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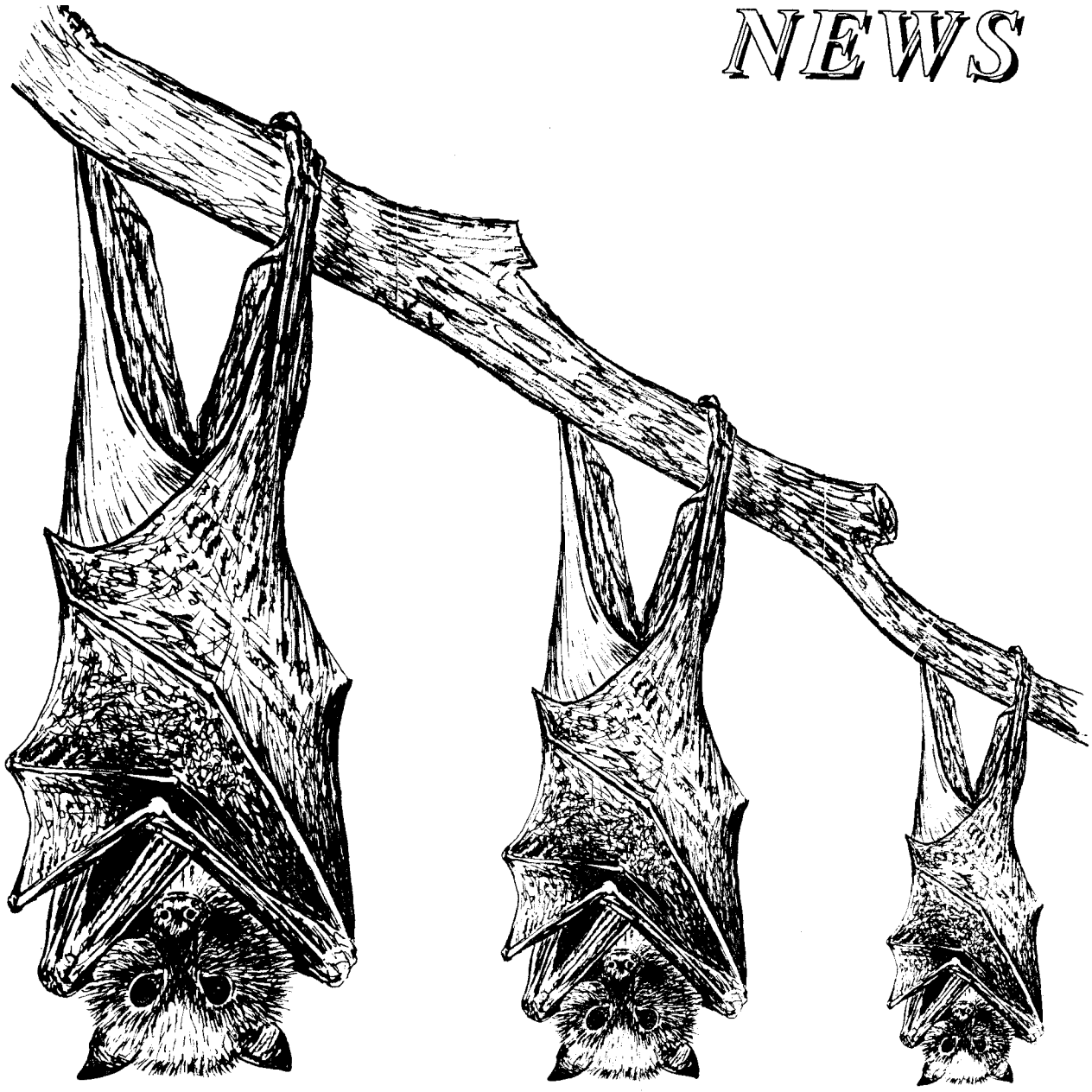

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Publisher and Managing Editor
G. Roy Horst
Department of Biology
State University College at Potsdam
Potsdam, NY 13676
Tel. 315-267-2219
FAX 315-267-3170
E-mail: horstgr@potsdam.edu.

Editor for Recent Literature
Thomas Griffiths
Department of Biology
Illinois Wesleyan University
Bloomington, IL 61702
Tel: 309-556-3230
FAX: 309-556-3411
E-mail: griffith@vmd.cso.uiuc.edu

Editor for Feature Articles
Allen Kurta
Department of Biology
Eastern Michigan University
Ypsilanti, MI 48197
Tel: 313-487-1174
FAX: 313-487-9235
E-mail: bio kurta@emunix.emich.edu

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Field Use of the Anabat II Bat-detector System to Monitor Bat Activity

John P. Hayes and Patrick Hounihan
Coastal Oregon Productivity Enhancement Program, Hatfield Marine Science Center, Newport, Oregon 97365
and Department of Forest Science, Oregon State University, Corvallis, Oregon 97330.

Abstract

We describe techniques to deploy successfully the Anabat II bat detector in the field, including simple modifications of the equipment to accommodate alternative battery types. Current cost of a fully operational system is approximately $1,000 U.S.

Introduction

Technological advances and the development of improved echolocation-detection equipment, or "bat detectors," have resulted in increased use of bat detectors in scientific studies of habitat utilization by bats. Use of bat detectors for monitoring studies by consultants and land managers interested in the potential impacts of land-use changes is also increasing. Thomas and West (1989) provided a detailed description of procedures to monitor bats using broad-band bat detectors. Recently, the development of the Anabat II bat-detector system (Titley Electronics, Ballina, N.S.W., Australia) has expanded the availability of voice-activated, broad-band, bat-detector systems to monitor nightly activity of bats.

The configuration of the Anabat II system that we use consists of a broad-band divide-by-n bat detector, along with a delay switch and tape recorder. When the bat detector receives an ultrasonic signal of sufficient intensity, the delay switch turns on the tape recorder. After the ultrasonic signal has ended, the delay switch causes the bat detector to emit a 40-KHz tone that can be later used to calibrate tape speed in the laboratory for interpretation of call frequencies. The delay switch then dumps the time onto the tape and turns the tape recorder off. In this paper, we describe our techniques to employ the Anabat II system in the field, considerations for appropriate equipment, and some minor modifications of the hardware to enable use of rechargeable batteries.

The System

Tape Recorder: Quality of tape recorder is not a major consideration. The only requirement is that the recorder must have microphone and remote jacks. The Radio Shack Minisette 20 (Radio Shack #14-2055B) is an economical and acceptable option.

Tapes: Any audio tape of reasonable quality seems to work fine for recording bat calls, but an important limitation of the system is storage capacity of the tape. We routinely use 110- or 120-minute cassette tapes, providing 55 or 60 minutes of available tape for any given night. This is more than adequate in some habitats, but it is sometimes insufficient to collect the entire night's activity at high-use sites. Digital tapes have greater storage capacity, but digital-taping equipment is considerably more expensive and thus is not a practical option in some situations, particularly when several bat-detector systems are deployed or when budgets are limited. Overcoming the storage limitations of audio tapes by development of inexpensive hardware to store calls digitally, such as on data loggers or similar hardware, would be an important technological step forward.

Battery Power: The Anabat II detector is designed to be powered by a 9-volt battery, and the Minisette 20 tape recorder is designed to be powered by two AA batteries. In our experience, alkaline batteries generally function two nights in this equipment, varying from one to three nights, apparently due to variation in ambient temperature and quality of batteries. Use of alkaline batteries for extended periods is costly and generates large quantities of waste. Using rechargeable nickel-cadmium (Nicad) batteries is inadequate because of the low voltage and amperage of Nicad batteries; the system often does not function for an entire night when powered by these batteries.

To alleviate these problems, we modify the

bat detector to be powered by seven Nicad AA batteries and the tape recorder by two, Nicad, D-cell batteries. We solder wires from two-pole trailer connectors (NAPA #TC6566) to the battery terminals inside the tape recorder and bat detector. Wires from the other end of the trailer connector are soldered to a D-cell battery holder (Radio Shack #27-386) for the tape recorder or an AA-cell battery holder (Radio Shack #27-387) for the bat detector. We use a dummy battery in place of one AA battery to achieve the correct voltage. After these modifications, we routinely replace batteries in the field after two nights of operation, but considerably longer battery life may be possible under some circumstances.

Although holders can be soldered directly to the bat detector and tape recorder without trailer connectors, we find it advantageous to use connectors. Use of connectors allows the battery holders to be disconnected from the bat detector and tape recorder. At times it is more convenient to remove the battery holder and power the equipment with the batteries for which the equipment was designed originally, especially when the bat detector is hand-held or used independent of the delay switch. In addition, if connectors are used, replacement battery sets can be assembled in battery holders in the laboratory. The entire battery set can then be replaced in the field, avoiding problems and possible confusion resulting from replacing individual batteries. The wires soldered to the battery holders when purchased are a small gauge and the solder joints do not hold up to field use. We recommend replacing the wires even if trailer connectors are not used.

We power the delay switch using two, 6-volt, gel cells (Radio Shack #23-181A) wired in series (although any 12-volt gel cell would suffice). The delay switch comes equipped with a 12-volt jack to accommodate a coaxial plug (e.g., Radio Shack #27401568), but on occasion the plug jiggles loose in the field, resulting in loss of data. Hence, we modify the delay switches by soldering wires from the trailer connectors to the terminals inside the delay switch. The wires from the other end of the connectors were crimped to 1/4-inch female blade connectors (NAPA #723114) that were then attached to the terminals of the gel cell. All trailer connectors were color-coded to minimize confusion in the field.

An alternative power source for the electronics is to power the bat detector, delay switch, and tape recorder by a single 12-volt gel cell. We have not attempted this, but Chris Corben (personal communication) informs us that it is possible to do so after minor modification of the leads.

Equipment Housing: A variety of containers for housing the equipment is possible. We use a 32 x 22 x 12 cm plastic container (Rubbermaid #3863, 2.2 gallon, rectangular). A 5-cm hole is drilled into one end of the container to accommodate the microphone for the bat detector. We glue a gasket made of 1-cm thick, closed-cell, foam pad around the hole inside the box to minimize entry of moisture. A 5-cm thick, open-cell, foam pad is placed in the bottom of the container with slots cut to accommodate the various system components. A small bottle containing silica gel is placed in each box to absorb moisture entering the box.

To protect the microphone from rain and muffle the sound of raindrops hitting the equipment, we place the equipment under an A-frame shelter. Our shelters are constructed of two 61 x 91 x 0.6 cm plywood sheets with a 5 x 5 x 61 cm strip of wood nailed to one end of each sheet. The sheets are joined together by hinges fastened to the strip of wood. The box containing the bat detector is placed on a platform oriented at a 30-degree angle under the shelter.

Day-night Sensor: We found that the day-night sensor on the delay switch is not sufficiently sensitive to activate the system prior to the emergence of the first bats in our region. In addition, differences in cloud cover, topography, and canopy cover among study sites can cause sensors to activate the delay switches at different times. Thus we leave our systems on throughout the day. Although this can result in recordings of diurnal noises, such as from insects, this has not been a substantial problem in our studies.

Cost

Total cost for one bat-detector system assembled as described is slightly over $1,000 U.S. (Table 1). Additional expenses for operating the system include audio cassettes and battery chargers.

Conclusion

Our technique for deploying the Anabat II bat-detector system is based on considerable trial and error during the course of over 250 detector-nights of experience. Undoubtedly, other workers will find alternative ways to deploy the system and will make improvements on the system that we have described. It is our hope that our description will minimize time required by others to begin echolocation-monitoring studies using the Anabat II system.

Table 1. Costs in U.S. dollars for one bat-detector system with the described configuration.

Item	Cost
Bat Detector	$350.00
Delay switch[1]	475.00
Tape recorder	59.99
Plastic box	7.99
Trailer connectors (3)	9.45
Open-cell foam pad	6.00
Closed-cell foam pad	0.50
12-volt gel cell[2]	48.00
AA-cell Nicad batteries[2]	35.00
AA-cell battery holder	1.49
D-cell Nicad batteries [2]	14.00
Dummy battery	1.50
Plastic bottle (for silica gel)	0.85
Silica gel	1.00
Miscellaneous (glue, solder, etc.)	5.00

[1]dependent on exchange rate for Australian dollar.

[2]Cost is for two sets of batteries.

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Noteworthy Records of Bats from Tabasco and Campeche, Mexico

Ma. de Lourdes Romero A. and Cornelio Sánchez H.

Centro de Educación Ambiental e Investigación Sierra de Huautla, UAEM, Av. Universidad 1001, Col. Chamilpa, C. P. 62210, Cuernavaca, Morelos (MLRA) and Instituto de Biología, UNAM, Ap. Postal 70-153, C. P. 04510, México, D. F. (CSH)

There are few studies on mammals living in the states of Tabasco and Campeche (Dowler and Engstrom, 1988; Hall, 1981; Jones et al., 1973; Lay, 1962; Ramírez-P. et al., 1986; Rovirosa, 1985; Villa-R., 1967). Consequently, after examining the mammal collections at the Instituto de Biología, UNAM (IBUNAM), we made four trips to these states in 1988. Seven previously unrecorded species of bats were collected or found in the collections at IBUNAM, and these specimens now represent first reported records for these states. New specimens also were deposited at IBUNAM. All linear measurements are in millimeters, and weight is in grams. When measurements are available for more than three specimens, we cite the mean and range.

Diclidurus albus virgo (Thomas, 1920)

Number 16959 of the IBUNAM collections is a female from Balancán de Domínguez, 100 m, caught in February 1980. This site is 400 km SW of the nearest reported locality at Los Tuxtlas, Veracruz (Coates and Estrada, 1985). This species normally inhabits lowlands, close to the sea or rivers, where these bats roost in coconut palms (*Cocus nucifera*) or other palms, such as *Orbignya guacayule* (Sánchez and Chávez, 1984). However, the capture area at Balancán de Domínguez is covered by short grasses and a small orchard, with only a few separated coconut palms; perhaps this habitat is strongly alterated, or perhaps this bat uses other types of trees. Coates and Estrada (1985) captured a male from a branch of a palm (*Astrocaryum mexicanum*), and McCarthy (1987) captured individuals of this species on the trunk of a fig (*Ficus insipida*).

Our female had an embryonic sac of 5 x 4 mm, in the left uterine horn. Measurements of the female preserved in alcohol are: total length, 90; tail length, 21; hindfoot length, 11; ear height, 15; forearm length, 69.9; length of third metacarpal, 62.1; tibia length , 23.3; maxillary toothrow length, 9.6; width of postorbital constriction, 5.1; and zygomatic breadth, 11.0.

Micronycteris megalotis microtis Miller, 1898

We caught 15 females and 13 males in two areas of Campeche--5 km S Campeche (3 specimens) and from km 35.3 to 50.5 along the road from Haltunchén to Ruinas Edzna,

from 50 to 65 m (25). These sites were 580 km NE of a previously reported capture locality at Rio Coco, Nicaragua (Jones et al., 1971).

The animals were captured with a hand net in a culvert that had an entrance covered with grass and shrubs. The dominant vegetation in the area was tropical deciduous forest. The number of individuals in the roost changed throughout the year, suggesting local movements. In this same location, we also caught *Glossophaga soricina, Mimon cozumelae,* and *Desmodus rotundus. M. megalotis* resided permanently in the culvert, and we recorded two females with embryonic sacs measuring 1 x 1, in January; three females with embryonic sacs of 16 x 10, 19 x 13 and 18 x 12, in April; six immature females, in September; and three immature females, in December. We recorded two males with scrotal testis of 4 x 2 and 4 x 3 and one immature male, in January; four immature males, in April; five immature males, in September, and one male with a scrotal testis of 4 x 3, in December. We speculate that mating probably takes place in early January, and births occur in early June, with lactation lasting through June or July. We believe this subspecies to be monoestrous.

Somatic measurements (mean followed by range) of 15 females and 12 males, respectively, are: total length, 62.4 (57.0-68.0), 62.4 (58.0-67.0); tail length, 13.8 (13.0-15.0), 13.4 (10.0-15.0); hindfoot length, 9.7 (8.0 -11.0), 9.0 (8.0-11.0); ear height, 20.4 (19.0 -22.0), 20.5 (19.0-22.0); weight, 7.5 (6.0 -10.0), 6.8 (5.0-8.0); forearm length, 34.5 (34.1-35.1), 34.2 (33.5-34.8); and length of third metacarpal, 26.4 (28.3-29.9), 28.9 (28.1 -29.6). Cranial measurements of five females and six males, respectively, are: greatest length of skull, 19.0 (18.8-19.3), 18.9 (18.5-19.4); maxillary toothrow length, 7.1 (7.0-7.2), 7.2 (7.0-7.2); condylocanine length, 16.2 (16.1 -16.3), 16.2 (15.9-16.4); braincase breadth, 7.6 (7.5-7.7), 7.6 (7.5-7.8); and width of postorbital constriction, 4.0 (3.9-4.3), 4.0 (3.9 -4.1). Zygomatic breadths of three females and five males, respectively, are 9.0 (9.0-9.2) and 9.1 (9.0-9.2).

Our measurements are smaller than Miller (1897) described for M. megalotis mexicana from Jalisco and Oaxaca and slightly larger than those cited for M. m. microtis. However, the distribution in Tabasco and Campeche is near the Gulf of Mexico and close to the Caribbean sea, near the range of M. m. microtis, and for this reason we consider our specimens to belong to this subspecies.

Centurio senex senex Gray, 1842

We captured one female, in January 1988, in the Balneario Agua Blanca, 64 km E and 7 km S Villahermosa-Escárcega Road, at 40 m. This location is within the known distribution of this species, but it is a first record for Tabasco. The dominant vegetation is tropical deciduous forest. The specimen had an embryonic sac of 8 x 7 mm, and the bat was captured at 2000 h, in a net set over a stream. In the same net, we caught *Mormoops megalophylla, Pteronotus davyi, P. personatus, Carollia brevicauda, Sturnira lilium, Artibeus intermedius, A. lituratus,* and *Dermanura phaeotis.*

Somatic measurements of this female are: total length, 59; hindfoot length, 12; ear height, 16; weight, 16; forearm, 41.0; length of third metacarpal, 37.2; and tibia length, 18.2. Cranial measurements are: greatest length of skull, 19.0; maxillary toothrow length, 5.0; condylocanine length, 14.9; width of postorbital constriction, 5.6; and zygomatic breadth, 14.6.

Chiroderma villosum jesupi J. A. Allen, 1900

We captured a female and three males at Quinta El Refugio, 6.5 km N Cárdenas, at 90 m (1 specimen), and from Rancho San Gabriel, 4 km N Cárdenas, at 90 m (3). These locations are within the distribution of this species, but they are the first records for Tabasco. The males were caught in March, and the female in September. All specimens were caught in nets set under cacao trees, between 1930 and 2100 h. The males had scrotal testes of 6 x 4, 6 x 4, and 5 x 3, and the female was immature. In the same nets, we caught *Glossophaga soricina, C. brevicauda, S. lilium, Artibeus jamaicensis, A. intermedius, Dermanura phaeotis, Eptesicus furinalis,* and *Rhogeessa tumida.*

Somatic measurements of the one female and the three males, respectively, are: total length, 67, 68, 74, 66; hindfoot length, 12, 12, 12, 12; ear height, 17, 17, 18, 17; weight, 22, 23, 22, 20; forearm length, 45.0, 45.2, 45.2, 43.5; length of third metacarpal, 46.3, 44.6, 46.3, 45.3; and tibia length, 18.4, 17.3, 15.9, 16.7. Cranial measurements of three males are: greatest length of skull, 25.3, 24.9, 25.1; and maxillary toothrow length, 8.8, 8.5, 8.5.

Dermanura watsoni Thomas, 1901

We examined a female from Río Puyacatengo, 3 km E Teapa (IBUNAM 7435) that was caught in March 1963. This location is included in the area of distribution of this species, but it is a first record for Tabasco. Somatic measurements are: total length, 55.3;

hindfoot length, 8.8; ear height, 13.4; forearm length, 38.7; length of third metacarpal, 36.9; and tibia length, 14.1. Cranial measurements are: greatest length of skull, 20.3; maxillary toothrow length, 6.5; condylocanine length, 17.8; braincase breadth, 9.0; width of postorbital constriction, 4.8; and zygomatic breadth, 11.4.

Diphylla ecaudata ecaudata Spix, 1823

We examined a lactating female from Tabasco, Río Puyacatengo, 5 km SE Teapa (IBUNAM 23770) that was caught in March 1985, and a male from Campeche, Ruinas Becán, km 146 of the road from Escárcega to Chetumal, at 230 m (IBUNAM 22725), that was taken in April 1986. In addition, we observed two specimens in a well, in Yohaltún, 7 km S and 62 km SE Champotón, in January 1988. These sites are included in the area of distribution of this species, but they are the first record for Tabasco and the second and third records for Campeche.

Somatic measurements of the female and male, respectively, are: total length, 82, 80; hindfoot length, 16, 18; ear height, 16, 17.5; forearm length, 56.2, 52.0; length of third metacarpal, 55.2, 50.1; and tibia length, 20.1, 20.1. Cranial measurements are: greatest length of skull, 23.8, 23.2; condyloincisive length, 21.5, 20.6; condylocanine length, 19.2, 18.5; braincase breadth, 11.6, 11.2; width of postorbital constriction, 7.4, 6.9; and zygomatic breadth, 13.6, 12.9.

Pipistrellus subflavus veraecrucis (Ward, 1891)

We examined a male caught in August 1976, in Río Puyacatengo, Municipio Teapa, at 300 m (IBUNAM 18526). The capture locality is 80 km NE of a previously reported site at 11 mi W Mal Paso (Hall, 1981). The specimen that we examined was caught in tropical deciduous forest. Somatic and cranial measurements are: total length, 83; tail length, 36; hindfoot length, 8; ear height, 13; forearm length, 30.5; length third metacarpal, 28.3; tibia length; 14.4; greatest length of skull, 12.4; maxillary toothrow length, 4.1; condylocanine length, 10.7; braincase breadth, 10.7; and width of postorbital constriction, 3.5.

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A Potential Method of Assessing Relative Abundance and Habitat Use: Molecular Scatology

Anthony S. Fischbach, Department of Zoology, University of Texas, Austin, TX 78712

Advances in molecular techniques have allowed the amplification of DNA sequences from minute and degraded samples (Boom et al., 1990; Pääbo et al., 1988). These techniques have been used to obtain DNA sequences for analysis from field-collected fecal samples produced by endangered Italian bears (Höss et al., 1992). DNA from gut epithelial cells found in the field-collected bear scat was amplified with the use of the polymerase chain reaction (PCR). Amplified sequences were of sufficient quality to analyze the genetic variability within the population of endangered Italian bears that had left the feces.

This same methodology could be adapted to amplify DNA from bat feces. Theoretically, DNA sequences amplified from field-collected bat feces could be used to identify the species of bat that produced the feces. Because the DNA extraction, PCR, and DNA analysis protocols may be readily performed on a large number of samples, it may be possible to use this methodology to sample bat communities by collecting feces at roosts or feeding sites. The information on the species identity of bats depositing the feces could then be used to assess relative abundance and possibly habitat use. The relative abundance data from molecular scatology may provide a means of assaying community structure that is independent of capture and echolocation-detection biases. However, several obstacles remain before this technique may be readily applied. The purpose of this paper is to describe some of those obstacles and my preliminary attempts to overcome them.

In the spring of 1993, in the laboratories of David Hillis, I attempted to amplify DNA from the feces of the frugivorous/nectivorous bat Anoura geoffroyi, which were kindly provided by Paul Heideman. Because this technique requires only 0.5-g samples for DNA amplification, it is not a problem that bat feces are much smaller than bear feces. Only one or two, fresh, fecal pellets were needed to obtain a half-gram sample. I used a modification of the Boom et al. (1990) extraction protocol to obtain DNA from fresh pellets. I replaced the silica puri-fication process of the Boom et al. extraction with a 5% Chelex-100 (Bio Rad) DNA extraction protocol, for which supplies were readily available in the Hillis laboratory. The extract was used as a template for a PCR gene amplification using the highly conserved Mus 12Sa (x2486/mf485, c strand AAACTGGG-ATTAGATACCCCACTAT) and Mus 12Sb (x2898/m901, s strand, GAGGGTGACGGG-CGGTGTGT) primers.

The PCR products were analyzed on agarose mini-gels stained with ethidium bromide. As a negative control, the extraction was performed on buffer alone. As a positive control, known titers of Mus DNA were added to the fecal samples prior to the extraction. A PCR product of the expected size (~400 Kb) was obtained from the positive control. No PCR product was obtained from any other preparation. The results demonstrated that insufficient quantities of bat DNA were present in the fecal pellets for successful amplification of the 12s region.

At least two new approaches should be tried. First, other extraction protocols need to be attempted, because the success of extraction protocols varies greatly with the substrate being extracted (Smith et al., 1991). Second, fecal pellets from bats that are known to have longer gut-passage times may yield sufficient amounts of epithelial DNA for successful extraction. The short gut-passage time of frugivorous and nectivorous bat species may not allow epithelial cells to be shed in sufficient quantities for this technique to work (Dobat and Peikert-Holle, 1985; Laska, 1990).

Once a technique has been developed to amplify bat DNA sequences from fecal pellets, several obstacles remain before molecular scatology may be used as a survey technique. Primers must be developed that flank a sufficiently variable region to allow for the resolution of all bat species in a community. This may prove to be too great a first hurdle. A more modest goal would be to develop primers that would flank a region of sufficient variability to assess the genetic variability in a single species, as has been accomplished with the Italian bears (Höss et al., 1992). Despite these obstacles, molecular scatology has the potential to become a useful tool for field biologists working with bats.

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Sexual Segregation in the Indian False Vampire Bat, *Megaderma lyra* (Microchiroptera)

J. Balasingh, R. Subbaraj, and S. Suthakar Isaac

Department of Zoology, St. John's College, Palayamkottai 627 002, India (JB) and Department of Animal Behaviour and Physiology, School of Biological Sciences, Madurai Kamaraj University, Madurai 625 021, India (RS and SSI)

In several bat species, the sexes segregate after copulation and live separately at least until parturition has occurred. For example, in certain populations of Pteropus poliocephalus, sexual segregation occurs between copulation and parturition, i.e., during gestation (Nelson 1965). In most temperate and some tropical species of bats, females form nursery colonies during pregnancy and lactation. Such segregation into unisexual groups varies greatly in duration, mechanism, and completeness (Bradbury, 1977). At Madhya Pradesh, India, Khajuria (1980) noticed that a colony of about 500 Megaderma lyra, decreased to about 350 bats just before parturition. Although he (Khajuria, 1980) suggested that this decrease was due to human disturbance, we suggest that adult males and females of M. lyra occupy different roosts during the parturition period. The objective of the present study was to document seasonal variation in the composition of a colony of *Megaderma lyra*, particularly during the breeding season.

A colony of about 350 *M. lyra* of both sexes inhabited the corridor of a temple, at Tirunelveli, in South India (8° 44' N; 77° 42' E). We determined the age of individuals using the method of Racey (1988). All bats in the temple roost were collected and marked with black plastic, collar bands with colored beads for individual identification (Balasingh et al., 1992). All males from this roost continued to occupy the temple roost after being marked. This roost was periodically visited by us at weekly intervals. To confirm the generality of our conclusions, additional observations were made of colonies in a temple, at Kallidaikurichi (35 km from the first temple roost), and in a cave, near the campus of Madurai Karamaj University (160 km from the first temple roost). The study was conducted from January 1989 to April 1990, at all three locations.

During the mating season (October and November), adult males were present among the females. At the time of parturition and lactation (January), the number of male *M. lyra* in the temple day roost drastically declined. Eventually several banded males (n=27) that had left the temple roost were located in an unused store room, 300 m from the temple roost. These bats roosted in the store room separately from the females, from January through August 1989 (Fig. 1). Thereafter, size of this all-male colony gradually increased to 37. After the first week of September, the number of bats in the all-male colony gradually decreased, and by the end of October, the roost was vacant. Most tagged male bats (n=21) from the all-male colony were found roosting in the main temple during November, December, and early January.

To confirm sexual segregation in *M. lyra*, a small colony of this species roosting at the Kallidaikurichi temple also was observed, and it yielded similar data. Tagged males (n = 5) had left the main temple roost during the breeding period and were located

during the breeding period and were located in a nearby ruined temple. Similarly, another *M. lyra* colony found in a cave, near the university campus, consisted of pregnant females, lactating females, juveniles, and subadults of both sexes during the asynchronous parturition period (Table 1). A few adult males, however, were also captured while emerging from the cave entrance during the period of parturition and lactation.

In most segregating species from temperate regions, males and females occupied different roosts at parturition (Bradbury, 1977). In such cases, the sexes hibernated together, but both then migrated individually to different roosts. In contrast, segregation in *M. lyra* was established prior to parturition by emigration of most adult males, although a few subadult and adult males were also seen roosting with the females at parturition. Thus the rigor of sexual segregation in *Megaderma lyra* differed from that reported for *Tadarida brasiliensis* (Twente, 1956), a species in which males were never present at nursery colonies. Less rigorous sexual segregation, similar to that of *M. lyra*, was also reported at nursery sites of *Plecotus auritus*, where a few males were present (Stebbings, 1966). The emergence of a few adult males of *M. lyra* with lactating females from the cave colony indicated that these adult males roosted in the same cave, and we have observed all-male groups in isolated cavities in this labyrinthine cave. In the temple colonies, when adult males were found with females, tagged adult males occupied different sites than the females and subadults, thus revealing the isolated/segregated pattern of distribution within the temple roost.

Acknowledgments

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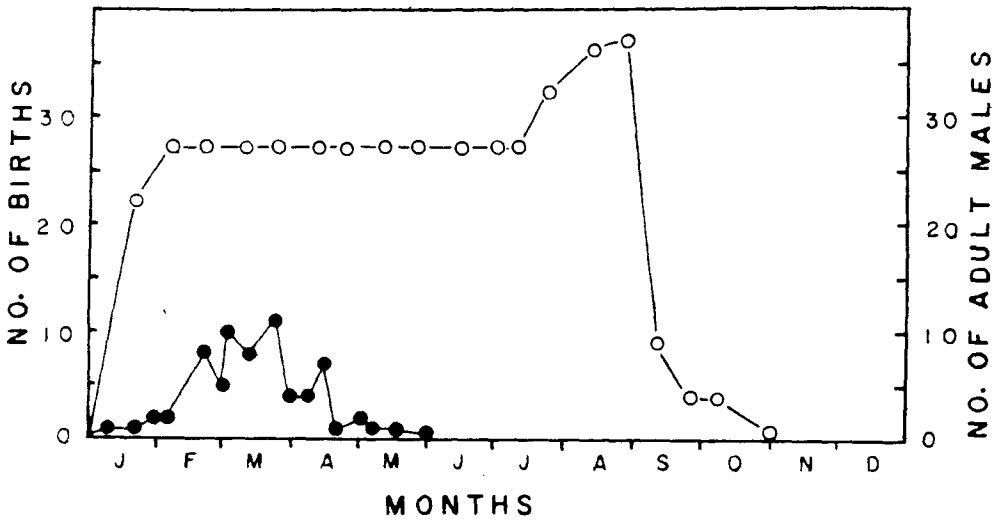

Figure 1. Number of births (solid circles) in *Megaderma lyra* at the temple roost and the number of adult males (open circles) at an all-male roost.

Location	Total	PG	LA	NR	JM	JF	SAM	SAF	AM
Krishnapuram Temple	201	15	62	3	32	31	49	9	–
Cave	127	3	46	1	21	25	20	3	8
Kallidaikurichi Temple	26	1	11	–	6	7	1	–	–

Table 1. Colony composition of *Megaderma lyra* during the breeding period of early March to late May. PG=pregnant, LA=lactating, NR=nonreproductive but sexually mature, JM=juvenile male, JF=juvenile female, SAM=subadult male, SAF=subadult female, and AM=adult male.

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Symposium Jurine

18th to 20th November, 1994

Echolocation of Bats

Muséum of Natural History of Geneva, Switzerland
1 route de Malagnou

Scientists from many countries of Europe and North America already have manifested their interest for this symposium, which is organized in commemoration of Louis Jurine who 200 years ago initiated the study of echolocation of bats.

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Oral papers are allowed 30 minutes (including time for discussion).
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Abstracts: will be included in the programme and should not exceed 15 text lines; they must be sent before September 30th, 1994
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The normal **technical equipment** is at your disposition(slide projector, video, film 16 mm, etc.).

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Abstracts of the VIth European Bat Research Symposium

Évora, Portugal. August 22-27 1993

Organizers:
European Bat Research Organization
Jorge Palmeirim, Universidade de Lisboa
Luisa Rodrigues, Instituto de Conservaçao da Natureza
Jodo Rabaça, Universidade de Évora

[Some of these abstracts are printed as they appeared in the official program, others were edited slightly to correct grammar, spelling, and other minor inconsistencies in usage. Any deviations in meaning from the original text are unintentional, and the editor appreciates the forbearance of the author or authors. GRH]

Development of Foraging Behavior of Young Noctule Bats *Nyctalus noctula* Revealed by Radio Tracking

Klaus Albrecht & Otto V. Helverson, Institut fur Zoologie II, Universitat Erlangen-Nurnburg, Erlangen, Germany

Fourteen young noctules, born in captivity and raised by their mothers were kept in an artificial roost. This bat-house was constructed with two compartments, as described by Gebhard(1988), separated by a lattice. One side was closed for the captive animals and the other side provided with an opening so that it could be used by wild noctules and also to release the juveniles in the study. When fledged they were placed into the open part, from where they could remain in contact with their mothers or decide to take their first trip to the outside. After leaving the roost, the behavior of the young was recorded by radio tracking. It was possible to study four bats from 10 to 33 days. Activity patterns of these bats were inferred from characteristics of the radio transmitter signals. Based on telemetric data in combination with visual observations, the development of foraging behavior could be divided into three distinct periods: flight training; maximizing feeding success; and exploration of feeding habitats. Exploration of suitable feeding grounds turned out to be a continuous process in the individual development of young noctules, but mainly they used single nights to scan their environment.

* * * * *

Main Habitats Used by Bats in Navarra(in Northern Spain)

J. T. Alcalde & M. C. Escala, *Depto. Zoologia, Universidad de Navarro, Pamplona Spain*

Navarra is a region in northern Spain that includes part of the Occidental Pyrenees and has an area of 10,000 sq. Km. There are some well conserved habitats including pine, beech and oak woods, Mediterranean steppes, and areas transformed by human activity such as pastures and agricultural fields. During the years 1988 to 1993 the area was surveyed to determine the distribution of bats. Several methods were used including ultrasound detectors, mist nets, threads over water and visits to potential shelters. Twenty species of bats have been found in this area. In this paper we present data concerning the most important habitats where these species have been found.

* * * * *

Differences in Hibernation Conditions between *Rhinolophus ferrumequinum* and *R. hipposideros* in Navarra(in Northen Spain)

J. T. Alcalde & M. C. Escala, *Depto. Zoologia, Universidad de Navarro, Pamplona, Spain*

Navarra is a region in northern Spain that includes part of the Occidental Pyrenees and has an area of 10,000 sq. Km. with important limestone massifs and with many caves. During the winter from 1988 to 1993 many roosts in caves, tunnels, mines and houses were visited in searching for hibernation shelters of *Rhinolophus ferrumequinum* and *R. hipposideros*. The

environmental conditions of the roosts inhabited by these species are shown and compared. These are temperature, relative humidity, elevation above sea-level, shelters and the habitats in which they appear. In addition, the winter distribution of both species is shown on maps of U.T. M. 10 km/side squares.

* * * * *

Rhinolophid Acoustic Orientation

Peter T. Andrews, Oliver Lodge Laboratory
The University of Liverpool, Liverpool, United Kingdom

The Rhinolophidae have a different strategy for vertical acoustic orientation from that used by the Vespertilionidae. The well known alternating movement of the outer ears of the Rhinolophidae during each echolocation pulse is geometrically equivalent to a rotation of the head and hence of the acoustic horizon. Because of this, it is possible for them to establish both the azimuth and elevation of an isolated sound source from changes in the difference between the sound intensities reaching the ears during a constant frequency echolocation pulse. When the scanned volume contains many echo sources, the bat must distinguish between them and the well known ability of these animals to detect small Doppler shifts in the echo frequency provides a possible method for making this discrimination.

* * * * *

Habitat Selection in Two Sympatric Sibling Species of Bats: *Myotis myotis* and *Myotis blythii*

Raphaël Arlettaz, Institute of Zoology and Animal Ecology
University of Lausanne, CH-1015 Lausanne, Switzerland

The greater and lesser mouse-eared bats, *Myotis myotis* and *M. blythii*, are two Vespertilionid bats that occur sympatrically over wide areas of the Western Palearctic region. These closely related sibling species often co-exist in their nursery roosts, building up mixed clusters. According to the principle of limiting similarity, this intimate co-existence should imply an ecological interspecific differentiation. Previous studies in the Swiss Alps (in press) have shown that the two species are gleaning bats and have different diets in sympatry: *M. myotis* eats mostly terrestrial beetles (Carabidae) whereas *M. blythii* captures essentially bush crickets (Tettigonidae). It is however, not clear if this major interspecific differentiation in diet results from different trophic specializations or from species specific differences in habitat selection. Radiotracking experiments have been carried out in 1990-1992 in a zone of sympatry in SW Switzerland. Twenty four radiotagged bats (12 *M. myotis* and 12 *M. blythii*) were followed for a total of 177 nights. Bats were radiotracked by a car from emergence till they reached their feeding grounds (up to 25 km away from the colony; commuting flight velocity up to 50 km/h). Because of animal foraging velocity and complex alpine topography, and also because radiotracking was performed by one person alone, locations within the feeding areas were estimated by the "homing-in on the animal" method. Each foraging contact was mapped on a 1 ha grill cell system. Every cell was associated with a unique habitat type, the one which was dominant within the cell unit. Habitat selection was estimated for each individual separately, by considering the frequency of available and effectively used habitat types (i.e. 1 ha cells) within its home range. Interspecific differences in habitat selection were merely tested by comparing the frequencies of the different habitat cells visited by the two species. *M. blythii* exploits mostly steppes, pastures, and meadows. *M. myotis* prefers more wooded areas, but do not avoid intensive orchards or freshly cut meadows. Both species could be seen foraging syntopically under some circumstances. These species probably show different adaptations towards habitat microstructure: *M. blythii* catches its prey from grass whereas *M. myotis* exploits "naked ground" (i.e. forest without undergrowth and with scarce grass cover, lawns of intensive orchards, freshly cut meadows, and overgrazed pastures). *M. myotis* must be considered a ground gleaning species and *M. blythii* a grass gleaning bat. These results support the hypothesis of habitat selection as a major niche separation mechanism in the two mouse-eared bats.

A European Program to Preserve World War Fortifications for Bat Protection

Association pour la Protection Transfrontalière des Chauves-Souris
c/o Musée National d'Histoire Naturelle, Marché-aux-Poissons, 2345 Luxembourge, Luxembourg

One of the major projects of our Association is the idea to preserve war fortifications as they are revealed to be very important as quarters for endangered bat species. In fact, studies in our five membership countries proved clearly the importance of those mainly underground quarters for the survival of our endangered bat species in Western Europe. These quarters are most important as winter-quarters, but also as summer-roosts for the small remaining population of both species of Rhinolophidae still occurring here. These fortifications, mainly of the last two world wars, the "Maginotline" in France and the "Westwall" in Germany, seem to be a last migration route through Europe for bats. We have proposed this protection program to the EC in relation to "Habitat directive" EEC No. 1973/92. We also intend to extend our idea to a network of protected bat quarters through Western Europe, in order to assist the conservation of the bat species who figure in the annex II of the "habitat directive". This bat protection project across borders will try to protect important bat quarters within the mean migration distance of bat species.

* * * * *

A community of microchiroptera in an East African Montane Forest Diversity in flight strategies and habitat selection

Hans Baagøe, Zoological Museum, Universitetsparken 15, 2100 Cophenhagen Ø, Denmark

Based on experience of distinguishing bats in the field with detectors, selected areas in the small Mazumbai Forest (W. Usambara Mts. Tanzania, altitude 1500-1800 m) were searched for bats with a Pettersson D980 detector. At each encounter, the bat cries were recorded over the time expansion system with comments on habitat and flight behavior, using a system of categories earlier used on European bats, estimating flight height, distance to vegetation, and maneuvers. At the same time great efforts were made to catch all bat species possible, and in this way try to match bats heard, with bats in the hand. After 12 days no unfamiliar bat sounds were heard, and only for three species matching could not be done with certainty. Of course more species may exist in the forest, but the numerous quantifications made during this one month study, showed that the 11-12 species found, are very clearly segregated as to where and how they fly and hunt their prey.

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Male Reproductive Cycles in some Indian Bats

Nilima K. Badwaik, Department of Zoology, Institute of Science, Nagpur-440 001, India

The sexual cycles of males differ widely among different Indian bats. Males of *Taphozous longimanus, Pipistrellus mimus* and *Pipistrellus dormeri* are sexually active throughout the year. In *Rousettus leschennaulti* the testis and accessory glands are active from October to April. In *Hipposideros fulvus fulvus, Rhinolophus rouxi, Megaderma lyra lyra* and *Scotophilus heathi* sexual activity in the males is confined to October to December. Males of *Rhinopoma microphyllum kinneari* and *Miniopterus schreibersii fuliginosus* are active only during February to April. In *Hipposideros speoris* in Eastern Vidarbha, while spermatogenetic activity is restricted to November and December after the testis undergoes regression, the accessory glands continue to be active until the middle of April and spermatozoa are stored in the cauda epididymis. This is an adaptation to serve the females coming to sexual activity during January to April.

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The Genetics of British and European populations of the pipistrelle bat, *Pipistrellus pipistrellus*

E. M. Barratt, Conservation Genetics Group, Institute of Zoology, Regents Park, London, NW1 4RY U.K.
G. Jones, Department of Zoology, University of Bristol, Bristol, BS8 1UG U.K.
P. A. Racey, Department of Zoology, University of Aberdeen, Aberdeen AB9 2TN U.K
R. K. Wayne, Conservation Genetics Group, Institute of Zoology, Regents Park, London, NW1 4RY U.K.

The pipistrelle bat *Pipistrellus pipistrellus* is the most widespread bat in Europe with a range that stretches from the Arctic circle to north west Africa and from Ireland to Afghanistan. Despite the apparent continuity of its distribution, biogeographic barriers may result in the partitioning of certain populations into genetically distinct units. Though summer maternity roosts have been identified throughout Britain, mating sites and winter hibernacula have been found only in England and Wales. This raises the question of what happens to pipistrelles in Northern Scotland from September onwards. It is suggested that these bats may migrate either to England or the mainland of Europe to mate and hibernate (Racey, 1985). This research project was designed to investigate genetic differentiation among populations and the extent of gene flow between them, across the full range of the species. These questions are being addressed using molecular genetic techniques, examining mitochondrial (cytochrome b and D loop) and nuclear (microsatellite) DNA markers. Two possible phylogeographic clades within the United Kingdom have been identified and this together with data and subpopulation structuring will be presented.

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Analyses of excrement of European bat species

Andres Beck, Zweieren 19
5443 Niederrohrdorf, Switzerland

The excrement of 17 bat species have been analyzed in terms of quality and quantity so as to obtain evidence for the food and the favorite groups of quarry. To substantiate the quantitative evidence, recourse has been made to the frequency with which a group of quarry appeared in the excrement random sample. This method is compared with other quantitative methods outlined in literature and discussed. The present paper is meant to point out possible results, the limits and the scope of analyses of bat excrements.

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Preliminary Results Regarding Activity Pattern and Foraging Areas of *Rhinolophus ferrumequinum* in an Alpine Valley of Switzerland

Andres Beck, Fabio Bontadina, Sandra Gloor, Therese Hotz, Miriam Lutz, and Erich Meuhlethaler
Arbeitsgruppe zum Schultz der Hufeisennasen Graubündens ASHG
Encarden 51, CH-7152 Sagogen/GR, Switzerland

The Greater horseshoe bat, at one time widespread in Switzerland, is today threatened with extinction as everywhere in Central Europe. The last major nursery roost of the Greater Horseshoe bat in Switzerland, totalling 130 animals, is in an Alpine Valley at 720 meters above sea level in the attic of a church. The nocturnal foraging areas and night roosts of the Greater horseshoe bat will be ascertained from spring to autumn 1993 by way of radiotracking. The biology of nutrition will be examined on the basis of faeces analyses as well as by means of light trapping. First results regarding activity pattern and foraging areas in spring of seven females of the Greater horseshoe bat are presented. In spring, the Greater horseshoe bats forage at nighttime only for a little while and often make rests in a nightroost. At this time of the year, the major foraging areas are riverside woods.

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Biometrics of *Myotis myotis* and *Myotis blythi*

Petr Benda and Ivan Horácek, Department of Zoology, Charles University, CS-128 Praha, Czech Republic

An extensive material of *Myotis myotis* and *Myotis blythi* (1143 specimens coming from the European, N-African, and Asiatic populations) have been examined. Twenty-six cranial measurements, four phenetic dental characters, and six external measurements were evaluated. The whole sample was subdivided into subsets (based on geographical origin, sex, and age) which were further analyzed and mutually compared using the standard statistical procedures. Clear differences between the two species were found in termination of skull ossification that is delayed in *M. myotis*. It seems that there is a cline variation in metrical characters in *M. myotis* while is not the case in *M. blythi*, although its local populations differ considerably. The discontinuities in patterns of geographic variation in M. blythi may suggest a reality of subspecies within its range (*oxygnathus, omari, blythi*). Validity of metrical criteria discriminating both the species has been confirmed for most of the regions except N-Africa. However, the biometrical criteria do not allow an exact species identification in the case of the N-African populations, their variation pattern seems to indicate rather their relation to *M. myotis* than to *M. blythi*. There are significant differences in skewness of metrical variation between the allopatric populations and those coming from the regions of sympatry. This seems to indicate a possible character displacement in both the species (in particular this concerns the SW-Europe and Switzerland).

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Confirmation of the Reproduction of *Vespertilio murinus* , in Switzerland

J.-D. Blant, Musée d'histoire naturelle, Léopold-Robert 63, CH-2300 La Chaux-de-Fonds, Switzerland
C. Jaberg, Institut de Zoologie, Chantemerle 22, CH-2000 Neuchâtel, Switzerland

The discovery of at least seven maternity colonies of *Vespertilio murinus* on the shores of Lake Neuchâtel confirms that this species is reproducing in Switzerland at the western edge of its distribution area. Brief descriptions are given of the reproduction sites, the ways in which they are occupied and movements between buildings. In addition, a hospital complex is occupied by a large group of males. It is likely that Lake Neuchâtel is playing a decisive role in the establishment of these colonies.

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Observations on Territorial Behaviour of the Noctule Bat *Nyctalus noctula* in the Mating Season

Wim Bongers, Nature Conservation Department, Agricultural University Wageningen
POB 8080, 6700 DD Wageningen, The Netherlands

In autumn, males of several species of bats show territorial behaviour. They produce social calls to indicate their territories and to attract females to their residences, be it crevices in walls etc., or holes in trees. Males of the Noctule Bat hide in tree holes, producing territorial sounds to attract the females. In the nature reserve "De Duivelsberg" (180 ha) in the vicinity of Nijmegen, the Netherlands, bordering the outer marches of the river Vaal, the residences of the males appear not to be randomly scattered throughout the forest, but clustered in a zone, bordering the outer marches, crossing the flight paths of the females between their nursery trees and their foraging areas above the outer marches of the river. The probability of meetings between females and males will thus be enhanced considerably, while all females have to pass the cluster of males twice a day: flying to and from between their foraging area and their nursery trees.

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How the Noctule Bat *Nyctalus noctula* Selects Its Roosts in the Area of the Town of Zürich, Switzerland

Fabio Bontadina, Hohlstrasse 86a, CH8004 Zürich, Switzerland
Sandra Gloor, Eichstrasse 14, CH8045 Zürich, Switzerland

The Noctule bat is one of four bat species that is found in large numbers in the environs of the town of Zürich. In the mating season in autumn and for hibernation, the Noctules arrive in Zürich in large numbers. To protect and support the roosts of the Noctule, an investigation was carried out in autumn 1990 with a view to setting up practical protective specification. Thirty two Noctule bats were provided with mini-transmitters and monitored in their roost selection over a total of 450 days. Fifty-seven new roosts have been located. Ninety-four percent of the roosts were found in the woods and eighty-five percent were woodpecker cavities. The roosts are above all in old wood areas in deciduous forests or in old individual trees. Practical measures are set forth, on medium-term basis for protecting individual trees and on long-term basis for fostering trees with woodpecker cavities.

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Preycatching by *Myotis daubentonii* in Close-up Photography

Zomer Bruijn, Nieuwstraat 23, NL-3811 JX Amesfoort, The Netherlands

This contribution is a presentation of color slides and sound recordings together with their explanation of a Daubenton's bat catching its prey. The slides are close-ups showing exactly how a Daubenton's bat approaches a detected insect on the surface of water, catches it with his hind legs, and transfers it into its mouth instantaneously. These close-ups and sound recordings are complementary and amplify the studies of Elizabeth Kalko (Germany) and Gareth Jones (England), adding a new point of view.

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Investigations on the Efficiency of the Visual System in Two Neotropical Bat Species

Kirsten Burghardt and Uwe Schmidt, Zoological Institute, Poppelsdorfer Schloss, D-53115 Bonn, Germany

In many microchiropteran species, the sense of vision seems to be of greater importance than expected. It may supplement the highly specialized acoustical system in various situations such as feeding, escape and long range orientation. In this study, the efficiency of vision in the frugivorous bat *Carollia perspicillata* and the omnivorous bat *Phyllostomus discolor* was investigated in a rotating drum. For comparison pigmented laboratory mice (*Mus musculus*) were examined. Our interest is focused in particular on fiding correlations between the abilities of the visual system and the demands made by the special way of living (activity period, mode of locomotion, feeding strategy). At present, the relationship between visual acuity and temporal resolution is examined. For these experiments, the cylindrical drum is covered with equidistant vertical stripes. The optokinetic nystagmus of the animals is registered by means of skin electrodes at the temporal orbits of both eyes. The maximal visual acuity found by this method ranges between 2-3°(*P. discolor, M. musculus*) and 4-5°(*C. perspicillata*). The temporal resolution differs considerably between bats and mice: All bats follow the rotating pattern up to angular velocities of at least 100°/s, whereas the mice respond to the stripes moving not faster than 45°/s. On the other hand, mice respond to much slower movements (0.5°/s) than the bats (5-10°/s).

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New Records of Bats from Galicia in Northwest Spain

Francisco Carro, Augusto de Castro and José M. Rey
Departmento de Bioloxía Animal, Universidade de Santiago, 15706 Santaigo, Spain
Rodrigo Fernandez, Blanco Porto 10 2°I Pontevedra, Spain
Alvaro Moraña, Real 33, 3° 36650 Caldad de Reis, Pontevedra, Spain

The distribution of bats in Galicia has been poorly known. This poster includes recent information about a number of new distributional records. The records are represented with a question mark over a map divided into squares ten kilometers on a side. Information is provided on the geographic status of 17 spedies of the 25 species known to occur in the Iberian Peninsula. We have confirmed the presence of *Myotis blythi*, previously unrecorded in Galicia. The species reported are: *Rhinolophus ferrumequinum, R. hipposideros, R. euryale, Myotis daubentonii, M. bechsteinii, M. natteri, M. emarginatus, M. myotis, M. blythi, Barbestella barbastellus, Plecotus auritus, Pipistrellus pipistrellus, P. kuhlii, Hypsugo savii, Eptesicus serotinus*, and *Minopterus schriebersii.*

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Pentachlorophenol Burden in the Greater Mouse-Eared Bat *Myotis myotis* from Northern Bavaria

Bettina Cordes, Inst. für Zoologie II, Staudtstrasse 5, D-91058 Erlangen, Germany

Timber and faeces samples from 70 maternity colonies of *Myotis myotis* in Northern Bavaria were analyzed for Pentachlorophenol (PCP) residues. Additionally, the PCP contents in tissues from 11 bats from different colonies were detected. Results show a striking correlation between residue levels in tissue and faeces but also between PCP found in faeces and timber treatment in the roost. Therefore, it is possible to estimate PCP burden of these animals by analyzing their droppings, a method which is less time intensive than tissue analysis. The distribution of PCP in *Myotis myotis* from four districts in Northern Bavaria is shown. The pesticide was detectable in nearly every faeces sample. Differences in level of contamination occur between the four regions. A possible reason for this fact might be the different industrialization and agricultural traditions.

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The Sound Pressure Level of the Echo Influences the Ranging Performances of the FM-Bat, *Eptesicus fuscus*

Annette Denzinger and Hans-Ulrich Schnitzler, Animal Physiology, University of Tübingen
Auf der Morgenstelle 28, 72076 Tübingen, Germany

Neurophysiological investigations on cortical delay-tuned neurons showed that the echo SPL is an important cue for ranging (Berkowitz and Suga (1989) Hearing Res. *41:255-264*). In order to test this hypothesis, we trained a Big Brown Bat to discriminate two phantom targets that differed in range. Echolocation calls were picked up by two microphones, electronically delayed and broadcasted by one of two loudspeakers, which were positioned 15 cm in front of the bat. Within a training session, the relative echo SPL was varied between -10 dB and -50 dB. In order to exclude a generalization effect, we began to collect data, when the bat performed better than 80% at relative echo SPLs of -10 dB, -20 dB, -30 dB, -40 dB and -50 dB. We started at a delay difference of 1000 µs and measured the whole psychometric curve. All experiments were conducted double-blind. The best performance was achieved at relative echo SPLs between -20 dB and -30 dB whereas the bat showed a reduced ranging performance when the echo SPLs were either 10 dB or 50 dB below the SPL of the emitted signal. The 75% threshold at a delay difference of approximately 300 µs might be due to the training procedure. Our results show that the SPL of the echo relative to the SPL of the emitted signal is a critical factor for range determination in bats and training procedures may have a strong influence on the shape and absolute values of threshold curves.

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Bat Conservation in the School Curriculum

Paul Elliott, Department of Science Education, University of Warwick, Coventry CV4 7AL, U.K.

Education is an essential part of bat conservation efforts. This paper evaluates curriculum materials that promote the study of bats and bat conservation in British schools. A selection of these materials have been tried with classes of children in state schools. The effectiveness of these materials in terms of increasing knowledge and understanding is assessed.

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Public Sensitization in Luxembourg

Edmée Engel, Musée National d'Histoire Naturelle, Marché-aux-Poissons, L-2345 Luxembourg

In 1992 the National Museum of Natural History in Luxembourg started a new campaign to sensitize the public of the problems of endangered species in Luxembourg. Therefore, the campaign was called "On the red list" and presented species, in which the public can cooperate to their protection. In 1992, bats were the first species to be presented. The museological service of the Museum elaborated a poster: A bat drawing on the recto and an explanatory text of the biology of bats on the verso. The same service created a new exhibition about bats in Luxembourg. This exhibition was presented specially to schools and municipal administrations and was found to be a great success. The exhibition was accompanied by didactic lectures, destinated to be used in schools. As good pamphlets about bats exist, the Museum made the decision to adapt the German brochure of the "Niedersüachsiches Landesverwaltungsamt-Fachbehörde für Naturschutz" to the chiropterological situation in Luxembourg. This brochure was distributed without charge to all interested people, to assure that it reached a larger public. During the entire year, the Luxembourg press was involved in this campaign and helped to make it a success. Through this campaign Luxembourg people became accustomed to informing the National Museum of Natural History about bats. The permanent contact from the public shows that the acceptance of bats in the immediate neighbourhood, for example in the house or under the roof, has grown distinctively.

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Bat Protection in Luxembourg

Edmée Engel and Jacques Pir, Musée National d'Histoire Naturelle
Marché-aux-Poissons, L-2345, Luxembourg

All bat species are protected in Luxembourg by the environmental protection law of 1982. Restoration of old buildings where bats are present is not permitted without following the criteria of bat protection. Since 1988 the summer roost site of *Eptesicus serontinus* (Serotine) in the old school of Weiler-la-Tour was the responsibility of the National Museum of Natural History in Luxembourg. Local people had known this population site since the 1950s. In 1991, the municipal administration of Weiler-la-Tour decided to restore the building. In collaboration with the authorities of the National Museum of Natural History, plans which respected the needs of a Serotine population, were adopted. The work in the roof was carried out from January until April 1992. In 1991 the administration of water and forestry started a programme to close caves known as bat hibernating sites. Special caves situated in the liassic sandstone called Mammerlayen were closed to the public during the winter. A copper mine in Stolzembourg was also known as an important hibernating site and is now closed. This programme will be continued during the following years. In 1988 the cave "St. Barbe" situated in the Mammerlayen was closed naturally by a land-slide. In the following years, several controls showed that the number of hibernating bats had distinctively increased.

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Roost Ecology of the Brown Long-Eared Bat *Plecotus auritus* in North-East Scotland

Abigail Entwistle, Paul Racey and John Speakman
Department of Zoology, University of Aberdeen, Aberdeen AB9 2TN, Scotland, U.K.

We aimed to examine whether *Plecotus auritus* selected the roosts it used in north-east Scotland, where it is most commonly found roosting in buildings during summer. We documented internal and external feactures for known roosts (n=56), and compaired these to equivalent features recorded for a random sample of buildings in the study area (n=20). Roost features which differed significantly from random were those relating to the overall type of house (roof lining, age, height, roof area, detached, gardens). Houses containing roosts were nearer to water and trees, and there was significantly more woodland within 0.5 km of such houses. The importance of this local habitat utilization was further investigated by radiotracking, which revealed that bats concentrated their foraging close to the roosts. Radiotracking has also demonstrated that *P. auritus* forages in both deciduous and coniferous woodland, although bats spent disproportionately more time in deciduous woodland.

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Important Bat Roosts in Galicia

Rodrigo Fernandez, Blanco Porto 10,2º I, Pontevedra, Spain
Francisco Carro, Depto Bioloxía Animal, Facultade de Bioloxía, Universidade de Santiago, 15706 Santiago, Spain
Alvaro Morañia, Real 33, 3, 366650 Caldas de Reis, Pontevedra, Spain

The important bat roosts were studied during 1991-1992 years in Galicia. We catalogued 55 roosts with 15 species of bats. The predominant species of *Rhinolophus ferrumequinum* and *Rhinolophus hipposideros*. This work deals with the situation of bat roosts in Galicia. Roosts type by its origin. Constancy and dominance of bat species (in percentages), in natural roosts, artificial roosts and total. Frequency of bat associations in summer and winter. Conservation status in Galicia.

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Some Observations on the Choice of Hunting Habitat by *Plecotus austriacus*

Peter F. Flückiger, Studerweg 8, 4600 Olten, Switzerland
Andres Beck, Zweieren 19, 5443 Niederrohrdoorf, Switzerland

As a preliminary for a study regarding the choice of the hunting habitat of *Plecotus austriacus*, a non-lactating female of this species has been telemetered during four nights in the Jura of Switzerland. Every night the specimen hunted within a radius of 1.4 kilometres from the day roost, occassionally hunting was interrupted by short breaks. It has been possible to locate six different hunting areas which were frequented more than once a night and also in different nights. The chase in treetops, in open fields, and inside forests points out two different hunting strategies, a small-area strategy within vegetation structures and a large-area strategy in the free air space.

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Investigation at a Nursery Roost of *Myotis myotis*

Malte Fuhrmann, Inst. f. Zoologie, Univ. Mainz, Saarstr. 21D-55099 Mainz, Germany
Andreas Kiefer, Wallaustrasse 59, D-55118 Mainz, Germany

Some problems have arisen concerning a nursery colony of the Mouse-eared bat *Myotis myotis* in a narrow river valley in the Eifel region (Rhineland-Palatinate, FR Germany) and the planned roadway by-pass on the top of a railway embankment. Thus, the low-flying bats are crossing this roadway-railway in front of their roost during the evening departures. However, the street was planned at the height of the existing embankment, thus, collisions between the

exiting and entering Mouse-eared bats and the traffic would be inevitable. During two years of investigation with observations of the flight-passes of the undisturbed bats and in connection with test models, possibilities for the solution of the problem could be demonstrated. On the understanding that the choice of another routing for by-pass would be impracticable, a "deep-seated" road line in combination with a so-called "green-bridge" as overpass and lateral leading walls in front of the bat roost could be favoured.

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Hibernation of Bats in the Undergrounds of Central and Eastern Poland

Elzbieta Fuszara, Grzegorz Lesinski, Jakub Pawel Cygan, Institute of Ecology PAS, Dziekanów Lesny, PL-05 092 Lomianki, Poland, and Marek Kowalski Research Station, Kampinowski National Park, PL-05080 Izabelin, Poland

The study was carried out in 77 underground shelters of bats over 1979-1993. We found 12 species of bats hibernating in Central Poland: *Myotis myotis, M. bechsteini, M. nattereri, M. mystacinus, M. brandti, M. dasycneme, M. daubentoni, Eptesicus serotinus, E. nilssoni, Plecotus auritus, P. austriacus* and *Barbastella barbastellus*. There were five sites with more than 100 bats recorded on one occasion at least, and another five with more than 50 individuals. *B. barbastellus* predominated in forts (ca 70%), *P. auritus* in small cellars (over 60%), *M. myotis* in caves (ca 40%) and *M. nattereri* in big town undergrounds (ca 80%). The changes in numbers during one hibernation period differed in particular undergrounds. Two types of sites were distinguished: (1) caves, where the total community numbers attained the maximum at the end of winter and (2) forts, where two peaks were noted, one in October (due to the maximum number of *M. daubentoni* and *M. myotis*) and another one in the middle of winter (due to numerous population of remaining species, especially *B. barbastellus*). A slight increasing tendency was noted during the study period in some large undergrounds, mainly for *M. nattereri, M. daubentoni* and *B. barbastellus*. The observed shorter fluctuations can be explained by the influence of various weather conditions in different years. Warm winters reduced the number of hibernating bats even up to 50% of the maximum number.

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Feeding Activity of Bats in Habitats along an Urbanization Gradient

Elzbieta Fuszara, Grzegorz Lesinski, Institute of Ecology PAS, Dziekanów Lesny PL-05 092 Lomianki, Poland, and Marek Kowalski, Kampinos National Park, Krasinskiego 49, Pl-05 080 Izabelin, Poland

The study was carried out in: Warsaw (about 2 million inhabitants), its suburbs, and Kampinos Forest with surroudning open areas. Five zones were distinguished based on the degree of urbanization. Feeding activity of bats was determined using simple detectors (D 90) on 46 transects in different habitats: built-up areas with tall buildings, built-up areas with low buildings, areas covered by trees (forests and parks), open areas, and waters. The highest relative density of feeding bats was noted near the Vistula river, in areas covered by trees and in built-up areas out of the town. The highest species diversity was observed in areas covered by trees. *Eptesicus serotinus* and *Nyctalus noctula* were reported most frequently in the study communities. Bats of the genus *Myotis* were present on many transects, less frequently *Pipistrellus nathusii* and only twice *Plecotus* sp. (determined visually). Both in the town and out, *Eptesicus serotinus* and *Nyctalus noctula* were noted together. There were no distinct differences in use of particular habitats by these species. *Pipistrellus nathusii* occurred mainly out of densely built-up areas. Simple encounters in the town were recorded only from parks. Bats of the genus *Myotis* used different types of habitats, excluding built-up areas with tall buildings. *Myotis daubentoni* was distinguished by a strong connection with waters.

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Abundance and Activity of a Large *Myotis emarginatus* Nursery Colony

Jiri Gaisler, Masaryk University, Kodarska 2, 611 37 Brno, Czech Republic
Jirina Nesvadbova, Jan Zukal, Institute of Landscape Ecology, Kvetna 8, 603 65 Brno, Czech Republic

Changes in numbers have been recorded by checking the bats leaving a loft of a small hunting-castle. Maximum numbers of adult bats per year showed an increasing trend with 212 individuals in 1987 and 440 in 1992. During the season, the number of bats leaving their shelter increased from 265 in May to 694 in July, including fledged young in the latter case. Hunting activity started after the time of civil dusk with a shift towards it during the season; early in August it started before the civil dusk. The colony disintegrates in August. In five cases 19 to 30 (24 in average) individuals were light tagged (Cyalume) and released either inside or outside the shelter. Tagged bats flew into forest stands in most cases. Field monitoring with QMC Mini, Skye and Pettersson bat detectors also revealed *Myotis emarginatus* hunting around trees at forest edges, road alleys or within patches of forest. The observations correspond to published data regarding the foraging strategy of the species.

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Observations on the Mating Behaviour of *Nyctalus noctuls* (Vespertilionidae) in the Hibernaculum

Jürgen Gebhard, Naturhistorisches Museum Basel, Switzerland

The copulatory behaviour of this species at a hibernating site has not yet been described. At 1992/1993 approximately 65 wild noctules were hibernating at the artificial hibernaculum "Hofmatt" near Basle. Beforehand, a few ringed individuals had been hibernating at this site for more than four years. The behavioural activities of the bats were monitored continuously by means of an infra-red camera and time-lapse video recorder system from November to March. In parallel, a datalogger recorded the temperature of the environment and the temperature within the bulk of hibernating bats. Some males seemed to copulate regularly from November to mid January. A number of different activity patterns and their spectacular effects on hibernating fellow bats are described.

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

Sandra Gloor, Eichstrasse 14, CH-8045 Zürich, Switzerland, Hans Peter B. Stutz and Vinzenz Ziswiler, Zoologisches Museum, Universitat Zürich, Winterthurerstrasse 190, CH-8057 Zürich, Switzerland

During one season (from April to November 1989) faecal pellets of the Noctule bat are collected in three roosts in buildings in villages. At seven roosts in trees in the town of Zürich, Noctule bats are caught every two weeks from April to November and faecal pellets are collected. The faecal pellets are analyzed both in terms of quality and quantity and compared regionally and seasonally. *Nyctalus noctula* feeds preferably on Trichoptera and Diptera (Chironomidae, Anisopodidae, Tipulidae), insects which fly in swarms, so the Noctule bat can 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 in spring and autumn, when larger insects such as Lepidoptera or Coleoptera (e.g. *Melolontha* sp. in spring, *Geotrupes* sp. in autumn) are frequent and swarming insects (e.g. Trichoptera) are rare, the larger insects are hunted by the Noctule bat too, a fact that points to an opportunistic hunting strategy.

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Phenetic Analyses of the Bat Genus *Myotis* from Palaearctic Region

Joanna Godawa, Institute of Systematics and Evolution of Animals, PL-31 016 Cracow, Slawkowski 17, Poland

Twenty continuous morphological features representing 45 Operational Toxonomic Units of genus *Myotis* were analyzed by principal components and cluster analysis. Fifteen dia-

gnostic dental characters were also used. Dental morphology of teeth is used in paleontology and constitute very important data for the reconstruction of evolutionary processes. Phenetic relationships among genus *Myotis* were discussed. *Myotis rosseti* was included in analyses. It was transformed into genus *Myotis* by Hill and Topal (1973).

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Distribution of Bats in Asturias (Northern Spain)

Félix González-Alvarez y Rolando Rodriguez-Muñoz
Grupo Asturiano para el Estudio y Conservación de los Murciélagos
Apdo. 380, SP-33080, Oviedo, Asturias Spain

A first revision of the geographical distribution of bat species in Asturias in northern Spain is presented. This region covers 10,565 km^2, in the north slope from the Cantabrian Mountains (Northern Spain). Distributional maps of individual species are included on UTM geographic grid with squares of 10 km x 10 km with differentiated symbols according to the dates of the records and reproduction information. These maps are based on irregular observations (544 locality records) recompiled for the area until 1992. 72.1% of UTM squares considered (140) have at least one species, and the cover of the territory is more complete (84.2 %) in the Eastern zone (UTM designation zone 30 T) than the Western one (64.1 %) (designation zone 29T). The species composition of bat fauna of Asturias exhibits a typical pattern of Cantabric area, predominated by eurasiatic (50.0 %) and European elements (36.3 %) with some meridional species (13.7 %). With the exception of *Rhinolophus mehelyi* and *Myotis capaccinii*, typical Mediterranean species absent of the Atlantic Iberian environments and *M. bechsteinii*, recorded in nearby areas, all the other bats identified in the Iberian Peninsula (22 species) have been found in this region. The occurrence of *Nyctalus noctula* is only known by two bibliography records, and *P. nathusii* and *P. kuhlii* are the most recently recorded species (*P. kuhlii* reported for the first time in Cantabric area).

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Get Fresh for Aride, Seychelles (Seychelles Wildlife & Plants)

E. A. Groenendaal, R. MacKay, Onder de Bomen 4, NL-6871 CH Renkum, The Netherlands

Abstract not available.

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A Comparison of Bat-Detectors (Self-Made & QMC-Mini)

E. A. Groenendaal, J. Ruysch, Onder de Bomen 4, NL-6871 CH Renkum, The Netherlands

Abstract not received.

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Echolocation Calls of *Hipposideros ruber* and *Hipposideros commersoni* from the Gulf of Guinea Islands

A. Guillén, C. Ibañez and J. Juste, C. Ruiz
Estación Biológica de Doñana (CSIC), Apartado 1056, SP-41080 Sevilla, Spain

Constant frequency calls and biometric measurements of handheld bats were recorded in São Tomé (*Hipposideros ruber* and *H. commersoni*) and Príncipe Islands(*H. ruber*) . Skull measurements were taken in a small sample of collected specimens. Island and sex have significant effect on size in *H. ruber*. Females are bigger than males and bats from S. Tomé are bigger than those from Principe. These effects are also significant on frequency. Males have higher frequencies than females in the two islands. A significantly stronger frequency dimorphism occurs in S. Tomé, for males emit higher calls than those from Príncipe, but females have the same frequency in the two islands. *H. commersoni* are strongly dimorphic

in biometric measurements but the two sexes produce signals with the same constant frequency. No correlation between constant frequency and biometric (external and skull) measurements was found in either species. These results are compared with the information available from other sites, and discussed in the light of the available theories to explain character divergence: reinforcement of reproductive barriers and ecological displacement.

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The Lek Mating System of the Lesser Mouse-Eared Bat, *Myotis blythi* in Northwestern Greece

Matthias Hammer and Otto von Helversen,
Institute of Zoology II, University of Erlangen, Staudtstrasse 5, D-91058 Erlangen, Germany

The mating behaviour of the vespertilionid bat *Myotis blythi* was studied in a population of individually marked bats in Northwestern Greece near Kastoriá. The males roosted singly in vertical drainage tubes of bridges, where they established small mating territories. They occupied their roosts in spring, while the females appeared from the end of July to the end of September. Within the group of males a low turnover rate and a high roost site fidelity was found, even from one year to the next. While hanging at the entrances to their roosts, the resident males exhibited audible calls as advertising displays. Females joined them and the bats remained together during the following day. Bisexual pairs were the rule, sometimes a cluster of three individuals (one male and two females) could be observed. The variation of male courtship success was greater than expected by chance. It did not depend on the location of the display territory, the age or any morphological parameter tested. The only factor positively correlated with the number of visiting females was the duration that a male was present at the mating arena during the night. Both sexes showed promiscuous behaviour, choosing up to six different partners. The mating behavior of the studied assembly resembles a lek mating system.

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Distribution and Status of Bats in Saarland (Germany) and South Luxembourg

Christine Harbusch, Am Schwalbacher Berg 155, D-W-66806 Ensdorf, Germany

The distribution and status of the 13 bat species of Saarland is strongly influenced by human activity. Saarland is among the smallest but most densly populated regions in Germany (418 people/km^2). Intensively used land as well as widespread deciduous woods are the main factors influencing the distribution of bats. Generalist species as the Pipistrelle, *Pipistrellus pipistrellus* and the Serotine, *Eptesicus serotinus* as well as dendrophilic species as the Noctule, *Nyctalus noctula* and Leisler's bat, *N. leisleri* are rather common and widespread. Specialized species such as the Greater Horseshoe bat, *Rhinolophus ferrumequinum* and the Mouse eared bat, *Myotis myotis* are most endangered. The bat fauna of Luxembourg is currently under its first systematic investigation. The southern half of the state has now been reviewed. Altogether 14 bat species are known in Luxembourg, a country offering a variety of climatic conditions, combined with mostly extensive land-use and low human population density (141 people/km^2). Again the Pipistrelle, *Pipistrellus pipistrellus* and the Serotine *Eptesicus serotinus*, reach the highest population density and the widest distribution whereas the Lesser and the Greater Horseshow bat, *Rhinolophus hipposideros* and *R. ferrumequinum* Geoffroy's bat, *Myotis emarginatus* and the Barbastelle *Barbastella barbastellus*, are the most endangered species.

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Encouraging Public Participation in Roost Monitoring and Conservation

Gill Hinchcliffe, VWT Bat Project, 5 Rose Terrace, Waterhouses, Durham, U.K.

One of the keys to successful bat conservation is gaining public sympathy for the plight of bats. The growth of 'Bat Broups' in the U.K. over the last ten years and the large number of volunteers who take the message of bat conservation 'to the people' has resulted in a much more positive attitude towards bats. This paper aims to present a number of approaches and activities which have been used to encourage both members of the public and those who play host to bat colonies that bats are interesting, fun to study, and worthy of conservation. The success of bat talks, walks, and watches is considered, together with other types of public events. The use of the media to bring bat conservation into people's living rooms is addressed and some possibilities are enabling these people to actively contribute to roost monitoring are given. The value of keeping in contact with those householders who regularly host bats is shown and ways of doing this are suggested.

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Monitoring of Territorial Males of the Common Pipistrelle *Pipistrellus pipistrellus*

H. Hollander, Asterstraat 163, NL-6708 DM Wageningen, The Netherlands
H. J. A. Limpens, Harnjesweg 17, NL-6707 ET Wageningen, The Netherlands
L. Verheggen, Breitnerstraat 57, NL-6165 VN Gellen, The Netherlands

Territorial males of the common pipistrelle (*Pipistrellus pipistrellus*) were mapped during three years (1990-1992) in a part of Wageningen, The Netherlands. The study area was visited 20 times in 1990, 5 times in 1991 and 6 times in 1992. In 1992, territorial males were also mapped in 24 visits to a part of Geleen. The observations obtained during each year were manually clustered, applying criteria similar to those used for breeding birds. Each cluster is throught to represent the territory of one male. The results of Geleen, 1992 and Wageningen, 1990 are compared. Numbers and densities are almost equal and the density of territories was 0.9 territories per hectare in both areas. The periods of highest activity are not comparable between the two cities. The results of three years of monitoring in Wageningen are discussed. The numbers and densities did not differ much among the years. A preference for higher buildings is found. This monitoring method can also be used with territorial males of *Nyctalus noctula* and *Pipistrellus nathusii*.

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Idiothetic and Allothetic Flight Control in *Phyllostomus Discolor*

Patrik Höller and Uwe Schmidt, Zoologisches Institut der Universität
Poppelsdorfer Schloss, D-5300 Bonn 1, Germany

Bats are known to orientate by spatial memory while flying within a familiar area. Several authors could show that the mode of orientation is rather fixed. For example bats fail to avoid an obstacle subsequently installed into the flight path, respectively they display evading movements although a well known obstacle has been removed. Nevertheless, the mode of orientation should not be too rigid if many individuals are flying in a confined space, such as the roosting trees of *Phyllostomus discolor*. Using an octagonal cage (h.: 150 cm; ø:100 cm) with four equal roosting sites inside, we investigated the orientation mode of *P. discolor* under spatial conditions similar to a natural roost. Rotating both the test-apparatus and the starting direction of bats, it was possible to demonstrate that *Phyllostomus* orients by means of spatial memory as long as no spatial parameter is changed dramatically. Further analysis of the experimental data showed, that spatial memory is based on idiothetic flight control. In spite of these very clear results we found that the bats were able to correct the approach to landing allothetically if, for example, the width of the roosting sites was reduced. So we have to assume that the orientation mode of *Phyllostomus discolor* is not as fixed as it was recently thought to be.

The Early History of Vespertilionid Bats

Ivan Horávek, Department of Zoology, Charles University, CS-128 44 Praha, Czech Republic

The European Oligocene and Early Miocene record of the vespertilionid bats consists almost exclusively of the forms that bear the *Myotis* -like dental pattern. Nevertheless, it seems that only just a few of them have belonged to the genus *Myotis* in fact. *"Myotis" missonei* (Quinet, 1965) can serve as a typical example. It is a nyctalodont form that with its sharply pointed molars resembles *Barbastella* rather than *Myotis*. In any event the situation is even more coplex with the Oligo-Miocene *Myotis* -like vespertilionids that possess the myotodont molar pattern. There, only a very minute difference and/or indirect evidence indicate that we may actually be dealing with the representatives of clades other than *Myotis* s. str. For instance, in the case of a large-sized form found in a MN1 site Merkur (NW Bohemia) this concerns a degree of M/3 talonid reduction that is beyond a state appearing in any *Myotis* spp. (thus indicating a proximity to the Eptesicoid-Scotophilid clade). The vespertilionids that actually attained the pipistrelloid grade are first evident (in more clades) as late as in MN 5-6. In these connections, the paper discusses possible relationships of the genera *Paleptesicus, Miostrellus,* and *Samonycteris,* as well as the Eocene Genus *Stehlinia.*

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Carbohydrate intake and metabolic rates in the fruit bat, *Artibeus jamaicensis*

G. Roy Horst and Jennifer Skutt, Dept. of Biology, Potsdam College of SUNY, Potsdam, NY 13676, U.S.A.

Few mammals are subjected to the enormous carbohydrate loads that some fruit bats impose upon themselves by having a nearly pure fruit diet. Conventional wisdom has been that fruit bats inadvertently consume very high loads of carbohydrates in order to satisfy their protein requirement from a food source rich in carbohydrates but very low in protein. The fate of this apparent excess caloric intake has been a perplexing question. We proposed and are in the process of testing the following hypotheses. 1] That the animals do indeed consume inordinately large amounts of food, but do not have very effective digestion and as a consequence, unlike other mammals, do not absorb all of the carbohydrates available. 2] That these animals maintain a high body temperature, and use much of their available energy maintaining this high T_B, necessitating a high resting metabolic rate, which in turn "burns off" the excess calories(we have demonstrated that these animals have extremely high resting metabolic rates). 3] That these animals reach high plasma glucose concentrations during the absorptive phase of their dietary cycle, considerably higher in fact than glucose reabsorption transport maxima in the kidneys, and as a result lose a considerable amount of glucose in their urine. 4] That some combination of these factors allows these animals to obtain an adequate protein supply by consuming an extraordinary amount of protein-poor but carbohydrate-rich food, "wasting" or discarding (or both) the extra energy gained from this unusual diet, remain in caloric balance, and they do not, in fact, become obese.

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Distribution of Bats in Patchy Ecosystems

Johnny de Jong, Department of Wildlife Ecology, Box 7002, S-75007, Uppsala, Sweden

Bats are usually unevenly distributed in the landscape. There are several explanations for this. It is obvious that insect abundance is one of the most important factors affecting the distribution of bats. In this study, another factor was investigated: the importance of the configuration of different habitats. How are bats distributed in a patchy landscape (an open landscape with patches of forest)? Bats are highly mobile animals. Are their distributions at all affected by habitat patchiness? How are patch area and patch isolation (distance to mainland) affecting different species? Is there any difference between real islands and habitat islands? The study was carried out during three years at three different study sites near Uppsala, in south Sweden. Bats were surveyed by using ultrasound detectors and habitat preferences were investigated for some species. Some species were found to avoid open

habitats and were negatively affected by patchiness. There is a positive correlation between patch area and number of species, but no correlation between patch isolation and species number. Different patterns were found when real islands and habitat islands were compared. Different hypothesis that explain why some species avoid open habitats are discussed.

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The Use of Echolocation and other Sensory Cues in the Frugivorous Bat *Artibeus jamaicensis*, while Foraging

Elisabeth K. V. Kalko, Animal Physiology, University of Tuebingen,
Auf der Morgenstelle 28, D-72076 Tuebingen, Germany

Leaf-nosed bats (Microchiroptera: Phyllostomidae) form the largest group of bats in the Neotropics. The species in this family display an unparalleled variety of feeding habits ranging from insects, small vertebrates and blood to fruit, pollen and nectar. Given this diversity of feeding habits, it is surprising that all leaf-nose bats show a rather similar and stereotyped echolocation behavior. This contrasts sharply with other families of Microchiroptera in which the design of echolocation signals varies substantially among species and is likely to reflect differences in foraging modes and habitat use. Furthermore, although all phyllostomids are able to echolocate, for most species the relative roles played by echolocation and other sensory cues as olfaction, vision, and passive hearing during foraging is unknown. In my talk I present results of field and flight cage studies of the echolocation and feeding behavior in the common fruit-eating bat, *Artibeus jamaicensis.* Behavioral experiments reveal that in this species olfaction as well as echolocation play crucial roles in the process of detecting, localizing, and identifying fruits.

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Hair Structure of European Rhinolophids

A. Keller, Muséum d'Histoire Naturelle, Case postale 434, CH-1211 Genève 6, Switzerland

The research carried out on the microscopical structure of hairs of the five European species of the genus *Rhinolophus: ferrumequinum, hipposideros, blasii, euryale* and *mehelyi* is a further contribution to already published studies on the hair morphology of European bats. These preliminary results concern more particularly the structure of the cuticular scales of the underhairs to point out the differential characters of the studied species. The author proposes an artificial identification key, principally based on the shape of the root and the scaly cuticula observed in the basal and middle hair part. The definitive conclusion will be published elsewhere.

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Bats as Traffic Casualties in Germany

Andreas Kiefer, Wallaustrasse 59, D-55118 Mainz, Hubert Merz, Gartenstrasse 10, D-85416 Langenbach,
Wolfgang Rackow, Northeimer Strabe 4, D--37520 Osterode/Harz,
Hubert Roer, Zool. Forschungsinst. und Museum Koenig, Adenaueralle 150164, D-53113 Bonn,
and Detlef Schlegel, An der Grotte 4, D-31515 Wunstorf, (all from)Germany

The authors collected more than 150 different records of dead or injured bats, which were proved to be casualties of road, plane flights, and railway traffic in Germany. Almost all native species could be proved to suffer as traffic casualties. The records are derived from literature, regional inquiries and announcements to the "Beringungszentrale" (Central-office of bat-banding) in Bonn. Most of the records were dated between 1960-1992. A remarkable quantity of bats fell victim to traffic accidents in the months of July, August, and September. These facts as well as the potential of danger for bat populations will be discussed.

Increased Population of Daubenton's Bat *Myotis daubentoni* in Poland

Tomasz Kokurewicz, Museum Natural History, Wroclaw Univ., Sienkiewicza 21, PL-50 335 Wroclaw, Poland

In most European countries, *Myotis daubentoni* has been classified as not threatened, with populations generally increasing over the last 40 years. I found in Lower Silesia (S.W. Poland) that the population of *Myotis daubentoni* increased by on average 860% within 23 years (1964 to 1987), and the increase of the number of occupied localities increased by ca. 64%. In Kraków-Czestochowa Upland (Central Poland) the increase was on average, 540% over 41 years (1950 to 1991), and the increase in the number of occupied localities was 124%. The stomachs of three individuals caught in July 1992 at a single site revealed that the diet of Daubenton's bat consisted mostly of non-biting midges (Diptera: Chironomidae) (94.3% to 99.8% stomach contents). The increased population of *Myotis daubentoni* may reflect the increased availability of insect prey, notably chironomids, caused by eutrophication processes as well as channelization of rivers and streams. The mechanism by which more favorable trophic conditions lead to increases in population may include earlier sexual maturity and/or increased survival.

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Hibernation Strategies of Five Bat Species in the "Nietoperek" bat Reserve (Western Poland)

Tomasz Kokurewicz, Renata Paszkiewicz and Rafal Szkudlarek
Museum Natural History, Wroclaw University, Sienkiewicza 21, PL-50 335 Wroclaw, Poland

In the winter of 1991/92 hibernation strategies of *Myotis daubentoni, M. myotis, M. nattereri, Plecotus auritus* and *Barbestella barbastellus* were studied on six plots in the "Nietoperek" underground fortification system. The wide range of microclimatic conditions in the plots (temperature 5°C - 9°C, relative humidity 59.5% - 95%, air flow 0.06 to 3.1 m/s) allowed bats to choose the optimal conditions in consecutive months of the hibernation period. The number of species and species diversity (H') were negatively correlated with relative humidity (- 0.576, $P < 0.005$ and - 0.711, $P < 0.001$ respectively) which suggests that *P. auritus* and the *Myotis mystacinus/brandti* group avoid humid environment. A positive correlation was found between population density of *M. daubentoni* and relative humidity on the study plots (0.476, $P < 0.02$). During winter bats seem to select their hibernation sites to obtain stable optimal hibernation temperature. The values of Shannon-Weaver index (H' = 1.875 & 1.598) in December and January were the highest on the warmest study plots (average 9.21°C and 9.13°C) which might be connected with winter feeding in those months. The observations of mass dynamics of *Myotis daubentoni* aged 0-1 and 1+ showed that during hibernation season (usually January) young individuals foraged more frequently than older ones. The fat deposits of individuals aged 1+ seem to be large enough to complete hibernation, contrary to individuals aged 0-1.

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Nitrogen Requirements and Energy Balance of the Fruit-Bat *Rousettus aegyptiacus*

Carmi Korine and Zeev Arad, Department of Biology, Technion, Haifa 32000, Israel

The fruit-bat, *R. aegyptiacus* is exclusively dependent upon plants as a source of food in the form of pollen, leaves and mainly fleshy fruit. Some of these fruits are characterized by a very low protein content. We therefore asked the ecologically relevant question of how does this species regulate its energy and nitrogen metabolism on various fruit diets. Individual bats were kept under laboratory conditions on four exclusive single-species fruit diets (*Ceratonia siliqua, Eriobotrva japponica, Ficus sycomorus* and *Murus nigra*). On all experimental fruit diets, body mass was maintained relatively stable. Fruits were found to be sufficient sources of energy and nitrogen balance was positive. Nitrogen balance analysis shows that these bats should be in balance when nitrogen intake is 0.15 $gN/Kg^{0.75}$ (1% protein). These results indicate that the fruit-bats may have a low protein requirement for maintenance and that fleshy fruits are nutritionally adequate as a source of food for this species.

Activity of Bats in the Area of Zagreb

D. Kovacic and O. Deban, Dept. Zoology, Rooseveltov trg 6, 41000 Zagreb, Croatia
D. Holcer and F. Ogulinca 27, 44000 Sissk, Croatia

Abstract not received.

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Bats of Zagred-Historic Review and Present Knowledge

D. Kovacic, Dept. Zoology, Rooseveltov trg 6, 41000 Zagreb, Croatia
D. Holcer, F. Ogulinca 27, 44000 Sissk, Croatia
B. Dulic, Dept. Zoology, Rooseveltov trg 6, 41000 Zagred, Croatia

Abstract not received.

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The Evolution of Bats in the Light of Adaptational Transformations of the Respiratory System

I. M. Kovalyova, Institute of Zoology of Ac. Sci. Ukraine, Kiev 30, Lenina 15, Ukraine

The proper respiratory, conductive air and respiratory motor organs of representatives of two families of bats (Rhinolophidae - 3 species, Vespertilionidae - 17 species) were investigated by morphological methods. The greatest differences between the species studied were established in respiratory motor organs, which have functional, beside topographical, ties with locomotor organs. So the adaptational transformations of the apparatus of locomotion involve the organs of respiration in this process. The study of the border types of bats (considering the quadrupedal locomotion) leads to the conclusion, that the elimination of the quadrupedal locomotion (representatives of Rhinolophidae) results in a sharp change in the structure of respiratory organs: the active use of the quadrupedal locomotion (representatives of Vespertilionidae) conserves the ancestral traits in their structure.

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Importance of Mining Systems for Social and Wintering Behavior of Several Bat Species: A Limestone Quarry Near Heidelberg (South West Germany)

Friedrich Kretzschmar, Bezirksstelle f. Naturschutz u. Landschaftspflege, Werderring 14, D-7800 Freiburg, Germany
Brigitte Heinz, Untere Strabe 15, D-6903 Neckargemünd-Dilsberg, Germany

One of the most interesting bat sites in South West Germany was discovered in the subterranean mines of a large limestone quarry near Heidelberg. Although the region is characterized by urban agglomeration and bats only occur in low density, we could confirm about 1000 wintering bats (most of them *Pipistrellus pipistrellus*). But with about 20 individuals of *Eptesicus serotinus* the quarry is also the largest winter colony of this species in Baden-Württemberg. Even more important is the fact that bats are not only found here in winter. "Swarming behavior" was recognized in August and September, in December and in April. We think that much higher numbers of bats use these quarters for social activity than as winter quarters. This investigation shows the importance of subterranean cavities for bat conservation. In the described case, the quarters were endangered by filling the quarry with rubbish. Consideriing only the function as winter quarters, the quarry would have been completely filled leaving open only a small entry for bats. By demonstrating the importance of the cavities, the entrance halls and the surroundings for social behavior of bats, we were able to halt the rubbish deposit plans.

Foraging and Roosting Behavior in the Two Phyllostomid Gleaning Bats *Tonatia silvicola* and *Trachops cirrhosus*

Dorothea Krull, Seydlitzstr. 63, D-8000 München 50, Germany
Elisabeth Kalko, Univ. Tuebingen, Zoophys. Inst., Auf der Morgenstelle 10, D-72076 Tuebingen, Germany

The roosting and foraging behavior of the phyllostomid gleaning bats, *Trachops cirrhosus* (2 males, 30 g) and *Tonatia silvicola* (1 male, 2 females, 32 g) was studied during the dry season (February) in 1993 on Barro Colorado Island, Panama, using radio telemetry. Harems of *Tonatia* consisting of one male and two or three females day-roosted in termite nests. Tagged bats were faithful to their roosts. A small group of *Trachops cirrhosus* roosted in a hollow tree which was used as day roost by four other bat species. *T. cirrhosus* were not loyal to their roost. Flight activity and use of habitat differed in the two species. *T. cirrhosus* emerged at dawn and stayed out of the roost for more than 9.5 h. They commuted up to 1.6 km to their foraging areas which were always close to streams. *Tonatia silvicola* left the day roost well after dark spending about 4 h (male) and 8 h (females) outside. They foraged within a radius of 1 km from the roost and exclusively in forested areas that were away from streams. In both species individual foraging areas were small (~3-4 ha, *Trachops cirrhosus* ; ~4-12 ha*Tonatia silvicola*) and overlapped in time and space. In *Trachops cirrhosus* and *Tonatia silvicola* short flights (< 1 min) from perch clearly dominated over continuous flights of more than 1 min. Continuous flights were more common and the average duration was longer in *Trachops cirrhosus* (mean = 3.8 min, 1-36 min, N = 195) than in *Tonatia silvicola* (mean = 2.81, 1-27 min, N = 126). differences in foraging strategies between the species may reflect differences in food selection and social structure.

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Allomaternal Care: Helper-Assisted Birth in the Rodrigues Fruit Bat, *Pteropus rodricensis*

Thomas H. Kunz and April L. Allgaier, Boston University, Boston, MA 02215, USA
John Seyjagat and Randy Caligiuri, Lubee Foundation, Gainesville, FL 32609, USA

We report observations of allomaternal care, or epimeletic (care-giving) behavior, exhibited by one female toward another, before, during, and after giving birth in the Rodrigues fruit bat, *Pteropus rodricensis* (Chiroptera:Pteropodidae). Interactions between the mother and other roost mates from the onset to completion of birth, were observed continuously over a period of approximately three hours. The attending female assisted the mother when she 1) intermittently groomed her anovaginal region , 2) grasped her with partially outstretched wings, 3) "tutored" her in a feet-down birthing posture, 4) groomed the emerging pup, and 5) physically assisted the mother by-maneuvering the pup into a suckling position. This is the first report of extensive assistance given by a female bat to another during parturition. We suggest that epimeletic behavior may be common in the highly social Chiroptera, especially among primiparous or inexperienced females and/or when a pregnant female experiences difficulty during labor and parturition. Our observations support the hypothesis that roosting associations in bats may be as important as relatedness in explaining the occurence of apparently altruistic acts.

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Preliminary Results of a Survey of Bats of the Athens Metropolitan Area

A. Legakis, C. Papadimitriou, and M. Gaethlich
Zoological Museum, Dept. of Biology, University of Athens, Panepistimioupoli, 157 84 Athens, Greece

The bats of urban areas in Greece have never been studied. No data exists on species present, on the status of populations or on the effects of urbanization on these animals. In order to study the bats of the Athens metropolitan area which is the largest urban conglomerate in Greece, concentrating more than one third of the total human population of

Greece, 50 sites were chosen according to several criteria. The sites were surveyed using an ultrasonic bat detector as well as roosts, number of foraging bats, vegetation, level of human disturbance and other factors were noted. Although not in large numbers, bats are found everywhere in Athens. The biggest concentration seems to be around the rock of the Acropolis and in the surrounding district of Plaka. Suitable foraging sites with high traffic and noise are avoided. The numerous caves in the surrounding mountains are important for hibernation. Pine trees which have been planted extensively in the last 40 years in and around Athens, do not seem to be suitable for bats.

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The "Song Flight" in the False Vampire Bat *Megaderma lyra*

Dieter Leippert, Zoologisches Institut der Universität München, Luisenstrasse 19, D-8000 München 2, Germany

Social interaction occurs in bats while they are hanging in a roost, crawling on the ground or flying around. In a group of ten *Megaderma lyra* (7 females and 2 adult males, and 1 juvenile female) held in captivity, a stereotyped socially motivated flying behavior ("song flight") could be observed. This behavior was displayed exclusively by the dominant male bat and addressed to the female members of the group, only. The "song flight" is composed of three behavioral stages, each stage being accompanied by a specific "song strophe". The "introducing flight" is accompanied by the "rhythmical strophe", the "advance flight" by the "trilling strophe", and the "final flight" by the "melodious strophe". The structure of the sound types (click, FM, FM_{down}/CF and CF/FM_{down}) used by *Megaderma lyra* as social calls in the "song flight" is similar to structure of the echolocating calls of various bat species.

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Discrimination Between Daubenton's Bat *Myotis daubentonii* and Natterer's Bat *Myotis nattereri* Hunting above Water, Based on Sound and Flight Behavior

Herman J. G. A. Limpens, Netherlands Bat Research Foundation, Harnjesweg 17, NL-6707 ET Wagening
and Minne Feenstra, Netherlands Bat Research Foundation, J. Vijghstraat 11, NL-6524 BN Nijmegan
The Netherlands (both authors)

In the Netherlands, the Natterer's bat can be observed hunting low over the water surface in the manner of the Daubenton's bat. In such cases, sonar and flight behavior are very similar and discrimination between the species is very difficult. Sonar and flight behavior were studied to minimize mistakes in species identification and maximize the chance of positive recognition of the Natterer's bat by the (amateur) bat workers participating in the Dutch Nationwide Bat Survey. Therefore, attention was not only directed towards the analysis of recorded sounds, but also towards visual and acoustical characteristics, enabling identification in the field. Although in many cases the parameters appeared to be dependent on the structure of the hunting habitat, exclusive differences were found with respect to sound quality and rhythm. In addition, sound intensity, (variation in)repetition rates, pulse length, (variation in)flight height above the water, and maneuverability can provide an indication of the species' identity.

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The Occurrence of Bat Rabies in the Netherlands

P. H. C. Lina, National Reference Centre for Nature, Forests and Landscape, NL-6700 AA Wageningen, J. Haagsma, Central Veterinary Institute, Bacteriology Department, NL-8200 AB Lelystad
J. H. M. Nieuwenhuijs, Veterinary Public Health Inspectorate, PO Box 5406
The Netherlands(all authors)

The first evidence of the presence of bat rabies in the Netherlands was found in 1987. Since then, 2712 bats collected from 1984 to 1992 and belonging to 11 species have been examined to rabies. Rabies was found in 189 Serotines *Eptesicus serontinus* and in four pond

bats *Myotis dasycneme*. Approximately 20% of the Serotines were diagnosed rabies positive. The majority of the infected animals was found north of the rivers Rhine and Meuse. The incidence of rabies in the Serotine in the Netherlands is similar as found for this species in Denmark and in the German federal states Schleswig-Holstein and Lower-Saxony. The present known data about rabies in European bat species make it likely that rabies is endemic in at least several populations of the Serotine and scarce or probably absent in the other species.

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Conservation Approach for the Lesser Horseshoe Bat (*Rhinolophus hipposideros*, in the Eastern Swiss Alps (Lugnez/Valsertal, Grisons, Switzerland)

Miriam Lutz, Erich Muehlethaler, Encarden 51, CH-7152 Sagogn, Switzerland

The mountain valleys "Lugnez" and "Valsertal" belong to the upper Rhine valley region in the eastern part of the Swiss Alps (Grisons). This area with a wide variety of rich habitats supports the last notable population of the Lesser Horseshoe Bat in Switzerland. Six nursery colonies with a total of approximately 350 individuals of this bat species, close to extinction in Middle Europe, are found within a very limited section of the two alpine valleys. The whole nursery population is confined to an area of probably less than 30 square kilometers. This study presents objectives and steps for effective conservation or even strengthening of this remarkable nursery population. It provides possibilities to help realize the proposed conservation measures within a short period of time. Considering the hitherto existing results, protecting the nursery and other diurnal roosts and their colonies and maintaining the nocturnal activity and foraging areas as well as the nocturnal resting sites in unspoiled and non-polluted conditions seems to be the key to a safer future of this nursery population of the Lesser Horseshoe Bat. Protecting the roosting sites can and should be done immediately.

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Sexual Dimorphism in the Common Vampire in French Guiana

C.S. Mann and S. Aulagnier, I.R.G.M., I.N.R.A., BP 27, F-31326 Castanet-Tolosan Cedex, France

The common vampire bat, *Desmodus rotundus*, widely occurs in the Americas, from Mexico to northern Argentina and Uruguay. As this bat feeds almost exclusively on the blood of mammals and is implicated in transmitting the rabies virus, studies were conducted in many countries. Some published measurements indicate that some sexual dimorphism is likely . During an ecological study in French Guiana, a large sample of specimens was collected and measured: 389 forearms, 146 skulls (7 variables). These biometric data are analyzed in respect to sexual dimorphism, and seasonal and geographical variations by multivariate analyses. As expected, females are generally larger than males; this is obvious for the forearm length, and is also statistically significant for most of the cranial measurements (length and breadth of the skull, zygomatic breadth, length of the mandible,... $p < 0.0001$). Some discriminant functions are calculated; with the forearm length, as many as 90% of the specimens can be rightly assigned to one sex (75% with only skull measures); males are statistically below 59.5 mm, but eight of them are larger while two adult females are smaller than expected. This significant sexual dimorphism is the only clear biometric variation, more particularly it appears relevant that all the common vampires of the French Guiana coast, from Cayenne region to Saint Laurent du Maroni region, belong to a sole population. Can this sexual dimorphism be concerned with feeding? While males and females feed on the same "prey", females need to fly even when pregnant or carrying their young as well as after a heavy blood meal.

A Portable Ultrasound Processor

K. Maries, Ultra Sount Advice, 23 Aberdeen Road, London N5 2Ug, U.K.

A Portable Ultrasound Processor is described with built-in signal display and analysis, timebase expansion/compression for recording/ replay, printer interfaces and a digital data port. Analysis by the Processor of bat sonar received in the field by the S-25 Bat Detector reveals that frequency slew rates of over 75 kHz/ms often occur. In these conditions, conventional Discrete Fourier Transform analysis will always produce indistinct frequency plots, however well-defined the original signal. Alternative methods of producing high-resolution, full-frequency sonar plots are compared.

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Fruit Bats and Endophytospory in the Guadaloupean Rainforest(lesser Antilles)

Didier Masson, Résidence Val-Notre-Dame, 126 bis. Boulevard du Maréchal Juin
F-78200 Mantes-la-Jolie, France

Abstract not received

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Bat Conservation in the Republic of Ireland

Kate McAney, The Office of Public Works, 16 Eyre Square, Galway, Ireland

Legislation protecting the seven bat species in Ireland was introduced in 1976. A national survey began in 1984 to assess the status and distribution of bats. This survey is conducted annually by the National Parks and Wildlife Service. In 1991 a full-time bat conservation officer was appointed by the Vincent Wildlife Trust, in partnership with The Office of Public Works. Results from the survey to date show that *Pipistrellus pipistrellus, Plecotus auritus* and *Nyctalus leislleri* are widespread and common, *Myotis daubentonii, M. mystacinus* and *M. nattereri* are widespread but occur in small numbers, and *Rhinolophus hipposideros* is locally distributed but common. Important lesser horseshoe sites are repaired and grilled. It is proposed to grant greater protection to important sites by declaring them "Refuges for Fauna" under the 1976 Wildlife Act. Educational material is produced to counteract the unfavorable public image of bats.

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The Influence of Climate on the Growth Rate of *Rhinolophus ferrumequinum* in West Wales

Thomas P. McOwat, 19 Parc Puw, Drefach Velindre, Llandysul, Dyfed, Wales, U.K.
Peter T. Andrews, Oliver Lodge Laboratory, University of Liverpool, P.O.Box 147, Liverpool L69 3BX U.K

The growth of the young in two colonies of *Rhinolophus ferrumequinum* was monitored for ten successive years from 1982 to 1991 and forearm measurements that were made on marked individuals at intervals varying from one to ten days have been analyzed by a method that obviates the need to know the exact birth dates. Growth curves have been calculated for every year and the distributions of birth dates in each year have been deduced from the forearm data by using these growth curves. Variations in the mean growth rate and mean birth date from year to year have been analyzed to detect any dependence on the monthly mean temperatures or rainfalls during the period from February to August. They were found to depend on the monthly mean temperatures between April and July but were independent of the rainfall.

Echolocation Calls of Nectar-Feeding Bats (*Phyllostomidae: Glossophaginae*)

Angelika Meschede, Klaus-Gerhard Heller and Otto v. Helversen
Department of Zoology II, University of Erlangen, Staudtstr. 5, D-91058 Erlangen, Germany

The echolocation behavior of nectar-feeding bats has been less intensely investigated than that of insectivorous bats. Therefore, we recorded the echolocation calls of 10 different species of glossophagine bats during free flight and during the approach towards a nectar source (all in a large flight cage). The species can be separated into two groups according to call type. Calls of the first group always included the lowest harmonic; this group contains *Glossophaga s. soricina, G. s. antillarum, G. commissarisii, Choeronycteris mexicana, Leptonycteris sanborni, Lichonycteris obscura* and *Hylonycteris underwoodi*. Species from a second group lack the lowest harmonic; this was the case for *Lonchophylla robusta, Monophyllus redmani* and *Anoura caudifer*. Both call types contain a varying number of harmonics, but the 1st and 2nd or 2nd and 3rd respectively are most prominent. When bats approach the nectar source, the calls decline in duration; however, a true final buzz cannot be observed. Instead, between two and five calls are packed into groups. During approach the highest frequency often exceeding 180 kHz does not change, but intensity decreases.

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The Old World Fruit Bat Action Plan

Simon Mickleburgh, Fauna and Flora Preservation Society, I. Kensington Gore, London SW7 1AR, U.K.
Tony Hutson, Bat Conservation Trust, I Kensington Gore, London SW7 2AR, U.K.
Paul Racey, Department of Zoology, University of Aberdeen,, Aberdeen Ab9 2TN, U.K.

Old World Fruit Bat: An Action Plan for their Conservation was published at the end of 1992. It is the culmination of six years work and has involved over 50 of the world's bat experts. It has already been circulated to over 300 government officials and nongovernmental organizations worldwide. The Plan summarizes the conservation status for all Old World Fruit Bats and suggests conservation projects for the species considered threatened. A number highest priorities projects are already implemented or are planned. Captive breeding of the highly endangered *Pteropus livingstonii* from the Comoros is underway while a similar program for *Pteropus voeltzkowi* from Pemba is about to begin. An expedition to the Maldive Islands to assess the status of threatened species is planned for late 1993. The Plan will be invaluable tool for the future promotion of fruit bat conservation. (Presented during the meeting of the IUCN/SSC Chiroptera Specialist Group)

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Field Recordings of Echolocation and Social Signals from the Gleaning Bat, *Myotis septentrionalis*

Lee A. Miller, Biologisk Iinstitut, Odense Universitet, DK-5230 Odense M, Denmark

We recorded echolocation and ultrasonic social signals of the bat, *Myotis septentrionalis*. The bats foraged for insects which were resting on or fluttering about an outdoor screen to which they were atracted by a "blacklight". The bats used nearly linearly modulated echolocation signals of high frequency (117 to 49 kHz). The orientational signals from patrolling bats were about 2.4 ms in duration and occurred at a repetition rate of about 18 Hz. The signals used by bats as they approached the screen were shorter (0.72 ms) and occurred at higher rates (33.8 Hz). We registered one feeding "buzz". We recorded social signals when two bats patrolled the hunting area. The social signals were characterized by their longer durations (6 ms), lower frequencies (70 to 30 kHz), and curvilinear sweeps. We calculated the source levels of orientational and social signals using the differences in arrival times at three microphones in a linear array. They were on average 102 dB peSPL at 10 cm. The signals used by bats as they approached the screen were much weaker.

Status and Conservation of Horseshoe Bats in Britain

A. J. Mitchell-Jones, English Nature, Northminster House, Peterborough PE1 1UA, U.K.

Both species of horseshoe bats found in Britain are rare and endangered and their distribution is confined to western Britain. The greater horseshoe bat *Rhinolophus ferrumequinum* is believed to have a total population of about 4,000 individuals spread between 12 breeding colonies, which range in size from about 600 to 80 breeding females. The species has been recorded from 315 sites since 1980, of which 217 contained more than a single bat. The lesser horseshoe bat *Rhinolophus hipposideros* is slightly more widespread and common with a total population of about 14,000. One hundred sixty two breeding roosts have been recorded since 1980 together with over 300 hibernation sites containing more than one individual. Many of the largest breeding and hibernation sites are now specially protected, though this process is not yet complete. However, legal protection does not always prevent sites from destruction or degradation and the sites need careful management. So far, little progress has been made in identifying and protecting critical feeding areas for the bats around the most important breeding sites, but this will be essential if the populations are to be maintained.

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Development of Vocalizations Produced by Prevolant and Volant Bats

Cynthia F. Moss and Colin Gounden, Department of Psychology & Program in Neuroscience
Harvard University, Cambridge, MA 02138, USA
Debby Redish, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA
Thomas H. Kunz, Department of Biology, Boston University, Boston, MA 02215, USA

This study reports on developmental changes in the vocal signals produced by prevolant and volant *Myotis lucifugus* living in the wild. Audio recordings were made from young animals ranging in age from 1 to 33 days and adults (over one year of age). The animals were removed from a maternity roost and tested individually. Vocalizations were recorded as the animals rested on a launching platform and after they were released from the platform via a hinged floor. When the hinged floor opened, the youngest animals (1-4 days) typically dropped onto a soft foam pad, whereas older animals either flapped their wings to achieve some horizontal displacement (> 4 days) or sustained horizontal flight (> 17 days). Vocalizations recorded under these conditions included communication sounds and those resembling adult echolocation sounds. Sounds resembling adult echolocation calls increased in frequency and decreased in duration during the first 25 days of age and subsequently became similar to those of adults. By contrast, communication sounds were similar in spectral composition and duration across all ages studied. Differences between the features of sounds recorded from bats resting on the platform and those recorded after release were prevalent in infants, juveniles, and subadults.

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Haemoglobin Polymorphism in some Indian Bats - Significance to Chemotaxonomical Studies

Manoj Muni, Bombay Natural History Society, Shaheed Bhagat Singh Road, Bombay-400 023, India

Abstract not received.

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Activity of Hibernating Bats in their Natural Habitat Recorded by Automatic Data Logging

Alfred Nagel, Zoologisches Institut der Johann-Wolfgang-Goethe Universitat, Siesmayerstrabe 70, D-6000, Frankfurt 1, Germany, and Rainer Nagel, Schwarenbergstrabe 127, D-7000 Stuttgart 1, Germany

Many European bats migrate to subterranean hibernacula during autumn and leave them during late winter. Meanwhile they hibernate continuously with only short interruptions of phases of activity in which the bats also may leave the hibernacula for a short time. The exact time span of hibernation, the occurrence of activity as well as potential relations to climatic factors are mainly unknown. That is why we investigated flight activity as well as climatic factors inside and outside a cave on the Swabian Alb (South Germany) during the winters 1991/92 and 1992/93, which is mainly used by the greater mouse-eared bat (*Myotis myotis*). The activity of flying bats was detected by passive infra-red movement recorders. Flight activity decreased during December and was minimal in January. From the middle of February flight activity increased till the end of April. At this time, most bats had already left the cave. In November and December, flight activity was strictly nocturnal. Later on it became more and more diurnal. Temperature inside the cave seems to have no influence on flight activity. But atmospheric pressure obviously has an influence. The lower the atmospheric pressure, the higher is flight activity. That leads to the conclusion that bats have the ability to perceive atmospheric pressure. Thus, hibernating bats might be able to receive information about the weather outside the hibernacula, because in wintertime, low atmospheric pressure often means warm weather.

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The Phylogeny of the *Myotis mystacinus* - Group: A Molecular Approach

A. Nemeth and O. von Helversen, Institute of Zoology II, University of Erlangen, Staudtstr. 5, D-91058 Erlangen, Germany

Mitochondrial (mt) DNA allows the assessment of systematic relationships between species, because of its unisexual mode of inheritance, high rate of evolution and high copy number. To elucidate the phylogeny of the *Myotis mystacinus* group, one region (510 bp) of the mt 12S rRNA was sequenced, which is suitable for studying the relationship of closely related taxa. DNA was amplified by PCR from *M. brandtii, M. mystacinus* (both from Germany), *M. "mystacinus" przewalskii* (from Greece and Turkey), *M.* spec.(from Greece), *M. muricola* (from Malaya), and *Nyctalus noctula* as an outgroup. According to morphological(Stubbe and Chotolchu 1968) and cytological data(Volleth 1987)*M. m. przewalskii* and *M.* spec. seem to be distinct from the species in Central Europe. This hypothesis was tested with the sequence data. Parsimony analysis was conducted with PAUP. There are at least three European species within the *M. mystacinus* group: *M. brandtii, M. mystacinus (mystacinus* and *przewalskii)* and *M.* spec.

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Detection of Temporal Gaps in Passband Noise in the Mexican Free-Tailed Bat, *Tadarida brasiliensis*

Volker Nitsche, Zoologisches Institut der Universitäbt, Luisenstrae 14, D-8000 München 2, Germany

Gap detection provides a psychoacoustic measure of time resolution, i.e. to which extent sequential acoustical events are perceived as distinct in time. Moreover, if the spectral content of the noise bands is varied at each side of the temporal gap, the width of the spectral auditory filters can be estimated. Three *Tadarida brasiliensis* were trained in a two alternative forced choice behavioral test to discriminate a sequence of two passband noises (bandwidth 2 kHz) with an intermediate temporal gap from another without a gap. For each threshold estimate the noise center frequencies were kept constant, while the gap durations were varied between 2 and 128 ms. The passband center frequencies and their overall loudness were randomized to

eliminate inadequate cues. The behavioral data show an increase of threshold gap duration corresponding to the frequency separation of the noise passbands from 10 ms, when there was no frequency separation to 50 ms, when the frequency separation was 14 kHz. Comparable results with a similar paradigm have been found in man.

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Flight Costs and Behavioral Ecology of Bats

U. M. Norberg, Dept. Zoology, University of Gothenburg, Medicinaregatan 18, S-41390, Gothenburg, Sweden

Flight costs in bats can best be understood and quantified when both theoretical and empirical approaches are used concurrently. The cost of hovering and forward flight in *Glossophaga soricina* were estimated to be 0.34 W (32.4 W kg^{-1}) in hovering and 0.14 W (12.3 W kg^{-1}) at minimum power speed[1]. Maximum range power varies with body mass as $P_{mr}oc\ M^{0.85}$. Multiple regression was further used to express P_{mr} as a functio nf body mass, wing spand and wing area[2]. As these latter characters are included in wing loading (weight/wing area) and aspect ratio (wing span squared/wing area), they highly influence flight power. The connection between flight morphology, behavior and ecology is discussed.

[1]Norberg, U.M., Kunz, T.H., Steffensen, J.F., Winter, Y., v. Helversen, O. (1993). *J. Exp. Biol.* (in press). [2]Winter, Y., v. Helversen, O., Norberg, U.M., Kunz, T.H., Steffensen, J.F. (1993). *Plant-Animal Interactions in Tropical Environments*, Bonn (in press).

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Geographic Variation of the Greater Horseshoe Bat *Rhinolophus ferrumequinum* in the Wester Paleartic

O. de Paz, Dept. Biología Animal. Universidad de Alcalá de Hanares, SP-2887 Alcalá de Henares, Madrid, Spain

This study describes geographic variation in the morphology of *Rhinolophus ferrumequinum*. The parameters examined were external dimensions (12 characters), skull size (18 characters) and dental dimensions (20 characters). A total of 552 specimens were measured and divided into 42 geographic groups distributed throughout the Europe, North of Africa and West of Asia. Multivariate analysis of the external, cranial and dentral measurements demonstrated that *Rhinolophus ferrumequinum* increases in size from west to east. The clinal variation seems to be an example of Wright's (1943) isolation-by-distance model. The wing complex size (PC2Ext) exhibited a strong trend toward larger size at a lower latitude. There is also a significant positive correlation between skull size (PC2Cra) of *R. ferrumequinum* and number of presumably competing species of *Rhinolophus* at a given locality.

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Epidemiology of Rabies in *Eptesicus serotinus*: A Preliminary Assessment

J. L. Pérez and C. Ibañez, Estación Biológica de Doñana (CSIC), Apartado 1056, SP-41080 Sevilla, Spain
M. Muðz, Laboratorio de Salud Pública, Gerencia Provincial del S.A.S., Avda. Muelle Manuel Heredia 34 29001 Malaga, Spain

In 1989, one individual infected with rabies virus was detected in a *Eptesicus serotinus* colony at Huelva (SW Spain). So we started monitoring of blood samples from several serotine colonies in the area to determine the prevalence of virus and serum antibody levels. Presence of rabies virus neutralizing antibodies was assessed by rapid fluorescent focus inhibition tests using *in vitro* challenge viruses strain EBL-1. Additionally, some bat brains from dead individuals or injured during handling were analyzed by immunofluorescence. Preliminary results indicate that: (1) Rabies virus did not occur continuously in the colonies

studied; or at least it was not in a virulent way. (2) Epidemic outbreaks may occur at local levels, affecting a large number of bats as revealed by the high prevalence and antibody levels, followed by periods with lower levels (3) Mortaility is low. Most of the individuals affected recover from this disease. (4) Epidemic outbreaks may spread very quickly in the colony.

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First Results of a Supra-National Monitoring Program of Five Threatened Bat Species in Western Europe

Jacques B. Pir, Association pour la Protection Tranfrontalière des Chauves-Souris
c/o Musée National d'Histoire Naturelle, Marché-aux-Poissons, 2345 Luxembourg, Luxembourg

The idea of our supranational bat protection organization was born in 1986 of the necessity of the exchange of information about the biology of bats and the inter-regional or trans-frontier protection of bats in Western Europe. Members of five countries are represented: The Netherlands (province Limburg); Belgium (region Wallonie); Federal Republic of Germany (Länder Nordrhein-Westfalen, Rheinland-Pfalz, Saarland); France (regions Lorraine, Champagne-Ardennes) and the Grand-Duchy of Luxembourg. Since 1990 a monitoring program has been installed to obtain further information about the reproduction and population development of the following bat species: *Rhinolophus hipposideros*, *Rhinolophus ferrumequinum*, *Myotis myotis*, *M. dasycneme* and *M. emarginatus*. Standardized data from both winter quarters and summer roosts were collected within the geographic frontier area of our association. The first results obtained show the actual reproduction rates and the approximate population size of both *Rhinolophidae* and *Myotis myotis*, but the lack of information about *M. dasycneme* and *M. emarginatus* makes the situation of these species uncertain at present. This monitoring program is serving as the basis for our organization to have better and more coordinated bat protection in our countries.

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Foraging Areas of the Noctule Bats in the Bialowieza Primeval Forest: Preliminary Results

Alek Rachwald, Mammal Research Institute, Polish Academy of Sciences, PL-17 230 Bialowieza, Poland

The study was conducted in the Bialowieza Primeval Forest (eastern Poland) in 1991 and 1992. Bats were surveyed by the QMC S200 Bat Detector, radiotelemetry (3 specimens in 1992) and visual observations. The registration of ultrasounds showed that foraging grounds of noctule bats were located in the open areas inside the Bialowieza Forest (in river valleys, clearings, and villages). In a deep forest, notcule bats foraged sporadically. The observed bats came to their foraging areas in the Bialowieza Glade from the surrounding forest. During the daytime, bats stayed in a tree hole. The roosting and the foraging areas were 0.5 - 3.0 km apart. Bimodal individual activity rhythms were observed with an after-dawn period (on average 29 min) and a post-dusk period (average 87 min). The area penetrated by noctule bats after dawn was smaller than that utilized during their post-dusk activity.

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Bats' Attachment to Different Shelters in Eastern Transcaucasia

Irina K. Rakhmatulina, Institute Zool., AS Azerbaijan Resp., Proezd 1128, Kvartal 504, 370602 Baku, Azerbaijan

Twenty seven bat species were recorded in four basic types of shelters in the region of the Eastern Transcaucasia. Different buildings (houses)are most popular. Twenty five species and 70% of the observed bats were discovered in these roosts, 15 species and 15% of the observed bats were in underground spaces, 14 species and nearly 10% were in chinks of

rocks, and 10 species and 7% were in tree cavities. In these regions a narrow specialization of bats to shelters is weakly manifested. *Pipistrellus kuhli* and *Eptesicus serotinus* are sinantrope species; *Rhinolophus blasii, R. mehelyi, R. euryale, Miniopterus schreibersi, Barbastella leucomelas* are cave-dwelling species; *Tadarida teniotis* inhabit chinks in rocks; and *Nyctalus leisleri* inhabit tree cavities. *R. hipposideros, Myotis nattereri, M. mystacinus, Plecotus auritus, Pipistrellus pipistrellus* inhabit all types of shelters. Maximum number of bats were characteristically found in caves (about 15,000 animals in Azykh Cave) and in buildings (ca. 10,000). About 200 individuals were found under the bark of trees and approximately 300 were found in the chinks of rocks.

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Zoogeography of Bats in Eastern Transcaucasia

Irina K. Rakhmatulina, Institute Zool., AS Azerbaijan Resp., Proezd 1128, Kvartal 504, 370602 Baku, Azerbaijan

Since the nineteenth century 27 species of bats have been recorded in Eastern Transcaucasia. The following species, in order of relative abundance, occur in this region; *Pipistrellus pipistrellus, Pipistrellus kuhli, Eptesicus serotinus, Rhinolophus ferrumequinum, Myotis mystacinus, Rhinolophus hipposideros, Myotis blythi, M. emarginatus, Nyctalus noctula, Plecotus auritus, Barbastella barbastellus* . The first three species listed are abundant and the next four species are common. These seven species account for approximately 80 % of all bats present. The Chiropteran fauna of the Eastern Transcaucasia is heterogenous and belongs to four faunal complexes. The majority of species (41%)comprise Eupalearctical mesofile and 37% favor the warm dry Frontasia (Mediterranean) habitats. The "European forest" habitats contain nearly 15%, and 7% occur in the desert and semidesert Turanoeremical region. We divide the Eastern Transcaucasia according to the characteristics (peculiarity) of its bat fauna, into the Caucasus district with regions of the Greater Caucasus, Lesser Caucasus and the Gircan, and Frontasian district including the Kura plain and Transcaucasian upland.

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Dynamics of the Number of Bats Hibernating in the Moravian Karst from 1983 to 1992

Zdenek Rehák and Kirí Gaisler, Faculty of Science, Masaryk University, Brno, Czech Republic
Jan Zukal, Institute of Landscape Ecology, CAS, Brno, Czech Republic
Miroslav Kovarík, Nature Conservancy Moravian Karst, Blansko, Czech Republic
Jan Zima, Institute of Animal Physiology and Genetics, CAS, Brno, Czech Republic

Visual censuses of hibernating bats were organized annually in 37 underground spaces, largely natural caves, in the Moravian Karst from 1983 to 1992. The total number of hibernating bats increased significantly during the ten year period of the census. The most striking increase in numbers was observed in the greater mouse-eared bat, *Myotis myotis*. A slight upward trend was also recorded in the lesser horseshoe bat, *Rhinolophus hipposideros*. Trends in dynamics of the number of other bat species (*Barbastella barbastellus, Plecotus*spp., small *Myotis* spp.) were ambiguous. Possible explanations for the observed changes in the abundance of wintering bats were discussed.

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G -, C -, and NOR Banding of *Hypsugo savii* and *Miniopterus schreibersii* from Spain

J. M. Reina and G. Pérez-Suarez, Dept. Biol. Animal, J. Navlet, Dept. Ciencias Morfológicas y Cirugia, O. de Paz, Dept. Biología Animal, (all from)Universidad de Alcalá de Henares, SP-28871 Madrid, Spain

Karyological studies of *Hypsugo savii* and *Miniopterus shreibersii* from Spain were made based on G-, C- and NOR pattern analysis. The karyotypes found in these two bat species correspond basically to those reported in other parts of their ranges in Europe. It was revealed that *H. savii* have 2n = 44 and FN = 50. The C-banding showed that the constitutive

heterochromatii was restricted to the centromeric region. The NOR activity was located on the secondary constriction of pair 15. *M. schreibersii* have 2n = 46 and FN = 52, the G- and C-banding confirm not only that a dot-like pair was biarmed but also several secondary constriction on the autosomes. The NOR banding showed high activity on two medium acrocentric pairs and in a small acrocentric pair.

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Do Polluted Water Sediments Affect the Population of the Pond Bat *Myotis dasycneme* ?

J. O. Reinhold, J.A. van der Velden and M. Ohm
Institute for Inland Water management and Waste Water Treatment, Van Leeuwenhoekweg 20
NL-3316 AV Dordrecht, The Netherlands

The Biesbosch (The Netherlands) is a large area (50 km^2) with polluted water sediments. In this area Chironomidae are the main group of benthic macro-invertebrates. Pollutions of the sediment can be transported by the Chironomidae-larvae to the Chironomidae-images. Chironomidae-images are probably eaten in large quantities by the pond bat. Do the transported sediment pollutants affect the pond bat population? To answer the main question, a pilot-study on the pond bat has started this year in the Biesbosch. Subquestions are: 1) Is the Biesbosch a good area to study the pond bat and to study the expected effects on this bat? In other words: Are there any pond bats using this area, can roosts be found and is the main part of the population hunting above polluted waters? 2) What is the concentration of several pollutants in: the water sediment, the Chironomidae-larvae and the Chironomidae-images. 3) Can be predicted, based on literature, what the concentrations of pollutants in bats will be? 4) How can the effects of the pollutants on the bats be measured? Results: Some of the subquestions can (partly) be answered after four months of research; other questions still have to be answered.

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New Records of Bats in the Baikal Region

Antonín Reiter, Petr Benda, Dept. of Zoology, Charles University, CS-128 Praha, Czech Republic

This paper surveys some results of bat investigations undertaken in the area of Svjatoj Nos peninsula and isthmus (southwest part of the Zabajkalskij National Park, NE-Baikal region of the Buryatia), i.e., the region whose fauna has until now been only poorly known. A total of five species of bats were found (mostly by mist netting) in five localities and at five different habitats as follows: (1) open grounds between wetlands and sand dunes, *Eptesicus nilssoni* and *Myotis daubentoni*; (2) wooded buildings in extensive pasture meadows, *Plecotus auritus* and *M. daubentoni*, (3) a spring march at the border between a light taiga forest and wetland, *E. nilssoni, M. daubentoni, M. brandti* and *M. ikonnikovi*, (4) Burtuj creek in the closed light taiga *E. nilssoni, M. daubentoni, M. brandti* and *M. konnikovi*), (5) a destroyed wooden building in a small island in Arangatuj Lake, a breeding colony about 50 specimens of *M. daubentoni*. *Eptesicus nilssoni, M. brandti* and *M. ikonnikovi* were found in the region for the first time. In contrast to previous data from the Baikal region, all species except for *P. auritus* were relatively abundant by mist netting efforts. Nevertheless, we did not find *Vespertilio murinus* and *Myotis mystacinus*, i.e., the species reported from there as common by previous authors (e.g. Krivoseev 1984, Svecov *et al.* 1984).

New Records of *Pipistrellus nathusii* in the Iberian Peninsula

Rolando Rodríguez-Muñoz, Félix González-Alvarez, Fco. Javier Pérez-Barbería
Grupo Asturiano para el Estudio y Conservación de los Murciélagos,
Apdo. 380, SP-33080, Oviedo, Principado de Asturias, Spain
Juan Tomás Alcalde Díaz de Cerio, Dept. Zool., Univ. de Navarra, SP-31080 Pamplona, Navarra, Spain

Seventy two years after the last mention of *Pipistrellus nathusii* in the Iberian Peninsula, the records described in this paper only confirm its current presence in the Basque-Cantabric area (north of Spain). One of them also suggests the existence of resident populations. A compilation of all Iberian records is included. The small number of available references supports the recommendation that *Nathusius pipistrelle* will be catalogued as insufficiently known species (K) in Spain.

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60 Years of Bat-Banding in Europe - Results and Tasks for the Future

Hubert Roer, Zoologisches Forschungsinstitut und Museum A. Koenig
Adenaueralle 150-164, D-5300 Bonn 1, Germany

At the beginning of the thirties, mammalogists in Europe and North America started to take more interest at bats. In Europe, it was Martin Eisentraut who as early as 1932 used forearm-banding on Mouse-eared bats *Myotis myotis*. This banding method was soon imitated in neighboring countries, resulting in the foundation of banding centers in Several European countries. Rediscovery of banded bats shows that some species, primarily indigenous of Eastern Europe are seasonally migrating between their winter and summer ranges which reach far beyond one climate zone (*N. noctula, P. nathusii, V. murinus, N. leisler* (?)) Other species are considered typical cave hibernators leaving the caveless plains in fall to take refuge in the mountains with their natural caves and mines to protect them from frost temperatures (*M. dasycneme, M. myotis, B. barbastellus).* Other species generally cover only a distance of less than 50 km between their summer and winter habitats or quarters. The central European Chiroptera can therefore be divided in migratory bats, bats capable of migration and resident bats. The recoveries made so far are evaluated by some migratory species. Furthermore, an overview of life-expectancy and age structure is made and unresolved questions are enumerated.

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Distribution of Bats in Romagna Region of Italy

Dino Scaravelli, Istituto per la Conservazione e lo Studio dei Materiali
Naturalistici della Romagna, Cummune die Cesena, Piazza P. Zangheri 6, I-47023 Cesena, Italy

The presence of Chiroptera in the fauna of the Romagna region was investigated by bibliographical data, museum specimens control, and direct research in the field. Sixteen bat species are present in this area located between northern continental and central Mediterranean Italy: *Rhinolophus ferrumequinum, R. hipposideros, R. euryale, Miniopterus schreibersi, Myotis emarginatus, M. bechsteini, M. myotis, M. blythi, Pipistrellus pipistrellus, P. nathusii, P. khuli, Hypsugo savii, Nyctalus noctula, N. lasiopterus, Eptesicus serotinus, Plecotus austriacus*. The field survey concentrated on the cave-dwelling species and until now there has been scarce information on species dwelling in trees and buildings: species that often are known only as old museum specimens *M. bechsteini, P. nathusii, P. pipistrellus, N. lasiopterus*. The cave communities often have a low diversity (maximum of seven species) with a mean Sorensen index among the ten main cavities of 0.66. Only karsic systems of discrete complexity, with more microhabitat, have a wider range of species. UTM 10 x10 Km maps of Chiroptera distribution are shown.

Canton of Aargau, Switzerland: Bat Protection as Public Assignment

Bruno Schelbert, Department for Nature Protection, Ministery of the Canton of Aargau, Switzerland

In Switzerland all bats are explicitly protected, the individual cantons being responsible for implementation. In the Canton of Aargau, the Department for nature protection of the Ministery of Civil Engineering is in charge of accomplishing this task. Federal law and cantonal rules forbid to catch, hurt, or kill bats and to damage or destroy their nursery roosts. Likewise it is not allowed to use poisonous substances that expose these animals to danger. Moreover, the communities are instructed to preserve the habitat of rare and endangered species. An inventory of the bat roosts (especially in buildings) has been made in the Canton of Aargau from 1988 to 1992. This inventory forms the basis for active protective measures such as: consulting communities, planning officials and private persons, formulating specifications and conditions in planning and approval procedures, subsidizing protective measures, laying down protective rules, and realizing particular protective projects. Examples of protective measures: Renovation of buildings: When renovating the church of *Muhlau*, special regard was paid to the *Myotis myotis* nursery roost. This involved additional expenses which were subsidized by the Canton and Confederation. The *Klingnau* schoolhouse accommodated a bat roost and when renovating the schoolhouse, the architect was given advice concerning saving the bats which assured the survival of the *Nyctalus noctula* colony. Protecting roosts for hibernation: A cave of the *Geissberg* had almost been destroyed by a building project. By merely imposing some changes in the building specifications it has been possible to prevent this hibernation roost from being filled in and it is now protected from disturbances. Old, closed up military tunnels on the *Frickerberg* have been reopened for bats. Checking/monitoring: Regular supervision of all known nursery roost colonies (counting of the flights) permits roost changes to be detected early and to provide for possible protective measures. Particular projects: For road construction projects, compensating measures are provided by law. When constructing a new road in *Döttingen* provision has been made for artificial roosts for hibernation as a compensating measure.

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A Plausible Hypothesis for the Evolution of Fish-Catching Behavior in Noctilionid Bats

H.-U. Schnitzler, E. V. Kalko, I. Kaipf, A. Grinnell

Animal Physiology, Univversiität of Tübigen, Auf der Morgenstelle 28, D-72076 Tübingen, Germany

The Fisherman bat, *Noctilio leporinus*, which preferably hunt for fish, and its smaller relative, *Noctilio albiventris*, which live mainly on insects, produce signals with rather long CF-components. We wanted to know why these signals are suited to hunt for fish, and how this special hunting technique may have evolved. Therefore, we studied the echolocation and hunting behavior of the two species at the Tortuguero river in Costa Rica. *N. leporinus* hunt for fish with different hunting strategies. The bats make pointed dips at spots where they have localized jumping fish. The fish reveal their presence by a typical glint pattern in the echoes returning from the fish body and from the water disturbances as a fish leaves and enters the water. They also randomly hunt for fish by raking with their claws through areas where they echolocated many jumping fish (directed rake) or if no jumping fish are present and therefore no echo cues available, where they have hunted successfully before (undirected random rake). In the same area, *N. albiventris* hunt over the river and pursue fluttering insects. Insects reveal their presence by the typical glint pattern of beating wings. They are often caught in the air. But sometimes an insect escapes by evasive movements which normally end in the water. In this case the bats turn around and scoop the still fluttering and glint-producing insect from the water surface. The hunting behavior of *N. albiventris* suggests how hunting for fish may have evolved. Like other CF-bats, noctilionid bats can detect fluttering insects by the glint pattern in the echoes. As jumping fish also produce temporary glint patterns, it can be assumed that insect hunting ancestors of noctilionid bats sometimes accidentally localized and caught a jumping fish instead of a floating, still fluttering insect. As fish is richer prey than insects, it is likely that this behavior was favored by evolution, thus leading to a new species, the Fisherman bat, *Noctilio leporinus*.

A Study of the Reproductive Success of Maternity Colonies of *Rhinolophus hipposideros*, the Lesser Horseshoe bat, in two Contrasting Roosts

Henry W. Schofield, Department of Zoology, University of Aberdeen, Aberdeen, Scotland, U.K.

Rhinolophus hipposideros, the lesser horseshoe bat, is one of the most endangered European bats. Efforts to conserve this species in the United Kingdom have centered on the protection of its summer roosts, which are typically found in nineteenth century buildings. However, the condition and structure of these sites can vary considerably, little is known of the reproductive phenology and productivity of colonies using different roosts. In this study, I tested the hypothesis that the condition and structure of summer roosting sites affects the reproductive success of a colony. The growth rates of young, time of earliest births, temporal spread of births, productivity and sex ratios were investigated in two contrasting maternity roosts within the same geographic area of Mid-Wales over two consecutive summers. The temperature within roosts and within clusters of adults were measured hourly using Grant Squirrel data-loggers, additional information on climatic conditions was gathered from a local weather station. General observations were made in respect of the clustering behavior of adults prior to, and following parturition. During the 1992 season, births were earlier than in the previous year. This may be related to climatic factors, particularly the mean monthly temperatures during March and April. However, over the two seasons studied no significant differences were found in the growth rates between the two roosts. Although no consistent differences were found in the sex ratios between the two sites, significant variations were established in their relative productivity.

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Sensory Preference in the Noctule Bat, *Nyctalus noctula*

Ralf Seine and Uwe Schmidt, Zoologisches Institut der Universität, D-53115 Bonn, Germany

Due to the enormous importance of echolocation for microchiroptera, the relevance of the other orientation systems was often underestimated. A number of recent investigations show that some species rely especially on visual and passive acoustic signals for specific orientation problems. We tried to evaluate the relative importance of echolocation, passive listening and vision by determining the particular detection thresholds and comparing the sensory preferences for individual close-to-threshold stimuli. Four Noctules were trained to walk into the arm of a Y-maze marked with the particular stimulus. These were: 1) sheet metal strips, 2) white noise 2.5 kHz - 50 kHz, 3) frosted glass pane 5 x 5 cm lit from behind. Our attempt to condition the bats to echolocate while walking failed, thus only the visual and the passive acoustic threshold could be determined (hearing thresholds: 15-25 db SPL, visual thresholds: $6 * 10^{-3} - 6 * 10^{-4}$ cd/m2). Direct confrontation of individual close-to-threshold visual and passive acoustic stimuli revealed an inconsistent behavior. Two of the four test animals chose about 50:50 in the test runs, one preferred the side marked with the visual, another the side marked with the passive acoustic signal.

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Paleoenvironmental Interpretation of the Upper Pleistocene Site of La Carihuela (Prov. of Grenade, Southern Spain) Based on Bat Sequence

Paloma Sevilla, Facultad de Ciencias Geológicas, Universidad Complutense, SP-28040 Madrid, Spain

Fossil micromammals are a very important source of information for the reconstruction of the paleoenvironment. Chiroptera are relatively common in Quaternary localities, especially in cave deposits. They are also used to carry out paleoclimatic interpretations, using parameters such as diversity or the presence of certain species as indicators of cold or warm climate. However, the meaning of diversity or of the presence of "indicator" species varies depending on the latitude of the locality. In this paper we present the paleoenvironmental interpretation obtained from the sequence of fossil bats from the upper Pleistocene section of the cave of La Carihuela, and compare it with the interpretations based on sedimentological evidence, pollen sequence as well as with the other micromammals.

Analysis of Spermatogenesis in *Scotophilus heathii*

P. Singh and S. B. Lall, Department of Zoology, M.L. Sukhadia University, Udaipur - 313001, India
S. Trivedi, J. N. Vyas University, Jodhpur, India and A. Madhwan, Matasundri College, Kottyam, India

Spermatogenesis in bats presents many unique features that relate to number and frequency of cell associations and steps in the transformation of round spermatids into sperms. *Scotophilus heathii* a maritime species of bat was chosen as a model to delineate the histoarchitectural characteristics of the testes. The number of cell associations was determined to be I-XII. Each presented a characteristic association of spermatogonial cell type (dark or pale), primary spermatocytes displaying meiotic prophase stages, secondary spermatocytes and spermatids in various phases of differentiation. The frequency of these cell associations also manifested variation. Unlike other placentals, the seminiferous tubules did not manifest more than one type of cell associations. These details will be presented.

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The Status and Distribution of Bats in Finland

Torsten Stjernberg, Zool. Museum, Univ. of Helsinki, P. Rautatiekatu 13, SF-00100 Helsinki, Finland
Olli Haukkovaara, Tyryntie 23, SF-37620 Valkeakoski, Finland
Juhani Lokki, Dept. of Genetics, Univ. of Helsinki, P. Rautatiekatu 13, SF-00100 Helsinki, Finland

Provisional maps of all nine bat species recorded in Finland are presented in 10 x 10 km squares (Finnish uniform grid system, Grid 27^{o} E). The data is based on museum specimens and sound recordings. Five species are more or less common (*Eptesicus nilssoni, Myotis daubentoni, M. brandtii, M. mystacinus, Plecotus auritus*), one is rare but apparently occurs in small local populations (*Myotis nattereri*) and three species have accidentally been recorded (*Vespertilio murinus, Pipistrellus nathusii, Nyctalus noctula*).

* * * * *

Variation in Echolocation Search Calls of Bats from Southwestern Norway

Tor André Stormark, Institute of Zoology, Univ. of Bergen, Muséplass 3, N-5007 Bergen, Norway

Variation in the echolocation search calls of bats flying in natural environments was studied on five species in southwestern Norway: *Myotis mystacinus, M. daubentonii, Eptesicus nilssonii, Pipistrellus pipistrellus* and *Plecotus auritus*. The following acoustic components were recorded: peak frequency, frequency bandwidth of total sonar pulse and at peak frequency, harmonics at peak frequency, composition of frequency-modulated (FM) and constant frequencies (CF) parts, length of the sonarpulse and pulse repetition rate. Environmental factors as tolerance to potential obstacles in flightpath (clutter tolerance), clutter diversity and relative flight-height was registered for correlation. The data collection included using a bat detector with a digital time-expansion recording utilitized for subsequent sound analysis. Greatest range of variation was found in *Pipistrellus pipistrellus*, a species using sonar pulses with several FM and CF combinations and with varying peak and terminal frequencies. The least variation was found in *Myotis* spp.; these species use a monotonous FM sonarpulse with fairly constant peak frequencies.

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A Tentative Assessment of Bat Diversity in Norway

Per Ole Syvertsen, Division of Zoology, University of Oslo, PO Box 1050 Blindern, N-0316 Oslo, Norway
Mette Nordseth, Rødstuveien 17, N-0572 Oslo, Norway
Trude Starholm, Døleveien 1B, N-1472 Fjellhamar, Norway
Tor A. Stormark, Department of Zoology, University of Bergen, Muséplass 3, , N-5007 Bergen, Norway
Asbjørn Lie, Kjerrheia 9, N-4621 Kristiansand, Norway

Norway, situated at the far northern corner of Europe, has a relatively poor bat fauna. This is most likely due to low summer and winter mean temperatures. Nine species have been reliably reported in the literature; at least two more species may occur. A review of the national iterature and unpublished results from recent fieldwork in various parts of the country reveals that species richness is highest in southeast Norway and along the southwest coast north to around 60° N. The number of species decreases inland and with increaseing altitude; north of ca. 65° N only one species has been reliably reported. Norway have the world's northernmost bats, with *Eptesicus nilssonii* breeding at least north to around 69° and occurring north to 70° 25'. When interpreting the results presented here, it should be kept in mind that bats are litle studied in Norway, and considerable gaps in knowledge characterize all parts of the country. Recent years have seen a growing interest in bats among professional and amateur zoologists alike, and surveys and mapping work are now being organized by the Norwegian Zoological Society.

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The Behavior of *Carollia perspicillata* and *Carollia castanea* Foraging for *Piper* in a Flight Cage

W. Thies, E.K.V. Kalko, and H. U. Schnitzler, Dept. Animal Physiology,
University of Tübingen, Auf der Morgenstelle, D-72076, Tübingen, Germany

During a stay at the Smithsonian Tropical Research Institute on Barro Colorado Island in Panama, we studied the behavior of the two bat species (Phyllostomidae) and their use of echolocation while searching for ripe fruits of *Piper* (Piperaceae). Immediately after their capture, the bats were transferred to a flight cage (4.35 m x 4.46 m x 2.06 m) where branches with ripe and several unripe fruits were offered. Both species foraged in a similar fashion: after circling around the branch they hovered several times near the ripe fruit, finally snatched it by the tip and carried it away. During this procedure, the bats continuously emitted faint frequency modulated echolocation signals with the main energy in the second and third harmonic. Experiments with real and imitated fruits where odor and/or form were manipulated show that *Carollia* uses odor for the detection, identification and rough localization of ripe fruits. Echolocation is needed for the determination of the bat's position relative to the *Piper* plant and for the fine localization of the tip of the fruit where the bat will grab it on its final approach. The foraging behavior of the two bat species differs only in time spent searching for fruits and in preference for different *Piper* species.

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Continuous Radio-Telemetry of Body Temperatures of Hibernating *Myotis lucifugus* : Initiation, Timing and Duration of Arousals

Don Thomas, Département de Biologie, Université de Sherbrooke, Sherbrooke, Québec Canada J1K 2R1

Arousals account for over 75% of winter fat depletion in hibernating bats, so understanding their underlying causes and organization is central to any analysis of winter energy balance. To examine the organization of arousals, I placed temperature- sensitive radio tags on 18 hibernating *Myotis lucifugus* and followed surface temperatures (T_S) over a 30-43 day period. Bats aroused during all times of day, with 48% of arousals occurring in the 0 h 0 - 12 h 00 period and 52% occurring between 12 h 00 and 24 h 00. The first post-

handling torpor bout (5.1 days) was shorter than subsequent bouts (ca. 13 days). In all cases where torpor bouts lasted less than seven days, arousal was preceded by a steady drift in Ts from ambient temperature (T_a = 4.5°C) to approximately 2.5°C above T_a. Rewarming took a mean of 1.6 h and bats remained active for about 1.8 h. Reentry into torpor required 1.4 h and was preceded by 0-8 test drops in T_s. was reset at T_a. Subsequently, T_s either drifted upward, resulting in a short torpor bout, or remained stable at T_a resulting in an extended torpor bout. These results confirm the absence of a "biological alarm clock" in *M. lucifugus* and raise questions about the control of metabolism and heat production in torpor.

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Two Types of Bat Postnatal Growth

M.P. Tiunov, Institute of Biology and Pedology
Far East Branch Russian Academy of Sciences, Vladivostok 690022, Russia

The investigation of postnatal growth of three bat species, *Myotis daubentoni, Vespertilio superans* and *Hypsugo savii* under natural conditions as well the comparison of literary data about other species made it possible to reveal the existence of two types of bat growth curves. The phase of forearm length and body mass linear gorwth of bats with growth type 1 (*H. savii*) remains constant up to beginning of flutter, when the forearm length is about 85% of adult size and body mass averages 65% of adult mass. For bats with growth type two(*M. daubentoni, V. superans*) the growth rate remains constant over a longer period. By the end of the linear growth phase, the forearm length of these bats achieves nearly adult size, and body mass is about 75% of adult mass. During the postnatal growth period body mass and forearm length have a rectilinear connection.

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Histopathology of Contralateral Ovaries of *Rhinopoma kinneari* During Early and Late Pregnant Phases

Seema Trivedi, Department of Zoology, J. N. Vyas, Univ. Jodhpur, India
S. B. Lall and Preeti Singh, Department of Zoology, Sukhadia Univ. Udaipur, India

Rhinopoma kinneari is a seasonally breeding microchiroptera exhibiting functional equivalence of the female genitalia. A single follicle reaches maturity once in a year. Ovulation occurs from either of the ovaries leading to ipsilateral pregnancy. Contralateral differences in the ovaries of late pregnancy have been deliniated in the present study. A comparison of changing ovary histopathology of aforesaid reproductive phase has been done. Follicular diameter; size of ova and number of associated granulosa cells of various follicles have been computed. Degenerative alterations in atretic follicles have been deliniated. The fate of extroverted corpus luteum has been microphotographed and will be discussed.

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Community of Bats Hibernating in Caves in Two Slovakian Karst Areas

M. Uhrin, Magnezitárov c/2, 050 01 Revúca, Slovakia

Abstract not received.

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Survival and Longevity of the Barbastelle *Barbastella barbastellus*

Zbkgniew Urbanczyk, Laboratory for Nature Protection, Lubuski Nature Society
PO-66 200 Swiebodzin, ul. 30 stycznia 23, Poland

Survival and longevity in a hibernating population of *Barbastella barbastellus* were studied for 14 years in Nietoperek Bat Reserve (W. Poland) with mark-recapture techniques. Two males were recaptured 10 years after being banded. Survival rates were calculated with Cormac's and regression method. Average annual survival rates were 0.572 for males and 0.520 for females. Mean remaining life expectancy was 1.79 for males and 1.53 for females. Survival depends significantly on body mass (fat reserves). Bats with maximum weight had a 50% survival rate whereas those with minimum weight had a survival rate of only 24%.

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The Importance of Linear Landscape Elements for Bats

B. Verboom and H. Huitema, Institute for Forestry and Nature Research
Agricultural University Wageningen, PO Box 9201, NL-6800 HB Arnhem, The Netherlands

Field observations indicate that most bat species in The Netherlands prefer to fly along linear landscape elements like hedgerows, tree lanes, and wood edges. Although linear elements still are the predominant landscape structures in many agricultural areas in the Netherlands, they are highly threatened by rural development. Recently, the governments' nature policy is strongly directed toward the ecological infrastructure for plants and animals. The Ministry of Agriculture, Nature Management and Fisheries supplied funds for a study on the importance of linear landscape elements for bats. In 1992, the project started with an analysis of the relation between two species of bats, *Pipistrellus pipistrellus* and *Eptesicus serotinus*, and the landscape structure. The results indicate that in 1 x 1 and 3 x 3 km blocks, there was a positive relationship between the presence of Serotine bats and the density of linear landscape elements, while the Pipistrelle showed no such relationship. However, the Pipistrelle was observed only within short distances of landscape elements, while Serotine bats more frequently crossed open areas. Serotine presence in open areas was, however, negatively affected by the distance to a landscape element and by (moderate and strong) winds. In 1993 we focused on the functional relationships between bats and linear landscape structures, assuming that linear elements may be used (1) for orientation (2) for foraging or (3) provide shelter from wind and predators.

Seasonal Movements of *Pipistrellus kuhlii* : 18 years of Observations on a Single Colony in Padova in N.E. Italy

Edoardo Vernier, Dipartimento di Biologia, Università di Padova (coll. est.),
Private Office: via delle Palme 20/1, 1-35137 Padova, Italy

Pipistrellus kuhlii usually changes roosts in different seasons. Observations were made regularly in a transition roost inside an important abbey in Padova (N.E. Italy) where a great colony of 250-400 individuals of the Kuhl's Pipistrelle occupy an ambulatory for about two weeks every year, from 28 August to 10-15 September. The possibility to study a single great monospecific colony of bats inside a building made it possible to make important observations on the ecology and behavior of this species. A high mortality of bats was observed, but no disease occurred in the colony. The regular changes of roost temerpature, breeding in the colony, roosting behavior, flight patterns, preferential roosting temperatures, and prey were all recorded. Many of the bats were banded and released in another part of the town, and some were recaptured. Recent regular observations of *Pipistrellus kuhlii* in Padova in winter has revealed that this species remains in the town and is active during winter.

Presence and Distribution of Bats in Padova, N.E. Italy

Edoardo Vernier, Dipartimento di Biologia, Università di Padova (coll. est.),
Private Office: via delle Palme 20/1, 1-35137 Padova, Italy

Padova is a ancient town on the Venetian plain. Despite its homogeneous landscape, the area of the ancient town presents many interesting microhabitats and twenty years of studies on bats has revealed a high diversity of species. Particularly, many historical gardens in the town contain some very old trees with great hollow cavities, and the river Bacchiglione and some artifical channels provide other interesting habitats for bats. Actually recorded were ten species, mostly with colonies: *Rhinolophus ferrumequinum, Myotis myosti/blythii, M. bechsteinii, Eptesicus serotinus, Pipistrellus kuhlii, P. nathusii, P. savii, P. pipistrellus, Nyctalus noctula,* and *Plecotus auritus/austriacus.*

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The Energetics of Hovering Flight in Nectar-Feeding Bats

C. Voight, Y. Winter, and O. von Helversen
Institute of Zoology II, University of Erlangen, Staudtstr. 5, D-91058 Erlangen, Germany

Nectar-feeding glossophaginae bats normally hover while feeding from flowers. As aerodynamic theory predicts that hovering is the most expensive mode of flight for a bat, it should make up a substantial part of a glossophagine's foraging cost. Due to their natural feeding behavior these bats are well suited for investigating the metabolism of hovering as they can be trained easily to hover in front of an artificial flower while feeding nectar. For this study individuals of *Glossophaga soricina antillarum* were trained to hover in front of a feeder for a duration of more than four seconds, which was measured photoelectrically. The feeder was constructed as a flow-through respiratory mask. The air drawn through the mask was sampled and O_2-depletion and CO_2-increase during hovering flight were determined by gas analyzers. From these data O_2-consumption and CO_2-production were calculated. The determination of the RQ indicates which substrate is oxidized and may indicate whether the muscles work under aerobic conditions.

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Color Spectrogram Frequency Analysis System for Bioacoustic Research Can Be Used in the Field

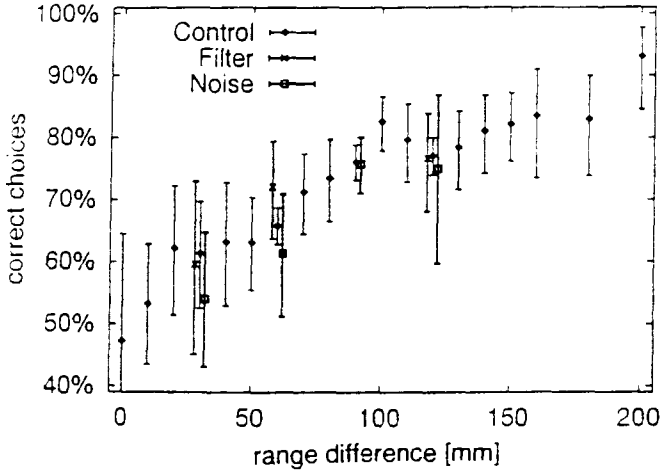
Bernd Waldmann, Dept. Animal Physiology, University of Tübingen,
Auf der Morgenstelle 28, D-72076 Tübingen, Germany

Analysis of bioacoustic signals in mammals or birds usually relies on expensive and bulky equipment for color spectrogram display. In field research on echolocating bats, the need arose for a lightweight, PC compatible tool for viewing and analyzing animal sounds. Using commercially available hardware, we developed a system for data acquisition and concurrent realtime color spectrogram displayed at up to 34 kHz bandwidth. Contrary to conventional systems, which are mainly geared towards engineering applications, our system was developed explicitly with the bioacoustics researcher in mind. A high-speed digital processor off-loads computational tasks from the host computer, thereby enabling the low-grade IBM A-T compatible computers to be used as a sophisticated tool without sacrificing performance. The half-size 8 bit PC slot card features an integrated a/d converter with 14 bits resolution and up to 7.5 kHz bandwidth, complete with microphone amplifier and anti-aliasing filter. Its small outline and low power consumption allows the board to be used even in lap-top computers, providing sound analysis directly in the field. An optional "digital microphone" with integrated a/d converter boosts specifications to 16 bits accuracy and up to 34 kHz bandwidth. Display options include various FFT lengths and offline zoom, control over dynamic range and cross-hair cursor measurement with data logging to spreadsheet-compatible text files. Data can be stored on harddisc for later retrieval and offline analysis. Hard copy output is supported for various types of printers, including inkjet color devices. Screen snapshots can be exported to graphics and paint programs. The system will be demonstrated at the conference. [An elaborate illustration accompanied this abstract, but could not be satisfactorily reproduced here.]

Range Discrimination in the Moustached Bat is not Impaired by Masking of the First Harmonic of its Echolocation Call

Bernd Waldmann and Hans-Ulrich Schnitzler
Dept. Animal Physiology, University of Tübinggen, Auf der Morgenstelle 28, D-72076 Tübingen, Germany

Neurons in the auditory cortex of the moustached bat respond to a combination of the first harmonic of the call with a higher harmonic of the echo in a delay-specific way (Suga (1988) in: Edelman, M. *et al.* (eds) *Auditory function*, 679-720). These neurons are supposed to be the basis of echolocation range measurement. However, their relevance to active echolocation has never been demonstrated. If these combination-sensitive neurons are necessary for echolocation, ranging performance should be degraded when perception of the pulse's 1st harmonic is disturbed, e.g. by masking with narrow-band noise. In the following experiments, this prediction was tested using psychophysical methods. Echolocation calls were picked up by two microphones, electronically delayed and broadcast from one of two loudspeakers, producing phantom targets of well defined spectral composition and apparent range. Moustached bats were trained to discriminate between two targets at different ranges. After the bats had learned the task, individual spectral components were removed from the echo with filters or masked with narrow band noise. The threshold for range discrimination was defined as that range difference where the 95% confidence interval (bars in fig.) for the



frequency of correct choices includes chance level (50%). According to this criterion, the threshold for range discrimination for the moustached bat is about 20 mm (fig.) Removing the 1st harmonic from the echo with a 40 kHz high pass filter has no effect on ranging performance (fig.) as we had expected. The bat perceives the first harmonic of its own call at less than ca 75 dB SPL. Assuming a critical ratio of ca 40 dB, narrow band noise of 10 kHz bandwidth centered around 28 kHz at 75 dB SPL will mask the first harmonic of the call. However, even at 80 dB SPL, there is no significant degradation of ranging performance (fig.) Therefore, the current theory of fm-fm combination-sensitive neurons as the sole neural basis for ranging is in need of reconsideration.

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Case Studies of Flight Activity in Three Species of Vespertilionid Bats

H. Walhovd and B. J. Lindhard
Institute of Biological Sciences & Dept. of Zoology, University of Aarhus, DK-8000 Aarhus C, Denmark

Colonies of *Pipistrellus nathusii*, *Nyctalus noctula*, and *Plecotus auritus* inhabiting artificial roosts were located during the day. In four cases (July - August) their flight activity and behaviour while departing and entering their roost was monitored continuously during the dark hours using infrared spotlights and a video camera. Thus a detailed survey could be made of the events around the roosts; e.g., flight behaviour, bat numbers, hours of departure from, and entry into the roost.

Bat Echolocation Call Structures and the Auditory Responses of Noctuid Moths

Dean A. Waters, Department of Zoology, School of Biological Sciences,
University of Bristol, Woodland Road, Bristol BS8 1UG, UK

Various shifts in the key parameters of bat echolocation calls have been proposed which reduce the apparency of the call to the auditory system of noctuid moths. The hypothesis that short duration, high frequency FM, and high frequency CF call types are acoustically less apparent to noctuid moths was tested. The calls of six species of British insectivorous bats were rebroadcast at tympanic preparations of *Agrotis segetum* and *Noctua pronuba*. No overall significant differences were found in the call apparencies of *Pipistrellus pipistrellus, Myotis brandtii, M. nattereri, Plecutus auritus* and *Rhinolophus ferrumequinum*. The 113 kHz CF call of *Rhinolophus hipposideros* was however significanly less apparent f rom its temporal and frequency structure alone. The key parameter for reducing apparency in FM, and sub-100 kHz CF bats appears to be call intensity, and more particularly, the interaction of the call structure with atmospheric attenuation.

* * * * *

Optimal Flight Speeds in Nectar-feedingBats(Phyllostomidae:Glossophaginae): Theoretical Models and Empirical Results

York Winter, University of Erlangen, Institute of ZoologyII, D-91058 Erlangen, Germany

During foraging a nectar-feeding bat expends energy for the flight between flowers and it gains energy from the consumed flower nectar. The flight costs of bats(cost/time) is not a constant parameter but it increases with flight speed(at speeds above a minimum power speed). A higher flight speed will therefore not only lead to a higher rate of flower visits and hence energy intake, but it will also increase concurrent flight cost. Using estimates of flight cost based on aerodynamic theory and results from physiological measurements, predictions of optimal flight speeds were derived according to two optimality models: 1) maximizing net gain per unit time, and 2) maximizing net gain per unit cost. Flight speeds were measured with a computerized timing system while a bat was flying between two feeders positioned at the opposite ends of a 40 m flight tunnel. The amount of nectar provided could be adjusted automatically and body mass was monitored with a balance connected to the bat's roost. The flight speeds at differing nectar energy densities and body masses will be compared to the predictions of the theoretical models.

* * * * *

Chiropterological Information Center in Poland-Six Years of Activity

Bronislaw W. Woloszyn,Chiropterological Information Center, ISEZ PAS,
PL-31 016 Kraków, Slawkowska 17, Poland

The Chiropterological Information Center (CIC) was established in May 1987 and is now a laboratory in the Institute of Animal Systematics and Evolution PAS in Krakow. The main goals of the CIC is to put on line all information concerning bats in Poland, promote the systematic and biogeographical study of bats, consult and advise the government and scientific institutions on the protection of bats in Poland. An important area of activity of CIC is to help to create local groups of amateur chiropterologists. Several such groups were established in major academic centers in Poland during the past few years. The CIC organized six bat-counts in Poland in the first half of February each year from 1988 to 1993. Bats hibernating in caves, mines, cellars, and tunnels were counted. The results of the censuses were presented during several national and international theriological or chiropterological conferences(i.e. Rome 1989 and Nyborg, 1990). The CIC edits two journals: the semi-annual CIC Bulletin and a quarterly annex to the Polish monthly magazine "Wszechswiat"(The Universe), named "Wszechswiat Nietoperzy"(the Universe of Bats), both in Polish. Since 1987 over 100 short notices, abstracts and critical reviews were published in these journals on bats and bat research carried out in Poland and other countries. The CIC

organized or cooperated in the organization of six national bat conferences in Poland(1987-1992). Another area of CIC activity is to organize each year a chiropterological "school" for the amateurs. During the past three years over 120 amateurs participated in these courses. CIC receives financial support from the Department of Biological Sciences of the Polish Academy of Sciences, but a substantial proportion of the research and organizational activities were made possible by volunteers, a majority of them being students and pupils of several Polish universities and colleges. Over 150 amateur chiropterologists cooperate with the CIC throughout Poland.

* * * * *

Postglacial History of the Bat Fauna of Southern Poland

Bronislaw W. Woloszyn, Chiroptological Information Center, ISEZ PAS,
PL-31 016 Kraków, Slawkowska 17, Poland,

The Holocene remains of bats are fairly abundant in the cave deposits of southern Poland. The accumulations of bat remains were due mostly to the dying out of winter colonies. In the fauna of this period bats are represented by recent species though the percentage of particular forms depart considerably from the modern percentages. At least four groups of thanatocenoses may be distinguished here. The first group, presumably the oldest one represents the climate optimum of the Holocene. Dominating elements were the species *Myotis bechsteini*, (which accounts for 45 to 60 % of the specimens), *M. nattereri* and *Plecotus auritus*. In the Tatra Mountains *Myotis myotis* began to appear. These bats inhabited caves in the Atlantic period. Beginning from the Subatlantic period, the climate gradually deteriorated and the composition of thanatocenoses depended on the situation of the cave in this period. In caves situated high in the mountains the cold-resistant species, chiefly *Myotis mystacinus*, began to prevail. In caves of upland plains the proportion of *M. bechsteini* in the fauna fell dramatically and *M. nattereri* increased considerably in number, while the percentage share of other species was low, due to the declining proportion of deciduous trees in forest associations. In the historical period due to the influence of man, species of bats appeared which preferred open areas, and synanthropic species such as *Rhinolophus hipposideros, Myotis emarginatus* and *Plecotus austriacus.*

* * * * *

A Preliminary Study of the Subfossil Bat Fauna from the Cueva Vieja de Villanua in the Spanish Pyrenees, Prov. Huesca, Spain

Bronislaw W. Woloszyn, Chiroptological Information Center, ISEZ PAS, PL-31 016 Kraków, Slawkowska 17, Poland, and Juan-Pablo Matinez Rica, Instituto Pirenaico de Ecolgia CSIC, Avda. Montañana, 177, Aptdo. 202, SP-50080 Zaragoza, Spain

The Cueva Vieja de Villanua is located on the left slope of the Aragon Valley in the Central Pyrenees at about 1,000 meters above sea level. Five samples of sediments were taken from the floor deposits of a small secondary corridor close to the middle entrance to the cave. Among the subfossil material obtained we have found at least 12 species of mammals belonging to Insectivora, Chiroptera, Rodentia, Lagomorpha and Carnivora. The Chiroptera are represented by seven species: *Rhinolophus euryale, R. mehelyi, R. ferrumequinum, R. hipposideros, Myotis cf. nattereri, M. emarginatus,* and *Miniopterus schreibersi.* Ninety five percent of the specimens and about 60% of the species identified were bats. A dominance of Rhinolophidae over Vespertillionidae shows that the faunal composition of the material investigated is of the North-Mediterranean type and represents a slightly warmer phase of the Holocene than the present.

* * * * *

Migration, Mating System and Population Density of *Myotis myotis* in Bavaria, Germany

Andreas Zahn, Zoologisches Institute der Ludwig Maximilians,
Universitat Munchen, Luisenstra. 14,D-8000 Munchen 2, Germany

The main results of a three year field study on the etho-ecology of *Myotis myotis* are: Exchange of females between nursery colonies happens regularly up to a distance of about 30 km. The emigration rate seems to be different per colony per year. -The solitary males use more than one roost (the maximum distance between roosts being more than ten km). Some roosts are only used during the mating season, others for taking a break while foraging. - Females visit males for mating purposes in roosts which can be as far as ten km from the colony. They can stay with one male for up to two weeks, but may visit several males within one mating season. Up to three females are sometimes seen with a male simultaneously. - There are considerable differences in population density within the area. There is a positive correlation between population density and forest cover in the region. Nursery colonies can be found in roosts with greatly differing climates (divergences of 8°C in the mean weekly temperature were measured in the period of examination (May- July 1992).

* * * * *

Computerised Monitoring of Weather Data and Bat Echolocation Activity

Karl Zbinden, Garbenweg 3, CH-3027 Bern, Switzerland

A computerised remote measuring station has been built to simultaneously monitor bat echolocation activity and weather data. The station is capable of assessing acoustic data at localized bat hunting sites or at the entrance of bat roosts such as houses, caves or tree holes. Since the device is solar driven, it allows data gathering in hunting habitats at very remote sites. The station has been successfully used to monitor bat flight activity at the entrance of a cave in France. It is now being set up to assess the impact of roof and lighting modifications at a skating rink near Bern, Switzerland, which is used by the bat *Nyctalus noctula* as an important hunting ground in late autumn. The station is based on a commercial weather data logger of British origin. The device measures temperature, humidity, pressure, light level, wind speed and wind direction, and was modified to log cumulative acoustic data instead of rainfall data. To achieve this, external electronics were built to convert the output signals of a Mini-II bat detecter into countable pulses. The countdown ratios are user selectable. The system offers an inexpensive solution to many problems of scientific activity monitoring.

* * * * *

Changes in the Bat Community of Katerinska Cave in the Moravian Karst

Jan Zukal, Institute of Landscape Ecology, CAS Brno, Czech Republic
Zdenek Rehák Faculty of Science, Masaryk University, Brno, Czech Republic

In 1992-1993, the bat community of a natural karst cave (Katerinská cave, Moravian Karst, southern Moravia) was investigated by means of regular winter census of hibernating bats and nettings in the cave entrance. In total, 13 species were ascertained. The number of bats was lowest in late June and July. The highest intensity of the cave visitation by bats occurred in late August and the first half of September, a minor peak was recorded in April. The species composition changed markedly during the whole year. The hibernating bat community is characterized by significant dominance of *Myotis myotis*. On the contrary, small *Myotis* species(*daubentoni, natteri, emarginatus* and *bechsteini)* dominated the autumn netting samples. Katerinská cave was also included in long-term monitoring of bat communities in Moravian Karst caves. The changes in numbers of hibernating bats have the same trend as in other caves, viz., a strong increase of *M. myotis* and a weak increase of *Rhinolophus hipposideros.*

Some readers have been inquiring about **BATLINE** or may have had problems using it. The following is provided for your assistance. GRH.

What is it?

BATLINE is an international information exchange network which was initiated to facilitate the timely exchange of research ideas, questions, and information among bat researchers. Messages sent out to the *BATLINE* are automatically distributed to all *BATLINE* subscribers. *BATLINE* messages are received in your e-mail mailbox. There are no fees for this service unless you are currently being charged for e-mail network access.

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Further Information

If you would like to receive a comprehensive list with explanations of user commands, send the message: **info refcard** to the appropriate **LISTSERV** address. Any questions regarding the *BATLINE* may be addressed to:

Mike Balistreri
Department of Biology
University of New Mexico
Albuquerque, NM 87131

(505) 277-3525
mikebal@triton.unm.edu

NEWS

From the Mariana Islands

David Worthington left the NBS National Ecology Research Center in Colorado in October and accepted a two-year position in the Commonwealth of the Northern Mariana Islands (CNMI) in the western pacific.$Since January, he has been conducting research on the Mariana fruit bat *Pteropus mariannus* on the island of Rota. Populations of this bat have dropped precipitously on the inhabited islands in the Marianas, including Guam, where only a few hundred still exist, and Saipan, where perhaps fewer than twenty are present. Bi-monthly counts reveal that there are probably near 1,000 bats remaining on Rota.

Work thus far has concentrated on increasing and refining census efforts, locating active roosts, public education, reviewing development sites to determine impact on bat habitat, and a telemetry study will begin in the next few months.

Fruit bats are a highly prized cultural food item in the Marianas--over 14,000 bats were legally imported from Palau into the CNMI in 1993! And the greatest threat to the bats is poaching that occurs on Rota and the remote islands north of Saipan. In October 1994, Palau will become an independent nation, and import of bats into the CNMI from Palau will be covered by CITES, and so will be illegal. Biologists in the region are concerned that poaching will increase after October when this legal source of bats is eliminated, and prices for local fruit bats, already reported to be near US $50, will increase sharply. By working closely with local and federal law enforcement agencies, Dave is hopeful that poaching can be kept under control, but it is a situation that will require close monitoring.

The CNMI also possesses a small population of the sheath-tailed bat, *Emballonura semicaudata*, in the CNMI extant only on the small island of Aguijan near Saipan. Dave hopes to travel to Aguijan this fall to search for this rare bat to determine its current status, and to remind himself that not all bats are the size of daschunds.

Dave may be reached via: Division of Fish and Wildlife, P.O. Box 1436, CNMI, Rota MP 95691 USA. 011-670-532-9095; Internet: davew@csn.org

From Wisconsin

Susan Lewis has recently accepted a position as an Assistant Professor of Biology at Carroll College in Waukesha, Wisconsin. Beginning this fall she will be the resident ecologist/zoologist. Eventually she will get a research program started that will undoubtedly involve bats, but her first task is to learn a little invertebrate zoology. Unfortunately she will not be able to attend the Symposium in Mexico but she will be at the Boston Symposium next summer. If there are any active bat folks in the Milwaukee/Madison area, she would appreciate hearing from you. Susan's address is Department of Biology, Carroll College, 100 N. East Ave., Waukesha, WI 53186. Tel.# 414-547-1211.
Her E-mail address is:
lewis012@maroon.tc.umn.edu

From Papua New Guinea

Helen Fortune Hopkins (now back in U.K.) and James Menzies of the University of Papua New Guinea have recently completed a short study of the feeding habits of some frugivorous bats near Madang in northern coastal Papua New Guinea, funded by the Christiansen Research Institute. They mist-netted some species (*Dobsonia minor, Rousettus amplexicaudatus* and several nyctimene bats), and collected samples from others at their roosts (*Dobsonia molucccensis* and *Pteropus conspicillatus*) to collect faecal material from which seeds were obtained. The seeds have been identified as far as possible, and the seedlings of a number of species raised in pots. The introduced shrub *Piper aduncum* was particularly abundant, and the majority of the remaining seeds belonged to several species of fig. The data are very perliminary, and sample sizes were small, but they indicate at least some overlap in diet between bat species, and raise the question of possible overlap with avian fig-specialists, such as *Manucodes*, which are Birds of Paradise, and Fruit Doves. They also illustrate the likely importance of bats in the regeneration of woody vegetation around Madang where some clear-fell logging has been practiced in the Gogal Valley. [my apologies for overlooking this interesting contribution which should have appeared in the last issue. GRH]

Letter to the Editor

In Volume 34: No. 4 of Bat Research News was the interesting paper by Pierson about damage caused by lipped wing bands on Plecotus. I have been using such bands on Daubentons bats Myotis daubentonii for a number of years at a site where I can relatively easily check on any damage caused by ringing. I, too have noticed the damage caused by the bands, but it is very variable. Some individuals have been carrying the bands for 12 years and show no ill effect, others have worn them for a few weeks and a hole has developed through the membrane. Interestingly some others some others have worn them with no ill effects for a number of years then suddenly the ring has closed up or stuck and the membrane became damaged. One problem with this species is that it will roost in tree cavities and some bands fill up with droppings or detritus from the tree so causing the band to stick. Why the band should close up in some cases after a number of years is unknown. In all cases where the band has caused damage it has been removed and fresh band fixed onto the other forearm. Subsequent recaptures have shown rapid healing, pink scar tissue, the complete healing so that the damage can no longer be detected. In some cases the hole remains and heals around the edges leaving a small but harmless hole. It has been said that some individual bats are more aggressive towards the band and I have seen some biting repeatedly at bands: one band I removed because it had tiny chunks of metal bitten from its edges. In such cases there is a greater chance of the bat damaging its wing membrane either with its own teeth or by forcing the band through.

I too have used coloured plastic bird-leg bands (filed to fit either side of the wing membrane), but only on a small scale. They certainly did not cause any more damage than the metal band and probably less, but the colours faded - a problem I least expected with an animal that lives in darkness. White became a faded orange colour, pink went yellow, blue went through green then cream to off-white. I suppose it is due to the ammonia from the urine in the enclosed roosting places. Embossed numbers on the plastic bands remained clear on some individuals but were nearly worn away by others.

Overall, when carrying out banding studies a balance has to be reached between the vast amount of very valuable information that can be gathered and the damage that may result.

Personally I feel quite happy about my project as I have the opportunity to check bands on weekly visits and can take action such as cleaning out solids from beneath the band.

Phil Richardson
Northern Bat Group
10 Bedford Cottages
Great Brington
Northampton, NN7 4JE
England

Please Notice

The remainder of this space (and as much more as is needed) is set aside for the news that no one has sent us. We will provide a free one year subscription to ***Bat Research News*** or extend your present subscription for one year **to the first five individuals** who send us news about their activities concerning bats. Everyone we have spoken to says that they find this section of BRN interesting to read, and they promise to send us a short piece, yet these never seem to arrive. Perhaps we should commission a few creative writers to compose pieces about your work with bats. We can hardly imagine that no-one is doing anything of interest! The Editors

You can send any news you might have via E-mail or FAX to:

horstgr@potsdam.edu

or FAX 315-267-3710

Announcing

the Following Bat Symposia and Other Related Meetings

24th Annual North American Symposium on Bat Research
October 19-22,1994
at Hotel Westin, Ixtapa, Mexico

Honorary Host; Bernardo Villa-R.
Co-hosts Hector Arita and Rodrigo Medellin
Center for Ecology
Universidad Nacional Autonoma de Mexico

for information regarding all aspects contact:
G. Roy Horst, Symposium Director
Department of Biology
SUNY College at Potsdam
Potsdam, NY 13676
abstracts are due August 15, 1994
Tel. 315-267 -2259 FAX 315-267-2259
E-Mail HORSTGR@POTSDAM.EDU

25th Annual North Americn Symposium on Bat Research
and the 10th International Bat Research Conference
August 13-19, 1995
at Boston University, Boston, Massachusetts, USA

Host and Organizer: Dr. Thomas H. Kunz
Program Director: G. Roy Horst

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

7th European Bat Research Symposium
Koningshof Conference Centre
Veldhoven, The Netherlands August 12-16, 1996

for additional information contact:
Peter Lina, 7th ERBS
c/o IKC - NBLF
P.O. Box 30, 6700 AA Wageningen,
the Netherlands
FAX +31837027561

a significant number of papers concerning bats will also be presented at the following meetings

Second European Congress of Mammalogy
The University of Southampton
Southampton, England
March 27 - April1, 1995

more details will appear in **Bat Research News** as they become available

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76th Annual Meeting of the American Society of Mammalogists
University of Vermont
Burlington, Vermont, USA
June 1995

C. William Kilpatrick, Local Committee Chair
Department of Zoology
University of Vermont
Burlington VT, O5402 USA
802-656-0453

MICHIGAN

Forthcoming, December 1994

Mammals of the Great Lakes Region

REVISED EDITION

Allen Kurta

Mammals evolved from an obscure group of reptiles about 230 million years ago. Early mammals were probably no larger than modern shrews or mice, and they remained this size-while living in the shadows of dinosaurs-for over 150 million years.

First published in 1957, *Mammals of the Great Lakes Region*, by William H. Burt, offered countless numbers of amateur and professional naturalists a source of information on mammals living in the Great Lakes basin. Over the past thirty-plus years, the knowledge of mammals has grown tremendously, and this new edition offers the most up-to-date information on the mammals living in the region.

Intended to serve as a quick reference for teachers, students, naturalists, and professional biologists, the heavily illustrated book can be tucked into a backpack and carried into the field. The author's introduction serves to help understand the major characteristics of mammals and the Great Lakes ecosystem. It outlines the physical factors that affect the distribution and abundance of mammals in the area, including surface geology, temperature, snowfall, and vegetation.

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Allen Kurta is Associate Professor of Biology, Eastern Michigan University.

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MICHIGAN

BAT RESEARCH NEWS

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CONTENTS

FRONT COVER

Since we have not received any photographs or drawings for the front cover of this issue, I decided to modify a drawing that we used a long time ago. The original was a drawing by Margaret Langworthy. Remember that we have a standing offer of a one year free subscription to ***Bat Research News*** to anyone who submits an illustration that we use for the front cover of future issues. No portraits or photographs of individuals, please. GRH

BAT RESEARCH NEWS

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BAT RESEARCH NEWS

Publisher and Managing Editor
G. Roy Horst
Department of Biology
State University College at Potsdam
Potsdam, NY 13676
Tel. 315-267-2259
FAX 315-267-3170
E-mail: horstgr@potsdam.edu.

Editor
Thomas Griffiths
Department of Biology
Illinois Wesleyan University
Bloomington, IL 61702
Tel. 309-556-3230
FAX 309-556-3411
E-mail: griffith@vmd.cso.uiuc.edu.

Editor for Feature Articles
Allen Kurta
Department of Biology
Eastern Michigan University
Ypsilanti, MI 48197
Tel. 313-487-1174

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BAT RESEARCH NEWS

Volume 35: Nos. 2 & 3 **Summer and Fall 1994**

Goatsuckers: Just Feathered Bats or Why I Talk about Birds at Bat Meetings!

R. Mark Brigham, Department of Biology, University of Regina, Regina, SK S4S 0A2 Canada

There has been a recent surge of interest in the natural history of night-active flying vertebrates, principally bats. However, some of this interest has focussed on creatures called "GOATSUCKERS". Although it may sound like these are things we need to protect children from, in reality they are harmless 40-100 g birds (I know it's a dirty word in this publication, but bear with me). Goatsucker is the literal translation of Caprimulgidae, a family of birds comprising about 90 species world-wide, occurring mainly in the tropics. They are more often called nightjars because of their night-jarring calls. The name "goatsucker", used principally in North America, comes from the European superstition that these generally nocturnal birds sneak down from the hills and suckle livestock. Of course, like all the best bat myths, the notion is baseless, although goatsuckers' huge gape makes the myth's origin understandable.

Some familiar North American goatsuckers are Common Nighthawks *Chordeiles minor*, Whippoorwills *Caprimulgus vociferus*, and Common Poorwills *Phalaenoptilus nuttallii*. Like bats, they consume small flying insects, often in vast quantities. In fact, another name for the nighthawk is "mosquitohawk", reflecting the fact that those insects are thought to part of the diet (however, like for bats this appears to be rare). Another common belief is that nighthawks use their huge mouth to vacuum up insects. This is also untrue, like bats, they also attack individual insects (Aldridge and Brigham 1991).

One reason for my initial interest in goatsuckers was because of the apparent similarity in foraging behaviour with bats. It turns out that the similarities extend far beyond simply what they eat and when. Goatsuckers, like bats have low reproductive rates (usually one or two offspring produced per year) and, for some species, the physiological ability to enter torpor and perhaps even hibernate.

Details about the natural behaviour of most species remains virtually unknown (most ornithologists, except for the odd owl biologist, are all asleep at night!). The mottled feathers make them so cryptic that most individuals and nests are only discovered when almost stepped on inadvertently. Using recent advances in telemetry, my students and I have been trying to find answers to many of the same questions currently being asked about bats.

Nighthawks lay a single clutch of two eggs on bare ground (akin to bats using buildings, these birds can use flat gravel roofs, although apparently not always; Brigham 1989). For goatsuckers about which there are data, albeit limited, both males and females incubate and feed the chicks. Thus, two adults help to look after two chicks as compared with female bats who work alone and perhaps consequently, normally raise only a single offspring. Poorwills also lay two eggs on the ground, but for unknown reasons lay two clutches per year (Csada and Brigham,1994).

The Hopi Indians refer to the poorwill as Hlchoko, "the sleeping one", which stems from the species' supposed ability to hibernate, a strategy known for many temperate bats. Poorwills are the only birds allegedly able to do this, although definitive evidence has yet to be collected (Csada and Brigham 1992). Data collected using temperature sensitive transmitters show that poorwills regularly enter short-term (24-48 hours) hibernation called daily torpor outside the nesting season (Brigham 1992; Csada and Brigham 1994). We have recorded body temperatures (T_b) in torpid birds to fall below 5°C, more than 35°C below T_b of active birds, but similar to T_b of torpid bats. This is the lowest naturally recorded T_b for any species of bird! Although adult poorwills incubating eggs or brooding chicks occasionally enter torpor, they appear to resist doing so (Kissner and Brigham,1993). Similarly, pregnant and lactating bats can enter torpor, but only appear to do so when conditions are particularly bad. Torpor likely retards the growth of the developing chicks or pups and reduces their probability of survival. In contrast to poorwills, and for reasons not

understood, there is no evidence that nighthawks can enter torpor, even on nights when poorwills do (Firman et al. 1993).

To warm up after a bout of torpor or when leaving hibernation, bats and many other mammals derive heat from brown adipose tissue (the acronym for which is, appropriately, "BAT"). There is no evidence that poorwills, or any other birds, possess this tissue (Brigham and Trayhurn 1994) and thus how they rewarm remains a mystery. I speculate that they use a different tissue type, but for essentially the same purpose.

Although both bats and goatsuckers consume flying insects, the means by which they detect them is substantially different. Bats are well known for sophisticated echolocation. The South American Oilbird *Steatornis caripensis*, a member of the Order Caprimulgiformes, echolocates crudely by tongue clicking to locate the nest inside caves. However, not even goatsuckers can use echolocation to detect prey. Despite differences in prey detection system, bats and goatsuckers at the same sites bats often consume the same prey (Brigham and Fenton 1991). Exactly how acute these birds' vision is relative to echolocation remains to be determined.

Feeding by nighthawks occurs crepuscularly (dusk and dawn) and in the Okanagan Valley of British Columbia, caddisflies are a principle prey (Brigham 1990). These birds forage like Eptesicus, catching insects whilst continuously flying. In contrast, poorwills sally after insects from the ground or a perch both crepuscularly and at night, in a manner reminiscent of some Rhinolophids. The diet consists principally of large beetles and moths (Csada et al. 1992; Bayne and Brigham 1994).

An obvious question is whether goatsuckers compete with bats for food. Most likely, insects are so abundant that there is no competition, however, if it does occur, goatsuckers may have one distinct advantage. Many moths, potential prey for groups, have a built-in set of bat detectors, namely ears. By detecting prey visually, poorwills do not betray their presence to these insects and perhaps enjoy a higher capture success.

This leads to the question of why chunky, hard to digest beetles are prominent in the diet of poorwills? The answer may relate torpor and the nature of fat, a reliable energy source for vertebrate animals. Saturated fats (butter has lots) are energetically rich but solidify at low temperatures and cannot be metabolized by torpid animals. However, poly-unsaturated fats (PUF; abundant in soft margarine) remain liquid at low temperatures making them metabolically available to torpid animals. Vertebrates cannot synthesize PUF, and must consume them. Among insects, beetles have one of the highest PUF content, meaning they might be a favoured prey, particularly for species who enter torpor or hibernate. Poorwills, who can enter torpor, regularly consume beetles (Csada et al. 1992; Bayne and Brigham 1994), but nighthawks who don't appear to use torpor, rarely eat beetles (Brigham 1990; Firman et al. 1993).

Visually-orienting poorwills concentrate their activity at dusk and dawn, and during periods of the night with moonlight (Brigham and Barclay 1992). Presumably this is because they need some light to silhouette insects against the sky. There is no strong evidence that insectivorous bats are effected by the lunar cycle. This is not surprising, given that they do not need light to detect obstacles or prey. Echolocation allows bats to be flexible in the timing of their nightly foraging periods whereas birds appear to be restricted by the duration of dusk, dawn, and moonlit periods of the night.

So are bats just furry goatsuckers or vice-versa? The many similarities which exist between these animals invites such a comparison. Only with time will we be able to unravel more of the mysteries surrounding both groups of amazing creatures and determine how similar they are in other aspects of their life histories.

ACKNOWLEDGEMENTS

I gratefully acknowledge the many colleagues who contributed to this work including Hugh Aldridge, Erin Bayne, Robert Barclay, Darren Bender, Anne Brigham, Tod Collard, Ryan Csada, Brock Fenton, Mitchell Firman, Scott Grindal, Matina Kalcounis, Kelley Kissner, Robin Mackey, Herb Matthews, Barry Milligan, Donald Thomas, Kaili Wang, and Kevin Zurowski. My research has been generously supported by the Natural Sciences and Engineering Research Council of Canada.

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A New Longevity Record for *Myotis lucifugus*

Wayne H. Davis and Harold B. Hitchcock
School of Biological Sciences, University of Kentucky, Lexington, KY 40506,
and 1 Locust Lane, Middlebury, VT 05753

For several years, Allan Hicks has led teams to census hibernating bats in an abandoned iron mine in Essex County, New York, where we, along with students from Middlebury College, had banded thousands of bats in 1961 and 1962. An earlier report (Sommers et al., 1993, Bat Research News, 34:3) listed several bats hibernating at the mine in 1992 that were at least 30 or 31 years old.

We now report a new age record. A live male *Myotis lucifugus* found in the mine on 1 February 1994 had been banded at the mine on 26 March 1961. Although we did not know the age of this bat at the time of banding, it could not have been born later than July 1960; thus, it was at least 33 years old when recently examined.

Erratum

In the last issue of Bat Research News, the model number of the tape recorder used with the Anabat detector (p. 1) was incorrectly stated as #14-2055B; it should be #14-1055B.

Capture of a Nectar-feeding Bat Species with a Modified Harp Trap

Sophie Petit, Leon Pors, Monique Surrel, and Jacques Petit
Department of Biology, University of Miami, Coral Gables FL 33124 (SP),
CARMABI, P.O. Box 2090, Curacao, Netherlands Antilles (LP), and
Montcaut, 64230 Denguin, France (MS, JP)

Mist nets are the most commonly used tools for the capture of flying bats. In certain cases, when bats are channeled through a small area (for example a trail in the rainforest), harp traps are also very effective. They have the advantage of not requiring excessive handling time because bats caught by a trap fall into a large bag, whereas those captured by a net sometimes become severely entangled.

In 1992 and 1993, while working on Curacao, a semi-arid island with no natural "channels," we were able to catch nectar-feeding bats (for an evaluation of their diet by pollen and feces collection) only as they returned to their roosting caves. For certain caves, in particular those having only one opening for a fairly large bat population, catching bats with a mist net proved a very stressful experience, for the bats as well as for the catchers. Our first trials with a harp trap were not very successful--the trap was very effective in catching insectivorous species, especially *Mormoops megallophyla*, but not the two nectar-feeding bats of Curacao, *Glossophaga longirostris* and *Leptonycteris curasoae* . The latter species is considered endangered in the United States (Wilson, 1985; Shull, 1988), and research on this maneuverable and fast flier is currently under way in several countries. Unfortunately, little information is published on species-specific methods of capture. We modified our trap in such a way that we increased the success of capturing *Leptonycteris* , the more difficult bat to catch, from 0% to 60% (N = 40 *Leptonycteris* flying through the trap at the Kueba di Jetchi site, 2 counts). Between 0400 and 0500 hours, the catching rate was up to 16 *Leptonycteris* per hour (n = 5 nights) with the improved trap.

We built a 2 m x 2 m collapsible trap of the type described in Tuttle (1974) and Kunz and Kurta (1988) [see also Palmeirim and Rodrigues (1993) for a newer version]. Our trap, however, had three layers (or rows) of vertical lines, and tension on the 8-lb monofilament nylon line increased from the first layer (toward the outside of the cave entrance) to the third layer, which was very tense for incoming bats to bounce back into the trap. We used a spacing of 8 cm between the first and the second layers, and 11 cm between the second and third layers. The lines of the first layer were placed every 3 cm; those of the second layer were placed every 1.5 cm, while on the last layer, the space between two lines was only 1 cm. The bats avoided the aluminum frame until it was painted black. Our new trap halted the flight of the bats, but success of capture still depended on the promptness of the catcher in grabbing bats temporarily dangling on the lines (and on his/her blood alcohol level). Bats that fell into the bag had to be retained by plastic flaps or able hands.

The trap proved very helpful in capturing nectar-feeding bats flying into caves with a minimum of handling time. Not one bat was hurt, and all were released on site, healthy and lively, including specimens of several species of insectivorous bats. Catching rate may be improved further with a fourth layer of lines (Francis, 1989), although we did not test this.

ACKNOWLEDGEMENTS

This research was supported in part by Bat Conservation International, Van Eeden Fonds, Roosevelt Scholarship, World Nature Association, Tropical Biology Fellowship (University of Miami), and Sophie Danforth Conservation Biology Fund. Our host on Curacao was CARMABI, the Caribbean Marine Institute.

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Bark Roost of a Male Big Brown Bat, *Eptesicus fuscus*

Allen Kurta, Department of Biology, Eastern Michigan University, Ypsilanti, MI 48197

The big brown bat (*Eptesicus fuscus*) is one of the best-studied bats in eastern North America (Kurta and Baker, 1990), largely because of the tendency of females to form maternity colonies in manmade structures. However, specific details on the lives of adult males in summer are scarce, and even where the males spend the day is not well known. A few reside in buildings, roosting by themselves or with the females (Mills et al., 1975), but the majority of males apparently shun man-made retreats. Occasionally males have been found roosting in caves (Whitaker and Mumford, 1982) or in woodpiles (Mills et al., 1975), but published observations of natural roosts in the East are surprisingly scarce. In this report, I describe the serendipitous discovery of a natural dayroost of an adult male big brown bat.

On 20 August 1994, in conjunction with a long-term study of Indiana bats (*Myotis sodalis*), I visited a wetland in Eaton Co., Michigan, to retrieve information from a data logger using a laptop computer. The wetland contained many dead and dying trees and had water depths averaging about 0.9 m at the time. The logger was situated on a plywood platform that was supported by wooden beams attached to three dying trees. While I worked with the computer, a strip of bark about 1 m in length fell from one of the trees and crashed into the water about 3 m away from me. Mixed in with the bark fragments and covered with duckweed (*Lemna* sp.) was a half-submerged bat that I eventually identified as an adult male big brown bat.

Presumably the bat had been roosting under the loose bark and had been dislodged when the piece fell from the tree. The animal was torpid, but otherwise unharmed, and after a 20-minute warmup period on the plywood platform (ambient temperature=22 C), the bat flew away. The tree was a green ash (*Fraxinus pennsylvanica*) with a dbh of 26 cm, and the dislodged piece originally was located about 4 m above the water. Although some species, such as the Indiana bat (*Myotis sodalis*) and northern bat (*M. septentrionalis*), are typically found under bark (Foster, 1994; Gardner et al., 1991), this apparently is the first report of big brown bats roosting in such a situation, and it may prove to be a common behavior of the solitary males.

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B. C. I. Student Scholarships

Bat Conservation International has established a student scholarship fund. Four to five grants of $2,000 to 2,500 each will be made annually in support of research that helps document the roosting and feeding requirements of bats, their ecological or economic roles, or their conservation needs. The application deadline is February 15, 1995. For application instructions and forms write to: Bat Conservation International, Scholarship Awards coordinator, P.O. Box 162603, Austin, TX 78716.

Observations of *Pteropus tonganus* on Niue, South Pacific Ocean

Gilbert S. Grant
Department of Marine and Wildlife Resources, P.O. Box 3730, Pago Pago, American Samoa 96799. Present Address: Department of Biological Sciences, University of North Carolina, Wilmington, NC 28403

The white-necked flying fox (*Pteropus tonganus*), known locally as peka, has been known from Niue (19°03'S, 169°52'W) since 1874 (Gunther, 1874). Niue is a small, nearly circular island (Fig. 1), about 18 km wide and 21 km long (259 km2), located 480 km east of Tonga and 550 km southeast of Samoa. It is an uplifted limestone (coral) block, riddled with caves, that extends only 69 m above sea level. The human population is less than 3,000, with many Niueans having emigrated to New Zealand.

Wodzicki and Felten (1975) and Hill (1979) last summarized the population status, food preferences, roosting habits, and human impact on the flying foxes of Niue. They attributed the greatly reduced population of flying foxes at that time to deforestation and overhunting. Hill (1979), however, did not visit Niue and based his paper on museum specimens. Wodzicki (unpublished data cited in Wodzicki and Felten, 1975:137) did not observe free-flying bats at any time during two extended visits (exceeding three months) during 1968 and 1969. He gleaned his natural history information from knowledgeable Niueans.

I visited Niue on 12-14 March 1993 and 27-29 May 1994 to obtain information on the current status of *P. tonganus* . I am very familiar with flying foxes in the region, recently having completed two years of field research (reproductive, roost-site, and radio-tracking studies) on *P. tonganus* and *P. samoensis* on American Samoa. On Niue, I saw bats at a number of locations, conducted informal interviews with two hunters, gathered some feeding data, and collected evidence that suggested the peka breeds year-round.

On 12 March 1993, I smelled male *P. tonganus* (the odor is quite strong, musky, and unmistakable) in three areas: 1 km east of Alofi, along the trail to Togo Chasm, and on the trail to Talava Arches (The Arches). In addition, I saw a single *P. tonganus* flying in a southwesterly direction, 200 m east of the Niue Hotel, on the evening of 12 March 1993. I saw a *P. tonganus* flying southwesterly at 1904 hours, on 13 March 1993, near the Niue High School, about 1 km east of Alofi. I heard a bat mating scream (the female frequently vocalizes when the male bites her neck - shoulder area during copulation) at 18:57 hours, on 13 March 1993, about 1 km east of Alofi.

I smelled bats along the Alofi-Liku Road, about 2 km east of Alofi, on 27 May 1994. Between 0545 and 0625 hours on 28 May 1994, Kalo Fakalanu and I saw 13 *P. tonganus* flying northward, towards Liku, over the Vinivini Track. On 28 May 1994, between 1735 hours and dark, I searched unsuccessfully for bats flying over the Alofi -Hakupu Road, about 1 km northwest of Hakupu.

In addition, I saw three *P. tonganus* in captivity at a fish-and-chips cafe near the water tower, about 2 km south of Alofi. Two were immature males, and one was a female. According to the cafe owners, the three were taken as dependent babies from females shot during the December hunting season.

I found evidence of *P. tonganus* feeding on *Terminalia catappa* at two sites. On 12 March 1993, along the Talava Arches Track, I found a single *Terminalia* fruit with obvious bat tooth marks present. On 28 May 1994, on the track between Liku and the reef, I found 39 partly chewed fruits of *T. catappa* , with bat tooth indentations and thumb claw scratches. In addition, I found six ejecta pellets at this site containing *Terminalia* pulp. *Terminalia catappa* is not listed as one of the primary food items used by the peka on Niue (Wodzicki and Felten, 1975). However, this fruit is utilized on American Samoa (pers. observ.; Banack, unpubl. data) and elsewhere by flying foxes (Wiles and Fujita, 1992). Citrus fruits (Citrus sp.) commonly are consumed by flying foxes on the Cook Islands, Yap, and Samoa (Wiles and Fujita, 1992), so I examined 400-500 ripe tangerine fruits, in a tree and on the ground, in an area uninhabited by humans, near Togo, on 28 May 1994. There was no evidence that these fruits were being utilized by bats on this occasion.

From these two brief visits it was not possible to ascertain the current population status of bats on Niue. Wodzicki and Felten (1975) expressed concerns that the population in 1969 was very low. In 1972 the General Assembly of Niue enacted an ordinance prohibiting the shooting of flying foxes. Currently, a month-long hunting season around Christmas is allowed on Niue (Wayne

Tagelagi, Environmental Officer, pers. comm., 27 May 1994). Mr. Tagelagi plans to conduct future surveys to monitor the number of bats harvested. Mr. Tagelagi estimated 300-500 peka are currently taken per district (10 districts) during the one-month season. Another hunter that I spoke to estimated that about 60 hunters take about 20 peka each during the season. Both of these estimates suggest that a sizeable population of flying foxes must be present.

I saw and smelled small numbers of bats in many areas on Niue during my brief visits. It is difficult to assess the population on Niue because the flat terrain provides no vantage points for observations and because extensive tracts of forest are largely inaccessible (some areas are without roads and others are "tapu"--off limits to outsiders).

Based on the presence of a fetus inside a female taken on 12 June 1971 and the estimated age of captive immature bats, Wodzicki and Felten (1975) determined that the breeding season for *P. tonganus* on Niue was between March and June-July. However, the three captive bats that I saw on 27 May 1994 were taken from females shot during the December hunting season. Thus, *P. tonganus* on Niue may give birth year-round as they clearly do in American Samoa (Grant and Banack, unpubl. manuscript).

ACKNOWLEDGEMENTS

I thank James and Tupu Poihega for information on bats and contacts on Niue, Wayne Tagelagi for sharing his knowledge of bats and hunting, and Kalo and Feilo Fakalanu and Mark Cross for allowing me to stay in Liku and guiding me to likely locations to see bats.

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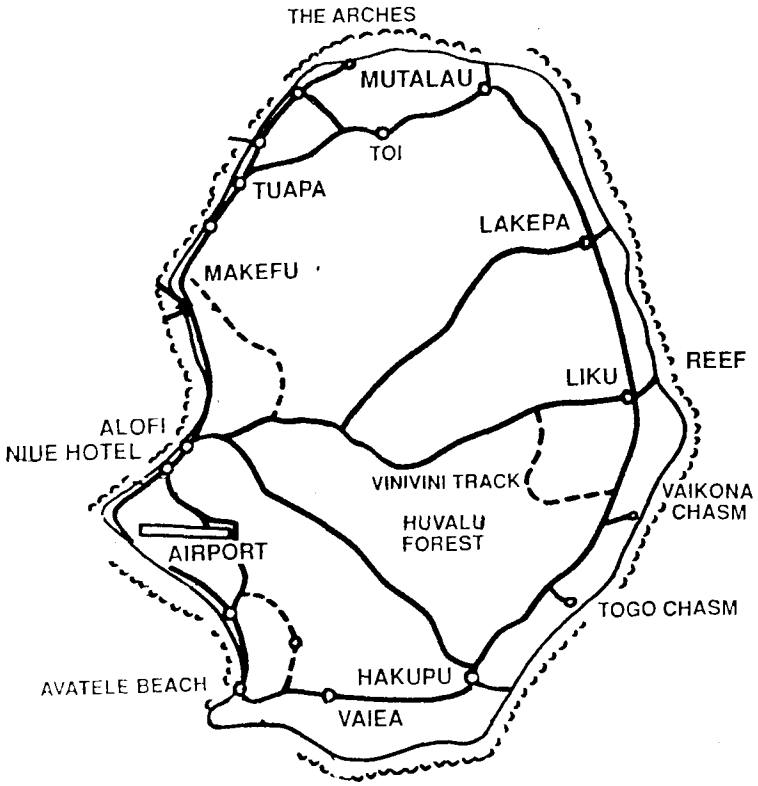

Figure 1. Major roads and villages on Niue. The island is 18 km wide and 21 km long.

The *GLOBE* Program : Global Learning and Observations to Benefit the Environment

Steve Young, Smithsonian Biodiversity Program and U.S.Environmental Protection Agency

Some of you may have seen an earlier posting about the Global Observations to Benefit the Environment (*GLOBE*) program. *Globe* was announced by Vice President Gore on Earth Day, April 22, 1994 and has received support from many other nations. Following is a short fact sheet prepared by the program, follwed by contact information. Additional information should be available directly from the *GLOBE* contact point.

The *GLOBE* Program brings school children, educators and scientists together to monitor the worldwide environment.

The objectives of the *GLOBE* Program are: to enhance the collective awareness of individual throughout the world concerning the environment; to increase scientific understanding of the Earth, and; to help ALL students reach higher standards in science and mathematics education

The *GLOBE* Program consists of a worldwide network of K-12 students: making environmental observations at or near their school (e.g., measurement of air temperature, wind speed and direction, precipitation, land cover, water chemistry, and soil moisture content), providing data useful to environmental scientists, and sharing the resulting global environmental images and knowledge with each other.

The *GLOBE* Program will employ an international transmission network, initially using the Internet, direct satellite transmission and television. The network will support: the acquisition of environmental data by students, transmission of the data to processing sites in the U.S. and other countries, distribution of vivid, graphical environmental pictures of the world to students at their schools and distribution of student[-acquired] data to environmental scientists throughout the world.

Scientists are involved in the design and implementation of the *GLOBE* program and will determine what types of measurements students are most capable of making and where students can make the greatest contribution.

The data acquired by the students are expected to be useful in the understanding of earth systems by students and environmental researchers in a wide range of fields. The student data will be quality-controlled during *GLOBE* processing prior to their use in producing environmental images and publicly available data.

Over 200 schools, at least 50 of which will be in the U.S., will participate in the initial *GLOBE* implementation, which will begin operation on April 22, 1995, the 25th Earth Day. Over the following few years, at least 1000 U.S. schools will be actively involved. Over 40 countries have already expressed interest in becoming involved.

Over 90% of the long term *GLOBE* expenditures are expected to be funded by foreign governments and non-government sources in the U.S. and abroad. Foreign governments will pay for their own country's participation to the extent they are able. A non-profit organization will be the focal point for U.S. private sector contributions for *GLOBE*.

Contact information

Mail address: The *GLOBE* Program744 Jackson Place, Washington, DC 20503tel. 1-202-395-7600 FAX: 1-202-395-7611
Inquiries by Internet: info@globe.gov
[a *human* will respond]

Express/courier address:
The *GLOBE* Program, The White House New Executive Office Building 725 17th Street G-1, Washington, DC 20006

The *GLOBE* Program Director is Tom Pyke; the Program Deputy Director is Rick Chappell.

Please share this with interested colleagues and other appropriate lists or groups, and excuse any cross-postings. I'm sure the program would welcome your ideas and offers of assistance.

I am not affiliated with the *GLOBE* Program but am trying to helpget the word out!

My E-mail # is:
Internet: young.steve@epamail.epa.gov

An Announcement about Recent Literature

Compiling the Recent Literature section of this journal is a job that has gotten easier in some respects in recent years. Electronic searching capability has allowed me to search many more journals in much less time than previously for articles dealing with bats. However, electronic data bases are full of errors of spelling, punctuation, and sometimes meaning, and they miss many journals.

I still would appreciate receiving a reprint of your journal article (especially those articles dealing with anatomy/histology, paleontology, systematics/taxonomy, or zoogeography of bats), but I understand that reprints are expensive and not to be given out lightly in some cases. In lieu of a reprint, I suggest that an author send me a complete citation by E-mail to:

tgriff@titan.iwu.edu or

griffith@vmd.cso.uiuc.edu

(use the second address only if you cannot get through on the first). Please be certain to follow the format of our Recent Literature section, including 1) give the full name of the journal - no abbreviations of any word; and 2) give a full mailing address where reprints may be requested (be sure to indicate whose address it is if not the first author's). Please - no "in press" or "in manuscript" citations. Thank you. Tom Griffiths

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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Assistant Biologist Opportunity

The Department of Marine and wildlife Resources, American Samoa, to provide field and office (data management) support for biologists researching forest bird and flying fox fruit bat ecology. Studies include monitoring the populations of forest birds, flying foxes, and other ecological projects. BA/BS in natural science required. Experience w/song identification, mist-netting, radio telemetry, and behavioral observation are highly desirable. Work entails hiking in hot, wet, steep, muddy, slippery and buggy, but beautiful rain forest. Collection of botanical specimens, aerial photo interpretation, mapping, archival research may also be included. Opportunities for own research. Two year contract. $13,000 - $18,000/year commensurate with experience. Housing and moving allowance provided. Send letter of interest, C.V., and names of three references to: Ray Tulafono, P.O. Box 3730, Pago Pago, American Samoa 96799. Tel: 684-633-4456, FAX: 684-633-5944

News and Letters

from New Jersey

In BRN Vol. 34:2-3 we reported that *Myotis sodalis* , the Indiana bat, was confirmed in a winter hibernaculum in the northwestern part of New Jersey. Under the leadership of Roy Powers of the American Cave Conservation Association, representatives of the U.S. Fish and Wildlife Service and the New Jersey Department of Environmental Protection's Division of Fish, Game and Wildlife and Division of Parks and Forestry, installed a bat-friendly gate at the hibernaculum in early July 1994.

The mine had been the largest hibernaculum for bats in New Jersey for over half a century. Abandoned in the early 1900's, museum specimens and literature records indicate that several thousand bats(predominantly *Myotis lucifugus*) were present in the mine in the late 1930's. Dr. John s. Hall of Albright college banded thousands of bats from the mine in the 1960-70's, and estimates in the 1980's were greater than 20,000 bats. In February of 1992 a small number of *Myotis sodalis* were found along with 26,000 + other bats and the impetus for protection of this hibernaculum was started, and certainly not too soon. Historically there were 134 shafts into the mine complex, but in 1988 the last remaining entrance had been cemented.

The New Jersey Division of Fish, Game and Wildlife, Endangered and Nongame Species Program and Bat Conservation International were able to negotiate with the landowners to partially open the cement barrier(vandalism in the mine was a serious problem for the landowners and they felt sealing it would end their problems) and attempted to arrange for a bat-friendly gate to be installed to prevent the vandalism and protect the bats. Then ownership changed hands and negotiations were stalled until *M. sodalis* were discovered.

At that point U.S. Fish and Wildlife Service became involved, and in a joint effort, the federal and state governments, along with support from B.C.I., developed plans to install a gate to protect the federally endangered Indiana bats.

Roy Powers spent his 4th of July in New Jersey, and completed his 84th (or 85th?) gate installation. John Cochner and Mel Smith of U.S.F.W.S. assisted in the cutting and welding of the steel as Annette Scherer (also of U.S.F.W.S.), Mike Valent and Ellen Pehek of New Jersey Division of Fish Game and Wildlife, and Rick Dutko of New Jersey Division of Parks and Forestry helped in lugging materials and other duties. The State of New Jersey is currently negotiating with the current landowners to purchase over 2,000 acres which will include the mine entrance.

I personally wish to thank all of the people who have made this endeavor a reality: R. Curry, C. Day, S. Ellis, R. Fitzgerald, J. A. Frier-Murza, J. Hall, A. Hicks, D. Hensley, P. Lekos, E. Muller, D. Peters, P. Prall, R. Powers, R. Rapp, B. Reizfeld, A. Scherer, J. Sciascia, D. Taylor, M. Tuttle, and M. Valent, as well as the Northern New Jersey Grotto and all of the agencies and organizations mentioned above. Any omission of gratitude and recognition are inadvertent.

Rick Dutko, 75 Smithfield Avenue, Lawrenceville, NJ 08648

from Georgia

Dr. Daniel V. Hagan and graduate student Ronnie Spears at Georgia Southern University are working on a project with the Non-game Species Program of Georgia on identifying the understudied bats of Georgia's Coastal Plain. In addition, Ronnie spears is looking at the ectoparasites of several species of bats that roost together in the same roost as well as the arthropods that inhabit the roosts and guano. Very little literature records the ectoparasites that are parasitic to the bats of Georgia. We have discovered several large colonies of *Tadarita brasiliensis* and a few smaller colonies of the evening bats and big brown bats. Several bridges have been found to host *Pipistrellus subflavus* in the area around Savannah. We are using several methods of capture for collecting bats. Only five species have been identified at this time. Within the next few months we hope to have identified several species that have not been recorded for many years here in the southwestern regions of Georgia.

News continued on page 74

Meeting Announcements

The Ninth Annual Meeting of the Society for Conservation Biology

will meet June 7-11, 1995 at Colorado State University in Ft. Collins, Colorado. For additional information contact **Richard L. Knight,** Department of Fishery and Wildlife Biology, Box 334, Colorado State University, Ft. Collins, CO 80309-0334

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The American Society of Mammalogists

will hold their 76th annual meeting June 20-24, 1995 at the University of Vermont in Burlington, Vermont. For registration materials or other information please contact: **William Kilpatrick,** Department of Zoology, University of Vermont, Burlington, VT 05405-0086.
Tel. 802-656-0453 Fax. 802-656-2914 E-mail wkilpatr@moose.uvm.edu

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The 10th International Bat Research Conference and the 25th North American Symposium on Bat Research

will meet August 6-11, 1995 at Boston University in Boston, Massachusetts. Subscribers to Bat Research News have already received registration materials. Others may receive registration materials from the Conference Host, **Thomas H. Kunz,** Department of Biology, Boston University, Boston MA 02215

Tel. 617-353-2474 Fax: 617-353-6340 E -mail: kunz@bio.bu.edu

Registration forms, abstracts of papers to be presented and payment are due, mailed to Kunz no later than April 30, 1995

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The Seventh European Bat Research Symposium(ERBS)

will take place at the conference centre Konigshof, near Veldhoven, August 12-19, 1996. Veldhoven is located some kilometers south-west of Eindhoven, in the southern part of the Netherlands. The centre has numerous facilities. The symposium will consist of oral presentations, poster papers, workshops and evening discussions. Suggestions on other events that could be associated with the symposium are welcome. The conference language will be English. After the symposium, the 3rd European Bat Detector Workshop will be held in the Grand Duchy of Luxembourg. Preliminary registration forms are obtainable from **Peter Lina,** 7th ERBS, c/o IKC-NBLF, P.O. box 30, 6700 AA Wageningen, the Netherlands. Fax: +31837027561. Final registration forms and a circular with more details will be mailed in Summer of 1995 to those who reply positively to this preliminary announcement.

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If any reader knows of other bat-related conferences or meetings planned for the next two years kindly relay that information to Roy Horst for inclusion in future issues of Bat Research News.

First Record of the Greater Noctule, *Nyctalus lasiopterus* (Schreber, 1780) in the Netherlands

Joost Verbeek, Gemaal 9, 1613AM Grootebroek, the Netherlands

On October 3rd, 1993, a large bat was discovered flying about a gymnasium at the village of Bovenkarspel, province of Noord-Holland, the Netherlands. After catching the bat with a landing net, I took the animal home. It appeared to be a female greater noctule *Nyctalus lasiopterus*. The greater noctule is one of the three European *Nyctalus* species. It is one of the largest bat species in Europe and looks rather like the common noctule *Nyctalus noctula*. It is however much bigger and has a broad kidney-shaped tragus (Verbeek, 1993). The following measurements were taken: left forearm 62.8 mm, right forearm 62.4 mm, tail length 58.3 mm, ear length 22.8 mm, ear width 15.6 mm, wingspan 410 mm, and weight 36 grams. The bat was fed great quantities of mealworms (60 -80 a day) till it was released on October 20, 1993.

This is the first record of the greater noctule from the Netherlands and the north -westernmost occurrence of this rare species in Europe. There are only four reliable records from north-western Europe: Bavaria and Thuringia in Germany, Normandy in France, and one in June 1987 in Britanny, France. The distribution of the greater noctule covers the south of Eurasia and North Africa, from the Iberian peninsula and the south of France to the middle and lower Volga provinces in Russia, Gilan province in Iran and Ust-Urt Plateau in Kazachstan.(Ibañez, et al., in pre-p).

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Verbeek, H.D.J., 1993. Eerste vondst van de grote rosse vleermuis *Nyctalus lasiopterus* in Nederland. Lutra, Vol.36:81-85 .

Illustrated in the front cover on this issue.

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News and Letters continued:

From Pennsylvania

Ken Andersen of Gannon University in Erie, PA writes that he is still involved in monitoring bat activity with the Petterson detector. He is also using his computer program far analysis of this data. At the present time the detector is being used in Maryland by Dana Limpert who is running a comparative study between this detector and a narrow band model. Two continuing student projects are a survey of the success of bat houses in northwestern Pennsylvania, and a mark-recapture study of immature little brown bats found roosting on the sides of campus buildings. It is too early for results but we hope to have more to say after another year of work.

and from Roy Horst in New York

Jennifer Skutt, a graduate student, and Amy Cook, a senior, are assisting me in a study of the ways in which fruit bats, *Artibeus jamaicensis* and *Phyllostomus discolor* handle the seemingly large amounts of carbo-hydrates they ingest in relatively short periods of time. Our preliminary findings are that the animals are consuming far more calories than they appear to need to meet their metabolic requirements in captivity, yet the do not gain weight.

These two young bat workers are also geting their fair share of editorial experience as we prepare the program and abstracts for the "Big Boston Bat Bash" in August.

We will see you there, won't we?

RABIES IN BATS presents a comprehensive review of rabies and rabies-related viruses in bat populations worldwide, encompassing discussions of rabies in the blood-lapping vampire bats of Latin America; the fruit-eating bats of Latin America and Africa; and the insect-eating bats of North America, Africa, Europe, and Asia.

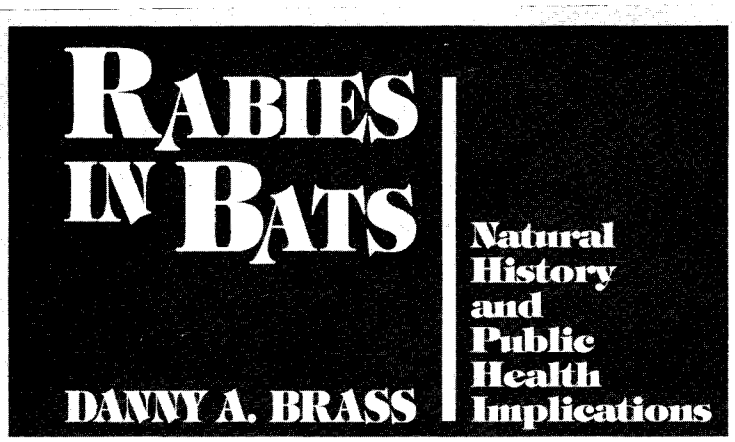
Rabies is a frightening and almost invariably fatal disease. Like all mammals, bats can become infected with this virus and have been known to transmit the disease to man and other animals. However, the irresponsible narratives that often characterize popular fiction have helped to forge a sinister image of these animals not at all consistent with scientific fact.

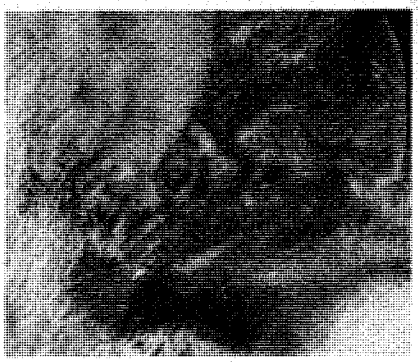
This fully illustrated text is a complete and up-to-date reference work, tracing the evolution of scientific thought and knowledge on bat rabies since the turn of the century. In exploring the nature of this disease in bats, the author considers species-specific epidemiologic importance and association with deep-rooted cultural phobias. Discussion focuses on the prevalence and distribution of rabies in bats, mechanisms whereby disease is maintained within various bat communities, the relationship of bat rabies to rabies in other animals (both wild and domestic), and the public-health significance of this disease in bat populations worldwide.

The author examines the scientific basis underlying modern concepts of rabies epidemiology in nonterrestrial (bat) reservoirs, particularly the strength of evidence linking disease in bats to that in terrestrial animals. In considering the global importance of bats to human health, the public-health hazards associated with bat rabies are placed in proper perspective.

Relevant aspects of bat biology and natural history are included. This is particularly true for discussions of vampire bats, since their unique hunting behavior and dependence on nightly meals of blood is so intimately related to their role in transmitting disease.

This book will be of great interest to anyone interested in bats and of enormous value to physicians, veterinarians, and public-health authorities, as well as zoologists and naturalists.





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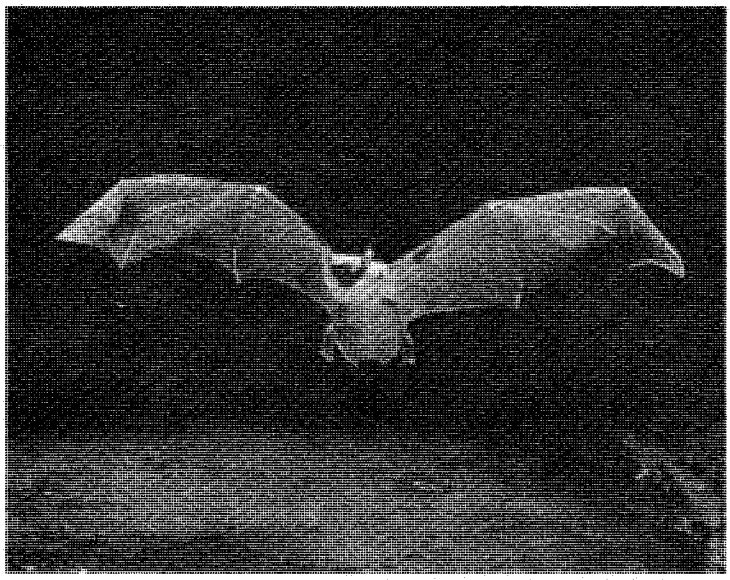

Several recent human deaths have been attributed to the rabies virus associated with silver-haired bats.

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BAT RESEARCH NEWS

Volume 35 **Summer and Fall** **Number 2 & 3**

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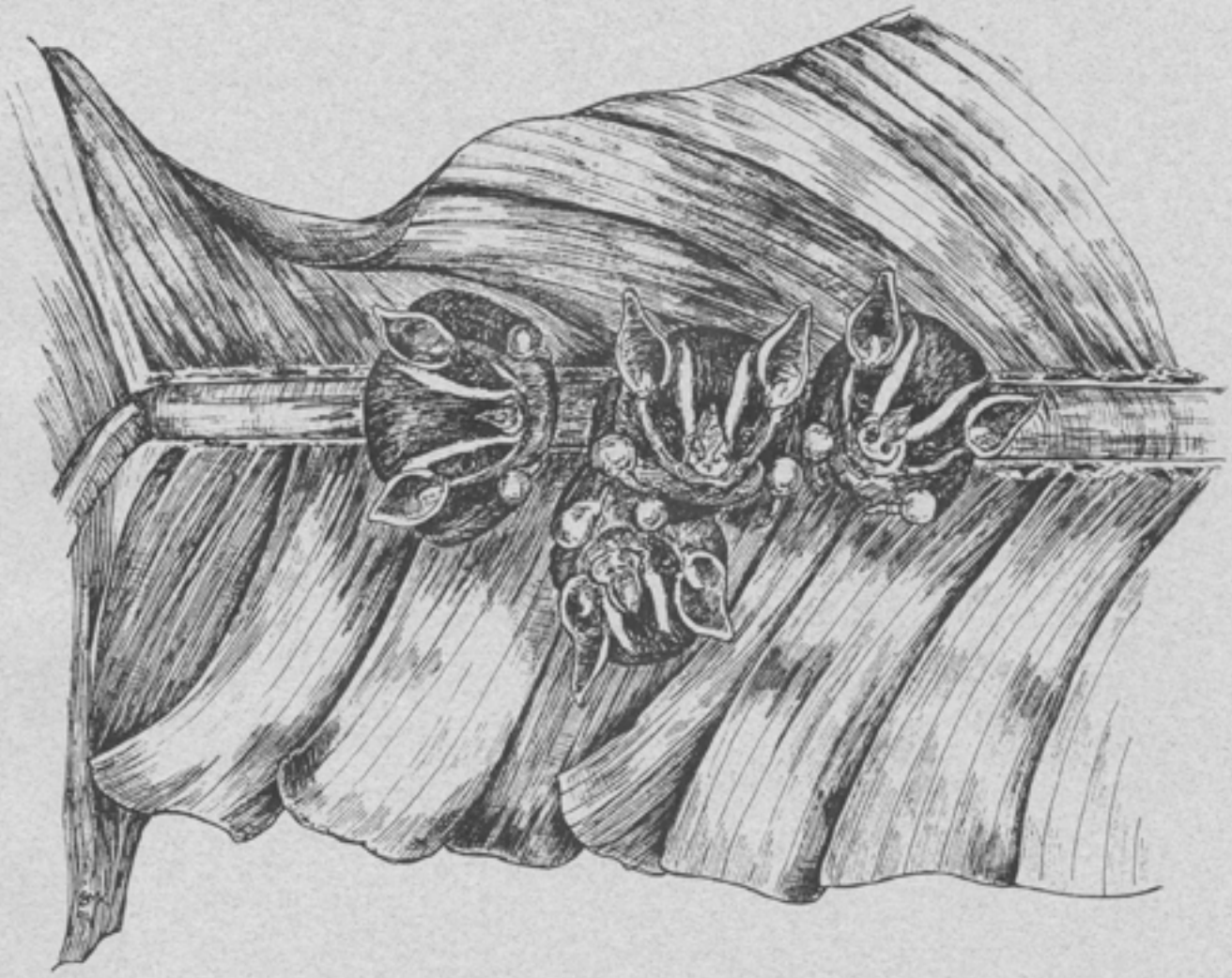
Front Cover

The very handsome greater noctule on the front cover this month was provided by Joost Verbeek to accompany his article (on page 74) documenting the first sighting of this species in the Netherlands. Our compliments on this very fine photograph.

BAT RESEARCH NEWS



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Publisher and Managing Editor
G. Roy Horst
Department of Biology
State University College at Potsdam
Potsdam, NY 13676
Tel. 315-267-2259
FAX 315-267-3170
E-mail: horstgr@potsdam.edu.

Editor
Thomas Griffiths
Department of Biology
Illinois Wesleyan University
Bloomington, IL 61702
Tel. 309-556-3230
FAX 309-556-3411
E-mail: griffith@vmd.cso.uiuc.edu.

Editor for Feature Articles
Allen Kurta
Department of Biology
Eastern Michigan University
Ypsilanti, MI 48197
Tel. 313-487-1174

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BAT RESEARCH NEWS

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An Invited Perspective:

Food Availability and Opportunistic Versus Selective Feeding in Insectivorous Bats

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

Food items eaten by insectivorous bats, as well as by most other vertebrate animals, vary depending upon availability of the food and selectivity by the predator. For most insectivorous bats, "available" prey consist of all flying insects that are within cruising distance of the bats' roost and that the bats are capable of capturing and eating. Insects consumed are then selected from those available. If bats or other animals simply ate whatever was available, they would eat everything present in an amount relative to which the food occurred. However, all predators select from available foods, as determined by several factors, including morphology of the predator, behavior of the prey item, ease of obtaining and utilizing the item, size of the predator and of the prey, nutritive value of the prey, and any predilection or preferences of the predator for certain prey.

Much has been written about opportunistic versus selective feeding in insectivorous bats. The approach generally used to determine whether bats feed opportunistically or selectively is to assess the insects available to the bats and to compare this with the foods actually eaten. Availability is assessed by sampling the insects present at the time and place where the bats are presumably feeding (Buchler, 1976; Kunz, 1988), whereas insects actually eaten are assessed by stomach or guano analysis (Whitaker, 1988). If the two sets of data coincide, one concludes that the bats are feeding opportunistically. If prey eaten by the bat differ significantly from those caught by the biologist, one concludes that the bats are selecting certain items over others (e.g., Anthony and Kunz, 1977; Swift and Racey, 1983). The purpose of this paper is to discuss two broad questions. First, what does "availability" of food to insectivorous bats mean, and how should it be determined? Second, do bats feed opportunistically or selectively?

What Is the Availability of Food to Insectivorous Bats, and How Should It Be Determined?

The first step in examining availability versus selectivity is to determine which items are available. However, reliable estimates of availability are very difficult and perhaps impossible to obtain. There are at least three problems. First, we do not directly assess the insects that are available to bats, instead we only sample insects where some bats happen to be feeding. In reality, we probably are sampling availability to us and to our collecting devices, rather than true availability to the bats, because availability to us and availability to the bats may be quite different. A second problem is that bats may have filled their stomachs somewhere else and then flown to the site where we happen to be assessing "availability."

A third, and much bigger problem is that bats are mobile and fly to selected feeding areas. Actually, insects "available" to bats are those that are reasonably close to the bats' roost, in the proper size range, and in a place where bats can fly. The bats exhibit selection simply by flying to their specific or preferred feeding sites. For example, big brown (*Eptesicus fuscus*) and evening bats (*Nycticeius humeralis*) feed where coleopterans are concentrated, long eared bats (*Plecotus*) select areas high in lepidopterans, and many mouse-eared bats (*Myotis*) select sites where dipterans are abundant. By flying to specific feeding areas the bats select against or avoid insects available to them at other potential sites within their effective feeding range. When biologists collect "availability" samples at sites where bats are feeding, biologists are using the same basic selectivity that the bats are using.

If the "available" insects are those within a reasonable distance from the bats' roost, then to assess availability in a realistic manner, biologists should assess insects in each habitat within that distance, rather than just at the actual feeding site. Then the insect data could be prorated by the percentage of each type of habitat within the overall feeding distance. This would give a much different, but probably more accurate, picture of food availability, although it might be impractical from a biologist's perspective.

Another minor problem is that we count insects for availability estimates and present the data in terms of percent of the total catch, but we usually present food habits data as percent volume (percentage by volume of each food item in the total sample) or, worse, by percent frequency (the percent of stomachs

or scats in which an item occurs). For best comparison of this sort, we should present food habits data in the same manner as the availability data, i.e., percent of the total number contributed by each insect type. This is much harder to do, but the minimum number of each type of insect in each scat could be estimated. For example, if the bases of three beetle hindwings are present, two left and one right, one could estimate a minimum of two beetles in that scat; three left forewings would indicate three beetles. For chironomids, head capsules probably could be counted, and the percentage of each item present could be calculated; for example 10 chironomids out of 200 insects present would be 5%.

Do Bats Feed on the Basis of Opportunism or Selectivity?

Researchers often have asked whether bats feed opportunistically or whether they choose from among the available prey. This is the wrong question, because bats can not eat what is not available. They must eat (select from) the available foods. Thus, foods eaten are a balance between availability and selectivity. As indicated above, there are two levels of selection by bats. The first occurs when the bats select their feeding area. The second occurs when the bats select among the insects within their chosen feeding areas. The first level probably is, by far, the most important, because it gets the bats to where the preferred insects are. However, availability in most studies is assessed at the second level, without regard for the first level.

Discussion and Conclusions

If all insectivorous bats simply ate whatever was available, all would eat basically the same foods. All bats do not eat the same foods. Since several species of bats occur together at many localities, it is advantageous for bats to partition the food supply--but not too completely. Moths, beetles, and flies are some of the more important groups of nocturnal flying insects and are almost always available. Some bats have evolved to feed heavily on these groups, and one can predict what they eat based on previous data. For example, *Eptesicus fuscus* and *Nycticeius humeralis* feed heavily on beetles and true bugs, *Plecotus* and *Lasiurus cinereus* on moths, and many species of *Myotis* on flies and small moths. However, as in other animals, it is advantageous for bats not to become over-specialized, and they retain the ability to vary their food based on changing conditions. If their normal foods are scarce, they would be able to feed on other items.

Also, there are some valuable food items that apparently occur too sporadically for bats to specialize on them--for example, caddisflies, mayflies, termites, and ants. On the other hand, many bat species will concentrate opportunistically on these insects when they become available in an area.

Evolutionary adaptation is another factor to consider. Bat species evolve differentially as they feed on different food resources, enabling the bats to take better advantage of those specific resources. For example, vespertilionids and molossids that feed on beetles typically have much stronger jaws than related species that feed on moths and flies (Freeman, 1979, 1981). Also, different species have evolved different echolocation strategies (e.g., Aldridge and Rautenback, 1987; Barclay and Brigham, 1991; Neuweiler, 1983) and wing morphology (Norberg and Rayner, 1987). These behavioral and morphological differences constrain where and how bats feed.

Hopefully, this paper will draw attention to the difficulty of collecting reliable information on foods that are available to bats and suggest that such data be interpreted with caution.

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An Infrared Video System to Count and Identify Emerging Bats

Luisa Rodrigues and Jorge M. Palmeirim
Instituto da Conservacão da Natureza, Rua Filipe Folque 46-2, P-1000 Lisboa,
and Dept. Zoologia, Faculdade de Ciências, Universidade de Lisboa, P-1700 Lisboa, Portugal

Introduction

Determining the number of bats in a roost can be a difficult task because of problems of human access to the roost and difficulty in finding the bats when they hide in crevices. Furthermore, in some roosts, there are large numbers of bats of various species, which are often too active to be identified and counted inside the roost. These problems are particularly serious in the case of underground roosts.

To overcome these difficulties, various authors recommend doing emergence counts at roost entrances, assuming there is enough light (e.g., Gaisler, 1979; Humphrey and Cope, 1976; Swift and Racey, 1983; Thomas and LaVal, 1988). However, under low-light conditions, these counts are difficult or impossible, particularly when there are large numbers of bats. When the number of bats is so large that the flow at the entrance can be considered regular, a sequence of pictures of the emerging bats can be used as samples from which the total number of bats leaving the roost is estimated (Humphrey, 1971; Rodriguez-Duran and Lewis, 1985). However, in most situations it is necessary to count individual bats, and it is usually desirable to distinguish among different species. We developed a method to obtain this type of data using an infrared-sensitive video camera, a video recorder, an infrared light source, and a bat detector.

Description of the System

The full system is shown in fig. 1. The entrance of the roost is illuminated with an infrared light source. A video camera receives images that are recorded by a video recorder. If there are several species of bats in the roost, it may be difficult to separate the species by the image alone. Therefore, the calls of the flying bats are recorded on the soundtrack of the video by connecting a bat detector to the audio input of the video recorder. The video tape of the emergence can then be played back in perfect synchronization with the sound recording. The image/sound combination makes it possible to identify bats of many species, especially if the observer already knows which species are present in the roost.

Video Camera. It is important to select a camera that is quite sensitive to infrared light, or you will have to use very strong infrared (IR) light sources. There are cameras that are sold specifically for IR applications, but these can be expensive. However, most black-and-white surveillance cameras are also satisfactorily sensitive to reflected IR. Actually, many of these cameras are fitted with filters by the manufacturer to exclude IR radiation, because it is undesirable for many applications. This is a good sign, because it shows that the camera is actually quite sensitive in the IR. The camera that we use is a Vicon VC-2400. Its sensitivity, without an IR filter, is 0.6 lux with the lens at f/1.4. Most large, video equipment manufacturers offer equivalent cameras, some of which specify a good IR response. Edmund Scientific , for example, sells a camera that seems to be quite sensitive in the IR for about US $800, but we have not tried it. If you want to count the bats passing a camera, a fixed shutter speed of 1/50 sec is adequate. But if you want to get sharp images of bats, you should get one with an adjustable shutter with higher available speeds. To cope with poor light conditions, it is important to get a lens with a large aperture (ours is f/1.2).

Video Recorder. If you are planning to use your system where mains power is not available, the easiest approach is to use a portable video recorder with a built-in monitor. There are many models available, but they are quite costly (above US $1000). We use a Sony GV-300E. It has separate video and audio inputs jacks that are convenient features common to many other models.

Bat Detector. Any bat detector that has an output for a tape recorder can be used. If the detector has both heterodyning and divider systems and the video recorder has stereo sound input, you can record one system in each channel.

IR Source. To film flying bats without disturbing them, it is necessary to have a source of light that they can not see, but to which the video is sensitive, i.e., reflected IR. This is electromagnetic radiation with wavelengths just a bit longer than those of the visible red. It is often confused with the emitt-

ted IR (or thermal IR), which has much longer wavelengths and is emitted by all objects, such as the bodies of warm animals.

It is possible to get IR light by simply placing an IR filter (obtainable from photographic supply shops or Edmund Scientific) in front of an incandescent light bulb. However, such settings are energetically very inefficient, and get very hot. Some video camera manufacturers also sell IR light sources--but for a very high price. You can build your own source very cheaply with IR light-emitting diodes (LEDs) and a few resistors.

When building your own, it is critical to select the right LEDs, because some are too weak or emit a very long wavelength to which the video camera is barely sensitive. We use Gallium-Aluminum-Arsenide high-output LEDs that emit energy at 880 nanometers and have a minimum radiant power output of 3.4 mW/cm^2. These LEDs have a very wide light beam, which is an advantage in most situations. There are also LEDs with narrow beams (e.g., Radio Shack's 276-143). LEDs have to be mounted in series with a resistor. For a single LED the appropriate resistance value (R_S) can be calculated with the following formula:

R_S=(Supply voltage-LED voltage)/LED current.

In our illuminator, powered by 12 volts DC, we mount 8 of the these LEDs in series with a 10 Ohm resistor. The illuminator has two of such series, with a total of 16 LEDs. This is just enough to illuminate the entrance of a cave that is about 1 x 1.5 meters in size. For larger entrances, we use several similar illuminators.

Power Supply. We use 12-volt, rechargeable, lead-acid batteries. These are convenient, because we can use the same battery for the IR illuminator, video camera, and video recorder (with a car-battery adapter). Although a single battery with a 6.5 amp-hour rating can power these components for about 5 hours, we often use separate batteries, which allows us to place the components far apart.

Setting Up the System

Place the video recorder far enough from the flyway to avoid disturbing the bats. To do this, you probably will need a long cable to connect the camera to the recorder. Using a tripod, position the camera so that the whole entrance is visible on the monitor. Place the IR light(s) as close as possible to the flyway. You will need more light if the background is dark. Adjust the aperture of the lens, taking into consideration that any daylight that may still be available will slowly disappear.

In may situations, the detector should be perpendicular to the flow of the bats, rather than pointing at the entrance, to avoid mixing the signals of the passing bats with those of animals flying inside the roost. If this orientation is not enough to eliminate those signals, you may want to reduce the angle of reception by placing the detector between two pieces of an absorbent material (e.g., foam or cork). Adjust the gain of the detector to avoid much overload, and eliminate the sound from the built-in speaker; you can hear the bats on the recorder, preferably using headphones.

Analyzing the Results

Play back the tape of the emergence, and count the bats flying out of the roost. If there are too many bats to count, or if they leave in groups, you may have to view certain sections in slow motion, or even to stop the image for a few seconds. To keep track of the bat count, it is helpful to keep the tape counter on. The sound track of the video will allow you to identify many bat species. Choose the heterodyning or divider channels depending on the frequencies of the calls of the species present in the roost. However, if the species present have calls with very different frequencies you may have to use the divider. In certain circumstances, it may be effective to use both channels to record the signals of two heterodyning detectors, tuned to different frequencies.

With a little experience, identifying the bats by listening to the soundtrack of the video tapes becomes an easy task with many species. However, when bats with very similar calls are present, it may be necessary to analyze the sound using a sonograph or digital sound-analysis system. To do this efficiently, it is important that the system shows the processed signals in real time. We use a German system--SONA PC, marketed by Medav (fax: +49 9131 58311).

If there are a large number of bats leaving the roost simultaneously, it becomes difficult to count the bats on the video recording. In such situations it may be advisable to count the bats on just a few samples of the recording (viewing the video in slow motion or frame by frame) and extrapolate to the total period of emergence. Care has to be taken, since the rate at which bats leave the roost may not be the same throughout the emergence period.

The total cost of our system was almost US $3000, but it may be possible to find cheaper components.

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R. Arlettaz made some suggestions based on a video system that he used to study intraroost behavior.

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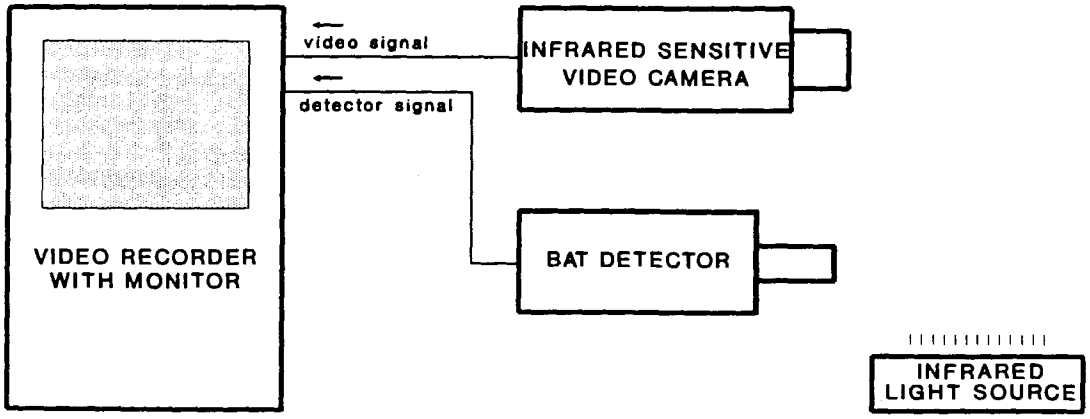

Figure 1. Diagram of the infrared system.

Longevity Records for Two Vespertilionids

J. Mark Perkins, 2217 E. Emerson Avenue, Salt Lake City, UT 84108

The life spans of bats are exceptionally long compared to other mammals of their size (Herreid, 1964). Longevity records contribute to clarifying survival rates, to examination of differences in sex ratios, and to an understanding of the enormity of loss when roosts are vandalized (Stebbings, 1966). I report here a new longevity record for *Plecotus townsendii* and the first documentation of longevity in *Lasionycteris noctivagans*.

An adult male *L. noctivagans*, originally banded at McGraw Lookout, Wallowa Co., Oregon, on 17 July 1989, was recovered and released at a pond, approximately 4 km W of the original capture site, on 12 August 1993. Minimum age for this individual is 4 years 26 days. In addition, I have recaptured other *L. noctivagans* in Wallowa County, with minimum ages up to two years two months. Schowalter et al. (1978) examined dental annuli of 46 *L. noctivagans* and speculated that some of their bats lived as long as 12 years; however, those authors examined no known-aged animals and could not verify the age estimates obtained from annuli. There does not appear to be any other published report concerning longevity in *L. noctivagans*.

A male *P. townsendii* was captured and banded (USFWS anodized band #321) by James Anderson at Skeleton Cave, Deschutes Co., Oregon, during November 1969. I noted the bat during two, successive, hibernaculum-monitoring counts (January 1989 and January 1991) at SR Cave, approximately 5 km SE of the original capture site. Minimum age for this individual is 21 years 2 months, exceeding the prior record for this species by five years (Paradiso and Greenhall, 1967). For comparison, Lehman et al. (1992) reported a longevity record of 30 years for the congener *P. auritus*. Although these records are modest data in the realm of bat research, they do serve to remind us that extirpation or vandalism of only 100 *Plecotus townsendii* represents a potential loss of 2,000 years

of animal life.

Acknowldegments

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Cimex pilosellus (Hemiptera: Cimicidae) on Mexican Bats

Oscar J. Polaco, Isabel Bassols, and Margarita Vargas
Departmento de Zoología, Instituto Politécnico Nacional, Col. Santo Tomás, México, D.F. 11340

The bat bug, *Cimex pilosellus*, was described from British Columbia and is now known from western Canada to central Mexico. This parasitic species is found mainly in bat roosts and, occasionally, on bats. Most known hosts are in the bat family Vespertilionidae (Usinger, 1966; Marshall, 1982).

The only previous specimen known from Mexico is that of a male bat bug collected from a *Natalus mexicanus* (= *N. stramineus*)--a specimen that extended the parasite's distribution to Mexico City and incorporated the bat family Natalidae among the known hosts of *C. pilosellus* (Hoffmann, 1944, 1972). Since 1987, however, a project entitled "Studies on the Association between Arthropods and Mammals" has been carried out at the Escuela Nacional de Ciencias Biológicas (ENCB), Instituto Politécnico Nacional (IPN), and the Subdirección de Servicios Académicos, Instituto Nacional de Anthropología e Historia (INAH). During this project, several bats harboring *C. pilosellus* were collected. All bats were deposited in the comparative osteological collection at INAH, and the bat bugs, in the acarological collection at ENCB. These bats belonged to three species of the family Vespertilionidae.

Antrozous pallidus. Two male pallid bats were collected at the community of Punta Chueca, Sonora. Two female bat bugs were found on one of the bats that was taken on 13 April 1993, . The bugs adhered to the wing membrane, in the angle formed by the distal forearm and the proximal metacarpals (one bat bug on each arm). The occurence of the bat bug on this host had been previously reported (Usinger, 1966).

Rhogeessa tumida. One female bat bug was recovered from one of two female bats collected at San Juan Evangelista, Veracruz, on 4 July 1989. The bat bug was found adhered to the ventral uropatagium and had seven small eggs inside it. *R. tumida* is a new host for *C. pilosellus*, and this specimen became the most southern record of this parasite, extending its known distribution southeastward by approximately 450 km.

Pipistrellus hesperus. Thirty-three specimens of this bat were collected over a small pond in Bustamante, Nuevo León, on 8 December 1992. Bed bugs were found on eight of them. One individual had two bat bugs, whereas the rest had only one. The bat bugs were located on the host in the same place as on *A. pallidus*, even in the case in which two of them were found. The bat bugs consisted of three males and six females, and there was no relation between the sex of the bat and that of the bat bug (Table 1). This host had already been recorded for *C. pilosellus* (Usinger, 1966).

In all cases, both bats and bat bugs were adults. All bat bugs were full of blood, with the bite site being the only noticeable harm. Both the morphological characteristics and the measurements taken from the bat bugs (Table 1), corresponded to *C. pilosellus* and showed no differences among hosts or localities. These records suggested that *C. pilosellus* occurs more frequently and has broader host associations on bats in Mexico than previously supposed.

Acknowledgments

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Catalog Number	Bat Sex	Bat Bug Sex	Total Length	Total Width	Head Length	Head Width	Antennae Length	Pronotum Length	Pronotum Width	Pronotum Bristles	Length/Width Hemelytral Pads
6244	F	F	4.82	2.18	0.53	0.78	?	0.49	1.25	0.12	1.71
2481	F	F	5.42	2.49	0.64	0.82	1.46	0.48	1.32	0.11	1.50
2487	M	F	5.96	2.88	0.64	0.85	1.57	0.46	1.42	0.11	2.41
2488	F	M	5.14	2.35	0.53	0.74	1.35	0.46	1.28	0.12	1.78
2494	F	M	4.60	2.19	0.53	0.74	1.37	0.42	1.17	0.13	1.91
2496	F	M	5.39	2.24	0.53	0.74	1.42	0.46	1.20	0.13	1.70
2506	F	F	5.60	2.60	0.60	0.78	1.24	0.42	1.32	0.10	2.00
2507	F	F	5.24	2.21	0.57	0.78	1.33	0.42	1.17	0.13	1.80
2513	M	F	5.44	2.14	0.53	0.78	1.46	0.46	1.35	0.15	1.70
2513	M	F	4.99	2.24	0.53	0.74	1.35	0.46	1.28	0.12	1.90
2682	M	F	5.82	2.82	0.67	0.85	1.64	0.51	1.39	0.13	1.80
2682	M	F	5.21	2.67	0.60	0.85	1.57	0.49	1.24	0.14	1.80

πTable 1. Measurements (in mm) of bat bugs (*Cimex pilosellus*) from Mexico

The 10th International Bat Research Conference and the 25th North American Symposium on Bat Research

will meet August 6-11, 1995 at Boston University in Boston, Massachusetts. Subscribers to Bat Research News have already received registration materials. Others may receive registration materials from the Conference Host.

Thomas H. Kunz,
Department of Biology, Boston University, Boston MA 02215
Tel. 617-353-2474 Fax: 617-353-6340 E-mail: kunz@bio.bu.edu

Registration forms, abstracts of papers to be presented and payment were due, mailed to Kunz no later than April 30, 1995.

However, it is never too late to register to attend, right up until arrival at the conference. **AND**, if you have a poster you would like to present, there is still time to squeeze it in, but you must have your poster title and abstract(as well as registration fee) in my hands no later than June 15th. E-mail to "horstgr@potsdam.edu" or FAX to 315-2676-3170. Last chance for fame and glory.

G. R. Horst

Letters to the Editor:

Editor's Note. With this issue, we are beginning a new (reviving an old?) feature in **Bat Research News** by including letters to the editor. Unlike technical articles, such letters will not be peer reviewed, but they will be edited for grammar, style, and clarity. Our intention is to provide an outlet for opinions, speculations, anecdotes, and other interesting observations that, by themselves, may not be sufficient or appropriate for a technical article. Letters should be no longer than two manuscript pages and should be sent to the Feature Editor.

A Huge Colony of the Dog Bat, *Rousettus leschenaulti*, in South India

M. K. Chandrashekaran and G. Marimuthu,
Department of Animal Behaviour and Physiology,
School of Biological Sciences, Madurai Kamaraj
University, Madurai - 625 021, India

In June 1992, we drove down to Tirunelveli (8°44'N, 77°42'E), 170 km south of Madurai and a one-hour drive from the southernmost tip of peninsular India, and saw a huge colony of fruit bats, *Rousettus leschenaulti*, occupying a temple. We estimated that there were more than 10,000 of these dog bats, even though Brosett (1962) estimated that the largest colonies of *Rousettus leschenaulti* contained only 1,000-2,000 individuals. Thousands of these bats were cramped into the various quarters of this lovely temple, now in ruins, but believed to have been built around the 12th Century A.D. In some chambers, the bats raised a shrill chorus on being disturbed and flew about in a clumsy fluttering flight. Often they collided against one another with some landing on the floor, and a stray dog made a meal of some of these hapless bats. Several bats flew out of the temple, but interestingly, they did not hide themselves in the branches of the many trees, perhaps bearing out Brosset's (1962) categorical statement that "this bat never lives in trees as *Cynopterus* and *Pteropus* usually do."

Most of the ripening mango fruits in the vicinity of the temple had been bitten into. *Rousettus* is believed to be less damaging to orchards than *Pteropus giganteus* and is supposed to subsist on wild berries and figs and fruits. We captured 13 bats and kept them in captivity for three weeks in an outdoor enclosure (7.5 x 3.4 x 3.5 m), where they were fed with fully ripe bananas, papayas, grapes, and custard apples. During the night, they flew within the enclosure. A Mini-2 bat detector (Ultrasound Advice) picked up ultrasounds of 20 to 50 kHz, which were emitted by the flying bats and may have been used for orientation. *Rousettus* is the only megachiropteran bat which employs echolocation by means of orientation clicks produced with their tongue (Suthers 1988, pp. 23-46 in Animal sonar processes and performance, Plenum Press, New York).

Spatial Memory in Some Insectivorous Bats of India

M. K. Chandrashekaran, Dept. of Animal
Behaviour & Physiology, School of Biological
Sciences, Madurai Kamaraj University,
Madurai - 625 021, India

In our laboratory at Madurai (9°58'N, 78°10'E), we have been working on the spatial organization of roosting and roost fidelity of insectivorous bats. Selvanayagam and Marimuthu (1984, Behav. Processes, 9:113-121) reported from their cave and laboratory studies that individuals of a cave-dwelling colony of *Hipposideros speoris* roosted singly and maintained fidelity to their roost sites for long periods. The males marked their roosts with urine and used olfactory cues in relocating their roost sites, but the females, which did not urine-mark, appeared to relocate roost sites by recognizing the position of neighboring conspecifics. We have also since noticed in laboratory experiments a strict hierarchical order exists in roosting among males of *H. speoris*, with the dominant male occupying the "highest" spot in observational cages and sub-adult males accepting lower positions (T. R. Radhamani, unpublished).

On the subject of roost fidelity and "spatial memory," we have an interesting anecdote to share with the readers of **Bat Research News**. We captured 12 *Rhinolophus rouxi* from the cellar of a gun house, in Mysore, roughly 350 km from Madurai. On returning to Madurai, we released them into a cage (50 x 50 x 50 cm) with a sleeve on one side to enable us to feed the bats. On one occasion, the sleeve had not been properly secured by oversight. One of the bats had escaped and flown out of the laboratory through an open window at night. On the third night, interestingly, the errant escapee had apparently returned through the open window, at an unknown nightly hour, and was found hanging on the outside of the cage. This is a possible case of spatial memory that the bat had acquired over a period of a few weeks in its new home. Neuweiler and Moehres (1967, Z. vergl. Physiol., 57:147-171) had indeed reported for another Indian bat, *Megaderma lyra*, that its spatial memory was good six weeks after the last training session.

An Unusual Concentration of Hoary Bats in Illinois

Allen Kurta and Rod Foster
Department of Biology,
Eastern Michigan University, Ypsilanti, MI 48197

Although the hoary bat has a very large geographic range, it is very uncommon in many regions of the Midwest (Barbour and Davis, 1969, Bats of America, Univ. Press Kentucky). For example, less than 35 hoary bats have been captured in nine seasons of mist-netting in Michigan (A. Kurta, unpubl. data). In addition, Hoffmeister (1989:123, Mammals of Illinois, Univ. Illinois Press, Urbana) stated that the hoary bat is not "abundant anywhere in Illinois." Consequently, our recent discovery of an area where hoary bats apparently are common is worth recording.

Between 21 June and 13 July 1991, personnel from Eastern Michigan University and Perino Technical Services, Inc., conducted a bat survey along Panther and Cox Creeks, S and W of Chandlerville, Cass County, Illinois. The survey was part of an environmental assessment for a large parcel of land that the Illinois National Guard considered developing into a new training base. The study area was dominated by fields of soybean and corn that were planted in upland loess soils and in narrow strips of bottomland near the creeks (Kurta et al., Amer. Midl. Nat., 130:405-407). The land was generally flat except where the streams had cut steep valleys into the otherwise level uplands. Deciduous forest of variable composition bordered the creeks and often covered the steep slopes separating the bottomland and upland fields.

Our mist-netting protocol called for erecting large net systems (usually 9 m high and 5-13 m wide) over the creeks and continuously monitoring the nets until 2 A.M. (CDT). Each night, three such systems were erected, approximately 100 m apart, and netting took place on 14 different nights at sites that were about 1 km apart, for a total of 42 net-nights over 14 km of stream. All bats were punch-marked for future recognition (Bonoccorso and Smythe, 1972, J. Mammal., 53:389-390).

Captured bats included 53 red bats (*Lasiurus borealis*), 25 hoary bats, 6 Indiana bats (*Myotis sodalis*), 5 big brown bats (*Eptesicus fuscus*), and 2 evening bats (*Nycticieus humeralis*). Thus, hoary bats made up 27% of the 91 bats caught. The hoary bats included 11 adult females, 1 adult male, 6 juvenile females, 6 juvenile males, and 1 individual that escaped before sexing/aging. Nine of the adult females were lactating, and another had well developed mammary glands with expressable milk, although hair regrowth had begun, suggesting that she was in very early postlactation. One adult female apparently was nonreproductive.

The most distinctive feature of the study area to us was its lack of humans. Entire sections (1-mile2 areas) were devoid of houses or other buildings. This likely explained the paucity of building-dwelling bats (e.g., *E. fuscus* and *M. lucifugus*) and the dominance of tree-roosting species in the total catch, but it did not explain why hoary bats were so abundant. The early summer dates, the presence of barely volant juveniles, and the large number of lactating females indicated that these bats were indeed residents and not part of a migratory wave. Why hoary bats were common here and not in other areas of Illinois was unclear, but our data did show that the species was locally abundant in contrast to Hoffmeister's assertion.

Infectious Disease and Bat Research: an Inquiry

Gary F. McCracken
Department of Zoology
University of Tennessee, Knoxville, TN

Bat researchers are at particular risk for infectious diseases. We immunize against rabies and know that histoplasmosis is an occupational hazard, but typically we don't worry or know much about the myriad of other pathogens to which we are exposed. Neither do we think much about what they might do to us. Here I share my own experience with an infection that may be connected with bats or caves. I know other bat researchers also have had similar symptoms. My goals are to alert you of a potential occupational malady, and to obtain information on its frequency among bat researchers.

In 1988, shortly after returning from research on Mexican free-tailed bats, I experienced painful, bilaterally symmetrical joint inflammation, first in my shoulders, and then in my hip[s and lower back. Nonsteriodal, anti-inflammatory drugs (NSAID'S) were partially effective in alleviating the symptoms. The inflammation persisted for about nine months, and then subsided. I was free of pain for about six years with no permanent joint impairment. In 1994, the inflammation returned, again bilaterally symmetrical and beginning at the shoulders. This time it spread to my hips, lower back, hands and to a lessor degree, feet. The second bout was severe and longer lasting than the first. When NSAID'S were largely ineffective, I received corticosteroid injections. Last summer, it was suggested that I begin treatment with methotrexate, an immune suppressing

chemotherapy often taken by people with rheumatoid arthritis. I did not take methotrexate. At present my symptoms have largely subsided.

Infectious arthritis is well known in the medical literature. These diseases often involve multiple joint inflammation, and frequently, but not always, the symptoms are self-limiting(i.e., are temporary). I have long suspected and infection, possibly from bats or caves as the cause of my problem. However local rheumatologists discouraged me from pursuing this possibility. The standard lore in rheumatology appears to be that an infectious agent can initiate an auto-immune response that causes joint inflammation, but that the infection itself is usually shortlived, and cannot be treated effectively unless it is identified very early in the cycle. Standard medical practice, following from standard lore, is to alleviate symptoms by using NSAID'S or, if they don't work, by suppressing the immune response with corticosteroids or chemotherapies like methotrexate These latter treatments are dangerous and if you have an active infection they can prolong and intensify the disease.

A profile of my immune system shows that I have an active infection. Antibody challenge tests identify it as a fungus. X-rays of my lungs show calcified nodules of earlier histoplasmosis, but there is no evidence that it is currently active. My Histoplasma antibody challenges are negative. Presumably my infection is something other than Histoplasma.

A growing body of medical literature, as well as my own experience, suggest that the connection between inflammatory joint disease and chronic infections is underrated. Treating an ailment that may be caused by an infection with therapies which suppress the immune system is potentially dangerous.

I know other bat researchers who have had similar joint problems. I'm curious about the prevalence of this problem among us and I'm collecting data. I'm not interested in you old folks (like Horst) who may have a sore shoulder or a worn-out knee. Almost all of us have had histoplasmosis, and I'm not collecting histoplasmosis horror stories. If you only suspect that you have had this problem, you probably haven't: if you've had it, you know you have! The important symptoms are intense pain resulting from inflammation that involves multiple joints and is usually bilaterally symmetrical.

If you have had this experience my questions are:\

1) Was the onset sudden or gradual

2) What joints were involved?

3) How did you treat the problem?

4) Did the inflammation go away? If so, how long did it last?

5) Have you had multiple episodes? If so answer questions 1 to 4 for each episode. Also what was the duration of each episode?

6) Has your problem been diagnosed? Has it been connected with an infection? Is there any connection with bats or caves?

I'm interested in anything else that you feel is relevant. I will treat your response as confidential. I'll be happy to share the results of this survey. Please respond to:

Gary McCracken, Department of Zoology,
The University of Tennessee, Knoxville, TN
37996
e-mail gmccrack@utk.edu

British Bats as Protectors of the Human Race in Great Britain

Peter Webb
Mammal Research Institute, Dept. of Zoology,
University of Pretoria, 0002 Pretoria, South Africa

In the spring of 1992 I was busy cleaning out accumulated bat guano from a pipistrelle bat(*Pipistrellus pipistrellus*) maternity roost in the rather small roof space of an old house in North-East Scotland. While wedged horizontally beneath the gables shovelling handfulls of dusty guano into an old feed sack, a combination of anoxia, methane and ammonia inhalation led to an elevated mental state in which I was able to perform the following analysis in a flash of lucidity.

The roost had been cleaned out eight years before since an average of approximately 620 adult females had used the roost for around 82 days each year to raise their young. In this time these bats had deposited 45 kg dry mass of the above mentioned guano. If we assume an assimilation efficiency of 85% and a water content fro insect prey of 70% wet weight, then these 45 kg of guano are the end result of the consumption of 1000 kg wet weight of insects, or 2.5 g per bat per day. Extending this rate of food consumption to a non-hibernal period of 215 days per year gives an estimate for the rate utilization by bats of 0.54 kg per bat per year.

Recently John Speakman has estimated the total number of bats residing in Great Britain to be in the region of 5.8 million implying a total annual rate of insect consumption by British bats of 3.13 thousand tonnes. This is equivalent to 1.42×10^{12} mosquitoes of mass 2.2 mg each. I have personal experience of numerous mosquito blood meals and estimate them

to be in the region of 1 mg of blood a sitting. As the average human being has a body mass of 65 kg and blood content of 5.58 kg (9% of body mass) this means that the British bats are effectively preventing the complete drainage of blood from 243,000 people each year. If the mosquitoes were malicious and only drew enough blood from each person to kill them, (2 kg) this would result in the death of approximately 710,000 people in Britain every year. A loss of manpower the British economy would at present be unable to support for more than 4 years. I have been unable to compute the global impact of such decimation but suspect that it would exceed the human casualty toll inflicted by sharks, spiders, snakes, and crocodiles combined.

I have yet to hear a more compelling argument for the prioritisation of bat conservation.

[Ed. note: "Glotta en bucca?"]

News from Your Colleagues

From Louisiana:

I began my Ph.D. work last September at the University of Southwestern Louisiana studying under Dr. Paul Leberg, whose area of interests are vertebrate ecology and evolution, conservation, and population, and who has had some experience working with bats. What I'd like to do, funds permitting, is study the effects of older-growth forest habitat disturbance (of an anthropogenic nature) on forest-roosting bats here in Louisiana. More specifically I'd like to look at how bat communities respond to such things as habitat destruction and large-scale fragmentation. Some of the species I may look at include: red bats, hoary bats, big brown bats, southeastern *Myotis*, Rafinesques big-eared bats, seminole bats, and some others. Southeastern *Myotis* and Rafinesque's big -eared bats are category 2 endangered species in Louisiana. I may work in upland fire-maintained pine communities or bottomland hardwood habitat - - depending on funding oppurtunities. Right now I need to whittle away at and focus my ideas into a workable research plan - as was kindly pointed out by a faculty member at my first ever departmental seminar. I've been able to procure some equipment (a couple Anabat detectors and some mist nets) and have applied for a couple of small grants (Bat Conservation International and American Museum of Natural History). I will spend the summer doing a lot of surveying that will familiarize me with my equipment and create a foundation for later research. I am more than a little excited for summer to arrive. In a certain sense, I owe a great deal of my interest in bats to Dr. Hal Black, who was my undergraduate professor advisor at Brigham Young University. He instills an enthusiastic fascination about bats in just about everyone who associates with him. I would be happy to communicate with any of the readers of Bat Research News who might share my interests.

Richard Lance
"rfl5640@usl.EDU"

From Tennessee:

Research Activities in Gary McCracken's Lab: We continue to use molecular gene markers to investigate interesting questions concerning evolutionary ecology, behavior, and conservation in natural populations of bats. One project involves the use of microsatellites (short (< 6 base), tandem repeats of simple nucleotide sequences that behave as single locus, codominate, gene markers) to assess gene pool diversity and parentage in the Lubee Foundation's captive colonies of *Pteropus rodricensis* and *P. hypomelanus*. We also are using these same markers to examine gene pool diversity in wild populations of *Pteropus tonganus* and *P. samoensis*. This project is in collaboration with Dr. Anne Brooke, my former Ph.D. student who, is now doing conservation research on these species in American Samoa. In collaboration with Kim Whitman of the Philadelphia Zoo, we also hope to obtain comparative information on gene pool diversity in the remaining wild population of *P. rodricensis* on Rodriques Island. These projects are all focused on conservation efforts for Old World Fruit Bats.

Lisa Comeau in our lab also is involved in this effort and is examining gene pool diversity in these species using different techniques: allozymes and RAPD's (random amplified polymorphic DNA).

Ya-Fu Lee, who did a Masters degree in my lab on resource partitioning of sympatric *Myotis sodalis*, *M. lucifugus*, and *M. keeni*, is back with us for a PH.D. Ya-Fu hopes to start this summer on a study of high altitude foraging ecology in Mexican free -tailed bats, *Tadarida brasiliensis* - a species that we can't seem to get away from. Ya-Fu's project is part of the United States - Mexico Binational Initiative for the Conservation of Migratory Bats. This initiative is in collaboration with Bat Conservation International and several other Mexican and American bat biologists.

As is typical for my lab, we also have ongoing projects concerned with genetics, ecology, and conservation of trout, snakes, and slugs, but you don't want to hear about these.

submitted by Gary G. McCracken
"gmccrack@utkvx.utcc.utk.edu"

From Cornell University, Ithaca, NY

Bill Schutt is driving headlong towards the timely completion of his dissertation on hindlimb anatomy of bats, especially in the vampires. His deadline is in May and the final chapter of his dissertation has taken a draft form: introduction, materials and methods, and discussion ("hey, where's the data???"). Well, assuming the "Results" get written up in the next two weeks, he will receive his Ph.D. by the time you all read this. We're all proud of the work he has produced and will miss his antics when he moves on to a new position. Jim Ryan, from Hobart and William Smith College has been a strong contributor to Bill's committee. We continue to collaborate with Jim on several of our bat muscle projects. Claudia Coen has taken up responsibility for the vampire colony and is studying nutritional physiology and ecology in Desmodus and Diaemus. Claudia, like Bill, is a student in the Zoology program and is planning a South American trip this summer to look at these bats in the wild. She works with Deedra McClearn and Milo Richmond. Down in the bowels of the neurosciences building, Paul Faure has been laboring away, but not on bat related projects....not even on poor-wills or the like. John Hermanson continues to mix his interest in muscle biology between bat flight and horse locomotion. It would be nice if a big "win" in the latter could pay for the former.

We have been engaged in a seminar on the mechanics and evolution of flight this semester involving a group of about 15 people from all corners of the campus. Significant discussion has focused on the impact of the relatively new "vortex models" of aerodynamics and how they might alter our perspective on existing hypotheses for the evolution of flight in the bats, birds, pterosaurs and insects. Our discussion of insect flight, which started this week, illuminated how much some of us need to review our notes on insect phylogeny and morphology. In April, Frank Fish will join us for discussion of the biomechanics of "flight" in water. Should be fun.

Those of you interested in functional morphology might consider attending the Northeastern Regional Vertebrate Morphology conference to be held on October 7th and 8th, 1995, at Cornell University. This is a particularly good student conference and has attracted a group reminiscent of the bat meetings of the late 1970's. For information contact John Bertram (email jeb2@cornell.edu).

submitted by John Hermanson

From Potsdam, NY

I would like to inform those of you who do not already know, that I have been appointed Director of the Office of Faculty Scholarship and Grants here at S.U.N.Y-College at Potsdam. I am still teaching ecology to approximately 60 juniors and seniors each fall semester and physiology to about 30 seniors each spring semester. In addition just as I thought I was about to get out of the "meeting business" I got "volunteered" to chair the Program Committee for the upcoming American Society of Mammalogist's Annual Meeting at the University of Vermont in Burlington next month. Happily that work is completed and now I can get back to answering all your mail. At the moment Gary Kwiecinski and I are working on the rates of glucose absorption in *Artibeus jamaicensis* and *Phyllostomus discolor* . We will report on that work at the meeting in Boston in August. Tom Kunz and I are working on the program and the Big Boston Bat Bash seems to be shaping up nicely. Ted Fleming will be spending two weeks in July in my lab when he and I will examine glucose absorption, metabolic rate, etc., in *Leptonycteris nivalis*.

In the event that I do not answer your mail exactly the next day (or ever) you know that I'm not on vacation or chasing mongooses on some tropical island. The big news is that:

I would like to inform all of you that after the 25th Annual North American Symposium on Bat Research and the Tenth International Bat Research Conference in Boston in August, **I will really retire** from the "Meeting Business". Someone out there should be getting ready to rush forward to organize and/or host the 26th Annual North American Symposium on Bat Research. [You do not need to promise to serve for 25 years]. I anticipate that there will be some sort of electoral (or drafting) process at the Boston Symposium.

I will continue to work on **Bat Research News.**

submitted by G. Roy Horst

RECENT LITERATURE

Authors are requested to send reprints of their papers to the Editor (Tom Griffiths, Dept. of Biology, Illinois Wesleyan Univ., Bloomington, IL. 61702-2900, U.S.A.) for inclusion in this section. If reprints are scarce, please send a complete citation (including complete name of journal and mailing address) by e-mail to tgriff@titan.iwu.edu or fax: 309-556-3411. Receipt of reprints is preferred as it will facilitate complete and correct citation. Our Recent Literature section is based on several bibliographic sources and for obvious reasons can never be up-to-date. Any error or omission is inadvertent. Voluntary contributions for this section, especially from researchers outside the United States, are most welcome.

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Abstracts of Papers and Posters Presented at the 24th Annual North American Symposium on Bat Research Hotel Westin, Ixtapa, Mexico October 19 to 22, 1994

The abstracts following are listed alphabetically by first author. Many of these were submitted in Spanish, and espite our best efforts at accurate translation, a few errors may have escaped our notice. We have also on a few occasions made minor grammatical corrections or edited slightly to improve the presentation. If in any case the original meaning has been altered, this is inadvertent and is solely the responsibility of the Editor. We are deeply indebted to Patricia Morton for translating the abstracts and assitsing in type-setting. We are also indebted to Heather Fink who arranged the abstracts in order and corrected the master copy of this section. GRH.

Compensatory growth of the wing in the little brown bat, *Myotis lucifuga*.

Rick A. Adams, Department of Biological Sciences,
University of Wisconsin, Whitewater, WI 53190-1790.

Although largely ignored, growth compensation in sequentially repeating morphological structures may be an important ontogenetic process. Specifically, growth compensation occurring in later-developing bony elements may adjust for variation (environmental or genetic) occurring in earlier growth. The mechanism of growth compensation allows for maintenance of structural integrity during development while maintaining morphological variation. The lengths of forearm, third metacarpal, and phalanges of the third digit, fifth metacarpal and phalanges of the fifth digit of 31 juveniles and 25 adults were measured. Results showed that individuals with closely similar wing lengths (forearm + third digit) and widths (fifth digit) manifested highly variable lengths of the individual bony elements making up these wing dimensions. In addition, variability in lengths of individual bony elements was higher than variability of total wing length within groups. Principal Component Analysis gave negative and positive loadings for the first three factors (92% of variation) concerning serially repeating bony elements of the third and fifth digits. These results indicate compensatory growth during development of some bony elements of the wing in *M. lucifuga*. Compensatory growth may allow for maintenance of wing shape during growth and development in juvenile bats.

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A new method of marking bats.

Miquel A. Amín and Rodrigo A. Medellín,
Centro de Ecología, UNAM, Ciudad Universitaria, A.P. 70-275, México, D.F. 04510.

Because of the need to mark captured bats, we have developed a new method for identification that seems to function well for both the large Phyllostomids (***Chrotopterus auritus, Phyllostomus stenops***) and smaller bats (***Glossophoga soricina***). Small plastic color bands in a numerical series were fitted to the neck of the bat, and they lasted a minimum of 12 months, probably extending through the life of the bat. They did not interfere with the bat's behavior. As of this moment, we have captured and marked 2192 bats of 34 species, and we have recaptured 163 individuals. Of the 163, 24 showed some injury to the neck area. We have recaptured pregnant females, subadults, and lactating females carrying their young on their backs (marked before parturition) that showed no signs of abrasion or damage. We suggest that this method can be used in a variety of conditions, but only with microchiropteras. It is the most practical and economical method that we have used to mark bats.

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Single-year study on the bat community of the Mapimi Biosphere Reserve.

Elizabeth. Aragón-Piña and Ma. Inéz Carranza-Pérez,
Instituto de Ecología, A.C., Centro Regional Durango, A.P. 632. Durango 34000, Durango.

This study was undertaken in a semi-desert area of the Chihuahuan Desert, within a protected are in which there were no previous studies on bats. Nine samples were taken throughout the year, using mist nets and insect nets, in several potentially attractive sites (caves, hallows, water bodies, constructions) and the

individuals of one refuge were marked and monitored. Eight species were found, pertaining to three families: five vespertilionids, two molossids and one phyllostomids, seven insectivores and one nectarivore in all. The genera *Antrozous*, *Tadarida* and one specie of *Myotis* were resident over much of the year, but not in winter. *Leptonycteris* was captured only in summer, and *Pipistrellus*, *Eumops* and two species of *Myotis* were recorded only in summer and autumn. *Antrozous pallidus*, *Myotis subulatus* and *Tadarida brasilensis* were the most abundant species and the rest of the species were uncommon. *Antrozous* was gregarious, while *Myotis* were solitary or in pairs, with more females detected than males. The reproductive period of these three species is in spring. Activity levels varied among species, hours and sampling periods. This study also includes morphological information on the species.

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Community structure of bats in tropical forest and modified habitats of the Lacandon forest, Chiapas.

Miguel A. Amín and Rodrigo A. Medellín,
Centro de Ecología, UNAM,Ciudad Universitaria, A.P. 70-275, México, D.F., 04510.

The effects of habitat perturbation on a community of bats has been seldom documented. We, therefore, report results from our study of the diversity and composition of the bat community in a variety of successional stages and patterns of land use in Chiapas, Mexico. We worked in five habitat types: forest, cocoa, old acahual (with more than 15 years of age), young acahual (with less than 10 years of age), and active milpas. In 10 months of field work, we recorded 34 species of bats, represented by 2413 individuals. Four species comprised 65% of all captured bats. The habitat with the greatest species richness was forest, with 27 species, followed by cocoa with 21, milpa and young acahual with 17 each, and finally old acahual with 16. We captured a higher number of bats in cocoa, old acahual, and young acahual, while trapping was more steady in forest and milpas. The species exclusively found in forest included carnivorous bats and other large species such as insectivores, frugivores, and pollenivores. Our analysis of vegetation (species richness and structure) suggested that diversity seemed to co-vary with complexity of habitat.

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Taxonomic Position of *Dermanura hartii* (Chiroptera, Phyllostomidae).

[1]Joaquín Arroyo-Cabrales and [2]Robert D. Owen, [1,2]Museum and Department of Biological Sciences, Texas Tech University, Lubbock, Texas 79409 and [1]Subdirección de Servicios Académicos, I.N.A.H., México.

The taxonomic state of *Dermanura hartii* was not resolved in the most recent revision of the Stenodermatini, and previous studies had not clarified the point. In this study we try to resolve the problem using a new approximation for the analysis of continuous characteristics through removal of common parts followed by a phylogenetic analysis of maximum closeness. The species *Carollia perspicillata* was used as the external group in the analysis. Results were compared with the most recent proposals of the *Dermanura* complex. The study showed the possible paraphyly within the genus *Dermanura* and the contradictory results with respect to the position of *D. hartii*. While waiting for more evidence, it is recommended for now that the species *D. hartii* continue residing within the genus *Dermanura*.

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Effects of age and weather on survival of female big brown bats.

Robert M. R. Barclay, University of Calgary, Calgary, Alberta.

For the past five years we have studied the survival of individually banded adult and juvenile big brown bats (*Eptesicus fuscus*) occupying two maternity roosts in Medicine Hat, Alberta. The colonies are in school buildings within 1 km of each other. Each contains approximately 100 adult females. All recaptures of adult females (N>500) and their female offspring (N>150) have been at the school the individual was originally banded at, suggesting that dispersal of females is low and should not greatly bias survival estimates. Estimated adult females (older than one year) survival varied from year to year from approximately 75% to over 95%. Juveniles (young-of-the-year), on the other hand, survived their first winter at rates between 40 and 50%. Survival of both adults and juveniles was higher in years with warmer and drier summers when parturition occurred earlier. In years with delayed parturition, pups born early had higher survival than those born late. In addition, survival to weaning was less variable than was survival from weaning through the first winter. These results suggest that when parturition is delayed by poor

weather and use of torpor by the adult females, both adults and young have little time to prepare for hibernation, and over-winter survival is low. They also indicate that mortality is high (50% or more) over the first winter, but that older females then have relatively low mortality. Early parturition and behaviors that achieve this, should be important components of the life history of temperate zone bats.

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Individual variation in echolocation calls of big brown and silver-haired bats.

Burr J. Betts and Kyle Haynes, Eastern Oregon State College, La Grande, OR.

Scientists and wildlife managers are using interspecific differences in echolocation call structure to survey bat species and study habitat use and feeding behavior. However, there is the potential for intraspecific variation to cause misidentification. It may well be true that variation in search call structure is sufficiently small to allow species identification, but for most species this information is simply not yet known. Big brown bats (*Eptesicus fuscus*) and silver-haired bats (*Lasionycteris noctivagans*) are both FM-CM bats whose calls are supposedly distinguishable but which appear similar for several variables. The purpose of our study was to measure individual variability in those parameters of call structure that could be analyzed with the Anabat ultrasonic detector system, which is currently gaining popularity in the Pacific Northwest. Fifteen big brown and 27 silver-haired bats from the same locale in Northeast Oregon were mist-netted and marked with light tags; their search calls were recorded while free-flying after release. The central 50% of the notes in one sequence for each individual were measured for maximum frequency, minimum frequency, note duration, duration of the constant frequency component, and time between notes. There was significant variation between individuals for all parameters for both species. The two species did not differ significantly in minimum frequency, note duration, or time between notes. Maximum frequency was significantly higher for *Eptesicus fuscus*, but this parameter is subject to atmospheric attenuation and is probably not very reliable. The CF-component of the notes was significantly longer in *Lasionycteris noctivagans*. Although this is probably the most reliable parameter for distinguishing the calls of these two species, at least with the Anabat system in Northeast Oregon, there is still enough individual variation that the distributions of this measure overlap for the two species and misidentification of some individuals is still possible. Our study supports the idea that caution is necessary in using echolocation calls for identifying species.

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Food habits of the endangered gray bat, *Myotis grisescens* in Missouri: Applications at Fort Leonard Wood.

Virgil Brack, Jr., Karen Tyrell, and Russell Rommé, VB and RR: 3D/Environmental, 781 Neeb Road, Cincinnati, OH 45233; KT: 3D/Environmental, 8406 Wood Road, Corryton, TN 37721.

The National Environmental Policy Act (NEPA) requires an assessment of effects of military training activities on endangered bats at Fort Leonard Wood, Missouri. The effects of military training activities on important prey species are part of a NEPA assessment of indirect and cumulative effects to gray bats on the military base. Fecal samples were collected in Missouri during two summers to characterize the food habits of gray bats, *Myotis grisescens*. These samples were collected at two maternity caves (Maternity Caves 1 and 2) during the first year and at three maternity caves (Maternity Caves 3-5) during year two. Fecal samples were also collected at two post-reproductive dispersal caves during year one. The insect community was sampled near each maternity cave while bats were foraging. At Maternity Cave 1, 3 and 5, reproductive females consumed predominantly aquatic-based insects (orders Trichoptera, Plecoptera, Ephemeroptera, and Diptera) on most sample dates. In contrast, juveniles often ate more terrestrial insects (orders Lepidoptera, Coleoptera, Homoptera, Hemiptera, and Hymenoptera). At Maternity Caves 2 and 4, reproductive females and juveniles sometimes consumed more terrestrial than aquatic prey. Consumption of terrestrial prey was high for both adult females and juveniles at post-dispersal caves. Males and non-reproductive females at Maternity Caves 3-5 typically consumed more aquatic than terrestrial prey. In all ages and sexes, individual variability in the types of prey eaten was generally high. Proportions of prey by order in the diet did not always correlate with insect availability. The Asiatic oak weevil, *Cyrtepistomus castaneus*, an exotic pest and a poor flyer, was a frequent component of the coleopteran portion of the diet.

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Prey selection by insectivorous bats: Is polyunsaturated fat an important currency?
R. Mark Brigham and Gina V. Schalk, University of Regina, Regina, SK.

Polyunsaturated fats (PUF) which cannot be synthesized by mammals, are usually required in only small amounts in the diet. However, mammals which hibernate or enter torpor require larger quantities, since they lower the melting point of fat stores to make them metabolically available at low temperatures. We assessed prey selection by different sex and reproductive classes of *Myotis yumanensis*, *M. lucifugus*, and *M. californicus* caught near Nelson, B.C., to determine whether bats preferentially consume insects with high levels of PUF. We expected that males and non-reproductive females would consume more PUF since they are thought to enter torpor more often. We ranked insect orders in bats' diets and light suction trap samples based on PUF content and used the ranks to derive diet and trap sample "fat scores." Dietary fat scores of males, non-reproductive, lactating and pregnant females did not differ significantly. However, dietary scores of males and lactating females were significantly higher than corresponding trap scores. Furthermore, fat scores of male *yumanensis* and *lucifugus* were significantly higher than male *californicus* which may suggest a difference in hibernation or use of torpor. Overall, prey selection by all bats was best predicted by insect availability, consistent with the poor prey discrimination abilities afforded by echolocation.

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Contribution to the knowledge of refuges and chiropterofauna of natural caves in Guerrero.
Catalina Chávez T., Leticia Espinosa A., Vicente Cortez D., and Francisco López M.
ENEP- Iztacala. UNAM, A.P. 314 Tlalnepantla, Edo. de México, México.

We explored seven caves in the municipalities: Olinala (3), Quechultenango (3), and Coala (1). The bat composition in the caves varied from 1 to 8 species, with a total of 11. We present in this paper reproductive data about *Balantiopteryx plicata*, *Mormoops megalophylla*, *Pteronotus davyi*, *P. parnellii*, *Choeronycteris mexicana*, *Desmodus rotundus*, *Glossophaga soricina*, *Leptonycteris curasoae*, *Macrotus waterhousii*, *Micronycteris megalotis* and *Myotis californicus*. The ambient temperature, soil and relative humidity vary between 23.8-34 °C; 24.8-31.2 °C and 34-100% respectively. *This work was supported by the state government.

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Diversity and species composition of bats in tropical seasonal forests.
J. Cuauhtémoc Chávez and Gerardo Ceballos,
Centro de Ecología, UNAM, A.P. 70-275, México, D.F., 04510.

Bat diversity and species composition was studied in two types of habitat with contrasting phenologies (tropical deciduos forest and tropical subdeciduos forest) in the Chamela- Cuixmala Biosphere Reserve, in Jalisco, Mexico. The present results correspond to 68 months of sampling between February 1992 and February 1994. Three misnets, spanning 38 linear meters, were placed in each site, during two nights in each one of the two vegetation types. Fifteen species were captured, which represent 45% of the 33 reported for the area. The most abundant species, *Artibeus jamaicensis*, *A. intermedius* and *Glossophaga soricina*, represented 73% of the individuals captured. The greatest specific richness was found in the deciduous forest, with 14 species, whereas the subdeciduos forest had 11 species. Apparently, diversity is different between the two sites. Species captured only in the deciduous forest are *Musonycteris harrisoni*, *Pteronotus parnellii*, *P. davyi*, *Carollia subrufa*, and only in the sub deciduos forest *Rhogeessa parvula*.

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Bat abundance and distribution in northern Alberta mixedwood stands of different seral stages.
Lisa H. Crampton, University of Calgary, Calgary AB, T2N 1N4.

In order to better understand bats' use of the boreal mixed wood forest, and the potential impacts of logging, we assessed the abundance and distribution of bats at sites in four early, four mature and four old stands from mid-May to mid-August 1993 and 1994. Additionally in 1994 we examined effects of the fragmentation by logging (which occurred in the winter of 1993) of two of the old and two of the mature stands. We monitored echolocation calls and feeding buzzes using QMC bat detectors to determine relative activity in different aged and in logged and unlogged stands. We mist-netted bats within and near the sites to determine population structure. We also tracked radio tagged bats to roost trees. We found *Myotis lucifugus*, *Myotis* spp., *Lasionycteris noctivagans*, *Lasiurus cinereus*, and *Eptesicus fuscus* in all aged stands. *Myotis*

to determine population structure. We also tracked radio tagged bats to roost trees. We found *Myotis lucifugus, Myotis* spp., *Lasionycteris noctivagans, Lasiurus cinereus*, and *Eptesicus fuscus* in all aged stands. *Myotis* spp. contributed the highest proportion of total activity (#passes/hr). Preliminary analyses suggest that mean total and *Myotis* activity were higher in old stands than in early and mature stands in both 1993 and 1994. Total activity was greater in unlogged old stands than logged old stands, but the contrary was found for mature stands. Of the 24 confirmed roost trees, 85% were *Populus tremuloides*; 40% of these were newly dead and 30% were alive or partly alive. The mean tree height was 20.95m and the mean diameter at breast height was 42.61cm. Activity patterns may reflect the distribution of these trees in different age stands.

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Noseleaf morphology of the Phyllostomidae.

Ryan Csada, Department of Biology, York University, North York, Ontario M3J 1P3.

It has been suggested that there is a relationship between noseleaf morphology and foraging behaviour in the Phyllostomidae. To answer this question, one must first determine if there is a difference in noseleaf morphology between bats with different diets (and presumably different foraging behaviours). I did this by comparing the morphology of alcohol preserved specimens from three subfamilies; the Glossophaginae (primarily nectar feeders), the Stenodermatinae (primarily fruit eaters), and the Phyllostominae (primarily carnivores). I further predicted that since phyllostomines have the greatest variation in diet, they would show the greatest variation in the morphological measurements. I found that there were significant differences in the noseleaf morphology between the subfamilies and that there was significantly more variation in the phyllostomines for some morphological measurements. Behavioural and physiological studies are necessary to determine if these morphological differences translate into differences in foraging behaviour.

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Energetic consequences of flight speeds of foraging red and hoary bats (*Lasiurus borealis* and *L. cinereus*; Chiroptera: Vestertilionidae).

Horacio de la Cueva, M. Brock Fenton, M. Brian Hickey, and Robert W. Blake, CICESE, México, York University, Ontario, Canada and University of British Columbia, Canada.

We used Doppler radar readings of the flight speeds of individually tagged, lactating, foraging *Lasiurus borealis* (n= 826) and *L. cinereus* (n= 544) to test aerodynamic morphologically based predictions of their flight performance. Measured flight speeds of both species are shown to be independent of individual, date, or place (3-way ANOVA), time of night (rank circular correlation); or moth number and mean hourly flight speeds (linear correlation). Both species flew at mean speeds (V= 6.7 and 7.1 m x s^{-1}, ,respectively) significantly different from minimum power speed (V_{mp}= 6.1 and 5.0 m x s^{-1}, respectively) or maximum range speed (V_{mr}= 8.7 and 9.3 m x s^{-1}, respectively), perhaps reflecting the active pursuit of moths performing evasive maneouvres. Predictions of lower variance of flight speed for higher costs of flight (0.57 and 0.35 W at V, respectively) are rejected by a variance test ($F= 1.57$ $df = 544,826$ $p > 0.05$). Aerodynamic differences between the two bat species include V_{mp} and V_{mr} (see above), cost of transport (0.55 and 0.15 kg x m^{-1}, respectively), best glide speed (V_{bg}= 5.5 and 6.4 m x s^{-1}, respectively), and minimum turning radii (1.24 and 1.69m, respectively). We used allometric scaling to produce flight performance for a *L. borealis* with the mass and wing dimmensions of a *L. cinereus* and viceversa, determining that the species are not scaled. During lactation *L. borealis* requires 55.90 kJ x day^{-1} flying at V, capturing 110 $\pm$ 139.38 kJ x day^{-1}, whilst *L. cinereus* requires 26.36 kJ x day^{-1}, capturing 40.82 kJ x day^{-1}. When thermoregulation, maintenance and increases in cost of lactation are considered, both bats seem to be operating under favourable energy budgets.

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The phylogeography of bats of the Atlantic forest of Brazil.

Albert David Ditchfield, 3101 VLSB, U. C. Berkeley, CA 94720-0001.

The question being investigated is--What is the geographic distribution and hierarchical structure of the genetic diversity for bats? I sequenced 402 base pairs of mitochondrial DNA for six species of bats in the Atlantic forest of Brazil. Some are associated with wet lowland forests, some are occuring in wet and dry

habitats. All are displaying evidence of a cluster of very similar, widely distributed haplotypes without any evidence of geographic structuring. This is very different from the pattern found for other mammals of the Atlantic forest, using the same gene. This seems to indicate that for most bats, over a wide geographic range, we are dealing with one huge metapopulation, connected by widespread geneflow. For *Artibeus cinereus* two very divergent haplotypes were picked up in sympatry, suggesting that we have two species, *A. cinereus* and *A. gnomus*, present in the Atlantic forest.

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Moth predation by free-foraging *Hipposideros caffer*.

Dorothy C. Dunning and Martin Kruger, West Virginia University, Morgantown, WV; Transvaal Museum, Pretoria, South Africa.

Insect predation by the bat *Hipposideros caffer* was studied at Skukuza in the Kruger National Park of South Africa, by comparing insect remains dropped by foraging bats with the insect population in the same general area over the same period of time. These bats, whose echolocation calls are inaudible to moths, fed overwhelmingly upon Lepidoptera, though insects of other orders usually predominated in local light trap catches. The relative numbers of noctuid, pyralid and arctiid moths taken by the bats were proportional to the representation of these families in the light trap collections, but they took disproportionately fewer moths of the family Geometridae. Although the overall proportion of arctiids in the bats' diet approximated those available, they caught disproportionately fewer arctiids capable of clicking. Since the moths could not hear the approaching bats, arctiids able to click would not do so before contact with the bats. Since the bats evidently took fewer such moths, any protective function of the clicks did not depend upon confusing the bats' echolocation systems before contact, either by jamming or by appearing as phantom targets. Since arctiid moths were rare in the local moth fauna at this time, the protective function of the clicks is compatible with the startle hypothesis. The clicks also may operate as aposematic sounds for these bats.

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Evolution of pollination syndrome by bats in monocotyledons.

Luis E. Eguiarte, Héctor T. Arita, César A. Domínguez, and Jordan Golubov, Centro de Ecología, UNAM, A.P. 70-275. Mexico, D.F., 04510.

Bat pollination syndrome has emerged independently in different lineages of flowering plants, both dicotyledons and monocotyledons. In this work, we present a preliminary analysis of the evolution of this syndrome in monocotyledons. Monocotyledons comprise close to 50,000 species and is a monphyletic group, in contrast to dicotyledons. This work uses comparative methods based in a phylogenetic reconstruction of monocotyledons obtained from morphological and molecular data, especially the derived sequences of the chloroplast rcbl gene of over 100 species. We discuss the different groups in which this syndrome has arisen independently, the conditions in which it has evolved and their relationship to ecological, biogeographic and reproductive conditions of the plants.

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Patterns of body mass diversity in Mexican volant and non-volant mammals.

Fernanda Figueroa and Héctor T. Arita, Centro de Ecología, UNAM, A.P. 70-275, México, D.F., 04510.

We measured body mass diversity for Mexican mammals. Separate analyses were conducted for terrestrial and volant mammals, using a 0.5° (lat-lon) grid, for conservation purposes. Mammalian species were classified in categories based on the logarithmic value of their mass, and diversity was measured using the Shannon index. Results for bats indicate that diversity of body mass strongly depends on species' richness, m in part as a result of the reduced range of body mass values and the reduced effect of this parameter on the ecology of these organisms. The comparison of patterns of terrestrial mammals and all mammals shows that for this kind of analyses volant and non-volant mammals must be separated. We suggest that the measure of ecological diversity using body mass should be taken into account for terrestrial mammals only, using alternative parameters for bats.

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Foraging behavior of *Leptonycteris curasoae*: How much is under plant control?

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

Nectar-feeding bats visit flowers to gain energy and other important nutrients. Optimal foraging theory predicts that bats should visit flowers on a schedule that maximizes their net rate of energy or nutrient gain, regardless of the potential fitness consequences to their food plants. In this coevolved mutualism, however, it is unlikely that the plants are "indifferent" to the foraging behavior of nectar-feeding bats. Some flower-visiting patterns are likely to result in higher levels of plant fitness than others. I propose that plants can control the visitation patterns of nectar-feeding bats with their nectar secretion schedules. I will present data, based on the interaction between the glossophagine bat *Leptonycteris curasoae* and the cactus *Pachycereus pringlei* in the Sonoran Desert of Mexico, which suggests that bats do visit flowers in a "rational" pattern that is dictated primarily by nectar secretion rates. I will also present preliminary experimental data which supports the hypothesis that plants can control the flower visitation behavior of their bat pollinators by their nectar secretion "behavior." I predict that observed nectar secretion schedules maximize fruit and seed set as well as the genetic diversity of cohorts of seeds.

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The current status of *Stenoderma rufum*, the red fig-eating bat on the island of Puerto Rico.

[1]Michael R. Gannon, [2]Richard D. Stevens, and [2]Michael R. Willig, [1]Dept. of Biology, The Pennsylvania State University, Altoona, PA 16601; [2]Ecology Program, Dept. of Biological Sciences and the Museum, Texas Tech University, Lubbock, TX 79409-3131.

Stenoderma rufum, the red fig-eating bat, is a rare frugivorous phyllostomid which was thought extinct until 1957. Its known distribution is limited to Puerto Rico and the Virgin Islands, however within the Luquillo Experimental Forest (LEF) of Puerto Rico it is an important keystone seed disperser. As a result of Hurricane Hugo, in September, 1989, the LEF population of *S. rufum* was severely reduced, and extirpation from the forest was feared. As this was the only locality at which *S. rufum* had been found in almost 20 years, a project of intensive population monitoring and survey work was begun on the island of Puerto Rico in an attempt to locate other populations and determine the status of this bat. Numerous forest localities were surveyed for bats during the summers of 1993 and 1994. Results indicate that although *S. rufum* does exist in a number of other sites on the island, it is rare in most localities. Most habitats where it has been found are isolated state forest lands with little chance of immigration to, or emigration from, these areas. Five years after the hurricane the LEF population appears to be returning and possibly even exceeding pre-hurricane levels, and at this time is cause for guarded optimism.

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Reproductive pattern of *Macrotus waterhousii* in Central and Western México.

[1]Carlos García E., [2] C. Sánchez H., [1]Ma. de L. Romero A., and [1]R. Vargas Y, [1]Fac. de Ciencias Biológicas, UAEM. Av. Universidad 1001, Col. Chamilpa, Cuernavaca, Morelos, México; [2]Instituto de Biología, UNAM, A.P. 70-153. México, D.F. 04510.

Existing information on the reproductive activity of *Macrotus waterhousii* suggests a seasonal monoestral pattern. Recent observations from the states of Jalisco, Michoacán, Guerrero and Morelos, and the revision of specimens in Mexican collections, suggest that the specie presents a continuous bimodal polioestral reproductive pattern. The first period is from December to March, with pregnant females in those months and lactating females in July and August. Young individuals were recorded from March to May and in July and August. Reproductively active males with scrotal testes larger than 6 mm are found throughout the year. We are grateful to the curators of the mammal collection of the IBUNAM and the IPN for their help in revising specimens, and the CONACyT for supporting the project Wild Mammals of the State of Michoacán, code number 400-335-51361N (CSH).

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Altitudinal distribution of a bat community in the Sierra Mixteca of Oaxaca, Mexico.

José M. García L., Miguel A. Briones S., and Victor Sánchez-Cordero,
Instituto de Biología, UNAM, A.P. 70-153, México, D.F. 04510.

This study presents the results on the abundance and altitudinal distribution of the bats in the Sierra Mixteca Alta of Oaxaca, Mexico. Bats were sampled during 1991 and 1992, with a total of 15 species recorded. The species most often collected was *Artibeus intermedius* (30%), while the least abundant specie was *Lasiurus intermedius* (0.2%). The greatest species was between 750 and 1,250 masl and the least abundances were above 1,600m. Likewise, trophic structure was more diverse between 750 and 1,600 masl. This structure is formed by eight species of frugivores, five species of insectivores, one haematophagous specie and one nectarivorous specie. The highest bat diversity was recorded in the medium forest, whereas the lowest was in cultivated areas.

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Seed dispersal and food habits of frugivorous bats in the Lacandona forest.

Osiris Gaona and Rodrigo A. Medellín, Centro de Ecología, UNAM,
Ciudad Universitaria, A.P. 70-275, Mexico, D.F. 04510.

The frugivorous bat plays an important role in the dispersion of seeds, participating in the succession processes of tropical forests. This study produced results from five habitats in the Lacandon forest of Chiapas, México: (1) forest, (2) cocoa, (3) young acahual, (4) old acahual, and (5) active milpas. In 14 months of field work, we collected a total of 650 scats from these areas with the following distribution: 40% cocoa, 19% milpa, 16% young acahual, 12% forest, and 11% old acahual. We observed a difference in the percentage of the seeds collected, but the species variation is not very marked. We have noted that throughout the year bats do not compete for food in an active manner, but that they can utilize different species of available plants. We analyzed a total of 3,650 seeds in 1,600 trapping days/nights over an area of 504 m^2 in each habitat. The seeds found with the highest frequency were from *Cecropia peltata*, and we noted a nocturnal dispersion. The data on food availability showed reduced fructification in *C. peltata* and *C. obtucifolia* between September and December and an increase from April to August, which correlates with the activities of *Piper hispidum* and *P. auritum*.

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Utility of the pectoral girdle for resolving interfamilial relationships of microchiropteran bats.

Jonathan H. Geisler, College of Charleston, SC and American Museum of Natural History, NY.

Interfamilial relationships among microchiropteran bats have remained largely unstudied in the last decade despite conflicting phylogenetic hypotheses. To investigate the value of using pectoral characters for constructing phylogenies, I compared the sternum, ribs, clavicle, and scapula in 39 species including members of each of the extant families of bats. A dermopteran and a tree shrew were used as outgroups. Anatomical comparisons yielded 45 characters which may be phylogenetically informative. Several characters (e.g. outward extension of the lateral processes of the manubrium, presence of a ventral projection on the anteromedial flange of the scapula) appear to be highly derived homologous characters which are shared by some families to the exclusion of others. The dorsal articular facet of the scapula (DAF), which is involved in the scapular locking mechanism, does not appear to be as useful in interfamilial systematics. Although its morphology is consistent within families, it is difficult to distinguish homologous conditions, and many taxa previously described as lacking a shoulder lock have a small but poorly defined DAF. Cladistic analyses of the data generated from the characters I describe resulted in most parsimonious trees that are remarkably congruent with aspects of previously published hypotheses. Groupings in trees generated from this data set apppear to reflect evolutionary clades rather than functionally convergent groupings, thus indicating the usefulness of pectoral characters in developing phylogenies. Initial results support monophyly of Mormoopidae, Molossidae, and Megadermatidae. Monophyly of the remaining families either was not tested or the results were inconclusive. Megadermatidae, Hipposideridae, and *Rhinolophus* consistently formed a clade. *Rhinopoma* and *Craseonycteris* formed an unresolved sister group to this clade. Relationships between many of the families remain unresolved. Although I do not imply that these results merit revision of existing microchiropteran systematics, I hope that these data can be added to existing data sets to help resolve interfamilial relationships. This research was supported by NSF Grant BSR-9106868.

Koopman's Infraorders Yinochiroptera and Yangochiroptera are better supported by hyoid data than are Weber's four superfamilies in the higher-level classification of microchiroptera.

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

In 1904, the German morphologist Weber first suggested that the Microchiroptera was composed of four natural subgroups, and in 1928 he formally proposed that the 12 bat families be arranged in the four superfamilies widely used and recognized (with minor modification) today: Emballonuroidea, Rhinolophoidea, Phyllostomoidea, and Vespertilionoidea. Koopman, in a 1984 issue of *Bat Research News*, suggested that the first two superfamilies be placed in the new taxon Infraorder Yinochiroptera (with a moveable premaxilla) and the latter two superfamilies be placed in the new taxon Infraorder Yangochiroptera (with a premaxilla that is fused to the anterior skull). At the present time, dissections of the hyoid regions of 11 of the 16 recognized families of bats are complete. Although the evidence has not been completely collected for all families of Yangochiroptera, there is a suite of derived hyoid characters that strongly supports the validity of Koopman's Yinochiroptera while casting doubt on the validity of at least one of the superfamilies within it. The hyoid evidence collected so far from bats placed in Koopman's Yangochiroptera also supports the validity of the group. The present paper is a progress report on the ongoing hyoid dissections by the author and his associates. Based on data collected to date, it appears that Koopman's (1984) classification of the Suborder Microchiroptera into two Infraorders may represent the most natural higher-level classification of the suborder.

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Impacts of forest harvesting on the foraging ecology of bats in southern British Columbia.

Scott D. Grindal, University of Regina, Regina, SK.

Forest harvesting creates openings and results in different habitat types which may affect wildlife. To assess potential impacts of forest harvesting on bats, relative commuting and foraging activity patterns were monitored using ultrasonic bat detectors placed in and around silvicultural openings (clearcuts, roads) and natural openings (avalanche runs, lakes). Detectors were placed in three habitat types associated with openings (center, along edge, and in adjacent forest) and operated for 90 minutes after sunset. Preliminary analysis of results suggested that activity patterns were similar for all forest openings, with greatest activity along the edge and in the center of openings. In the forest, minimal foraging activity was observed and commuting activity peaked briefly after sunset, implying that forest habitat is not a primary foraging area but may be important for roosting habitat. The preference for edge and open habitat suggests that forest harvesting may create habitat beneficial to foraging bats. However, other aspects of bat ecology must also be considered before comprehensive conclusions about the impacts of forest harvesting on bats can be made.

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Reproductive pattern of three species of the genus Pteronotus (Chiroptera: Mormoopidae).

[1]José Guerrero, [1]Ma. de L. Romero A., [2]C. Sánchez H., [1]Fac. de Ciencias biológicas, UAEM, Av. Universidad 1001, Col. Chamilpa, Cuernavaca, Morelos, México; [2]Instituto de Biología, UNAM, A.P., 70-153 México, D.F. 04510.

We present information on 381 specimens of *Pteronotus parnellii* (210), *P. davyi* (104) and *P. personatus* (67) from the coastal regions of Jalisco, Michoacán, Guerrero and Oaxaca. *P. parnellii* presented an asynchronic monoestral reproductive pattern, with pregnant females being found from December to May, lactating from March to December and young individuals in May and June. The size of the embryos in March and May, and the overlap between pregnant and lactating females in the same months, suggest a reproductive asynchrony. Mature males were recorded from October to March and in July. Pregnant females of *P. davyi* were found from February to May, lactating females and young individuals in May and June, young individuals in June and July and mature males in February and March. From July to January, the specimens examined of the last two species were sexually inactive, suggesting a monoestral seasonal reproductive pattern. We are grateful to the curators of the mammal collection of the IBUNAM and the IPN for their help in revising specimens, and to CONACyT for supporting the project Wild Mammals of the State of Michoacán, code number 400-355-1361 (SCH).

Notes on bat populations on San Salvador Island, Bahamas.

John S. Hall, Craig Stihler, and Phillip L. Dougherty, Albright College, Reading, PA; Division of Natural Resources, Elkins, WV; and Albright College, Reading, PA.

During an eight day period, 10-17 January 1994, we studied the population numbers, distribution, behavior and ecology of *Erophylla sezekorni* and *Natalus tumidifrons* on San Salvador Island, Bahamas. Since little is known about these two species, which are endemic to the Bahamas, the limited data that we obtained should be of interest. The investigation of nine caves resulted in a total count of 257 *E. sezekorni* and 609 *N. tumidifrons*. Populations of *E. sezekorni* seemed to be consistent in two caves that were investigated on three occasions. Groups of *N. tumidifrons* seemed to be transitory and may move from cave-to-cave in large groups. Social behavior of *E. sezekorni* was observed with a night vision scope. Apparent males compete by face-to-face wing flapping for space on the ceiling of the cave. Data were obtained on the numbers of wing flappers and non-flappers. We plan to continue this study in January 1995, to include light tracking at night to study movement patterns, the investigation of additional caves and observation of behavior with infrared equipment.

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Foraging and diet of juvenile and adult big brown bats (*Eptesicus fuscus*) in southeastern Alberta.

Ian M. Hamilton, University of Calgary, Calgary, AB.

I studied foraging behavior and diet of juvenile, yearling, and older adult female big brown bats at two maternity colonies in Medicine Hat, Alberta, from May through August 1994. Bats were captured in mist-nets upon exit from or return to the maternity colonies. Age, sex, and reproductive class were assessed, and mass, forearm length, and wing area were measured. Fecal samples were collected to determine dietary differences between different age classes. Echolocation calls of adult and known-age juveniles were recorded through the post-fledging period. Transmitters were placed on juvenile (n= 5), yearling (n= 5), and older adult (n= 13) females. I compared foraging location and activity of yearling and older adult females prior to parturition. After parturition, pups were banded in the roost. Forearm and mass of known-age pups were measured to produce age-predictive equations. After fledging, foraging and activity patterns of juvenile and adult females were compared. Preliminary results indicate that the survival rate of juveniles over their first winter is lower than that of adults. Yearling females returning from hibernation are smaller and more likely to be non-reproductive than are older females. In 1994, none of the yearling females captured were reproductive. Inefficiency at detecting, capturing, or handling prey items, or inexperience in selecting foraging sites may result in juveniles being less able to accumulate sufficient fat reserves for overwinter hibernation than are adults, resulting in lower survival and reproductive rates for bats returning from their first winter than for older adults. Preliminary findings on foraging and dietary patterns of juveniles and adults during the post-fledging period, and of yearling and older adults upon return from hibernation will be presented.

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Relationship between fruit production and reproduction of fruit eating bats in a subtropical cloud forest of Western Mexico.

Luis Ignacio Iñiguez-Dávalos, Instituto Manantlán de Ecologia y Conservación de la Biodiversidad, Depto. de Ecol. Aplic. en Sist. de Montaña, Universidad de Gudalajara, Valentín Velasco 253, El Grullo, Jalisco, México 48740.

In several mammals, the relationship between reproduction and food availability have been shown. Some reproductive stages (e.g. pregnancy and lactancy) are highly demanding of energy and nutrients and must be synchronized with the maximum availability of food. Since 1991, I sampled bats monthly in Las Joyas Scientific Station of the University of Guadalajara, in Jalisco, western Mexico. During the one week sampling periods, I recorded populational and reproductive data on the fruit-eating bats that were captured with mist nets in the understory of the subtropical cloud forest. At the same time, phenology and fruit production on species eaten by bats were recorded in marked plants. Both fruit production and bat abundance vary seasonally in the same manner. Relationships between fructification patterns and lactancy were found in *Sturnira ludovici* with three species of *Solanum*, and in *Dermanura tolteca* with two species. The phenotipic and behavioral plasticity in response to fruit production patterns seems to be improtant in fruit-eating bats' reproduction.

Sea water ingestion in *Pteropus hypomelanus*.

C.A. Iudica, F.J. Bonaccorso, and G. Richard, University of Florida, Gainesville, FL.

Upon departure from day roosts in Madang and Karkar Island, Papua, New Guinea, *Pteropus hypomelanus* and *Pteropus conspicillatus* (chiroptera: Pteropodidae) frequently fly over ocean shallows and dip their head and chest below the surface of the water presumably to drink sea water. After repeating this "dipping" behavior one to six times, animals fly inland to foraging areas. This study offers controlled experiments to demonstrate that *Pteropus hypomelanus* drink sea water and excrete high concentrations of sodium and chlorine in its urine. Five males and five females were separated from a colony at the Lubee Foundation, Gainesville, Florida. Control animals were offered a diet of fresh water and cut cantaloupe pieces. Experimental animals were offered cut cantaloupe pieces previously soaked in sea water. Blood and urine were collected from treatment and control animals 1/2, 1, 1 1/2, 3, or 6 hours after feeding was initiated. Control animals provided reference ranges for blood and urine while experimental animals indicate the impact of sea water intake on blood and urine electrolyte balance. There is a positive correlation between sodium and chlorine concentration and the amount of time each animal was offered sea water and soaked fruit. Values for blood and urine show an important increase in chlorine and sodium of treatment versus control animals. Values for BUN (blood urea nitrogen) and creatinine (diagnostic variables to measure kidney stress and failure) remain normal in control as well as experimental individuals. We conclude that *P. hypomelanus* is well adapted to drink sea water and to excrete salt according to its daily intake and physiological requirements. Such a mechanism probably allows *Pteropus hypomelanus* to obtain a mineral requirement from ocean water that replaces nutrient deficiencies in its fruit and blossom diet.

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Foraging strategy and predation risk as factors influencing emergence time in echolocating bats.

Gareth Jones and Jens Rydell, University of Briston, UK; University of Aberdeen, UK.

The time that bats emerge to feed in the evening varies substantially from species to species, even in the same place. In northern Europe, for example, noctules *Nyctalus noctula* often feed alongside swifts at high elevation soon after sunset, and yet Daubenton's bats *Myotis daubentonii* and the brown long-eared bat *Plecotus auritus* typically do not emerge until half an hour or more later. Why does this variation in the timing of evening emergence exist? We hypothesized that interspecific differences in evening emergence time among echolocating bats were subject to natural selection through effects of variation in food availability and predation risk, both of which are related to flight technique and foraging strategy. We predicted that bats which feed on small aerial insects emerge relatively early to gain access to the peak in flight activity of small dipterans at dusk. By emerging before darkness falls, however, they expose themselves to increased risks of predation and/or harassment from insectivorous birds which may still be active. Bats which can feed independently of the dusk peak of dipterans, i.e. those which are adapted to feed on moths, flightless prey or plants, would be expected to emerge later, thus minimising their predation risk. We tested these predictions by analysis of two data bases; one including European bats only, and another including a world wide sample. The predictions were largely supported. The evening emergence time appears to be a function of dietary specialisations and foraging strategy, and is probably also affected by the ability to avoid predation.

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Management considerations of *Leptonycteris curasoae* in Arizona, including foraging and roosting information.

John Jorgensen, Ginny Dalton, Sarah Schmidt, University of Arizona; Pima College; University of Arizona, Tucson, AZ.

For proper management and conservation of bats, information needed includes abundance of animals, distribution and occurrence, dietary requirements, territory and habitat use, number and location of roosts (day, night, transient), roosting and foraging behavior, migration patterns and reproductive biology. Over the past several years, we have been obtaining information on the foraging, migration and in-roost behavior of *Leptonycteris curasoae*. Methods and techniques used include in-roost placement of temperature sensors, infrared video taping, banding, flower tagging, light tagging and radio tracking. Temperature probes placed in the roosts have provided information on arrival and departure times of large numbers of bats, the preferred roosting sites within each roost and movement among the roosting sites. The bats were raising the local temperatures of preferred sites by several degrees. Video taping within the roost has provided information

on local movements throughout a 24-hour period. During radio tracking, we found alternate day roosts used by the bats around mid-summer. When including the data from light tagging and flower tagging, we obtained further information on foraging behavior of individual bats and specific feeding areas. Guano collected at the roosts during the summer season contained predominantly pollen and seeds of columnar cacti.

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Selection of tree roost sites by big brown (*Eptesicus fuscus*), little brown (*Myotis lucifugus*) and hoary (*Lasiurus cinereus*) bats in Cypress Hills, Saskatchewan.

Matina C. Kalcounis, University of Regina, Regina, Saskatchewan, Canada.

As it is easier to find and access bats roosting in human-made structures than bats roosting in natural sites, our understanding of roost site selection by bats under natural conditions is limited. I examined tree roost site selection by big brown (*Eptesicus fuscus*), little brown (*Myotis lucifugus*) and hoary (*Lasiurus cinereus*) bats captured and outfitted with radio transmitters in the West Block of Cypress Hills Provincial Park, an area where there are few human-made structures. During the spring and summer of 1993 and 1994, 11 big brown, two little brown and three hoary bats were tracked to 29 tree roosts. Big brown bats exclusively used trembling aspen (*Populus tremuloides*) trees as roost sites. Maternity colonies of up to 40 individuals were found in cavities, created by tree scars or woodpeckers, of both live and dead trees. Roost sites of little brown bats were more variable, with individuals roosting behind bark on stumps of white spruce (*Picea glauca*) trees as well as in trembling aspen cavities. Hoary bats used both types of coniferous trees available, white spruce and lodgepole pine (*Pinus contorta*), as roost sites. Using a paired design, I compared cavity and tree characteristics of roost and random trees. Neighbouring trees were quantified to determine habitat complexity around roost and random sites. Temperatures within vacant roost cavities, random cavities, tree snags and behind bark were monitored for 24 hr. periods and compared with ambient temperatures. Preliminary analysis indicates that cavity roosting bats are selecting trees which are taller than mean canopy height, have higher light intensity at solar noon and have cavity openings that are not much larger than the bats themselves. The habitat in front of roost exits is open whereas the habitat directly behind roost exits is more cluttered. Although temperatures in roost trees are more variable, they are consistently warmer than tree snags and behind bark. All three species switched roosts frequently. Big brown bats in maternity colonies showed roost tree fidelity both within and between years. These results suggest that bats are actively selecting roosts and choosing sites which have thermal environments that minimize energy expenditure, protect them from predators, have suitable light environments and offer them easy flight access.

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Distribution and ecology of bats from far-western Africa.

Karl F. Koopman, American Museum of Natural History, New York, NY.

Lists of bat species were compiled for six countries from Ghana to Guinea-Bissau (79 from Ghana, 62 from Ivory Coast, 57 from Liberia, 57 from Sierra Leone, 37 from Guinea, 24 from Guinea-Bissau) with a total of 94 species. All but two species extend east of this region, 40 extend west of it, and two (*Rhinolophus guineensis, Hipposideros marisae*) appear to be confined to it. On the basis of overall distribution, 46 species are classified as basically forest, 18 as savanna, 25 ecologically widespread, and five (*Rhinolophus simulator, R. clivosus, R. maclaudi, Hipposideros marisae, Myotis tricolor*) to upland areas of West Africa.

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Maternal investment and post-natal growth in bats.

Thomas H. Kunz and April L. Allgaier, Boston University, Boston, MA.

We analyzed post-natal growth data for body mass from 33 species of free-ranging and captive bats using the logistic growth equation. When these data were examined using linear regression and covariance analysis, we found that growth rates decreased linearly with increasing asymptotic body mass. When we removed the effect of body mass, growth rates showed no significant differences with respect to diet (insect vs. fruit), taxonomic affiliation (Megachiroptera vs. Microchiroptera), growth condition (captive vs. free-ranging), or basal metabolic rate. Climate (tropical vs. temperate) was the only variable that had a significant effect on post-natal growth rates, with temperate bats growing faster than tropical species. This climatic effect was also evident when insectivorous bats were examined separately. When we examined post-natal growth rates at the intraspecific level, we found differences based on gender, litter size, colony

size, climate, latitude, food abundance (insects), and growth condition (captive vs. free-ranging). While post-natal growth rates may provide a valuable index of maternal investment, milk energy output of females during lactation should provide the most direct link between the environment and growth of pups. Milk composition and milk-energy output as indices of maternal investment have been investigated in only a few species of bats. From the limited data available it appears that milk composition of insectivorous species is higher in percent dry-matter, fat, and protein than is that of frugivorous species.

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Evaluation of TOBEC and isotope dilution space for estimating lean mass and lipid reserves in four species of neotropical bats.

Thomas H. Kunz and April L. Allgaier, Department of Biology,
Boston University, Boston, MA 02215.

Total body electrical conductivity (TOBEC) and isotope dilution are two non-destructive methods with the potential for monitoring changes in body composition in free-ranging and captive bats. We used four species of neotropical bats (*Artibeus jamaicensis, Brachyphylla cavernarum, Noctilio leporinus* and *Phyllostomus hastatus*) to validate these methods for estimating body fat and lean mass. We measured TOBEC from five positions on the EM-Scan carrier to establish the position that yielded the maximum electrical conductivity in the measurement chamber. TOBEC measurements explained at least 95% of the variation in lean body mass for each of the four species tested. No single measurement proved a good predictor of fat content, but multiple regressions incorporating TOBEC score, body mass, and forearm length yielded r^2 values from 0.6-0.88. Measurements were affected by position of the animal in the chamber and by the presence of stainless steel ball-chain necklaces and stainless steel wing bands. There was no significant difference in TOBEC measurements from animals fitted with plastic or aluminum wing bands. Estimates of total body fat from TOBEC measurements averaged 10% less than total body fat from determined from solvent extraction. Isotope dilution (using tritium, deuterium, and oxygen-18) provided a reliable estimate of total body water (TBW). Although estimates of fat content and lean mass content derived from estimates of TBW (based on isotope dilution) were highly correlated, confidence intervals were sufficiently large as to make predictions highly imprecise.

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Thermal aspects of Indiana bats (*Myotis sodalis*) roosting in trees.

Allen Kurta and Kimberly J. Williams, Eastern Michigan University, Ypsilanti, MI .

During 1992 and 1993, we monitored body temperatures of 16 Indiana bats that were roosting in an unshaded wetland, for one to ten days each, using temperature-sensitive radiotransmitters. Although the literature suggests that body temperature of 34-35°C may be lethal for this species, our data do not support such a statement. Thirteen bats achieved a body temperature greater than 35°C on at least one day, and some bats exceeded 35°C on as many as six consecutive days. The highest body temperature recorded for these thirteen bats averaged 37.9 $\pm$ 0.4 (SE)°C. The highest single value was 40.3°C, and it occurred at a time when ambient temperature external to the roost was 22°C. We also remotely monitored temperatures of two roosts on more than 30 days, although not concurrently with body-temperature measurements. Temperatures underneath the bark generally were 1 to 4 degrees higher than ambient temperature measured in the shade. Temperature of the tree trunk usually exceeded temperature of the air under the bark, by as much as 5°C, both day and night. Solar heating of the unshaded trunk and thermal inertia of the wood during the night and on overcast days may be important factors in the energy budget of tree-roosting bats in northern areas.

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The bat fauna of Taiwan and its current status.

Ya-Fu Lee, University of Tennessee, Knoxville, TN.

Eighteen species of Chiroptera have been reported occurring in the area of Taiwan. However, for most species the available information regarding their current status and biology is very little, and many collecting records come from the early days before World War II. During a nine-month residence, from November, 1993 to July, 1994, the main island and an off island were surveyed for bat fauna. By mist-netting and roost-searching in the field, examining the bats in captivity and the preserved specimens, and by

communicating with native researchers, fifteen species of bats belonging to Pteropodidae, Rhinolophidae, Hipposideridae, Vespertilionidae, and Molossidae are confirmed to be present. The identification of one specimen was thought to be *Vespertilio orientalis*, but it still remains uncertain. The other two species, *Harpiocephalus harpia* and *Nyctalus noctula*, were not located by any means in this survey. Currently, only *Pteropus dasymallus formosus* is under legal protection (also in the Priority I List of IUCN). However, it is far from declaring a save status for this species and all others as well. Poaching of *Pteropus dasymallus formosus* is not completely terminated. Losing suitable habitat and food resources because of logging, agricultural development, urbanization, and suffering from human disturbance activities (e.g. guano harvesting, recreation, etc.) also may have affected their populations. A more comprehensive survey should be conducted, and the responsible agency of ROC government needs to pay more attention to this group of animals.

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Educational design in Mexico: "Importance of bats."

Fransisco López M., Noe Castillo V., Leticia Espinosa A., and Catalina Chávez T., ENEP-Iztacala, UNAM, A.P. 314 Tlalnepantla Edo. de México, México.

The lack of interest and knowledge about biology and importance of bats that is held by both rural and urban inhabitants, as well as the falsely negative information transmitted to children and young adults in myths and legends, has bred an atmosphere of reject and hatred towards those animals. Therefore, as an educational alternative, the Fauna and Environmental Educational project has designed a protocol for classes given to 5th, 6th and 9th grade students. This includes aspects such as habitat, feeding, reproduction, diversity and conservation, and is to be backed up by representative specimens from the region, alive and, or, dissected, in alcohol, embedded in resin and prepared as skeletons. The activity includes 5 stages: 20' test before the information is given, 40' speech, 30' questions and answers, 20' test. The quantitative and comparative results of classes imparted in primary schools in the states of Mexico (5) and Oaxaca (1), and one secondary school in Mexico City, is presented.

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Fluctuating asymmetry in the hybrid zone between *Uroderma bilobatum davisi* and *Urodema bilobatum convexum* in Central America.

[1]Celia Lopez-González, [2]James Taylor and [1]Robert D. Owen, [1]Department of Biological Sciences, Texas Tech University, Lubbock, TX 79409; [2]The University of Missouri-Kansas City, Kansas City, MO.

The hypothesis that hybrid populations should show a decrease in the stability of their ontogenetic development owing to the rupture of complexes of coadapted genes was tested using fluctuating asymmetry (small random differences between the two sides of bilateral structures) as an indicator. Twenty cranial measurements were made on *U. bilobatum* from hybrid and parental populations. A preliminary analysis showed the presence of genetic asymmetries (directional asymmetry and antisymmetry) in some characters. Differences in fluctuating asymmetry in those characters that did not present this type of asymmetries is discussed.

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Food habits of *Dermanura azteca* in a winter refuge.

Gerardo López-Ortega, Dept. de Biología, UAM-Iztapalapa, Michoacán y la Purísima s/n, México, D.F. 09340.

The food choice and availabilty for *Dermanura azteca* were analyzed in a tunnel located 10 Km E. of Tlaxco at an elevation of 3220 m. The bats use this site as a refuge from September until April. A monthly analysis of stomach contents, scats, and food remains at the night roost showed that 90% of their winter diet consists of *Prunus capuli*, *Crataegus mexicana*, and *Juniperus depeana*.

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Population dynamics of *Plecotus mexicanus*.

Ricardo López-Wilchis, Dept. de Biología, UAM-Iztapalapa, A.P. 55-535, México, D.F. 09340.

From 1982 to 1985, individuals of *Plecotus mexicanus* at one locality in the Sierra de Tlaxco, Tlaxcala, were monitored. The data reveal that the number of individuals present varied between 0 and 900 individuals, with a density of 1.7 individuals/hectare. The birth rate is close to 100% but the death rate for the first year is close to 80%; the mean animal survival rate for the populations is 75.4%, but females have a larger survival rate than males. The sex ratio of births is 1:1.

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Altitudinal movements in *Myotis velifer velifer*.

[1]Ricardo López-Wilchis and [2]Sandra Arratia-González, [1]Dept. de Biología, UAM-Iztapalapa, A.P. 55-535, México, D.F. 09340; [2]Escuela de Ciencias, UAEM, El Cerrillo Piedras Blancas, Toluca, México.

To evaluate the hypothesis that *Myotis velifer velifer* moved vertically during winter, we banded 2,627 individuals of this species in two different locations in the states of Puebla and Tlaxcala, Mexico from March 1990 to August 1994. There was a difference of 1,900 meters between the two locations. We discuss results in support of the thesis.

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Anthropod epizootic bats in the Municipio of Tlatizapán, Morelos, México.

Arturo Losoya-Solis and Juan B. Morales-Malacara, Laboratorio de Acarología, Departamento de Biología, Facultad de Ciencias, UNAM, México, D.F. 04510.

One thousand seventeen anthropods were obtained from 98 bats representing six species of the families Emballonuridae, Mormoopidae, and Phyllostomidae. The fauna corresponded to 21 of acarus and eight of insects. Each of the chiroptera species showed differences in the diversity and abundance of their ectoparasites. *Leptonycteris* sp. presented six species of acarus and three of Diptera: *Artibeus* sp. three species of acarus and four of Diptera; *Pteronotus parnellii* with two of acarus and four of Diptera; *Sturnira* sp. with five of acarus and one of Diptera; *Balantiopteryx plicata* with five species of acarus and *Glossophaga* sp. with two of acarus and one of Diptera. Some of the arthropod ectoparasites shared various hosts, such as the tick *Ornithodoros rossi* found on four of the collected chiropteras, of which *Blantiopteryx plicata* and *Pteronotus parnellii* represented new hosts for the parasite. The Diptera *Exastinion clovisi* and *Nycterophilia coxata* were found on three bat species, and *Trichobius sphaeronotus* was found on two bat species. Of all the ectoparasites collected, the acarus of the genus *Expletobia*, the species *Phyllostomybia leptonycteris* and *Ornithodoros knoxjones*, and the Diptera *Trichobius dugesioides* represented new registers for the country. There were seven species of acarus and four of Diptera that were new registers for the state. The miobido of the genus Eudusbabekia collected on *Leptonycteris* sp. was a new species that was described in other work. This investigation was supported by the Dirección General de Asuntos del Personal Académico, UNAM, project IN03593.

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Post-natal growth in the Old World leaf-nosed bat, *Hipposideros turpis*.

Sumiko Matsumura, The School of Allied Health Sciences, Yamaguchi University, Ube, 775 Japan.

Hipposideros turpis is the only one hipposiderid bat in Japan and is known to be the species living in the northern limit. Little is known about growth and development of hipposiderid bats. The aim of this study is to describe the characters of post-natal development in this subtropical members in the field. Most of the nursing mothers left their infants on the ceiling of the roost when foraging. The newborns were promptly marked and measured during mothers' absence. The delivery term lasts for a month. About two hundred infants were marked with aluminum bands. Recapturing and measuring of infants were repeared over two months. In this presentation, I focused on the individual tracing of growth. Individual growth curves of forearm length (F.A.L.) and body weight of 1993 and 1994 were showed. The feature of the curve differs from that of the temperate relatives (*Rhinolophus*). *Hipposideros turpis* grows slower: the growth curve of F.A.L. reached the plateau by 7 to 8 weeks. Difference of the feature of growth between F.A.L. and body weight, yearly variation of the growth rate of F.A.L. within the first two weeks, and ranging birth size are briefly discussed.

Genetic diversity in captive colonies of *Pteropus rodricensis* and *P. hypomelanus* as estimated using microsatellites and allozymes.
Gary F. McCracken and Bruce D. McKee, University of Tennessee, Knoxville, TN.

Microsatellite loci are short segments of DNA that consist of 10-40 tandem repeats of short (< 6 nucleotide base pairs), identical sequences. The numbers of repeat units within a locus are highly variable among individuals, resulting in levels of heterozygosity that are typically an order of magnitude larger than the variability observed at protein-coding allozyme loci. Microsatellite variation shows single locus, codominant inheritance, making it much more useful for many studies than the multilocus variation observed in "DNA fingerprints." The application and utility of microsatellites in conservation genetics research is illustrated in a comparative analysis of genetic diversity in captive *P. rodricensis*, which have experienced several generations of inbreeding, and wild-caught, and presumably not inbred, *P. hypomelanus*.

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Abundance of two species of bats (Chiroptera: Mammalia) in relation to temperature.
Bettie A. Milam and Troy L. Best, Auburn University, AL.

Samford Hall, located on the campus of Auburn University, Alabama, was the home of big brown bats (*Eptesicus fuscus* and Le Conte's free-tailed bats (*Tadarida brasiliensis cynocephala*) for >50 years. Le Conte's free-tailed bat is listed by the state of Alabama as a threatened species. The daily and seasonal movements of the bats were correlated with temperature changes within the attic. Temperature was recorded every hour by a computer attached to 25 thermistor probes placed throughout the attic at predetermined locations. These locations were determined by personal observation of bats present, guano accumulation, and oil stains on the wood and bricks. The number of bats within 0.5 m of the sensors was recorded biweekly by observers at 3-h intervals during a 24-h period and at 6-h intervals for the following 24 h. Comparisons between the number of bats present and the temperature for that hour were made to determine daily and seasonal movements within the roost. In March 1994, bats were excluded from the attic.

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Seed dispersal and the structure of a coastal evergreen forest in southern India.
Shahroukh Mistry and P. Balasubramanian, University of New Mexico, Albuquerque, NM;
and Salim Ali Centre for Ornithology and Natural History, Kalampalayam P.O.,
Coimbatore, India.

The role of dispersal agents such as wind, water, birds, bats and large mammals in structuring a tropical evergreen forest was examined to determine the relative contribution of these agents to the processes of colonization, succession and recruitment. The study area consists of a coastal evergreen forest with distinct vegetation zones ranging from small ephemeral sand dunes near the beach, to old growth forest on permanent ridges, with many intermediate stages inbetween. The sand dunes experience seasonal flooding, have considerable disturbance from wind and water and are generally inhabited by small shrubs. The old growth forest is dense with a high canopy and is relatively unaffected by wind or water. Belt transects were placed in five zones from dunes to old growth, and all woody species were identified and measured. Species composition changed dramatically from coastal to inland transects with each zone exhibiting distinct species groups. Throughout all transects there were a significant number of bird dispersed plants, though this was most evident in the old growth and to a lesser extent in coastal areas. Plants on small and large dunes near the coast were dispersed primarily by wind and large mammals. Intermediate zone plants exhibited greater reliance on water and birds for dispersal, whereas the old growth forest species were almost exclusively bird and bat dispersed. In contrast to other disturbance regimes such as neotropical treefall gaps, and clearcuts, the dispersal agents responsible for the colonization of recent disturbances at this site are initially wind and large mammals, and later, birds. Thus the type of disturbance pattern as well as the underlying forest structure play an important role in determining dispersal agents for colonization.

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Acarus ectoparasites of *Lonchorhina aurita* in San Lucas Ojitlán, Oaxaca, Mexico.

Juan B. Morales-Malacara and Martha Corona-Tinoco, Laboratoriod de Acaralogía, Departmento de Biología, Facultad de Ciencias, UNAM, México, D.F. 04510.

Fifty-eight acarus ectoparasites were obtained from a male bat *Lonchorhina aurita* (Chiroptera: Pyllostomidae) collected from a cave in Polvorín, San Lucas Ojitlán, Oaxaca, Mexico. These ectoparasites represented a species of Mesostigmata of the family Spinturnicidae, *Periglischrus gameroi*, three species of Prostigmata belonging to the family Trombiculidae, and three species of Astigmata of the family Chirodiscidae, two of the genus *Paralabidocarpus* and one genus *Alabidocarpus*. Five species of parasites are new records for this bat, likewise the three species of astigmados represent new species that were described in another publication. This investigation was supported by the Dirección General de Asuntos del Personal Académico, UNAM, Project IN203593.

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Ectoparasite fauna of *Dermanura azteca* in Tlaxcala, Mexico.

[1]Juan B. Morales-Malacara and [2]Gerardo López-Ortega, [1]Departamento de Biología, Facultad de Ciencias, UNAM, México, D.F. 04510; [2]Departamento de Biología, UAM-Iztapalapa, A.P. 55-535, México, D.F. 09340.

About 100 ectoparasitic arthropods were obtained from eighteen specimens of Dermanura azteca (Phyllostomidae) collected from the state of Tlaxcala, Mexico, that included one species of insect and seven of acarus: the insect was *Paratrichobius* sp. (Diptera: Streblidae); the acarids were *Macronyssoides kochi* and *Parichoronyssus* sp. (Mesostigmata: Macronyssidae), *Periglischrus iheringi* (Mesostigmata: Spinturnicidae), *Spelaeorhynchus* sp. (Mesostigmata: Spelaeorhynchidae), *Eudusbabekia ca. viguerasi* (Prostigamata: Myobiidae), *Chirnyssoides ca. caparti* (Astigmata: Sarcoptidae), and *Chirorhynchobia* sp. (Astigmata: Chirohynchobiidae). The majority of the ectoparasites represent new species registered for the chiroptera and also for the state of Tlaxcala. This investigation was supported by the Dirección General de Asuntos del Personal Académico, UNAM, project IN203593.

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Roost-site characteristics of forest dwelling bats in north-central Arizona.

[1]Thomas E. Morrell, [1]Heather M. Green, [1]Kai Yasuda, [2]Rick Miller, [2]Jim deVos, and [1]J. Burt Grantges, [1]Ball State University, Muncie, IN; U. S. Forest Service, Flagstaff, AZ: Lane CommunityCollege, Eugene, OR; [2]Arizona Game and Fish Dept., Phoenix, AZ; Bat Conservation International, Austin, TX.

Little information exists on the roost-site characteristics of forest dwelling bats in ponderosa pine forest of north-central Arizona. We used radio-telemetry to locate the roost-sites of 39 bats of five species during June-July 1993-1994. All of the species studied used snags for roosts. Of 59 roosts observed, 47 (80%) were found in ponderosa pine snags. Most snags (66%) used for roosting were classified as stage four snags (loose bark with some branches intact). Five long-eared myotis (*Myotis evotis*) were observed roosting in rock crevices located on the ground and another was observed using downed logs. Distance from trap locations to roost-sites differed among species ($P = 0.002$). Mean distance ($\pm$ SD) from trap location to an initial roost site ranged from 1.1 ± 0.7 km for long-eared myotis to 3.6 ± 2.0 km for Arizona myotis (*Myotis occultus*). Strength of roost-site fidelity varied among species. Eighty percent of the telemetered long-eared myotis used multiple roosts during the study. Similarly, 71% of long-legged myotis (*Myotis volans*), 44% of Arizona myotis, an 28% of fringed myotis (*Myotis thysanodes*) used multiple roosts. In contrast, Allen's lappet-browed bats (*Idionycteris phyllotis*) were not observed using more than a single roost.

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The effects and results of an influx of money on bat management in Arizona.
Debra C. Noel, Shawn V. Castner, and Tim K. Snow, Arizona Game and Fish Department, Phoenix, AZ.

The Arizona Game and Fish Department's Bat Management Program was formally established in 1991 after an initiative was passed to divert Lottery dollars into wildlife management and conservation programs. Since that time, three biologists have spent many hours mist netting, conducting bat surveys in over 1800 mines and caves, and inspecting several bridges, dams and buildings for bat presence. These activities have resulted in increased knowledge of species occurrence and distribution, as well as the documentation of numerous significant bat roosts. Many of the roosts are receiving intense conservation measures such as monitoring, installing bat gates, scientific analysis and environmental assessment mitigation.

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The structure in neotropical frugivorous bat communities under a new competitive perspective.
Jorge Ortega-Reyes and Héctor T. Arita, Centro de Ecolgía, UNAM, A.P. 70-275, México, D.F. 04510.

We analyzed 21 neotropical communities of frugivorous bats to assess the influence of competition. To do so, we used the ideas of Hopf et al. (1993), who analyzed two mechanisms: the cost of the rarity and the cost of the commonness. Both have an influence in the community structure, but if the mechanism C is strong, it can generate a local low numerical dominance and irregualr assortment patterns, and if the mechanism C is weak, it can generate a local high numerical dominance and regular assortment patterns. We measured numerical dominance by the bull's-eye method (Hopf and Brown, 1986); we used the mean, minumum, variance and G parameters in the forearm length, to search for a morphological assortment pattern. Our results show that only 11 communities have a high numerical dominance, and these communities do not show a regular morphological assortment pattern, probably because the competition for food is weak among neotropical frugivorous bats.

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Phylogenetic systematics of stenodermatine bats.
Robert D. Owen, Departement of Biological Sciences, Texas Tech University, Lubbock TX

Interest continues in the systematics and toxonomy of stenodermatine bats (e.g., Handley, 1978; Gardner and Ferrell, 1990; Owen, 1991; Pacheco and Patterson, 1992; Lim, 1993; Arroyo-Cabrales and Owen, 1994; Van Den Bussche et al., in prep.). Lim (1993) purported to test Owen's (1987) division of Artibeus (sensulato) into *Artibeus* and *Dermanura*, but failed to do so, because his data coding assumed the monophyly of all *Artibeus* and *Dermanura* species. For the present study, available are reanalyzed, on a species-by-species basis, using maximum likelihood and parsimony, to reflect phylogenetic properties of different characters. Resultant phylogenetic hypothesis are tested against each other using consensus analysis, and a robust hypothesis of stenodermatine phylogeny is proposed.

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Recapture success of bats banded at repetitively sampled forest sites.
Andrew J. Perkins, J. Mark Perkins, and Joshua R. Peterson, PNW Bat Research Team-5130 SW Idaho, Portland, OR. 97221.

Results of the banding of more than 3,000 individual bats over a period of five years show locality, loyalty and movement, particularly for *Lasionycteris noctivagans*. Radio tagging in conjunction with banding efforts indicate that some species abandon the capture site, and move drinking and foraging activities to adjacent areas. Other species (most notably *Myotis volans* and *Eptesicus fuscus*) remain loyal to the area and continue use. A longevity record for *L. Noctivagans* was recorded.

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Roost selection in hibernating *Plecotus townsendii*.

J. Mark Perkins, Joshua R. Peterson, and Andrew J. Perkins,
PNW Bat Research Team-5130 S.W. Idaho, Portland, OR. 97221.

We surveyed over 1,000 caves and mines located in Oregon, Washington and northern California for hibernating bats. We noted that preferred roost sites were: 1) in caves or mines with discernible air flow (usually the result of multiple entrances); 2) range of preferred roost height when bats were undisturbed was <3 m; 3) roost temperatures were highly variable, but most bats were situated in cave or mine tunnels where temperature centered around 1-2 deg. C°; and 4) when disturbed by humans, roost selection was characterized by either movement to the highest roost locations or roost abandonment. Each of these characters indicate that the bats are likely late in use of caves as roost sites as noted by Humphrey and Kunz.

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Maternity roost distribution on a managed forest, as determined by mist-netting.

Joshua R. Peterson and J. Mark Perkins, PNW Bat Research Team-5130 SW Idaho,
Portland, OR. 97221.

Our results, derived from four years of mist net and radio-tagging efforts on the Wallowa-Whitman National Forest, describe the distribution by elevation, geography and roost structure. Twelve bat species are confirmed from the confines of this National Forest. We have noted roost sites or mist net sites with concentrations of pregnant or lactating females, or post-lactating females with volant young for the following species: *Eptesicus fuscus, Lasionycteris noctivagans, Myotis californicus, M. ciliolabrum, M. evotis, M. lucifugus, M. thysanodes, M. volans, M. yumanensis and Plecotus townsendii*. Roost sites are: living trees, snags, stumps, witches brooms, cliff faces, mines and caves.

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The effectiveness of two bat species in the pollination of columnar cacti on Curacao, Netherlands Antilles.

Sophie Petit, University of Miami, Coral Gables, FL.

Two species of columnar cacti, *Subpilocereus repandus* and *Stenocereus griseus*, are pollinated on Curacao by two glossophagine bats, *Leptonycteris curasoae curasoae* and *Glossophaga longirostris elongata*. I examined single visit effectiveness for fruit set, seed set, and fruit size of the two bat species. For *Su. repandus, L. curasoae* pollination tended to result in higher fruit set than *G. longirostris* pollination. The fruits also contained significantly more seeds than those originating from *G. longirostris* pollination. The *L. curasoae* sample size was small for *St. griseus*, but it seems that *G. longirostris* is more effective than *L. curasoae* in pollinating this species. *G. longirostris* is more effective in pollinating *St. griseus* than *Su. repandanus*. The total mass, height, width, and mass of pulp and seeds of the fruits of both cactus species were positively correlated with the number of seeds. Bat abundance and behavior are thus expected to influence pollination success (number of seeds) as well as fruit pulp availability. The bat-cactus mutualism is very important on Curacao because many animals rely on cactus fruits in the dry season, but bats are threatened and cacti are removed at an alarming rate due to urban development.

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Distribution and habitat associations of *Eumops perotis* and *Euderma maculatum* in California: Implications for Conservation.

Elizabeth D. Pierson and William E. Rainey, Museum of Vertebrate Zoology,
University of California, Berkeley, CA 94720.

Historic records suggest western mastiff bat (*Eumops perotis*) distribution in California was centered in the south, particularly around the Los Angeles basin, and that the spotted bat (*Euderma maculatum*) was patchily distributed across southern California, including both slopes of the southern and central Sierra Nevada Mountains. Recent surveys indicate the range of both these predominantly cliff roosting species is more extensive than previously recognized, and they frequently co-occur. Populations of *E. maculatum* have been identified for the first time in the Klamath Mountains of northwestern California and individuals were detected above 3,300 m in the Sierra Nevada Mountains. Populations of *E. perotis* are present in several river drainages in the western Sierra Nevada, and recurrent individual records extend the species' range

to within 50 km of the Oregon border. *E. maculatum* is observed at higher latitudes and altitudes, whereas *E. perotis*, a non-hibernating species, is presumably confined to areas with moderate distances of non-freezing winter temperatures. Because both species emit relatively loud, audible echolocation calls, they can be readily detected by acoustic survey. Difficulties in consistently distinguishing their calls with the unaided ear can be resolved using a broad band bat detector, and recording calls for later analysis. Threshold alteration of the audio frequency noise filters in commercial bat detectors can perceptibly improve detection of these species. In central to northern California both species feed predominantly in open areas -- over meadows, open forest, or broad river valleys -- with *E. perotis* apparently traveling considerable distances, and foraging in groups, and *E. maculatum* frequently maintaining small individual feeding territories, which are predictably re-occupied. Cliff alterations for highways and explosive growth of recreational rock climbing pose threats to the localized roosting habitat of both these species, while livestock grazing in montane meadows and desert riparian corridors, fire suppression, and urbanization of desert washes alter foraging habitat over time. We infer that extensive reservoir development in high-relief, rocky canyons has reduced foraging and especially roosting habitat for both species, and hypothesize that low elevation reservoirs have particularly limited winter refugia for *E. perotis* on the west slope of the Sierra Nevada.

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Maternity roosts and geographic scale of foraging activity of *Lasionycteris noctivagans* in northern Californian forests.

William E. Rainey and Elizabeth D. Pierson, Museum of Vertebrate Zoology, University of California, Berkeley, CA 94720.

Silver-haired bat (*Lasionycteris noctivagans*) maternity roosts were located by radio tracking fourteen lactating or post-lactating females netted over flowing water in the upper Sacramento River Canyon of northern California (elev. 610 m) in mid-July 1992 and 1994. All accessible roosts were in trees, typically in bole cavities or crevices in snags, but with a few under bark. Most roosts were colonial (=10-70 bats), but two were occupied only by the radiotagged female and another bat, probably a juvenile. Repeat emergence counts over a week of a subset of colonies were constant or declined slightly. Both 1992 roosts were abandoned by early August and not reoccupied in 1993, but one was reoccupied during 1994. All 12 bats radiotagged in 1994 were captured on one night within 200 m, but none shared a roost site. Maximum distance between the capture site and a diurnal roost site was 17 km, with elevation differences exceeding 1100 m. Three roosts were located across a major drainage divide in the Trinity River basin. Nocturnal telemetry showed some radiotagged females returned to the vicinity of the capture site, that regularity and geographic scale of foraging movements differed among individuals, but that flights of several tens of km in mountainous terrain are apparently common for a species not usually regarded as a long distance forager. These data and radio localization of tree roosts for other bat species in the upper Sacramento drainage underscore the importance of cavity trees to the maintenance of bat community diversity and abundance in western North American forests. This preliminary sample suggests that, except for a preference for roosts higher than 10 m and large diameter trees, the roost requirements of *L. noctivagans* are not highly restrictive and this species is relatively common in a largely forested landscape with a complex mosaic of timber extraction histories. However, with rising timber values, elements of intensifying forest management, e.g., declining rotation periods, removal of hardwoods, selective extraction of large remant snags, unlimited firewood cutting of snags near roads, and topping or creating snags at 20 feet in height to enhance habitat for cavity nesting birds presage long term decline in habitat quality for *L. noctivagans* and other tree roosting bats.

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Population estimate in a complex bat colony.

Armando Rodríquez-Durán, InterAmerican University, Department of Biology, Minillas Industrial Park, Bayamón, PR 00959.

Large multispecies populations of bats housed in highly complex roosts such as limestone caves are extremely difficult to assess. Commonly used methods such as visual emergence counts, electronic devices, mark-recapture, and stereoscopic photography are not suitable for estimating numbers under these circumstances. Photographic techniques have been previously used to estimate the numbers of *Tadarida brasiliensis* and *Pteronotus quadridens* in caves with population sizes ranging from hundreds to thousands to millions. By sequentially photographing exiting bats against a screen and a chronometer with two cameras, I estimated the flight speed and flow denisty in a multispecies bat colony. Assuming a steady flow, I combined the results of the photographs with flow-rate equations to estimate population size. Treating the

photographs as simple random samples of the exiting bats allows to calculate the standard error of the population estimate. Errors introduced in previous estimates are discussed.

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Population study of nectarivorous bat species, in relation with presence of stational floral resource in the Tehuacan Valley, Puebla.

Alberto E. Rojas-Martínez and Alfonso Valiente-Banuet, Centro de Ecología, UNAM, A.P. 70-275, México, D.F. 04510.

The life history of *Leptonycteris curasoae*, *L. nivalis* and *Choeronycteris mexicana*, three species of nectarivorous bats, has always been studied in the light of the the species' migratory habits. Migration has been documented in the north of their distributions. However, it is practically unknown whether this occurs in the Mexican tropics, where the greatest diversity of nectarivorous bat species and their food sources (agaves, columnar cacti and some tropical rainforest plants) exists. Recent information seems to suggest that migration does not occur in the tropics, and even in certain northern localities, indicating a little-known aspect of such bat communities. This project studies the situation in the arid tropics of Mexico.

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The community of bats in a heat cave as a maintaining factor of animal diversity in the cave.

Ada A. Ruíz-Castillo, Saúl Aguilar, Laura L. Del Castillo, Juan B. Morales-Malacara and Livia S. León, Museo de Zoología y Laboratorio de Acarología, Departamento de Biología, UNAM, México, D.F. 04510.

The community of bats of the Arroyo del Bellaco cave, was studied over two years (1992-1994). The average population was 113,000 bats (between four species of Mormoopidae and one specie of Natalidae), with the following percentages: *Mormoops megalophylla* 30.1%, *Pteronotus davyi* 27%, *P. personatus* 18.8%, *P. parnellii* 9.7% and *Natalus stramineus* 14.4%. The mormoopids' reproductive period fell in the dry season, which had the largest number of bats, 118,500 individuals contrasting with 108,000 individuals in the rainy season. The bat community toghether with the cave topography define the so-called "heat caves," since they maintain stable physical conditions of 34°C and 88% relative humidity (yearly average). This bat community sustains a community of parasites and other guano-inhabiting creatures with a total of 52 taxa: Acarida 44.2%, Insecta 23%, Arachnida 17.2%, Marsupialia, Reptilia and Osteichthyes 9.6%, decapodes, myriapods and mollusks (2% each). Fluctuations in the bat community in different seasons directly provoke a rise or fall of certain arthropod populations; such as *Antricola sp.*, Guanolichidae and Cryptostigmata which in the dry season present lower populations than in the rainy seasons. This work was supported by the Dirección General de Asuntos del Personal Académico, UNAM, project IN203593.

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Thermal infrared imaging techniques for estimating bat populations.

Bruce M. Sabol and M. Kieth Hudson, U.S. Army Waterways Experiment Station, Vicksburg, MS; and Alabama Department of Conservation and Natural Resources, Montgomery, AL.

Estimating bat population size during nocturnal emergence from caves relies on visual counting techniques that are subjective and highly dependent on observer skill. A noninvasive semi-automated thermal infrared imaging technique, involving digital picture processing, is developed and tested at several northern Alabama caves. The new techniques compares favorably with standard visual techniques. The imaging technique is described along with numerous variations to the technique appropriate for various cave configurations.

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The natural history and population status of the nectar-feeding bat, *Platalina genovensium* in southwestern Peru.

Catherine T. Sahley and Luis E. Baraybar, University of Miami, Coral Gables, FL; Universidad de San Agustin, Arequipa, Peru.

We present data on morphology, diet, and population status of the nectar-feeding bat, *Platalina genovensium* at a 2500 m site in Arequipa, Peru. Our field observations and 13 carbon isotope ratios in toe muscle tissue indicate that *P. genovensium* depends primarily on the columnar cactus, *Weberbauerocereus weberbaueri*, for food at this site. Aspects of the wing morphology of *P. genovensium*, especially its low wing loading of 9.4 N/m^2, may represent an adaptation to reduce the power required for flight at high altitudes, where cactus abundance and diversity is greatest. We suggest that *P. genovensium* may be primarily a mid-to-high elevation cactus specialist throughout most of its range. Numbers of *P. genovensium* are relatively low in Arequipa. We found an estimated 86 individuals in late 1991. In 1992, during a severe drought caused by an El Niño event, cactus flower and fruit production decreased and bats emigrated from the area. In late 1993, after normal rains resumed, flower and fruit production increased but bat numbers were still 60% lower than in 1991. We propose that irregular migratory schedules caused by El Niño events may have significant influence on the co-evolution of bat-plant mutualisms in southwestern Peru. Persistence of small bat populations in Arequipa may be threatened because bats are used in folkloric medicinal remedies.

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Observations on the social organization and reproductivepattern of *Dermanura azteca*.

[1]Cornelio Sánchez-Hernández, [2]Ma. de Lourdes Romero A., [2]A. Guerrero E., and [2]C. García E.,
[1]Instituto de Biología, UNAM, Depto. de Zoología, A.P. 70-153, México, D.F. 04510; [2]Facultad de Ciencias Biológicas, UAEM, Av. Universidad 1001, Col. Chamilpa, Cuernavaca, Morelos, México 62210.

Some reproductive aspects of *Dermanura azteca* from two localities in the state of Michoacán are presented. In March 1994, a colony of pregnant females was found. In May, there were babies and lactating females in the colony. The separation of the sexes and the formation of a maternity colony suggest a possible segregation of refuges and food sources. Pregnant females were recorded in July, and lactating females in August, indicating a continuous bimodal reproductive pattern. In August, adult males were also found in the colony, probably indicating a greater food availability or the prescence of oestrus and the continuation of reproductive activity.

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Phylogenetic diversity of Mexican bats.

Karina Santos del Prado G., and Héctor T. Arita, Centro de Ecología, UNAM, Ciudad Universitaria, A.P. 70-275, México D.F. 04510.

We used published data to obtain a general phylogenetic tree for all species of Mexican bats. With this tree followed Vane-Wright et al's (1991) and May's (1990) methodologies to calculate conservation values for each species and a percentage value that represents the contribution of phylogenetic information for each taxon to the general cladogram. Then we divided the map of Mexico into squares of 0.5° x 0.5° LAT-LONG, and using our data base for the distribution of Mexican mammals, we obtained the sum of percentage values of all species present in each quadrant. Our results, using 10% of the squares with the highest sum values, shows no difference between both methologies and shows two important zones: southeast zone (Chiapas, Tabasco and part of the states Veracruz and Oaxaca) and southwest zone (parts of the states of Jalisco, Colima, Michoacán and Guerrero).

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The summer roosting behavior of bats on the White Mountain National Forest.

D. Blake Sasse and Peter J. Pekins, University of New Hampshire, Durham, NH.

Roost selection by bats in a northern New England forest was studied by placing radiotransmitters on female northern long-eared bats (*Myotis septentrionalis*) and little brown bats (*Myotis lucifugus*) during 1993 and 1994. Northern long-eared bats (n=26) were found in 59 tree roosts, 78% of which were snags. The most commonly used species were red maple (*Acer rubrum*), beech (*Fagus grandifolia*), sugar maple

(*Acer saccharinum*), and yellow birch (*Betula alleghaniensis*). Little brown bats (n=2) roosted in a red maple and a yellow birch. Analysis of 1993 data indicated that roosts had significantly greater average dbh (44 cm), height (18.9 m), and bark remaining (88%) than did snags in the surrounding 1 km^2. In 1994, additional roosts were located by recording bat activity using ultrasonic bat detectors at snags similar to 1993 roosts, which were located on transects through several forest types. At snags where bat activity was found, observers returned in order to verify roosting by making visual exit counts the next evening. Our research suggests that a constant supply of large snags in managed forests may be important in maintaining local bat populations.

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Interactions between *Sturnira ludovici* and plants of the mountain cloud forest.

Jorge Schöndube F. and Luis I. Iñiguez-Dávalos, Instituto Manantlán de Ecología y Conservación de la Biodiversidad, Universidad de Guadalajara, A.P. 1-3933, Guadalajara, Jalisco, México 44100.

In this study we explore some of the factors that affect the existing relationship between *Sturnira ludovici* and the plants of their diet in the mountain cold forest. In the Estación Científica Las Joyas, Jalisco, we conducted experiments to find the benefits of three species of fruits (*Solanum brachystachys*, *S. aphyodendrom* and *Conostegia volcanalis*), their nutritional content, the time necessary to digest and pass them through the gastro-intestinal tract, the effectiveness of digestion of these fruits by bats, and rates of removal of these fruits from the field. The results show the existence of a narrow relationship between *S. ludovici* and *S. brachystachys*.

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Hindlimb morphology in the vampire bats (Phyllostomidae, Desmodontinae): Does *Diphylla ecaudata* possess a sixth digit?

William A. Schutt, Jr., Department of Anatomy, Cornell University, Ithaca, NY.

Although some bats are capable of terrestrial locomotion, vampire bats exhibit a degree of complexity and agility during quadrupedal locomotion that is unparalleled in the Chiroptera. Recent studies indicate that variation exists in quadrupedal locomotor performance between vampire genera that may be related to principle prey selection. *Desmodus rotundus*, the common vampire, typically feeds from the ground, primarily on terrestrial mammals. *Desmodus* exhibits remarkable speed and agility during quadrupedal locomotion using powerful jumps to inititate flight. *Diaemus youngi*, the white-winged vampire bat, moves at a more deliberate pace while locomoting quadrupedally than does *Desmodus* and does not perform flight initiating jumps. Feeding on avian blood while hanging below its perching prey, *Diaemus* initiates flight by simply dropping from this position. This study was undertaken to determine if differences in vampire bat quadrupedal locomotion would be reflected by variations in hindlimb morphology. Dissection and microscopy were used to study comparative hindlimb morphology in preserved specimens of *Desmodus*, *Diaemus* and *Diphylla ecaudata*, the hairy-legged vampire. Like *Diaemus*, *Diphylla* is reported to be an arboreal feeder. Its diet is thought to consist exclusively of avian blood. In *Diaemus* and *Desmodus* the calcar (the bony or cartilaginous projection from the ankle that braces the uropatagium) is absent or reduced, respectively. In *Diphylla*, the calcar is digitiform and may serve a unique function as a sixth digit during arboreal locomotion. Finally, since phylogenetic character analysis has been difficult in vampires their relationship within the Family Phyllostomidae remains uncertain. It is hoped that this study will generate characters which may prove useful in resolving phylogenetic relationships.

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Environmental correlates of insectivorous bat foraging activity.

Michael G. Scott, University of Tennessee, Knoxville, TN.

Insectivorous bat foraging activity was correlated with meteorological conditions and insect abundance as part of an ongoing study of barometric pressure detection by bats. Observations were made at two study sites in Tennessee (USA) from June to September 1994. Bat foraging activity was monitored using bat detectors. Insects were collected using suction traps. Meteorological conditions recorded included barometric pressure, light intensity, air temperature, relative humidity, wind velocity, wind direction, precipitation, cloud cover and moon phase. A correlation between bat foraging activity, insect abundance and barometric pressure would suggest a possible function for bats' ability to detect barometric pressure.

Preliminary Results on Species Diversity and Ecology of Bat Fauna in the Coastal Plain of Georgia.

Ronald E. Spears and Daniel V. Hagan, Department of Biology, GeorgiaSouthern Univ., Statesboro, GA.

Objectives of this study are 1) to capture and identify the species of bats that are present in the Coastal Plain of Georgia, 2) to locate and document permanent bat roost sites, and 3) to study the environmental parameters of preferred roost sites by each species, and 4) to examine ectoparasites living on the bats and in the roosts. Eleven bat species are documented that have a range that covers southeast Georgia. These species include *Myotis austroriparius, Lasionycteris noctivagans, Lasiurus cinereus, L. intermedius, L. borealis, L. seminolus, Nycticeius humeralis, Tadarida brasiliensis, Pipistrellus subflavus, Eptesicus fuscus,* and *Plecotus rafinesquii*. Seven species have been identified to date in this study. Several large roost sites have been identified and surveyed during this study. Environmental changes and ectoparasitic levels of *Tadarida brasiliensis* and *Nycticeius humeralis* occupying the same roost are also being monitored. A noteworthy result of this study is the documentation of a colony of Rafinesque's Big-eared Bat, *P. refinesquii* which is presently designated as rare in the state of Georgia, and has not been recorded in Georgia for over ten years. A male *P. rafinesquii* was located roosting in an old, wooden building in a coastal maritime forest. Up to twenty bats have been seen roosting in this structure, although these larger numbers have not been seen recently. In the course of this project this roost site will be monitored for numbers of bats and various environmental characteristics.

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Patterns in abundance as measures of community structure: An evaluation of Latin American bat communities.

Richard D. Stevens, Michael R. Willig, and Alec B. Shaner, Ecology Program, Department of Biological Sciences and The Museum, Texas Tech University, Lubbock, TX 79409-3131.

Classic null models in community ecology are designed to detect strong competitive interactions that induce nonrandom patterns of morphology within guilds. Competitive interactions of intermediate intensity can induce nonrandom patterns in abundance, yet not influence morphological differences, per se. Classical null models are incapable of addressing this possibility. We developed a series of null models to detect nonrandom guild structure resulting from competitive interactions of different intensities. More specifically, we evaluated 24 feeding guilds from nine Latin American bat communities to determine whether the effect of competition on structure is ubiquitous or pervasive. Deterministic structure, based on the relationship between morphology and abundance, was not ubiquitous within guilds. Although only a fraction of frugivore and gleaning animalivore guilds, and none of the nectarivore guilds, exhibited significantly nonrandom structure, the combined results for communities indicated a deterministic pattern in half of the cases. Nonetheless, considerable variation exists regarding the extent to which competition structures communities. Further investigation will focus on the extent to which environmental instability influences the degree to which competition induces deterministic strucuture.

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Local distribution and foraging behavior of the spotted bat, *Euderma maculatum*, in northwestern Colorado and adjacent Utah.

Jay F. Storz, University of Colorado, Boulder, CO.

This study investigated the local distribution and foraging behavior of the spotted bat, *Euderma maculatum*, in Dinosaur National Monument, Colorado-Utah, by monitoring echolocation calls. I verified the occurrence of this species in a variety of habitats in canyon bottoms and other low elevation sites, which indicates that the animals are widely distributed and locally common in the area. Foraging spotted bats concentrated flight activity in the open air space above meadows and occasionally exploited near-canopy habitat (within 8 m of foliage). Foraging spotted bats attacked airborne prey every 2.15 min on average. Consistent with published observations, spotted bats maintained exclusive foraging areas. Distinct vocalizations indicating agonstic encounters occurred when a bat encroached on the foraging area of a conspecific.

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Placental histomorphology of *Natalus stramineus*, *Micronycteris megalotis*, and *Macrotus waterhousii*.

[1]Claudia K. Torres-Villaseñor, [2]Cornelio Sánchez-Hernández, [1]Ma. del Carmen Uribe Aranzabal, and [1]Maricela Villagran, [1]Facultad de Ciencias, UNAM; [2]Instituto de Biología, UNAM, A.P. 70-153, México, D.F. 04510.

Placentas were analyzed by viewing external morphology and by histology. By viewing external morphology, the placentas of the three species were the discoidal type, with *Micronycteris megalotis* and *Macrotus waterhousii* showing a single disk and *Natalus stramineus* having two disks. Histologically the placentas of the three species were classified as hemoendotheliochorial.

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Bat Conservation International progress report.

Merlin D. Tuttle, Bat Conservation International, Austin, TX.

The mine closure issue had dominated the past year's efforts to conserve North American bats. BCI established the North American Bats and Mines Project, hired a project director, using matching funds from the U.S. Bureau of Land Management and private donations, provided a variety of training activities for mine lands managers, published a *Bats and Mines* technical bulletin, and gained new state and federal agency collaboration. New partnership agreements with the U.S. Forest Service and the Soil Conservation Service have further extended cooperation to help bats in mines, and field research projects with the Forest Service contributed essential knowledge of habitat requirements for tree-roosting bats. Eighty wildlife managers and private conservationists attended BCI's Bat Conservation and Management Workshops in the summer of 1994, greatly expanding knowledge and concern for bats in federal and state agencies. A joint research project with the Texas Department of Transportation on "bat-friendly" bridge designs documented the roost requirements of some six million bats in 600 bridges, leading to creation of new habitat during bridge construction. The North American Bat House Research Project expanded to include 1500 participants in 48 states and continues to make rapid gains in knowledge regarding bat use of artificial roosts. Additional projects addressed the needs of declining Mexican free-tailed bats and provided new educational materials.

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Conservation of the endangered Indiana bat (*Myotis sodalis*) at the Indianapolis International Airport, Indiana.

Karen Tyrell, Virgil Black, Jr., and Russell Rommé, 3D/Environmental, 8406 Wood Road, Knoxville, TN; 3D/Environmental, 781 Neeb Road, Cincinnati, OH.

In support of an Environmental Impact Statement required under the National Environmental Policy Act, 3D/Environmental (3D/E) completed a survey for endangered species at the proposed site of an extensive airport development project. A mist net study and habitat assessment was conducted to determine the status of the Indiana bat (*Myotis sodalis*) in the project area. So that the proposed project could lawfully continue, 3D/E developed an approach to minimize project impacts to individuals, and compensate for loss of habitat resulting from project development. At the project's inception, there was little precedence for implementing these requirements for endangered species, and virtually no work of this scope has been undertaken for the Indiana bat. 3D/E developed the first mitigation plan to evaluate impacts to roost and foraging habitat of this species, and incorporate these findings into a comprehensive approach to enhance, restore, and create habitat to support the continued existence of the species in the project region. Habitat suitability in both the impact and mitigation sites has been evaluated using a Habitat Suitability Index developed in conjunction with this project, following the Habitat Evaluation Procedures (HEP) guidelines established by the US Fish and Wildlife Service. The HEP model provides a promising tool for evaluation impacts to Indiana bat habitat, and defining suitable conservation goals and methods. A variety of techniques has been used to implement habitat conservation goals. Artificial roost sites were placed along the riparian corridor and upland woods near a perennial stream in the project region. Along this corridor, wooded habitat typical of pre-settlement vegetation, and of sites where Indiana bats occur, is being created. Project success is being monitored to allow evaluation of conservation techniques. Multiple maternity colonies of Indiana bats have been identified in the project area. While Indiana bats have not been observed using artificial roosts, other species of bats have been observed in these structures. Multiple maternity colonies of Keen's bats (*M. septentrionalis*) have been found in artificial roosts. In newly created

(future) habitat, where vegetative community structure is modeled after suitable Indiana bat summer habitat, plant survivorship is high.

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Patterns of fruit resource use in pteropodids.

Ruth C. B. Utzurrum, Boston University, Boston, MA, USA and CENTROP, Silliman University, Dumaguete City, Phillipines.

Food habits were recorded for nine species of pteropodid bats in a primary tropical rainforest in southern, Negros Island, Phillipines. Figs (F. Moraceae) were found to comprise a major portion of these bats' diet in the area: at least 11 out of 30 *Ficus* species identified were present in splats, ejecta, and fruit remains of bat consumption. Fruits of 11 other plant species belonging to seven other plant families were noted in the diets. No size relationships between bats and the fruits consumed were evident. Instead, data suggest differential choice of fruit along lines of fruit color (i.e., bright versus dull-colored fruits) and on the basis of available crop density and plant height. A descriptive model of fruit choice based on the observed patterns will be presented as a template for further studies on food resource partitioning in these species and the role that biochemical quality of fruits may play in food choice.

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Geographic similarities and ecological patterns between nectarivorous bats and columnar cacti in Mexico.

Alfonso Valiente-Banuet, Ma. del Coro Arizmendi, and Alberto Rojas-Martínez, Centro de Ecología, UNAM, A.P. 70-275, México, D.F. 04510.

In Mexico the role of nectarivorous bats (Phyllostomidae: Glossophaginae) in the pollination of plants has been somewhat neglected, especially in arid and semiarid zones. For example, the importance of the Glossophaginae in the pollinization and disperal of columnar cacti, even though 67% of Mexican species show bat-pollination syndrome, and the centres of greatest diversity of both groups overlap in central Mexico, had not been explored. We present the results of a project that is under way to study the ecological patterns of the interactions between the guilds in the valley of Tehuacan, where the greatest diversity of bat groups is found.

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Presence of *Desmodus rotundus murinus* in Morelos, Mexico.

Rodrigo Vargas-Yañez, Laboratorio de Sanidad, CIB-UAEM, Av. Universidad 1001, Col. Chamilpa, Cuernavaca, Morelos, México 62210.

The state of Morelos has a surface of 4,958 square kilometers, which corresponds to 0.25% of the country. There are two large physiographic regions, the Neovolcanic Belt Province and the Sierra Madre del Sur Province. The state is considered to have a medium prevalence of bovine paralytic rabies. The presence of *Desmodus rotundus murinus* has been recorded in 22 of the 33 municipalities in the state. In the present work, a total of 50 refuges were visted out of the 140 that have been recorded. The 80% of the refuges visited had colonies with high densities (1500 individuals) or low densities (10). However, most colonies had from 150 to 300 individuals. The wide distribution of this haematophagous specie leads us to a constant monitoring of refuges, as well as the intensification of control measures.

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Occurence of bats in cave of Morelos.

Rodrigo Vargas-Yañez and Regina Vargas-Bahena, Laboratorio de Sanidad, CIB-UAEM, Av. Universidad 1001, Col. Chimilpa, Cuernavaca, Morelos, México 62210.

There are 18 species of cave-dwelling bats in Morelos, México. In this study from 1991 to 1994, 37 caves in this state were explored. Owing to their large spaces and more constant microclimatic conditions, caves hold a large number of bat species. Some species, like the members of the family Moormopidae, were found in large colonies; a large colony of ***Natalus stramineus*** was found in one cave. Of the 44 species of bats reported for Morelos, 41% live in caves. A total of 12 caves (32%) hold >3 species, while 25 caves (68%) hold <2 species. A greater protection for caves with a high sprichness is suggested.

Roosting ecology and roost-site selection by forest-dwelling bats in the West Arm Demonstration Forest near Nelson, B.C.

Maarten J. Vonhof, University of Calgary, Calgary, Alberta.

During the summers of 1993 and 1994 I set out to characterize the trees used by bats as roosts in the West Arm Demonstration Forest, an area of approximately 14.5 thousand hectares in the southern interior of Bristish Columbia. I addressed the question of whether bats are selecting trees for certain characteristics at two levels: the area immediately surrounding the roost tree and other areas within the same forest stand. Tree roosting sites were located by attaching radio-transmitters and tracking bats to their roosts, or by watching trees at dusk for emerging bats. The bat species examined included *Lasionycteris noctivagans*, *Eptesicus fuscus*, *Myotis evotis*, and *M. volans*. A 0.1 ha plot was established around each roost tree and the characteristics of all wildlife trees in the plot were measured. Two additional 0.1 ha plots were established at random locations within the same stand and the characterisitics of all wildlife trees within these plots were measured. The characteristics of roost trees were compared to those of other wildlife trees to determine whether roost trees have different characteristics than trees in the immediate vicinity of the roost tree, and trees in other areas of the same stand. The results of these analyses will be discussed. Preliminary results indicate than bats prefer western white pine snags over other tree species, and snags in particular stages of decay. In addition, roost trees tend to be tall, often protruding above the canopy.

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The genetic structure of social groups of *Myotis lucifugus*.

Melanie E. Watt, Department of Zoology, University of Toronto, Ontario, Canada

The genetic structure of maternity roost groups of *Myotis lucifugus* in Chautauqua, New York was examined using recently developed DNA extraction and fingerprinting techniques. Mean percent bandsharing between mothers and their presumed young was significantly higher than bandsharing between all other groups, suggesting that *Myotis lucifugus* do preferentially suckle their own young. Mean percent bandsharing between young was significantly higher than between their mothers, suggesting that mating is not random as previously suggested for this species, but may be skewed for individual males or male lineages. Although philopatric behavior and group stability at *Myotis lucifugus* maternity roosts suggested the possibility of roosts comprised of close kin, DNA fingerprinting evidence showed that roost mates are not necessarily related. Bandsharing withing maternity roosts was not significantly different than bandsharing between roosts, demonstrating that the cohesion of *Myotis lucifugus* maternity roost groups is not based on close genetic ties. However, in one roost with two exits, pairwise comparisons between bats captured at one exit hole showed significantly higher percent bandsharing than comparisons made between individuals using different exits, suggesting that the roost may be partitioned within the building. This provides evidence that groups of related individuals may sometimes associate in maternity roosts. No relationship was found between size of roost and degree of relatedness of individuals. Within roosts, no significant difference in bandsharing was found between animals caught together and animals caught on different nights. One pair of adult female bats switched from one maternity roost to the other at approximately the same time during the study, but based on DNA fingerprinting, they were not likely a mother young pair.

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Phylogeography of *Leptonycteris curasoae* using mtDNA sequences.

G.S. Wilkinson and T.H. Fleming, University of Maryland, College Park, MD and University of Miami, Coral Gables, FL.

The endangered lesser long-tongued bat, *Leptonycteris curasoae*, only visits the southwestern United States during the summer to give birth and rear young. Because this nectarivorous bat feeds extensively on the pollen of columnar cacti and agave, migratory bats could follow flowering corridors to and from northern nursery sites. Here we combine census information on the presence and abundance of *L. curasoae* from 14 sites distributed throughout the Sonoran desert, Baja California, Chiapas and northern Venezuela with mitochondrial DNA sequence information to infer migration routes and recent evolutionary relationships of this bat. DNA was extracted from wing membrane samples excised from four individuals at each site. Over 300 bp of the d-loop, adjacent to the pro-tRNA gene, was obtained for 60 individuals by direct sequencing of PCR products. Sequences from *L. nivalis*, *Glossophaga soricina*, and *Phyllostomus hastatus* were included as outgroups. Maximum parsimony analysis reveals two major clades of Mexican *L.curasoae yerbabuenae* -- one that includes bats primarily from coastal sites in Baja and Mexico, and one

that includes bats primarily from inland Sonoran and Chiapas populations -- that differ by 3%. The presence of bats from both clades at some sites is used to identify movements between roosts. Implications of these results for bat-cactus coevolution and bat social behavior will be discussed.

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The influence of reproduction on foraging behaviour and diet of big brown bats, *Eptesicus fuscus*.

Lisa Wilkinson, University of Calgary, Calgary, Alberta.

To understand the influence of reproductive demands on the diet and foraging behaviour of insectivorous bats, it is instructive to compare reproductive females to males. For two seasons in Southeastern Alberta, maternity colonies of big brown bats (*Eptesicus fuscus*) containing small populations of males were studied. Ambient temperature had the most pronounced influence on foraging behaviour; cool weather in 1993 led to similarly reduced foraging bouts for both sexes. In 1992, there was more varability in foraging times, with males typically foraging as long as possible. The river valley was the primary foraging area for both sexes, within which there was little variation in habitat type or available insect fauna (based on suction traps). Females, particularly during pregnancy and lactation, tended to forage within a 5 km range of the roosts, resulting in smaller feeding areas than males. Males showed less fidelity towards foraging sites, often flying to more remote locations than females. One of the greatest reproductive demands faced by female bats is the need for calcium to support the large skeleton of growing pups. Diets of males and females were compared through fecal analysis, and prey items were analyzed by atomic absorption spectrophotometry to determine calcium levels. Diets were similar with the exception that females ate significantly more beetles than did males. However, beetles did not contain higher levels of calcium than other prey items; in fact, all insects were uniformly low in calcium. Thus, it seems unlikely that females can feed selectively to meet calcium demands. äIn order to test the hypothesis that physiological mechanisms may enhance the absorption of calcium, a feeding experiment was conducted.

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Latitudinal gradients of diversity in New World bats: A stochastic model and empirical test.

Michael R. Willig and S. Kathleen Lyons, Ecology Program, Department of Biological Sciences and The Museum, Texas Tech University, Lubbock, TX 79409-3131.

Although latitudinal gradients in species richness are well-documented for a wide variety of taxa in both terrestrial and aquatic environments, little consensus exists concerning the predominant biological factor that is responsible for producing the patterns. Because of the ubiquity of such latitudinal gradients, a single factor often is assumed to cause the relationship. Nonetheless, detectable patterns could be the product of stochastic processes or a consequence of a multitude of factors acting in concert. To test these alternatives, we constructed an analytical model to assess the degree to which patterns in species richness for bats could be a product of a random location of species ranges in the New World. We tested our model by first comparing actual gradients for the entire New World to the analytical prediction based upon chance, and second by taking random sections of the New World, and comparing actual gradients to simulated gradients therein. In each instance, a significant portion of variation in species richness was predicted by a stochastic model. The efficacy of the model is dependent on the latitudinal domain within which the simulations were conducted (entire New World, latitudinal extent of the entire fauna, or smallest latitudinal extent encompassing 95% of the fauna). Factors purported to affect gradients in species richness must account for deviations from the predictions of our stochastic model; consequently the model represents an operational definition of the null hypothesis for studies concerning latitudinal gradients.

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Bat communities of Big Bend Ranch State Natural Area, Texas.

Franklin D. Yancey, II, and Clyde Jones, The Museum and Department of Biological Sciences, Texas Tech Univ, Lubbock TX.

With the support of the Texas Parks and Wildlife Department, a two-year study of the bat communites of Big Bend Ranch State Natural Area (BBRSNA) is underway. The presence of several water-associated habitats interspersed throughout an otherwise typical Chihuahuan Desert ecosystem makes BBRSNA an

especially unique locality to study bat communities. To date, 14 species of bats have been documented. The community structures of bats from BBRSNA are discussed and compared with the bat faunas of other Chihuahuan Desert regions, such as Big Bend National Park, and the states of Chihuahua, Coahuila, and New Mexico.

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Rousettus aegyptiacus available

An animal dealer who has imported approximately 100 *Rousettus aegyptiacus* for resale has been informed by federal agencies that these bats cannot be sold or given to any individuals or organizations except those engaged in scientific research or in recognized and fully licensed zoos. This dealer is most eager to divest herself of as many of these animals as possible. They are about evenly distributed between the two sexes and are breeding in captivity. They appear to be in good health and to be free of ectoparasites. The purchaser will need to obtain and/or provide all the necessary papers and permits, pay the cost of shipping and supply an approved shipping container. The price is negotiable but appears to be in the vicinity of $75.00 per animal. Interested parties should contact:

Ms. Pat Storer at P.O. Box 160, Columbus, TX 78934, Phone 409-732-3562, FAX 402 732-9417.

For more information on permits for trsnsporting or holding these animals contact:

Dr. Stephanie R. Ostrowski, at the C.D.C. in Atlanta, GA, whose e-mail address is "SRO1@cpsod1.em.cdc.GOV"

This announcement in no manner implies endorsement of this dealer or these animals and is merely offered as a service to those readers who may be interested in these animals. G.R. Horst.

The Seventh European Bat Research Symposium(ERBS)

will take place at the conference centre Konigshof, near Veldhoven, August 12-19, 1996. Veldhoven is located some kilometers south-west of Eindhoven, in the southern part of the Netherlands. The centre has numerous facilities. The symposium will consist of oral presentations, poster papers, workshops and evening discussions. Suggestions on other events that could be associated with the symposium are welcome. The conference language will be English. After the symposium, the 3rd European Bat Detector Workshop will be held in the Grand Duchy of Luxembourg.

Preliminary registration forms are obtainable from **Peter Lina,** 7th ERBS, c/o IKC-NBLF, P.O. box 30, 6700 AA Wageningen, the Netherlands. Fax: +31837027561.

Final registration forms and a circular with more details will be mailed in Summer of 1995 to those who reply positively to this preliminary announcement.

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The American Society of Mammalogists

will hold their 75th annual meeting June 20-24, 1995 at the University of Vermont in Burlington, Vermont. For registration materials or other information please contact: **William Kilpatrick,** Department of Zoology, University of Vermont, Burlington, VT 05405-0086.
Tel. 802-656-0453 Fax. 802-656-2914
E-mail wkilpatr@moose.uvm.edu

I have seen the program and there are a lot of good bat papers being presented. Vermont is lovely in late spring early summer, don't miss it! G R H

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Front Cover

Peter Smith and Sheelagh Kerry of Bettwys, Abergavenny, Gwent NP7 7LG Wales, U.K. sent along the cover illustration of several *Artibeus sp?* they discovered under banana leaf tents in Trinidad. The illustration is a pen and ink by Sheelagh, who apparently could have a second career as an illustrator.