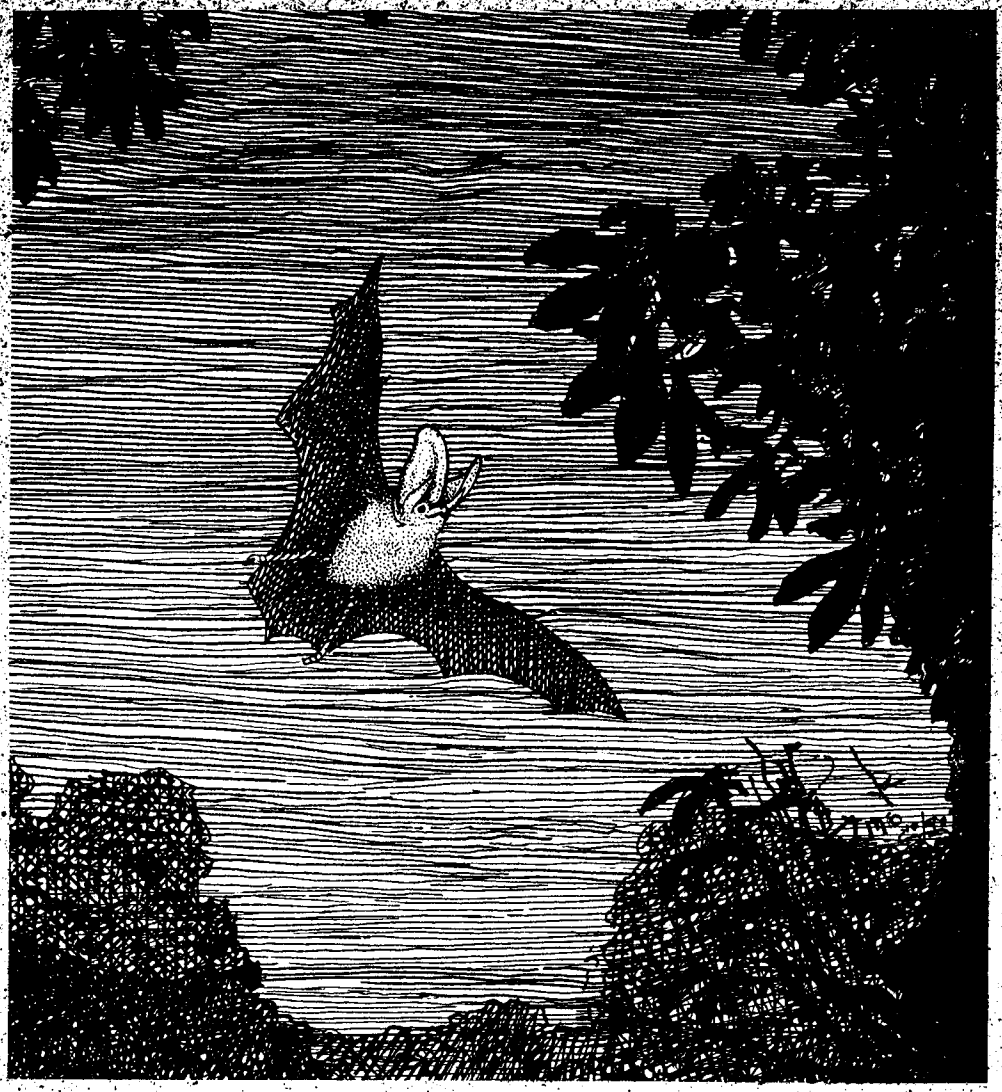
BAT RESEARCH NEWS



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BAT RESEARCH NEWS

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BAT RESEARCH NEWS

Volume 32 Spring 1991 Number 1

A New Adhesive for Use on Sticky Traps

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Bat biologists are often interested in comparing the diet of particular individuals or species with the available flying insect prey in order to assess whether bats (1) actively select prey to maximize net energy gain (Jones, 1990; Aldridge and Brigham, 1991); (2) capture prey opportunistically (Fenton and Morris, 1976); or (3) "appear" to select prey due to detection constraints imposed by echolocation (Barclay, 1985). An accurate assessment of the food available is crucial to evaluating potential prey selection by bats. As a result, researchers have used a large number of different devices to try to adequately sample the insects potentially available as prey to bats (Kunz, 1988).

Sticky traps, one of the more popular devices, work on the principle that airborne insects adhere to sticky substances upon contact (Southwood, 1978; Kunz, 1988). The advantages of this method of insect sampling are that these traps are very simple in design (e.g., PVC tubing) making them economical to construct, easy to operate, and very portable. Using sticky traps, it is possible to simultaneously sample insect abundance in similar or different habitats and at different heights within habitats. One disadvantage to using this type of trap is the difficulty of handling the non-setting adhesive and removing insects intact from the sticky surface (Ryan and Molyneux, 1981). Two commercially available adhesives, Tangletrap and Oecotak both suffer from this problem (Ryan and Molyneux, 1981).

During the past 3 years, the Department of Pest Management in Regina, Saskatchewan has undertaken an extensive insect sampling program using sticky traps to monitor the occurrence, abundance and potential spread of pest insect species, mostly lepidopterans. After initial sampling using Tangletrap, it was found that Shell Darina Grease AX (Shell Canada, Limited, Toronto, Ontario M5W 1E1) was a suitable alternative. Sticky traps coated in the grease captured, among other insects, large (>20 mm) geometrid, notodontid and noctuid moths and large scarab beetles.

Darina AX is advertised as a water resistant, multipurpose grease, with no melting point. It is specifically designed to lubricate automotive wheel bearings. The grease is thickened with "Microgel," the content of which Shell Canada is reluctant to divulge. The product is available at well equipped Shell service stations and from wholesale bulk distributors. The grease comes in 400 g tubes costing $1.25 (Can.) wholesale and 17 kg pails ($42.00 Can.). For those researchers intending to do a lot of sampling, Darina AX also comes in 55 kg kegs and 180 kg drums. Relative to Tangletrap, the advantages of using Darina AX as an adhesive on sticky traps include: the lower cost; the retention of adhesive

properties for periods of several months, even during the winter when temperatures in Regina are up to 40° C below zero; and the high degree of solubility in ethanol which makes the removal of intact specimens for identification and measurement much easier. To our knowledge, this compound was not included in Ryan and Molyneux's (1981) assessment of sticky trap adhesives, although we are not certain of this because the chemical components of the grease are unknown. We are presently undertaking an experimental study to determine if the efficiency of sticky traps coated with the grease is equivalent to traps coated with Tangletrap. In the meantime, it is our opinion that this product represents a superior alternative to commercially available adhesives and is worth trying.

We thank G. Gauthier of Shell Canada for supplying technical information and prices.

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Evidence for Mosquito Consumption in *M. lucifigus*

Nina Fascione, Teresa Marceron, and M. Brock Fenton

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Insectivorous bats are often identified as beneficial because of the quantities of insects they consume (Tuttle, 1988). Demonstrating that ubiquitous species frequently eat mosquitoes (Culicidae) could significantly affect public attitudes towards bats and thus promote their conservation. However, there are few quantitative data to support this contention. The purpose of this study was to assess the incidence of mosquitoes in the diet of *Myotis lucifugus* during August 1989 at two swarming sites (Fenton, 1969) in southeastern Ontario, Canada.

We sampled swarming bats with a Tuttle trap (Tuttle, 1974) set in the entrance to two hibernacula on four nights: 11 and 15 August at the Renfrew Mine and 13 and 16 August at Tyendinaga Cave. The two sites are approximately 120 km apart. Forty *M. lucifugus* (5 males and 5 females from each site on each night) were captured between 2200 h and 2400 h after the first foraging period (Anthony and Kunz, 1977). Subjects were removed from the trap and identified by species and sex. Each bat was confined in a styrofoam cup for at least five hours, and

fecal samples were collected from the cups, individually packaged, and labelled for later analysis. Feces were placed in petri dishes, mixed with water and teased apart with forceps. The fecal samples were searched for mosquito remains either under 45x magnification with a binocular dissecting microscope, or under 430x magnification. Since digested mosquito parts are sometimes difficult to distinguish from the remains of other insects, we took two bats that had fasted for approximately 24 hours and fed them five mosquitoes each. We then collected feces and compared them to undigested parts for reference.

Our results demonstrate that in southeastern Ontario little brown bats eat mosquitoes. Fecal samples were obtained from 39 of 40 bats, and 33 contained mosquito remains (84.6%). The presence of mosquitoes in the feces did not differ by gender ($\underline{X}^2 = 0.33$, d.f. = 1, $\underline{P} = 0.1$), location ($\underline{X}^2 = 3.33$, d.f. = 1, $\underline{P} = 0.1$), or sampling date ($\underline{X}^2 = 3.22$, d.f. = 3, $\underline{P} > 0.05$).

These data support other studies indicating that *M. lucifugus* eat mosquitoes (Coutts et al., 1973; Anthony and Kunz, 1977) and they are particularly striking given that this species may consume more than its body mass in insects each night (Kurta et al., 1989). Our data therefore suggest that little brown bats can play an important role in the biological control of insect pests.

This research was conducted during the first Bat Conservation International Bat Study Workshop. We thank the other participants in the workshop for their assistance and M. Hutchins for advice about statistics. The U.S. Forest Service and P. McNesby provided funding which enabled N. Fascione and T. Marceron to attend the workshop.

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Winter Roosting of the Red Bat, *Lasiurus borealis*

Terri Koontz and Wayne H. Davis

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On December 22, 1990, at noon, Koontz found two red bats, *Lasiurus borealis*, hanging from a branch of an American beech, *Fagus grandifolia*, at National Bridge State Park, Powell County, Kentucky. The site was a ridge top (e. 380 m) on trail number 5 at the park boundary marker. The branch and bats were at eye level (1.5 m) out over the trail. The bats were about 50 cm apart.

Young beeches were the only deciduous trees that had leaves. Their russet color was remarkably similar to that of the bats. Each bat clung to a leaf with its belly to the underside of the leaf in such a way that the leaf provided some protection from rains of that morning. The fur of the bats was damp. The day was warm, shirtsleeve weather, surely in the range in which red bats would

be expected to fly on a winter afternoon (Barbour and Davis, 1969). When we revisited the site December 24 following a low temperature of -12°C the bats were gone. We inspected 17 other young beech trees and found no bats. Koontz returned on a warm day December 29 and found no bats.

Red bats are common winter residents in the Ohio River Valley (Barbour and Davis, 1969), a region where temperatures sometimes range below freezing for weeks at a time and sub-zero readings on the Fahrenheit scale sometimes occur. Although they occasionally enter caves and perish there (Myer, 1960), red bats do not hibernate underground. Circumstantial evidence (Davis and Lidicker, 1956) suggests they are tree bats in winter as well as summer. Their hibernation sites remain a mystery. Apparently the only two reports of winter roosting in the Ohio River Valley are of one found on a fence post in West Virginia in February (Davis and Lidicker, 1956) and one apparently hibernating in a woodpecker hole in Kentucky in March (Fassler, 1975).

Unfortunately, this new record does not tell us where red bats spend the coldest days; the beech leaves may have provided a temporary warm weather roost. The previous week had been warm with the high temperature the day before the discovery being reported as 18° C, warm enough that red bats would arouse and feed. After really cold weather arrived the bats were gone.

The sites where the bats were found fits in part the characteristics listed by Constantine (1966) as necessary for day roosts of red bats. There was no obstruction beneath the bats, allowing a downward drop to begin flight. Branches of the small beech (5 m tall) that were not over the trail would have been unsuitable; ground cover included greenbrier (*Smilax*) and mountain laurel (*Kalmia latifolia*).

The bats were not protected from view by a leaf canopy as Constantine (1966) described; they were clearly visible. However, leaf canopies were restricted. The evergreen *Rhododendron maximum* provided dense canopies, as did occasional oaks (*Quercus*) which had broken off and lodged in other trees, retaining their brown leaves. No other dense canopies were available, and only young beech trees provided leaves with color to match the bats.

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REQUEST

Please send us a few lines of "news" about what you are doing these days in "the bat business". The readers of ***Bat Research News*** are very interested in such things as field trips, research projects, small or limited observations that you may think aren"t worth an article but would be good to share, grants, graduate programs, recent publications, questions about equipment, ideas about projest design, things that you would like to see done, but don't have time to do, letters to the editors, etc. Send them to either of us, our addresses are inside the front cover. We are grateful.

Tom Griffiths and Roy Horst

BOOK REVIEW

Schober, Wilfried, and Eckard Grimmberger. 1989. ***A Guide to Bats of Britain and Europe.*** Hamlyn Publishing Group, Ltd, London, England, 224 pp. (ISBN: 0 600 5642 4X - UK Price £10.95) [Originally published in 1987 in Germany as *Die Fledermäuse Europas* - translated by Iain and Ingrid MacMillan of the Worcestershire Bat Group, edited by Robert E. Stebbings]

Reveiwed by Thomas A. Griffiths, Department of Biology, Illinois Wesleyan University, Bloomington, IL 61702

Sometimes things turn up in the oddest places. I had been wanting a copy of this book since I first heard of its publication in English in 1989. I had been unsuccessful in obtaining a copy up to the time when, in May of 1990, I left for a month of travel in the People's Republic of China to do research on China's bats. As I was coming out of the PRC, I stopped in Hong Kong for three days and spent some time exploring this fascinating city. On my last day there, a sudden torrential downpour forced me into a Kowloon bookseller's shop where I found this book. Although in the past I have gone to great trouble and expense to acquire the books I need, it is undoubtedly some sort of personal record that I, an American bat biologist, would need travel to an East Asian bookstore to purchase a book on European bats.

The body of this book is in four main sections entitled "The Life of Bats," "Protect Our Bats," "Which Bat Is It?," and "Identification Key to European Bats." There is also a short Preface, a Bibliography, and a well-done Index. Though the primary purpose of the book is to serve as a key and field guide to the bats of Europe and Britain, the authors wisely decided to include a "Life of Bats" section on the natural history and ecology, folklore and mythology, and methods of studying bats. The section opens with a brief piece in which the mythology, superstitions, and folklore about bats are discussed. Though lack of space prevents an exhaustive treatment of these topics, the authors hit the high points, including the mostly negative European historic view of bats, and the rather more positive Mayan and Oriental historic views of bats. The "Life of Bats" then continues with a segment on evolution of the group (written for the lay person) entitled "50 million years on earth," and a segment on the more interesting aspects of bat anatomy entitled "They fly with their hands." Both segments are very well crafted, and include lots of tidbits that the non-specialist and specialist alike will find useful and interesting. For example, I recently was called upon to explain the mechanism in a bat's toe that allows the weight of the bat to passively flex the toe while hanging. I remembered the excellent illustration on p. 18 of this book and found that it made my explanation much easier. Potential roosting sites are exhaustively discussed in "Where do bats live?," and the important aspects of echolocation are presented in "Hunting prey by echolocation" and "Echolocation - the sixth sense of bats." "Harems and nurseries" recounts the mating behavior, reproductive cycle, and developmental biology as it is known for European bats. This is followed by "The social behaviour of bats" which purportedly should be an account of some of the fascinating behavior observed among adult bats, but is mostly about grooming. This is perhaps the one segment in "The Life of Bats" that falls short of my expectations. "Hibernation - life in suspended animation" is, by contrast, outstanding. It contains everything an amateur naturalist could wish to know about hibernation ecology and physiology. "Migration to frost-free winter roosts" is a short, concise segment that contrasts the flights of European long-distance migratory species with short-distance migrators. The final segment, called "Ringing," is all about the practices and purposes of bat banding, with a few comments on mist-netting, harp trapping, and handling ringed bats.

The second quarter of the book - "Protect Our Bats!" - is about the threats to bats from humans, and ways to protect bats and encourage them to roost nearby. Comments about gating of winter roosts, construction of bat boxes, and feeding of injured bats offer nothing new to the naturalist who is already involved in bat conservation and preservation. But this section is well written and illustrated, and

should prove to be of great interest to the neophyte bat biologist. If nothing else, it should help raise public consciousness about the threats to bats.

The last two quarters of the book, entitled "Which bat is it?" and "Identification key to European bats," form the heart of the volume. Beginning on p. 86 and running nearly 100 pages is a well-illustrated, superbly written, species-by-species account of the five rhinolophid bat species, 24 vespertilionid bat species, and one molossid bat species commonly found in Europe. Each species account contains the common names of the bat in English, French, and German; information necessary for identification of the species (very complete!); similar species; distribution in Europe; status; habitats; migrations; reproduction; maximum known age; data on hunting and feeding; echolocation; and social calls. There is at least one superb photograph of each species in each account, and often several. Excellent line drawings of teeth, wing shape, etc. aid the reader in visualizing and identifying the species. I can find only one trivial omission: the accounts would benefit from the insertion of a species range map for each. The key to European bats seems straightforward and easy to use. Following the key is an illustration of important body measurements and (once again) superb photographs of nose leaves, ear shapes, tail membranes, and reproductive organs of European bats. The final section concludes with sonagrams - a useful addition in these days of increasing use of bat detectors - and tables summarizing knowledge of European species and bats of the world.

One of the great strengths of this book is its illustrations. There are 97 color photographs, 73 black and white photographs, and 29 line drawings. All except 23 of the color and 6 of the black and white photographs are by Grimmberger. They are, without exception, exquisitely done, as are the line drawings by Mrs. T. Schneehagen of Leipzig. The illustrations add enormously to the value of the book, making it easier for the non-specialist to identify the bat he or she is examining and giving the non-European specialist one of the most useful guides available for European Chiroptera. The book is sturdily sewn and bound, and it is a convenient size to take into the field. The faults with the book are few and trivial. I note that the authors still consider noctilionid fishing bats as being in the superfamily Emballonuroidea (p. 216) despite an increasing tendency to classify them as phyllostomoids. The social behavior section could be expanded considerably and I wish there were range maps included in the species accounts.

All told, the book is well worth its price. It is probably easily available to anyone who does not have to deal with the parochial booksellers of the American Midwest. And for those of us who do, there's always Hong Kong...

NEWS

AUSTRALIA

Grant Baverstock and Lawrie Conole send us the following interesting account of their activities.

We have been surveying bat distribution and studying aspects of the ecology of microbats and to lesser extent, megabats in southeastern Australia since 1981. Functioning as amateurs with a professional attitude, our work began with two home-made harp traps in early 1982. When we commenced our survey of the Geelong-Otway area in the state of Victoria, an area of approximately 1,000 square kilometers, very little was known of the structure, composition and ecology of tree -hole dwelling bat communities in the state. The advent of the portable collapsible trap known as a harp trap, in the late 1970's, saw a burgeoning of field work in Australia on forest bats - with about 50 years of knowledge to make up on cave bat studies. Working first on large forest and woodland blocks such as the Otway Ranges(ca. 400,000 hectares) and medium sized woodland remnants such as the Inverleigh Common Flora Reserve(ca. 400 hectares), we slowly established trends in distribution and habitat usage for two megabat species and 14 microbat species. Typically, large forest and woodland blocks have a standard fauna of about 10 microbats(the two megabat species are vagrants so far south) with

variation of one or two more species where caves or mines are available in suitable habitat. One habitat in particular, riparian and paludal woodland of river red gum *Eucalyptus cameldulensis,* has two extra species which are confined to that vegetation type, the little mastiff bat *Mormopterus planiceps,* and the western broad-nosed bat *Scotorepens balstoni.* The large-footed Myotis, *Myotis adversus,* is a specialist aquatic forager(insectivore-piscivore), and only occurs on suitable permanent watercourses. The common bent-wing bat, *Miniopterus schreibersi,* occurs in lava caves on the largely pastoral basalt plains, in limestone and sandstone sea caves on the ocean coast of the Otway Ranges, and in some old gold and antimony mines. Little is known of the ecology of the rarely encountered yellow bellied sheath-tail bat, *Taphozous flaviventris*, a largely tropical species of marginal occurrence in this cool temperate region. Recently we have been concentrating our field work in degraded ecosystems, in particular largely cleared farmland. Surprisingly, microbat species diversity and overall numbers are very high in remnant river red gum open woodland west of Geelong. There are ten microbat species in this habitat near Inverleigh, compared with seemingly less degraded forest and woodland blocks in the area with 7 to 9 species. In severely degraded ecosystems and urban areas, the microbat fauna is often restricted to the ubiquitous "gang of four" (term coined by Cam Beardsell): the white striped mastiff bat *Nyctinomus australis,* Gould's wattled bat *Chalinolobus gouldii*, the lesser long-eared bat *Nyctophilus geoffroyi*, and the little forest Eptesicus *Eptesicus vulturnus.* The core species for a typical "intact" community include the "gang of four" plus: the great pipistrelle *Falsistrellus tasmaniensis*, the large chocolate wattled bat *Chalinolobus morio*, and Gould's long-eared bat *Nyctophilus gouldii.*

Our ongoing projects are:

1) continuing the survey of bat distribution and community composition in the Geelong- Otway area.

2) fine resolution mapping of the rare/restricted species *Taphozous flaviventris, Myotis adversus, Miniopterus schreibersi, Mormopterus planiceps, and Scotorepens balstoni.*

3) resolution of the supposed movements of the putative migrants *Taphozous flaviventris* and *Falsistrellus tasmaniensis.*

4) establishing patterns of movement into this area by the nomadic megabat species little red flying fox *Pteropus scapulatus* and the grey-headed flying fox *P. poliocephalus.*

5)data collection for the eco -morphological studies on Victorian microbats.

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Laurie Conole, 165 Separation Street, Northcote, 3070 Victoria, Australia. telephone 03-4814926(home) and 03-6699842(work); and Grant Baverstock, 1350 Noyes Road, Lethbridge, 3332 Victoria, Australia. telephone 052-817256.

At York University in Toronto

Lalita Acharya has finished her Master's degree about what the information feeding buzzes and following silent intervals reveal. She is presently doing her first season of field work for her doctoral dissertation on the graduated response of moths to approaching bats(*Lasiurus borealis and L. cinereus*) in Pinery Provincial Park, Ontario. Doris Audet is spending her summer in Germany in southern Bavaria. She is comparing *Myotis myotis* roosting in two sites which differ in several parameters such as temperature, colony size, etc., with a variety of methods including radio tracking and using the doubly labeled water technique. Joe Cebek is comparing the genetic structure of *Eptesicus fuscus* in several colonies in Canada and the USA. He is examining correlations between genetic relatedness and echolocation call differences, and is planning on completing his dissertation this year. Brian Hickey is finishing counting the enormous numbers of insects he has captured, and is completeing his dissertation on energetics , foraging time etc., in *Lasiurus cinereus.* Leesa Fawcett is investigating the attitudes of children of different ages towards different animals such as bats, rabbits, and snakes, before and after exposure to the animal under consideration. Cathy Merriam is

spending her first season in Costa Rica comparing sensory modalities for prey detection in several species of bats. Daphne Syme is examining the community structure of Myotis lucifugus in Chautauqua, NY. This is in part, a continuation of the work that Alison Nielson did for her Master's thesis. Dorothy Dunning is a visitor in the lab for one year doing field work with *Eptesicus fuscus*. She is attempting to add yet another chapter in the "click story" on this species. Lella Dal Farro is exposing moths to artificial bat calls and examining their responses. She is also working in Pinery Provincial Park. Two new students, Jennifer Long and David Pearl are joining the lab this summer. Martin Obrist is continuing his study on the hunting behaviour of *Lasiurus borealis* and recently visited Jeff Wenstrup's lab in Ohio. Martin is returning home to Switzerland in July, to continue working on bats and "look for a job". There is no news about any of Professor Fenton's activities, but with a crew this size, and so many projects to oversee (and fund), his charitable work on blindness prevention, and being Grand Poohbah of the Department to boot, he probably is gainfully occupied.

The Editors are grateful to Martin Obrist for providing most of the above information.

LETTER TO THE EDITOR

We have received the following very interesting letter from Lois Sakolsky, one of our readers. While it is not either a research paper or a note, it certainly is interesting and will be very helpful to both "professionals" and "amatuers" who are raising bats in captivity. The editors encourage more such contributions, afterall that is what ***Bat Research News*** is all about...

...Bats, being intelligent and clean, require very little special care when kept in laboratory conditions. They often however, following all the rules and regulations of animal care, must be turned over to students or technicians who have no experience with bats and their offspring. It is to this group that this article is directed. This information was gathered in caring for 7 big brown, pipistrelles and Keen's bats. It is certainly meant only as a starting point for animal care people.

After two months of using eight different sized containers, ranging from the standard rat lab cage size through intermediate sizes of 0.5 to 1m, I found the best home was the biggest--this may differ according to your lab space. My bats are now being maintained in a "cave" 3m x 1m x 3m which has been sealed using molding around the edges, and all openings being reinforced with weather stripping; the type that is used for garage doors is widest and best. Rather than separating animals which live in groups, I found them to respond well simply banned and living together. I did keep my pregnant females separate with other non-pregnant females during the time they had young. The walls of the cave are lined with bath towels for landing ease. The young cling to it easily. While foam or Styrofoam works well, the towels can be easily washed once a month for a clean smell. In some areas I overlap the towels and the bats can most often be found in the folds of these overlaps. Each day I wash the floor with a natural sponge using mild soap; the natural sponge picks up the feces quickly and the soap is gentle in a closed environment. After cleaning, the best deodorizer is a container of alfalfa hay, although coffee, and cedar blocks work well. A 40-watt bulb lights the cave and does not seem to bother the bats as they often perch within sight of it. The floor of the "cave" has a shallow water container which is changed and cleaned daily.

For exercise each evening and morning I give them 30 minutes of free flight in a room 10m x 4m. They are hand fed on a target to which I trained them quickly by first training them to a whistle for food and then whistling near the perch until they go to it whenever they are out of their cave. Any whistle is fine--dog whistle, bells, or your own efforts if you tend to lose things and are afraid of misplacing the whistle. Twice in the last 3 years I have had a bat loose and each time they returned to the target in the evening. It seems to be a good idea to train them to a target in any area where they work. Their diet consists of mealworms, crickets, and all the beetles I can catch. For safety, I do not feed from the same captured insects more than 2 meals in a row, due to sprays and

pesticides. Once or twice a week I sprinkle the mealworms with a dust from a multivitamin and mineral tablet. As to the quantity of food: I weigh the bats once a week and keep their weight a gram or two above the normal weight as given by the experts. When they put on a gram or two I ease off the number of worms or purchase smaller worms if I'm training them, and need to reward them often. A hemostat is the best feeding instrument but I also teach them to eat from a large aquarium with worms on the floor. This is practical when no one is available to feed during a holiday.

In training bats for the lab, my best advice is not to teach them anything that may later be a problem. For example, one of my bats loves to hang on my glasses. This is a rather cute stunt but since I sometimes wear contact lenses it can be dangerous. Most of all, do not rely on bats forgetting anything. Last year I taught them various targets, and how to run around a grid for food. Both behaviors took approximately a week of 4-5 reps per day to master. After hibernating all last winter, they remembered both behaviors on the first try even though it was six months later. If a bat is new or very young, I often wear cotton gloves so they can grab on to my hand but cotton gloves are not usually necessary.

Hibernation is accomplished easily in a normal refrigerator. I prepare a Styrofoam carrier--the size used to carry two six-packs--by placing smaller pieces of Styrofoam inside for bats to hang easily. For my convenience I cut a hole in the top and place screening in the opening with duct tape. This can also be a great carrier for bats at any time. On the bottom of the container I place a dish of water which I maintain by refilling about once a month. To ease them into hibernation, I place them in a basement or porch during the cool nights for a period of two weeks, and then the container goes into the refrigerator. During this period I feed them only occasionally when they wake in the evenings and fly. From then I simply forget them in the refrigerator (7 degrees C) except to water once a month. In March, I remove the containers from the refrigerator and over two or three days wake them in the evenings for a mealworm or two and then permit them to fly. Once they are flying, I return them to their 'cave' for summer.

This year one of my *Eptesicus* females gave birth and is raising her young quite easily in the cave. I did not disturb her for two or three days, and fed her as she hung on the towel. The pups, a male and female are beautiful and growing rapidly. By the third day, she came down for her free flying without the pups. Only a mother or someone who has spent time in Attica can tell you how she felt when she first took wing after the pups were born. They cling easily to the towels and sleep with their mom or another female. The only problem with the pups which I encountered was parasites. Not wanting to harm a pregnant female or the pups, I waited until they were 3 weeks old to delouse them. My zoo vet recommended pyrethrins dabbed on just one spot to check for sensitivity. This can be followed by more dabs if there is no problem. As with anything, this should be done carefully and under close supervision.

A small hint which may help whenever the bats are carried from one area to another. If they are carried in a container such as a jar or plastic box, line the box with a sheet of paper toweling. The paper towels or tissue keep the urine and feces in place on the bottom of the container.

My mother bat has been of special interest to me. While I have no expertise in echolocation I have noted that my female and her young all echolocate audibly, the young beginning what I assume is her frequency when they were 3 days old. (They are under the readings on my bat detector and quite easily heard by the human ear. Bip...bip...bip.) My other Eptesicus female who usually can be found at the 38 level is sometimes audible also.

While I am busy designing bat toys for the pups, I hope you found something helpful in this discussion. Perhaps if you have helpful hints on bat care you would share them with me, Lois Sakolsky, 221 Parker Drive, Pittsburgh, PA 15216, and I will write another article combining all of your efforts for another issue. Many thanks for your attention.

Abstracts of Poster Presentations at the Fifth European Bat Research Symposium, August 20-25,1990 Nyborg Strand, Denmark

Bat Research News published the abstracts of the papers presented orally at the Bat Symposium last summer in Nyborg, Denmark(Vol. 31:4). In addition to that large collection of abstracts there where more than forty poster presentations. The posters were equally as informing as the platform presentations and in some cases involve much more preparation and effort than an oral presentation. There simply was not enough space in one issue to include the abstracts of these presentations as well, and as a consequence those abstracts were promised to you in this issue. One must keep in mind that these presentations included a great deal of graphic information that is necessarily lacking in an abstract, and several of the abstracts themselves included graphs that were to complex or extensive to include here. Many of the abstracts were written by authors not fluent in English, and every effort was made that when correcting the language, the author's original meaning was not altered. In the event that this did occur, it was purely unintentional, and the original author has my apologies. G.R.H.

Conservation of a Nursery Colony of the Greater Horseshoe Bat Rhinolophus ferrumequinum in the Swiss Alps

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The Greater Horseshoe Bat is one of the most endangered bat species in Switzerland. Only three nursery colonies remain in the country, all three located in the Central Alps. One of them was discovered only in 1986, just a year before the local authorities decided to rebuild the abandoned church which the bats used as a roost for many years. The main problem for the conservation of this colony is that the nave of the church has no arches and hence no real roof space (except a little "room" above the choir), unlike the other traditional churches in the region. As a consequence, the bats flew inside the entire nave ,and their droppings fell directly upon the seats. This situation could not be tolerated by the authorities and architects. In the first year of restoration (1987), the Horseshoe Bats were accustomed to use less than one third of the space previously occupied, in the little room located just above the choir, and in an adjacent tiny tower. They were also forced to use a different opening through the tower instead of their traditional entrance into the nave. The bats readily accepted these new constraints and the number of adults present (30 and juveniles born (14) in 1987 was similar to that of the previous year (30 and 15 respectively).

However, in 1988 no more than 18 adults were recorded and only 2 young were born. A possible cause of such a decline could be the decrease in mean roost temperature that followed the renewal of the roofing, whereby the old black slates were replaced by small wooden planks. This suggested us to set a heater in the room as Stebbings (1988: *Conservation of European Bats*) did in Great Britain. From May to August, the temperature in the room was artificially maintained between 25 and 28°C. This artificial heating led nevertheless to an unexpected ecophysiological problem. As suitable microclimatic conditions for entering into "true" (i.e. rather deep) torpor did no longer exist (this was the case before restoration) inside the heated church, particularly bad weather could constrain the bats to move into another colder roost. This would imply a high energetic cost, mainly during lactation because the young would be carried by their mothers, and especially as such an alternative roost probably does not exist in this area. Ransome (1973: *Factors*

affecting the timing of births of the Greater Horseshoe Bat) has shown that *R. ferrumequinum* hunts with optimal efficiency as long as the ambient temperature does not fall below 8°C, and that this species is virtually able to maintain a normothermic state during the daytime rest if nocturnal ambient temperature remains above this lower threshold. Fortunately, external temperature in the vicinity of the church in 1989 never fell below this critical value between late May and early October, suggesting that the bats presumably were never forced to enter torpor during the main reproductive period. Furthermore, the spring arrival and autumn departure of the bats coincided exactly with the time when ambient temperature respectively increased above and fell below the 8°C threshold value.

The recovery of the colony was nearly complete in 1989 since a maximum of 28 adults was noted and 13 young were born.

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Field Morphological Distinction of Living *Myotis myotis* and *M.blythii* Biochemically Identified and Preliminary Results of Their Trophic Ecology in a Zone of Sympatry(Southern Switzerland)

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The Greater and Lesser Mouse-eared Bats are two sibling species hardly distinguishable in the field. A recent biochemical method (Ruedi, Arlettaz & Maddalena, *Mammalia* in press) now allows an unequivocal distinction between these species: In the field, a single blood sample (20-80 microlitres) is taken from the brachial vein of the bat, transferred in an heparinized tube and quickly frozen in carbonic snow. Subsequent electrophoretic laboratory analysis of two or three blood isoenzymes provides an absolute segregation of the two species. In summer 1989, 167 individuals of both species (79 *M. myotis* and 88 *M. blythii*)were trapped at nursery roost entrances, in caves or above ponds in seven different sites of the southern Swiss Alps (Valais). Here the bats not only live in sympatry, but also share the same roosts. Furthermore, all three known nursery colonies of *M. myotis* or *M. blythii* in this area are mixed colonies. Along with the blood samples, some external measurements were taken on living animals (weight, forearm, third, and fifth digit lengths, ear width and length). Based on protein differentiation, none of the 167 investigated animals was a hybrid. The subsequent discriminant analysis performed on segregated sexes showed that a combination of some external characters gives a valid tool for field identification of living animals. Another new qualitative external character, namely the presence or absence of a white spot of hairs on the upper part of the head, between the ears, may also be discriminant as 56 (95%) of 59 *M. blythii* had the spot whereas 27 examined *M. myotis* lacked it. Fecal analysis of droppings individually collected from 159 animals, and preliminary investigations on diet indicate that *M. myotis* and *M. blythii* exploit quite different trophic spectra, implicating some segregation in habitat selection.

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Impact Assessments and Protection of Bats in Buildings: the Example of Perreux, Neuchatel Jura, Switzerland

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The destruction during the renovation of buildings of potential or actual roost sites of bats which live close to humans is one of the main causes of the decline of the bat population in Europe. Any conversion or renovation project for a significant bat site should henceforth be accompanied by an impact assessment report designed to establish protection measures as an integral part of the conversion project. For the first

time, a large-scale expert appraisement has been undertaken in Switzerland as part of a project to renovate a hospital complex (The Cantonal Psychiatric Hospital in Perreux, 30 km west of Neuchatel), a site which is particularly rich in terms of the bat population. It deals with the protection of the bats in the buildings of their habitat on the grounds.

This expert appraisement comprises four stages:

1) The drawing-up of an initial account of the current state of affairs, listing 10 species of bats on the site, three of which reproduce in buildings *(Myotis myotis, Eptesicus serotinus, Plecotus auritus)* and two in the grounds *(Myotis bechsteini, Myotis daubentoni)*, in holes in trees.
2) The establishment of protection zones which correspond to the degree of vulnerability of the bat population.
3) In close collaboration with the architects and major contractors, the determination of protection measures as an integral part of the renovation project (project, work).
4) The monitoring of the building site and the observation of the consequences of the protection measures adopted.

The case of Perreux illustrates the usefulness of the impact assessment procedures in protecting bat sites under threat from large-scale projects. In our view, the impact assessment represents the only method by which the conflicting interests of conversion and protection can be reconciled in a satisfactory manner. Like the measures taken in connection with the protection of our historical heritage, the legal framework should be strengthened as of now in Switzerland and in other countries in order to ensure that this procedure is applied to all conversion projects for significant bat sites.

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Phylogenetic Analyses of the Bat Family Rhinolophidae I. Metrical Characters

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The continuous morphological data set representing 64 Operational Taxonomic Units of *Rhinolophus* sp. was analyzed by the maximum likelihood method (size-free and common-part-removed transformations). Of several groups of species recognized by Andersen (1905 a. b. 1918), Tate and Archbold (1939), only a few were well defined and supported phylogenetically. The majority, like the *Philippinensis* group of Tate and Archbold (1939), for example, did not represent natural assemblages. The results suggested the eastern part of the Oriental Region or "Australo-Indo-Malayan Tract" as a center of origin for Rhinolophidae.

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Recordings of the Rhinolophids in Cyprus and Their Taxonomy

Peter Boye and Bärbel Pott-Dörfer

All records of Rhinolophid bats in Cyprus are documented. *Rhinolophus ferrumequinum, R. hipposideros, R. euryale, R. mehelyi and R. blasii* occur on the island. *R. ferrumequinum* seems to be separate from neighbouring populations in having a big skull and short forearms as indicated by one obtained skeleton. The reduced forearm length might be an adaptation to strong winds. *R. hipposideros midas* is quite common while all other species are very rare on the island.

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Sensory Prevalence in *Carollia perspicillata*

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For orientation bats not only rely on their highly specialized sonar system, but they also depend on information from other sensory modalities. In our study the relative importance of the three passive senses vision, olfaction, and hearing for food location was investigated in the Short-Tailed Fruit Bat *Carollia perspicillata.*

The experiments were performed by means of a food-rewarded training procedure in a three-choice flight-arena. During training the three modalities (broad-band-noise; illuminated frosty glass pane; mango-odour) were presented simultaneously at one of three positions.

After responding nearly 100% correctly to this combined stimulus, the bats had to decide between the modalities, presented each at different locations. All preference tests were intercalated between training flights with the combined stimuli. The result of this preference-test left no doubt: all animals chose the visual cue by about 100%. So, in this special training situation, light was definitely the most preferred stimulus.

In a following test the non-preferred cues, noise and odour, were tested against each other. Here the bats showed individual behavioral patterns. While one bat favored the olfactory hint, the second preferred the acoustic cue and the third reacted intermediately: at the beginning of the test it favored the olfactory, later the acoustic stimulus. In a second set of experiments, the importance of the three sensory systems was tested directly. At first the bats were trained to recognize the three stimuli as positive by conditioning each stimulus separately. The following preference-test showed that now the olfactory cue was preferred to the visual cue, whereas the location marked by noise was rarely chosen .

These experiments indicate that *Carollia perspicillata* is able to use vision and olfaction as well as passive hearing for accurate location. Depending on the experience of learning the olfactory or optical cue was chosen. An orientation on optical cues seems to be easy to learn for *Carollia*, but having the same training experience for all three modalities, olfaction is preferred.

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Hibernating Bats in Belgium: A Survey

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The evolution of the number of hibernating bats is amongst others presented by means of distribution maps of most bat species found to occur in Belgium. Most data for the 1980's sightings were collected by the "Vleermuiswerkgroep", while additional records presented by Fairon, et al. (1982). This allowed us to distinguish four time periods: prior to 1964, 1965-1974, 1975-1982 and 1983-1989.

The most successful species, which were found in an increasing number of grids, were *Myotis daubentoni*, with 1754 specimens out of 5533 bats observed in 1988-89, *Plecotus auritus I austriacus* and *Pipistrellus pipistrellus I nathusi*. Both *Myotis mystacinus / brandti* and *Myotis nattereri* seem to recover from a small decline between 1965 and 1982, whereas *Myotis dasycneme* is found in a rather stable number of grids, which however show a shift to the northern part of the country. The number of occupied grids occupied by *Myotis emarginatus, M. myotis, Barbastella barbastella, Eptesicus serotinus* and *M. bechsteini* decreased.

During the 1988-1989 survey *Nyctalus noctula* specimens were found in a bat box. This should lead to a more thorough examination of these boxes during the next years. The situation of *Rhinolophus ferrumequinum* and *R. hipposideros* is alarming, since neither of these species was found in Belgium since 1982.

Although the number of species

decreased, the total numbers of observed bats increased over the last few years: from about 1500 in 1982 to 5533 in 1988-89. A rise, which has also been observed in individual localities, such as the fortresses of Steendorp and Oelegem and the limestone quarries of Reimst (Zichen-Zussen-Bolder) and Vise (Lanaye-Caestert).

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Summer Occurrence of Bats in Agrocoenoses

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Data were gathered since 1976 on mammals in the agrocoenoses of southern Moravia. The territory is 45 km^2 in area, bordered by roads linking six villages. Arable land makes up 93% of the total, the remainder is used for vineyards, orchards, forest shelterbelts (windbreaks), woods, the largest measuring 0.9 km^2, and paths. The only water patch is a fishpond. Thirty seven mammalian species were found, viz., 7 Insectivora, 5 Chiroptera, 13 Rodentia, 2 Lagomorpha, 7 Carnivora, and 3 Artiodactyla. From among the bats *Eptesicus serotinus, Plecotus austriacus* and *Myotis myotis* were recorded in buildings of the bordering villages, *Nyctalus noctula* in a hollow alder tree and *Pipistrellus nathusii* free outside shelters (2 dead specimens).

In 1988-89, the authors attempted to compare the density of bats foraging in agrocoenoses to that in more natural habitat of a near-by reserve of Palava, 75 km^2 in area. The most important part of the reserve is a limestone ridge about 12 km long and 3-4 km wide which towers over the surrounding lowland. Woodland covers about one third of the area.

Two QMC-mini-bat-detectors were used simultaneously when walking for 20 minutes (a transect), and the echolocation signals of bats were recorded. There were 58 such transects, 29 of them in the territory of agrocoenoses and 29 in the reserve. The average length of a transect was 800 meters, and the authors rotated in the two habitats. The density (D) was estimated using a formula (Burnham & Anderson 1984) where n = the number of bats, L = the length of a transect, w = the distance at which bats can be detected with a QMC-mini-bat-detector. The bats were divided into two groups: (1) *N. noctula*, w = 70 m, (2) other bats, w = 10 m. The audibility of ultrasounds was estimated after Limpens et al. (1989) and our own unpublished observations.

Results:	Agrocoenoses	Reserve
N. noctula	n=4, D=1. km^{-2}	n=28, D=9. km^{-2}
other spp.	n=16, D=34.km^{-2}	n=42, D=91.km^{-2}

These and other data (e.g., total duration of bat vocalizations as recorded at individual transects) show that the agrocoenoses are less suitable to foraging bats. However, bats do occur there, mainly around small woods, windbreaks, in the outskirts of villages and in and close to barns in the fields. No bats were registered inside windbreaks and over open fields.

Burnham, K. P., D. R. Anderson, 1984: The need for distance data intransect counts. J. Wildl. Man., 48: 1248-1254.

Limpens, H. J. G. A. et al., 1989: Bats (Chiroptera) and linear landscape elements. Lutra, 32: 1-2C.

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Nutritional Habits of the Noctule Bat *Nyctalus noctula* in the Northern Part of Switzerland

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During one season (from April to November 1989) feces of the Noctule bat were collected in three roosts in houses. Noctule bats were caught every two weeks from April to November at seven roosts in trees in Zurich, and fecal pellets were collected from these bats. The fecal pellets are analysed both in terms of quality and quantity and compared regionally and seasonally. *Nyctalus noctula* preferably

feeds on Diptera (Chironomidae, Anisopodidae) and Trichoptera, insects which fly in swarms over water, e.g. along riverbanks. These insects are mostly soft, small and fly locally in large numbers, so it is possible for the Noctule bat to hunt and catch a lot of prey in a very short time (filter feeding). Nevertheless, it is surprising that the Noctule bat with its powerful and strong teeth hunts such soft and small insects, but at times during the year, when bigger insects such as Lepidoptera or Coleoptera (e.g. *Melolontha* sp. in spring, *Geotrupes* sp. in autumn) are frequent, they are also hunted by the Noctule bat, a fact that points to an opportunistic hunting strategy.

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Pliocene and Pleistocene Bat Fauna from Przymilowice, Poland

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Przymilowice, a newly discovered fossil site in the Krakow-Wielun Upland, has yielded abundant Pliocene and Pleistocene bat fauna. The oldest remains, of upper Villanyian age, belonged to the families Rhinolophidae and Vespertilionidae, among them *Rhinolophus kowalskii,* originally decreased from the lower Pliocene of Podlesice by Topal (1979). The dominant species found in the youngest layers are *Myotis emarginatus* and *M. bechsteini* of the family Vespertilionidae; precise age of these remains uncertain, considering the lack of rodents.

Topal, G. 1979. Fossil bats of the *Rhinolophus ferrumequinum* group in Hungary (Mammalia :Chiroptera). Fragm. Mineral. Palaeontol, 9:61-101.

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Regional and Seasonal Comparison of the Diet of *Myotis myotis* in the Central and Eastern Parts of Switzerland

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Feces collected in 14 maternity roosts and 2 small non-breeding colonies in the Central and Eastern parts of Switzerland were analysed and the qualitative and quantitative results compared regionally and seasonally. The large share of Carabidae in the food of *M. Myotis* can be confirmed. The share of other food items in the feces however shows distinct regional differences. Orthoptera and Diptera feed much more frequently in the regions of the lower Alps and the Central Alps than in the lowlands where the Carabidae are the very dominant prey group. There are fundamentally two possible explanations. On the one hand, the absence of many insect groups due to the intensive agriculture of the open areas in the lowlands may be the reason for this specialization on Carabidae. On the other hand, the more frequent records of Orthoptera and Diptera in the regions of the lower Alps and the Central Alps could be the result of a shortage of Carabidae in these regions. That the prey availability influences the food can be shown by the seasonal occurrence of the different food items. The specialization on medium and large prey, and the fact that most prey can be captured on the ground can be confirmed. The results show further that forests are the main foraging areas, but specially in autumn *M. myotis* seems to hunt at least in several regions including open field areas.

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Taste Preferences of the Mouse-eared Bat, *Myotis myotis* in Captivity

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The aim of this study was to establish the taste preference and taste tolerance in the Mouse-eared bat *Myotis myotis* . The tests were carried out on two individuals (male and female). The tests included reactions to four basic tastes: bitter (quinine), sour (citric acid), sweet (glucose) and salty (natrium chloride). The reactions were observed after the bats had been offered meal-worm larvae (*Tenebrio molitor*) previously soaked in a solution of one of the above taste giving chemicals. The results were as follows:
1.) Mouse-eared bats preferred sweet and salty tastes decisively rejecting sour and bitter tastes. 2.) The results of tolerance tastes agreed well with preference, i.e., the lowest tolerance threshold occurred in bitter taste trials which provided the fewest positive reactions. The second lowest threshold was found in sour taste trials. For the most preferred tastes (sweet and salty) the upper tolerance limits could not be obtained. 3.)The amount of previously eaten food affected the food preference in Mouse-eared bats. The number of negative reactions toward the rejected tastes increased in animals feed prior to the trials.

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The Influence of Olfactory Marks on Roost Selection in *Phyllostomus discolor*

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The neotropical spearnosed-bat *Phyllostomus discolor* is a social animal. Groups of up to 400 individuals live together in one retreat, such as a hollow tree. These roost-sharing groups are subdivided in "one male group" or "harems". For this social organization necessarily all individuals must be able to distinguish between their own and other group members. This investigation attempts to show the importance of olfactory cues in the context of roost selection.

Histological investigations of the chest gland of one male *P. discolor* and the analogue skin-region of a female showed a sexual dimorphism in the morphology of the gland. The male's chest-gland is a composition of a huge sebaceous and a smaller odouriferous part, whereas in the female the sebaceous part of the gland is rudimentary while the odouriferous gland is well developed. The responses of two adult males, and two females of *P. discolor* upon different olfactory marks of conspecific males, including urine, feces and above all the secretions of the chest-gland were tested. The animals could choose between two roosting-grids, one perfumed either by the tested individual itself or by a conspecific, the other without an olfactory mark.

In blind-experiments all individuals preferred one site. We postulated, that for roost-selection the spatial position is crucial and olfactory cues exert a modifying influence.

Whereas males did not react in a straightforward way to their own marks at their preferred roost-site, they showed a significant higher presence at the other grid, in case their odour marks were applied there. In contrast, the males showed no increased presence at the non-preferred roosting-grid if it smelled of a dominant, familiar male, whereas they visited their preferred grid more often and stayed there longer, if the odour of this alpha-male was receptible (detectable)at this place.

The females didn't modify their roosting-behaviour when noticing the odour of a male. Neither the smell of the harem-male nor of a strange harem's male evoked more reaction than a short turning towards the perfumed grid and one or two short exploratory visits.

It is presumed that male substrate-marking in *P. discolor* signals as a pars pro toto, the presence of a male. The markings evoke competitive behaviour in males but seem to be no cue to choose roosting-place in females. This difference may be caused by the necessity of males to be able to select a

safe roosting-place even if all conspecifics are absent, whereas females need more than olfactory information about the group composition before joining it. Nevertheless scent-marks seem to be an important information for females, as scent-evoked exploration behaviour was always the first reaction of the females when approaching the targets.

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Hibernation Ecology of Whiskered and Brandt's Bats Sharing the Same Roost Site

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The sibling species *Myotis mystacinus* and *M. brandti* hibernate in the same limestone mine in south-west England. Flight morphology was examined and investigated by using multiple discriminant analysis to determine whether wingshape differed between the two species. The temperature and humidity requirements of the bats are described.

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Echolocation Behavior of *Plecotus autriacus* While Catching Moths in the Laboratory

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It has been reported that some species of gleaning bats refrain from echolocation while searching for insects. It is very difficult to decide whether a gleaning bat does not emit echolocation sounds when approaching a target or whether the microphones just do not pick up the weak echolocation signals. To solve this problem we studied the echolocation behavior of the gleaning bat *Plecotus austriacus* while picking moths from leaves under controlled conditions in the laboratory.

A bat learned to catch moths from the leaves of a branch. We filmed the bat with two 16 mm cameras while approaching and catching an insect and made synchronous sound recordings. The bat always produced sounds when it approached the leaf with the insect. While closing in on the moth it reduced the sound duration and increased the repetition rate. In most cases it emitted a short buzz consisting of 5 to 10 pulses.

We will describe the echolocation and the hunting behavior. The sound pattern of the approaching bat is similar to the typical approach patterns described for other species. This indicates that the bat locates a target. We cannot decide whether it is the branch or the insect on the leave. However, we are sure that *Plecotus austriacus* does not refrain from echolocation as it has been assumed for other *Plecotus* species.

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The Morpho-Functional Research into the Formation of the Bat's Sternum

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Studies of the thorax and its elements in representatives of twelve families of bats have shown significant differences in the thorax as a whole and in the shape of its elements, particularly the sternum.

It has been established that in the bats with the thorax compressed dorsiventrally (representatives: Emballonuridae, Megadermatidae, Noctilionidae, Phyllostomatidae, Desmodontidae, Vespertilionidae, and Molossidae) a keel is absent on corpus sterni; where it is present in the bats whose thorax has acquired a rounded shape (members of Ptéropidae, Nycteridae, Rhinopomatidae, Rhinolophidae, Hipposideridae). The latter also have "the shift" of proximal elements of a thoracal extremity, scapula and humerus, which are located more dorsal relative to

thorax frontal aspect than in the bats with thorax compressed dorsiventrally. At that, the fibres of mm. pectorales are directed at an acute angle to the frontal aspect of sternum, which is a premise of keel appearance on corpus sterni. Such "shift" is evidently caused by the presence of the rounded thorax when the radius of curvature of costae sterni is smaller than in bats with the flattened thorax. In latter the proximal elements of the thoracic limb are placed more craniad relative to cranial aperature of thorax than in bats with a rounded thorax. This resulted in a decrease in an angle of slope of muscular fibres of pectoral muscles relative to long axis frontal aspect of sterni and stipulated the cranial direction of the ventral process of manubrium sterni. In bats with a rounded thorax, the ventral process of manubrium sterni also has the ventral direction.

We conclude that both keel on corpus sterni and ventral process of manubrium sterni are a result of the pectoral muscle actions. The degree of development of these structures correlates with an angle of slope of the pectoral muscle fibres to the plane of sternum, which, in its turn, depends upon a disposition of proximal links of the thoracic limb relative to thorax as well as on thorax shape.

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Changes in the Number of Bats in Szachawnica Cave in Central Poland Over a Ten Year Period

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The study area was a limestone cave consisting of about 1 km of corridors. Parts of the corridors were widened by the mining of limestone. Bats were counted twice a year; January 29, and March, in the years 1981to1990. Nine species of bats were observed in the cave. The maximum number recorded was 1,477 individuals on March 7, 1987.There were 721 *Myotis nattereri*, 374 *M. myotis*; 212 *M. daubentoni*; 80 *Plecotus. auritus*, 57 *Myotis mystacinus sensu lato*; and others. The number of bats was generally higher during controlled counts made in March in comparison to those in January. The majority of species showed a slow increase in numbers over the ten years, mostly strongly expressed in the case of *M. daubentoni* and *M. nattereri*. [Ed. note: A rather complex table accompanied this abstract, but space does not permit its inclusion here].

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Does a Good Method for Measuring Bat Fingers Exist?

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Measurement of fingers, the 3rd and 5th, especially, has been considered by several authors as a good method for discriminating similar species of European bats on morphological criteria. This particularly concerns identification of Greater and Lesser mouse-eared bats (*Myotis myotis* and *Myotis blythi*), or Pipistrelle (*Pipistrellus pipistrellus*) and Nathusius pipistrelle (*Pipistrellus nathusii*). Finger length of bat fingers, although all of them include metacarpus in the finger length. We have thus conducted on a small and a large species of bats, a comparative study on the reproductibility, i.e. the reliability of the four most commonly used methods of measuring fingers of bats: (1)finger plus wrist measured from the outside of the wing using a short steel ruler with a stop end; (2) finger without wrist measured from the inside of the wing using a steel ruler; (3)addition of the respective lengths of, wrist plus metacarpus, 1st phalanx, and 2nd and 3rd phalanxes, measured with dial calipers ; (4) measurement of finger, starting from mid-wrist, on the internal side of the wing, using a steel ruler .

During two nights of bat catching using mist-nets, we have performed, in field conditions, two series of measurements on two series of bats, respectively a group of 4 Daubenton's bats (*Myotis daubentonii*) caught on a river, and a group of 3 Serotines (*Eptesicus serotinus*) caught at a cave entrance. The animals were placed in identical small linen bags which were distributed by an operator, in an order known only to himself, to two other operators, alternately, who measured the 5th finger of the right wing of the bats, using successively the four methods, in the above mentioned order (methods 1, 2, 3, and 4). Each bat was measured 3 non-consecutive times by a given operator, who never knew at any time which specimen he was measuring.

Results were processed using the coefficient of variation analysis. For each measurement method, the coefficient of variation was first calculated from the measures taken by the two operators on each bat specimen. Here are given the mean coefficients of variation established for the four methods and for each species of bats. For the measurement method 1, 2, 3, and 4 the mean coefficients of variation were respectively 0.57, 2.17, 1.29, and 1.26 when calculated from the data from *M.daubentonii*, and 0.53, 0.71, 0.68 and 0.65 when calculated from *E. serotinus*. We have also compared for each measurement method the mean variation between the mean values of finger length obtained by each operator. For the measurement methods 1, 2, 3, and 4 the mean variations between means were respectively 0.43, 2.32, 0.94 and 1.21 when established from data obtained in *M. daubentonii*, and 0.33, 0.54, 0.33 and 0.33 when calculated from *E. serotinus*.

Taken together, our results clearly indicate that, whatever the size of the species, the most reliable method of measuring bat fingers in field conditions, seems to be that consisting in measurement of wrist plus finger, on the external side of the wing, using a steel ruler with a stop end (1-method). This method gives both the best within-operator precision and the best between operator reproductibility. In contrast, measurement of bat fingers without wrist, from the internal side of the wing, using a non-stopped steel ruler (2-method) gives the most highly variable data, both for one operator and between operators. It seems interesting to note that this method, although the worst, is the one recommended in two of the more recently published field guides of European bats. Other methods for measurement of finger length of bats give intermediate results.

In conclusion, our present data might be useful in view of harmonizing the mode of measuring length of bat fingers.

The authors gratefully acknowledge the financial support provided by the French Ministere de l'Environment through Delegation Regionale a l'Architecture et a l'Environment de Haute Normandie.

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Activity Patterns of *Pipistrellus pipistrellus* in Oxfordshire, England

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A maternity colony of *Pipistrellus pipistrellus*, in Risinghurst, Oxfordshire, was studied on 62 nights between March 1, 1989 and October 6, 1989. An infra-red "automatic bat counter" was installed at the roost, to record the number of bats entering and leaving the roost each minute throughout the night. Air temperature, light levels at sunset, cloud cover, wind speed, and rain were recorded on each night of monitoring. Insect abundance was estimated on 18 nights.

The nightly activity pattern for bats at Risinghurst was found to be unimodal in pregnancy, bimodal during lactation and unimodal post-weaning, similar to that previously observed by Swift (1980) for pipistrelles in Scotland. Mean time outside the roost, per bat, ranged from 1 hour 43 minutes to 8 hours 3 minutes, with a mean of 5 hours 30 minutes.

Ambient air temperature and length of night showed a significant positive correlation with mean time spent outside the roost. There was a slight trend for longer periods outside the roost from pregnancy to lactation to post-weaning. Insect abundance showed no significant correlation with time spent outside the roost. Wind and rain

showed no apparent effect on time spent outside the roost.

It is suggested that differences in temperature and length of night, between the south of England and north of Scotland, may help explain the longer times spent outside the roost by bats in this study compared to those observed by Swift (1980) for pipistrelles in Scotland.

Swift, S.M. (1980) Activity patterns of pipistrelle bats (*Pipistrellus pipistrellus)* in north-east Scotland. *J. Zool. Lond.* **190**. 285-295.

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Dyfed Bat Note

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19 Parc Puw, Drefach Velindre, Llandysul, Dyfed, Wales, U.K.

The Country of Dyfed is a lightly populated, mainly agricultural area of South West Wales. It is triangular in shape with two sides being coast. It has an upland core dissected by a number of river valleys. The geology is predominately shales with a significant band of carboniferous limestone along the southern coast and north into the eastern land boundary to a height of about 600 meters. In many of the valley communities the field systems are small and bounded by hedges and small often linear woodlands. The area has escaped some of the ravages of agricultural change that have marked other parts of Britain. The area would appear to be very good for some species of bats with eleven species recorded. Roost sizes are not large but a high roost density is known to occur in some of the rural communities.

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Residues of Chlorinated Hydrocarbons in Six European Bat Species

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Organochlorine pesticides are responsible for the dramatic decline in European bat populations of the last 30 years. Although the application of most of these substances is forbidden now, organochlorine insecticides and fungicides and poly-chlorinated biphenyls(PCBs) can often be found in bats in remarkable amounts. To get an idea about the actual situation, 66 animals of six European bat species were the subject of extensive investigations of chlorinated hydrocarbon burden. A total of 25 *Pipistrellus pipistrellus,* 16 *Nyctalus noctula,* 9 *Myotis mystacinus,* 7 *Plecotus auritus*, 5 *P. austriacus,* and 4 *Myotis myotis* were used to study the concentrations of eleven organochlorine pesticides and six PCB compounds. Each animal was handled as one sample. Using a gas chromatograph, these samples were analyzed for penta-chlorbenzene, alpha- and beta-hexachlor-cyclohexene, gamma-hexachlorcyclohexene (Lindane), hexachlorbenzene, heptachlor, heptachlor-epoxide, aldrin, DDT, DDD, DDE, as well as the PCBs Nos.28, 52, 101, 138, 153 and 180. All chlorinated hydrocarbons could be found in at least one sample. The mean concentration of most of the analyzed substances are lower than 1 mg/kg fat. The sum of DDT and its metabolites(DDD and DDE) show the highest concentrations of all analyzed insecticides in all species. It is the lowest in *Plecotus auritus* (8.29 mg/kg fat) and highest in *Nyctalus noctula* (21.5 mg/kg fat) and *Myotis myotis*(20.4 mg/kg fat). The concentrations of the most common PCBs(Numbers 138, 153 and 180) are even higher than those of the pesticides. These PCBs together show concentrations from 7.3 mg/kg fat in *Plecotus auritus* to 49.9 mg/kg fat in *Pipistrellus pipestrellus.* Comparing the burden of organochlorine substances in the different species, the mean concentration of

DDT and its metabolites is highest in *Nyctalus noctula*(0.41μg/g wet mass) and *Plecotus austriacus*(0.59μg/g wet mass) whereas one of the PCBs is lowest in *Nyctalus noctula*(0.22μg/g wet mass). The highest concentration can be found in *Pipistrellus pipestrellus*(0.82μg/g wet mass) and *Myotis mystacinus*(0.51μg/g wet mass) respectively. The different accumulation of organochloride substances can be explained by different habitats of the bats. The highest amounts of organochloride residues can be found in *Pipistrellus pipestrellus*, a species which normally lives in towns(1.09μg/g wet mass). On the other hand *Plecotus auritus*, a forest inhabiting species shows the lowest values(0.51μg/g wet mass).

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Effect of Adrenalectomy and Adrenal Hormones on Plasma Sodium and Potassium Levels in *Rousettus leschenaulti*

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The role of the adrenal gland in sodium and potassium metabolism of the bat, *Rousettus leschenaulti*, is assessed by adrenalectomy(ADX) and administration of metopirone and adrenal hormones. The ultrastructural changes produced in the various zones of adrenal gland are also recorded. ADX and Metopirone administration produced a decrease in plasma sodium level and elevated plasma potassium. There was an increase in the nuclear diameter of the cells in both the zona glomerulosa and zona fasciculata regions following metopirone treatment and unilateral adrenalectomy. Administration of both hydrocortisone and aldosterone increased plasma sodium and decreased plasma potassium. The nuclear diameter of cells of both zones decreased. The adrenal gland of metopirone-treated bats exhibited hypertrophy. Electron microscopic observation showed decreases in chromatin matter of the nucleus, and altered shape and vacuolization of mitochondria. Adrenal hormone treatment also brought about changes in ultrastructure such as an increase in fat droplets and changes in size and shape of mitochondria. The present study confirms the active involvement of the adrenal gland in the electrolyte metabolism of the bat.

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Serotonin and Pancreas in the Hibernating Bat *Rhinolophus ferrumequinum korai*

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The relationship between a biogenic amine 5-hydroxytryptamine and the pancreas has been examined in hibernating bats by means of light and electron microscopy, which are thought to be advantageous for synchronizing the glandular activities so that naturally occurring states can be studied in which all of the glandular cells are active or inactive. In hibernating bats (late December), a number of fine cytoplasmic granules were observed in the exocrine pancreatic cells and endocrine cells of the Langerhans islet, which were so closely associated with pancreatic acinar cells that a connective tissue layer was hardly recognized between those endocrine and exocrine cells. The exocrine pancreatic cells were characterized by the presence of abundant rough endoplasmic reticulum and large number of mitochondria containing spherical lamellated dense bodies, irregularly-shaped saccular structures, and enlarged lysosomal bodies. In active bats (late June), no radical morphological changes were observed in the light and ultrastructures but a certain degree of morphological variations were found in the mitochondria, endoplasmic reticulum, and cell inclusions. After an experimental depletion of serotonin with reserpine or parachlorophenylalanine, pancreatic acinar and endocrine cells were examined to find any morphological changes in the cell organelles. After tryptophan administration, formation of parallel paracrystalline arrays of stacked membranes and round or pleomorphic osmiophilic granules was examined to clarify the possible

relationship between those structures and seasonal serotonin variation in the acinar cells. For identifying the exocrine and endocrine cells, victoria blue-acid fuchsin stain were adopted in the light microscopy.

*****

Preliminary Results on Activity Rhythms and Space Use Obtained by Radio-tracking a Colony of *Eptesicus serotinus*

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Individuals of the species *Eptesicus serotinus* can be found all the year round inside the expansion joints of a bridge in a town in southwestern Spain. Both the number of bats and degree of aggregation change with the seasons, reaching a minimum of 1-10 individuals in winter (December-January) and a maximum of 150 females during the breeding season (June). During 1989-90, 14 bats were fitted with small radio transmitters.

The results obtained confirmed that; there is activity all through the year although with noticeable seasonal variations; both the activity period and followed distances vary considerably (from 20 minutes and a distance of 1 km to the hunting place in January; up to 3 hours and 30 minutes and 5 km in August); the different individuals use very definite zones as hunting sites; both age class and weather conditions determine activity; and finally, alternative refuges relatively close to the bridge are used.

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Seasonal Weight Dynamics of *Miniopterus schreibersii*

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The main objective of this paper is to describe the seasonal variation of body weight of *Miniopterus schreibersii* in Portugal. Throughout 1988 and 1989 a total of 1493 adult and flying juvenile bats of both sexes were weighed to the nearest 0.05 gm. From their lowest weight (12 gm), at the end of hibernation in February, adult females increased almost 4 gm until the end of pregnancy in May. After parturition their weight fell to less than 13 gm and remained more or less constant until October. In preparation for hibernation they then gained over 2 gm, reaching their highest winter weight in November. During hibernation ringed adult females lost an average of 0.05 gm per day. First year females (non-reproductive) kept a fairly constant weight (about 12 gm) until the months before hibernation. Like adult females, they then increased in weight about 2 gm in preparation for hibernation. Their lowest average weight(just above 11 gm) was also obtained at the end of hibernation in February. During the spring they gained about 1.5 gm and then generally maintained this weight until the beginning of the following hibernation period. At the end of hibernation adult males were at a low of 11.5 gm. They gained 2 gm until July and kept this weight until the onset of hibernation; they did not increase their weight before hibernation as much as the females. First year males became heavier until November, when they reached the weight of the adults. After this month the weight changes were assumed to be similar to those of adult males.

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Comparative Studies of Echolocation and Hunting Behavior in the Four Species of Mormoopid Bats of Jamaica

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The echolocation and hunting behavior of the four species of Jamaican mormoopid bats has been studied in the field and in a flight cage.

In search flight *Pteronotus parnellii* (PP) produces signals with a rather long portion of constant frequency followed by a short downward frequency-modulated sweep (long cf-fm). In contrast the pulses of *Pteronotus macleayii* (PM) and *Pteronotus fuliginosus* (PF) consist of very short cf-parts followed by short fm-sweeps (short cf-fm). *Mormoops blainvillii* (MB) emits short fm signals with a change from a more shallow to a steeper sweep. In all species the signals are rather loud and contain several harmonics from which the second is the strongest. The frequency of the cf-part is species specific. The 2nd in PM at about 72 kHz and sweeps to about 54 kHz, and in PF at about 81 and sweeps to about 62 kHz. The fm-signals of MB cover a range of 63-45 kHz.

In the field we observed PP only in rather dense vegetation whereas PM and PF hunted for insects in open areas. All three species searched for insects continuously on the wing. The echolocation sequences of hunting PP, PM and PF were recorded and will be described. We could not find MB while hunting.

All four species hunted for insects in a flight cage so that we could take photographs with a stroboscopic system and make synchronous sound recordings. The analysis of the photos and the sound recordings allows a detailed description of the flight and echolocation behavior of all species while hunting for insects.

Our data support the hypothesis that long cf-fm signals are adapted to search for insects in dense vegetation. Short cf-fm signals are less suited for this task so that bats producing such signals mainly hunt along the vegetation and in the open.

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Echolocation Signals of the Aerial Hunters Guild in a Mediterranean Forest Chiropteran Taxocommunity

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In the study area (*Quercus suber-Quercus canariensis* forest in SW Spain) the taxocommunity of bats is apparently represented by three echolocating guilds: the over-canopy aerial hunters (typical FM steep to shallow sweep with terminal CF signals), the surface hunters (steep FM signals) and the sub-canopy aerial hunters (long FM signals with short and steep initial and terminal FM sweeps).

The echolocation signals in search phase of the over-canopy aerial hunters (*Miniopterus schreibersi, Pipistrellus pipistrellus, Pipistrellus kuhli, Pipistrellus savii, Nyctalus leisleri, Eptesicus serotinus, Nyctalus lasiopterus* and *Tadarida teniotis)* are described. Several interesting differences in the frequency of the terminal CF (minimum frequency) from descriptions in central and northern Europe are revealed.

The echolocation calls reveal a characteristic pattern from short signals with long and steep FM portions with short and high frequency terminal CF *(Miniopterus schreibersi, Pipistrellus pipistrellus* in this edge) to long signals with very shallow FM portions and long and low frequency terminal CF (*Nyctalus lasiopterus, Tadarida teniotis*), advertising a structured pattern in the taxocommunity. This pattern seems to be related with species size, foraging distance to ground and objects and, possible, prey size.

*****

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Fusion of Temporal and Spectral Representations into Unified Images Having a Computed Display or Range Axis in *Eptesicus fuscus*

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The FM echolocating bat, *Eptesicus fuscus,* perceives images of complex targets in terms of the distribution of their reflecting points, or glints, along the range axis. The delay of echoes from the nearest glint is encoded by the timing of neural discharges and is susceptible to amplitude-latency trading. Glints located further away reflect echoes having slightly longer delays, but these later echoes overlap with the earlier echoes to produce an interference spectrum that represents the time separation of echo components within the whole complex echo. The bat's auditory system initially encodes the peaks and notches long the frequency axis of the spectrum, but this representation is transformed into an estimate of the underlying time separation itself and perceived as a discrete range for each glint, with absolute range calibrated by the time-domain delay estimate derived from the earliest echo component. The separation of echo cues into time- and frequency-domain representations is governed by the delay separation of echo components in relation to the integration time of echo reception (about 350 μsec echo delay separation constitutes a critical test of the Spectrogram Correlation and Transformation (SCAT) algorithm for processing echoes.

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The Postnatal Development of Hearing in *Corollia perspicillata*

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Ontogenetic development of auditory threshold curves and auditory midbrain (inferior colliculus, IC) tonotopy was investigated in 16 *Carollia perspicillata,* a neotropical frugivorous and nectarivorous HF-bat, in weekly intervals from day of birth until the seventh week of life. The bats were taken from a captive colony, which is established at the University of Bonn () since 1981. Consequently, the age of the young bats could be determined with a precision of less than 24 hours.

In stereotactic cone-like penetrations the IC-multi-unit responses to pure tone stimulation were recorded. The best frequency (BF) for each recording site (about 170 sites/animal) was determined audio-visually. Electrolytical lesions, made in defined distance in one or two of the last electrode tracts, allowed morphometrical reconstructions from frozen brain sections.

Starting with the representation of the lowest frequencies in the most dorsorostro-lateral area, the developing tonotopical order of frequency representation in the ICC shows a successive spatial addition of Iso-frequency-layers containing neurons, tuned to higher frequencies in the ventro-caudo-medial region.

Since a morphometrical analysis of the experimental animals' brain sections showed, that their IC does not grow after birth, a postnatal functional addition of formerly unresponsive areas must be assumed. In the IC of *Carollia perspicillata* no significant developmental frequency-place-code shift was ascertainable.

Newborn *Carollia* must be characterized as extremely precocial. Their hearing range amounts to 68% of the auditory capacity of the adult animals, and expands

toward higher frequencies during ontogenesis. The neural threshold intensity decreases, especially for the frequency range, which corresponds to the main energy containing harmonics of the developing echolocation pulse (Fig.1). [Ed. Note:The quality of the copy of this figure available to us did not allow accurate reproduction]

But in all age classes the most sensitive part of the bats' audiogram was found between 15 and 30 kHz and therefore outside the echolocation range.

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Biology and Ecology of Hibernation of *Myotis daubentoni* and *Barbestella barbastellus*

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Different bat species have different life-history strategies. Although many works have been published our knowledge of the biology and ecology of bats is relatively poor, and autecological research is still required. More detailed knowledge of the biology and ecological requirements of individual species is necessary in bat conservation. Biology and ecology of hibernation of *Myotis daubentoni* and *Berbestella barbestellus* was studied in Nietoperek Bat Reserve under license of the Nature Conservancy Department. This poster presents data about duration of hibernation, number dynamics, kind of shelter and site preferences(temperature and humidity), body mass changes, sex ratios and sexual activity. Clear differences are found in the behaviour and ecological requirements of both species. *M. daubentoni* seems to be more flexible, whereas *B. barbestellus* appears to be a more specialized species.

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Movements of Bats Hibernating in Nietoperek

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Information about the movement of bats banded or recaptured in Nietoperek Bat Reserve (western Poland) are given.

Myotis myotis comes from distances as far as 220 km, even from Brandenburgia and Mecklemburgia in Germany. Some individuals have been ringed during winters in hibernation quarters in Brandenburgia.

M. daubentoni comes from distances of up to 260 km.

Plecotus auritus and *M. nattereri* have been found in summer quarters which are 12 to15 km from Nietoperek.

Some individuals of *M. myotis, M. daubentoni, Eptesicus serotinus* and *Barbastella barbastellus* spend the summer in the close vicinity of Nietoperek.

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Present Status of Bats in Italy

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The Italian bat fauna includes 30 species. The situation trends are different in the three families of Italian bats. In general, *Rhinolophidae* are decreased greatly everywhere. The only species with good populations is *Rhinolophus ferrumequinum.* Two species considered as very rare, *Eptesicus nilssoni* and *Vespertilio murinus* were recently discovered again in Italy, and *Myotis brandti* was recently recorded for the first time. The status of *Nyctalus lasiopterus* and *N. leisleri* is not known, but they are presumably very rare as no specimens have been found in many years. The status of *Myotis bechsteini* has been published recently. Of the two species of *Plecotus* in Italy, *P. austriacus* is more abundant. *Myotis dasycneme* and *Rhinolophus blasii* are formally extinct in Italy. *Myotis daubentoni*

seems quite rare, but *Pipistrellus kuhlii* appears to be an expanding species. In recent times some interesting colonies of *Tadarida teniotis* were found in South and Central Italy. There are still some good populations of *Miniopterus schreibersi, Myotis myotis, M. blythii, M. capaccini* in some caves, and of *Pipistrellus pipistrellus,* and *P. kuhlii* in urban areas, but the roosts are not protected in Italy and disturbance in caves and restoration of buildings create great problems for conservation of the bat populations. Three national projects were recently planned to create a good database on Italian bat populations and to encourage and support a new awareness and understanding of these mammals.

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Chromosomal Evolution in Vespertilionidae:Phylogenetic Implications

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Due to the presence of only a few morphological features which are suited for the construction of a phylogenetic tree, the intergeneric relationships of the family Vespertilionidae remained rather unclear. A sufficient number of good characters, however, could be revealed by comparison of banded karyotypes of several genera. Concerning the Pipistrelloid genera, the results support the suggestions made by Horacek and Hanak, 1986, and Hill and Harrison, 1987, drawn from morphological studies. The suggested cladogram can be described as follows: The Miniopterinae are the first to branch off from the common Vespertilionidae stem. The next branches belong to the Murininae, Kerivoulinae, and the tribe Myotini, formerly included in the Vespertilioninae. The subfamily Vespertilioninae is divided into four tribes: Plecotini, "Nycticeini" (possible polyphyletic), Vespertilionini and Pipistrellini. The members of Vespertilionini (*Vespertilio, Hypsugo, Vespadelus, Chalinolobus, Nyctophilius, Tylonyceteris, Philetor*) and the Pipistrellini (*Nyctalus, Pipistrellus* subgenus *Pipistrellus, Scotozous, Glischropus*) are clearly separated from the others by the presence of two common chromosomal rearrangements. Equally, they can be distinguished from each other by means of karyological features. From the results of the chromosomal studies, the following taxanomic implications can be drawn: The genus *Eptesicus* does neither belong to the Pipistrellini nor to the Vespertilionini. Therefore, it has provisionally been placed into the "Nycticeini", which is presumably a polyphyletic group. To avoid a polyphyletic state of the genus Pipistrellus, the subgenera *Vespadelus* and *Hypsugo*, both belonging to the Vespertilionini, have to be raised to the generic level.

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Bat Activity in Relation to Habitat Structure and Insect Prey Availability in a Mixed Lowland Woodland

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Most of the 15 species of Vespertilionid bat in Britain are known to use woodlands. However, little is known about the habitat use and preferences of individual species. This study investigated bat activity related to habitat structure in a mixed lowland woodland.

The habitat requirements of woodland bats were studied by investigating bat activity, insect prey availability and vegetational structure in 6 discrete habitat types; oak woodland, coniferous plantation, felled/restock areas, woodland rides/glades, riparian/pond habitats and pasture. Results suggest that there are significant differences in vegetational structural complexity and insect availability between habitats. Greater numbers of large (> 10 millimeters) insects were found over ponds. Bats utilize pond and woodland ride habitats significantly more

than others and bat activity increased with increasing ambient night temperature. Bat activity was significantly related to insect size, insect abundance at ground level, and vegetation in the lower shrub layer (2-4 meters). It may be possible to predict bat activity and habitat selection from knowledge of vegetational structure.

SUMMARY

Most British bats are known to use woodlands, however little is known about the habitat preferences of individual species. Bat activity was investigated in a mixed lowland woodland between mid-July and mid-September 1989 using a QMC S200 bat detector. Daubentons, Leisler's, Noctule, Pipistrelle, and Serotine Bats were positively identified in some habitats. Brown Long-eared and Natterer's Bats were unconfirmed. The woodland was divided into 6 habitats and significant differences in activity were found between and within habitats. Greatest activity occurred over ponds and in woodland rides. Activity in preferred sites increased with an increase in minimum night temperature. Variability in bat activity between and within habitats is probably explained by an increase in insect species diversity and density in pond and woodland ride habitats, suggesting that the creation and sensitive management of these habitat types will enhance woodlands for foraging bats.

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Biostalactites-Bat Origin Organic Stalactites

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In an attic of a local school building at Sokole Pole near Janow (Southern Poland) I found, in summer of 1986, unusual epigenetic structures in the form of thickened stalactite tubes and infiltration coats covering beams of a roof structure. At the south end of the attic, a 10 cm wide gap between the reinforced concrete beams of the ceiling structure is inhabited in summer (June-August) by a breeding colony of about 200 mouse-eared bats, i.e. females with their offspring. Two and a half metres of all the inner and lower surfaces of the beams were covered by a layer of yellow-brown infiltration coats and stalactities. The lengths of the stalactites range from 1.5 to 9.0 cm, being 3.88 on the average. They have been formed during the last thirty years. The stalactites (speleothems) are very hard and show crystalline fracture. Its origin is undoubtedly related to the presence of bats in the attic. The stalactites remained "active" only in summer to dry up later when the bats leave and they stayed dry irrespective of climatic conditions until the bats returned in June the next year.

The above described speleothems are probably composed of crystals of urea, but their exact mineralogical composition is not known. There may be some other components washed out by urea from the underlying material. The literature offers only one report about a stalactite form associated with the presence of a colony of bats. In 1957, A. Kolb described deposits on a wooden beam of a roof structure inhabited by a breeding colony of Mouse-eared bats. A 30 cm wide infiltration coat was formed there. In his opinion the infiltrations were formed only by the urine of subadult bats born in the breeding colony. It seems that the structures I found have been formed in the same way. The differences ie. the prevalence of stalactites over infiltration coats may result from the differences in the underlying materials.

This scarcity of information indicates how rare such structures are. It is probable that their growth requires numerous favorable factors present at the same time: very low humidity of both air and underlying material, neither too few nor too many animals in the colony (in both cases the colonies numbered about 200 individuals) that could ensure a steady but not too intensive influx of organic matter. Low humidity of the environment enables complete drying of the infiltrations after the bats leave, and does prevent corrosion. I would recommend the term "biostalactites" for such formations.

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Chiropterological Information Center: Three Years of Activity

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The Chiropterological Information Center (C.I.C.) was established in May, 1987, by B. W. Wokoszyn, first as an informal institution, and one year later in May of 1988, it was incorporated to the Institute of Systematic and Experimental Zoology (now Institute of Animal Systematics and Evolution) Polish Academy of Sciences in Krakow. The C.I.C. is located now as a Laboratory in the Institute of Animal Systematic and Evolution of Polish Academy of Sciences, 31-016 Krakow, Slawkowska 17, Poland.

Because of severely limited financial support the staff of the C.I.C. is currently limited to only two persons: Dr. Bronislaw W. Wokoszyn, D.Sc., head of the C.I.C., and Danuta Wokoszyn, M. Sc., the C.I.C. secretary. Dr. Wincenty Harmata, D. Sc., Associate Professor of the Jagiellonian University in Krakow, also cooperates with C.I.C., as scientific advisor on bat banding problems, and Dr. Peter Lina from Holland as co-organizer of IBEN Expedition to the "Nietoperek" - reserve. More than fifty professionals and amateur chiroptologists cooperate with the C.I.C. throughout Poland.

The main goals of the C.I.C. is to put on line all information on bats in Poland, promote systematic and biogeographical study on bats, and consult and cooperation with the government and scientific institutions on the protection of bats in Poland. The C.I.C. prepared three bat censuses which were presented at the Fifth International Theriological Congress in Rome (1989) and the results of a third census, DSN' 90, during this European Bat Conference. It is planned to continue these censuses as formerly, in the first half of February of subsequent years. The C.I.C. also organized three international expeditions to the famous "Nietoperek" reserve in western Poland. Twenty six chiropterologists from five countries took part in the three expeditions (IBEN'88, IBEN'89 and IBEN'90 respectively). Another area of activity of C.I.C. is to help to create local groups of amateur chiropterologists. Two such groups were created last year in Poznan and Warsaw respectively.

The center edits two journals; the C.I.C. Bulletin (two times a year)and a quarterly annex to the Polish monthly naturalist magazine "Wszechswiat" (The Universe), named "Wszechswiat Nietoperzy" (The Universe of Bats). Both published in Polish., The C.I.C. Bulletin is distributed free of charge among professional and amateur chiropterologists and also to the national and landscape parks in Poland. Since 1987 about 80 short notices, abstracts and critical reviews were published in both journals on bats and bat research carried out in Poland and other countries.

The financial situation is such that funding has continued as the preoccupying feature throughout the years. Partial financial support was obtained from various sources. During the years 1988-89 from the "Man and Environment" Research Committee of Polish Academy of Sciences. and1989-90 we received financial support from the Second Dept. of Biological Sciences of the Polish Academy of Sciences. But a substantial proportion of research and organization activities of the C.I.C. were realized by volunteers, the majority of them being amateurs, i.e., students and pupils of several Polish universities and colleges. In spite of difficult financial situation, the research and popularization programs of the C.I.C. have progressed with initiative and vigor.

The C.I.C. operates mainly in Poland, but has many relations to institutions and specialists in Europe and other continents. The principal groups are the Chiroptera Specialist Group at IUCN; the Bat Research Foundation - Bat Support Fund; Bat Conservation International in Austin, Texas); and The Robert Stebbings Consultancy in the United Kingdom. The support offered by the European Bat Research Foundation is also most important, above all for supplying us many recent publications and instruments (i.e. mist-nets, ultrasonic detectors, etc.).

Monitoring the Underground Hibernation Sites of Bats in Poland, Winter 1990

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The Chiropterological Information Center at the Institute of Animal Systematic and Evolution, Polish Academy of Sciences in Cracow, prepared three bat' sensuses in 1988 (DSN'88), 1989 (DSN'89) and 1990 (DSN'90) all carried out in the first half of February. Bats hibernating in caves, mines, cellars and tunnels were counted. The result of the two first censuses were presented during the Fifthth Theriological Congress in Rome (Woloszyn, 1989), and are shown in Table No. 1. The results of the third bat' census,DNS'90,are presented in Table No 2.

Table 1. The results of Bat' censuses DSN'88, DSN'89 and DSN'90 in Poland.

Bat census	DSN'88	DSN'89	DSN'90
# of participants	16	40	over 40
# of hibernation roosts	60	103	123
# of species	13	13	14
Total count	21,802	24,927	26,214

The most numerous winter colony has been found in a 30-km underground system at Miedzyrzecz in the "Nietoperek" reserve - Western Poland (Urbanczyk, 1989). About 90% of all bats counted hibernate there. About 3000 bats have been recorded from the remaining 122 localities. The bats censuses are an introduction to a constant monitoring of the population of bats hibernating in Poland. The censuses are planned to continue, as formerly, in the first half of February of the subsequent years.

During the past 40 years the population of bats hibernating in the caves in Poland underwent strong fluctuations. During the '60s and '70s we have observed a considerable decline of bat populations by a factor of 16, and in the case of some species, e.g. *Rhinolophus hipposideros* by a factor of 100 (Woloszyn, 1976, 1981). In the '80s we can observe a slow recuperation of the population. However, the restitution of the chiropterofauna did not maintain the former ratio between species. Some of them, especially *Myotis myotis* and *M. daubentoni* became dominants (Table 2); while others ,e.g., *Rhinolophus hipposideros* only maintain their former low numbers or increase their numbers very slowly.

Table 2
The results of bat counts in 1990 - DSN'90

Species:	Total per species	% of total
Rhinolophus hipposideros	49	0.19
Myotis myotis	9,144	34.88
M .daubentoni	13,207	50.38
M. dasycneme	2	0.01
M. nattereri	1,121	4.27
M. bechsteini	2	0.01
M. mystacinus + brandtii	60	0.23
Plecotus asutriacus	2	0.01
P. auritus	890	3.39
Barbastella barbastellus	1,289	4.92
Eptesicus serotinus	16	0.06
Vespertilio murinus	3	0.01
Pipistrellus pipistrellus	28	0.11
Chiroptera indet.	401	1.53
Total Count	26,214	100.00

The authors wish to thank all the participants of the DSN'88, DSN'89 and DSN'90 censuses for their invaluable field work and assistance.

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Acoustic Cues for Vertical Localization Encoded by the External Ear in *Eptesicus fuscus*

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To determine the acoustic directionality of the external ear of *Eptesicus fuscus*, transfer functions and impulse responses were calculated for many different azimuths and elevations. As elevation was decreased below the horizon the delay between reflection points in the impulse response increased. A change of 3° in elevation corresponded to 1 microsecond change in delay. In the frequency domain, elevation cues were represented in the transfer functions as a directionally dependent frequency notch for positions below about 10° and above this as changes in the amplitude of a broad spectral peak. There appeared to be a trade-off of vertical information between the peak and notch cue but had little effect on the pattern of the peak cue in the transfer function. It seems likely that pinna-tragus reverberations encode vertical information for positions below about 10°. Both the spectra of the echolocation call and the transfer function of the external ear have a frequency notch centered around 50 kHz in the median sagittal plane. Matching these two notches could provide the bat with a mechanism for aiming an object directly ahead.

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Standard Karyology of Fourteen Species of Vespertilionid and Molossid Bats from Eurasia

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Karyotypes of the following fourteen species of bats from the U.S.S.R., Mongolia and Vietnam are investigated: *Myotis mystacinus* (2n = 44), *M. brandti* (2n = 44), *M. blythi* (2n = 44), *Plecotus austriacus* (2n = 32), *Barbastella leucomelas* (2n = 32), *Otonycteris hemprichi* (2n = 30), *Eptesicus serotinus* (2n = 50), *E. bottae* (2n = 50), *Pipistrellus pipistrellus* (2n = 35, 36), *Hypsugo savii* (2n = 44), *Nyctalus noctula* (2n = 42), *Tadarida tenoitis* (2n = 48). Phylogenetic relationships and intraspecific karyotype variations are discussed.

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ANNOUNCEMENT

The Ninth International Bat Research Conference will be held in Madurai, India, August 3-7, 1992. For additional information contact Dr. G. Marimuthu, Department of Animal Behaviour, School of Biological Sciences, Madurai Kamaraj University, Madurai - 625 021, India; or for those in North America, Dr. Kunwar Bhatnagar, Department of Anatomy, Health Science Center, University of Louisville, Louisville, KY. 40292 (tel. 502-588-5174).

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

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The Editor regrets that the abstract below was inadvertantly left out of the published abstracts (BRN Vol 31:4, 1991) and is presented here with profound apologies to the authors. GRH

Passive Acoustic Pinna Properties and Their Relation to the Behaviour of Bats

Martin K. Obrist, Judy L. Eger, Peter Schlegel, Peter Witzke, and M. Brock Fenton.

York University and Royal Ontario Museum, Toronto, Canada and Ludwig Maximilian's University of Munich, Munich, Germany

Bats are highly dependent upon their ability to accurately localize sound sources. High frequency sound localization can be achieved by using either binaural arrival time or intensity differences. The shape and orientation of the external ears affect the sound pressure levels received at the tympanic membrane and hence the neural representation of space. The variety in echolocation and foraging in bats gives rise to the hypothesis that these differences will be reflected in the passive acoustic properties of the pinna. We measured the sound pressure transformation of the pinnae of 47 bat species from 14 families. We used alcohol preserved or frozen specimens (ROM) for the experiments. The sound pressure at the position of the tympanic membrane was registered while a speaker scanned the area ±130 degrees in azimuth and ±80 degrees in elevation in front of the bat. A frequency range of 5-125 kHz(some Hipposideridae -225 kHz)was scanned in 10 kHz steps under computer control. The measurements were repeated after removal of the pinna. From the data fields the computer extracted the directionality pattern, position of the acoustic axis, 3 dB acceptance angle, interaural intensity difference (IID) and intensity gain caused by the pinna, all in function of the scanned frequency range. The external ears of the Hipposideridae show clear tuning of their pinna gain curves to the dominant harmonic of the CF echolocation calls. Ears of Rhinolophidae exhibit this tendency to a lessor degree. This results in peaks at the frequency of the CF in either the pinna gain or the IID curves. In Emballonuridae we found clear tuning to the frequency of the first harmonic, sometimes mainly to the FM part of the calls. In the Mormoopidae only the ears of *Pteronotus parnellii* exhibit some adaptation to the sonar frequency band. Most Molossidae show only moderate domination of their call frequencies in the ear characteristics. In Desmodontidae, Natalidae, Noctilionidae, Phyllostomidae, Rhinopomatidae, Vespertilionidae, and also Pteropodidae no specialization of the pinna became obvious. Megadermatidae, Nycteridae, and the vespertilionid *Antrozous pallidus* show the highest pinna gain found at low frequencies. In *Megaderma lyra* a drop in the IID around 50 kHz coincides with decreased lateralization performance in behavioural experiments. This observation and the tuning of pinnae of CF-bats encourages us to make some predictions about so far unknown echolocation frequencies likely to be found in a few species analysed.

ANNOUNCEMENT

AND CALL FOR PAPERS

Twenty-First Annual North American Symposium on Bat Research

The 21st North American Symposium on Bat Research will be held on October 16-19, 1991, in Austin, Texas. Our hosts will be Merlin Tuttle, Patricia Morton, and Jacqueline Belwood of Bat Conservation International. ***The Crest Hotel on Town Lake*** is the official hotel for the meetings and all meeting functions, except for a possible field trip, will be held in the Crest Hotel Facilities.

Program

The past several years have shown a rather large increase in both the number of people attending the symposium and in the number of papers submitted for presentation. It has been almost impossible to schedule more that about 40 papers during a two day conference without having concurrent sessions. The assembled participants have invariably voted to have single sessions only, but even so last year at our symposium in Lincoln we had to resort to a few concurrent sessions in order to include all the titles submitted. We anticipate a similar number of papers and participants this year, and to that end, we have extended the conference to three days of presentations. This will allow a much more leisurely pace of presentation and not require an almost military adherence to an uncomfortably tight schedule. The opening social events will be held on Wednesday evening instead of Thursday as in the past, and papers will begin on Thursday morning and continue through Saturday. There may be time for an afternoon field trip to a cave in the area around Austin. Dr. Tuttle and his staff are arranging that part of the program.

Registration

Registration will be $35.00. This is $5.00 higher than last year, but we will be meeting an extra day, requiring the use of the meeting hall, coffee breaks, etc., for an extra day.

Hotel Accommodations

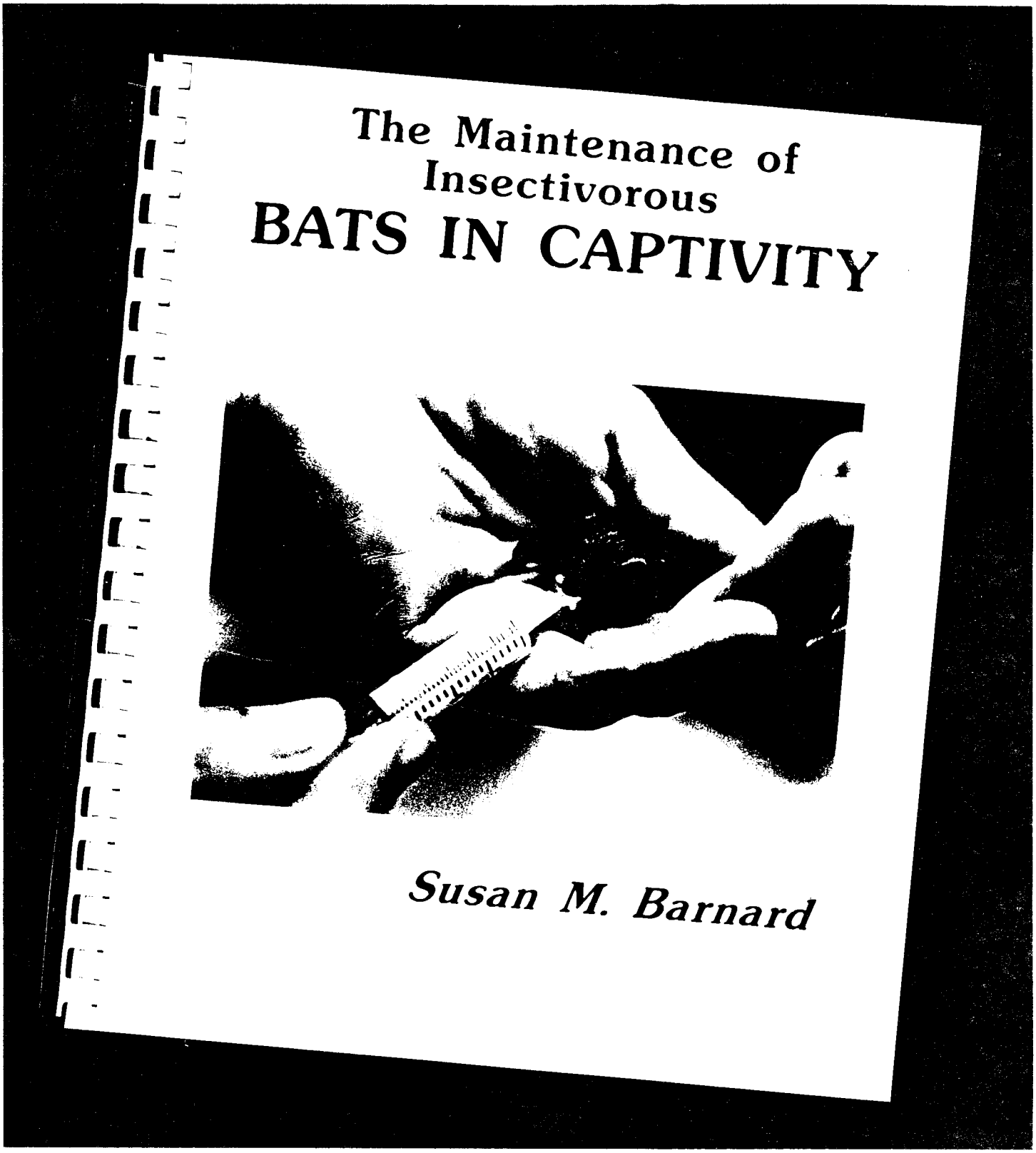
Our host hotel will be the **Crest Hotel on Town Lake,** in Austin. This is very near the famous bridge with the large colony of Tadarida. We have completed negotiating hotel rates, a banquet date, and prices for the support services provided by the hotel. Room rates will be $60.00 for a single(one person to a room); double, $65.00; triple $75.00. These rates are about one half of the hotel's regular rates. We request that you make your own reservations. The **Crest Hotel's** toll free registration number is 1-800-456-5253. Be sure to inform them that you are part of the Bat Research Symposium to assure that you get our special rates. The hotel is holding a block of rooms for us until September 16,1991, but they have requested that we make our reservations as early as possible. Reservations can always be cancelled(no charge if cancelled 24 hours in advance) in the event that you cannot attend. Please direct any and all questions concerning accommodations directly to the hotel registration desk.

Other Information

Direct any questions concerning the program to me (Roy Horst). My telephone number is 315-267-2259, or you may write to me at the Department of Biology, Potsdam College of S.U.N.Y., Potsdam, NY, 13676. I will be doing fieldwork (on bats and mongooses) in the Caribbean from August 1 to 13, and August 18 to 28. I will be in my office every day after September first. I will leave as many instructions (concerning the program) as possible with Pat Morton and Jackie Belwood at B.C.I.(512-327-9721) in the event that you have a serious scheduling problem that must be resolved before September first.

We look forward to seeing you in October in Austin.

The Maintenance of Insectivorous Bats in Captivity is an informative text for anyone caring for bats in captivity. In addition to successful methods for hand raising baby bats, contents include information on using bats for demonstrations, as well as handling, exercising, housing, feeding, transporting and rehabilitating them. Also included is a section on medical and necropsy considerations. Revised annually: 70 pp: 45 illus. Prices quoted in U.S. dollars and include postage and handling: U.S. $5, Canada $5.50, other countries $8 surface rate, $11 air mail. Available from Susan M. Bernard, 6146 Fieldcrest Drive, Morrow, GA 30260 U.S.A. SMB



BAT RESEARCH NEWS

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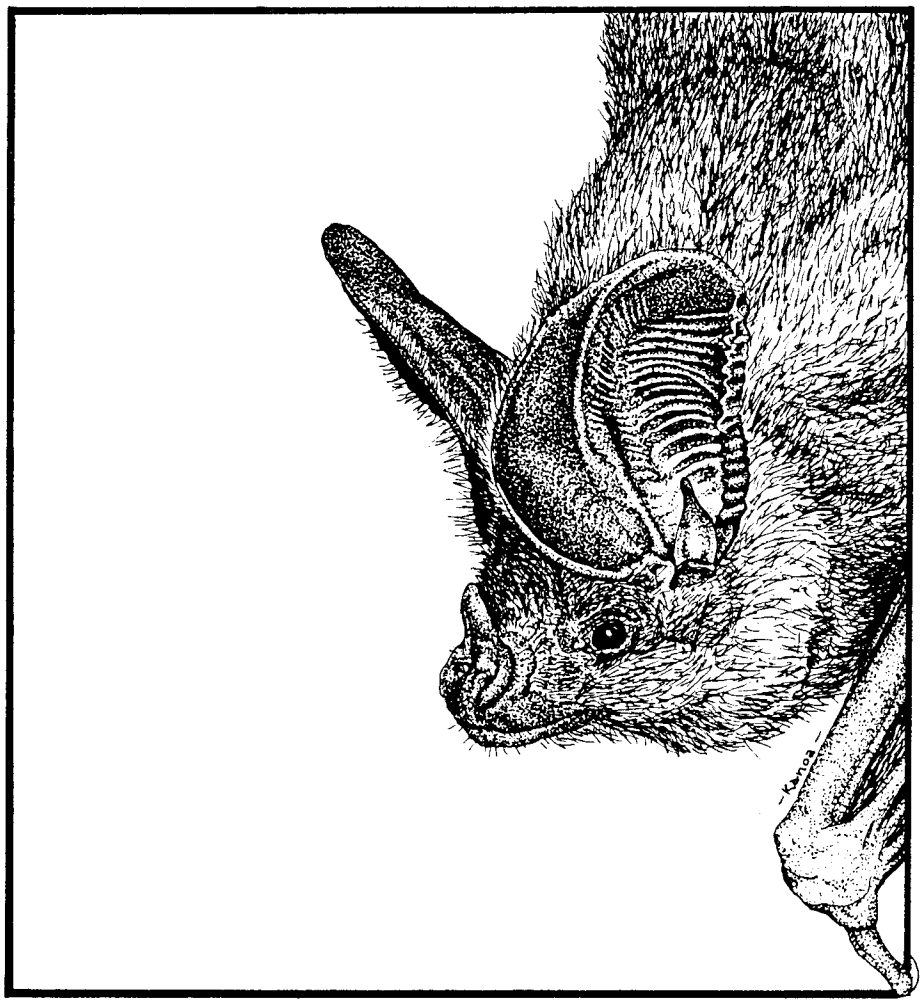

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BAT RESEARCH NEWS

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Little Brown Bat, *Myotis lucifugus*, Living in a Bluebird Box

Wayne H. Davis and Daniel Dourson

School of Biological Sciences, University of Kentucky, Lexington, KY 40506 (WHD); and U.S. Forest Service, Stanton Ranger District, Stanton, KY 40380 (DD)

On July 30, 1991, we found an adult male little brown bat, *Myotis lucifugus*, in a bluebird box at the Gladie Creek Historical Area in the Red River Gorge, Menifee County, Kentucky. The box has a slot entrance 10 cm x 3 cm, formed by having the front extend to within 3 cm of the flat roof which overhangs the entrance by 5 cm. The bat was resting on the floor, 10 cm below the entrance. The box is 1.2 m above ground facing south in a mowed field where there is no shade. The more than 40 droppings suggested that this was the bat's regular roost.

Moriarty and Davis (1984) reported the use of similar boxes by *Myotis septentrionalis* on reclaimed surface mines in eastern Kentucky. There the boxes provided the only shelter on an extensive area of artificial grassland and ponds, and it appeared as if bats stopped in occasionally; there were no accumulated droppings.

At Gladie Creek, on the other hand, there were good alternate roost sites. As a part of the U.S. Forest Service's efforts to create a watchable wildlife area at Gladie Creek, we had built and erected a large bat house of the type used by LaVal and LaVal (1980) to attract *Myotis lucifugus*, and had placed two bat boxes similar to those designed by Bat Conservation International in one of the two old barns on the property. We had also fastened a 1 x 3 m strip of tar paper on the inside wall of the barn to attract bats. Except for traces of usage of the tar paper (3 droppings), none of these efforts had yet been successful when we found the bat residing in the bluebird box.

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A Letter from the Editors

During the past year there has been a noticeable shortage of items submitted for publication as articles in ***Bat Research News.*** We presume that this reflects your busy schedules and your preference to publish your work in more prestigious journals, and we do not in any way wish to discourage you from such publication, it is after all how one establishes one's credentials and reaches a wider audience. It would seem however that many of you must have a short article or two lying around which may not be of interest to such journals as *Nature, Science, the Journal of Mammalogy, etc.,* but would still be of great interest to our readers. ***Bat Research News*** is currently reaching an audience of nearly 700 subscribers in 46 countries around the world, and in some cases may be the only publication containing bat oriented articles that a reader has available. ***Bat Research News*** is well received by its readers and is one of the few little journals that is probably read cover to cover shortly after arrival. We strongly encourage you to polish up those little tidbits and send them in, we will make every effort to help them see the light of day.

Tom and I are the first to recognize that in the past we have not always been very prompt at publishing ***Bat Research News***; even this issue is several months late. We have, since the meeting in Austin last October, added an additional Editor for Feature Articles, Allen Kurta of Eastern Michigan University, and he will see to it that these articles are reviewed, edited if necessary, and prepared for publication quickly. We have also reorganized the way we set up the publication and are now using a computer software package that practically does all the work for us.

So why is this issue so late? We have but a single article to present to you, along with the recent literature section, and assorted announcements. The next issue, already being prepared will include all the abstracts from the Symposium in Austin in October. That issue has been delayed somewhat by our agreement to allow authors to rewrite their abstracts(some of whom were not very punctual); they are now ready and that issue should arrive in February.

We also have received very little in the way of news from any of you. Surely most of you are doing very exciting things with bats, going on field trips, starting new projects, going to conferences, presenting short courses, or designing new techniques that you might like to share with the rest of us. Even items that are merely anecdotal in nature would be welcome. For example, it would have been very interesting(and we still look forward to seeing such an article) to hear the details of Emily Mobley's ordeal in the cave in New Mexico in her own words. How about it Emily? I'm sure the rest of you **all** have something that the rest of us would like you to share with us. A humorous idea that has been suggested is that we choose by drawing lots, five or ten of you each issue, ask you for a news article, and if after an appropriate time we have not received a response, a committee (chaired by none other than Brock Fenton) will write an article for you, exercising whatever journalistic license that they see fit. We are sure we will not have to resort to this novel approach. Seriously, please take a few minutes to fill out the ***News Form*** that is tucked in this issue and send it to Roy Horst. Send any copies of articles or titles that you feel should be included in the *'Recent Literature'* section to Tom Griffiths, and send feature articles to Allen Kurta. We have the capacity to read both IBM compatible and Macintosh software if you wish to send your contributions on small floppy discs. Within the next month Horst will also be set-up so that you can submit articles by E-mail. That address will be included in the next issue. Our addresses, phone numbers, and FAX numbers are inside the front cover.

We hope that ***Bat Research News*** will live up to its title, and not become *Bat Research History*. Tom and Al and I are all resolved to work even harder to keep your little journal coming to you in as timely a fashion as possible. We can only make it more interesting, informative, and useful with your help. Please help us to make this ***your*** journal and not merely something that "arrives in the mail on occasion". We thank you in advance for your efforts on behalf of all your colleagues who subscribe to ***Bat Research News.*** T.G., A.K., and R.H.

Announcement

The 22nd Annual North American Symposium on Bat Research

Dates: October 21 to 24, 1992

Host: Dr. Donald Thomas of Universite de Sherbrooke

Site: Le Chateau Frontenac in Quebec City, Quebec, Canada

At the last symposium in Austin in October, 1991, we received and accepted an invitation from Tom Kunz on behalf of the University of Florida and the Lubey Foundation in Gainesville to hold our 22nd symposium in Gainesville, Florida, on whichever weekend was most convenient concerning hotel accommodations, conflicts with home football games, etc. Upon my return from Austin, I began inquiries of the local hotels and was informed that every weekend in October 1992 was already booked to capacity. Upon consultation with the University of Florida I learned that in 1992 there will be home football games every weekend in October and also the first weekend in November. It is virtually impossible to obtain rooms in a city the size of Gainesville when competing with 80,000 football fans for hotel space.

After consulting with other possible hosts who had expressed interest in hosting the symposium "sometime in the future". Don Thomas of the Universite de Sherbrooke has agreed to be our host. After more consultation with several of the senior members of the group, and with Tom Kunz, we have accepted Don's invitation. The dates will be Wednesday evening, October 21 to Saturday evening, October 24, 1992. The site of the Symposium will be at Le Chateau Frontenac in Quebec City.

The room rates for the bat symposium participants will be approximately $98(U.S.) per night for two persons in one room(two beds), slightly more for three persons in one room. This includes all taxes.

The Chateau is a Canadian Pacific Hotel, and a grand old landmark of this grand old city. It is situated in the heart of the 'old town', surrounded by shops, restaurants, pubs, and other sorts of entertainment, limited only by your imagination and your funds. The hotel stands on the eastern edge of the historic Plains of Abraham above the Saint Lawrence river where Generals Wolfe and Montcalm fought their epic battle. The hotel has many conference rooms, exhibition halls, and several restaurants. It regularly hosts conferences of as many as a thousand participants and can easily accommodate all our needs. This is the off-season in Quebec, and the rates are very reasonable for an establishment such as this. Quebec City is a major international gateway to Europe and the rest of Canada and has a large well-served airport. The local language is of course French, but nearly all those with whom we are likely to come in contact are bi-lingual.

More detailed information will appear in each succeeding issue of ***Bat Research News,*** and you will receive a mailing of all forms that you will need for symposium registration, submitting titles, abstracts, etc., as well as registration at the hotel, in early April, 1992. G. Roy Horst

RECENT LITERATURE

Authors are requested to send reprints of their papers to the Editor (Tom Griffiths, Dept. of Biology, Illinois Wesleyan Univ., Bloomington, IL. 61702-2900, U.S.A.) for inclusion in this section. Receipt of reprints 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 welecome.

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REQUEST FOR SPECIMENS

Dr. Thomas Quinn of Creighton University in Omaha, Nebraska, is interested in examining preserved specimens from the Craseonycteriidae and Mystacinidae. If you have specimens from these taxa that you can lend to him, please call him at 402-280-2965.

MEETING ANNOUNCEMENTS

The Ninth International Bat Research Conference

will be held in Madurai, India, August 3-7, 1992. For additional information contact Dr. G. Marimuthu, Department of Animal Behaviour, School of Biological Sciences, Madurai Kamaraj University, Madurai - 625 021, India; or for those in North America, Dr. Kunwar Bhatnagar, Department of Anatomy, Health Science Center, University of Louisville, Louisville, KY. 40292 (tel. 502-588-5174).

The Sixth International Theriological Congress

will meet in Sydney, Australia, July 4 to July 10, 1993. The conference will be held at the University of New South Wales in Sydney. It is anticipated that the conference will include symposia and workshops on the biology of bats. Registration fee is $350 (Australian dollars) and lodging at the University will be approximately $38A per day for bed and breakfast. Tours and activities for non-participants are being arranged, as are pre-conference and post-conference tours. Those interested in receiving additional information and details of registration should contact Barry Fox or Mike Augee, both of the School of Biological Science, University of New South Wales, Sydney, Australia.

The Sixth European Bat Research Symposium

is being planned for August, 1993 to be held in Lisbon, Portugual. The prospective host is Jorge Palmeirim of the Department of Zoology, Faculty of Sciences, University of Lisboa, 1700 Lisboa, Portugal. The exact dates are not available at this time, but those who may be planning to attend both this meeting and the Congress in Australia(above) should contact Jorge at the first opportunity. Presumably these two dates will not be in conflict.

The 72nd Annual Meeting of the American Society of Mammalogists

meets June 14-18, 1992 at the University of Utah in Salt Lake City, Utah, 84112. Many good bat papers are anticipated. Eric Rickart and Carol Rowsemitt are co-chairs of the Local Committee and all inquiries should be addressed to them. Rickart's address: Museum of Natural History ,TEL:801-581-6927, FAX 801-585-3684. Rowsemitt's address: Dept of Biology, TEL:801-581-8608, FAX 801-581-4668. Both are at the University of Utah, Salt Lake City, UT 84112. Watch these pages for updates as they become available

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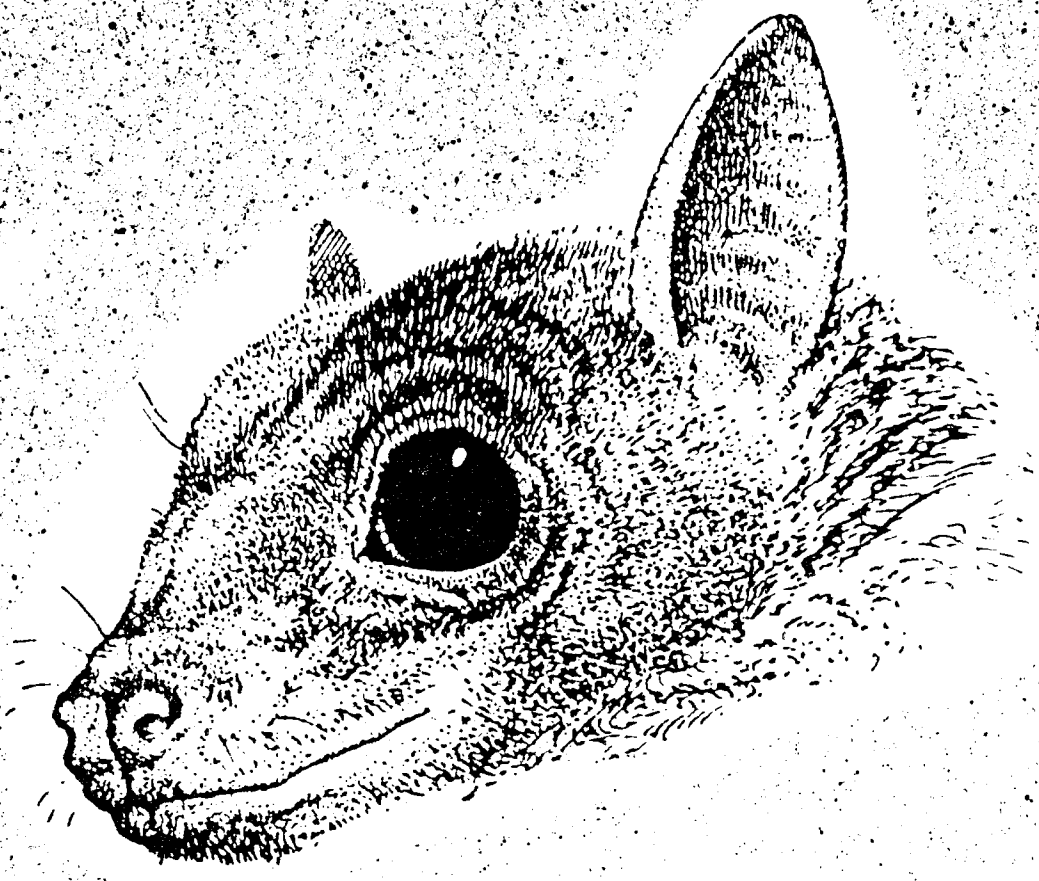
FRONT COVER

The illustration on the front cover, of *Macrotus californicus*, was generously provided by KANOA - Kim Duffek of 2601 North Lloyd Bush Road, Tucson, Arizona. 85745 Kim is interested in doing artwork for bat publications. She can be contacted at 602-743-7905.

BAT RESEARCH NEWS



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BAT RESEARCH NEWS

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A Rare Sighting of a Python Ingesting a Flying Fox *Pteropus giganteus* from a Natural Colony

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The Indian flying fox, *Pteropus giganteus,* is widely distributed throughout India. It is one of the largest frugivorous bats in the world. Indian flying foxes live in colonies consisting of hundreds and often thousands of individuals in large trees, observing a strict hierarchy of position of each individual in the tree. The dominant alpha male occupies the highest branch or twig of the tree that can sustain its weight. It is proper to state that *Pteropus giganteus* is the most visible of Indian bats, conspicuously hanging from tree branches and bamboo clumps in broad daylight, noisily interacting with conspecifics and flying around the tree any time of the day. The social behaviour of a colony of *Pteropus giganteus* living in the Ameer Mahal Palace in Madras has been studied by Neuweiler (1969). It has been speculated that these bats did not have any natural predators except humans who shoot or capture them for their meat which is believed to cure rheumatism (Brosset, 1962). These huge bats often face death by electrocution when they get entangled in live overhead electric wires while flying low at night (Khajuria, 1979). Fortunately, in a few parts of India, people consider the flying foxes to be sacred and guard against their being killed (Marimuthu, 1988).

We report here a rare and fortuitous sighting of a snake (*Python sp.*) swallowing a flying fox, from a natural colony on a late afternoon. The huge colony, consisting of about 3000 members of both sexes and mixed age, occupied the higher branches of tall trees growing in the Alagarkoil hills. The hills are a nature preserve situated nearly 25 km northwest of Madurai (lat 9o 58'N long 78o 10'E) with an average altitude of 200 m. Most of the hill country is covered with forests and scrub jungle and is home to several rare species of butterflies, beetles, spiders and a pill millipede. A popular Hindu temple is situated just 200 m away from the daytime roosting site of the colony of flying foxes; the bats must therefore be accustomed to the activities of the daily throngs of devotees. On 20th November 1991 we visited Alagarkoil and looked up the flying foxes in the afternoon at 17.00 h. The bats were autogrooming and fanning themselves by silently flapping their wings. The majority of individuals hanging from the branches of one of the trees were flying obstreperously around and high above the tree. All of a sudden, what seemed like the horizontal branch of the tree at a height of about 15 m seemed to slowly move forward. We also noticed that a bat in the moving branch was

also frantically flapping its wings. The head of the bat was not visible to us in our position on the ground. We suddenly realised that the flying fox had just been captured by a huge snake about 1.5 m in length. The snake was a python and it was obviously ingesting the flying fox head first. Hence the frenzied flapping of the wings of the rest of the bat. The snake succeeded in swallowing the prey in its entirety in about 45 min, dropping at the end of its meal just the membranous wings. The other bats continued to execute their noisy flight around the top of the trees and did not seem to be aware of the plight of their hapless conspecific. By about 18.30 h all the individuals of the colony were flying around well above the tree tops and started to head towards southwest in sizeable numbers apparently to reach the foraging areas and orchards. Nightfall arrived quickly thereafter.

We are not sure that *Pteropus giganteus* is a staple or even principal element of the python's diet. These flying foxes are alert to any kind of disturbance even though they roost in colonies adjacent to busy human settlements. The whole colony becomess restless and may even fly away as soon as a man tries to climb the tree from which the members hang. The python apparently slithered up the branches silently and slowly, then lunged at the right moment to snap the head of the flying fox and then make a leisurely meal of it. We have neither heard it narrated nor read in literature previously about a python preying upon a flying fox.

This study was supported by a grant from DOEn, Government of India to G.M.

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Book Review

Grzimek's Encyclopedia. Mammals, Vol. 1. McGraw Hill Publishing Company, New York. 648 pp. English language version, 1990. (Price unknown)

This massive, richly illustrated volume is the first of six volumes that detail the lives of wild mammals. Bernhard Grizmek died in early 1987, one year before the original German version of this first volume appeared, but clearly was its guiding spirit from conception to birth. The series follows the tremendously successful 16 -volume series entitled "Grizmek's Encyclopedia of Animal Life", which is one of the most popular and widely used references for the serious amateur biologist and student. The current series is a multi -authored compilation that follows the same format, but focuses exclusively on mammals.

Volume 1 consists of a lengthy (189 page) introduction to the biology of mammals, 18 pages on monotremes, 186 pages on marsupials, a brief introduction to the "higher mammals", 118 pages on insectivores, 100 pages on bats, and 8 on dermopterans. All sections contain beautiful photographs that illustrate and enliven portions of the text, and full-color drawings of anatomical features make the reading easy for non-specialists.

As I read the text, I quickly became aware that it presented a perspective that I know rather poorly, and that I found quite fascinating. The book has been written by northern and central Europeans, with a strong focus on the animals with which they are most familiar but bringing in species from other geographic regions to round out the picture. All of the authors of the bat sections are among the "grand old men" of German mammalogy, with a wealth of personal knowledge and experience. There is an introduction by Erwin Kulzer, a brief section on paleontology by Erich Thenius, and the main section by Erwin Kulzer and Uwe Schmidt. As is so often the case, it seems that the greatest strength of the book is also its greatest weakness. The book draws very heavily on research carried out by northern Europeans, principally Germans, thereby

containing information about species that North Americans know poorly, and presenting a summary of the traditional German-language perspective on biological research that is rarely addressed by current English-language approaches. The weakness is that it generally fails to utilize either the approaches or information embodied in the other language/cultural traditions.

The bat sections begin with an excellent, easily read description of the gross anatomy of bats. This is followed by a very brief summary of what little is known about the early fossil history of bats and the classification of bats, under the misleading section heading of "phylogeny" (phylogeny is not addressed anywhere in the text). There follows a series of discussions of various aspects of the biology of bats, the best being "bat flight" (wing morphology and flight aerodynamics), diet (including a gratifyingly horrific description of blood-feeding by vampire bats), echolocation (with some fine examples of the extraordinary sensitivity of bat auditory perception), delayed fertilization/implantation/development, and hibernation. Sections on roosting sites, population dynamics, behavior, and conservation biology contain much interesting information on European bats, but suffer from lack of use of better information from other regions. There is also an excellent tabular summary of the life history traits, habitat, and conservation status of all western and central European species.

What emerges from all of this is a strong picture of bat biology in the Germanic tradition, with strong emphases on basic natural history and descriptive morphology, physiology, and behavior. It is a broad, integrated view that addresses nearly every aspect of anatomy, physiology, ecology, and behavior. It is also almost entirely different from the viewpoint I would expect from a young American biologist. For example, the following topics are not covered, or at least mentioned in a context different from what one sees in current American journals: functional morphology, phylogeny, foraging strategies, energetics, life-history tactics, behavioral ecology, evolutionary biogeography, and epidemiology.

Feeling rather smug about this, I pulled out of my bookcase Eisenberg's "Mammalian Radiations" and Vaughn's "Mammalogy", and scanned them for their views of bat biology. What I found was nearly as surprising as what I had seen in Grizmek's Encyclopedia. Almost no reference was made to the Germanic literature, and little to European species. More comprehensive, technical volumes such as "Ecology of Bats" and "Ecological and Behavioral Methods for the Study of Bats", both edited by Kunz, referred to the Germanic literature, but it seemed to be underutilized. The strong perspective built by the northern and central Europeans during the 1930s, -40s, and -50s seems to have been lost to current American literature as completely as our recent literature has been lost to the senior German community.

For this reason, I heartily recommend that all students of bat biology read this book. It is lively and entertaining, and is unlikely that you will leave it without a better sense of what knowledge has been gained in recent years by English-speaking biologists, and what we may loose if we do not pay attention to other traditions.

I cannot end this without a few comments on the usual stuff of reviews. Although the translation from German to English was generally excellent, a number of oddities crept into the text in the process. For example, microchiropteran bats are referred to throughout the text as "insectivorous bats", even when it leads to such phrases as "fruit -eating insectivorous bats" as a name for some phyllostomids. I was somewhat amused to see bats referred to as being "in rut" and having a "brooding season", and reference being made to bats feeding on butterflies (from the German use of a word that includes moths). Errors were generally minor. Old World fruit bats do not have "no tail at all or only a vestigial tail;" many have quite stout, moderately long tails that seem to be quite functional. Not all bats have teeth that are fully erupted by the age of one month. The assertion that all Old World fruit bats "simply land belly-first on a branch" is definitely not true. All 15 or so species I've seen swoop up and land gently, usually on a cluster of leaves. The statement that the vast majority of insectivorous bats prefer to roost in caves appears to have a strong north -temperate zone bias, as does the comment

that horseshoe bats prefer to roost in the "unused lofts of forts, castles, and churches" (I've seen nary a one in castles in the tropics!).

On a more substantive level, I was uneasy with the often-stated assumption of the authors that the ancestral bats were insectivorous; given that many systematists view the herbivorous/frugivorous dermopterans as the likely sister-group and the frugivorous/nectarivorous pteropodids as the more "primitive" of the living suborders, I felt that a more broadly-based approach was in order. The "old chiropterologist's tale" that female bats roosting in huge colonies nurse babies at random because they cannot locate their own babies is unfortunately repeated. The authors correctly describe the varying sizes of groups in which bats live, but refer to some as being solitary. I doubt that any bats are truly solitary, and two of their "prime examples", Macroglossus and Ptenochirus, are definitely not (they live in small groups).

I was much struck by several bits of information: bats are the only organisms able to actively control the camber of their wings; some species may be able to discriminate between drilled 1mm holes in wood that have smooth bottoms versus those that have rough bottoms; and the annual migration of common noctules from central Russia to Bulgaria covers 1400 miles in about two weeks!

All in all, I recommend this volume highly as a source of information and entertainment, and, more importantly, as a window on a scientific tradition that is too infrequently utilized in current American literature.

Lawrence R. Heaney, Department of Zoology, Field Museum of Natural History, Roosevelt Road at Lake Shore Drive, Chicago, IL 60605.

GOING TO MADURAI ?

Everyone will have noticed that between 3 and 7 August 1992, the 9th International Conference on Bat Research will be held on the campus of Madurai Kamaraj University. The university is situated just outside the city of Madurai in Tamil Nadu Province of India. There are direct flights to Madras from several points in Europe and from there it is easy to connect to Madurai by air or by rail. For those seeking adventure, it also is possible to travel by vehicle, having hired a car and driver.

Between 26 February and 6 March 1991, I had the distinct pleasure of visiting the campus and the Department of Animal behavior and Physiology. I highly recommend the venue for the meeting and the colleagues who are organizing the conference. Furthermore, there are some interesting bats (is there any other kind?) and bat sites to be seen in and around Madurai. If you have a yen to see *Rhinopoma hardwickei, Megaderma lyra, Taphozous nudiventris, Taphozour melanopogon, Hipposideros bicolor, Hipposideros speoris, Cynopterus sphinx, Pteropus giganteus,* and *Pipistrellus mimus,* then Madurai is a good place to be.

My experience suggests a few pointers which visitors to Madurai could find useful. The first is a mosquito net for your bed. Believe me, the mosquitoes there are something else and a net will give you a shot at a good night's sleep. You can buy nets locally, they cost about 125 ruppees.

The second concerns changing money. While buying rupees is easy and quick at the airport in Madras, doing this in Madurai is a process that redefines your definition of eternity. When I was there, there was no place on campus to change money. The banks have interesting hours and the ritual for changing money there is both routine and time-consuming. Please remember that you do need your passport to change money, and your signature on the passport should match the one on the traveller's cheque. Also remember that the bank officials may ask for receipts to prove that you are the one who purchased the traveller's cheques. It was entertaining to

watch people who were not prepared for these eventualities as they tried to buy rupees.

The third is taking note of the fact that the Madurai Kamaraj University campus is dry (in more than one sense of the word). But there is, in a nearby village a store that sells beer and spirits. The people at the guest houses on campus do not appear offended by the notion of beer being stored in their refrigerators.

If you have a choice between staying on campus and staying in Madurai, itself, remember that getting from the city to the campus requires about 40 minutes of driving. The traffic offers many exciting photographic opportunities.

So.....bring your mosquito netting, your camera and lots of film. See you in Madurai.

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York University, North York,
Ontario, Canada M3J 1P3

News from Wherever Good and Interesting Things are Happening

from Illinois

Tom Griffiths (your editor, remember him) writes, "I am continuing my long-term research project, the ultimate aim of which is to examine the hyoid anatomy of nearly every genus of microchiropteran bat and construct a cladogram based on hyoid morphology. To date, I have published on some phyllostomids, nycterids, rhinolophids, and a few vespertilionids, but have not yet performed a cladistic analysis of those data. I have finished completely the emballonurids and rhinopomatids and have published complete cladograms for the families. A paper on all megadermatid genera is in press in the AMNH Novitates. Very soon I will have finished a manuscript in progress on all rhinolophids and nycterids, thus completing roughly half of all microchiropteran genera. One continuing source of frustration: I still have not dissected even a single example of *Craseonycteris*. With the data I have in hand from emballonurids and rhinopomatids, I am reasonably certain that a single glance at the hyoid region of *Craseonycteris* would reveal an enormous amount about the phylogenetic relationships of this enigmatic bat.

from New York

"This past August John Hermanson and Bill Schutt of Cornell University and Jim Ryan of Hobart and Smith Colleges returned from a successful field trip to Trinidad where they collected 20 species of bats. Although most bats were released, a small number of specimens collected (including *Artibeus jamaicensis, Desmodus rotundus,* and *Carollia perspicillata*) are currently being utilized in studies on the biology of bat flight muscles, motoneruon control mechanisms, and hind limb functional morphology. During their visit to Trinidad, the trio enjoyed the hospitality of Farouk Muridali, Carol James, and Graham White and they visited such intriguing sites as Tamara Cave, the Asa Wright Nature Centre and the Pointe-a-Pierre Wild Fowl Trust. In other developments at Cornell, Paul Faure is studying gleaning behavior in tropical bats in Ecuador and Nina Ingle has returned to the Phillippines to embark on some field studies for her dissertation project. We all miss her and we wish her the very best of luck in her endeavors." William A. Schutt, Jr.

from Quebec

Don Thomas sends along the news that he and Roy are very busy getting all the details worked out for the next Bat Symposium in October. He is busy sampling all the better restaurants in the area around the hotel Chateaux Frontenac, so that a list can be ready by October. Plans are coming along nicely and there are only a few hundred restaurants left to survey.

from Kentucky

Wayne Davis, the founder of ***Bat Research News*** , writes, "The LaVal bat house, which involves a major construction project with $300 worth of materials, is an attractive and impressive looking structure which surely must be attractive to bats. My son-in-law who is a home builder and I have built a couple of these houses. The first went up in July 1990 at the Kentucky Department

of Fish and Wildlife Resources in Frankfort. The second was constructed in May, 1991 in the Daniel Boone National Forest. The people at the U. S. Forest Service liked it so well that they requested a couple more in their 1992 budget. We have prospects for several more. We like to build them. During 1991 a colony of *Myotis lucifugus* moved into the one at Frankfort. We are at the ragged southern edge of the summer range of the species where colonies are scarce and local, so we are especially pleased with this success." Wayne H. Davis

from New Jersey

In July, Ray Davis, who has been photographing a *Myotis lucifugus* colony for the past two years in central New Jersey, captured on film a female exiting the roost with a baby attached. He also shot a series of rather spectacular photographs of a *Myotis lucifugus* bearing down on a mosquito.

This past July three graduates of Bat Conservation International's 1990 ten day long Bat Field Study Workshop (and students of field applications of Fentonesque Limerickology) put their brand new bat surveying skills to work; Eileen Miller, Gail Zippilli and Sue Ellis set up the first habitat use survey conducted in southern New jersey in recent history. Three other intrepid surveyors participated: Rick Dutko of New Jersey's Division of Parks and Forestry, and Alice and Francis Ellis, who built harp traps. The fields adjacent to Atlantic Coastal Forest(Pine Barrens) and rural agricultural fields were heavily used by *Eptesicus fuscus, Lasiurus borealis* and *L. cinereus.* The suburban habitat showed high use levels by *E. fuscus* while the coastal salt marsh habitat saw very low use by this species only.

Plunging into yet deeper guano for an ecology course project, Sue Ellis began collecting and analyzing *E. f. fuscus* feces in August to determine monthly changes in prey consumption in one southern New Jersey aggregation. She discovered that not only can fecal analysis become obsessive-compulsive, but that a large majority of the bats' diets consist of agricultural pests such as Chrysomelidae (leaf beetles), Scarabaeidae (June beetles), and Pentatomatidae (stinkbugs). Assorted Diptera and Lepidoptera become more frequently consumed toward the onset of winter. She has plans to continue the study as spring approaches, incorporating more site data, and would be happy to receive the address of the east coast chapter of Fecal Analysis Anonymous.

From Pennsylvania

"We are attempting to call a meeting in spring of 1992 of bat researchers in Pennsylvania, the Pennsylvania State Game Commision, animal rehabilitators and educators from environmental centers and zoos who are interested in forming a more effective sharing of information and help for bats. We are also seeking a more efficient way of working with the public. We know of Paul Racey's work in Scotland and Robert Stebbings' work in England. Has any other state or province been able to form such a group to work effectively together?" If interested in sharing information please contact Lois Sakolsky, 221 Parker Drive, Pittsburgh, PA 15216, U.S.A

from California

Steve Gellman is currently working on two projects: one involves the potential use of old growth redwood hollows, i.e., the entrances and hollows(cave analog) at the bases of redwood trees that are potential roosting habitat for a variety of bat species. There are approximately 200-300 of these on one research site along the northern coast of California. Of particular interest is Townsend's big-eared bat *Plecotus townsendii townsendii.* As traditional roosting habitat is lacking for this species, and it is believed to be in this area, this is a potential habitat that has been previously unexplored, and prone to immediate decline due to current logging practices.

The other project involves a study of the use of a portable isoflourine machine for anesthetizing sensitive species in and out of the field. Some studies have indicated an associated short term loss of memory with this inhalent. Reduction of stress when handling bats may be an important consideration during breeding season and may help to curtail site abandonment. Current focus is on the design and calibration of a modification of this apparatus appropriate to bats and other small mammals.

from New York

Gary Kwiecinski from the University of Scranton and some of his students have been working with me on my mongoose population dynamics project in Puerto Rico and the Virgin Islands. We have made several trips there during the past twelve months, and this has given us an excellent opportunity to survey the bat populations on these two islands. Gary is particularly interested in finding healthy and stable colonies of *Artibeus jamaicensis* that can provide a reliable source of a few bats now and again for his research on thyroid metabolism. We have identified several colonies of *A. jamaicensis* on Puerto Rico. We also captured several *Noctilio lepoinus,* a few of which remain in captivity under the care of Sue Ellis in New Jersey, and which will be part of a digestive and absorptive efficiency study that she and I are about to begin. Gary and I have also managed to capture all four species of bats reported to occur there by Nellis on St. Croix; *Artibeus jamaicensis, Molossus major, Brachyphylla cavernarum,* and *Noctilio leporinus* (the latter seen fishing but not netted). We have spoken with many of the Virgin Islanders and they report that since the severe hurricane "Hugo" in 1990 the number of bats on St. Croix "appears greatly reduced". This is also our experience as before the hurricane we could capture many *Artibeus* and *Brachyphylla* in under an hour, using just one net, but since that storm, we have caught only a few bats after many hours of effort. G. Roy Horst

from Michigan

We currently have a number of graduate research projects underway. Dennis Viele, who worked with Eugene Studier as an undergraduate, is studying emergence behavior of Eptesicus fuscus and Myotis sodalis. Kim Williams, who came here from Michigan State University,will be working this summer on the effects of ambient temperature and body temperature on roost switching by *Myotis sodalis.* Joe Teramino is looking at factors affecting the metabolic rate of *Eptesicus fuscus.* Two undergraduates, Dave King and Glenn Lehr are helping put together accounts of *Lasiurus ega* and *Eptesicus furinalis* for Mammalian Species. We are still in need of photographs of either of these species, and we would like to hear from anyone who would like to contribute such photographs.

I am beginning some long-term studies of *Myotis sodalis* on the northern edge of its range, with funding (I hope) from the Michigan Department of Natural Resources. I have recently agreed to rewrite William Burt's "Mammals of the Great Lakes Region". Alan Kurta

The winner of the free banquet ticket at the Quebec Symposium, for sending in the first news item in response to our last request for news is: William Schutt of Cornell University.

I renew this challenge again with this issue. So.....write and tell us what is going on at your place. G. R. H.

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

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Twenty First Annual North American Symposium on Bat Research

The Annual North American Symposium on Bat Research met for the twenty-first time on October 16 to 19, 1991 in Austin, Texas. The symposium was attended by 214 people from 36 states and provinces of the United States and Canada, as well as from 14 countries abroad. The meetings were hosted by Bat Conservation International and convened at the Crest Hotel on Town Lake in the heart of Austin. Merlin Tuttle, Patricia Morton, and Jacqueline Belwood led the efforts of the local committee, and arranged the busiest and most ambitious schedule of events in our history. It is a real credit to their organizational skills that all went as smoothly as planned.

The meeting convened informally on Wednesday evening, October 16, with a pool-side cocktail party at the Crest Hotel. This was a lovely setting, on the terrace overlooking Town Lake and the Congress Avenue Bridge with its large and famous colony of *Tadarida*, which nearly all of us got to see leaving their roost. The only disappointment on this first evening was that some of the planned entertainment did not come off, due mostly to the cowardice of those graduate students placed in charge, i.e., the much anticipated handshake of Merlin and Roy waist-deep and fully clothed in the pool.

The formal sessions began on Thursday morning, October 17, with the presentations by the students in the special session of papers to be presented for honoraria. These presentations are always among the very best at the symposium and this year they proved to be exceptionally well done. Unlike in the past when these presentations were ranked first, second and third, the panel in charge of judging these presentations decided that since all were exceptional in quality, the authors of the best four oral presentations and the best poster presentation should all be honored equally. The winners were *David Jacobs* of the University of Hawaii, *Susan Lewis* of the University of Minnesota, *Dianne O'Reilly* of the University of Maryland, *Scott Pedersen* of the University of Nebraska-Lincoln, and the winning poster was presented by *Loren Ammereman* of the University of Texas in Austin. The awards for these presentations were prizes of $100.00 to each of the winners. These funds came from a variety of sources, but Emily Mobley gave a substantial portion of the award funds in appreciation of our support of her well-known emporium of chiropteran paraphernalia. Fred Andurka of Holohil Systems Ltd., of Ontario also contributed. Susan Ellis, from New Jersey has also generously donated the honoraria that she received for several bat lectures to local groups in New Jersey. Other funds came from the sale of back issues of Bat Research News, and two anonymous sources. We are grateful to all these individuals for supporting this very worthwhile effort.

There were a total of 86 papers, 72 of these were presentations from the platform and 14 were poster presentations. A milestone was reached this year, as we have, since our beginning in 1970, had over one thousand titles presented at our twenty one meetings. With just a little manipulation of the schedule it was possible to arrange that the honor of presenting paper number 1,000 fall upon the worthy shoulders of Thomas Kunz, the only individual (other than this writer) who has attended all 21 of the symposia.

In addition to the main item of business which was the presentation of this enormous amount of new(mostly)information about bats, there were highlights of this year's meeting. David Schmidly and Merlin Tuttle outlined in detail a most ambitious plan for establishing a major research group at Texas A. and M. University to study the broad subject of the biology of bats, especially those aspects concerning ecology and conservation of endangered species.

At the banquet on Friday evening were we treated to a very interesting and enlightening address by Mr. Andy Sansome of the Texas Parks and Wildlife Department. He outlined some of the official steps being taken or planned, to aid and support the efforts of bat conservation in Texas. It was refreshing and most encouraging to hear someone from government who was so well informed and genuinely concerned about the conservation of our natural heritage.

A heart-warming tribute honoring the life-long contributions of Karl Koopman was presented by Tom Griffiths. Tom also presented Karl with the presentation copy of the collected volume of papers entitled, "Contributions to Mammalogy in Honor of Karl Koopman" by many of Karl's friends and students, and published as No. 206 of the Bulletin of the American Museum of Natural History. It is an opinion shared by all that no other individual has done more than Karl has to shape and influence the concept of "bat biology". He has been one of its prime movers and nothing and nobody relating to the world of bats escapes his piercing gaze or his affectionate embrace. Truly, Karl will be remembered as "a founder" of our group world-wide; he will inspire us and keep us on the 'straight and narrow' for years to come.

Many of the participants were treated to a trip to Bracken Cave on the last evening to see the enormous colony of bats leaving the cave (and witness Merlin's skill with a chain saw). Merlin informed us that due to the lateness of the season, some of the bats had already migrated south, but for those of us who had never seen millions of bats at once before it was a truly memorable sight.

The meeting adjourned Saturday October 19, resolved to meet again in October 1992 in Gainesville, Florida. Subsequent events have forced a change of location to Quebec City (see inside of the back page of this issue for details). G. Roy Horst

Announcements concerning the next meeting of the North American Bat Research Symposium and registration materials are enclosed with this issue.

Abstracts of Papers and Posters

[listed in alphabetical order by first author]

Anti-bat noises: a geometrid moth joins the arctiid club
Lalita Acharya, York University, Toronto, Ontario

Many species of moths in the family Arctiidae produce high frequency clicks in response to bat echolocation calls or artificially generated ultrasound. Field and laboratory observations suggest that arctiid clicks affect the behaviour of foraging bats and cause them to abort attacks on the moths. In July and August 1991, in Pinery Provincial Park, Ontario, I observed *Lasiurus borealis* attacking the moth *Nepytia canosaria* (Geometridae). Of 68 attacks observed, the bats avoided, or made physical contact and dropped, the moths on 66 occasions. This distribution is not significantly different from that obtained from observations of *L. borealis* attacking the clicking arctiid *Hypoprepia fucosa* (n = 55 attacks, n = 55 avoidances or drops of moth). I tested the hypothesis that *N. canosaria* produces sound in response to ultrasonic stimuli. I placed 4 moths in stationary flight and exposed them to artificially generated, pulsed, ultrasonic signals that were similar to the terminal calls of foraging *L. borealis*. A fifth moth walking inside a net was exposed to the same signals. In response to the stimulus, the moths produced a series of transient, low intensity clicks. These clicks had an average ($\bar{X}$ ± SD) peak frequency (frequency with the most energy) of 45.4 ± 6.1 kHz (n = 48 clicks analysed for all signal parameters). The frequency range of the clicks was between 13.8 and 81.6 kHz with an average ($\bar{X}$ ± SD) bandwidth of 53.9 ± 3.8 kHz. There were significant differences among individuals in minimum, maximum and peak frequencies, but not in bandwidth. I suggest that these clicks are responsible for the observed avoidance of *N. canosaria* by foraging *L. borealis*, and function (in the context of bat-moth interactions) like arctiid clicks as an anti-bat defence mechanism.

GROWTH OF THE WING AND DEVELOPMENTAL CONVERGENCE OF NICHE SPACE IN THE LITTLE BROWN BAT (*MYOTIS LUCIFUGUS*). Rick A. Adams, University of Colorado, Boulder, CO. It has long been observed that differences in wing shape and size determines interspecific niche partitioning in bats. Studies of wing growth and the relationship of its development to intraspecific niche space in bats is lacking. Last year I reported on intraspecific resource partitioning (habitat) between juvenile, subadult, and adult *Myotis lucifugus* in a mosaic habitat setting. Juveniles were restricted to open areas in which to forage, probably due to their limited flight ability. In this paper I will describe changes which occur in the development of wing morphology (shape and size) which best correlate with habitat associations between age groups of *M. lucifugus*. As juveniles mature, their wing morphology converges with that observed in adults. This leads to (and perhaps allows) an associated convergence in niche space between juveniles and adults. While some aspects of wing morphology such as wing-tip length, wing area, and wing loading show significant shifts in relation to habitat associations, other aspects such as forearm length and wing shape show exceedingly little change from essentially prevolant young through adulthood. Furthermore, wing shape, which has been shown to be indicative of interspecific habitat associations, has little or nothing to do with habitat partitioning between different age individuals of *M. lucifugus*.

A PROGRAM TO EVALUATE BAT USE AND OCCUPANCY OF ABANDONED MINES IN NEW MEXICO. J. Scott Altenbach and Homer E. Milford, University of New Mexico, Albuquerque, NM; Department of Energy, Minerals and Natural Resources, Santa Fe, NM.

Closing of abandoned mines by backfilling or otherwise plugging entrances poses an obvious threat to bats as well as other types of wildlife. The Abandoned Minelands Bureau of the state of New Mexico has entered a cooperative agreement which facilitates systematic internal and external surveys of all mine features scheduled for closure. Significant use of a mine feature by bats or other wildlife justifies a closure which is compatible with continued use by the species involved.

Internal, as well as external, exploration of a mine feature in both cold and warm season establishes occupancy or use by bats that could not be detected by external inspection alone. Internal exploration, especially of shaft\drift operations requires specialized equipment, techniques and training and should only be attempted as a team effort.

This program has completed internal exploration of 60 mine features in a one-year period. Eighteen of the features exhibited evidence of bat or other wildlife use and the remainder have been cleared for closure by any appropriate means. Significant bat use will require application of bat gating to at least 12 of the 18. Several of these features require closing of secondary openings with gating or netting to permit air circulation which seems critical for continued bat occupancy. A mine which is used as a migratory stopover roost for *Myotis yumanensis*, a maternity colony of *Myotis auriculus* and several large *Plecotus townsendii* roosts have been discovered during this program.

This program has illustrated the feasibility and difficulties of such an approach as well as the need for a clearinghouse for bat gating designs and their application. If the program is widely adopted there will be a need for prefabricated bat gating that can easily be adapted to a variety of mine collars at reasonable cost.

IDEAL FREE MOUSE-EARED BATS? Doris Audet. York University, North York, Ont. M3J 1P3.

Reproductive success in bats can be influenced by factors from roost and foraging environment. Stability in size and composition of colonies may depend on the interaction between these factors. The purpose of my study was to determine wether the size of nursery colonies of bats could be explained using an ESS model of group size selection. The model is based on the assumptions that site quality declines as the number of individuals at that site increases, that animals monitor the quality of available sites and that the cost of moving between sites is negligible. It predicts that sites are chosen to ensure approximate equality of fitness among all occupied sites. I studied the behaviour and young production of female Myotis myotis in two nursery colonies (ca. 60 and 600 adults) on four years between May and August. The colonies were located 8 km apart in similar habitats in buildings presenting different temperature regimes. I used radio-telemetry to study foraging and thermoregulatory behaviour of 32 adult females, and banding (95 adults, 100 juvenile) allowed me to compare young production of individuals, juvenile growth and survival. As predicted, females from the large colony commuted greater distances to their foraging sites, and I observed active roost selection from banded individuals. However, data on reproductive success did not support the model. Juvenile survival in the large (warmer) colony was greater than in the small colony, and coincided with earlier date of birth and larger size at the end of the summer. In the system that I studied, the benefits of a warmer roost outweighed the cost of commuting longer distances to foraging sites.

REDUCED NUMBER OF RIBOSOMAL SITES IN BATS: EVIDENCE FOR A MECHANISM TO CONTAIN GENOME SIZE.Robert J. Baker, Mary Maltbie, James G. Owen, Meredith J. Hamilton and Robert D. Bradley, Texas Tech University (RJB, MM, JGO, and RDB) and University of Idaho (MJH).

The number and position of sites of tandemly repeated ribosomal genes were identified in bats by biotin labeled probes and in situ hybridization. The number of sites ranged from one to four pair with one pair being the most common condition. Comparative studies on 43 rodent species found the number of sites ranged from 2 pair to 10 pair. The number of sites is statistically significantly lower in bats. Bats have the smallest amount of DNA per haploid genome thus far reported for mammals. We interpret these results as being incompatible with the hypothesis that the low number of rDNA sites and associated low variation is a result of maintenance of a primitive condition through the absence of character state evolution. We view genome size in mammals as the end result of an equilibrium between the forces that amplify tandem repeats, transposable elements, and other repetitive DNA and the battery of selective forces that contain and reduce these "selfish" DNA elements. At this stage, the hypothesis that the selective force maintaining low copy number of such selfish elements is much stronger in bats than in rodents, remains a viable explanation.

NIGHT ROOSTING AND LUNAR PHOBIA IN THE INDIAN FALSE VAMPIRE, MEGADERMA LYRA.
J. Balasingh, St.John's College, Tirunelveli. South India.

Megaderma lyra night roosted singly and not in groups. An adult female bat continuously occupied the same night roost for more than 6 months. The night roosts were mostly located 50 to 500m away from the diurnal temple roost which included cow-sheds and unoccupied buildings. The effects of lunar light on the duration of the night roost occupancy and the duration of foraging bouts were observed in tagged males and females. The duration of night roost occupancy and the duration of foraging bouts varied depending on the phases of the moon and the reproductive conditions. In general, activity during bright moon hours was greatly reduced. In addition this moon light avoidance was significantly higher during breeding season than during non-breeding season.

PREY DISCRIMINATION BY INSECTIVOROUS BATS? A FIELD TEST
Robert M. R. Barclay and R. Mark Brigham. University of Calgary, Calgary, Alberta; and University of Regina, Regina, Saskatchewan.

Although insectivorous bats display amazing abilities to distinguish amongst targets under laboratory conditions, no field experiments of prey discrimination have been done. We presented little brown (Myotis lucifugus) and Yuma bats (Myotis yumanensis), that were foraging over water, with stationary and moving targets to determine their ability to distinguish amongst edible and inedible items under natural conditions. Three types of targets were presented: edible sized moths, moths too large for the bats to consume, and edible sized leaves and sticks. For stationary targets the bats reacted equally to small moths and leaves/sticks but rarely attacked either. They ignored the large moths. Bats reacted and attacked all three target types more often when bat activity was high. Response and attack rates were significantly higher to all targets when the targets were moving and there was no significant difference in the response or attack rates amongst the prey types. We suggest that the short prey detection range and reaction time bats face in the wild precludes the fine detailed discriminations possible in the lab.

BAT CARE: ASSISTING THE INQUIRING PUBLIC. Susan M. Barnard. Zoo Atlanta, Atlanta, GA.

As the public becomes better informed about the benefits of bats, their reactions toward them are shifting slowly from fear of these animals to concern for their welfare. It is, therefore, likely that anyone encountering a bat might contact the nearest bat biologist to learn how to care for it.

Large styrofoam coolers are practical and inexpensive for containerizing bats. T-shirts provide comfortable roosts for most species. Some exceptions include bats in the genera Lasiurus and Macrotus. These animals need the addition of a twig in the cooler to serve as a perch. Because dehydrated bats have difficulty in swallowing, they require hydrating with lactated Ringer's solution via subcutaneous injection. Feed wild bats mealworms from the end of blunt forceps. They accept this diet readily once they have the opportunity to taste the viscera. Plenty of drinking water, fortified with vitamins and minerals, should be available to bats ad libitum. Most species of native bats can be maintained at ambient temperatures ranging from 72 degrees F in winter to 82 degrees F in summer. Release healthy adult bats as soon as possible.

Infant bats can be hydrated and containerized in the same manner as adults, but ambient temperatures should be increased to 80-82 degrees F. The diet of choice is Esbilac (Pet-Ag, Inc.), mixed as directed on the label. For pups in the genus Lasiurus, add Lactaid (Lactaid, Inc.) to the milk because they may be lactose-intolerant. Feed pups at 2-hr. intervals, beginning at about 6 A.M. and discontinuing at about midnight. Pups learn quickly to lap milk from the palm of the hand, or directly from an eyedropper or syringe. When a pup's milk teeth have been replaced by the permanent ones, wean it onto mealworms. Hand-raised and captive-born pups should remain in captivity. These animals can be used in education and conservation programs.

ASSISTANCE NEEDED: PLACEMENT OF BAT ROOSTS. Susan M. Barnard, Zoo Atlanta, Atlanta, GA.

The E.L. Huie, Jr. Land Application Facility in Clayton County, Georgia, was visited recently by Zoo Atlanta staff to observe its wildlife. This facility offers a unique opportunity to bat conservationists and ecologists for testing a variety of bat roost styles, and for studying the role of bats as predators of insects as an alternative to chemical means of insect control. The Huie facility comprises 4,000 acres with a 100-acre, five-cell effluent holding pond. This pond is ideal breeding habitat for midges and mosquitoes. On the evening the Zoo Atlanta staff visited the facility, three species of bats were observed feeding over the pond - Lasiurus borealis, Myotis austroriparius and Eptesicus fuscus. The staff noted, however, that the number of bats using the area was surprisingly low considering the large size of the water area. It appeared that insect populations were too sparse to support a greater density of bats, and it was assumed (correctly) that pesticides were being used to control the insect populations.

Staff at Zoo Atlanta have proposed to the Huie facility governing body the concept of using bats to control midge and mosquito populations as an alternative to chemicals. Part of this plan involves providing appropriate roost areas to encourage bats to use the pond as a feeding ground. To this end, your expertise is required in determining the number, styles and placements of roosts for Myotis austroriparius and Eptesicus fuscus. Trees will be strategically planted around the pond to accommodate Lasiurus borealis. If you have ideas or references that might be useful toward making this a successful project, please submit your name, address and telephone number.

BATS AND MINES:ABANDONED DOES NOT ALWAYS MEAN EMPTY. Jacqueline J. Belwood and Rachel J. Waugh. Bat Conservation International, Austin, TX.

In recent years large numbers of cave-dwelling bats have come to use abandoned mines as regular roosting sites. This is a response to the loss of traditional cave roosts. Twenty-nine of the 42 bat species in the U.S. are now regularly found in abandoned mines and many species, including threatened and endangered ones, use mines as their permanent and only residences. For example, in winter up to 95% of bats in Wisconsin use abandoned mines to hibernate. Some populations can number close to a million individuals, which makes them among the largest known concentrations of hibernating bats anywhere in the world.

There are two mining law reform bills now before Congress (S.433 and H.R.918) that contain provisions requiring the formation of a fund to reclaim abandoned hard rock mines on federal, state, and private land. Reclamation is intended to return mined lands to their pre-mining condition, by back-filling, bulldozing, and dynamiting the mines shut.

Future reclamation programs that involve the complete closure of mine entrances will be disastrous for many North American bat species. Bat Conservation International supports measures to protect the general public from the hazards of abandoned mines, but is working hard to ensure that human safety concerns and the protection of bats that now use mines as permanent roosts are not mutually exclusive. Various aspects of this will be discussed.

FORAGING ECOLOGY OF THE ENDANGERED GRAY BAT (MYOTIS GRISESCENS) IN NORTHERN ALABAMA: A PRESENTATION OF OBJECTIVES AND A PRELIMINARY REPORT. Troy L. Best, Travis Hill Henry, Gregory L. Gardner, Scott C. Frazier, and Bettie A. Milam, Auburn University, AL.

In recent years, aquatic vegetation has expanded in Guntersville Reservoir, Alabama, and other reservoirs maintained by The Tennessee Valley Authority. Along with the increase in aquatic vegetation has been an increase in the number of gray bats occupying three large maternity colonies near Guntersville Reservoir. Whether the presence of aquatic vegetation, gating of caves, or some other cause has resulted in the increase in number of bats is unknown. However, because removing some of the aquatic vegetation is being considered, it is of interest to determine where these endangered bats are foraging at Guntersville Reservoir. The present study uses the number of calls and feeding buzzes made by bats to assess which habitat receives the greatest use. In addition, radio-monitoring of bats is used to track movements among habitats. To date, only preliminary data are available, but it is clear that insects associated with aquatic vegetation are consumed by gray bats and there is differential use of aquatic habitats in the study area.

OBSERVATIONS ON THE PINEAL OF THE BIG BROWN BAT, Eptesicus fuscus, WITH SPECIAL REFERENCE TO MELANIN. Kunwar P. Bhatnagar, F.K. Hilton, R. J. Reiter. Louisville, KY and Univ. of Texas, San Antonio (RJR).

Observations on melanin in the Eptesicus pineal demonstrate that photoperiod may influence its synthesis and distribution within the gland. The Eptesicus pineal measures 0.7 x 0.5 mm (N=10), with a volume of 0.0332 mm^3 and a weight of 3.59 x 10^{-2} mg (N=1). Bats were maintained under several photoperiodic and temperature conditions. Gross observations showed a particular pattern of pigmentation in the pineal (see Table). Microscopically the Eptesicus pineal is pigmented. The "unpigmented condition" designated here is one in which pigment is not observed grossly. Melanocytes containing melanosomes in Eptesicus pineals were observed ulstrastructurally. Subjective scoring (+, no pigment to ++++, heavy pigmentation) suggests that pineals from bats from a continuous 24 h light regimen or from a summer population contain very little, externally visible melanin. In contrast, pineals from 75% of all animals subjected to constant darkness or hibernation exhibited very heavily pigmented pineals. This phenomenon would thus appear to be seasonal and cyclic. It is well known that darkness enhances melatonin synthesis. However, an early report (not on bats) denies any role of melatonin affecting melanocytes in mammals. Our observations would suggest that exposure to constant darkness causes an increase in pigmentation in the Eptesicus pineal. Additionally, other environmental clues such as temperature, and activity levels of Eptesicus could also modify pigment and its deposition. Further observations on pigmentation of the pineal in other bat species will be presented. Supported by the Grad Res Council and Sch of Medicine Res Council, Univ. of Louisville.

	Experiment	Observations
I.	20°C, 8 wks, 270 lux 5 ♂♂ in each group	
	24 hr Dark (D)	Heavy pigment
	24 hr Light (L)	No pigment
	1:23 LD	Variable pigment
	16:8 LD	Variable pigment
II.	20°C, 10 wks, 47 ♂♂	75% heavy pigment
	24 hr Dark	25% no pigment
III.	4°C, 16 wks,	76% heavy pigment
	5 ♂♂, 20 ♀♀, 24 hr D	24% no pigment
IV.	Summer bats	60% lack pigment
	3 ♂♂, 31 ♀♀	40% pigment spots

THE INFLUENCE OF PRECIPITATION ON REPRODUCTION BY BATS IN THE SOUTH OKANAGAN VALLEY, BRITISH COLUMBIA. R. Mark Brigham, Scott D. Grindal, Tod S. Collard, and Robert M.R. Barclay. University of Regina, Regina SK; University of Calgary, Calgary AB.

Rainfall is a climatic factor which can influence the timing of breeding in temperate insectivorous bats, principally in that it affects insect density. Low insect density prompts many insectivorous bats to enter torpor, a strategy which conserves energy but is known to delay parturition in females. The purpose of this study was to use data collected during an extremely wet year (1990), to test the prediction that reproduction in Myotis lucifugus, M. yumanensis and M. ciliolabrum would be delayed and or decreased compared with previous summers. For all three species, the latest date of first capture of lactating, post-lactating and juvenile bats occurred in 1990, while the driest year (1979) had the earliest records for lactating females. Of perhaps greater importance, was the significantly reduced proportion of reproductive female M. lucifugus and M. yumanensis in 1990 compared with 1982. We conclude that high levels of precipitation not only delays reproduction, but may induce some individuals to forego it altogether. Given the potential lifespan of temperate bats, this may be the best strategy to maximize lifetime reproductive success.

THE DIET OF NOCTILIO LEPORINUS. A. Brooke, U. Tenn, Knoxville, TN

The diet of Noctilio leporinus on Culebra Island, Puerto Rico, was examined by an analysis of scats and the remains of prey found in roosts. A comparison of summer and winter diet shows a shift toward more insects and less fish during the summer months. During January, 60% of the dry weight of scats collected were insects: beetles, moths and tetphrid flies. The remaining 40% contained fish scales which were identified as tilapia and silversides in nearly equal proportions. During summer, moth and beetle remains made up 80% of the dry weight of scats, the remaining 20% were silversides. Scales from sardines, ballyhoo, squirrel fish and shrimp exoskeletons were present sporadically in scats. Fiddler crab claws were found occasionally in the roosts.

The amount of time bats spent foraging varied seasonally. Three pregnant bats that were followed by radio telemetry foraged only for 45 minutes nightly. Post-lactating females implanted with passive transponders left the roost an average of twice nightly: foraging bouts averaged two hours. Adult males implanted with transponders left the roost only once nightly: most foraging bouts lasted an hour to an hour and a half. Bats gained 5-9g in mass during the time spent out of the roost, an increase of 1/10 to 1/5 of body weight.

HAREM FORMATION IN THE CALIFORNIA LEAF-NOSED BAT, MACROTUS CALIFORNICUS. Patricia Brown and Robert Berry. Department of Biology, U.C.L.A., Los Angeles, CA; and China Lake Naval Weapons Center, Ridgecrest, CA.

Observations made in summer maternity colonies of the insectivorous California leaf-nosed bat (Macrotus californicus) have revealed separate clusters of bats within the larger roosting area. These clusters contain 5 to 25 females with babies and a single male. The male displays to the females with wing-flapping and audible vocalizations. Other males entering the cluster area are driven away by the "harem" male. In the summer the bats are found close to the mine entrances in areas where temperatures reach 90° to 95°F, whereas winter roosts of this species occur deep in geothermally-heated mines in the California desert.

COMPARATIVE SENSITIVITY OF LITTLE BROWN BATS (MYOTIS LUCIFUGUS) TO ACUTE DOSAGES OF SODIUM CYANIDE. Donald R. Clark, Jr., Elwood F. Hill, and Paula F. P. Henry. U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD.

Thousands of dead birds and mammals have been reported at cyanide-extraction gold mines in Arizona, California, and Nevada. About 34% of the dead mammals were bats. Mortalities are continuing and both the numbers of mines and numbers of states with this type of mining are increasing. We used a 24-hr oral LD50 test to determine relative sensitivities of little brown bats (Myotis lucifugus), white-footed mice (Peromyscus leucopus), house mice (Mus musculus), and mallard ducks (Anas platyrhinchos) to sodium cyanide. LD50s were: mallards 2.9 mg/kg; little brown bats 8.4 mg/kg; house mice 8.7 mg/kg; and white-footed mice 28 mg/kg. Slopes of dose-response curves were extremely steep for mallards and house mice. Little brown bats were unique in showing delayed mortality, which suggests that relatively more bats may die away from mines where they are less likely to be found and reported.

FORAGING ECOLOGY OF RAFINESQUE'S BIG-EARED BAT, PLECOTUS RAFINESQUII, IN NORTH CAROLINA. Mary K. Clark; North Carolina State Museum of Natural Sciences; Raleigh, NC.

Studies of a nursery colony of Plecotus rafinesquii in Chowan County, NC yielded information on foraging habitat and behavior, prey availability and food items. Twenty-seven bats were tagged and individually tracked during two nights in August 1988. Fecal pellets were taken from the roost for prey analysis throughout the summer of 1988. To assess habitat and strata differences in prey availability insects were sampled with Malaise traps.

Habitats surrounding the colony site included open fields, mature forested wetlands, a river and tributary. Light-tagged bats either flew into the swamp-forest or back into the day roost. All bats that flew into the forest followed a similar route when foraging and several of these rested in a hollow tree on this route. Distance from the nursery roost to the hollow tree was a about one-half km. The greatest distance light-tagged bats were observed to travel was to an alternate roost in a garage about 1 km from the nursery roost. Light-tagged bats flew below the subcanopy and were often seen about 1 m above ground. Dipping flights to water surfaces were observed at standing water in the swamp and along a creek bank. Although the river and tributary were less than 1 km from the nursery roost, light-tagged bats did not forage over water.

Nineteen orders of insects were represented in the twenty-two samples obtained from Malaise traps. Orders comprising the highest sample percentages were Diptera (45%), Coleoptera (20%) and Hymenoptera (about 10%). Only six percent of the samples were Lepidoptera, but preliminary analysis of fecal samples indicates that Lepidoptera comprise the majority of this bat's diet.

PREY SELECTION IN RELATION TO INSECT AVAILABILITY BY THE COMMON POORWILL (*PHALAENOPTILUS NUTTALLII*). Ryan D. Csada. University of Regina, Regina, SK.

A recent focus of research by bat biologists is to determine if specific sizes or types of insects are selected actively (e.g., for energetic reasons) or passively due to detection constraints imposed by echolocation. Thus it should be of interest to bat biologists to know if visually orienting nocturnal insectivorous birds actively or passively select prey. I determined the diet of common poorwills (*Phalaenoptilus nuttallii*) by analyzing fecal samples collected from roost or nest sites in the Okanagan Valley of British Columbia. The major insect orders present in the diet in 1989 were coleopterans (47% by volume) and lepidopterans (49%). These two orders comprised only 15% and 3% respectively of the insects sampled using sticky traps in 1989. Based on the femur length of coleopterans consumed, I calculated that all coleopterans eaten were longer than 10 mm (excluding the head) whereas 88% of the coleopterans caught on sticky traps were less than 10 mm long. I found no evidence to support the prediction that poorwills would broaden their diet to include other insect taxa or size classes during 1990, when wet conditions likely depressed prey availability and foraging opportunities. There was no difference in the proportions of various taxa consumed or the size of coleopterans eaten between 1989 and 1990. I conclude that the apparent prey selection by poorwills, like many insectivorous bats, results passively from the constraints imposed by detecting prey under conditions of low light.

USER-FRIENDLY SIGNAL PROCESSING SOFTWARE FOR PC-BASED ANALYSIS OF ECHOLOCATION CALLS AND OTHER SIGNALS. Jeff W. Dawson, and James H. Fullard. University of Toronto, Mississauga, ON, Canada.

Bat and insect researchers have relatively few options to choose from in terms of bioacoustic analysis software when compared with avian and medical acousticians. Most signal processing packages are inappropriate for analyzing ultrasound (e.g. high frequency, short duration pulses), primarily due to slow sampling rates and inflexibility in analysis features. Also, most packages require purchasing custom hardware that is identical in features and surpassed in performance by hardware that is commercially available at reduced cost. We have developed software that is appropriate for analyzing ultrasound and other signals. This software should be of particular interest to echolocation and insect bioacousticians. The program has a shallow learning curve and will appeal to teachers and technicians. A pull-down menu system with a mouse-driven user interface has been incorporated to reduce analysis time and input errors. The software was designed to work with commercially available, high-speed A/D conversion boards or devices thus increasing the usefulness of this package.

The computational engine is based on a decimation-in-time (Cooley-Tukey) FFT algorithm applied to a selectable power of two data points. To eliminate signal clipping and unnecessary analysis of extraneous signals (e.g. echoes, background noise), the user sections the time buffer into intervals containing only data of interest. Each defined interval can be analyzed independently. Of interest to users of Racal™ tape recorders, the program optionally accounts for slowed playback into the A/D device. The program fully supports data exportation into commercially available statistical and plotting packages.

Park size, deforestation, and conservation of bats in the Indo-Pacific region.

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Abstract

I reviewed the size of terrestrial protected areas, remaining forest habitat, deforestation rates, and bat species richness among 23 countries of the Indo-Pacific region. Interaction of these variables resulted in the development of a conservation potential/threat index (CPTI) which identifies countries in which populations of megachiroptera will face greatest threats from deforestation and lack of protected habitat. The index shows that among the countries richest in bat species, only Indonesia and Brunei, and possibly Papua New Guinea, are likely to maintain extensive forest cover in and outside of protected areas. I applied the CPTI at the national level to forecast the prospects for bat conservation among the biogeographic or administrative sub-units of Indonesia, Malaysia, and the Philippines. At the level of reserves, I use bat endemism to assess the biological importance of the 35 protected areas in Indonesia selected as high priority for conservation action. Finally, I compare species richness in the megachiroptera with patterns observed in other taxa to determine if distributions of megachiroptera species per country are consistent with overall patterns in vertebrate and plant species richness for Indo-Pacific countries.

RESPONSES OF INSECTIVOROUS BATS TO MOTHS. Dorothy C. Dunning and Lalita Acharya. West Virginia University, Morgantown, WV and York University, North York, Ontario.

In Ontario, bats of two species rejected more moths of the family Arctiidae than they ate, while feeding mainly on moths of other families (primarily Noctuidae, Notodontidae, Geometridae and Pyralidae). Red bats (*Lasiurus borealis*) foraging around lights usually broke off pursuits of free-flying arctiids before making contact, but they often caught and ate other moths. Those arctiids they caught usually were dropped without being eaten. Captive big brown bats (*Eptesicus fuscus*) presented with appendage-trimmed moths of different families but similar body sizes, in proportions representing those captured at local ultraviolet lights, ate fewer arctiids than moths of other families. These responses were most pronounced during the first half of the field season: a larger proportion of the arctiids was eaten in the second half of the season, although they comprised a smaller fraction of the available moths. The negative overall reactions of both red and big brown bats to arctiid moths are similar to those obtained from other species of insectivorous bats and support the aposematic signals hypothesis as an explanation of the ultrasonic clicks that some of these arctiids can produce.

GLEANERS ARE CHEATERS: THE AUDITORY RESPONSE OF NOCTUID MOTHS TO THE ECHOLOCATION CALLS OF GLEANING *VERSUS* AERIAL BATS. Paul A. Faure†, James H. Fullard*, & Jeff Dawson*. †Neurobiology & Behavior, Cornell University, Ithaca, NY, USA; and *Erindale College, University of Toronto, Mississauga, ON, CANADA.

Moths possess ears sensitive to ultrasound and presumably their ears evolved to detect the echolocation calls of predatory bats. To date, research on bat-moth interactions has been limited to the auditory or behavioral response of moths in flight, since until recently, it was assumed that aerial foraging was a bat's only method of hunting. Few studies have considered other types of foraging strategies, particularly substrate-gleaning. Gleaners typically emit echolocation calls that are high frequency, short duration, and low intensity; call characteristics thought to be acoustically mismatched to tympanate prey. This allows us to predict that moths will find gleaners difficult to detect, thus leaving moths particularly vulnerable to predation. The purpose of this study was to examine the auditory response of underwing moths (*Catocala* spp.) to the echolocation calls of gleaning *Myotis septentrionalis* and aerially-hawking *Myotis lucifugus*. We determined auditory thresholds of 4 species of underwings to frequencies between 5-125 kHz, and pulse durations mimicking those employed by gleaning (1 ms) and aerial bats (5 & 10 ms). We tested moths with their ears covered by their wings (i.e., mimicking moths resting on vegetation or warming up for flight) *versus* moths with their ears uncovered (i.e., wings outstretched to mimic flying moths or moths fluttering on a surface). Our results show that the moth auditory receptor is less sensitive to pulse durations used by gleaning bats; a situation worsened when the ear is covered by the wing. Surprisingly, moths with their ears covered maintained hearing sensitivity in the frequency range used by aerial bats, but showed a pronounced deafness in the range used by gleaners. We exposed moths (while recording from their ears) to gleaning attacks by *M. septentrionalis* and search call flights by *M. lucifugus*. Results from these experiments suggest that the moth ear responds inconsistently and with fewer spikes to gleaning attacks by *M. septentrionalis*, whereas search call flights by *M. lucifugus* elicit a more consistent response with a greater number of spikes. Our results support the hypothesis that the echolocation calls used by gleaners are acoustically mismatched to the ears of moths, thus giving gleaners a distinct advantage in this evolutionary game of cat-and-mouse.

CHILDREN'S ATTITUDES TO BATS: IMPLICATIONS FOR BAT CONSERVATION AND EDUCATION. Leesa Fawcett, York University, North York, Ont. M3J 1P3.

Although bat biologists have observed that the protection and conservation of bats depends on public attitudes and education (Fenton 1983, Hill & Smith 1984, Tuttle 1988), a consistent data base is missing. The working hypothesis of this research is that our cultural and individual beliefs about bats can contribute to a form of animal "stereotyping" which has serious consequences for conservation and education. The research subjects are two samples of Canadian children (N=240): 1) five and six year old, considered pre-literate and representative of Piaget's pre-operational stage, and 2) nine and ten year old, considered literate and representative of Piaget's concrete operational stage. The independent variables are age and sex. The research design consists of three phases, the pre-test (drawings, interviews and stories), treatment (experience of the animal) and post-test. The research design assumes that actual experiences of bats can lead to contradictions between the folklore about the animal and the reality of encountering one. These contradictory situations are a potential source of attitudinal and behavioural change. Results from the pilot study show the following trends: 1) children's beliefs change in a positive direction after they experience the animal, 2) five year old score more positive beliefs (i.e. less fear, etc.) than the ten year old, 3) female ten year old have more negative beliefs overall. The implications of the preliminary findings will be discussed in terms of conservation actions, social learning, science education and folklore.

PHYLLOSTOMID BATS AS INDICATORS OF HABITAT DISRUPTION. M. Brock Fenton, Lalita Acharya, Doris Audet, M. Brian C. Hickey, Cathy Merriman, Martin K. Obrist, Daphne M. Syme and Bruce Adkins. York University, North York, Ontario, Canada M3J 1P3

Mist netting bats at 11 sites in the vicinity of Akumal, Mexico between 7 and 19 January 1991 produced 363 bats representing 20 species. A comparison of captures revealed significant differences in species diversity (H_s) between disturbed and undisturbed sites (as reflected by deforestation). Species in the subfamily Phyllostominae were captured significantly more often at forested than at deforested sites. Comparison of captures between disturbed and undisturbed sites suggests that in the study area, phyllostomine bats are useful indicators of habitat disruption. The low intensity echolocation calls of phyllostomid bats makes it unfeasible to monitor their distribution and abundance with bat detectors.

NECTAR CORRIDORS AND THE DIET OF MIGRATORY NECTARIVOROUS BATS.
Theodore H. Fleming, Robert Nunez, and Leonel de Silveira Lobo Sternberg. University of Miami, Coral Gables, Fl.

We used stable isotope techniques to determine the general diet of four species of Mexican nectarivorous bats. These species included the migratory Leptonycteris curasoae, L. nivalis, and Choeronycteris mexicana and the non-migratory Glossophaga soricina. Our analysis involved determining the ratio of 13C:12C in toe muscle tissue from museum specimens collected in different localities in Mexico and the southwestern United States at different times of the year. This technique allows us to determine when bats are feeding primarily on carbon from C3 plants (tropical and subtropical trees and shrubs), from CAM plants (Cactaceae and Agavaceae), or from a mixture of C3 and CAM plants.

Our results indicate that mainland populations of the three migratory species feed mostly on C3 plants during the late fall and winter. Migrants feed exclusively on CAM plants during migration and in the northern parts of their ranges. The population of L. curasoae on Baja California, in contrast, appears to feed nearly exclusively on CAM plants year-round and is apparently non-migratory. The non-migratory G. soricina feeds primarily on C3 plants year-round in southern Mexico. Migratory nectar-feeders fly north in the spring along a nectar corridor consisting of at least four species of columnar night-blooming cactuses. In the fall, they fly south along a nectar corridor consisting of several speices of Agave. Agave flowering schedules on Baja California differ from those on mainland Mexico and provide bats with a nearly year-round food supply.

AUDITORY CHANGES IN MOTHS FROM BAT-FREE ENVIRONMENTS: MORE THEORIES THAN FACTS. James H. Fullard, University of Toronto, Mississauga, Ontario, Canada.

One of the main assumptions in moth/bat coevolution has been that bat echolocation places the main (only?) evolutionary pressure on the physiological design of moth ears. If this assumption is true we should witness signs of auditory degeneration in Lepidoptera that have evolved in the absence of bats. This prediction seems to hold for lepidopterans that live in temporal isolation from bats (e.g., diurnal butterflies, spring-emerging bombycoid moths) although there are interesting exceptions. Geographical isolation constitutes another source of bat-free environments although these habitats are few and far between. Oceanic islands provide suitable locales to search for evolutionary changes but only two such studies presently exist (Faroe Is., Hawaii). Before these evolutionary predictions can be tested it is necessary to ensure that the islands possess: 1. ancient bat-free environments and, 2. sufficient genetic isolation for the endemic radiation of predator-released moths. I have begun to examine the endemic and immigrant moths of the islands of French Polynesia since this site is one of the few in the world that satisfies both of the preceeding criteria. Morphological examinations of moths collected on the Society islands of Moorea and Raiatea reveal that auditory changes appear minimal at the level of endemic species and suggest that auditory systems experience a high degree of 'phylogenetic inertia'. Endemic genera reveal morphological changes suggestive of auditory degeneration (thickened eardrums, smaller tympanal cavities) and the endemic, single-species family of moths from the extremely isolated island of Rapa has lost ears entirely. These preliminary results indicate that endemic taxa represent an evolutionary 'clock' and that ears are more resistant to change than originally thought. Future studies will examine the presumably more plastic physiological and behavioral correlates of these morphological findings.

PREY-CAPTURE BEHAVIOR IN THE DESERT PALLID BAT (*ANTROZOUS P. PALLIDUS*): PASSIVE SOUND LOCALIZATION OF TERRESTRIAL INSECTS. Z.M. Fuzessery, P. Buttenhoff, B. Andrews, J.M. Kennedy. University of Wyoming, Laramie, WY.

The prey-capture behavior of desert pallid bats was studied in a 22x16x11 foot room to determine the sensory information the bats used to locate and capture crickets. The possible roles of vision, echolocation and passive hearing were entertained. All results suggest that these bats relied on the sounds made by walking crickets to capture their prey. When walking sounds were eliminated by having crickets walk on soft foam, none of the crickets were captured. Chirping, stationary crickets were also not captured, suggesting the cricket communication signals were not, or could not, be used in passive sound localization. Vision was not essential because the bats performed as well in total darkness as in the dim red light illumination present in all other studies. The use of echolocation in prey capture was also appeared nonessential because no change in the emission rate or echolocation pulse structure was recorded just prior to prey capture, and bats emitted no echolocation pulses while walking on the floor searching for prey. To test the limits of their passive sound localization abilities, the bats were trained to capture anesthetized crickets thrown on the floor. The thrown crickets produced sounds with low spectral peaks between 3-8 kHz, with durations of only 3-5 msec, yet the bats were able fly to the point of impact and pounce upon the cricket from a distance of 16 feet. Such results suggest that pallid bats are capable of highly accurate, closed-loop, passive localization of low frequency sounds.

THE STATUS OF *MYOTIS AUSTRORIPARIUS* IN ILLINOIS; WITH DISCUSSIONS CONCERNING ITS STATUS THROUGHOUT THE RANGE. James E. Gardner, Joyce E. Hofmann, and *James D. Garner. Illinois Natural History Survey, Champaign, IL; *Illinois Department of Conservation, Springfield, IL.

Myotis austroriparius (southeastern bat) is listed as endangered in Illinois and as a Category 2 candidate species (considered for threatened or endangered status) by the United States Fish and Wildlife Service. It is a species of the deep south, whose range extends up the Mississippi and Ohio River valleys, reaching its upper limits in extreme southern Illinois and Indiana and western Kentucky. Barbour and Davis (1969) said, "apparently this race is nearing extinction," alarmed even then by steady declines in known populations. Unique among the *Myotis* in usually producing two young per litter with high reproductive success (90%; Rice 1957), it is especially alarming that populations have continued to decline. Threats to this species are the same as those for *Myotis sodalis* and *Myotis grisescens*, two species declared federally endangered in 1973. Distribution and radiotracking studies of this bat in Illinois resulted in the discovery of three maternity areas including a summer colony in a hollow tree; foraging habitat of the colony was subsequently studied. The findings of the Illinois studies will be briefly summarized followed by status reports compiled from authorities throughout the range of *M. austroriparius*. Hopefully, interested parties will participate in an open discussion concerning the proposed federal listing of this species.

STATUS OF MATERNITY COLONIES OF THE SOUTHEASTERN BAT, MYOTIS AUSTRORIPARIUS, IN FLORIDA. Jeffery A. Gore and Julie A. Hovis, Florida Game and Fresh Water Fish Commission, Panama City, FL and FGFWFC, Ocala, FL.

Myotis austroriparius typically rears its young in large colonial roosts in caves. It has been recorded throughout much of the southeastern coastal plain of the United States, but very few maternity colonies are known outside Florida. In spring 1991, we visited all former, current, and potential maternity caves in Florida that were known to us. At each occupied cave, we measured or estimated the area covered by roosting adult bats prior to birth of the young and in midsummer we captured emerging bats to determine whether volant young were produced.

Combined results from past surveys indicate roughly 400,000 adult female M. austroriparius previously occupied 15 maternity caves. In 1991, we found less than half that number of bats and only five of the 15 caves still served as maternity roosts. Three other caves contained previously unreported maternity colonies, possibly bats that had abandoned other caves. Human disturbance is the most likely reason caves were vacant: of the 18 current or former maternity caves, three were closed, 13 showed some signs of disturbance, and only two were well-protected. Several of the eight maternity caves to which the bats are now restricted are subject to flooding and thousands of roosting bats have drowned in recent years. Efforts are underway to protect the maternity caves in Florida, meanwhile the use of non-cave maternity roosts and the status of the species outside the state should be evaluated.

VAMPIRE BATS: CONSERVATION AND CONTROL. Arthur M. Greenhall, American Museum of Natural History, New York, N.Y. 10024.

The principal reason to control vampire bats is their transmission of rabies to cattle and man. New vaccines protect against rabies and new bat control methods use anticoagulant. Economic pressures have forced humans into new areas with few resident vampires introducing ecological changes that produced a cycle where bat transmitted rabies is emerging as a public health problem. This requires a review of methods used for vampire control. Eradication of vampires is neither recommended nor desirable. Most vampire populations are rabies free and bat predation may be tolerated. Three methods using warfarin are specific for vampire control at low cost: 1) The topical treatment of vampires, effective for halting rabies outbreaks, requires nets to capture vampires and people applying the chemical must be able to identify vampires. 2) The most practical and selective control to protect herds is the intramuscular injection of bovines with warfarin which can be applied by anyone who knows how to inject cattle.No need to handle live bats. 3) The topical treatment of bat bites with strychnine or warfarin is safe to use and strychnine will kill a vampire in seconds while warfarin requires days, permitting a bat to return to its roost and forage. Application of anticoagulant to roost walls is not recommended since it is residual, effective up to a year, thus posing secondary hazards to about 45 bat species which share roosts with Desmodus rotundus, the common vampire bat.

SYSTEMATICS OF MEGADERMATID BATS (CHIROPTERA, MEGADERMATIDAE), BASED ON HYOID MORPHOLOGY.
Thomas A. Griffiths, Allison Truckenbrod, and Pamela J. Sponholtz. Illinois Wesleyan University, Bloomington, IL 61702-2900

The hyoid musculature and hyoid apparatus of bats of the family Megadermatidae are described and compared with the hyoid morphology of bat families described by TAG elsewhere. Megadermatid bats share an apomorphic character state with nycterids, rhinopomatids, and emballonurids in that the omohyoid muscle has shifted its origin from the scapula to the mid-clavicle. We suggest that because of the omohyoid shift, megadermatids have been able to develop a morphological condition described previously only in New World phyllostomid bats. The sternohyoid, hyoglossus, and geniohyoid muscles have partially detached from the basihyal, retaining a connection only through a tendon and a few deep fibers of the geniohyoid. The styloglossus muscle has a posteriorly-shifted insertion, as in phyllostomids. Within the Megadermatidae, there is morphological variation in the origin of the sternothyroid, hyoglossus, and sphincter colli profundus muscles, in the morphology of the styloglossus, and in the insertion of the geniohyoid and ceratohyoid muscles. A cladistic analysis of the data suggests that Lavia frons is closely related to Megaderma spasma and M. lyra. Cardioderma cor is a sister species to the Lavia-Megaderma group. Macroderma gigas is the most distantly related of the four megadermatid genera. Our cladogram has a number of differences when compared with the only previous cladogram generated for megadermatids, that of Sue Hand based on teeth.

USE OF TORPOR AMONG MALE EPTESICUS FUSCUS COMPARED TO FEMALES DURING PREGNANCY AND LACTATION.
Lara Grinevitch. University of Calgary, Calgary, Alberta.

Compared to the strategies of reproductive female bats, it has been assumed that because males are free of the energy constraints of pregnancy and lactation, they are able to minimize energy expenditures by using torpor at every opportunity. To address this question, a radiotelemetry study of free-living male Eptesicus fuscus was conducted on bats living in the maternity roosts of the same species in southeastern Alberta. The length of time spent foraging and the use of torpor among males was compared to the same parameters for reproductive female bats under the same conditions. The studies were carried out in May through August 1991.

SEASONALITY AND SYNCHRONY OF REPRODUCTION IN TROPICAL BATS: ASSESSING SEASONALITY AND THE PHYSIOLOGICAL MAINTENANCE OF RHYTHMS. Paul D. Heideman and F. H. Bronson. Institute of Reproductive Biology, Department of Zoology, University of Texas, Austin, TX 78712.

Many, and perhaps most, tropical species of bats reproduce seasonally and synchronously. Two important problems hamper our understanding of seasonal breeding in the tropics: (1) difficulty in the assessment of weak seasonal peaks or lulls when breeding is only weakly seasonal and, (2) a nearly complete lack of knowledge about the environmental cues and physiological mechanisms tropical mammals actually use to regulate seasonal breeding. In this study, we first apply a randomization technique to analyze data on the timing of reproduction in a Philippine population of Macroglossus minimus, a paleotropical nectarivorous bat. Most female M. minimus in the population on southern Negros Island (9° N) probably give birth to single pups twice per year. When presented graphically, the timing of births appears to be aseasonal and asynchronous. However, births were in fact loosely centered on two periods of the year, February through April and July through September. Both of these clusters are statistically significant. Second, we show that an important physiological component of seasonal breeding in a population of a neotropical frugivorous bat (Anoura geoffroyi) from Trinidad (10° N) is an internal rhythm of reproduction. Males captured in late October 1990, when adult females held mid-term embryos, had small testes. Groups of 10-13 males in light-sealed, ventilated flight chambers were subjected to two constant and four gradually varying photoperiod treatments. The gradually-changing treatments mimicked either the natural variation in daylength that these bats would see at 10° N latitude, or mimicked this change, but accelerated it to a 6-month cycle. In all six treatments, testis growth began in April and May and reached a plateau in July.

THE MANAGEMENT OF AN INTERPRETIVE BAT SITE CONTAINING MATERNITY COLONIES OF MEXICAN FREE-TAILED BAT (TADARIDA BRASILIENSIS) AND CAVE MYOTIS (MYOTIS VELIFER). Donna Hensley, Texas Nature Conservancy, San Antonio, TX 78295

The Eckert James River Bat Cave in Central Texas is a seasonal home to approximately four million Mexican free-tailed bats and twenty thousand cave myotis. The colonies of mostly female bats, residents from March to November, are among the largest in Texas, and are essential to conservation planning. Roosting in densities from 200 to 500 per square foot, these bats are extremely vulnerable to disturbance. In April of 1990, the cave was deeded to the Texas Nature Conservancy (TNC) under the condition that it be open for the public to enjoy. Evening emergences are spectacular, ranking among nature's most awesome phenomena. Management of the cave is accomplished by a partnership between the TNC and Bat Conservation International. An interpretive exhibit educates visitors and helps to protect bats. A conservation intern cares for the site, provides evening programs and monitors nightly emergences and public visitation. The first year's results and current management program will be discussed.

GEOGRAPHIC VARIATION IN THE DIET OF THE PALLID BAT, Antrozous pallidus, AS REVEALED BY STABLE ISOTOPE ANALYSIS. Luis G. Herrera, Theodore H. Fleming, and James S. Findley. University of Miami, Coral Gables, FL; University of New Mexico, Albuquerque, NM.

The pallid bat, Antrozous pallidus, is well-known for eating large arthropods such as scorpions which it captures on the ground. It has also been reported to eat the pulp of Organ Pipe cactus in southern Arizona and has been captured in Agave inflorescences. The faces of several individuals netted in Sonora, Mexico, in April 1990 were covered with cactus pollen. These observations raise the question: Is Antrozous a facultative pollinator and disperser of the seeds of night-blooming bat plants in arid regions of the southwest United States and Mexico?

To answer this question, we determined the ratio of 13C:12C in toe muscle tissue from museum specimens collected in different localities in Mexico and the southwestern U.S. during the warm months of the year. If Antrozous is partially nectarivorous/frugivorous, its tissues should contain substantial amounts of carbon derived from CAM plants (i.e. Cactaceae and Agavaceae). We also examined muscle tissue from other species of insectivorous bats (Macrotus californicus, Eptesicus fuscus, and Tadarida mexicana) captured at the same time and places as Antrozous as controls. Unless they also visit flowers or eat insects specialized on CAM or C4 plant tissues, these bats should be C3 in carbon composition.

Our results indicate that considerable geographic variation exists in the carbon composition of Antrozous muscle tissue. At some locations and dates, it is as strongly CAM as the obligate nectarivore Leptonycteris curasoae; in others it contains a mixture of C3 and CAM carbon; in still others it contains exclusively C3 carbon, as is the case in the control bats. Most, but not all, of the heavy CAM sites fall within the Sonoran and Chihuahuan deserts. Sources of CAM (or C4) carbon in the diet of Antrozous outside the ranges of the Cactaceae and Agavaceae are currently not clear but must include insects that specialize on feeding on CAM or C4 plants. Our results suggest that at certain places and times of the year, Antrozous consumes substantial amounts of nectar and probably serves as a pollinator of night-blooming bat plants.

THE EFFECTS OF AMBIENT TEMPERATURE AND INSECT AVAILABILITY ON THE FORAGING BEHAVIOUR AND THERMOREGULATION IN HOARY BATS (LASIURUS CINEREUS). M. Brian C. Hickey. Biology Department, York University, North York, Ontario M3J 1P3, Canada.

At ambient temperatures below 15°C some bats entered torpor but not all bats adopted the same thermoregulatory strategy on the same night. On nights with low insect density, bats used more foraging sites and spent less time at their main foraging site than when insect density was high. These data support the hypothesis that hoary bats should switch from a risk-averse to a risk-prone foraging strategy at low insect densities. The ability to enter torpor may make risk-prone foraging by hoary bats less risky.

SEASONAL EFFECTS ON REPRODUCTION BY EPTESICUS FUSCUS IN ALBERTA.
Susan Holroyd. University of Calgary, Calgary, Alberta.

A female faced with pregnancy and subsequent child-rearing at the onset of the reproductive period must make decisions which will maximize her long-term reproductive output and survival. These decisions are made under constraints from her environment and her own physical condition at the onset of pregnancy.

Adult female Eptesicus fuscus in southeastern Alberta, give birth to litters of two young 10% of the time. To determine how environmental factors influence the reproductive and behavioural decisions females make in this environment, bats were followed with temperature sensitive radio transmitters throughout pregnancy and lactation. Nightly activity (foraging and use of torpor) was recorded. Activity of pregnant bats was compared to that of early and late-lactating bats. Bats were caught throughout the reproductive period to follow changes in mass and reproductive condition. Mass, length of forearm and epiphyseal gap measurements were taken on young E. fuscus. Using known age individuals, growth curves were calculated to produce predictive age equations.

Differences were found between the 1990 and 1991 field seasons that may be correlated with differences in early season ambient temperatures. Parturition and volancy were 10 to 14 days earlier in 1991. May temperatures in 1991 were much warmer than in 1990 and a greater proportion of foraging activity was recorded for the colonies during this period in 1991.

POTENTIAL CHARACTER RELEASE IN THE HAWAIIAN HOARY BAT, Lasiurus cinereus semotus.
David S. Jacobs. University of Hawaii at Manoa, 2538 The Mall, Honolulu, Hawaii 96822.

Ecological theory regards interspecific competition as a significant force that shapes the morphology and behavior of organisms. Such characters may change in the absence or reduction of interspecific competition, a phenomenon called character release. The insectivorous Hawaiian hoary bat, Lasiurus cinereus semotus, is the only bat in Hawaii. Conspecifics exist in North America with a number of other insectivorous bat species some of which are congeneric. Character release in the Hawaiian hoary bat was investigated on the island of Hawaii. The study determined whether or not the Hawaiian bat, without competitors, consumed a broader range of prey than does its North American counterpart, Lasiurus cinereus cinereus, in the presence of competitors. Flight morphology was also investigated. The Hawaiian bat consumed a broader range of insect prey than the North American hoary bat. It had a lower wing loading and a proportionately broader wing, than its North American counterpart. No difference was found in the relative lengths of the wing tips. These wing parameters suggest that the Hawaiian bat is capable of a wider range of flight speeds when foraging than its mainland counterpart. This enables it to utilize a a broader range of habitats and, therefore, also a wider range of insect prey. These results are consistant with predictions of a character release hypothesis.

CAUSES AND CONSEQUENCES OF INDIVIDUAL VARIATION IN THE ECHOLOCATION CALLS OF BATS.
Gareth Jones and Roger D. Ransome. University of Bristol, Woodland Road, Bristol BS8 1UG, UK.

The adaptive significance of interspecific variation in the echolocation calls of bats is now well understood. Species use calls which are related to the bats' hunting behaviour, and calls are often designed according to predictions from acoustical theory. For example, bats which hawk insects at high speed in open habitats tend to emit low frequency signals with most of the call energy focussed into a narrow band of the frequency spectrum. Such signals are designed for long range target detection, and travel to distances far ahead of the flying bat.

The substantial variation in search phase pulse design within species and within individuals has received little attention however. Both effects are explored in this paper. It is shown that body size affects call frequency in some species (*Myotis adversus, Asellia tridens*), while sex, but not size is important in others (*Rhinolophus hipposideros*). We have recorded the echolocation calls of *Rhinolophus ferrumequinum* adults aged between 1-26 years over the past five years, and show that call frequency changes over an individual's lifetime. Reference frequency increases between years 1-3, and thereafter remains relatively stable until about years 12-15. Thereafter reference frequency may fall in very old bats (> than about 15 years), and this fall is associated with increased mortality rates of bats. Comparisons of the call frequencies with those of offspring are made to explore whether the transmission of reference frequency is mainly genetic or learnt. Possible consequences of intraspecific and intra-individual variation in pulse design are explored.

THE EFFECTIVENESS OF AXLE GREASE AS AN ALTERNATIVE ADHESIVE FOR USE ON STICKY TRAPS. Matina C. Kalcounis. University of Regina, Regina SK.

In order to understand the foraging behaviour of insectivorous bats it is important to compare the diet of individuals with the available food supply. A frequently used method for sampling aerial insects is sticky traps. Advantages of sticky traps are their low cost, simple structure and portability. Drawbacks include the difficulty in handling commercially available adhesives such as Tangletrap, and removing the insect specimens intact from the adhesive. The purpose of this study was to compare the effectiveness of sticky traps coated with Tangletrap as compared with those coated with axle grease (Shell Darina Grease AX). I tested the hypothesis that the Tangletrap would sample insects no more efficiently than the grease. The grease may be a preferable alternative because of its lower cost, better retention of adhesive properties over long periods of time and its solubility in ethanol which makes the removal of insects considerably easier. On 37 nights between 6 June and 27 August, 1991, I hung five pairs of sticky traps. Each pair of traps consisted of two PVC pipes, one coated with Tangletrap and the other with axle grease. Preliminary analysis indicates that axle grease performs as well if not better than Tangletrap as an adhesive.

ECHOLOCATION AND HUNTING BEHAVIOR OF EUROPEAN PIPISTRELLE BATS. Elisabeth Kalko. University of Tübingen, FRG.*

I studied 3 species of pipistrelle bats foraging in their natural habitats. I used two 35 mm cameras and a multiflash unit for photographing and simultaneously recorded echolocation signals. This method allows a three-dimensional reconstruction of the flightpaths of the bats and their prey as well as a correlation of hunting behavior with echolocation behavior. *Pipistrellus pipistrellus, P. nathusii* and *P. kuhli* catch insects in the air with their tail membrane and/or a wing. The bats follow their prey either directly or use interception maneuvers in which they must predict the future position of the insect. Design of echolocation pulses of pipistrelle bats is highly variable. In the search phase signals vary from extreme narrowband to wideband signals which have a steep frequency-modulated initial part. The transition between the signal types can be smooth or abrupt. The use of the various signal types depends on the orientation situation of the bat. Bats flying in cluttered space use wideband signals whereas bats flying in uncluttered space use predominantly narrowband signals. After detecting a target pipistrelle bats emit exclusively frequency-modulated signals. They avoid overlap of outgoing signals and returning echoes by adjusting sound duration in relation to their distance from a target. Sound duration and signal structure of search phase signals allow predictions of a minimum distance at which a bat should detect prey and of the space within a habitat in which certain species of bats are likely to hunt.

FUNCTIONAL ORGANIZATION IN THE AUDITORY MIDBRAIN OF THE DESERT PALLID BAT, (*ANTROZOUS P. PALLIDUS*). J.M. Kennedy and Z.M. Fuzessery. University of Wyoming, Laramie, WY.

The pallid bat is adept at both active and passive sound localization. The functional organization of its inferior colliculus (IC), which we studied using electrophysiological multiunit recording, revealed some striking specializations that can be related to this species' abilities to passively locate low-frequency (< 20 kHz) sounds generated by terrestrial insects as well as echolocate at higher frequencies (30-90 kHz). Electrode penetrations throughout the IC revealed three functional areas which can be distinguished by their selectivity for pure tones, noise and frequency modulated (FM) sweeps. The pure-tone selective, or "frequency map", region shows a tonotopic organization common to most mammals, with low frequencies represented dorsally and frequency tuning increasing ventrally. This frequency map is unusual in that it occupies only a small portion of the IC and the lower frequencies (6-25 kHz) are overrepresented. The noise selective region, by far the largest, contains neurons that respond preferentially to low frequency noise. Noise bursts as short as 1 usec at intensities near 0 dB SPL can be detected by this neuronal population. Finally, the FM selective region responds selectively to the downward 60 to 30 kHz frequency sweep of the bat's echolocation pulse. Deletion of any frequencies in the sweep, or reversing the direction of the sweep, decreases the response dramatically. These specializations of the pallid bat's inferior colliculus may be neural correlates of its acumen in both actively and passively localizing sound sources.

THE ECTOPARASITES OF THE SOUTHEASTERN BAT, *Myotis austroriparius*, FROM FLORIDA. William H. Kern, Jr. University of Florida, Gainesville, FL.

The arthropod ectoparasites were collected from numerous southeastern bats representing four separate colonies. The majority of the bats examined were salvaged during a severe freeze that began 23 December 1989. The following ectoparasites were collected and examined by scanning electron microscopy or were mounted in Hoyer's Solution and examined under the light microscope; *Olabidocarpus whitakeri* (Acarina: Chirodiscidae), *Acanthophthirius nsp.* (Acarina: Myobiidae), *Spinturnix americanus* (Acarina: Spinturnicidae), *Macronyssus jonesi, M. crosbyi* (Acarina: Macronyssidae), *Basilia boardmani* (Diptera: Nycteribiidae), and *Thichobius major* (Diptera: Streblidae). Two species previously reported to infest the southeastern bat were not found, *Euschoengastia pipistrelli* (Acarina: Trombiculidae) and *Sternopsylla distincta texana* (Siphonaptera: Ischnopsyllidae).

ENERGETICS OF FLIGHT IN BATS AND BIRDS: A COMPARISON OF THEORY AND EMPIRICAL RESULTS. Thomas H. Kunz and Ulla M. Norberg. Boston University, Boston, MA and University of Goteborg, Goteborg, Sweden

Available empirical data on flight costs for bats and birds are compared with estimates of mechanical power (power output) derived from aerodynamic theory. We also examine the assumptions and potential biases of the theoretical and empirical approaches used to estimate flight costs in bats and birds. The RMA regressions for bats and birds, based on data from wind-tunnel experiments and time-energy budget studies using doubly-labeled water, are P_{met} (W) = 69.2 M(kg)$^{0.869}$ and P_{met} = 64.1 $M^{0.892}$, respectively. Combining these equations with those estimated for basal metabolic rates gives the (mechanical) flight costs for bats and birds as multiples of BMR as P_{bat} = 26.2 $M^{0.13}$ x BMR and P_{bird} = 17.8 $M^{0.21}$ x BMR, respectively. Predictions from aerodynamic theory for bats (Rayner 1988, 1990; Norberg and Rayner 1987; Pennycuick 1989) coincide with results from doubly labeled water and wind tunnel experiments, assuming a mechanical efficiency of 0.06 for small bats (0.010 kg), and an efficiency of 0.21 for a 0.800 kg bat. Predictions from aerodynamic theory for birds (Rayner 1988, 1990; Pennycuick 1989) coincide best with results from doubly labeled water experiments, assuming a mechanical efficiency of 0.06-0.10 for small birds (~0.010 kg), and an efficiency of 0.16-0.20 for a 0.400 kg bird. By contrast, results from wind-tunnel experiments on birds give considerably higher values than those derived from doubly labeled water experiments and aerodynamic theory. Comparing results from wind-tunnel studies with aerodynamic theory, the mechanical efficiency for a 0.010 kg bird would be almost zero, and about 0.10 for a 0.400 kg bird.

PRELIMINARY OBSERVATIONS ON INDIANA BAT (MYOTIS SODALIS) ROOST TREES IN MICHIGAN. Allen Kurta and David King. Eastern Michigan University, Ypsilanti, MI.

In summer 1979, 10 Indiana bats were mist-netted over a short stretch of the Thornapple River, in Eaton Co., Michigan, only 15 km from the northern edge of the species' range. Despite diligent ground searches, we never located their roost that year. In June 1991, we returned to the Thornapple River, mist-netted an Indiana bat, and attached a small radiotransmitter. The next morning the bat was found roosting underneath the loose bark of a mostly dead, green ash (Fraxinus pennsylvanica) tree in the middle of a small wetland. This is the first report of Indiana bats using green ash trees and the first colony to be found in an open wetland. During July and August 1991, we made 25 observations of emergence behavior at this tree and alternate roost trees located nearby. As many as 46 bats were present, and we identified 7 other roost trees within 150 m. Although some trees were continually used by Indiana bats for over three weeks, the number residing in any one tree fluctuated dramatically and continually.

BIOSONAR EMISSIONS OF *PTERONOTUS PARNELLII* DURING FREE AND PENDULUM FLIGHT. Winston C. Lancaster, Arthur Keating and O.W. Henson, Jr. University of North Carolina Chapel Hill, Chapel Hill N.C.

Investigations in our laboratory have used a pendulum to study echolocation behavior. It has been demonstrated, however, that wing beats in bats are coupled to respiration and hence to vocalization and it is of interest to compare other aspects of echolocation between the pendulum and free flight conditions.

For free flight measurements, we used an FM transmitter coupled to an electret microphone (Knowles Model 1759). The transmitter with battery weighed 0.85 grams and was carried on the head of *Pteronotus parnellii parnellii* engaged in landing maneuvers. Frequency and pulse-echo timing were measured on a Rapid Systems Spectrum Analyzer/Digital Oscilloscope. The difference in frequency between the transmitted vocalization and the signal recorded on a stationary microphone was used to calculate instantaneous velocity and Doppler-shifts.

Frequency parameters and Doppler-shift compensation were comparable in both methods, but in other respects there were significant differences. In free flight, the typical phases of echolocation behavior were reflected in pulse group structure, duration, repetition rate, and interpulse interval. Search phase groups consisted of 1 or 2 pulses per group, approach phase consisted of 3 to 5 pulses per group and terminal phases usually had 5 or more pulses. Groups usually lasted less than 100 ms. Pulse durations were long at higher flight speeds. In approach to a target, duration and velocity decreased. Repetition rate was low in search phase, higher in approach phase and highest in terminal phase. Interpulse interval showed a bimodal distribution of intervals between pulses and intervals between groups. In both groups, interval duration decreased during the flight. On the pendulum the typical phases were seldom seen. Groups of multiple pulses appeared early in the swing and some groups were longer than in flight. Mean durations were also longer than in flight. There was often no clear difference among intervals between pulses versus those between groups.

SOCIAL AGGREGATIONS OF PREGNANT AND LACTATING PALLID BATS. Susan E. Lewis University of Minnesota, Minneapolis, MN.

Like many North American bats, female pallid bats (Antrozous pallidus) form maternity groups during the summer. Previous research has suggested that pallid bat groups are characterized by strong bonds between individuals and well developed social communication. This is the first detailed study of the daily patterns of association and grouping of specific individuals in pallid bat maternity colonies. A total of 89 female pallid bats were captured and banded in Central Oregon in 1990 and 1991. Most bats were captured in mist nets while entering one of three night roosts. Thirteen of the 14 bats captured more than once were recaptured at the same night roost each time, including the six bats captured in both years. Although in 1990 most bats gave birth in mid- to late June, no lactating bats were captured in 1991 until mid-July and there appeared to by much lower reproductive success this year. This is most likely attributable to cooler, wetter weather in the spring and early summer of 1991 that placed additional stress on pregnant females.

Radiotransmitters were attached to thirty-four bats (20 when pregnant, 11 when lactating, 1 when not pregnant, and 2 when pregnant and again when lactating) to allow me to locate their diurnal roosts. Roosting groups size was determined by visual inspection of the diurnal roosts or by counting bats as they exited the roost at dusk. Bats roosted alone or in groups of from 2 to 90 bats (average group size 37.8). Pregnant bats were much more likely to roost alone than were lactating bats. Pallid bats in this area changed roosts more frequently than has been reported in southern populations. In 1991, bats moved every 1.4 days on average, spending from one to five days at a single roost. Of 57 diurnal roosts located in 1991, only three had also been used in 1990 and seven were used on non-consecutive days in 1991. Interestingly, radiotracked bats roosting together often changed roosts independently of one another. It appears that pallid bats in Oregon have a more fluid social structure than has been reported for this species elsewhere.

Annual Weight Cycles in the Fruit Bat *Rousettus aegyptiacus*. David Makin, Kfar Hyyim 42945, Israel (current address, Department of Biology, Boston University, Boston, MA)

In the process of a capture-mark-recapture investigation conducted in Israel on the local fruit bat, *Rousettus aegyptiacus*, 6000 bats were marked during the period from 1982 to 1990. Adults were subjectively sorted into relative age groups according to the abrasion of their canine teeth. The absolute ages of the groups were estimated on the basis of the recaptures of known-age individuals. The recapture of adults provided information on age determination by providing data on the rate of canine tooth abrasion. The relationship between body weight, month of capture, time of capture, and age were investigated. The results show that body weight in adults exhibits a circannual cycle and a daily cycle, and is influenced by age.

NURSING BEHAVIORS IN NATURAL MATERNITY COLONIES OF RHINOLOPHUS FERRUMEQUINUM NIPPON, RHINOLOPHUS IMAIZUMII AND HIPPOSIDEROS TURPIS. Sumiko Matsumura. Yamaguchi University, Ube, 755 JAPAN.

Natural nursing colonies of Japanese greater horseshoe bat(R. f. n.) were studied in the Main Island in the temperate. Other two endemic species, Iriomote lesser horseshoe bat(R. i.) and Yaeyama leaf nosed bat(H. t.) were studied in Iriomote Island locating subtropical region near Taiwan.

These Old World species have a common nursing organ, named pseudo mamma. This organ is a kind of skin appendage at the abdominal region of adult female. They appear on their first parturition and remain after. Infants bite it tightly with teeth in formal resting posture during nursing period. Thus mother and infant took typical reverse direction; mother hangs upside down while infant directs the reverse. Due to this organ mother can hold her infant tightly and carry it safely for a long distance.

A slight difference is found in the degree of relative development of this organ among the three species. The most well developped one is Hipposideros, greater horseshoe bat is the middle and rudimentary outlooks is found in Iriomote lesser horseshoe bat. The difference is closely related to the nursing habit and colony size of these species.

I'll present typical nursing behaviors(retrieval behavior, cradling behavior, flight training etc.) recorded in maternity roosts of these species. Adding I'll show some preliminary data of their cluster effect recorded with Thermal Imager(farinfrared imaging).

THE GALAPAGOS BATS REVISITED. Gary F. McCracken, John P. Hayes, Jaime Cevallos and Carlos Romero. University of Tennessee, Knoxville, TN; and Escuela Politecnica Nacional, Quito, Ecuador.

The five islands in the Galapagos Archipelago judged most likely to support viable bat populations were surveyed using ultrasonic bat detectors during June and July 1991. The putative endemic species Lasiurus brachyotis is locally abundant on the islands of Santa Cruz and San Cristobal, but there was no evidence for its presence on the islands of Isabela, Floreana, or Santiago. The only other bat species known from the Galapagos, Lasiurus cinereus, is present on all five islands, although it appears to be rare on Santiago relative to its abundance on the four other islands. Both species occupy diverse habitats ranging from coastal, xeric to upland, mesic regions. Temporal changes in the abundances of both species are suggested by surveys on the island of Santa Cruz with L. cinereus, and to a lesser extent L. brachyotis, apparently moving from the cooler, more mesic uplands to the hotter, drier lowlands with the onset of the cool, damp Garua season. Twenty-one L. brachyotis (9 females and 1 male from Santa Cruz, 2 females and 9 males from San Cristobal) were captured. The skewed sex ratios and locations of these collections suggest that, at least during the Garua season, this species shows differential, sex-biased, use of habitats with females abundant in the lowlands and males abundant in the uplands. Three L. cinereus (1 male and 1 female from Santa Cruz, 1 male from Isabela) also were captured. Voucher specimens (4 L. brachyotis, 3 L. cinereus) and blood samples from all bats were collected for genetic and systematic studies. Feces and ectoparasites were collected from both species. Echolocation calls of both species on all islands were recorded using an S-25 bat detector on countdown mode. These calls are currently being analyzed and inter-island patterns in call structure will be discussed.

SENSORY ECOLOGY OF PHYLLOSTOMID BATS Cathy Merriman, Department of Biology, York University. Toronto, Ontario, Canada.

Frugivorous bats in the family Phyllostomidae tend to have relatively large eyes and faint echolocation signals, and previous work has suggested that these bats use vision more than do other microchiropterans when performing various behaviours. In this study, I used two types of experiments to evaluate the importance of vision to four species of phyllostomid bats (*Artibeus jamaicensis*, *Carollia perspicillata*, *Glossophaga soricina* and *Sturnira lilium*). I tested escape response behaviour in order to investigate the bats' sensory cue preferences. Wild bats were placed in a Y-maze where they were presented with one of ten possible treatments. The treatments consisted of combinations of visual cues (light/dark), acoustic cues (open/closed tunnel) and a combined visual and acoustic cue (visible barrier allowing passage of light). Preliminary analysis indicates that these frugivorous and nectarivorous bats showed no significant preference for visual over acoustic cues. In obstacle avoidance tests, I observed that individual *A. jamaicensis* trained to fly to food learned to avoid both visual and acoustic obstacles.

SEX-RATIO VARIATION IN A NURSING COLONY OF *MYOTIS YUMANENSIS*. Barry N. Milligan. University of Victoria, Victoria, BC.

Offspring of *Myotis yumanensis* were studied in a nursing colony near Sorrento, British Columbia during June and July, 1991. The purpose of the study was to determine if the sex of young was related to the physical condition of the mother. Offspring from 244 mothers were sexed and aged relative to other offspring in the colony. I found that the sex and age of young were related to the physical condition of mothers. Offspring of different relative ages had significantly different sex-ratios (x^2 = 16.33, DF = 5; P = 0.006). Offspring born early during the parturition period were more likely to be males while offspring born later were more likely to be female. Mothers giving birth later had significantly less tooth wear relative to mothers giving birth to earlier. This suggests that mothers are more likely to give birth to females as they age.

ECOLOGY OF FRUGIVOROUS AND NECTARIVOROUS BATS FROM INDIA. Shahroukh Mistry. The University of New Mexico, Albuquerque, New Mexico.

Bats play an important role in the pollination and dispersal of plants throughout the world, yet research on the role of megachiropteran bats as effective agents of pollination and seed dispersal has been quite limited. Most studies have examined single bat species and have not considered community level interactions. In addition, there have been few rigorous comparative studies between the ecology of Old World and New World frugivorous and nectarivorous bats. In this paper I present preliminary results on the distribution of the megachiroptera of India and outline future research goals. The study was conducted in the state of Sikkim in northeast India. The montane forests of Sikkim and the nearby areas contain some of the richest fruit bat fauna of India. The species in the area include Pteropus gigantus, Cynopterus sphinx, Rousettus leschenaulti, Eonycteris spelaea, Megarops eucaudata, Macroglossus sobrinus, and Sphaerias blanfordi. Cynopterus sphinx, R. leschenaulti, and E. spelaea (not previously reported in Sikkim) are the most common species during the summer monsoon months. Eonycteris spelaea exhibited significant morphological variation between sexes suggesting possible foraging differences. The interactions of community members in pollination and seed dispersal, dietary and dispersal differences between New and Old World bats, and the role of Pteropodid bats in the conservation of forests will be the future emphases of this project.

TROPICAL AMERICAN BATS--A THREATENED NATURAL RESOURCE--AND THE VAMPIRE-CATTLE CONNECTION: SOLUTIONS TO RESOLVE CONFLICTS. Patricia A. Morton, Bat Conservation International, Austin, TX U.S.A.

Bats play a key role in maintaining the diversity of life throughout tropical America. More than 200 species inhabit the area, about half feeding on fruit and nectar. These are vital seed dispersers and pollinators for numerous plants that are essential components of whole ecosystems and local economies. Most other Latin American bats are insectivorous. Large colonies can consume tens of thousands of kilograms of insects nightly. Despite their many benefits, Latin American bats are among the least appreciated and most threatened animals. Due to superstition and misinformation about vampires, millions of beneficial bats are killed annually. Inappropriate vampire control programs jeopardize the sustainability of tropical ecosystems and economies. The presence of the common vampire, Desmodus rotundus, has darkened the reputation of all bats. Economic lossses due to vampire bats total an estimated $50 million each year. The future of bats in tropical America, and the plants and ecosystems that depend on them, will rely on successfully addressing vampire bat management along with raising public awareness and appreciation for these essential animals. The poster presentation will cover bat diversity, importance to tropical ecosystems and people, and the effects of vampire bats, rabies control, and other problems. (Poster text is in Spanish)

COLORADO'S BATS/INACTIVE MINES PROJECT. Kirk W. Navo, Connie L. Knapp, and Judy Sheppard. Colorado Division of Wildlife, 6060 Broadway, Denver, CO.

Colorado's rich mining history has resulted in more than 20,000 inactive mines throughout much of the state. While the Colorado Mined Land Reclamation Division (MLRD) is currently closing these mines to safeguard them for the public, they may provide important roosting habitat for some of Colorado's 17 species of bats. The Colorado Division of Wildlife has initiated a volunteer-based project in an attempt to survey these mines for significant bat use prior to closure.

Volunteers were recruited, trained and assigned specific mines sites to survey using bat detectors outside the entrance. Sites with significant bat activity were recommended for bat gate closures to protect roosting habitat that would otherwise be permanently lost. Selected sites were further investigated by biologists to verify species and determine type of use. Plans are being developed to monitor mine sites with bat gates to determine acceptance of gate design.

ENERGY COST OF HOVERING FLIGHT IN *GLOSSOPHAGA SORICINA*, ESTIMATED WITH DIFFERENT METHODS. Ulla M. Norberg*, Thomas H. Kunz**, John F. Steffensen+, York Winter++, and Otto v. Helversen++. *Dept. Zoology, Univ. of Göteborg, Sweden; ** Dept. Biology, Univ. of Boston, Boston, MA; +Marine Biol. Lab., Univ. of Copenhagen, Helsingør, Denmark; ++Dept. Zoology, Univ. of Erlangen-Nürnberg, Erlangen, Germany.

The energy cost of flight in animals has previously been estimated in different ways. Methods used are estimates bases on mass loss during long flights, the doubly labeled water technique or estimation of food consumption combined with time budgets, O_2 consumption or CO_2 production in a closed or open flow system, and aerodynamic theory. However, all methods suffer from various limitations, and comparisons between results from field and laboratory experiments and from theory are therefore difficult to make. In this project we use several different methods to estimate the energy cost of hovering flight in one and the same bat species, *Glossophaga soricina*: (1) respiration measurements (O_2 consumption), (2) doubly-labeled water technique and (3) energy intake combined with time-budgets, and (4) aerodynamic theory combined with direct measurements of the velocity of the induced air flow. According to the respiratory measurements, the energy cost of hovering (power input) in *G.s.* was 1.15 W. Results from aerodynamic theory (power output) give a corresponding mechanical efficiency (power output/power input) of ~~0.24 (24%)~~. The mean velocity of the induced air in the contracted zone below the wing disk was ~~5.7~~m s^{-1}.

DESIGN AND MANAGEMENT OF PROTECTED AREAS IN THE CONSERVATION OF VENEZUELAN BATS. Jose Ochoa, and Mariapia Bevilacqua. Sociedad Conservacionista Audubon de Venezuela; Direccion General Sectorial de Parques Nacionales, Caracas, Venezuela.

At least 145 species of bats inhabit the Venezuelan territory. Of these, two species are endemic (Lonchorhina fernandezi and Myotis nesopolus) and require special management for their conservation. Forty-three other species are restricted to specific regions. Many of these regions suffer from conflicting land uses and the ecosystem degradation associated with forestry, mining, and agriculturral and urban expansion. Unfortunately, current environmental and research programs do not consider the conservation of bats and their habitats a priority. Only the Andes and the Coastal Mountain Range possess an appropriate system of protected areas. In other regions, the protected areas remain insufficiently large to conserve the diversity of natural ecosystems. This is particularly true south of the Orinoco River, where most of the national parks protect the highland ecosystems of the tepuyes, while a large area of lowland rain forest (11 million ha, or 12.8% of the national territory) has been earmarked for timber exploitation. In these commercially exploited forests, we have initiated a study of the ecological impact of timber extraction on mammal communities. This study includes an inventory of species, population monitoring, and evaluation of habitats using bats as one group of indicator species. The results have revealed changes in the composition of the bat community associated with modifications in the forest structure and composition following logging. These changes include reduction in species diversity, increase in the occurance of aerial insectivores, and absence of some gleaning carnivorous species. The study has generated a proposal for the protection of areas within exploited forests, which would function as biodiversity corridors and would facilitate the protection of the most sensitive species.

Bringing Bats to Your Bat House. Melville J.(Jack) Onan. Center for Blindness and Aberrant Behaviour Research, Pullitsbourgh, Newfoundland.

Using advanced photographic enhancement techniques I succeeded in luring bats into previously unoccupied bat houses. A total of 60 Bat Conservation International bat houses was installed within a 10 km radius of the Institute in typical Canadian boreal habitat. Each house was modified by expanding the landing platform beneath the box part of the house. The bat houses were divided into four experimental groups. On the expanded landing surfaces, I installed excellent photographs of a prominent and famous bat biologist (M. D. T.) = Group 1; an heroic person (Margaret Thatcher) = Group 2; a random black and white design = Group 3; and no ornaments = Group 4. To score bats' use of the houses, I counted bat droppings (the turd index) on the landing platforms and ornaments. The bats were by far the most active at group 1 houses which showed turd index values highly significantly greater than the others which were not significantly different from one another. The lure of the Group 1 photograph was very strong, but waned with increasing turd index. At five Group 1 bat houses, individual *Myotis lucifugus* were observed cleaning the visage of the famous bat person. At these houses there was no evidence of waning bat activity with increasing turd indices. Substituting a photograph of our fearless Symposium Leader showed a dramatic drop in droppings, suggesting a value judgement on the part of the bats, or perhaps some more mysterious aversion, but that evidence is not presented here. I conclude that an excellent photograph of an appropriate individual indeed draws bats to unoccupied bat houses. Future work will test its effectiveness with fruit bats. Supported by C. F. B. & M. R. grant #Y.U. - 88.

PATTERNS OF VARIATION IN THE VOCALIZATIONS OF INFANT GREATER SPEAR-NOSED BATS.
Diane L. O'Reilly. University of Maryland, College Park, MD.

As part of a larger study on the function of vocal communication signals in the greater spear-nosed bat (Phyllostomus hastatus), I examined variation in the isolation calls of one to four week old pups recorded from three cave colonies in Trinidad, West Indies. These bats are unusual in that they form highly stable clusters of about 20 unrelated females that are tended and mated by a single male, and female groups stay together as a unit independent of the male despite disruptions. While it is advantageous for females to disperse from their natal roosts in order to prevent mating with their fathers, it is not clear what facilitates group formation or maintains relationships that exceed 12 years among unrelated individuals. Infant vocalizations were studied as a first step to determining the information available for communication through analysis of variation at the individual, group and colony levels. Preliminary results show considerable variation within individuals. Infants emit four distinct types of calls which are composed of three basic syllables. These calls have fundamental frequencies near 16 kHz, with multiple harmonics reaching frequencies up to 120 kHz. Call types are distinguished by the number of breaks in the continuity of the sound, and they range from a continuous sinusoidal frequency modulated call (50 msec.) to a series of two, three, or four syllables (15-25 msec. each) ending with a short frequency sweep (5-10 msec.). The double note calls of 70 bats (5 calls/bat, 5 bats/group, 14 groups from 3 colonies) were chosen for multivariate and univariate analyses of the variation in nine time and frequency measures. The results indicate that these calls are individually distinct and convey information regarding age and sex of the bat. An overall group effect was also observed, but no variation at the colony level was detected. Alternative causal explanations for these patterns of variation will be discussed.

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ECTOPARASITES OF MEGACHIROPTERA FROM INDIA. Michael J. Patrick and Shahroukh Mistry. The University of New Mexico, Albuquerque, New Mexico.

A total of 62 Megachiropteran bats from India were examined for ectoparasites in the summer of 1990. There were 39 individuals infected with batflies (63%). Altogether there were 92 batflies collected. In one montane forest community in northeast India, 39 bats of the species Rousettus leschenaulti, Eonycteris spelaea, and Cynopterus sphinx were examined for batflies. The infection rate of R. leschenaulti was 96% (22/23), E. spelaea 27% (3/11), and C. sphinx 40% (2/5). The mean number of batflies per bat was 1.95, however the range was greatest for R. leschenaulti (0-6), E. spelaea (0-4), and C. sphinx (0-1). There is a strong relationship between the roosting habits, group size and the number of batflies infecting these bat species. Colonial cave dwelling species, such as R. leschenaulti, exhibit greater numbers of ectoparasites than on tree dwelling species like C. sphinx. Eonycteris spelaea exhibited far fewer numbers of ectoparasites than were expected. Most bats of this species did not carry any large ectoparasites and the two individuals that did were pregnant females. This suggests that this colony of Eonycteris may not dwell in caves or be as colonial as one might expect. Further investigation of the roosting habits of this species may help resolve the question of low parasite loads.

ECHOLOCATION AND THE ONTOGENY OF HEAD POSTURE IN CHIROPTERA.

Scott C. Pedersen, University of Nebraska, Lincoln, NE.

Radiographic cephalometry can be used to detect patterns of skull growth and skull pattern formation. Cephalometric angles reflect volumetric changes between and competition for space among the brain, sensory capsules, pharynx and muscles. Based upon these angular relationships, embryos of leaf nosed (nasal emitting) and non-leaf nosed (oral emitting) taxa are indistinguishable early in development. However in nasal emitting taxa, differential growth of the brain and the pharynx eventually distorts the skull; by rotation the skull ventrally about the cervical axis, by depressing the rostrum below the basicranial axis, and by rotating the lateral semicircular canals so as to retain their horizontal orientation. This study suggests that evolution of the chiropteran skull has followed two distinct path towards oral and nasal emitting forms. The demands of echolocation and the soft tissue functional matrix of the head have strongly canalized the evolution of chiropteran skull morphology and head posture.

MIGRATORY PATTERNS OF *LASIONYCTERIS NOCTIVAGANS* IN OREGON AND WASHINGTON.

J. Mark Perkins and Steven P. Cross. Portland, OR. and Southern Oregon State College, Ashland, OR.

Our research indicates *Lasionycteris noctivagans* divides migratory habitat between the sexes by space and time. We noted that males begin northward movement to Oregon and Washington (May), earlier than females (June). Statistical analysis of capture and museum data indicates reproducing females consistently occupy territory separate from that of males. Sexual segregation appears to decline in Oregon and Washington beginning in late August or early September and an apparent southward migration of adults begins.

THE IMPORTANCE OF MINES AS ROOSTING HABITAT FOR BATS: *PLECOTUS TOWNSENDII* IN CALIFORNIA.

Elizabeth D. Pierson and William E. Rainey, University of California, Berkeley, CA; Dolora M. Koontz, Homestake Mining Company, Lower Lake, CA.

Sixty-four percent of the 45 continental U.S. bat species have been found roosting in underground mines. For some of the more sensitive species of the West, mines are the most important roosting habitat. For *Plecotus townsendii*, 13 of the 33 currently known maternity roosts in the state of California are in abandoned mine workings. This species has experienced serious population declines in the past forty years, primarily due to the loss of suitable roosting habitat. Many building roosts have been lost to urban/suburban expansion and deterioration; a number of cave roosts have been abandoned due to human disturbance, commercialization, and inappropriate gates. Mine workings, although also subject to various threats, frequently offer ideal roosting conditions, and can be easily and inexpensively protected by gating. An abandoned mine in Napa County, California, which had occasional bat use, was gated in May 1988 by the Homestake Mining Company, and has since served as a maternity roost for a *P. townsendii* colony displaced by their nearby open pit mine. A microcomputer system, using passive infrared motion detectors and roost temperature probes, provides a minimally intrusive approach to monitoring daily and seasonal patterns of colony activity in relation to environmental variables. Visual emergence counts using night vision devices suggest a stable to increasing population.

BATS IS BATS? GENOME SIZE VARIATION, MONOPHYLY AND POLYPHYLY IN CHIROPTERA.

Luis A. Ruedas. Laboratory of Wildlife Genetics; Department of Wildlife and Fisheries Sciences; Texas A&M University; College Station TX 77843-2258.

Because of the particular and peculiar adaptations involved in flight, the Chiroptera have, until recently, been thought of clearly as monophyletic. Recently, however, questions about this monophyletic origin have arisen, primarily based on the retinotectal pathway between the eye and brain, and on possession of a pendulous penis. In the suborder Megachiroptera, this particular character, or suite of characters, more closely approximates the same character in Primates than in Microchiroptera, which in turn appear to be more closely related to Xenarthra among the Eutheria. In the present study, genome size data were obtained and brought to bear on the question of the phyletic origin of the two chiropteran suborders. Genome sizes were obtained from 108 Megachiroptera, >200 Microchiroptera, 8 Primates, 4 Dermoptera, and 4 Xenarthra. The Microchiroptera sampled to date in this study had a mean genome size 5.59 picograms (pg) DNA, close to the figure of 5.43 pg found by other investigators; both estimates markedly contrast with the generalized eutherian pattern of ~7 pg. Far from approximating the remaining archontan orders, or even Eutheria, Megachiroptera present a more reduced genome size even than Microchiroptera. The Megachiroptera sampled to date averaged 5.34 pg DNA, although their hypothesized primitive genome size is 5.48 pg, close to the Microchiropteran average. In contrast, both Primates and Dermoptera range from 7.0 - 7.8 pg. Xenarthra, the most morphologically divergent eutherian order, ranges from 9.0 - 14.5 pg, broadly overlapping a sample of three species of Didelphidae (10.09 - 10.68 pg). The genome size data support the traditional interpretation of Chiroptera as monophyletic, and the Xenarthra as the most divergent order within the Eutheria.

FEEDING ACTIVITY OF BATS IN NORTHERNMOST SWEDEN (65°N).
Jens Rydell, University of Lund, Sweden.

Only one species of bat, the Northern bat (Eptesicus nilssoni) occurs regularly at 65°N in Sweden. In one maternity colony observed during three summers, the young were born in mid July and flew by early August. The mothers' diet consisted mainly of small (3-10 mm) insects, predominantly dipterans, which were captured and eaten in the air. The bats' feeding activity was centered around midnight (the "darkest" period; 2200-0230 h), and the females spent about three hours outside the roost each night. Hence, due to the short periods of darkness (about 1.5 h), the foraging flights usually started and ended in full daylight. The bats' activity did not follow that of the insect prey, but was apparently modified by some other factor, possibly predation risk. Habitat use reflected the occurrence of small insects near vegetation.

A BAT HOSPITAL:CHANGING PUBLIC PERCEPTIONS. Lois Sakolsky. The Flying Mammal Wildlife Rehabilitation Center, 221 Parker Dr., Pgh., PA. 15216

The rehabilitation of injured or orphaned bats by a state sanctioned organization sends a message to the public that bats are beneficial and worth saving. Our bat hospital, The Flying Mammal Wildlife Rehabilitation Center, consists of two rooms, an intermediate outdoor cage, and a walk-in cave-room in my home. We hold a mammal Wildlife Rehabilitation Permit from the Pennsylvania Game Commission and are regulated by them. While we care for other city mammals, our outreach program is centered upon the introduction of non-releasable bats to groups of children. Two gentle, big brown bats (*Eptesicus fuscus*) and a video of the bats in flight bring groups closer to the reality of bats and are intended to lessen fears and superstitions. The staff includes myself and two volunteers, and advice from a sponsoring veterinarian. Located in a suburban Pittsburgh neighborhood and not being open to the public, we rely upon publicity from local newspapers and TV for funding and donations. The real reward for all of this activity comes when I sit on a roof top with a soon-to-be released bat while other wild bats fly in to investigate and then seeing them all fly off together into the twilight sky.

THE BATS OF TEXAS: HISTORY, STATUS, AND CONSERVATION EFFORTS TO PRESERVE A CRITICAL RESOURCE.
David J. Schmidly, Merlin D. Tuttle, and Patricia A. Morton. Texas A&M University and Bat Conservation International.

Texas hosts all four families of bats occurring in the United States and thirty-two species. Although a few of these species, each represented by a single specimen, are probably vagrants, no other state has a bat fauna more diverse. In addition, Texas is home to the largest concentration of bats at a single site in the world, and the Big Bend Region supports the greatest diversity of species of any localized area in the U.S. This paper reviews the history of bat conservation efforts in Texas, provides an assessment of the current status of species and some of the most significant threats to their survival, outlines the important elements for effective bat conservation in the state, and describes a dynamic new interaction between Texas A&M University and Bat Conservation International to promote effective conservation and wise management of this critical resource.

Ontogeny of myosin isoforms in the pectoralis muscle in the little brown bat, Myotis lucifugus
William A. Schutt, Jr. and John W. Hermanson. Cornell University, Ithaca, NY.

The contractile protein myosin, which plays a major role in determining the performance of skeletal muscle, has been shown to exist in a number of transitional isoforms. Embryonic, neonatal and adult myosin isoforms have been demonstrated in rat and chick skeletal muscles. In this study, the ontogeny of myosin isoforms in a primary flight muscle, the pectoralis was examined in the little brown bat, Myotis lucifugus. The adult M. lucifugus pectoralis is interesting since it is the only purely fast twitch muscle, composed of a single fiber type, type IIa, found in mammals. The pectoralis, which is not utilized for it's primary purpose, flight, until postnatal day 24, remains relatively undifferentiated until approximately postnatal day 21 (Powers et al. 1989, Bat Research News, 30:75a). Our data on fetal and neonatal pectoralis muscle suggest that it may indeed be undifferentiated but that fetal pectoralis muscle contains at least two native isoforms and possibly as many as five myosin heavy chain, MHC, isoforms. By postnatal day 9, however, a single native isoform (which comigrates with the adult isoform FM_4) is present. MHC studies reveal an additional slow embryonic isoform in these neonates. This study demonstrates the presence of transitional myosin isoforms in bats. We suggest that contractile proteins associated with flight are produced in young neonates although pectoralis muscle fibers require an additional two weeks of growth and development before flight can be achieved.

WHAT THE FOSSIL RECORD CAN --AND CANNOT--TELL US ABOUT THE ORIGIN AND DIVERSIFICATION OF BATS.
Nancy B. Simmons, Department of Mammalogy, American Museum of Natural History, New York, NY 10024

The fossil record of bats is poor in comparison with that of most other mammalian orders. With the exception of a few spectacular specimens, bat fossils generally consist of isolated elements, frequently only teeth. Half the living families of bats are unknown in the fossil record. Contrary to recent claims, the fossil record of bats does not support the hypothesis that bats are diphyletic. The bat fossil record (as currently known) does not preserve any unique evidence relevant to questions concerning bat monophyly or the relationships of bats to other mammals.

Cochlear structure indicates that the earliest known fossil bats (Early Eocene of Europe and North America; ?Late Paleocene/Early Eocene of Australia) were echolocating forms related to living microchiropterans. Presence of these bats on three continents by the Early Eocene suggests that the microchiropteran lineage originated (separated from other mammalian lineages) at some earlier time, probably in the Paleocene or Late Cretaceous.

Emballonuroids, rhinolophoids, and vespertilionoids all make their first appearance in the Middle/Late Eocene of Europe and/or North America. The earliest phyllostomoids occur in the Late Miocene of South America. The appearance of members of three of the four living microchiropteran superfamilies in the Late Eocene suggests that a major diversification occurred within Microchiroptera during the Eocene. This adaptive radiation may have been precipitated by the evolution of echolocation. While positive evidence suggests that this radiation occurred in Europe or North America, absence of fossil deposits of comparable age in Australia leaves open the possibility that the radiation of modern families might have involved Australia.

The fossil record of Megachiroptera is extremely poor. Only two *specimens* are known; this sparse fossil record makes it impossible to estimate the time of origin of the megachiropteran lineage. If bats are monophyletic (a hypothesis supported by most phylogenetic studies), at least 20 my of megachiropteran history remain undocumented.

This research supported by NSF Grant BSR-9106868.

AN INVESTIGATION OF THE VALIDITY OF THE BAT SPECIES *MYOTIS SODALIS* MILLER AND ALLEN, 1928 (CHIROPTERA: VESPERTILIONIDAE). Jeffrey Skibins, Thomas A. Griffiths, and Lisa J. Brown. Illinois Wesleyan University, Bloomington, IL 61702-2900.

In 1928, Gerrit S. Miller and Glover M. Allen described a new bat species that they believed was a hitherto unrecognized species of *Myotis*. The new species, *Myotis sodalis*, was based not on new specimens collected in the field, but rather on a series of 78 specimens that existed in collections at the U.S. National Museum, the American Museum of Natural History, the Field Museum of Natural History, and the MCZ at Harvard University. Miller and Allen believed that *Myotis sodalis* had been misidentified as other species of *Myotis* (mostly *Myotis lucifugus*). The new species purportedly differed from other *Myotis* species in having a slightly longer tail, a smaller foot, a keeled calcar, pinkish grey fur with a looser texture, a narrower braincase, and a more pronounced saggital crest. The range of the new species supposedly included Vermont through Indiana-Illinois and southward to northwest Arkansas, Tennessee, northern Alabama, and east to North Carolina. In the 63 years since the description of the species, field biologists have noted that *Myotis sodalis* (1) can be extremely difficult to identify with certainty in the field and (2) seems to be quite rare over much of its range. The second observation prompted its inclusion as an Endangered Species under the U.S. Endangered Species Act. While it is possible that *Myotis sodalis* is a valid, endangered species, it is also possible that its rarity and difficulty of recognition are because it is not and has never been a valid species. Rather, it may be simply a false grouping of morphological extremes of *Myotis lucifugus* and/or other *Myotis* species. To see if this is the case, we measured or otherwise evaluated twenty-six skull and body characters on 219 specimens of *Myotis sodalis*, *M. lucifugus*, *M. keenii*, and *M. leibii*. Included in this sample were all available specimens of the original 78 measured by Miller and Allen, and included in the measurements were all of the original measurements taken by Miller and Allen. A cluster analysis (SPSSX package) was performed on the measurement data, (but not on the qualitative data collected). In no analysis did the *Myotis sodalis* specimens cluster as a separate group, which suggests that the group of bats that has been identified as the species *Myotis sodalis* is not morphologically distinct from other species of *Myotis*. It is possible that *Myotis sodalis* is not a valid species.

THE ENERGETICS OF ECHOLOCATION. John R. Speakman and Paul A. Racey.

Active sensory systems based upon the production of sound and the detection of echos have evolved in relatively few animal species. A constraint on the evolution of echolocation may be the high cost of producing pulses which can be detected over any practically useful distance. The energy cost of producing echolocation pulses in a small (6g) insectivorous bat, when hanging at rest, was recently measured at 0.067 Joules per pulse. This implies a mean cost for echolocation in flight of 9.5x BMR (range 7 to 12x). Since flight itself is very costly, whether the costs of echolocation and flying are additive is an important question. In the present study we measured the energy costs of flight in two species of small echolocating Microchiroptera using a novel combination of respirometry and doubly-labelled water (DLW). In the pipistrelle bat (*Pipistrellus pipistrellus*) the cost of flight averaged across 17 individuals was 1.12 Watts, equivalent to 14.9x BMR, and in three brown long-eared bats (*Plecotus auritus*) averaged 1.02 Watts (= 12.75x BMR). The relationship between flight energy expenditure and body mass for echolocating bats does not differ significantly from the relationship for non-echolocating bats and birds. Echolocation therefore places little energetic demand on flying bats, and this may have been a significant factor favouring its evolution in this group.

LIVE MASS, AND WATER, NITROGEN AND MINERAL LEVELS IN SOME INSECTS FROM SOUTHERN LOWER MICHIGAN. Eugene H. Studier and Steven H. Sevick. University of Michigan-Flint, Flint, MI

Live and dry mass, percent water content, nitrogen, sodium, potassium, magnesium, calcium, and total iron levels are reported (or are available from the authors) for members of 16 orders and approximately 360 species of mostly adult insects from southern lower Michigan. Compared to published nutritional requirements for birds and mammals, adult insects are routinely excellent sources of nitrogen, potassium, and magnesium, but are highly variable as sources of sodium and iron. Of all insects tested, only plecopterans, or stone flies, were adequate calcium sources. In some insects that exhibit incomplete metamorphosis, some elemental levels (especially nitrogen, potassium, magnesium, and iron) are inversely related to body mass. In box elder bugs, Leptocoris trivittatus, mass and all elements tested, except sodium, vary significantly with season, and mass and potassium level also vary significantly with sex.

NITROGEN AND MINERAL LEVELS IN GUANO FROM BIG BROWN BAT (EPTESICUS FUSCUS) SUMMER ROOSTS. Eugene H. Studier, Steven H. Sevick, and John O. Keeler. University of Michigan-Flint, Flint, MI.

Weekly guano samples were collected from six big brown bat (Eptesicus fuscus) maternity roosts throughout part (2) or all (4) of the summer roosting period of 1990. Those samples were analyzed for concentrations of six elements (N, Ca, Fe, Mg, Na and K). With the possible exception of Ca, no fecal elemental densities exhibit patterns which correspond to reproductive condition. Fecal N levels remain constant, levels of Fe, Mg and Na generally decrease and become less variable, and levels of Ca generally increase and become more variable as summer progresses. Fecal K levels show two distinct peaks during the summer roosting period. In the four roosts followed throughout the summer, fecal elemental densities are generally concordant from week to week which suggests that bats from each of the four roosts consume insects of similar elemental composition over time. Exceptions to this generality, however, also suggest that bats from some roosts consume locally abundant insects of differing elemental composition during parts of the summer roosting period.

FORAGING ECOLOGY OF THE LITTLE BROWN BAT (*MYOTIS LUCIFUGUS*) OF CHAUTAUQUA, NY. Daphne M. Syme. York University, Toronto, Ontario, Canada.

There is increased concern about the decline of a large Little Brown Bat (*Myotis lucifugus*) population at Chautauqua, NY. The population is now estimated at around 10 000 individuals, though anecdotal evidence suggests it was larger 20 or more years ago. One possible reason for this decline is a decrease in food availability. I examined this by collecting insects in emergence traps at three sites around Lake Chautauqua twice a week from June 25 to August 18 1991. The size of the total bat population was determined by locating all the roost sites and counting each colony as it exited its roost at dusk. Since bats' energy requirements depend on their age, sex and reproductive state, the insect biomass required by the total bat population was determined by weekly trappings of bats to find out the sex ratio, age structure and reproductive state. The insect samples indicate insufficient insect biomass to support the present bat population at Chautauqua. This low level of food, and the loss of roosts due to house renovation, may both contribute to the decline in the bat population.

RESPIRATORY AND ACID-BASE PHYSIOLOGY OF THE TORPID BAT, *EPTESICUS FUSCUS*. Joseph M. Szewczak and Donald C. Jackson. Brown University, Providence, Rhode Island.

By exploiting this bat's preference to roost in crevices, we could use a flow through metabolic chamber having a small dead space volume and short time constant. This allowed us to detect ventilatory movements and separately measure O_2 uptake during ventilatory bouts and apneic periods. Below body temperatures (T_b) of 30°C, a typical ventilatory cycle consisted of a bout of rather evenly spaced breaths from less than 1 to 9 minutes duration, followed by an apneic interval. Occasional sporadic breaths punctuated the apneic interval, most commonly at T_b=20°C. The longest recorded apnea was 147 minutes at T_b=10°C. This bat was apneic 95% of a complete respiratory cycle. Arterial blood samples taken from indwelling catheters at the end of a ventilatory bout and near the end of an apneic period at T_b=20°C revealed cyclic changes in pH (from 7.49 to 7.34), P_{O_2} (from 96.6 to 30.8 torr), and P_{CO_2} (28.2 to 45.9 torr). Between 10 and 37°C, ventilatory pH varied inversely with temperature, with a $\Delta pH/\Delta T$ slope of -0.011U/°C, which is typical of an ectothermic acid-base strategy. Oxygen uptake during apneas free from sporadic breaths accounted for 26, 54, and 35% of total O_2 uptake for T_b's of 20, 10, and 5°C, respectively. Cardiogenic pulsations during apneas, and theoretical calculations of airway and cutaneous diffusion potentials, support the notion that apneic O_2 uptake occurs down an open airway by both diffusion and bulk convection. Based upon our measurements of the oxidative cost of ventilation in this bat, we conclude that the energetic savings contributed by apneic O_2 uptake can extend hibernation survival by 8 to 14 days under typical hibernaculum conditions

FOREST AGE ASSOCIATIONS OF BATS IN THE SOUTHERN WASHINGTON CASCADES AND OREGON COAST RANGE. Don Thomas. University of Sherbrooke, Sherbrooke, Quebec, Canada J1K 2R1

As part of the Old Growth Forest Wildlife Habitat Program, I studied the use of old-growth, mature, and young Douglas-fir (Pseudotsuga menziesii) stands by bats in the southern Washington Cascades and the Oregon Coast Range. Using ultrasonic detectors to identify commuting and feeding bats, I was able to quantify bat activity in the three stand age classes. In Washington, the Myotis species had activity levels 2.65-5.67 times higher in old-growth than in younger stands. In Oregon, the Myotis species and Lasionycteris noctivagans had activity levels 2.54-9.75 times higher in old-growth. Feeding rates were extremely low in the forest stands and most bat activity was confined to a brief peak during the first 15 min of the evening. This suggests that bats used the forest stands primarily as roosting sites. Vegetation features such as the abundance of damaged or diseased trees and snags appear to be important to bat populations, but correlations of bat activity with these parameters are weak. Reproductive females were captured at sites >300m on the western slope of the Washington Cascades, but they were common to the east and south. Old growth forests appear to be important habitat elements for bats in the Cascades and Coast Range, but management priority should be given to the latter region.

PROGRESS AT BAT CONSERVATION INTERNATIONAL. Merlin D. Tuttle, Bat Conservation International, Austin, TX.

BCI embarked on a landmark new partnership with Texas A&M University to establish the International Center for Bat Research and Education. Funds will be raised jointly to endow the center with sufficient resources to hire talented research scientists, support graduate students, and provide special training opportunities for visiting educators and conservationists.

BCI's new documentary, "The Secret World of Bats," aired throughout Europe and Australia and is expected to air in the U.S. early next year. A two-thirds interest in Bracken Cave, home of the world's largest bat colony, was purchased. Surveys to determine the current status of Mexico's largest remaining free-tailed bat colonies were completed. Law enforcement and management progress for Pacific Island flying foxes was made. Studies on behalf of key bat habitat in Guatemala and Peru and on how U.S. highway planners can provide important bat habitat through use of certain bridge designs were sponsored. An awareness campaign on behalf of bats in abandoned mines was initiated. And an "Educator's Activity Book About Bats" was published for teachers to use in developing conservation awareness among children.

BIOLOGICAL ALARM CLOCK AROUSES HIBERNATING BATS--AN UPDATE. ENDOGENOUS OR EXOGENOUS REGULATION? John W. Twente. University of Missouri, Columbia, MO 65211 USA

Twelve years ago (10th Ann. Symp. Bat Res.) John W. and Janet Twente reported a new, precise and invariant 24-hour rhythm that aroused hibernating bats exclusively in the afternoon or evening. We termed this a "biological alarm clock" (BAC). Results were consistently significant. Although we consider arousal from hibernation to be modulated by the consequences of metabolism, superimposed is the BAC which specifies the time of day of arousal. *Eptesicus fuscus* maintained in complete darkness virtually always aroused in the afternoon or evening irrespective of the duration of hibernation. Individual times were relatively constant and never free-running. *Pipistrellus subflavus* and four species of Myotis exhibited identical behavior. Experiments wherein hibernating or aroused bats were exposed to light at different times of day and intensities failed to rephase arousal. Although published in 1987 (Can. J. Zool. 65:1668-1674) we know of no attempts to test this unique rhythm. We plead for independent studies. Experiments have failed to identify environmental cues that could serve as stimulators of the BAC. We cannot distinguish whether the BAC is endogenous or the result of some subtle, exogenous factor. To differentiate these we propose to measure the time of day of arousal from hibernation of *E. fuscus* transported from Missouri to a laboratory in a time zone of six or more hours difference. We invite collaboration with interested scientists in other countries whom we could assist in the timing of the BAC in transported bats. Such a union may lead the way toward the solution of this confusing, chiropteral conundrum.

A REPORT ON THE CONSERVATION STATUS OF PHILIPPINE FRUIT BATS (PTEROPODIDAE). Ruth C. B. Utzurrum, Silliman University, Dumaguete City, Philippines and Boston University, Boston, MA.

There are 23 species of fruit bats (Pteropodidae) belonging to 15 genera currently known from the Philippines. Of the 15 genera, four (27%) are endemic, including Alionycteris, Haplonycteris, Otopteropus, and Ptenochirus. Endemism at the species level is remarkably high: 15 of 23 species (65%) are known only from the Philippines, six of which were described in the last 40 years. Two of these endemic species (Acerodon lucifer and Dobsonia chapmani) are currently believed to be extinct. This paper will review available information on the various species, including distribution and ecology. A rough assessment of conservation status and needs will be presented, and recently initiated efforts to meet these needs will be described.

ACTIVITY PATTERNS, AND DAILY ENERGY AND WATER INTAKE OF FREE-FLYING CAPTIVE COLONIES OF LACTATING AND POST-LACTATING PIPISTRELLE BATS, *PIPISTRELLUS PIPISTRELLUS*, SCHREBER. Peter I. Webb, John R. Speakman and Paul A. Racey.

In order to investigate the impact of lactation on energetics and water flux in pipistrelle bats, *Pipistrellus pipistrellus*, and the factors influencing activity patterns of lactating bats in the wild, flight activity and food and water intake were monitored in free-flying captive colonies of lactating (n=6 days), and post-lactating (n=11 days) bats maintained under a 12L:12D photoperiod, and fed *ad lib* on mealworms (*Tenebrio molitor*). Estimated mean daily energy intake (25.88kJ, se=0.89) and estimated mean daily water turnover (2.35g, se=0.08) of lactating bats, were significantly greater than those of post-lactating bats (13.98 kJ, se=1.76, and 1.28g, se=0.15 respectively). Mean daily water turnover of post-lactating bats was estimated to be 1.47 times that predicted allometrically from other captive eutherian mammals, and 0.90 times that predicted allometrically from other eutherian mammals in the field. Of estimated total water intake, a mean of 51.1% came from drinking, 21.6% from free-water in the food, and 27.3% from metabolic water production. There was no difference in these proportions between lactating and post-lactating bats. Based on direct measurements of energy expenditure, post-lactating bats were estimated to spend less than 41% of the time homeothermic. A linear relationship explained 87% of the variation in juvenile growth rate with age during the first 10 days of life, and the slope of this relationship predicted the efficiency of conversion by adults of food to juvenile body tissue to be 14.5%, suggesting that mobilisation of adult body reserves did not occur at this time. There was no significant difference in mean time spent in flight (50.0min.bat^{-1}, se=4.4, n=17 days), or in the temporal distribution of flight activity, between lactating and post-lactating bats, with almost all (99.8%) flight activity occurring during the dark period. Both colonies showed a peak in activity at the beginning, and a suppression of activity at the end of the dark period.

INVESTIGATING THE GENETIC CONSEQUENCES OF PHILOPATRIC BEHAVIOR IN MATERNITY ROOSTS OF *MYOTIS LUCIFUGUS*. E. Melanie Watt. University of Toronto, Toronto, Canada.

Individual female *Myotis lucifugus* are known to exhibit philopatric behavior by returning to their natal maternity roosts to have their young. In Chautauqua, New York, over 6,000 *M. lucifugus* have been banded in an ongoing mark recapture study. These bats show high site fidelity and return to the same roosts nightly and yearly. The purpose of this study is to investigate the genetic consequences of this philopatric behavior at maternity roosts. Blood samples (30-80µl) were collected over a two year period from 380 bats from 11 maternity roosts in and around Chautauqua. As a comparison, blood was also collected from 100 bats at swarming sites in Renfrew and Belleville, Ontario. To determine 50% relatedness levels, samples were also collected from mother/young pairs before the young became volant. DNA extraction techniques have been optimized for these small volumes of bat blood to enable detection of individually variable DNA fingerprints using two alkaline phosphatase-conjugated oligonucleotide probes. Reprobing of these small amounts of DNA is achieved with chemiluminescent detection. DNA fingerprint comparisons within and between gels are facilitated by assigning specific molecular weights to each band based on in-lane molecular standards. These techniques are now being used to determine genetic relatedness of individual bats within and between maternity roosts and swarming sites.

AUDITORY SPATIAL SENSITIVITY OF PONTINE NEURONS OF THE BIG BROWN BAT, *EPTESICUS FUSCUS*. Min Wu, *Tsutomu Kamada and Philip H.-S. Jen. University of Missouri-Columbia, MO; and *Hokkaido University, Sapporo, Japan

Using free-field acoustic stimulation conditions, we studied the response properties and spatial sensitivity of 146 pontine neurons of the big brown bat, *Eptesicus fuscus*. The best frequency (BF) and minimum threshold (MT) of a pontine neuron were first determined with a sound broadcast from a loudspeaker placed ahead of the bat. A BF sound was delivered from the loudspeaker as it moved across the frontal auditory space in order to locate the response center at which the neuron had its lowest MT. Then, the basic response properties of the neuron to a sound delivered from the response center were studied. As in inferior collicular and auditory cortical neurons, pontine neurons can be characterized as phasic responders, phasic bursters and tonic responders. They have both monotonic and non-monotonic intensity-rate functions. However, most of them are broadly and irregularly tuned as are cerebellar neurons. In 9 neurons, variation of MT with a BF sound delivered from several azimuthal and elevational angles along the horizontal and vertical planes crossing the neuron's response center was measured. In addition, variation in the number of impulses with several stimulus intensities at 10 dB increments above a neuron's MT delivered from each angle was also studied. The auditory spatial sensitivity of the pontine neurons was also studied by measuring the response area of each neuron with stimulus intensities at 3, 5, 10, 15 or 40 dB above its lowest MT. The response areas of pontine neurons expanded asymmetrically with stimulus intensity,but the size of the response area was not correlated with either MT or BF. In half of the pontine neurons studied, the response area expanded greatly and eventually cover almost the entire frontal auditory space. The response areas of the other half of the pontine neurons only expanded to a restricted area of frontal auditory space. The response centers of all 144 neurons were located within a small area of the frontal auditory space. The locations of response centers of these neurons are not correlated with their BFs. The distribution pattern of these response centers is comparable to that of superior collicular and cerebellar neurons but is different from that of inferior collicular and auditory cortical neurons. The results of our study suggest that auditory information is integrated in the pontine nuclei before being further sent into the cerebellum.

RESPONSES OF INFERIOR COLLICULAR NEURONS OF *EPTESICUS FUSCUS* TO SOUNDS DELIVERED FROM SELECTED HORIZONTAL AND VERTICAL ANGLES. Min Wu, Philip H.-S. Jen and *Tsutomu Kamada. University of Missouri-Columbia, MO; and *Hokkaido Univertsity, Sapporo, Japan.

Auditory spatial sensitivity of Inferior collicular (IC) neurons of *Eptesicus fuscus* was studied under free field stimulation conditions. The best frequency (BF) of each neuron was determined with a sound (4 ms duration, 0.5 ms rise-decay times) delivered from a specific angle of azimuth and elevation (i.e. response center) at which the neuron had its lowest minimum threshold (MT). The variation of the neuron's MT to a BF sound broadcast from several angles along the horizontal or vertical plane crossing its response center was then determined. In addition, variation of its number of impulses to a BF sound delivered at several intensities above its lowest MT was also studied. For some neurons, a series of the intensity-rate functions for a BF sound and frequency threshold curve were determined with the sound delivered from several angles. All IC neurons studied varied their MTs and number of impulses with sound direction. The majority (85%) of all 252 contralaterally located response centers were within 20^0-60^0 contralateral and 15^0 up 30^0 down elevational. While the azimuth of the response center significantly shift from lateral to the midline with increasing BF, the correlation between the elevation of the response center and the BF was not significant. Within each series of the impulse directional sensitivity curves, not every curve peaked at the same angle. However, the angle of maximal number of impulses determined with intensities within 20 dB re lowest MT was generally in conformity with the angle of lowest MT. The frequency threshold curve determined at different azimuthal or elevational angles only varied appreciably in MT but not in BF and shape. Conversely, each series of intensity-rate functions of a neuron determined at different angles peaked at different stimulus intensities due to the change in its MT. According to the directional sensitivity curves determined in elevational and horizontal planes, high BF neuron generally had larger directional slope (db/deg) than low BF neurons did.

EXAMINATION OF THE MONOPHYLY AND INTERORDINAL PLACEMENT OF CHIROPTERA BY USE OF A MITOCHONDRIAL GENE SEQUENCE. Ronald M. Adkins and Rodney L. Honeycutt. Texas A&M University, TX.

The Order Chiroptera is composed of the two easily-distinguishable suborders Megachiroptera and Microchiroptera. Recently it has been suggested that these two suborders may not be each others closest relative. This argument is based primarily upon identification of neurological and penile similarities among primates, flying lemurs (Order Dermoptera) and megachiropterans which are not present in microchiropterans. In addition, these arguments rely upon the enumeration of the many physical differences between the chiropteran suborders. However, other morphologists have found numerous unique traits of the skeleton and wing innervation shared between Mega- and Microchiroptera which support chiropteran monophyly. At a higher taxonomic level, it has been suggested that Chiroptera and Dermoptera share a sister-group relationship within a larger assemblage containing these two orders along with Primates and Scandentia (tree shrews). To examine the monophyly of Chiroptera and its placement within Eutheria, we sequenced the protein-coding mitochondrial gene cytochrome oxidase subunit II in representatives of Megachiroptera, Microchiroptera, Primates, Dermoptera, and Scandentia. To these sequences were added the previously published sequences of members of Rodentia and Artiodactyla. An armadillo was used as the root for all phylogenetic analyses. Both weighted parsimony and phenetic analyses were used to evaluate inter-relationships. The results of our study indicate that Primates, Dermoptera, and Scandentia form a monophyletic assemblage which does not include Chiroptera. In addition, the monophyly of Chiroptera was supported. No support was found for a close relationship among Primates, Dermoptera, and Megachiroptera.

THE 22nd ANNUAL NORTH AMERICAN BAT SYMPOSIUM

MEETING ANNOUNCEMENT AND FINAL CALL FOR PAPERS

DATES: 21-24 October, 1992

PLACE: Chateau Frontenac
Ville de Québec
Québec, Canada

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PRE-REGISTRATION DATE: 7 SEPTEMBER, 1992

YOUR PERSONAL INVITATION

The 22nd Annual North American Bat Symposium will be held in Quebec City at the Chateau Frontenac Hotel from 21 to 24 October 1992. For those of you not familiar with your history and "La Belle Province", Quebec City is the architectural jewel of North America. Founded in 1608, "la vielle ville" (the old town) climbs up a steep slope from the waterfront on the St. Lawrence River. At the top, the copper-roofed Chateau Frontenac overlooks a wide, 1 km long boardwalk and the river some 100 meters below. Within spittin' distance is a tremendous array of excellent restaurants, cobblestone streets with outdoor artists, museums, and bars. Most of the original stone buildings and all of the original walled fortifications in the old town remain and this has led to Quebec being named by UNESCO as the only International Heritage City in North America. Quebec offers the same feeling of deep-rooted history and culture as Paris, London, or Prague ... and at a fraction the price! The Québécoise are proudly French-Canadian, but you will find that language is not a problem. Most people contacting the public speak passable to fluent English and are warm and open ... especially if you don't mention the division of constitutional powers between Ottawa and the province!

You will find enclosed with this issue forms for registration for the Symposium, for submitting a title, for submitting an abstract, and a special form for those students who wish to compete for honoraria. Please return all these forms to Roy Horst by the dates indicated.

6th European Bat Research Symposium

(Évora, Portugal, 22-27 August 1993)

First circular

The Sixth European Bat Research Symposium will take place at the University of Évora, Portugal, on August 22-27, 1993.

Évora is a historical town, included in the World Heritage system. It is located about 150 km west of Lisbon in the province of Alentejo, an area of vast plains and rolling hills covered with wheat fields and cork oak woodlands, and dotted with many unspoiled small towns. The most convenient international airports are those of Lisbon and Faro. The organization will provide transportation between the Lisbon airport and Évora, but the town is also easily accessible by train and bus.

The Symposium will consist of oral presentations, poster papers and evening discussions (all in English). We are also trying to organize a workshop on bat identification using detectors. We naturally welcome any suggestions on other events that could be associated with the Symposium.

There will be a short field trip during the meetings, and a longer excursion afterwards.

University accommodations will be available, but in Évora there are also numerous hotels and a campsite.

A second circular with more details will be mailed in the Autumn to those returning the Preliminary Registration Form. The registration fee will be announced in the second circular, but we believe that it will be quite low.

To lower the costs of travelling from Eastern Europe we are considering the possibility of organizing a charter flight from that region.

The Preliminary Registration Form should be returned, before the end of August 1992, to:

J. Palmeirim and L. Rodrigues
Dept. de Zoologia
Faculdade de Ciências
Universidade de Lisboa
P-1700 Lisboa, Portugal
Fax: 351-1-7597716

Organizers:

Jorge M. Palmeirim - Universidade de Lisboa
Luísa Rodrigues - Serviço Nacional de Parques Reservas e Conservação da Natureza
João Rabaça - Universidade de Évora
European Bat Research Organization

VI EBRS - Preliminary Registration Form

Please print clearly in Block Capitals - If the information on the label is correct and complete you can skip the corresponding fields. Please notice that this information will be included in the final list of participants.

Family name _____ First name(s) _____ Sex ____

Address _____

_____ Post code _____

City _____ Country _____ Telephone _____ Fax _____

I am interested in a charter flight from an Eastern European City Y/N.

Rank your choices: Prague___, Warsaw___, Moscow ___ , Other _____

I hope to present an oral paper Y/N. I hope to present a poster paper Y/N.

Provisional titles of papers that you may present:

_____

_____

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