tailed Bat at Carlsbad Cavern, New Mexico: A Dietary Review

McWilliams, Lisa A. and Troy L. Best, Auburn University, AL

During spring and summer months, Carlsbad Cavern in Carlsbad Caverns National Park, Eddy County, New Mexico, is home to a large colony of Mexican free-tailed bats (*Tadarida brasiliensis mexicana*). Fecal pellets of 1,303 Mexican free-tailed bats were collected (April-September 1998) from individual bats as they returned to the cavern from nightly foraging bouts. The fecal pellets were examined to ascertain variation in diet of the Mexican free-tailed bat during its annual stay at Carlsbad Cavern. The average percentage composition by volume of each food item was visually estimated (to the nearest 1.0 percent). Remains of 11 orders and 38 families of Insecta, unidentified Insecta, two orders of Arachnida (Araneae, Acari), bat hair, and mist net were found. Further results will be presented.

Spatial and Temporal Activity Patterns of Vespertilionid Bats in Northeast Missouri as determined by Anabat II Ultrasonic Detectors

Miller, Matthew N., Kevin L. Murray, John C. Timpone, and Lynn W. Robbins
Southwest Missouri State University, Springfield, MO

Bats are known to use a variety of habitats for roosting, foraging, and traveling. Many of these habitats can be difficult to survey with traditional sampling methods. Using ultrasonic detectors, it is possible to compare bat activity among habitats and species, particularly in areas not amenable to standard capture methods. We conducted a survey in and around Deer Ridge Conservation Area in northeastern Missouri in Summer 2001. This area is home to a large breeding population of federally endangered Indiana bats (Myotis sodalis) in addition to several other species. We used Anabat II detectors and ZCAIMs connected to laptop computers to record echolocation calls in a variety of habitats including upland and lowland riparian zones and forested flyways. We will compare total bat activity among habitats and discuss temporal variation in activity throughout individual nights and the entire season. We will focus our analysis on the Indiana bat to determine foraging areas, preferred habitats, and temporal patterns of activity. Our data should indicate the general effectiveness of ultrasonic detectors relative to traditional survey methods, as well as the inherent difficulties associated with these types of studies.

Identifying Hotspots of Bat Species Richness on the Indian Subcontinent

Mistry, Shahroukh, Grinnell College, Grinnell, IA

The Indian subcontinent is home to more than 11% of the world's bats, with one endemic genus and 16 endemic species. Yet of these 119 species, 18 are critically endangered, endangered or vulnerable. An additional 52 species are considered data deficient, and 14 have not been evaluated. Thus only 29% of the bats are categorized as low risk. Over sixty species of Indian bats are known from less than 10 localities, with 20 species from just one locality. These include rare endemics such *as Otomops wroughtoni* and *Latidens salimalii*. Most of these species face enormous pressures from habitat destruction, and given the rate of deforestation and disturbance, a species-level conservation plan alone may not be the most efficacious. The identification of hotspots, based on species richness and endemism, may be useful in the classification of areas for conservation priority. The preservation of such hotspots, along with population viability analysis of select, at-risk species may be the best strategy for bat conservation in India. This paper identifies hotspots by creating kriging maps based on known distribution patterns and endemism. Two major hotspots are identified, one in Northeast (67 species) and the other in the Western Ghats (37 species). These two regions combined have 89 species, and also coincide with the hotspots for endemism. The use of such information along with land-use maps in a GIS will allow for more accurate determination of hotspot locations. Additionally, a pilot study was initiated to examine the feasibility of using ultrasonic bat detectors to monitor the population of *Otomops wroughtoni*. Estimates based on calls emitted by bats leaving the cave at night suggest that the population may be twice as large as previous studies. Such non-invasive techniques of population monitoring, along with large-scale analysis of conservation priorities may aid in the preservation of a substantial number of the world's bat species.

Bat Distribution in Kinleith Forest, an Exotic Plantation Forest in New Zealand

Moore, Geraldine E., Massey University, Palmerston North, New Zealand

New Zealand's long-tailed bat (*Chalinolobus tuberculatus*, Vespertilionidae) and short-tailed bat (*Mystacina tuberculata*, Mystacinidae) are threatened. They are generally associated with indigenous forest. However, surprisingly, bats have been seen in Kinleith Forest, a 130,000 ha predominantly *Pinus radiata* forest in the central North Island. There could be significant implications for both bat conservation and forest management if bats use this habitat. This study is the first in New Zealand to investigate bat distribution in exotic plantation forest. Long-tailed bats were confirmed to be present and their distribution was surveyed using bat detectors at fixed sites spread over a broad area, and by continuous monitoring for bat calls using driving transects. Sightings were also collected from the public. Evidence for the presence of the more cryptic short-tailed bats was evaluated from anecdotal accounts of sightings of the bats themselves, and of *Dactylanthus taylorii*, a rare plant naturally pollinated by short-tailed bats. Results were considered in light of distribution records reviewed for the central North Island. Long-tailed bats are widespread in Kinleith Forest. In places activity is high. Given the decline in this species elsewhere, it is

significant that long-tailed bats are present in some areas from which they were known historically. Long-tailed bats may have a fairly continuous distribution in the central North Island. Results suggest that instead of approaching unsurveyed plantation forests with the expectation that long-tailed bats are absent, long-tailed bats should be assumed present until proven otherwise. The presence of short-tailed bats in Kinleith Forest cannot be ruled out.

Roosting Ecology of Sympatric Forest-dwelling Vespertilionids in Northern Missouri

Murray, Kevin L., John C. Timpone, Matthew N. Miller, and Lynn W. Robbins
Southwest Missouri State University, Springfield, MO

Due to similarities in characterisitics of day-roosts used by several forest-dwelling species of bat, there is potential for temporal and spatial overlap in roost utilization among these species. However, this potential has not been thoroughly investigated. Very little is known about competition among species for day-roosts. It is unclear if different species of bat use a single roost tree simultaneously, or if they occupy different roost sites on a single tree. To address some of these questions, we conducted a study of roosting habitat of four sympatric species of vespertilionid bats (*Eptesicus fuscus, Myotis lucifugus, Myotis septentrionalis*, and *Nycticeius humeralis*) in Northern Missouri from May through August 2001. We mist-netted bats, attached Holohil mini-transmitters (0.48-1.06 g) to their dorsal side, and then tracked them to day-roosts using 3-element Yagi antennas and receivers. Exit counts were performed when necessary to confirm the identity of a roost. These four species used a variety of roost structures including live trees, snags, stumps, and buildings. We found limited evidence of two species using the same roost at different times during the summer, and of simultaneous use of a roost by different species of bats. Our data indicate that future telemetry studies including multiple species may provide valuable insight into how bats partition available roosting habitat.

Nutritional Landscape Ecology of *Pteropus tonganus* in American Samoa

Nelson, Suzanne, University of Florida, Gainesville, FL

Agricultural fruits are nutritionally poor compared to fruits of the native forest in American Samoa. As forests are cleared for agriculture and the demands of a growing human population, fruit bats foraging across the island landscape may suffer nutritionally, particularly for calcium. This study examined whether agricultural or native fruits were preferred by the Tongan flying fox (*Pteropus tonganus*). A habitat map of the island was created to delineate zones of high, average and low nutrient content. Native forests were areas of high nutrient content, mixed agroforests were average in nutrient content, and agricultural or village areas were lowest in nutrient content. Using radiotelemetry on 18 bats, I was able to document use of these three nutrient zones as the bats foraged throughout the night. I further examined preference for native or agricultural fruits by performing feeding experiments on 23 captive wild bats. Combinations of native and agricultural fruits of known nutrient value were presented to the bats and a strong preference for agricultural fruits was documented. Together, these studies provide insight into food choices of bats and determine if bats seek out nutrients as they forage across the Samoan island landscape.

The Foraging Ecology of Bats in Harvested Boreal Forest in Northwestern Alberta

Patriquin, Krista J., University of Calgary, Calgary, AB, Canada

Several factors influence the suitability of foraging habitat for insectivorous bats, including prey availability and the ability to obtain prey. However, within a forested ecosystem these two factors often cannot be maximized simultaneously. Studies suggest that insects are more abundant in intact forest and edge habitat than in adjacent open habitat. However, the density of obstacles that a bat must contend with is also higher in intact forest and edge habitat. The influence of such obstacles on habitat quality may differ among bat species due to differences in wing morphology. In northern Alberta, I investigated the use by bats of habitat patches of varying tree densities, including open (i.e. cleared), thinned and intact patches. Specifically, I tested for differences among species in their habitat use. Using AnabatII detectors, I measured relative bat activity in habitat patches. To address differences among species, I quantitatively identified echolocation calls recorded in the various habitats to species. I was able to identify 30% of *Myotis spp.* passes to species. I found that bats with different wing morphologies displayed differences in habitat use. Silver-haired bats did not occur in intact forest and were most active in clear-cuts. Little brown

bats showed a preference for the edge of clear-cuts, whereas northern long-eared bats did not use the centre of clear-cuts and preferred intact forest. These results indicate that differences among species should be considered when assessing habitat use by foraging bats, rather than measuring use by the bat community or species' groups.

Influence of Habitat Type on the Ability to Detect Ultrasound using Bat Detectors

Patriquin, Krista J., Laureen K. Hogberg, Bryan J. Chruszcz, and Robert M. R. Barclay
University of Calgary, Calgary, AB; Parks Canada, Banff, AB

Bat detectors are common tools for addressing questions regarding the habitat use patterns of foraging bats. Although some have assumed that the ability to detect echolocation calls varies depending on the nature of the habitat, most studies ignore this potentially confounding variable, and none have measured it. This may mask or inflate differences in bat activity levels in different habitat types and result in false conclusions about the ecology of bats. We measured the ability to detect 25 and 40 kHz pulses of sound in various forest types and harvest regimes in northern Alberta, Canada. We predicted that tree density would influence detection ability. Although habitat differences did influence our ability to detect ultrasound, the pattern was not as predicted. Sound transmission was influenced by forest type (deciduous, coniferous, mixed), but this varied depending on the harvest regime. Increased vegetation density among open, thinned and intact stands did not significantly reduce our ability to detect 40 kHz sound. However, it was more difficult to detect 25 kHz sound in intact stands than in thinned ones. Our results suggest that differences in detectability may confound studies of habitat use by bats, and not in entirely predictable ways. While the differences in detection range in our study were only 12% between forest types, this could translate into a 40% or greater difference in the volume of air sampled by detectors. This could severely compromise conclusions and is something that deserves further consideration and study.

Biogeography of the Bats in the Northern Lesser Antilles: Recent Census Activity on Montserrat, Antigua, Nevis, and St. Kitts: 1993 – 2001

Pedersen, Scott, Hugh Genoways, Matthew Morton, Gary Kwiecinski, Karen Hadley, and Rick Adams
South Dakota State Univ., Brookings, SD; Univ. of Nebraska State Museum, Lincoln, NE; Bristol, UK; Univ. Scranton, PA; Trout Lake, WA; Univ. Wisconsin, Whitewater, WI

Two groups have been working independently on the bat fauna in the Northern Lesser Antilles since 1993. Pedersen et al. have focused primarily on which species of bat are found on each island and how these populations have fluctuated in response to natural disasters, namely hurricanes and the recent volcanic activity on Montserrat. Morton et al. have focused upon roost surveys, aiming to provide resources for local conservation efforts and further study. Here we present a combined overview of nine years of census data on four islands (Montserrat, Antigua, Nevis, and St. Kitts) which vary greatly in size (93–280 sq. km) and physiography. The number of bat species found on any one of these islands is theoretically correlated with (1) the size (area) of the island, (2) the distance away from the mainland, and (3) the elevation of the island which, in turn, correlates with increased rainfall and a more diverse vegetation. Following models that have been applied to herps, birds, and mammalian fauna, we present several possible species-area curves based on recent census data. We also discuss the respective abilities of each curve to model patterns of chiropteran biodiversity throughout the Antillean archipelago.

Roosts of Tree Bats in a Diverse Forest Landscape of the Ouachita Mountains, AR

Perry, Roger W. and Ronald E. Thill,
USDA Forest Service, Southern Research Station, Hot Springs, AR; and Nacogdoches, TX

Diurnal roosting sites are critical habitat for bats and their availability may limit numbers and distribution of certain species. Little is known about selection of natural roosts in forested landscapes, especially in areas like the Ouachita Mountains that have few caves, mines, or buildings. Likewise, little is known about the effects of forest management practices on the availability of roosting sites. Of the thirteen species of bats likely to occur in the Ouachita Mountains, twelve roost in tree foliage, under loose bark, or in hollow trees, and four utilize trees almost exclusively for summer roosts. A comprehensive study was initiated during summer of 2000 in the Ouachita Mountains of Arkansas. The objectives are (1) to characterize roosting sites of tree bats in the Ouachita Mountains; (2) to relate roost selection to site, stand,

and landscape-level habitat attributes; and (3) to evaluate the impacts of different silvicultural systems on availability of roost sites. The study is being conducted in a 4,958 ha basin where six forest management systems are being developed: large-opening group selection, small-opening group selection, single-tree selection, pine savanna restoration, typical forest management (a dispersed mix of even and uneven-aged management), and unmanaged mature forest. The basin also contains a large block of industry-managed pine plantations. Thus, most of the forest types, silvicultural systems, and management practices that exist in the Ouachita Mountains are present within this study area. Bats are mist netted during summer, instrumented with transmitters, and tracked to roost sites during the day. Detailed measurements of roost site and surrounding habitat are being collected and compared with randomly selected trees and their surrounding habitat. For objective three, the distributions of known roost sites among different silvicultural systems are being compared. To date, 72 bats representing eight species have been captured and 41 bats have been tracked to 114 roost sites: 79 vegetation roosts and 35 cavity/crevice roosts. Preliminary findings suggest tree bats of the Ouachita Mountains tend to roost as readily in partially harvested areas as in mature, unharvested forests but tend to avoid young pine plantations. The study is to last an additional 3–5 years and may be expanded to characterize winter hibernation sites.

Inferring Recent and Historical Population Dynamics within *Corynorhinus townsendii*

Piaggio, Antoinette J., University of Colorado, Boulder,CO

Townsend's big-eared bat, *Corynorhinus townsendii* includes five subspecies, and all are uncommon. At the Western Bat Working Group Meeting in Reno, Nevada (1998), the western subspecies of *C. townsendii* were ranked as a species of highest priority for funding, planning and conservation efforts. *Corynorhinus townsendii* is listed as a Species of Concern by the United States Fish and Wildlife Service (USF&WS), a species of special concern by several western states, and a Sensitive Species by the U.S. Forest Service in regions 1 and 4 and the Bureau of Land Management. The two eastern subspecies, *C. t. ingens* and *C. t. viginianus*, are listed as endangered by the USF&WS. Because of their conservation status, I intend to use mitochondrial DNA (mtDNA), nuclear microsatellites, and Y chromosome microsatellites to infer phylogenetic relationships, and determine the degree of differentiation between populations, subspecies and among geographic areas for these bats. This information is needed to design appropriate management strategies, and to justify further conservation efforts and funds if necessary. I have begun to construct a molecular phylogeography of all the subspecies of C. townsendii using mtDNA sequence in the hypervariable control region. Currently, I have sequenced approximately 1 kilobase of DNA from samples collected in Colorado, New Mexico, Oregon and Sonora, Mexico. Phylogenetic analyses of these sequences have resulted in 18 parsimony trees (length = 145). A strict consensus tree infers that each bat has a unique haplotype, and pairwise differences range from 1 to 67 bases, the ti/tv ratio ranges from 0 to 10, and there are 18 indels, 14 of which are within the Sonoran sample alone. The Sonoran clade represents the *C. t. australis* subspecies, and the Oregon clade represents the *C. t. townsendii* subspecies, and both are unique and distant from the *C. t. pallescens* samples from Colorado and New Mexico. The *C. t. pallescens* samples fall into two clades. The Colorado *C. t. pallescens* are divided between both clades. Most interesting, is that the samples from the eastern slope of the Rocky Mountains in Colorado fall into three clades each more closely related to western slope or New Mexico samples than to each other. This pattern is particularly obvious in the Boulder County samples. Further work will include more sampling in western states and Mexico. All samples will be analyzed using mtDNA, nuclear microsatellites and Y chromosome microsatellites to infer phylogeographic relationships and population differentiation.

Seasonal Patterns of Bridge Use by Bats along an Elevational Gradient in the Sierra Nevada of California

Pierson, Elizabeth D., William E. Rainey, Chris J. Corben, and Gregg A. Erickson
Berkeley, CA; Rohnert Park, CA; California Department of Transportation, Sacramento, CA

We examined seasonal patterns of bridge use along an elevational gradient in the Sierra Nevada of California by repeated surveys of twenty bridges, ranging in elevation from 33 m in the Central Valley to 2,616 m near the Sierran crest. Large, single species aggregations (both day roosts and night roosts of primarily *Myotis yumanensis* and *Tadarida brasiliensis*) were concentrated at elevations below 1000 m. Between 1000 and 2000 m fewer bridges harbored large aggregations, but diversity was higher, with up to

ten species using a single bridge. Above 2000 m, bridge use was low. Large guano deposits from *T. brasiliensis* suggest brief occupation of some bridges by migratory aggregations in the fall. Acoustic monitoring in conjunction with bridge surveys showed that, for those species known to use bridges, more were usually detectable in the vicinity than were observed at the bridges. Thus while bridge roost surveys provide a convenient, time efficient method for sampling bats and obtaining demographic data, as with other techniques, only a subset of the local community is examined. At the same time, bridge surveys can provide valuable records for species difficult to sample acoustically (e. g., in this study, day roosts for *Corynorhinus townsendii* and the first record of *Myotis volans* for Yosemite National Park). Also, high fidelity to bridge roosts offers the opportunity to follow individuals and populations over time.

Distribution and Roost Selection by Myotis Bats along a Disturbance Gradient in the Sub-boreal Spruce Forest of British Columbia

Psyllakis, Jennifer M., University of Regina, Regina, Sask

I used data on the distribution of bat captures and radio telemetry to assess the effects of natural disturbance (fire) and logging on roost selection and behaviour of bats belonging to the genus *Myotis* in the sub-boreal spruce forests of north-central British Columbia. Natural disturbance patterns have recently been adopted as models for timber harvesting practices. However, our understanding of how natural disturbances affect populations is in its infancy. In order to incorporate the natural disturbances management "lessons," it is imperative that we understand the effects of, and the differences between, naturally disturbed versus harvested landscapes. I found that bat capture success and sex ratio were dependent of disturbance history. Fewer bats were captured in disturbed sites (fire and logged) compared to undisturbed sites and more females than expected by chance were captured in undisturbed sites. I tracked 17 female *Myotis* bats to 33 day roosts and found four additional roosts by random observations and inspecting cavities for guano. Roosts tended to be closer to capture locations in undisturbed habitats compared to logged habitats. There was no significant difference in distance traveled between roosts used on consecutive days. The 37 day roosts occurred primarily in two species of trees, lodgepole pine (*Pinus contorta*) and trembling aspen (*Populus tremuloides*). In pine trees, bats roosted under bark, usually alone, whereas cavities in aspen were primarily used by maternity colonies. All maternity roosts were in naturally formed lateral cracks and colony size was large. No roosts were located in cavities excavated by woodpeckers which implies management plans that incorporate bats as secondary cavity users may not be sufficient to maintain populations. In sub-boreal forests, management of bat habitat should focus on the maintenance of mature stands and retaining and recruiting snags of both lodgepole pine and trembling aspen.

Prolonged Static Calling in Aerial Hawking Vespertilionids

Rainey, William E. and Chris J. Corben, Berkeley, CA; Rohnert Park, CA

Calling from perch sites serves for both social signalling and foraging in the Microchiroptera. In the Old World families Rhinolophidae and Hipposideridae with high duty cycle ("CF") echolocation, calling from perches and sallying to capture prey is a common foraging mode. A diverse assemblage of species in other families (including Megadermatidae, Nycteridae, and Vespertilionidae) commonly also hunt in part by short forays from perches, although many rely significantly on passive prey detection rather than echolocation. Among vespertilionids typically regarded as morphologically unspecialized aerial hawkers, there are as yet few reports of perch foraging, but acoustically distinctive advertisement calling by perched and flying males is well documented for several genera (e.g., *Pipistrellus, Nyctalus*). Here we report observations of static calling by *Eptesicus fuscus, Myotis californicus* and a *Myotis species* echolocating at 40 Khz (probably *M. volans*) in Yosemite National Park, California. Evidence of *E. fuscus* and 40 KHz Myotis static calling derives largely from overnight passive Anabat recordings, but., for *E. fuscus*, is supplemented by night vision observation of a calling bat and active acoustic monitoring of another radiotracked bat. Bats typically called from boles of large snags. In a few instances of repeated monitoring at the same site, up to three sequential nights with static calling events were observed. Individual pulses in static calling events resemble normal echolocation calls of bats in moderate clutter, but interpulse intervals are prolonged. Events involve steady calling for several minutes, punctuated by brief decreases in the interpulse interval, which may reflect prey detections, or more prolonged feeding sequences with a buzz, brief silence and return to static calling. This behavior seemingly involves feeding attempts, and, unlike

previously known advertisement calls, closely resembles normal echolocation. While a social signalling function is not excluded by these limited observations, when viewed as an alternative foraging mode, it raises interesting questions about the conditions (e.g., prey density) that trigger this activity.

To Glean or Not to Glean? Behavioural Plasticity in Two Species of *Myotis*

Ratcliffe, John M., Jeff W. Dawson, M. Brock Fenton, and James H. Fullard
University of Toronto, Erindale College, Mississauga, ON; York University, Toronto, ON

We investigated foraging flexibility in wild-caught *Myotis septentrionalis* and *M. lucifugus* in a large screened outdoor flight room at Queen's University Biological Station, near Chaffeys Lock, Ontario, Canada. *Myotis septentrionalis* is assumed to rely primarily on prey generated sounds while gleaning. *M. lucifugus* uses approach phase echolocation calls and feeding buzzes to capture flying prey. We exposed both species to tethered flying moths and fluttering moths restricted to the surface of a bark covered trellis. Both species readily captured prey in the air and from the surface of the trellis. We present data comparing echolocation and flight path characteristics used during successful attacks.

Paired Foraging in the Red Bat at Pinery Provincial Park in Southwestern Ontario

Reddy, Liz, York University, Toronto, ON

In May, June and July 2001 using focal animal sampling, I observed 19 individually-marked *Lasiurus borealis* foraging around flood lights in Pinery Provincial Park in southwestern Ontario. During this period 21% of 337 attacks by foraging bats on moths were successful (= the attacking bat caught the moth). On 23 nights up to 14 bats (5.26 ± 5.25 sd) foraged around any of the sites at any one time, and 27 of the attacks involved more than one bat. When two bats were involved in an attack on a moth, the first bat was successful in its attack on one occasion, the second bat on nine occasions when the second attack occurred within 15 seconds. These data demonstrate that when more than one bat is involved in an attack, the second attacking bat has greater success than the first attacker, and I used them to test the following predictions arising from the hypothesis that the bats forage co-operatively. 1) Bats engaging in the chasing behaviour (foraging in pairs) have an increased foraging success rate than those foraging on their own; 2) Foraging success rate increases with respect to position in pair (i.e. 1st or 2nd); 3) Bats spend an equal amount of time in either position (i.e. 1st or 2nd). Based on the data collected the foraging behaviour is not cooperative, but rather opportunistic, as bats engaging in cooperative foraging would have equal success rates.

Metapopulation Structure of Yuma Myotis in the Pacific Northwest: A Molecular Approach

Restrepo, Cynthia M., Debbie Duffield, Pat Ormsbee, and Jan Zinck, Portland State University, OR

We assume that seemingly geographically distinct subpopulations of Yuma myotis (*Myotis yumanensis*) observed in summer in the Pacific Northwest are to some extent genetically interconnected and function as a metapopulation. Verifying that subpopulations are interconnected and understanding the degree of genetic redundancy between them can enhance our understanding of population dynamics, so that monitoring, management, and conservation efforts can be effective to relative conditions such as panmixia or isolation. Our study compares genetic variability of Yuma myotis, within and between four geographic areas, as an indication of metapopulation structure in the Pacific Northwest. Individual Yuma myotis were captured from each area in the Pacific Northwest during summer and a 3-mm wing biopsy from each bat was taken. We extracted DNA from the wing tissue and a 300-bp region of mitochondrial DNA, spanning the cytochrome-b gene and a portion of the D-loop, was amplified. After sequencing the amplified region, we compared sequence variability among individuals and between the four geographic areas. We will discuss preliminary results and management implications.

Bats, Insects, and Islands: Predator-prey Interactions and the Effect of Island Size on Abundance and Species Richness

Rice, Heidi K., Eastern Michigan University, Ypsilanti, MI

This study seeks to identify bat and insect fauna present in Sleeping Bear Dunes National Lakeshore, and determine the effect of island distance and size on prey availability, predator diversity, and predator diet. The study site is a protected national park located on the eastern side of Lake Michigan, encompassing over 71,000 acres of woodland, lake, and dune areas on both the mainland and offshore islands. During two sampling periods over the summer, I trapped insects, netted bats, and monitored bat activity with ultrasonic detectors on the two islands, North Manitou and South Manitou, as well as the park mainland. Diets of bats eventually will be determined by analyzing feces collected from captured bats. Four sites on each island and seven sites on the mainland were sampled each period, for a total of 30 net nights. Two previously unreported species of bats were identified on North Manitou Island, *Lasiurus cinereus*, and *Lasionycteris noctivagans*, and one additional species of bat was identified on South Manitou Island, *Myotis lucifugus*. Preliminary results show bat species richness and insect abundance was higher on the larger North Manitou Island and the mainland, suggesting a possible effect of island size.

Roosting Behavior and Social Organization of the Neotropical Tent-roosting Bat

Rinehart, J. Benjamin, Boston University, Boston, MA

The tent-roosting bat, *Rhinophylla pumilio*, is common throughout its range in the Amazon Basin and lowland forests of Northern South America. Despite its abundance, little is known about the ecology or behavior of this widespread species. This study was conducted at the Tiputini Biodiversity Station (TBS) in Eastern Ecuador, a research facility comprising 650 hectares of undisturbed tropical lowland forest. Surveys were conducted intermittently between January 1998 and April 2001. A total of 150 individual bats were captured using a combination of mist-netting over trails and hand captures from tent roosts using a hoop net. Each bat was individually banded and adult males were fitted with radio-transmitters for subsequent location. Bats roosted in groups ranging from one to nine individuals. Generally, social groups consisted of a single adult male and up to three adult females and their associated pups, suggesting a harem social structure. Single gender groups consisting of up to four individuals were also encountered. Radio-tracking revealed that a single individual may roost in up to eight different tents and that tent style is highly consistent with respect to architecture. Social groups were generally stabile from one day to the next, even when the group changed tents, and long-term associations of over one year were observed. In addition to these findings, capture data were used to estimate abundance and dispersion of *R. pumilio* and other tent-roosting species at TBS.

Mist-nets and Anabat: Effective Survey Methods for the Indiana Bat

Robbins, Lynn W., Kevin L. Murray, Matt N. Miller, and William D. Hendricks
Southwest Missouri State Univ., Springfield, MO; WDH Ecological Services, Symsonia, KY

The Federally listed endangered Indiana bat, *Myotis sodalis*, is considered to be a forest bat, and any disturbance to the forest habitat within the summer breeding range of this species could be disruptive to the breeding success of this species. Because of this, the Indiana Bat Recovery Team and the U.S. Fish and Wildlife Service have provided guidelines for summer habitat mist net surveys to determine presence or absence of Indian bats in a particular area. With the increased use of ultrasonic bat detectors, in particular the Anabat II system, to identify flying bats to species, it is now possible to use an additional tool to determine the presence or absence of this species. The purpose of this paper to determine the accuracy of these two methods in documenting the presence of Indiana bats in areas that they are know to be present in Missouri. Data from 148 net nights and 128 Anabat nights from five counties in Missouri are compared to determine the efficiency of each method to detect the presence of Indiana bats. Recommendations will be discussed relating to maximum likelihood of detection with minimum effort using the two techniques

Oxygen Transport and Wing Morphology of Antillean Bats

Rodríguez-Durán, Armando, Inter American University, Bayamón Campus, PR

Blood oxygen transport properties and heart mass of eleven species of bats in the families Phyllostomidae, Mormoopidae, Noctilionidae, Molossidae, and Vespertilionidae were investigated and related to morphological characteristics of the wings and to phylogeny. These eleven species represent 85% of the assemblage of bats in the subtropical moist forest of northern Puerto Rico. Hemoglobin concentration (15–19 g Hb/100 ml) and hematocrits (47–64%) fall within values expected for bats. Heart mass and hematocrits were significantly correlated to wing shape and wing loading, but not to phylogeny.

Quadrupedal Bats: Form, Function, and Phylogeny

Schutt, William A., Jr., and Nancy B. Simmons
Southampton College of Long Island Univ., Southampton, NY; The Amer. Mus. Nat. Hist., NY

Quadrupedal locomotion varies tremendously in bats – from frantic, clumsy scrambling to incredible feats of agility and speed. However, relatively few researchers have explored this interesting phenomenon. In this study, the post-cranial morphology of three bats known to exhibit efficient quadrupedal *locomotion (Cheiromeles sp., Desmodus rotundus*, and *Mystacina sp.*) was examined. Skeletal and fluid-preserved specimens were used to study adaptations related to quadrupedal locomotion. Observed similarities and differences were evaluated from a phylogenetic and comparative perspective. Related taxa not known to exhibit efficient quadrupedal locomotion were used for comparison. Convergence was identified in a number of characters (e.g., presence of a complete fibula) seen in those bats that display quadrupedal locomotion. Many unique features (e.g., the opposable hallux in *Cheiromeles*) were examined in detail for the first time.

Bats and Undergraduate Research Experience

Scott, Mike, Lincoln University, Jefferson City, MO

Bats can present an engaging and diverse topic for undergraduate students that are being introduced to research. Lincoln University is similar to most primarily undergraduate institutions in which facilities and funding for student research are limited. Several characteristics of bats and bat biology make them a useful focal point for building an ongoing undergraduate research-training program. Most students are fascinated with bats and find them to be interesting study subjects. Seasonal ecology projects can be conducted with a reasonable amount (cost) of equipment while remote observations decrease the potential for health and safety issues involving students. Bats are also common inhabitants of urban areas, which makes "field" research stations much more accessible. My students and I have started what is intended to be an ongoing research-training program studying bats in the urban area surrounding Lincoln University. We started with two modest goals for the first year. We planned, built, and installed four identical bat houses in two different locations to test the placement of bat houses on bat house use. Bats occupied none of the houses this year. In the future, we plan to increase the number of bat house locations and experiment with different construction techniques and house placement . The second goal was to begin a survey of local bridges as potential bat roost sites. The predominate types of bridges on the roads that were surveyed were culverts and flat slabs that had few potential roost sites. Bridges that were surveyed along a bike/hiking trail were converted railway bridges with exposed beams. Even though there were many small crevices, most were open at the upper surface. No bats were located in any of the bridges examined. In the future, we expect to expand this survey to a larger area containing more diverse types of roads. There are many other projects that can be easily included in this kind of program such as studying environmental influences on bat foraging activity, bat roost site selection, and habitat use.

* Dry Season Foraging by *Pteropus* on Anjouan Island, Comoros, West Indian Ocean

Sewall, Brent J., University of Minnesota - Twin Cities, St. Paul, MN

Livingstone's flying fox, *Pteropus livingstonii* is an endemic species of the Federal Islamic Republic of the Comoros in the West Indian Ocean. This species is considered under IUCN Red List criteria to be critically endangered, and environmental organizations working in the Comoros have begun conservation efforts, mostly focusing on identification and protection of roost sites. This work has been successful thus

far, but further conservation is hampered by a poor understanding of the foraging ecology of the species. The Comoros are also home to the more common Seychelles yellow-headed flying fox, *Pteropus seychellensis comorensis*, making the Comoros one of the few areas where two species of *Pteropus* coexist. The foraging ecology of *P. s. comorensis* is also not well known, and it has not been clear how the two species partition food resources. I studied frugivory by *Pteropus* in native forest, underplanted forest, degraded forest, and agricultural habitats in the Mutsamudu River watershed on the Comorian island of Anjouan. I divided the watershed into six study sites based on altitudinal class and side of the river. Within each site, I characterized vegetation and measured fruit availability at random points. I also measured diet of both bats species using fruit collection tarps to capture ejecta pellets. In addition, I observed bat foraging during late afternoon and evening foraging periods to identify criteria used by bats in selection of foraging sites. Results from the dry season period of July and August, 2001, indicate *that P. livingstonii* exhibits a strong preference for two relatively rare tree species, whereas *P. s. comorensis* has a much more varied diet, with fruit from more than ten tree species, including relatively common trees, eaten regularly during this period. In addition, both species exhibit a preference for large emergent trees with abundant fruit. Finally, results indicate a significant human modification of native forest in the Mutsamudu River watershed, on all but the steepest slopes; this may be an important factor in the decline of the *P. livingstonii* population. Further study is needed at other periods of the year to determine seasonal variation in diet and foraging behavior by the two bat species. Conservation efforts for *P. livingstonii* should be expanded to include protection of specific tree species and remaining foraging sites, as well as reforestation with the preferred species, and community-level environmental education in villages located near foraging areas.

***Brent Sewall received the Lubee Foundation Award for the pest presentation concerning Pteropids**

* Roost Fidelity of Townsend's Big-eared Bat in Utah and Nevada

Sherwin, Richard E. and William L. Gannon, University of New Mexico, Albuquerque, NM

The biological importance and degree of expression of roost fidelity in Townsend's big-eared bat (*Corynorhinus townsendii*) remains largely unknown. While reports of movement among and between roosts have been noted, it is unclear whether these movements were a result of human disturbance or part of some unknown, but normal, pattern of bat behavior. Current management and conservation strategies assume that *C. townsendii* exhibits strong roost fidelity across space and through time. We investigated the validity of this assumption at roosts throughout the Great Basin. Movement among roosts was common throughout the study area, with a high degree of intra/inter-seasonal variation observed. However, at larger temporal scales (i. e., across years), patterns of use emerged. Differences in lability were noted between roost types, with use of caves more static (through space and time) than use of mines. The implications of these findings on management and conservation efforts are discussed.

* **Richard Sherwin received the Karl Koopman Memorial Award for the best presentation concerning distribution or biogeography.**

Reassessing Bat Diversity: How Many Species Are There in the World?

Simmons, Nancy B., American Museum of Natural History, New York, NY

The last definitive classification and summary of bat species diversity of the world was completed by Karl Koopman in the early 1990s. At that time, he recognized 926 species of bats, which he arranged in 177 genera. The species concept employed by Koopman was highly conservative, requiring (1) demonstration of sympatry and/or major diagnostic differences, and (2) resolution of all outstanding taxonomic and identification problems (e.g., literature records) before two putative taxa were recognized as distinct species. Many taxa recognized by other systematists as distinct species were treated as subspecies by Koopman because of problems in one of these areas. In the course of preparing the Chiroptera chapter for the next edition of Mammal Species of the World, I examined species and subspecies limits for all extant bat taxa. Reevaluation of taxonomic limits using a revised species concept based on diagnosability revealed much greater species diversity than previously recognized. Including taxa described since the early 1990s, there are over 1000 extant species of bats. Not surprisingly, the five largest families (Vespertilionidae, Pteropodidae, Phyllostomidae, Rhinolophidae, and Molossidae) account for the largest increases in recognized diversity. Most of the "new" species are not actually new to science, but have

names that are well established in the literature, often dating back to Thomas and Andersen in the late 1800s and early 1900s. Changing species concepts, availability of additional specimens, application of new methods (e.g., morphometrics), and availability of new types of data (e.g., DNA sequences) have all contributed to significantly increase the number of bat species that can be distinguished. In addition, new species are described every year based on newly captured individuals. Continued inventory work (particularly in the tropics) and ongoing systematic research will doubtless continue to increase the number of valid bat species in future years.

Influence of Structural Clutter and Prey Availability on Foraging Behaviour of Insectivorous Bats

Sleep, Darren J.H., University of Guelph, Guelph, ON

Clutter tolerance as well as foraging strategies influence habitat partitioning by some aerially foraging bats. When structural complexity increases, typically so does prey availability within habitats. The question is, how do these conflicting influences affect bat activity? In order to examine the effects of both spatially complex habitat (i.e. clutter) and prey availability on foraging bats, I built three-dimensional 'clutter cones' of various densities and monitored bat activity in them using ultrasonic detectors. In a sample of the cones I placed UV lights to generate ephemeral prey patches for bats. My results indicate that activity by small or large bats, or by all bats taken together, was unaffected by various densities of clutter. However, activity by small bats (e.g. *Myotis lucifugus*) at all lit sites increased significantly while activity by large bats was unaffected. These results indicate that clutter tolerance plays a primary roll in foraging decisions by temperate insectivorous bats, while prey availability exerts a secondary influence.

Morphological Differences between Mountain and Prairie Populations of Western Long-eared Bats (Myotis evotis) in Alberta

Solick, Donald I., University of Calgary, Calgary, AB

Populations in one environment may experience different selection pressures than populations elsewhere, leading to differences in morphology. Differentiation is facilitated by obstructions to gene flow between populations, such as geographic distance, physical barriers, or isolating mechanisms. As flying animals, the potential for genetic exchange between bat populations is high, suggesting that differentiation among bat populations may be rare. Instead, individuals may possess morphologies that allow them to exploit a wide range of environmental conditions. The western long-eared bat, *Myotis evotis,* occupies a variety of environments throughout western North America. In Alberta, populations have been documented in the Kananaskis Valley and along the south fork of the Saskatchewan River. These populations are separated by nearly 400 km of open prairie and experience very different environmental conditions. The Kananaskis Valley is cool, wet, and forested while the Saskatchewan River Valley is hot, dry, and open. The main objectives of this study were to determine whether populations of *M. evotis* in Alberta exhibit differences in morphology and, if so, whether these differences are related to differences in climate. Specifically, I compared mass, forearm length, pinnae width and length, pelage colour, hair length and width, hair density, and wing area between living individuals captured in the two environments this past summer. Results from this work will be presented and implications for the mating behaviour and winter roosting ecology of *M. evotis* will be discussed.

Erophylla sezekorni and Brachyphylla cavernarum: Diet of Two Phyllostomid Bats in Puerto Rico

Soto-Centeno, J. Angel, Armando Rodriguez-Duran, and Elvis Cortes-Rosa
Eastern Michigan University, Ypsilanti, Mi; Inter American University, Bayamon, PR

We studied the diet of two phyllostomid species of bats in Puerto Rico *(Erophylla sezekorni* and *Brachyphylla cavernarum*) throughout a one-year period. Diet was analyzed by capturing bats at the entrance of a cave (*E. sezekorni*) or by regular placement of fecal traps beneath clusters of bats inside a different cave (*B. cavernarum*). Although *E. sezekorni* is usually classified as a nectarivore and *B. cavernarum* as a frugivore, our study reveals that the two species consume a large amount of insects as well. In the fecal samples of *E. sezekorni* we found that 87% contained insects and 44% contained seeds.

For *B. cavernarum*, 42% contained insects, 12%, seeds, 24%, insects and seeds, and 22% were unidentifiable. Both species are apparently feeding on the same order of insects, Coleoptera. Due to the large amount of insects found in the fecal samples, we can suggest that these species of bats are not only eating insects that could be asociated with flowers or fruit, but preying on insects that are easy to detect using the sense of vision.

Bat Survey and Closure Plan for an Abandoned Mine in Nevada

Stefan, Carol I., Golder Associates Ltd., Calgary, AB

Abandoned mines in Nevada provide potential roosting sites for 19 of the 22 bat species found in the state. Although many of the mines are unsuitable as bat roosts, some mines may be used at different times of the year as day roosts, night roosts, maternity colonies, or hibernacula by single bats or large colonies of bats. However, as abandoned mines can pose a safety hazard to people entering caves for prospecting or recreation, many are being reclaimed. El Paso Energy Corporation Minerals Company – Nevada (EPEC) contracted Golder Associates Ltd. to develop a reclamation and closure plan for the Half Moon Adit in Fondaway Canyon in Churchill County, Nevada. One component of the plan was an assessment of the use of the adit by bats. This survey was conducted in July 1999 and six individuals of three bat species [Townsend's big-eared bat (*Corynorhinus townsendii*), California myotis (*Myotis californicus*) and western pipistrelle (*Pipistrellus hesperus*)] were captured at the adit. Bats were also observed and recorded using remote bat detector systems inside the adit. To protect this roost site, it was recommended that a bat gate be installed. However, concerns over the quality of seepage water draining from the adit led to regulatory approval for backfilling of the adit. To mitigate the impact of mine closure on bats using the Half Moon adit, bats were excluded from the adit over a period of a few days. Alternate roost sites in the local area were also investigated using remote bat detector systems and roost watches at dusk. The results of this survey suggest that there is roosting potential for bats in the local area; however, it was beyond the scope of this study to determine if the quality or seasonal use of alternate roost sites was equivalent to that of the Half Moon Adit.

Additional Support for the Phylogeny of Megadermatidae

Stiner, Eric O. and Nancy B. Simmons, American Museum of Natural History, NY

Megadermatidae is a small family of insectivorous and carnivorous Paleotropical bats. There are five extant species, all characterized by a noseleaf, and large ears fused medially at the base with a long bifid tragus. The largest species, *Macroderma gigas*, is an Australian endemic. Two other species, *Lavia frons* and *Cardioderma cor*, are restricted to Africa. The remaining species, *Megaderma spasma* and *Megaderma lyra*, are widespread in the Paleotropics although neither occurs in Africa or Australia. In a previous study, we combined morphological data from various anatomical systems in a simultaneous analysis to arrive at a phylogeny for these five taxa. In our current study, we have added 36 new dental characters to the original character list [n=180]. Inclusion of the new data in our preliminary analysis supports the monophyly of all families and superfamilies, but also supports previously unresolved relationships among sister-groups at the family level. Outgroup species included members of the families Rhinolophidae, Nycteridae, Rhinopomatidae Craseonycteridae, and Emballonuridae. Within Megadermatidae, we found support for monophyly of an African clade (*Lavia* + *Cardioderma*) and a southeast Asian clade (*Megaderma*). *Macroderma* appears to represent the basal lineage in the family. Our analysis includes a comprehensive character list plus all previously published data, and shows results which differ from those proposed by previous researchers. Limited data sets may explain why previously published attempts at resolving relationships among megadermatids showed completely incongruent results.

Dynamics and Large Scale Deformations of the Wing Skeleton during Flight

Swartz, Sharon M., Kristin L. Bishop, and Maryem-Fama Ismael Aguirre, Brown University

The vertebrate skeleton is typically viewed as the stiff, deformation-resistant substrate upon which muscles and external forces act to produce movement at joints. However, recent work has shown that in both birds and insects major individual skeletal elements undergo significant internal deformations during

flight and add significantly to motions due to rotations at joints. We report the first evidence that deformation is a major feature of bones of the wing and shoulder girdle in bats. We studied wind-tunnel flight in 10 species of Australian bats using high-speed (500 fps) IR videography. Kinematic analyses of these videos demonstrate that the clavicles of all species bend in such a way as to shorten to 70-90% of their resting length during the downstroke, and apparently undergo elastic recoil during the upstroke. Metacarpals and phalanges also deform significantly, with more variation found among flight speeds, individuals, and species. We hypothesize that the deformations of the clavicle are a passive result of wing aerodynamics and result from the large aerodynamic forces directed medially and cranially at the glenohumeral joint. We also suggest that the deformations of the metacarpals and phalanges are an integral part of the development of a very high degree of wing camber, and that this large camber may indicate that unsteady mechanisms play a more important role in the aerodynamics of bat flight than previously believed.

Distribution and Roost Site Selection of Chiropterans in Eastern South Dakota

Swier, Vicki J., South Dakota State University, Brookings, SD

South Dakota is split into western and eastern regions by the Missouri River. In the western side of the state, bats find suitable habitat for maternity colonies or hibernacula roosts in caves such as Wind Cave and Jewel Cave which are located in the Black Hills. The hills are mostly covered by ponderosa pine forest, however, the remainder of the state is a mosaic of private land (cropland, uplands/wetlands, pasture) and public state and federal land. From 1861 to 1998, twenty-four studies have focused on the bats of the western half of the state, while only Jones and Genoways (1967) and Findley (1956) provide a detailed account of bats found in eastern South Dakota. This sparse data on eastern South Dakotan bats may be related to their wide distribution and low abundance, which is limited by the availability of suitable roosts (Humphrey, 1975). Before considering management plans, a much more thorough and recent study needs to be done on the bats of eastern South Dakota. As such, I have conducted surveys in the summer of 2000 and 2001. My objectives were to: 1) resample the sites visited by Jones and Genoways; 2) document which species of bats are present in eastern South Dakota by sampling several state parks and wildlife refuges; 3) determine the current distribution of resident bats in eastern South Dakota; and 4) locate possible roosts (trees, cliffs or rock quarries). Bats were captured using mist nets and their echolocation calls recorded using the ANABAT system. Six species were captured: *Myotis septentrionalis, Myotis lucifugus, Lasionycteris noctivagans, Eptesicus fuscus, Lasiurus borealis*, and Lasiurus *cinereus*. The majority of bats were captured along the Missouri River, making it a target of future conservation efforts. Roosts were found for *Myotis lucifugus* and *Eptesicus fuscus*. Of note, *Myotis lucifugus* was found roosting in picnic shelters in a small number of state parks even though tree roosts were also available. *Eptesicus fuscus* was radio tracked in the summer of 2000 and roosts and foraging ranges were documented. I present some pilot data on *Eptesicus fuscus* foraging ranges in eastern South Dakota.

Gleaning in Natterer's and Brown Long-eared Bats - A Comparative Study

Swift, Susan M. and Paul A. Racey, University of Aberdeen, Aberdeen, Scotland

Two species which glean prey directly from plant surfaces, the brown long-eared bat, *Plecotus auritus*, and Natterer's bat, *Myotis nattereri*, are sympatric in Scotland. However, they eat different arthropods, possibly due to the methods they use to detect prey. The present study aimed to identify the cues used to locate prey and to test the hypothesis that, unlike *P. auritus*, *M. nattereri* does not switch off echolocation while gleaning, and this affects its prey composition. Groups of each species were maintained in a flight room and their foraging behaviour compared. *M. nattereri* continued to emit echolocation calls throughout gleaning attacks, and feeding buzzes were detected in 79% of capture attempts. Echolocation was the most important cue used during gleaning: bats were able to locate prey using echolocation alone, but not by using only prey-generated sound. In contrast, *P. auritus* stopped echolocating for up to 1s before gleaning prey, and feeding buzzes were rarely emitted. It was able to locate prey in the absence of all cues except prey-generated sound, and the loudness of this sound significantly affected the ability of *P. auritus*, but not of *M. nattereri*, to detect prey. In a habitat where both species occurred, moths constituted 31.8% of the diet of *P. auritus* during May–September, but only 4.2% of that of *M. nattereri*. It is likely that *M. nattereri* does not hunt moths selectively because it cannot glean without echolocating and cannot therefore avoid alerting moths to its presence.

Bat Torpor, Hibernaculum Environment, and Survival

Szewczak, Joseph M., University of California White Mountain Research Station, Bishop, CA

Despite general acknowledgement that changes in the hibernaculum environment can affect bat survival, little information exists relating the magnitude of changing hibernaculum environment with bat survival. Such information could support resource management decisions for the prediction and protection of appropriate hibernaculae that may change in temperature, for example from physical ateration of portals. I formulated a model of hibernation energetics using laboratory-derived data from torpid bats combined with that of the known energetics of periodic arousals. The model predicts that a big brown bat hibernating at 100C for six months would forfeit 23 days of hibernation endurance with a 20C rise in temperature. However, the same bat hibernating at 50C, would forfeit 20 days, while at 10C it would forfeit just 14 days with a 20C rise in temperature. The energetic effect of this 20C temperature change equates to 1.5, 1.2, and 0.8 additional arousal episodes at 10, 5, and 10C, respectively. Thus, bats that hibernate in relatively warmer hibernaculae have a greater sensitivity (and thus vulnerability) to increased hibernaculum temperature than do bats in colder hibernaculae. The sensitivity of hibernation endurance with changing temperature also suggests that hibernating bats (and other hibernators) may fare poorly with increased global warming, particularly those on the southern limits of their extant ranges (assuming the northern hemisphere, reverse the latitude reference for considering the situation in the southern hemisphere). Because of the accelerated endurance decline with warmer hibernaculae, bat populations hibernating at the southern limits of their ranges may diminish most noticeably, forcing a northward displacement of their ranges.

Evolution of Sexual Dimorphism in Short-faced Bats: A Phylogenetic Perspective

Tavares, Valeria C. and Nancy B. Simmons
American Museum of Natural History, NY; City University of New York, NY

The Tribe Stenodermatina comprises eight monotypic genera of "short-faced" phyllostomid bats, with four broadly distributed Central-South American species and four Antillean endemics nested as a clade within Stenodermatinae. These bats are the only phyllostomids that show marked sexual dimorphism. Females are considerably larger than males in all Antillean genera, and in the mainland *Pygoderma* and *Ametrida*. In contrast, males and females of the other two mainland genera, *Centurio* and *Sphaeronycteris*, are not dimorphic in size. However males of all mainland species, including the latter two, present a variety of unusual secondary sexual characteristics, such as the well-developed pendulant chest gland in *A. centurio*. We used character mapping onto a phylogeny provided by a combined matrix of molecular and morphological characters to investigate patterns of variation related to the evolution of sexual dimorphism within short-faced bats. As an initial hypothesis, we treated sexual dimorphism as a multistate character, under the assumption that it had evolved in concert, affecting males and females simultaneously. The rechecking (congruence analysis) of this first hypothesis led us to treat dimorphic traits in males and females as separate characters, suggesting that different selection pressures might have acted in the two sexes. A third hypothesis recognizes two characters that most parsimoniously explain variation within Stenodermatina: a character related to size selection in females, and another describing the dimorphic features of males. Although distinct, and apparently non-homologous structures account for the differentiation of sexual characters in males, they are consistently found in a clade formed by all mainland genera. While scenarios for the evolution of dimorphic characters in males should probably involve sexual selection, it is difficult to choose among competing hypotheses that could account for the phenomenon of large sized females, given: 1) the paucity of behavioral and ecological data for short-faced bats, and 2) that many different factors other than those related to sexual selection are likely to underlie the evolution of larger females. Short-faced bats present a unique opportunity for investigating the evolution of large sized females among mammals because of the non-overlapping dimorphism they present, best exemplified by Ametrida centurio, the most extreme case of such dimorphism within the order Mammalia.

The Bats and Forests Initiative: A Collaborative Approach for Integrating Bat Conservation and Forest Management

Taylor, Daniel A. R., Bat Conservation International, Austin TX

Historically, bats that form large aggregations in caves, mines, and structures have received the majority of research and conservation efforts. However, concerns about forest habitat alteration, a lack of knowledge of forest bat ecology, and the threatened status of several forest-roosting species have increased interest in forest bats. BCI recently established the Bats and Forests Initiative to address these issues. Working collaboratively with private and public partners, the Initiative is facilitating forest bat research, conservation, training, and education; a critical first step to conservation. The Initiative recently worked with the Forest Service, Bureau of Land Management, Fish and Wildlife Service, and the National Fish and Wildlife Foundation, to produce and distribute educational posters on eastern and western forest bats, and is planning a brochure on forest bat conservation to be distributed at forestry offices nationwide. The director has delivered presentations on forest bat conservation at regional and national wildlife and forestry conferences, and is publishing articles on forest bat conservation in industry and professional society newsletters. Additional research on forest bats, and the effects of forest management on forest bat populations, is greatly needed. The Initiative is supporting the Northwest Bat Cooperative, a group of public and private forest managers collaboratively prioritizing and funding long-term forest bat research in the Pacific Northwest. This approach provides forest managers with the reliable data needed for making informed management decisions. A Hawaiian hoary bat research cooperative is being developed, and additional regional cooperatives will be pursued. The Initiative is conducting innovative artificial roost experiments with artificial bark, tree-trunk-like culverts, and new bat house designs, on public and industry forests in the midwest, southeast, and northwest. The Initiative is also sponsoring two new annual graduate scholarships for long-term forest bat research. Training is essential to provide the skills necessary for effectively managing and conserving forest bat populations. The initiative recently worked with the FS, USFWS, and National Council on Air and Stream Improvement to produce a handbook on forest bat conservation in eastern woodlands. In 2002, the Initiative and it's partners will be holding three-day forest bat conservation and management workshops in the southeast and northwest, and a second national symposium on bats and forests is being planned for 2003 to bring together foresters and bat biologists from across North America. By working cooperatively to better understand and address bat habitat needs, we can take the steps necessary to maintain viable bat populations while still meeting society's demand for forest resources.

Food Habits of Phyllostomus and Phylloderma in Two South American Localities

Tejedor, Adrian, American Museum of Natural History

Dietary data are a key element for understanding the ecology of any animal. Yet, sometimes such basic information is lacking even in the case of commonly captured species. This study reports the first detailed account of the food habits of *Phyllostomus elongatus* in two rain forest localities in South America. Also, it includes the first mention of food items found in specimens of *P. latifolius* and provides additional information on the diet of *P. hastatus* and *Phylloderma stenops*. Food item identification was conducted using fecal pellets provided by bats mistnetted mostly during dry seasons at Saul, French Guiana and Manu National Park, Peru. Food items were identified to ordinal and often to familial level. *Phyllostomus elongatus* consumed mostly insects, pollen and floral parts. Insects were dominated by beetles of the families Scarabaeidae, Curculionidae, and Cerambycidae, and by Hymenoptera (wasps) and Homoptera (Cercopidae). Fruit remains were only rarely found in pellets of this species. *Phyllostomus latifolius* consumed only insects while *Phylloderma stenops* consumed mostly fruit pulp and seeds. The diet of *P. hastatus* was very similar to the diet of *P. elongatus*. Dietary comparisons are made between the two field sites, and with Central American localities. The possible influences of dietary overlap between these species on resource partitioning and the relationship between dietary and morphological diversity in these two genera are discussed.

Comparative Roosting Ecology and Biogeography of Three Temperate Bat Species

Thibault, Katherine M., University of New Mexico, Albuquerque, NM

Despite the fact that the majority of analyses of mammalian distribution patterns have excluded bats, several studies suggest that temperate bats are constrained predominantly by availability of suitable roosts, especially maternity sites, in which the development of young occurs. Furthermore, for intuitive reasons, rather than due to evidence provided by rigorously acquired data, microclimate is considered the predominant driving force behind roost site selection in bats. Thus, I hypothesize that species having larger geographic ranges employ a generalist strategy of roosting and exhibit greater phenotypic plasticity, manifested as the ability to tolerate more variation in roost microclimate, than species with more restricted distributions. To test this hypothesis, I am investigating 1) patterns of roost site selection in terms of microclimate of three temperate bat species with disparate geographic distributions and varying preferences for structural types, *Antrozous pallidus, Eptesicus fuscus,* and *Myotis thysanodes,* and 2) the potential physiological mechanisms that yield such patterns. These investigations are being conducted across environmental gradients on a small scale, i.e., intensively throughout my study sites in New Mexico, and on a large scale, i.e., opportunistically throughout the geographic ranges of the species. Preliminary data concerning the comparative roosting ecology of the study species, in terms of microclimate and structural type, will be presented.

Diet Preferences of Rafinesque's Big-eared Bat, as Determined by Culled Parts Collected from a Roost in Coastal South Carolina

Thomas, Heather A. and Troy L. Best, Auburn University, Alabama

The largest known colony of Rafinesque's big-eared bat, *Corynorhinus rafinesquii*, in South Carolina is located at Hampton Plantation State Park in an abandoned kitchen building. This colony of up to 80 individuals provided an opportunity to study the seasonal diet of C. rafinesquii. Fecal samples were collected from the roost from mid-March through late November. During these collections any culled parts found were collected. These were mostly wings and legs dropped by the bats. Insect samples were also collected using aerial traps from various locations within the park on nights corresponding to fecal sample collections. Fecal samples will be analyzed and compared to insect samples to determine diet preferences of *C. rafinesquii.* The culled parts allow further identification of the insects eaten by the bats. In all, I collected 45 culled parts representing 13 families and 9 orders.

The Use of Ultrasonic Bat Detectors to Study Bats in Red Pine Forests

Tibbels, Annie E., University of Tennessee, Knoxville, TN

I hypothesized that thinning of red pine (*Pinus resinosa*) forests would result in an increase in bat activity by creating flyways through the stands and increasing space for maneuvering during aerial foraging. Ultrasonic bat detectors (Anabat II) were used to compare activity of bats in twelve pairs of thinned and unthinned red pine stands, as well as openings within those stands, at sites within the Huron-Manistee National Forest, Michigan. There was no significant effect of thinning on bat activity, but there was a significant difference in activity between forest stands and openings within those stands. Number of files per night (mean ±1 SE) for unthinned stand, unthinned opening, thinned stand, and thinned opening were 2.85 ± 1.2, 41.13 ± 9.8, 3.6 ± 1, and 50.6 ± 9.1, respectively. Total buffer size per night was 7.7 ± 4.4, 129.6 ± 30.6, 5.9 ± 1.9, and 180.4 ± 49.6, respectively, and mean total pulses were 11.3 ± 3.5, 426 ± 105.4, 21.3 ± 5.6, and 572.6 ± 143.1, respectively. Comparing calls of unknown bats with previously recorded calls from known bats identified presence of six species. The most common species identified were *Eptesicus fuscus* and *Myotis lucifigus*. There was no significant difference in insect biomass between unthinned and thinned sites, but forest stands yielded less biomass than openings. Both Lepidoptera and Trichoptera were significantly more abundant in the openings than in the stands. Basal area (4,144 ± 377 cm2 cover / 100 m2 ground) and total density (1.4 ± 3.7 trees/100 m2) of thinned stands was lower than basal area (6,848 ± 636 cm2 cover / 100 m2 ground) and density in unthinned stands (22.1 ± 2.2 trees/100 m2). Ground coverage increased significantly in the openings, 70.5 ± 8.1 %, compared with stands, 46.5 ±5.2 %. Lack of increased bat activity in unthinned stands could be because there is not a sufficient food source to attract the bats into the stands or that the flyways are not large enough to accommodate a foraging bat.

Day-roost Characteristics and Movements of the Indiana Bat in Northeast Missouri

Timpone, John C., Matthew N. Miller, Kevin L. Murray, and Lynn W. Robbins
Southwest Missouri State University, Springfield, MO

During the past few decades, Indiana bat (*Myotis sodalis*) populations have suffered their most precipitous declines in the state of Missouri, possibly a result of diminishing summer habitat. Our study site, Deer Ridge Conservation Area in northeast Missouri, offers a good opportunity to study the summer roosting habits of Indiana bats in a managed forest. Throughout the summer of 2001 we radio-tracked nine adult female and four juvenile Indiana bats to 47 day-roosts: 14 silver maples, 10 American elms, 9 pin oaks, 3 red oaks, 2 white oaks, 7 shagbark hickories, 1 cottonwood, and 1 honey locust. Eighty seven percent of day-roosts were located in snags and the rest were either living shagbark hickories or white oaks. Indiana bats roosted under tree bark 91% of the time while the remaining roosts were in crevices or broken branches. Height of day-roosts averaged 18.2 m (range= 3.6–27.7) and dbh averaged 44.8 cm (range= 16–83). Exit counts were conducted at most trees and a total of five primary roost trees (>30 bats) were identified. Eighty percent of primary roosts were located in lowland floodplain habitat. Simultaneous counts (56–151) were performed at four primary roost trees, with a total count of 467 bats counted before volant young were observed.

Association Patterns and Genetic Relationships in Spix's Disk-winged Bat Social Groups

Vonhof, Maarten J., M. Brock Fenton, and Curtis Strobeck
York University, Toronto, ON; University of Alberta, Edmonton, AB

Thyroptera tricolor is a small (3-4.5 g) Neotropical bat that roosts in the young, tubular leaves of musaceous plants (Heliconia, Calathea, Musa). These leaves may occur at high densities, and are only available to the bats for a single day. It was our prediction that the high availability and low permanency of roost-sites should affect the stability and composition of groups of bats forming in these leaves. Here we present the results of a study carried out over two field seasons at the Caño Palma Biological Station in northeastern Costa Rica to address this question. We found a total of 259 roosts and made 927 captures of 304 adults (170 males, 134 females), as well as 28 juveniles, during the two field seasons at Caño Palma. Group sizes varied between one and eleven, with a mean ± SD size of 4.1 ± 2.07 individuals, and a modal size of five individuals. The composition of groups was highly variable, from entirely female to entirely male. Cluster analysis of pairwise association index values revealed that within subunits, populations of T. tricolor are clearly differentiated into distinct social groups that rarely, if ever, interact with one another. These social groups use largely non-overlapping roosting home ranges that were very small, ranging from 0.0045 – 0.62 ha, with an overall mean of 0.19 ± 0.180 ha (N = 21). Social groups tended to be composed of related individuals, with a mean relatedness value within groups of 0.14. Mean relatedness between females was high (0.29), and 89% of observed mother-daughter relationships were between members of the same social group. Surprisingly, male offspring were also retained within social groups, with >70% of mother-son relationships between members of the same group. However, mean relatedness between males within groups (0.03) was considerably lower than between females within social groups, likely reflecting increased male dispersal. Mating did not take place between members of the same social group, and typically took place between individuals in different habitat patches within our study area. The retention of offspring of both sexes within social groups, limited dispersal between habitat patches, and small home range size has resulted in significant genetic differences between social groups and habitat patches within our 5.69 ha study area.

Putting Bat Biodiversity on the Map: A Global Bat GIS

Walsh, Allyson L., Kate E. Jones, Angela England, Wes Sechrest, and John L. Gittleman,
Bat Conservation International, Austin, TX; University of Virginia, Charlottesville, VA

The geographic ranges of species are profoundly important to our understanding and ultimately conserving ecological diversity. Worldwide, bats constitute over 1/4 of all mammalian biodiversity and over a half of the thousand species of bats are threatened or near threatened with extinction. To understand the patterns of threats facing bats, and to identify how and where effort should be invested to have maximum impact on the future conservation of bat biodiversity, a crucial element is an analytically

rigorous data set of species geographic ranges. We are therefore constructing a taxonomically complete geographical information database (GIS) of geographic ranges for all extant bat species worldwide. Extent of occurrence maps are being generated from the latest information (publications and unpublished records), and where point locality data is limited, a variety of range estimation techniques are being applied. The process of data collation and quality checking will involve a network of experts and researchers in the field, in particular we are collaborating with a working group currently developing a global database of terrestrial vertebrate distributions for the National Center for Ecological Analysis and Synthesis (NCEAS). The completed GIS will be a publicly available resource on the web that will provide information to test hypotheses for explaining variation in range distributions in bats, and, more generally, to assist in establishing and refining conservation priorities. In compiling such a database, sources of error and biases are important considerations. Comparing fine scale extent of occurrence range maps for 38 North American bat species collected by a Bat Conservation International mapping project with large scale presence/absence range data (presence/absence in states, in counties, and in 5 degree latitude longitude squares), we found a high degree of congruence between the different measures of range. However, we found measures using a finer spatial scale resolution (presence/absence in counties or 5 degree latitude longitude squares) were better predictors of range extent for species with small ranges and those with ranges that have disjuncts (ie. non-continuous ranges made up of smaller but connected ranges). The construction of a quantitative and complete bat GIS with attached data sources and quality indicators will make a significant contribution to large-scale studies of biodiversity. Importantly, it will serve as a focus for future geospatial mapping and will highlight poorly surveyed areas and those species whose distributions are poorly known.

Distribution of Bats in Fragmented Wetland Forests of Southeast Missouri

Warwick, Adam, Leigh H. Fredrickson, and Mickey Heitmeyerßß
University of Missouri Columbia, MO; Gaylord Memorial Laboratory, Puxico, MO

Bottomland Hardwood wetlands in the Mississippi Alluvial Valley (MAV) were gradually converted to rowcrops beginning in the mid-1800's. Among states with wetland forests in the MAV, Missouri has the most severe losses and modifications with about 40,000 ha of the original 1 million ha remaining as small patches of remnant forests in nine southeastern counties. Little is known about remnant wildlife populations within this highly fragmented landscape and foremost among these taxa is the order Chiroptera. Bats play an important role in bottomland forests as prey for snakes, hawks, owls, skunks, and opossums. Furthermore, bats serve agriculture by controlling common crop pests. We report on the abundance and species richness of bats in three landscapes of varying amounts of forest cover. We also report on the distribution of bats among natural forest remnants, and sites with agroforestry, buffer strips, and windbreaks. The first field season of 5500 net hours and 200 detector hours has revealed that landscapes with medium forest cover are used the most by bat species, with the highest abundance and species richness occurring in buffer strips and natural forest patches. Species of concern such as *Myotis sodalis* and *M. grisescens* have been documented on some study sites. In addition, male little brown bats *M. lucifugus* have been encountered in multiple forest patches, implicating bottomland hardwood forests as important summer habitat. These results are essential to develop landscape-level predictions of bat abundance and species richness in relation to forest cover and habitat type in disrupted floodplain systems.

Variation in Bat Detections due to Detector Orientation in a Forest

Weller, Theodore J., U.S. Forest Service, Pacific Southwest Research Station, Arcata, CA

Bat detectors are widely used to compare bat activity among habitats. To evaluate the effect of detector orientation on the number of bat detections received, we placed 8 Anabat II bat detectors at two heights, three directions and two angles with respect to horizontal. All detectors were within 3m x 2m area. The orientation that received the maximum number of detections had 1.4 – 2.4 times more detections than the mean of the other seven orientations on the same night. We found that detectors on 1.4 m stands received 30% more detections than detectors placed directly on the ground. Detectors oriented toward the direction with the least trees received 24 – 44% more bat detections than those at two other directions. Studies that standardize methods among sites and maximize the number of bat detections received at a site via detector placement will be most effective.

Mist Net Effort Required to Characterize a Bat Species Assemblage in a Western Coniferous Forest

Weller, Theodore J. and Cynthia J. Zabel,
U.S. Forest Service, Pacific Southwest Research Station, Arcata, CA

In recent years, interest in and surveys for bats have increased substantially. Due to limited resources, surveys often attempt to cover a large area within a narrow window of time. Surveying under these constraints may fail to detect the uncommon species that are often the focus of surveys. We summarized data on bat captures in mist nets along small, forested streams in a portion of a 100 km2 watershed in northwestern California. The purpose of this work was to provide guidelines on the sample effort required to describe bat species assemblages. We sampled bats using mistnets 12–41 nights per year for a total of 136 nights over five years. We captured a total of 11 species. Nine of the species were captured on more than three nights and in more than two years. All nine species were never captured during the same year. Annual species assemblages were captured after 6–19 nights of effort. It took 6–11 nights per year to capture the six most common species in the watershed. Capture effort was reduced 17–64% by eliminating efforts prior to the capture of the first juvenile of the year. Sampling four productive sites repeatedly was more efficient than sampling additional sites. We recommend a pilot season to locate high quality sites and estimate the time of the year when young become volant prior to full-scale surveys.

Community Structure and Roosting Ecology of the Southeastern Bat *Myotis austroriparius* in Delta National Forest, Mississippi

Wilf, Lann M., J.D. Wilhide, Drew Reed, and Tony Reed
Arkansas State University, State University, AR

Delta National Forest is considered a bottomland hardwood ecosystem in which water is not a limiting factor. However, the topography is not low enough to be considered a true swamp with extensive amounts of bald cypress and water tupelo, with some bald cypress occuring along water courses. On the high ground the tree species consist of sweetgum, nuttall, and willow oak, in low areas overcup oak and water hickory are dominant, and sugarberry, green ash, and american elm occur on intermediate elevations. Three distinct habitats occur in Delta National Forest. Mist net surveys were conducted throughout the fall of 1999, spring and summer of 2000, and summer of 2001. Six hundred ninety-nine bats of nine species were captured and banded with 8 recaptures. Ten female *Myotis austroriparius* were radiotagged, and four day roosts were located. One female northern long-eared bat (M. septentrionalis) was radiotagged and tracked to her day roost in a bald cypress. Vegetative data such as diameter at breast height, tree height, and canopy density were collected around each roost and ten random trees. Capture rates were compared throughout the forest in order to determine habitat preference with regard to timber harvest and topography. Data collected during this study will add to existing information on bat habitat requirements within a bottomland hardwood ecosystem.

*Daily Heterothermy and Roost Selection in Two Temperate, Insect-eating Bats

Willis, Craig K.R., and R. Mark Brigham, University of Regina, Regina, Saskatchewan

Temperate, insectivorous bats often use heterothermy, or torpor, to cope with thermoregulatory costs when ambient temperature and prey availability reduce the benefits of foraging. Torpor delays prenatal and neonatal development in bats so it has been predicted that reproductive females will avoid heterothermy. Species differences in life history traits, however, could have implications for the use of torpor in the field. Big brown bats (*Eptesicus fuscus*) are a medium-sized, colonial vespertilionid that hibernates during winter. Females of this species have been shown to avoid torpor relative to males. Hoary bats (*Lasiurus cinereus*) are larger, solitary, foliage-roosting vespertilionids that migrate for winter. Using temperature telemetry, we tested the hypothesis that female hoary bats would rely more heavily on torpor during the breeding season than female big brown bats. An exposed roosting strategy may require a greater reliance on torpor while a migratory wintering strategy could relax the selective costs because juvenile hoary bats need not fatten to avoid overwinter starvation.

*** Craig K.R.Willis received the Bat Research News Award for the best presentation on the subject of physiology.**

Home Range and Movements of an Obligate Nectarivore, *Melonycteris melanops* (Pteropodidae), on the Island of New Britain

Winkelmann, John, Frank Bonaccorso, Deanna Byrnes, and Emily Ruell,
Gettysburg College, Gettysburg, PA; Papua New Guinea National Museum and Art Gallery, Boroko, Papua New Guinea; University of Wisconsin, Madison, WI

The black-bellied bat, *Melonycteris melanops*, is endemic to the islands of the Bismarck Archipelago and is the largest obligate nectarivore among the Chiroptera. Four male black-bellied bats, (Pteropodidae), were radiotracked for up to 36 days in West New Britain Province, Papua New Guinea. The study was conducted in disturbed habitat at about 100m elevation on the flank of Mount Garbuna. The site contained coconut palms, domestic bananas, cacao and other traditional garden plants, as well as regenerating forest; it was flanked by an extensive cacao plantation below, and by primary rain forest above. Small patches of remnant forest persisted in a bordering ravine. Nets were set in both primary forest and second growth/garden habitat. Only the latter nets caught *M. melanops*. *Macroglossus minimus* were also netted in the same habitat. The three adult and one subadult *M. melanops* in our pilot study were 46 to 57 g in body mass. The mean home range was 3.58 ha and mean core use area was 0.98 ha (27.4% of mean home range). The mean home range of *M. melanops* is very similar to values for smaller nectarivores, *Syconycteris australis* and *Macroglossus minimus*, studied on New Guinea Island. Of four adult males simultaneously tracked and having contiguous home ranges only two showed significant overlap in home range. The mean long axis across home ranges was 434.5 m (360 to 528 m range, n = 4). All bats roosted singly each day under dead leaves of banana plants or in vine tangles in understory vegetation. Bats were well hidden from visual predators; in one case we observed an adult male tucked between drooping halves of a dead banana leaf (a natural tent). Additionally, black-bellied bats are cryptically colored (orange and black) to blend with dead leaves. Each of three bats observed over more than four weeks used a single day roost over a period of many days, but relocated one or more times to a new roost during our study. There was no overlap in day roost areas between any simultaneously tracked bats (n=4). Activity hot spots were centered on banana plants with nectar producing inflorescences. One adult male appeared to exclude other males from a rich feeding area that included 14 nectar-producing inflorescences, the highest density in the study area. We suggest that adult black-bellied bats may defend rich, compact feeding territories, but that foraging areas overlap where resources are too diffuse to defend economically.

Applying Genetic Analysis to the Conservation and Management of Bat Populations

Zinck, Jan M. and Patricia C. Ormsbee
Portland State University, Portland, OR; Willamette National Forest, Eugene, OR

Our ability to survey and manage for bats is restricted by our inability to detect presence and measure abundance of species with confidence and consistency. Capture surveys using nets and traps can be problematic and eluding for the captor, and invasive to bats. Additionally, it is difficult to differentiate species of captured bats when morphological characteristics are not measurably distinct. The same problems of accuracy, precision, and consistency are also encountered with non-invasive survey methods such as the collection and interpretation of bat vocalizations. Genetic analysis using DNA extracted from feces offers an alternative non-invasive technique for the survey of bat species. We have developed species-specific genetic markers of approximately 200 base pairs in length selected from a 1.56 kilobase region of mitochondrial DNA (mtDNA) spanning the majority of the 12S and 16S ribosomal RNA (rRNA) genes. We captured and identified twelve species of bats from which we collected a series of paired 3mm wing biopsy and fecal samples. We used DNA extracted from the wing biopsy samples to validate the preferential amplification of bat DNA from the feces. The ability to genetically distinguish bat species using DNA extracted from feces provides a non-invasive method for identifying bat species and estimating abundance where feces are deposited, even when bats are absent. Additionally, the use of species-specific genetic markers to distinguish sympatric sibling species when morphologic or acoustic traits are not reliably distinct is of value for both research biologists and land managers. Preliminary results from the 1999 – 2001 field seasons and strategies for incorporating this new survey method into current management practices will be discussed.

Report of the 31st Annual North American Symposium on Bat Research

Margaret A. Griffiths, Associate Program Director

The 31st annual North American Symposium on Bat Research met at the Victoria Conference Centre in Victoria, British Columbia, Canada from October 24-27, 2001. Mark Brigham was the conference host, assisted by Anne Brigham and Laura Friis, the Local Committee. Initially after the tragic events of September 11th, Program Director Tom Griffiths and I were uncertain whether people would be able (and willing) to travel to Victoria for the 31st NASBR, and thus we wondered "Would the 31st NASBR really happen?" Multiple registration and paper cancellations occurred during the first weeks after the terrorism attacks, and very few new registrations were submitted during that time. But as it turned out, the 31st Annual NASBR did take place, and it was the largest non-international meeting of the Society to date! There were 281 registered participants, not counting the educators who attended the special Bat Education Workshop on Saturday morning. Almost 31% of the participants this year were students (87 students), and over 3% of the participants came from countries outside of North America (Germany, the United Kingdom, Australia, New Zealand, Papua New Guinea, and American Samoa). While the majority of the participants this year came from the United States (75.5%), 19.5% of the participants were from Canada and 2% were from Puerto Rico and Mexico.

Tom, the Board of Directors, and I were pleased to announce at the meeting in Victoria that the NASBR is now recognized by the U. S. Federal government as an official 501(c)(3) tax-exempt, not-for-profit scientific organization. The granting of this status means that the society does not have to pay U. S. federal and state income taxes and most excise taxes, and this designation will remain with the NASBR as long as the society continues to operate in the same way that it has operated for the past five years. It also means that when donations are accepted from individuals, those individuals may now more easily deduct those their contributions on their U. S. tax forms, and the Koopman Fund can now be invested and can earn interest without the society having to pay taxes on that interest. All of the original documentation resides with the Program Director, but copies of all records and documentation regarding this and the tax returns have been given to the Treasurer of the NASBR (Trish Freeman for 2000-2001, and Nancy Simmons for 2001-2002). A financial report for the NASBR is given in another section *Bat Research News*. Please read that report for information about the financial status of the society. In Victoria, Tom gave a formal report to all members of the Board of Directors, and Board members also received copies of the society's financial report. Please contact any member of the Board with questions regarding the society's financial report and/or constitution.

One hundred and twenty-five scientific papers were presented at the Victoria meeting, not counting the special presentations for teachers made during the Saturday morning workshop. Thirty-four of these were poster presentations. Because of the number of papers submitted for the meeting this year, concurrent sessions were held on the second and third days of the meeting. Not only was this the largest non-international NASBR meeting, but it was also the first to have concurrent sessions for two full days. The beautiful and historic Empress Hotel was the site of the opening night Reception, as well as the hotel which provided room accommodations for many of the meeting's participants. The site for the meeting, the bat biologists who participated in it, and the number and quality of papers presented at the 31st NASBR all made this a very memorable 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. This year more than forty students initially submitted papers for the student platform competition, many more than could be accommodated in the allotted time for the first day of the meeting! Therefore, the Program Director, Chair of the Board of Directors, and Local Host had to decide how to handle the number of student papers received for competition given the total time available for the Student Competition Session on Thursday. The decision was made to fill the available time slots on Thursday with the student papers, in the order in which the student papers were received, until those slots were completely filled. Thus twenty-four papers were presented in the Student Competition Session, which filled the entire first day of the meeting. The remaining eighteen student platform papers were presented early on Friday in concurrent sessions, but were not judged in the competition. A special committee headed by Roy Horst judged twenty-four student platform papers and nineteen student posters. Four cash prizes of $250 USD

each were awarded at the Friday evening banquet. Cori Lausen of the University of Calgary, Alberta, Canada won the Bat Conservation International prize; Craig Willis of the University of Regina, Saskatchewan, Canada won the *Bat Research News* prize; Brent Sewall of the University of Minnesota - Twin Cities, St. Paul, MN won the Lubee Foundation prize; and Richard Sherwin of the University of New Mexico, Albuquerque, NM won the Karl F. Koopman prize. The special SPELEOBOOKS merchandise prize was awarded to Adrian Tejedor of the American Museum of Natural History, New York, NY 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 and Michael Warner of SPELEOBOOKS made four of the prizes possible. Donations from a number of individuals made the Karl F. Koopman Prize possible.

The Friday evening banquet was another memorable event at the meeting. The local host, Mark Brigham, arranged for the banquet to be held at the Crystal Garden Conservation Centre in Victoria. All banquet attendees had access to the Garden and the animals there. In addition to presentation of the student awards, another highlight of the banquet was the presentation of the Gerrit S. Miller, Jr. Award to Patricia ("Trish") W. Freeman of the University of Nebraska, Lincoln, Nebraska. The Gerrit Miller Award is presented to persons "In recognition of outstanding service and contribution to the field of chiropteran biology," and is the North American Symposium on Bat Research's highest honor. Trish joins a small group of distinguished individuals who have received this prestigious award, and becomes the first woman to win this award. The Crystal Garden was a wonderful setting for the banquet and the presentation of these awards, and we all thank Mark for his choice of this unique place.

Although unable to attend this year, Pat Morton of Texas Parks and Wildlife once again organized a special bat education workshop on Saturday morning of the conference. Her co-organizers this year were Cullen Geiselman of Bat Conservation International, and the Local Committee, Kerrie Post and Laura Friis of the Stn. Provincial Government in Victoria, BC. While Pat's presence at the workshop was sorely missed, Cullen and Laura did an outstanding job of running the workshop on Saturday morning, and along with Pat and Kerrie, helped to make it a success. The workshop was well attended by Victoria-area teachers, conservation workers, and other local persons interested in the conservation of bats. This was the sixth year in a row that Pat has organized this workshop in conjunction with the NASBR. We thank Pat, Cullen, Laura, and Kerrie for their efforts which made the workshop possible, and also Bat Conservation International, the Lubee Foundation, and *Bat Research News* for their generous donations to help support the workshop. Finally, let me extend Tom's and my special thanks to Mark and Anne Brigham, to the members of the Board of Directors 2000-2001 (Hector Arita, Robert Barclay, Ted Fleming, Trish Freeman, Tom Kunz, Gary McCracken, and Nancy Simmons), and to Roy Horst for all the hard work they did to make this meeting a success.

Characteristics of Buildings Used as Bat Roosts in Waukesha County, Wisconsin

Deana N. Pavwoski and Susan E. Lewis
Department of Biology, Carroll College, Waukesha, WI 53186

Abstract

We used questionnaires to determine characteristics of buildings occupied by bats, as well as characteristics of a randomly selected set of buildings, in Waukesha Co., Wisconsin. Bats most often roosted in uninsulated attics or wall spaces, in wooden barns or residential buildings. Most roost entrances faced south and east and were located 3–6 m above the ground. Compared with randomly selected buildings, structures occupied by bats were significantly more likely to be greater than 50 years old, located in barns or garages, and unoccupied by humans. Waukesha Co. is one of the most rapidly developing counties in the state, and as the county continues to urbanize, it is likely that availability of roosts favored by bats will decrease, potentially leading to a decline or shift in the bat population.

Introduction

Bats occupy various types of roosts, including tree cavities, rock crevices, modified leaves, foliage, exfoliating bark, caves, bridges, and buildings (Kunz, 1982). Roosts provide protection from predators and other environmental factors and possess a microclimate suitable for growth and development. They are especially important for females raising offspring, and the diversity of bats throughout the United States appears limited by availability of maternity roosts (Humphrey, 1975). In a direct study of the importance of the roosting environment, Brigham and Fenton (1986) found that maternity colonies of big brown bats (*Eptesicus fuscus*) that were experimentally evicted from preferred roosts had 30% lower reproductive success than colonies that remained undisturbed.

Many North American bats prefer buildings for maternity roosts (Humphrey, 1975). Buildings are abundant in many environments and provide a diversity of roosting options for bats, ranging from small crevices under shutters or loose boards to large cavities in attics or under eaves. There is also diversity in the microclimate within building roosts, especially in larger cavities where bats can select particular locations to hang, based on thermal or other environmental parameters (e.g., Licht and Leitner, 1967). Fenton (1970) hypothesized that construction of buildings and mines, as North America was settled, was a primary factor contributing to rapid population expansion for at least one nearctic species, the little brown bat (*Myotis lucifugus*).

Given the importance of roosts, biologists should expect bats to exhibit preferences for particular characteristics of the roosting environment. Previous research indicates that bats select roosts based on factors such as temperature (Humphrey, 1975; Krull et al., 1991, Entwistle et al., 1997), humidity (Betts, 1997; Churchill, 1991), age of structure (Entwistle et al., 1997), availability of nearby cover (Jenkins et al., 1998), proximity to foraging areas (Krull et al., 1991; Entwistle et al., 1997; Jenkins et al., 1998), and closeness to water (Gellman and Zielinski, 1996; Tidemann and Flavel, 1987). Nature of the roosting substrate and space available within the roost also could impact transmission of parasites or diseases and might be another basis for choice.

Studies investigating characteristics preferred by bats occupying buildings typically focus on a particular type of building (e.g., houses) and examine primarily rural environments (e.g., Entwistle et al., 1997, Jenkins et al., 1998). In this study, we describe structural characteristics of buildings occupied by bats and compare characteristics of bat-occupied buildings to randomly selected buildings in Waukesha Co., one of the most rapidly urbanizing counties in the state of Wisconsin. As an area urbanizes, types of buildings available as roosts change. In particular, older buildings, vacant buildings, and wooden barns and outbuildings typically are replaced by newer, occupied structures. The newer structures are likely better insulated and have fewer potential entrances for bats. The pattern in which rural areas develop also could affect proximity of roosts in buildings to foraging areas and sources of water. If, in fact, these factors influence preferences of bats for particular roosts, urbanization may have a strong impact on population dynamics and conservation of building-roosting bats.

Methods

To locate bat-occupied buildings, we posted notices describing our research (n = 87) at grocery stores, public libraries, post offices, and gas stations. In addition, four local newspapers published articles describing the project, and each concluded with a request for information concerning bat-occupied buildings. Each person who contacted us was mailed a survey (see below).

To identify a comparison group of randomly selected buildings, we consulted records of the county tax assessor for each municipality in the county. We randomly selected addresses from these listings at a ratio of 1:450 per municipality (to provide approximately 250 random structures) and mailed a general survey to each.

The survey mailed to the owner/resident of each bat-occupied building was developed following a review of the literature to identify characteristics that likely are relevant to bat roosting ecology. The final survey included questions about the building's age, occupancy status, and composition (e.g., brick, wood, etc.), where in or on the building the roost was located, type of human community in which the building was located, and proximity of the building to wooded areas and water sources. The survey sent to randomly selected owners was identical, except that questions referring to the nature of the roost location were omitted.

Chi-squared analyses were performed with Statview 5.0 (Abacus Concepts, 1994). *P*-values for post-hoc comparisons were converted using a standard normal curve from the *Z*-values calculated from the contributions to chi squared (Wardrop, 1995).

Results

Seventy-nine percent of surveys mailed to owners or residents of bat-occupied buildings were returned with usable responses (42 of 53). Four additional surveys were returned, but were unusable because the specific roosting location was not identified. Surveys returned with information about more than one roost in the same building were counted as a single sample, but for surveys returned with information about roosts in more than one building, each building was counted as a separate sample. Thirty-four percent of random surveys were returned with usable responses (90 of 266), and 23 additional surveys were returned as undeliverable and excluded from the total number of surveys mailed. Ten percent of respondents to surveys mailed to randomly selected addresses indicated that they were aware of bats roosting in the building they described. These responses were included only in the random group.

Bats occupied various locations within buildings, but the most common sites were attics and wall spaces (n = 11 roosts each). Bats also frequently were found under shutters (9), in rafters or under eaves (8), or under siding or in attic vents (7). Less common responses included under a roof (2), in a chimney (1), and in a cement wall (1).

Bats occupied wood-sided buildings (37) more often than buildings with brick (including stone, concrete, and slate; 6), aluminum/vinyl siding (4) or other coverings (stucco, metal; 2). Forty-one of 48 roost locations were in uninsulated parts of the building. Roost entrances were directed more often toward south (17) or east (15) than north (12) or west (7). After dividing the data on height of roost entrance into 3-m intervals, we found that modal height of the roost entrance was 3–6 m.

Eighteen percent of respondents indicated that a single bat occupied the roost, but most (65%) estimated that 2–50 bats occupied the building. Twelve percent estimated population size at 50–200 bats, and 6% appeared occupied by more than 200 bats. Respondents often reported presence of bats in more than one season. Bats were seen in summer most frequently (n = 29 surveys), followed by autumn (n = 20), spring (n = 19), and winter (n = 6). Only 5% of roosts were occupied in winter but not summer.

Bat-occupied buildings were significantly older than randomly selected buildings (X^2 = 45.08, d.f. = 4, $P < 0.0001$; Fig. 1a) and less likely to be occupied by humans (X^2 = 47.51, d.f. = 1, $P < 0.0001$; Fig. 1b). There were also differences between types of buildings available and those occupied by bats (X^2 = 36.31, d.f. = 3, $P < 0.0001$). Post-hoc comparisons indicate that a larger percentage of bat-occupied buildings were barns (including silos and an ice house; $P < 0.01$) or garages ($P < 0.05$), whereas a larger percentage of randomly selected buildings were residences ($P < 0.01$) or industrial/commercial structures ($P > 0.05$; Fig. 1c). Bat houses were excluded because there was no comparable structure among random buildings. Buildings occupied by bats were more likely to be located in farming communities (X^2 = 29.14, d.f. = 2, $P < 0.0001$) than in residential or urban areas (Fig. 1d), and more likely to be located on lots larger than 2 ha (X^2 = 22.93, d.f. = 3, $P < 0.0001$; Fig. 1e).

Buildings occupied by bats tended to be closer to a water source (river, stream, lake, or swimming pool) than randomly selected buildings, although this difference was not statistically significant (X^2 = 8.89, d.f. = 4, P = 0.06; Fig. 2a). There was no significant difference in distance to the nearest wooded area (X^2 = 7.63, d.f. = 4, P = 0.11;

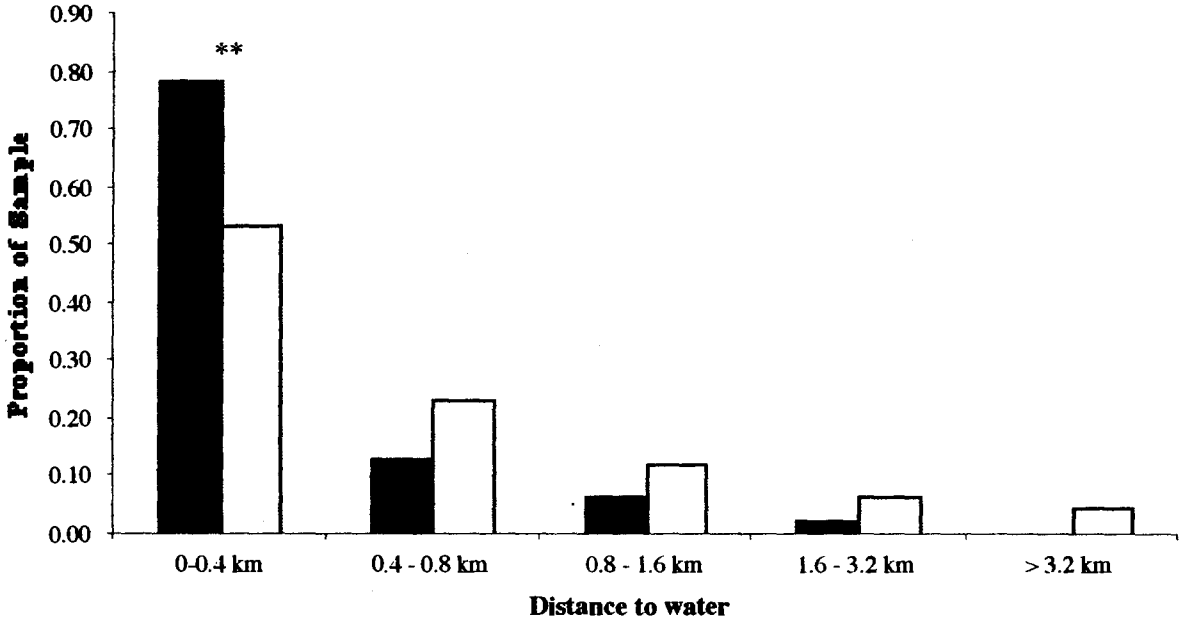

Figure 1. Characteristics of buildings occupied by bats (solid bars) and randomly selected buildings in Waukesha Co., Wisconsin (open bars): a) age of building, b) human occupancy, c) type of structure, d) location of building, and e) lot size. Asterisks indicate significant differences in post-hoc pairwise comparisons (* = $P < 0.05$; ** = $P < 0.01$).

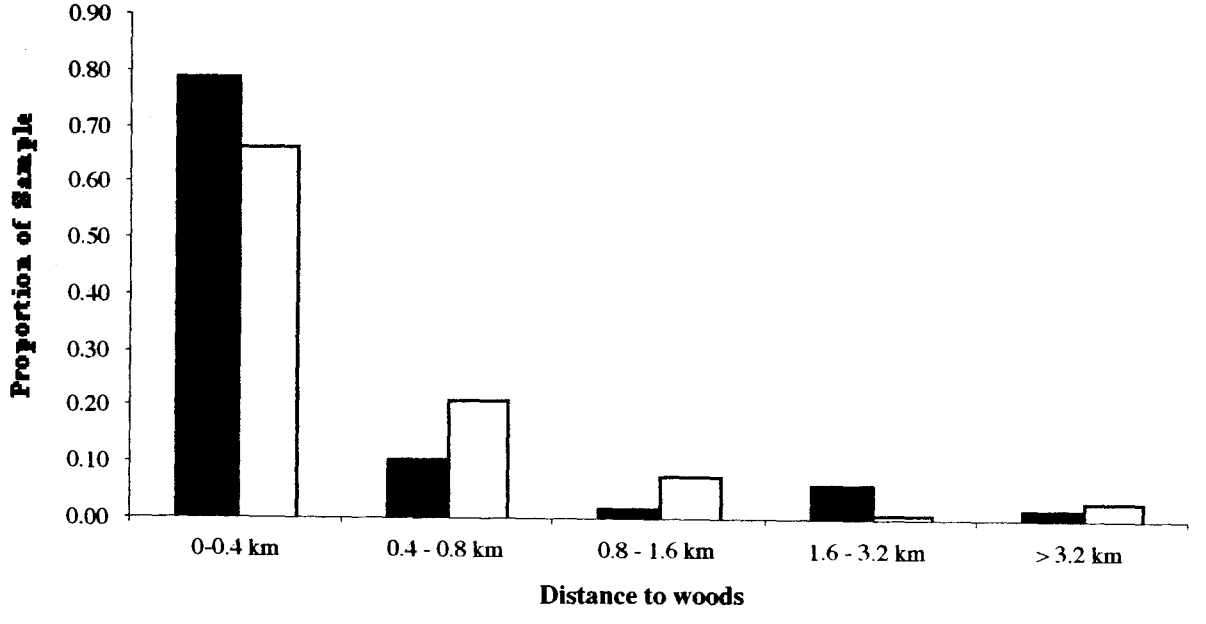

Figure 2. Location of buildings occupied by bats (solid bars) and randomly selected buildings in Waukesha Co., Wisconsin (open bars): a) distance to nearest water and b) distance to nearest woods. Asterisks indicate significant differences in post-hoc pairwise comparisons (* = $P < 0.05$; ** = $P < 0.01$).

Discussion

Microclimate and protection from predators frequently are cited as essential factors influencing roost selection by bats (Brigham, 1991; Brigham and Fenton, 1986; Kunz, 1982; Lewis, 1995; Tidemann and Flavel, 1987). Our results are consistent with this expectation. Eighty-five percent of bat roosts were located in uninsulated areas of buildings that are likely warm in summer. Most roosts (76%) were located in buildings with wooden siding, which could reflect a preference for thermal characteristic of wood, although it could be an artifact of the availability of wooden structures compared with other types of buildings in the county. Bats also occupied roosts that opened to the south (33%) or east (30%), aspects that would be warmed early in the day, but also protected from the most intense heat of late afternoon. Similar behavior has been observed in bats roosting in rock and tree cavities (e.g., Callahan et al., 1997; Lewis, 1996). A previous study of bats roosting in uninsulated attics of barns and houses in California indicated that solar radiation can increase temperatures near roost sites to over 50°C, to which bats respond by shifting locations within the roost (Licht and Leitner, 1967).

Thirty-two percent of respondents indicated that the roost entrance was 3–6 m above the ground, although there was considerable range in height. Presumably, bats roosting at greater heights are better protected from potential terrestrial predators. Bats may be constrained in their choice of roost height, however, by availability of roosts at various heights. The part of the building in which the roost was located was also highly variable. It seems likely that finding a crevice or cavity with appropriate characteristics is more important to bats that the actual location of that potential roost.

Species identity of bats occupying a roost was not determined. However, we assumed that most were occupied by little brown bats or big brown bats, the two most common species of cavity-roosting bats in southeastern Wisconsin (Jackson, 1961). The northern myotis (*Myotis septentrionalis*) also could have been represented. It is likely that most roosts were maternity sites because 82% of respondents indicated that the roost was occupied by groups of bats and that only 5% were occupied in winter but not summer.

Compared with randomly selected structures, bat-occupied buildings were more likely to be greater than 50 years old, unoccupied by humans, in barns or garages, on lots more than 2 ha in size, in rural or farming communities, and within 400 m of water. Unoccupied, older buildings, especially barns and garages, likely are more easily accessible to bats and contain a diversity of potential roosting locations. Rural areas are more likely than urban or suburban areas to have buildings of these types. These areas also may present more foraging opportunities for bats. Proximity to water is an important consideration for some bats because it provides both drinking and foraging opportunities (Gellman and Zielinski, 1996; Kunz, 1982).

Although these results are consistent with our expectations, they must be interpreted with caution. Responses that we received from randomly selected addresses may not accurately represent all buildings in the county. For instance, unoccupied buildings may be under-represented because there would be no one living at the address to respond to the survey. Similarly, barns and garages may be under-represented because a respondent might complete the survey based on characteristics of his/her primary residence even though outbuildings existed on the property. Moreover, there may be inaccuracy with respect to whether or not buildings actually were inhabited by bats because we did not verify statements from respondents.

Even with these limitations, results described in our study concerning roosts, when combined with earlier mist-netting studies (Everette et al. 2001; Kurta and Teramino, 1992), raise potential conservation concerns for bats in urbanizing areas. Types of buildings that bats apparently prefer and the rural areas in which these buildings are located are the areas most likely slated for development as the human population continues to grow. For this reason, bat populations should be closely monitored in rapidly urbanizing areas. Conservation might be facilitated in these areas by encouraging installation of bat houses, allowing some older or abandoned buildings to remain standing, and considering construction techniques that would allow safe roosting options for bats.

Acknowledgments

We are grateful to the citizens of Waukesha Co. who completed surveys as part of this study. R. O'Farrell and M. Gurka provided statistical advice. Feedback from J. Cope, K. Albright, B. Fenton, and two anonymous reviewers significantly improved the final manuscript. Funding for the project was provided through a grant from John and Sue Herrits.

Literature Cited

Betts, B. 1997. Microclimate in Hell's Canyon mines used by maternity colonies of *Myotis yumanensis*. Journal of Mammalogy, 78:1240–1250. continued>>>

Brigham, R. M., and M. B. Fenton. 1986. The influence of roost closure on the roosting and foraging behaviour of *Eptesicus fuscus*. Canadian Journal of Zoology, 64:1128–1133.

Brigham, R. M. 1991. Flexibility in foraging and roosting behaviour by the big brown bat (*Eptesicus fuscus*). Canadian Journal of Zoology, 69:117–121.

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.

Churchill, S. K. 1991. Distribution, abundance, and roost selection of the orange horseshoe bat, *Rhinonycteris auritanius*, a tropical cave-dweller. Wildlife Research, 18:343–353.

Entwistle, A. C., P. A. Racey, and J. R. Speakman. 1997. Roost selection by the brown long-eared bat (*Plecotus auritus*). Journal of Applied Ecology, 34:399–408.

Everette, L. A., T. J. O'Shea, L. E. Ellison, L. A. Stone, and J. L. McCance. 2001. Bat use of a high plains urban wildlife refuge. Bulletin of the Wildlife Society, 29:967–974.

Fenton, M. B. 1970. Population studies of *Myotis lucifugus* (Chiroptera: Vespertilionidae) in Ontario. Life Science Contribution, Royal Ontario Museum, 77:1–34.

Gellman, S. T., and W. J. Zielinski. 1996. Use by bats of old-growth redwood hollows on the north coast of California. Journal of Mammalogy, 77:255–265.

Humphrey, S. R. 1975. Nursery roosts and community diversity of nearctic bats. Journal of Mammalogy, 56:321–346.

Jackson, H. H. T. 1961. Mammals of Wisconsin. University of Wisconsin Press, Madison, Wisconsin.

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

Krull, D., A. Schumm, W. Metzner, G. Neuweiler. 1991. Foraging areas and foraging behaviors in notch-eared bats, *Myotis emarginatus* (Vespertilionidae). Behavioral Ecology and Sociobiology. 28:247–253.

Kunz, T. H. 1982. Roosting ecology of bats. Pages 1–55 *in* Ecology of bats. Plenum Press, New York.

Kurta, A., and J. A. Teramino. 1992. Bat community structure in an urban park. Ecography, 15:257–261.

Lewis, S. E. 1995. Roost switching in bats: a review. Journal of Mammalogy, 76:481–496.

Lewis, S. E. 1996. Low roost-site fidelity in pallid bats: associated factors and effect on group stability. Behavioral Ecology and Sociobiology, 39:335–344.

Licht, P., and P. Leitner. 1967. Behavioral responses to high temperatures in three species of California bats. Journal of Mammalogy, 48:52–61.

Tidemann, C. R., and S. C. Flavel. 1987. Factors affecting choice of diurnal roost site by tree-hole bats in south-eastern Australia. Australian Wildlife Resources, 14:459–473.

Wardrop, R. 1995. Statistics. Wm. C. Brown Publishers. Dubuque, Iowa.

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.

Notes on Summer Roosting of Indiana Bats

Timothy Carter[1], George Feldhamer[1], and Joseph Kath[2]
[1]Department of Zoology, Southern Illinois University, Carbondale, IL 62901-6501
[2]Illinois Department of Natural Resources, Division of Natural Heritage, 524 South Second Street, Springfield, IL 62701-1787

Indiana bats (*Myotis sodalis*) rarely use manmade structures as dayroosts in summer. There are records of two males found in standard bat houses (Salyers et al. 1996), one male roosting under a bracket on a utility pole (Harvey, in press), and a number of adult males and juveniles using bridges (Mumford and Cope, 1958). In addition, Butchkoski and Hassinger (in press) describe a maternity colony living in the attic of an abandoned church. In this note, we report a group of female Indiana bats using a bat box and a group of males roosting in a mine.

In spring 2001, Bat Conservation International donated two rocket-style bat houses (Dourson and MacGregor, 1997) to Southern Illinois University. These were installed along the edge of a ditch, in bottomland forest, located in the Mississippi River floodplain of Jackson Co., Illinois. The ditch is used to control water levels in a waterfowl management area (i.e., a "greentree reservoir"). Throughout summer, water levels in the ditch vary from 0 to >1m in depth, depending on precipitation. This bottomland forest has a well-established maternity colony of Indiana bats that has been studied for the last 3 years (T. Carter, unpubl. data). Both houses were installed on posts (10 cm by 10 cm by 10.2 m), with one end buried approximately 1 m.

In early September 2001, boxes were inspected for signs of use. At one box, much guano was sprinkled on leaves of plants around the base of the pole, and bats were heard inside. On 25 September 2001, we caught nine bats as they exited the box. Eight were adult female Indiana bats, and one was a male little brown bat (*Myotis lucifugus*). Although an accurate count was not possible, due to our efforts to catch these bats, we estimated that between 35 and 50 bats were using the box on this day. The extensive collection of guano around the base and in the cracks and crevices in the box suggested that it was occupied for a long time.

Additionally, we report a large bachelor colony of Indiana bats roosting in an abandoned silica mine in Alexander Co., Illinois. When discovered 3 years ago, there already was a substantial pile of guano (0.6-m long, 0.3-m wide, and 0.3 m deep). Although use of the area by bats appears very high, this pile has grown little in the last 3 years, suggesting that the original guano pile developed over many years.

During August 2001, a survey was conducted to identify the species present. The main cluster contained an estimated 1,000 bats, and there were additional groups of 30-50 animals scattered in cracks and crevices. We estimated total number of bats in this colony as 1,500 animals. We captured 12 individuals; 11 were male Indiana bats and one was a female little brown bat. This was the first discovery of an aggregation of male Indiana bats in the state of Illinois in summer. Upon closer inspection of the cluster, we noticed a small group of bats in the center that were orange in color rather than brown. We captured a few of these and identified them as female southeastern bats (*Myotis austroriparius*), a state-endangered species. This mine is part of a series of abandoned mines in the area that are important hibernacula (Kath, in press) and apparently also important summer roosts for many species of bat in southern Illinois.

Literature Cited

Butchkoski, C. M., and J. D. Hassinger. In press. Ecology of a maternity colony roosting in a building. *In* The Indiana bat: biology and management of an endangered species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Dourson, D., and J. MacGregor. 1997. A post bat house design. Bat Research News, 38:20-22. >>>

Harvey, M. J. In press. Status and ecology in the southern United States. *In* The Indiana bat: biology and management of an endangered species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Kath, J. A. In press. An overview of hibernacula in Illinois, with emphasis on the Magazine Mine. *In* The Indiana bat: biology and management of an endangered species (A. Kurta and J. Kennedy, eds.). Bat Conservation International, Austin, Texas.

Mumford, R. E., and J. B. Cope. 1958. Summer records of *Myotis sodalis* in Indiana. Journal of Mammalogy, 39:586-587.

Salyers, J., K. Tyrell, and V. Brack. 1996. Artificial roost structure use by Indiana bats in wooded areas in central Indiana. Bat Research News, 37:148.

Notes and Observations

Winter Records in Texas for *Lasionycteris noctivagans, Lasiurus borealis, Lasiurus cinereus*, and *Nycticeius humeralis*

Barbara French, Bat Conservation International, Austin TX

I recovered an adult female silver-haired bat (*Lasionycteris noctivagans*) in Manor, Texas (Travis County) on February 9, 1998, and a juvenile female in Austin, Texas (Travis County) on January 17, 2001. This species had not been previously documented in this county. I also recoevered two male red bats (*Lasiurus borealis*) in Austin, Texas (Travis County) on November 9, 2000. The torpid bats were found on the ground buried in Sycamore leaf litter. Daily high's had dropped from 75 degrees F on 11/6, to 49 degrees F on 11/8. The low on 11/8 was 39 degrees F. The daily high had returned to 63 degrees F on 11/9 when the bats were discovered. I also received a call regarding a torpid adult male hoary bat (Lasiurus cinereus) found buried in a hay pile in San Antonio, Texas (Bexar County) on November 13, 2000. The bat was recovered by David Chapman. The daily high had dropped from 80 degrees F on 11/12, to 58 degrees F on 11/13 when the bat was found. And finally, although the specific dates and sexes were not recorded, three torpid evening bats *(Nycticeius humeralis*) were recovered from buildings in the Dallas, Ft. Worth area in Texas by the Bat World sanctuary between December 2000 and January 2001.

Captive Longevity Record for *Eptesicus fuscus*

Barbara French, Bat Conservation International, Austin TX

A captive longevity record of 21 years and 8 months is reported for *Eptesicus fuscus*. The bat was retrieved as a juvenile female in July of 1977 from a wooded area on the campus of Indiana University in Bloomington, Indiana by Michele Sims. The bat remained in captivity until March 2, 1999 when it was aroused briefly from hibernation and fed. It was maintained in captivity with a second female received in the spring (April or May) of 1999. The bats were fed mealworms that were sprinkled with Brewer's yeast a few times each month. Both bats were alive on March 2, 1999, but had died when they were re-checked again on March 19, 1999.

RECENT LITERATURE

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ANATOMY

Canals, M., J. Iriarte-Diaz, R. Olivares, and F. F. Novoa. 2001. Comparison of the wing morphology of *Tadarida brasiliensis* (Chiroptera: Molossidae) and *Myotis chiloensis* (Chiroptera: Vespertilionidae) as representatives of two flight patterns [Spanish]. Revista Chilena de Historia Natural, 74: 699-704. [Univ. Chile, Fac. Ciencias, Dept. Ciencias Ecol., Casilla 653, Santiago, Chile; mcanals@abello.dic.uchile.cl]

CONSERVATION

Brooke, A. P., and M. Tschapka. 2002. Threats from overhunting to the flying fox, *Pteropus tonganus*, (Chiroptera: Pteropodidae) on Niue Island, South Pacific Ocean. Biological Conservation, 103: 343-348. [Box 102, Newfields, NH 03856-0102; abrooke@nh.ultranet.com]

Kurta, A. 2001. Bats on the surface: The need for shelter, food, and water. *In* Bat conservaton snd mining (K. C. Vories and D. Throgmorton, eds.), Pp. 197-204. Office of Surface Mining, U. S. Department of the Interior, Alton, IL [Dept. Biology, Eastern Michigan Univ., Ypsilanti, MI 48197]

DISTRIBUTION/FAUNAL STUDIES

Baagøe, H. J. 2001. Danish bats (Mammalia: Chiroptera): Atlas and analysis of distribution, occurrence, and abundance. Steenstrupia, 26: 1-117. Copenhagen. [Baagøe: Zool. Mus., Universitetsparken 15, DK 2100 Copenhagen Ø, Denmark; hjbaagoe@zmuc.ku.dk]

Baagøe, H. J. 2001. Flagermusene i Høstemark skov. S. 256-262, i: P. Hald-Mortensen (red.): Høstemark - Status 2001. 306 s. Aage V. Jensens Fonde. ISBN 87-9866687-1-4. Odense.(English summary: Bats in Høstemark)

Baagøe, H. J. 2001. *Myotis bechsteinii* - Bechsteinfledermaus. Pp. 443-471. In: F. Krapp (ed): Handbuch der Säugetiere Europas. Bd. 4/I. Fledertiere., 603 pp. Aula -Verlag GmbH.

Baagøe, H. J. 2001. *Vespertilio murinus* - Zweifarbfledermaus. Pp. 473-514. In: F. Krapp (ed): Handbuch der Säugetiere Europas. Bd. 4/I. Fledertiere., 603 pp. Aula -Verlag GmbH.

Baagøe, H. J. 2001. *Eptesicus serotinus*- Breitflügelfledermaus. Pp.519-559. In: F. Krapp (ed): Handbuch der Säugetiere Europas. Bd. 4/I. Fledertiere., 603 pp. Aula -Verlag GmbH.

Martinus, W. S., and A. Kurta. 2001. Eastern Pipistrelle in Ottawa Co., MI. Michigan Birds and Natural History, 8: 133-135. [Kurta: Dept. Biology, Eastern Michigan Univ., Ypsilanti, MI 48197]

Robinson, M. F., and M. Webber. 2000. Survey of bats (Mammalia: Chiroptera) in the Khammouan Limestone National Biodiversity Conservation Area, Lao P. D. R. Nat. Hist. Bull. Siam Soc., 48: 21-45. [2 Claremont Villas, All Saints Rd., Uplands, Stroud Gloucestershire, GL5 1TS, Great Britain; mark.robinson23@virgin.net]

Strelkov, P. P., and A. V. Abramov. 2001. Sexual and age proportion of males in different parts of range in migratory bat species (Chiroptera, Vespertilionidae) from Eastern Europe and adjacent territories during nursing period [Russian]. Zoologichesky Zhurnal, 80: 222-229. [Russian Acad. Sci., Inst. Zool., St. Petersburg 199034, Russia]

Weyandt, S. E., T. E. Lee, and J. C. Patton. 2001. Noteworthy record of the western yellow bat, *Lasiurus xanthinus* (Chiroptera: Vespertilionidae), and a report on the bats of eagle nest canyon, Val Verde County, Texas. Texas Journal of Science, 53: 289-292. [Lee: Abilene Christian Univ., Dept. Biol., Box 27868, Abilene, TX 79699; lee@biology.acu.edu]

ECHOLOCATION

Siemers, B. M., E. K. V. Kalko, and H. U. Schnitzler. 2001. Echolocation behavior and signal plasticity in the Neotropical bat *Myotis nigricans* (Schinz, 1821) (Vespertilionidae): A convergent case with European species of *Pipistrellus*? Behavioral Ecology & Sociobiology, 50: 317-328. [Univ. Tubingen, Dept. Anim. Physiol., Inst. Zool., Morgenstelle 28, D-72076 Tubingen, Germany; bjoern.siemers@uni-tuebingen.de]

Speakman, J. R. 2001. The evolution of flight and echolocation in bats: Another leap in the dark. Mammal Review, 31: 111-130. [Univ. Aberdeen, Dept. Zool., Aberdeen AB24 2TZ, Scotland; J.Speakman@abdn.ac.uk]

White, E. P., and S. D. Gehrt. 2001. Effects of recording media on echolocation data from broadband bat detectors. Wildlife Society Bulletin, 29: 974-978. [Univ. New Mexico, Dept. Biol., Albuquerque, NM 87131; epwhite@unm.edu]

ECOLOGY

Barclay, R. M. R., and R. M. Brigham. 2001. Year-to-year reuse of tree-roosts by California bats. (*Myotis californicus*) in Southern British Columbia. Am. Midl. Nat., 146: 80–85. [Dept. Biol. Sci., Univ. Calgary, Calgary, AB T2N 1N4 Canada; barclay@ucalgary.ca]

Brunet, A. K., and R. A. Medellín. 2001. The species-area relationship in bat assemblages of tropical caves. Journal of Mammalogy, 82: 1114-1122. [Dept. Ecol., Evol., and Beh., and James Ford Bell Mus. Nat. Hist., Univ. MN, 1987 Upper Buford Circle, St. Paul, MN 55108; anja.brunet@stanfordalumni.org]

Everette, A. L., T. J. O'Shea, L. E. Ellison, L. A. Stone, and J. L. McCance. 2001. Bat use of a high-plains urban wildlife refuge. Wildlife Society Bulletin, 29: 967-973. [U. S. Geol. Survey, Midcontinent Ecol. Sci. Ctr., 4512 McMurry Ave., Ft. Collins, CO 80525; Lance_Everette@usgs.gov]

Fenton, M. B., S. Bouchard, M. J. Vonhof, and J. Zigouris. 2001. Time-expansion and zero-crossing period meter systems present significantly different views of echolocation calls of bats. Journal of Mammalogy, 82: 721-727. [Dept. Biol., York Univ., North York, ON M3J 1P3, Canada; bfenton@yorku.ca]

Jaberg, C., and A. Guisan. 2001. Modelling the distribution of bats in relation to landscape structure in a temperate mountain environment. Journal of Applied Ecology, 38: 1169–1181. [Centre de coordination ouest pour l'étude, et la protection des chauves-souris, c/o Musée d'histoire naturelle, Av. Léopold-Robert 63, CH-2300 La Chaux-de-Fonds, Switzerland; christophe.jaberg@rpn.ch]

Kalko, E. K. V., and C. O. Handley. 2001. Neotropical bats in the canopy: Diversity, community structure, and implications for conservation. Plant Ecology, 153: 319-333. [Univ. Ulm, Dept. Expt. Ecol. Bio. 3, Albert Einstein Allee 11, D-89069 Ulm, Germany; elisabeth.kalko@biologie.uni-ulm.de]

Murray, K. L., E. R. Britzke, and L. W. Robbins. 2001. Variation in search-phase calls of bats.. Journal of Mammalogy, 82: 728-737. [Robbins: Dept. Biol., Southwest Missouri State Univ., Springfield, MO 65804; LynnRobbins@smsu.edu]

Seidman, V. M., and C. J. Zabel. 2001. Bat activity along intermittent streams in northwestern California. Journal of Mammalogy, 82: 738-747. [California State Parks, 250 Executive Park Blvd,., Ste. 4900, San Francisco, CA 94134; vseid@parks.ca.gov]

Stoner, K.E. 2001. Differential habitat use and reproductive patterns of frugivorous bats in tropical dry forest of northwestern Costa Rica. Canadian Journal of Zoology, 79: 1626–1633. [Estación de Biología Chamela, Inst. Biología, Universidad Nacional Autónoma de México, AP 21, San Patricio, Jalisco 48980, México; kstoner@ibiologia.unam.mx]

EVOLUTION

Castella, V., M. Ruedi, and L. Excoffier. 2001. Contrasted patterns of mitochondrial and nuclear structure among nursery colonies of the bat *Myotis myotis*. Journal of Evolutionary Biology, 14: 708-720. [Univ. Lausanne, Inst. Ecol., Zool. Lab., Biol. Bldg., CH-1015 Lausanne, Switzerland; vincent.castella@ie-zea.unil.ch]

Hosken, D. J., K. E. Jones, K. Chipperfield, and A. Dixson. 2001. Is the bat os penis sexually selected? Behavioral Ecology & Sociobiology, 50: 450-460. [Univ. Zurich Irchel, Museum Zool., Winterthurerstr 190, CH-8057 Zurich, Switzerland; hosken@zoolmus.unizh.ch]

Killian, J. K., T. R. Buckley, N. Stewart, B. L. Munday, and R. L. Jirtle. 2001. Marsupials and Eutherians reunited: Genetic evidence for the Theria hypothesis of mammalian evolution. Mammalian Genome, 12: 513-517. [Duke Univ., Med. Ctr., Dept. Radiat. Oncol., Box 3433, Durham, NC 27710; jirtle@radonc.duke.edu]

Lewis-Oritt, N., R. A. Van Den Bussche, and R. J. Baker. 2001. Molecular evidence for evolution of piscivory in *Noctilio* (Chiroptera: Noctilionidae). Journal of Mammalogy, 82: 748-759. [Dept. Biol. Sci., Tex.as Tech Univ., Lubbock, TX 79409; rjbaker@ttu.edu]

Mayer, F., and O. von Helversen. 2001. Cryptic diversity in European bats. Proceedings of the Royal Society of London - Series B: Biological Sciences, 268: 1825-1832. [Univ. Erlangen Nurnberg, Inst. Zool. 2, Staudtstr. 5, D-91058 Erlangen, Germany; fmayer@biologie.uni-erlangen.de]

GENETICS

Burland, T. M., and J. W. Wilmer. 2001. Seeing in the dark: Molecular approaches to the study of bat populations. Biological Reviews, 76: 389-409. [Univ. London Queen Mary & Westfield Coll., Sch. Biol. Sci., Mile End Rd., London E1 4NS, England; t.m.burland@qmw.ac.uk. jmww@bu.edu]

PALEONTOLOGY

Mead, J. I., and D. G. Mikesic. 2001. First fossil record of *Euderma maculatum* (Chiroptera: Vespertilionidae), eastern Grand Canyon, Arizona. Southwestern Naturalist, 46: 380-383. [No. Arizona Univ., Dept. Geol., Flagstaff, AZ 86011; James.Mead@nau.edu]

PARASITOLOGY

Giorgi, M. S., R. Arlettaz, P. Christe, and P. Vogel. 2001. The energetic grooming costs imposed by a parasitic mite (*Spinturnix myoti*) upon its bat host (*Myotis myotis*). Proceedings of the Royal Society of London - Series B: Biological Sciences, 268: 2071-2075. [Univ. Lausanne, Inst. Ecol., Lab. Zool. & Ecol. Anim., Batiment Biol., CH-1015 Lausanne, Switzerland; maud.giorgi@ie-zea.unil.ch]

PHYSIOLOGY

Barclay, R. M. R., C. L. Lausen, and L. Hollis. 2001. What's hot and what's not: Defining torpor in free-ranging birds and mammals. Canadian Journal of Zoology, 79: 1885–1890. [Dept. Biol. Sci., Univ. Calgary, Calgary, AB T2N 1N4, Canada; barclay@ucalgary.ca]

McNab, B. K., amd M. I. Armstrong. 2001. Sexual dimorphism and scaling of energetics in flying foxes of the genus *Pteropus*. Journal of Mammalogy, 82: 709-720. [Dept. Zool., Univ. Florida, Gainesville, FL 32611; mcnab@zoo.ufl.edu]

SYSTEMATICS

Ahlén, I., and H. J. Baagøe. 2001. Dvärgfladdermusen uppdelad i två arter. Fauna och Flora, 96: 71-78. (English summary: The common pipistrelle split into two species). [Baagøe: Zool. Mus., Universitetsparken 15, DK 2100 Copenhagen Ø, Denmark; hjbaagoe@zmuc.ku.dk]

Baagøe, H. J., and I. Ahlén. 2001. Dværgflagermusen opsplittet i to arter. Flora og Fauna, 107: 47-52. Århus. (English summary: The common pipistrelle split into two species).

Bradley, R. D., and R. J. Baker. 2001. A test of the genetic species concept: Cytochrome-*b* sequences and mammals. Journal of Mammalogy, 82: 960-973. [Dept. Biol. Sci., Mus. Tex. Tech Univ., Lubbock, TX 79409; rbradley@ttacs.ttu.edu]

Hoffman, F. G., and R. J. Baker. 2001. Systematics of bats of the genus *Glossophaga* (Chiroptera: Phyllostomidae) and phylogeography in *G. soricina* based on the cytochrome-*b* gene. Journal of Mammalogy, 82: 1092-1101. [Dept. Biol. Sci., Mus. Tex. Tech Univ., Lubbock, TX 79409; fhoffman@ttacs.ttu.edu]

López-González, C., and S. J. Presley. 2001. Taxonomic status of *Molossus bondae* J. A. Allen, 1904 (Chiroptera: Molossidae), with description of a new subspecies. Journal of Mammalogy, 82: 760-774. [Centro Interdisciplinario de Investigacion Para el Desarrollo Integral Regional Unidad Durango, Comision para el Fomento de Actividades Academicas-Instituto Politécnico Nacional, Sigma s/n Fracc. 20 de Noviembre II, Durango, Durango 34220, México; celialg@prodigy.net.mx]

Owen, J. G., and R. J. Baker. 2001. The *Uroderma bilobatum* (Chiroptera: Phyllostomidae) cline revisited. Journal of Mammalogy, 82: 1102-1113. [Universidad Salvadoreña "Alberto Masferrer," AP 2053, San Salvador, El Salvador, Central America; jgowen@salnet.net]

Nikaido, M., K. Kawai, Y. Cao, M. Harada, S. Tomita, N. Okada, and M. Hasegawa. 2001. Maximum likelihood analysis of the complete mitochondrial genomes of eutherians and a reevaluation of the phylogeny of bats and insectivores. Journal of Molecular Evolution, 53: 508-516. [Okada: Tokyo Inst Technol , Grad Sch Biosci & Biotechnol , Midori Ku, Nagatuta Cho, Yokohama, Kanagawa 2268501; nokada@bio.titech.ac.jp]

Ruedi, M., and F. Mayer. 2001. .Molecular systematics of bats of the genus *Myotis* (Vespertilionidae) suggests deterministic ecomorphological convergences. Molecular Phylogenetics and Evolution, 21: 436-448. [Dept. Mammalogy and Ornithology, Natural History Museum of Geneva, CP 6434, 1211 Geneve 6, Switzerland; manuel.ruedi@mhn.ville-ge.ch]

Spitzenberger, F., J. Piálek, and E. Haring. 2001. Systematics of the genus *Plecotus* (Mammalia, Vespertilionidae) in Austria based on morphometric and molecular investigations. Folia Zool., 50: 161-172. [Mus. Nat. Hist., Burgring 7, POB 417, A-1014 Vienna, Austria; Friederike. Spitzenberger@nhm-wien.ac.at]

TECHNIQUES

Iudica, C. A., W. M. Whitten, and N. H. Williams. 2001. Small bones from dried mammal museum specimens as a reliable source of DNA. BioTechniques, 30: 732-736. [Mammalogy, Florida Mus. Nat. Hist., Dickinson Hall, POB 117800, Univ. Florida, Gainesville, FL 32611-7800; casaiud@flmnh.ufl.edu]

NEWS

From New Brunswick, Canada
ANABAT BLOWN-UP AFTER SEPTEMBER 11.

Very little work has been conducted on bats in New Brunswick, Canada, and so, after their use on Hugh Broders doctoral project elsewhere in NB this summer, we set out a series of 6 Anabat systems in, and around the city of Fredericton. Our Anabats are run on wheel-chair batteries, connected to the laptop and housed in large plastic containers that allows reception of the echolocation but keeps out the rain. To bat researhers, it is a common sight. To University security staff it looked suspicously like a bomb.

Our Anabat was found on a forested trail on the large campus after dark, found to be suspicious enough to warrant bringing in the police and a remote-controlled water cannon, which promptly blew apart $1300 worth of research equipment. This all occured 2 weeks after Sept. 11 and nobody was taking risks. The student who had set out the Anabat was on his way to pick it up when he heard the story on the radio - "Bomb detonated on UNB campus!".

In obvious hindsight, we should have told campus security about the equipment, and by bad luck, this Anabat was the only one in use that was not labeled with purpose and contact person. Live and learn!

Submitted by Graham Forbes, Ph.D., Director, NB Cooperative Fish and Wildlife Research Unit, Director, Sir James Dunn Wildlife Research Centre, University of New Brunswick, Fredericton, NB E3B 6C2 506-453-4929, 506-453-3538 (fax)

From New Mexico
BAT SURVEY IN SELECTED STATE PARKS *"Night Life"*

We're the bat education source for New Mexico. This past summer, thanks to an award from Share With Wildlife, our non-profit youth development and environmental organization conducted bat species inventories in three selected state parks.

The principal investigators used mist-nets over streams and other bodies of water in order to capture and identify. Furthermore, Dr. William Gannon, renowned bat researcher at the University of New Mexico, Museum of Southwest Biology, is collaborating with Talking Talons on this project by performing acoustic surveys using the AnaBat II instrument. This high frequency sound detector records the echolocation calls of bats and plots them, frequency in kilohertz against time in seconds, on a graph on a laptop computer.

The three participating parks are the Rio Grande Nature Center (in Albuquerque), Villanueva State Park (between Pecos and Las Vegas, NM), and Oliver Lee State Park (near Alamogordo, NM). As we go to press (in mid-August), one survey has been conducted at each park. A Western Small-footed Myotis (Myotis ciliolabrum) and a Hoary Bat (Lasiurus cinereus) were captured and released at Villanueva. At Oliver Lee, the species netted were the California Myotis (Myotis Californicus), and the Western Pipistrelle (Pipistrellus Hesperus).

Upon completion of the surveys, an 'interpretive guide to bats' will be produced for state park visitors, and educational programs using Talking Talons' own non-releasable bats, will be conducted at the participating parks. Relates Abrams, "There are 45 species of bats in the United States, and New Mexico is blessed with 27 of those, making it an important venue for bat advocacy."

Submitted by Daniel Abram, Executive Director of New Mexico's Talking Talons Youth Leadership.

ANNOUNCEMENTS

MAPPING GLOBAL BAT BIODIVERSITY

Biodiversity loss is one of the world's most pressing crises. Over half of the nearly thousand species of bats on our planet are classified as threatened or near threatened with extinction. How can we use science to direct our global conservation strategies? Given the reality of limited resources, establishing priority sites and taxa is critical to guide conservation decisions effectively on a global scale, and to link priorities for bats to wider global conservation planning initiatives. To meet this challenge, we need a digital database of all bat geographic ranges around the globe, which allows the implementation of methodologies for large-scale conservation, such as mapping priority areas that contain hotspots for species richness, phylogenetic diversity, complementarity, and species endemism.

In an international collaborative project, researchers from the University of Virginia USA, Bat Conservation International and Conservation International are assembling the geographic range maps of all bats into a Geographic Information System (GIS). Once complete, the database will be publicly available on the web and efforts will be made for continual updating and maintenance. We see this project as crucial for developing science-based global, regional and local conservation strategies and tactics that can be monitored and refined in response to change over time. We also see the GIS database as providing improved centralized access to the latest distributional information, such as survey, museum and population records.

Ultimately, the value of such a database depends on the quality of the data going into it, and this is where we need your help. Already an extensive search of literature for bat geospatial data has collected 3212 published extent of occurrence maps representing part or all of the range of 864 species (from taxonomic accounts, regional atlas projects, Mammalian Species accounts, museum records, IUCN records). We need to complete the collection of range data by facilitating the accessibility of currently non-public datasets and datasets we may have missed. We are asking experts all over the world to send us information on any recently compiled - possibly previously unpublished - sources of range data and most importantly to check the accuracy of the species maps we have produced for different countries/regions. The IUCN/SSC Chiroptera Specialist Group is fully endorsing the GIS project, and we are working with organizations such as Fauna and Flora International, on specific difficult geographic areas and to ensure information collection is not duplicated. Your help is crucial to produce a database that all conservationists and researchers can reliably use to pinpoint global conservation priorities and to use in research examining global patterns in bat ecology.

If you can help the project in any way or want more detailed information please contact Dr. Kate Jones, University of Virginia (kate.jones@virginia.edu) or Dr. Allyson Walsh, Bat Conservation International (awalsh@batcon.org).

FOR SALE

Ultrasonic Detection Equipment

Willing to sell slightly used (one field season) Anabat* bat detecting equipment in good condition. We also will sell 9 laptop computers that can be used directly with the Anabat equipment for remote recording in the field. A complete list of equipment and asking prices follow:

10 Anabat II bat detectors @ $200 each (original price = $385)

10 Anabat II delay switches @ $175 each (original price = $332)

9 Anabat ZCA Interface Modules @ $175 each (original price = $335) 9 Compaq Elite4 refurbished laptops (486 / 16MB MEM / 510MB HD) @ $125 each (original price = $190)

A manual, guide, and replaceable transducer (total value = $119) will be included free of charge with the first four sales. For more information, or if you are interested in purchasing any, or all, of this equipment, please contact:

Tim Preuss, Department of Forestry and Natural Resources
Purdue University, West Lafayette, IN 47907-1159
Tel. 765-496-3032 e-mail: tspreuss@fnr.purdue.edu

SCHOLARSHIPS , GRANTS, EDUCATIONAL OPPORTUNITIES

James Cook University, Townsville, Queensland, Australia

Greetings all. We are pleased to be able to offer an opportunity for a suitable enthusiastic student to undertake PhD research into aspects of the population genetics of the spectacled flying fox in wet tropical Queensland. Details of the project can be found at:
http://www.tesag.jcu.edu.au/genetics/sff/
Applicants must be Australian citizens or residents to be eligible for scholarship support.
For further information, contact David Blair at: David.Blair@jcu.edu.au
Dr. Jon Luly, School of Tropical Environment Studies and Geography
James Cook University, Townsville, Queensland. Tel. 07 47814571

University of Louisiana ,Lafayette

Master's degree level: Research Assistantship (Bat ecology): An assistantship for a Master's level student interested in studying the ecology and conservation of forest-dwelling bats is available starting in summer 2002. The stipend will be $10,000 per year and with waiver of tuition and most fees. Please contact Paul Leberg at: leberg@louisiana.edu if interested.

Doctoral Fellowships: The University of Louisiana at Lafayette will have available University Fellowships and Louisiana Board of Regents Doctoral Fellowships to doctoral students for studies in evolution, conservation, ecology, and marine biology. Fellowships are funded for three to four years and carry stipends of $12,000- $17,000 per year with waiver of tuition and most fees. University Fellows are assigned limited teaching responsibilities; there is no teaching requirement for Board of Regents fellows. For more information about the graduate program visit:

http://www.louisiana.edu/Departments/BIOL/

or contact Dr. Karl H. Hasenstein, Graduate Coordinator, Department of Biology, University of Louisiana Lafayette, Lafayette, LA, 70504-2451.
e-mail: hasenstein@louisiana.edu
Applicants are strongly encouraged to directly contact prospective advisors. The research interests of individual faculty and adjunct faculty, as well as contact information, can be found at our web site.
Submitted by Paul Leberg, Associate Professor, Department of Biology, P.O. Box 42451, University of Louisiana-Lafayette, Lafayette, Louisiana, USA 70504
e-mail: 116743@louisiana.edu 337-482-6637 337-482-5660 (Fax)

NEW WEBSITES

Flying Foxes

There is a fantastic web-site documenting (with great photographs) the biology and natural history of flying foxes from Bellingen Island in AustraliaThe URL is: http://www.bellingen.com/flyingfoxes

European Bat Regulations

For information about The Eurobats Agreement visit www.eurobats.org where you will find a lot of valuable information. Eurobats Agreement is the most important document for the legislative protection of bats in Europe. Submitted by Milan Regec, Slovakia

"Batdata"

This is a message board intended for posts of, or requests for, scientific data related to bats. Banded bat recoveries are also posted on this line. It is not a "chat" line. Anyone may subscribe, although all messages are checked prior to posting. To subscribe, send a message to: batdata-subscribe@yahoogroups.com. To post a message, send it to: batdata@yahoogroups.com

Future Meetings

March 4 - 6, 2002

The U. S. Fish and Wildlife Service, Bat Conservation International, and the USDI Office of Surface Mines are sponsoring a **Symposium on Cave and Mine Protection Options**, to be held in Austin, Texas on 4-6 March, 2002, with an optional field trip on 7 March. A flyer on the symposium, registration materials, conference agenda, and list of current sponsors is at http://www.mcrcc.osmre.gov/bats. The proceedings from this meeting should provide a definitive "gating manual" for biologists and resource managers. Contact Jim Kennedy at 512-327-9721 or jkennedy@batcon.org

March 7 - 9, 2002

A meeting concerning the **Status of Bats in South Florida**. Jack Stout and Laura Finn will be be co-chairing the FCREPA (Florida Committee on Rare and Endangered Plants and Animals) session at the 2002 Florida Academy of Sciences meeting. The FAS meeting is at Barry University 7-9 March 2002 and the FCREPA session will be held Friday morning. Lets make this year's meeting a good one and let all our colleagues know what we are working on. Please forward this message to anyone you think would be interested, but who may not be aware of the meeting. Registration information and instructions are available at: http://www.FloridaAcademyOfSciences.org or contact Laura S. Finn, Fly By Night, Inc., P O Box 562, FL 32764-0562 407-324-0647 www.flybynightinc or orglaura@flybynightinc.org

April 2 - 5, 2002

The dates for the **Australasian Bat Society Conference** have been set for the week following the Easter weekend - Tuesday 2 April to Friday 5 April 2002 . There will be pre (Sat. 30th / Sun. 31 March) and post (Sat.6 / Sun.7 April) conference workshops. One will be "Megabat" , the other "Microbat" so that conferencees can attend both if desired . The megabat weekend will include a full day carers' workshop . Ideas for the microbat workshop so far include use of Anabat and gating of mines. Please send in your ideas for the workshops . No decision has been made about which weekend is which yet. It may depend on suitable dates for presenters. The dates are school holidays in Queensland. The conference is to be held at the Cairns Colonial Club, a great venue and with an accommodation price that is not excessive. If people are prepared to share then it is very reasonable. A room with 4 people is Aus$135 , or Aus$105 for single/twin share. We are looking for cheaper single accommodation close to the venue but hope as many people as possible can stay onsite. We don't have costings done yet for registration, etc. Jon Luly has agreed to handle the abstracts for the meeting. The abstracts will also be published in the following issue of Bat Research News. All those wishing to present papers. PLEASE send abstracts 300 words or less to Jon. [e-mail]: Jonathan.Luly@jcu.edu.au or by snail mail to: Jon Luly, School of Tropical Environment Studies and Geography, James Cook University, Townsville, Qld 4811 Australia.

April 15 - 17, 2002

A **Bat Echolocation Symposium and Tutorial** will be held at the Hyatt Regency Hotel on Town Lake, Austin,TX. Over 20 leading bat echolocation experts from around the world will be presenting on ultrasound equipment, field techniques, analysis, reporting, and agency perspectives. The symposium focuses on evaluating the capabilities, limitations and appropriate applications of ultrasound equipment. There will be opportunities for participants to receive hands on experience and individual instruction in recording and software use. An optional post-symposium trip to watch the amazing emergence of millions of Mexican free-tailed bats at Bracken Cave will close the fun! We are encouraging attendance from individuals who are actively involved in echolocation monitoring and research with a working knowledge in ultrasound basics. Please visit http://www.batcon.org/home/echosym/index.html to review the agenda topics and for detailed information on registration and accommodations. Registration is **$250.00** >

Space is limited. Posters are welcomed. Although limited equipment will be available, we encourage you to bring your own. Tentative speaker list includes: Ahlen, Barclay, Boye, Brigham, Britzky, Corben, Fenton, Gannon, Griffin, Jones, Krusak, Kunz, Limpens, McCracken, Parsons, Pettersson, Rainey, Siemers, Szewczak, Walsh, Waters

For additional information on the agenda or speakers, please contact: Brian Keeley at bkeeley@batcon.org or (512) 327-9721. For registration information or questions, please contact: Janet Tyburec at jtyburec@batcon.org or (520) 743-0265.

May 15 - 19, 2002

The Lubee Foundation, Inc., the American Zoo and Aquarium Association Bat Taxon Advisory Group and the University of Florida Veterinary Medical Teaching Hospital will host a symposium on the **Medical Management and Captive Care of Chiroptera.** The venue will be the Holiday Inn, 1250 W. University Ave., Gainesville, Florida 32601 Program includes presentations on medical management, emerging diseases, field programs, conservation, education and captive husbandry and management of Chiroptera. The program will include sessions on Zoo Education, Emerging Diseases, and Ecology and Captive Management. Sessions, workshops, and the banquet dinner will be at the Holiday Inn. On Sunday evening(May 19) A special program "Rodrigues Fruit Bat Family Extravaganza" will be held at the Lubee Foundation, Inc., 1309 NW 192nd Avenue, Gainesville, FL 32609. For further information on this conference or the workshops, please contact one of the following: John Seyjagat, Lubee Foundation at 352 485-1250 or LUBEEBAT@aol.com, Peter Riger, Nashville Zoo at 615-746-2526 or priger@email.msn.com, or Denise Tomlinson, OBC Florida Bat Center at 941 637-6990 or: DRTomlinsn@aol.com

August, 26 - 30, 2002

The IXth European Bat Research Symposium will convene 26 - 30 August in Le Havre, France. The Organizing Committee will be chaired by Stephane Aulagnier, I.R.G.M., C.R.A. Toulouse, B.P. 27, 31326, Castenet-Tolosan Cedex ,France. Pre-registration deadline is November 1, 2001. Please see the website for additional information. The website is: http://www.univ-lehavre.fr/actu/9ERBS Aulagnier's e-mail is: aulagnie@teleirgm.toulouse.inra.fr

November 6 - 9, 2002

The 32nd Annual North American Symposium on Bat Research will convene in Burlington, Vermont hosted by William Kilpatrick and Roy Horst. Arrangements have been made for participants in the symposium to stay at the Radisson Hotel at very reasonable rates. All symposium sessions, displays, etc., will be in the Radisson which overlooks Lake Champlain only a 5 minute walk away. Just a few minutes away are historic St. Paul Street and Church Street, both famous for the great number of fine restaurants, and the Burlington Brewpub. Unfortunately the spectacular fall foliage season will be past (which incidentally is why we can get such reasonable room rates). For details see our website at: www.nasbr.com

If you know of other meetings, anywhere, large or small, send us the details for inclusion in the next issue. Thank you. G. Roy Horst E -mail: horstgr@potsdam.edu

Financial Report for the North American Society for Bat Research

Margaret A. Griffiths, Associate Program Director

Financial information for the North American Symposium on Bat Research from 1996 through the end of 2000 is given in the following tables. In 1996, Tom Griffiths became the Program Director for the NASBR, and the financial report begins at that time. In 1999, the NASBR membership voted to become an organized, formal scientific society, adopted a constitution, and officially developed and voted in a Board of Directors. As Program Director, Tom presented the financial report of the society to the Board of Directors at their meeting at the 30th NASBR (2000, Miami) and the 31st NASBR (2001, Victoria); the Chair and Secretary-Treasurer of the Board then reported to the membership at the annual business meeting.

All members of the NASBR Board of Directors have received detailed financial statements regarding the society. Please direct any questions regarding the finances of the society, or the society itself, to a member of the Board. The final financial report for fiscal year 2001 will not be available until after May 2002, and will be presented at the 32nd NASBR in Burlington, VT (Nov. 6-9, 2002).

Reports of the financial status of the NASBR and the Karl F. Koopman Student Fund follow. Table 1 gives a summary of income, expenses, and net income of the society for fiscal years 1996 through 2000. Table 2 and 3 give detailed breakdowns of income and expenses for 1999 and 2000, respectively. Table 4 shows the financial breakdown for the Koopman fund.

TABLE 1
Financial Summary of Income and Expenses for the North American Symposium on Bat Research, 1996-2000

TOTAL INCOME	(EXPENSES) (Meeting)	(EXPENSES) (Miscellaneous)*	NET INCOME
26th NASBR, 1996 (Bloomington, IL)			
$19,925.00	$(14,543.59)		$5,381.41
27th NASBR, 1997 (Tucson, AZ)			
$27,904.99	$(29,518.01)		$(1,613.02)
28th NASBR, 1998 (Hot Springs, AR)			
$19,706.00	$(15,626.20)		$4,079.80
29th NASBR, 1999 (Madison, WI)			
$38,475.50	$(34,573.10)	(743.00)	$3,159.40
30th NASBR, 2000 (Miami, FL)			
$37,988.80	$(34,732.67)	(2,840.70)	$415.43
TOTAL NET INCOME for NASBR (as of 12/31/00)			**$11,423.02**

Note: *Miscellaneous expenses are costs other than those associated with the annual meeting but are incurred during that fiscal year; for example, deposits for facility rental in future years. Meeting expenses are the costs of running the annual scientific meeting, which include, but are not limited to: facility rental, break items, A/V equipment rental, symposium program and abstract book, photocopies, postage, credit card website maintenance, bank fees for checking account and for Skipjack (electronic registration), telephone and fax costs, etc.

TABLE 2
Breakdown of Total Expenses for the 29th NASBR (1999 - Madison, WI)
NOTE: All amounts listed are in U. S. Dollars

SOURCE	INCOME	ITEM	(EXPENSES)
Registration Fees [Includes Registration and Banquet Fees and Tee Shirt payments]	34,200.50	Conference Administration Fees [Professional conference managers were hired at UW for this meeting]	(6,475.00)
		Refunds	(755.00)
		Catering	(4,958.50)
		Abstract Book	(3,551.63)
		A/V Equipment Rental	(1,943.13)
		Website Costs	(1,590.90)
		Brochure - Call for Papers	(904.91)
Teacher's Workshop	775.00	Teacher's Workshop	(886.72)
		Credit Card Fees	(714.28)
		Computer Memory	(540.54)
		Parking Fees	(493.50)
		Shuttle	(468.00)
		Postage	(379.50)
		Phone/FAX/Photocopying	(100.51)
		Bank Checking Account Fees	(24.00)
Income from Meeting	$ 34,975.50	Costs for Meeting	$ (23,786.12)
		Tee Shirts 10/30/99	(1,860.00)
Donation [for costs of souvenirs and band]	2,500.00	Mouse Pads 9/21/99	(1,313.48)
		Band for Banquet	(1,100.00)
		Banquet 10/29	(6,013.50)
Donation [St. Awards & Meeting Support]	1,000.00	Student Awards (BCI, Lubee)	(500.00)
TOTALS	$ 38,475.50		$ (34,573.10)
Miscellaneous Expenses in Fiscal Year 1999			
		Victoria Conference Deposit #1	$ (473.00)
		Crystal Garden Deposit	$ (270.00)
GRAND TOTALS	**$ 38,475.50**		**$ (35,316.10)**

TABLE 3
Breakdown of Total Expenses for the 30th NASBR (2000 - Miami, FL)
NOTE: All amounts listed are in U. S. Dollars

SOURCE	INCOME	ITEM	(EXPENSES)
		Coffee Break Items	(13,557.09)
		A/V Equipment Rental	(2,140.00)
		Poster Board Rental	(1,960.00)
		Program printing/shipping	(1,400.78)
		Credit Card Processing Fees	(1,265.08)
		Band for Banquet	(1,000.00)
		Souvenirs [water bottles/posted notes]	(926.59)
		Expenses - M. Griffiths [travel/meals]	(765.04)
		Payment to student workers	(669.47)
		Rooms [Fleming, Morton]	(635.65)
		Board of Directors meeting [Room/Dinner]	(311.75)
		Initial cost Website domain	(159.95)
		Namebadges	(133.11)
		Phone/FAX	(119.50)
		Gift for Greeter	(28.00)
		Photocopying	(27.77)
		Fees for Checking Account	(24.00)
Registration + Banquet	35,142.80	Refunds	(2,147.00)
		Tickets (for banquet entrees)	(8.24)
Donations for Teacher's Workshop	400.00	Breaks Teacher's Workshop	(294.38)
Teachers Registration fee	350.00	Organization for Bat Conservation Videos for Workshop	(129.90)
Income from Meeting	$ 35,892.80	Costs for Meeting	$ (27,703.30)
Program Resales	70.00	Banquet 9/29	(5,834.77)
T-shirt sales	776.00	Island Brew Promotions [T-shirts]	(694.60)
Donations [Student Awards and Meeting Support]	1,250.00	Student awards	(500.00)
TOTALS	$ 37,988.80		$(34,732.67)
Miscellaneous expenses in Fiscal Year 2000			
		Site trips to Burlington, VT (x2) for 2002 NASBR	$ (1,425.70)
		Deposit - Radisson Hotel Burlington VT, 2002 NASBR	$ (500.00)
		Deposit 2, VCC, 2001 NASBR	(915.00)
GRAND TOTALS	**$ 37,988.80**		**$(37,573.37)**

TABLE 4
Financial Summary Karl F. Koopman Student Fund, 1996-2000

TOTAL INCOME	(EXPENSES) KFK Award	(EXPENSES) Student Rebates	NET INCOME
Student Fund, 1996* $1,735.00	$(0.00)		$1,735.00
Koopman Fund, 1997 $3,125.00	$(0.00)		$3,125.00
Koopman Fund, 1998 $3,627.00	$(250.00)	$(1,905.00)**	$1,472.00
Koopman Fund, 1999 $3,866.40	$(250.00)		$3,616.40
Koopman Fund, 2000 $94.00	$(250.00)		$(156.00)

Koopman Net Income (as of 12/31/00) $9,792.40

*In 1996 a student fund was established by G. Roy Horst and Tom Griffiths to help defray some of the costs for students who presented papers at the annual NASBR. After the death of Karl Koopman in 1997, the student fund was named the Karl F. Koopman Student Fund in his honor. In 1998, the Karl F. Koopman Award was established for presentation to a student for an outstanding platform paper at each annual meeting. The Koopman Award was presented for the first time at the 28th NASBR, and has been presented each year since then. The cash prize for this annual award is provided by the Koopman Fund.

**In fiscal year 1998, rebate checks for registration fees were sent to students who had presented papers in the Student Competition at the 1997 (Tucson) and 1998 (Hot Springs) NASBR meetings, totaling $(1,050.00) and $(855.00), respectively. This money came from the Koopman Student Award Fund. Because checks were not issued for the 1997 meeting until after the start of the 1998 fiscal year, the total of the two rebates is reported here.

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Front Cover

The front cover illustration of *Rhinolophus ferrumquinum* is the work of Philippe Penicard. Mr. Penicard is the creator of an excellent series of illustrations of the bats of France. He is an artist who specializes in illustrations of animals for educational purposes. He is active in bat protection and conservation activities in Brittany. His address is 16 bis, route du Port, F-29252, Plouezoch, France. We reproduce his handsome art with his kind and generous permission.