BAT RESEARCH NEWS

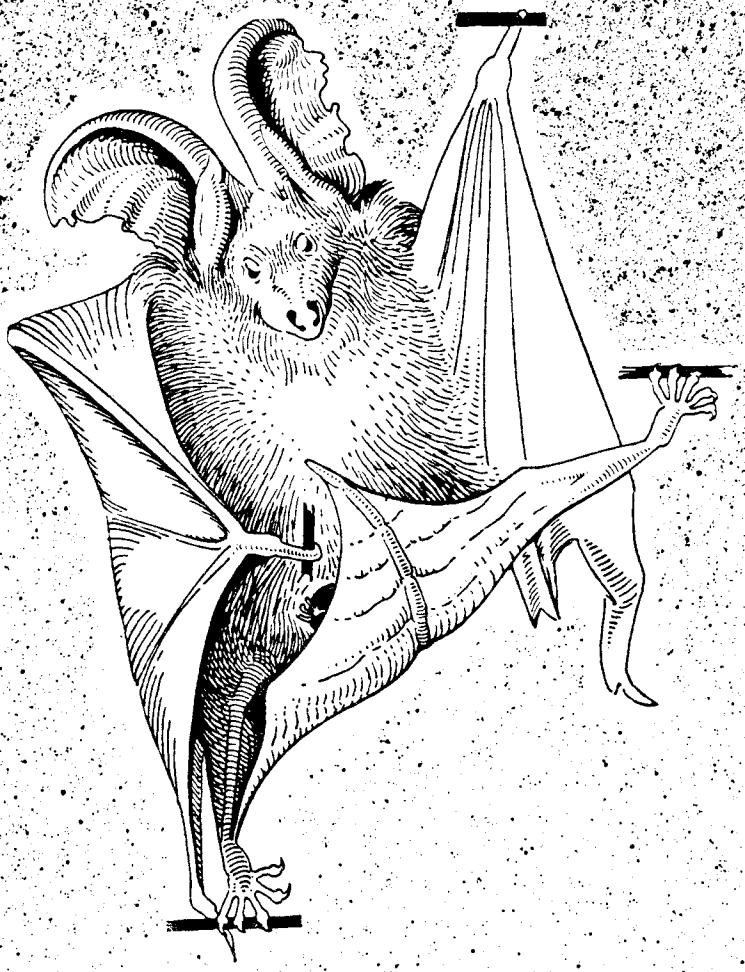

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Table of Contents for Volume 33, 1992

Volume 33: Number 1, Spring 1992

Volume 33: Number 2/3, Summer/Fall 1992

BAT RESEARCH NEWS

Table of Contents for Volume 33, 1992

(cont.)

Volume 33: Number 4, Winter 1992

BAT RESEARCH NEWS

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BAT RESEARCH NEWS

Volume 33 Spring 1992 Number 1

Recent Records of the Big Brown Bat, *Eptesicus fuscus,* in Southern Florida

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The big brown bat, *Eptesicus fuscus* is rare in Florida, particularly in the southern part of the peninsula. Rhoads (1901) described specimens collected in April 1892 near Tarpon Springs, Pinellas County, as *E. f. osceola*, and the only other published records south of that locality are from Highlands and Charlotte counties (Rand and Host, 1942; Sherman, 1945). There is also a specimen from Miakka, Manatee County, collected in December 1897 by O. Tollin in the Florida Museum of Natural History collection (UF 233). This note reports three additional records from the southern limit of the known range of the big brown bat in peninsular Florida. The specimens are preserved in the mammal collection of the Archbold Biological Station (ABS).

On 17 September 1983, an adult male (ABS 67) was captured by Jane Adams in an abandoned wooden school house 6 km ESE of Arcadia, DeSoto County. The bat was found in a crevice in a door frame inside the building which had been occupied by six or seven bats (presumably also *E. fuscus*) several days before. The building was located in an open stand of small sand live oaks *Quercus geminata* near the edge of the citrus grove.

Two other specimens were collected by Debbie Danley in 1988 and 1989 at the same locality - the yard of a house in a subdivision 7 km SW of Lake Placid, Highlands County. An adult male (ABS 68) was found hanging on a low fence on the lawn on 19 September 1988, and on 30 May 1989 a juvenile female (ABS 69) was captured after it fluttered down on the lawn at dusk. It still possessed lacteal dentition, and the cheek teeth were just erupting. Its forearm length was 40 mm and body mass was 10.4 g. Based on growth curves given by Kunz (1974), it was approximately 25 days of age. The house was in an area of scrubby pine flatwoods habitat with a dense shrub layer and scattered live and dead south Florida slash pines *Pinus elliottii* var. *densa.* Several of the snags near the yard had woodpecker cavities, and it is probable that the young, which was just beginning to fly, had come from one of these. Big brown bats recorded by Rand and Host (1942) from Highlands County were found in a cavity in a tall dead pine in August. At least six individuals were present, four of which were still in the cavity when the snag was cut down. Jennings (1958) found *Eptesicus* was primarily associated with colonies of *Tadarida brasiliensis* in buildings in northern Florida, but none were collected from *Tadarida* colonies in southern Florida.

The testes of the males were 10.0 by 5.5 mm (ABS 67) and 9.0 by 4.5 mm (ABS 68). The cauda epididymides did not contain sperm. Based on the estimated age of 25 days, the juvenile had been born in early

May, which is about 1 month earlier than parturition in a Maryland population (Christian, 1953) but about the same time as births in Kentucky (Barbour and Davis, 1969). Jennings (1958) collected three lactating females on 22nd June in an abandoned building in northern Florida (Hamilton County).

On geographic grounds, big brown bats from southern Florida are referable to *E. f. osceola.* Although Scudder and Humphrey (1978) considered this subspecies to be synonymous with E. f. fuscus, other recent authors (Hall, 1981; Burnett, 1983) have recognized it. Rhoads (1901) stated that *osceola* was distinguished from *fuscus* by its deeper and darker brown pelage coloration. However, Howell (unpublished MS) found no distinct color differences between specimens of the two subspecies. The three southern Florida specimens reported here were rich, dark brown in color and did not differ in any appreciable way from a series of skins from Illinois, New York, Pennsylvania, and North Carolina in the Florida Museum of Natural History. In contrast, the pelage of a female (ABS 8) collected in Highlands County by Rand and Host (1942) is a bright coppery color, probably an artifact of preservation or storage.

Measurements (mm) and mass (g) of the adult males from DeSoto (ABS 67) and Highlands (ABS 68) counties, respectively, were: total length 124, 113; tail 48,43; hind foot 9,9.5; ear from notch 18,16; forearm 48,45; mass 14.1, 14.0. The female collected by Rand and Host (1942) had measurements of 110-48-11-ear 16. Measurements of the male type of *E. f. osceola* and means of four topotypes (sexes not stated) given by Rhoads (1901) were 101-38-9.5 and 113-44-10.6, respectively. For comparison, means and ranges (in parentheses) of five males and 10 females from Illinois and New York are: males - total length 111.4 (110-114), tail 45.0 (42-47), hind foot 9.6 (8.5-11), ear 16.8 (16-17), forearm 46.9 (44-50), mass 14.2 (12.7-15.5); females - total length 117.5 (111-124), tail 44.4 (40-49), hind foot 9.6 (8-11), ear 17.1 (15-18.5), forearm 42.4 (44-50), mass 15.5 (14.9-22.1). Although sample sizes are too small for critical comparison, the data do not suggest any size difference between southern Florida and northern specimens of E. fuscus, as also noted by Rhoads (1901). However, a small sample used by Burnett (1983) to represent *osceola* fell outside the range of *fuscus* in a principal components analysis of skull measurements of females even though it included specimens outside the usually accepted range of *osceola* (northern Florida and the coastal plain regions of Georgia and South Carolina). The scarcity of specimens of big brown bats from southern peninsular Florida precludes critical evaluation of the status of *E. f. osceola*, but the available data raise a question as to its validity.

I thank Jane Adams and Debbie Danley for collecting the three new specimens reported here and Laurie Wilkins for permission to examine specimens in the mammal collection of the Florida Museum of Natural History.

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Polygynous Groups of Bats: Should They Be Called Harems?

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The study of chiropteran behavior has revealed a wide variety of interesting social interactions. As in most mammals, the common mating system in bats is polygyny (Bradbury, 1977). Within that classification, researchers have found systems ranging from long-term, stable associations of several females with a single male (e.g., McCracken and Bradbury, 1981; McWilliam, 1988) to males that defend territories with transient female groups (e.g., Bradbury and Emmons, 1974; O'Shea, 1980; Williams, 1986). Often, these polygynous groups are termed "harems." I propose that the use of the term harem should be avoided because 1) it has anthropocentric connotations that are generally inappropriate to the situation being described, and 2) the use of a single, poorly defined term obscures the causes and consequences of grouping and mating behavior.

The tendency in animal behavior research in the past decade has been to move away from anthropocentric terms to more descriptive, less functionally biased terms: e.g., rape has been replaced by forced copulation, bastardy by non-paternity, and adultery by extra-pair copulation (e.g., Estep and Bruce, 1981; Gowaty, 1982; Power, 1980). Beach (1978, 1979) discusses the problems associated with ascribing specialized meanings to words from common use and of redefining words to suit a English Dictionary recognizes the use of the term harem as it relates to describing the female quarters of Moslem houses or the occupants thereof, especially wives and concubines. In common English usage, harem has connotations of male control or dominion over females. The connotations of the term are transferred to the animal group described as a harem and may or may not reflect preconceptions regarding group structure. When groups of *Myotis boccagei* are called harems, with the male as "harem -master" (Brosset, 1976), the implied message is that the male controls the structure of the social group. Even though males rarely, if ever, are called harem-masters in current primary literature, continued use of the term harem retains the implications of male control. A disturbing manifestation of this is the description of male *Phyllostomus hastatus* as "harem masters" in a widely-read introductory animal behavior textbook (Alcock, 1989:446) even though the primary research upon which the description is based used "harem males" (McCracken and Bradbury, 1997, 1981).

Calling a group a harem also has implications for behavioral biology. Using the term harem encourages assumptions about the types of relationships among individuals within groups, the social structure, and the mating system of the species in question (Wrangham and Rubenstein, 1986).

Frequent use of "harem polygyny" (e.g. McCracken, 1984; Williams, 1986) implies that a single, uniform mating system is being described. But the term harem has been used to describe resource defense polygyny with compositionally stable groups of females (e.g., Morrison, 1979), resource defense polygyny with transient groups of females (e.g., O'Shea, 1980; Williams, 1986), female defense polygyny (e.g., McCracken and Bradbury, 1981), female defense polygyny with elements of resource defense (e.g., McWilliam, 1988), and species in which the type of polygyny is unknown (e.g., Brooke, 1990; Brosset, 1976). In my own experience, I have been asked by other researchers about what they assume to be harems of tent-making bats *Uroderma bilobatum,* even though very little is known about the structure and stability of groups in this species and even less is known about the mating system. Using the term so indiscriminately to describe a wide variety of social systems creates the potential for confusion among researchers, students, and laypersons regarding the actual system being described.

Confusion can also be seen among researchers in what a harem actually is. Although the basic definition of "a group of females associated with a single adult male" (Kunz and Gustafson, 1983:20) is most widely accepted, some researchers have included multi-female, multi-male groups in their classification as harems (e.g.McWilliam, 1987). Some researchers refer to only the female groups as the harem; for example, "colonies consist of a single harem, a harem male, and one or more peripheral males" (McCracken, 1984), while others speak of harems as a particular mating system; for example "harem or resource defense polygyny" (Williams, 1986:265). Again, the lack of agreement on the correct use of the term results in the potential for miscommunication.

In summary, I believe the use of the term harem to describe groups of bats should be avoided because of its anthropocentric connotations, the implications it carries regarding social behavior, and the imprecision that exists in how the word is used. More appropriate terms include: unimale social unit (Gowaty, 1982); mixed-sex group; single male, multi-female group; maternity group (or female group) with one or more associated male(s); or, if details of the mating system are known, polygyny, female defense polygyny, or resource defense polygyny. While the descriptions are more bulky, they lead to a more precise depiction of the biology of the bats and are free of the unnecessary "baggage" of words such as harem.

I would like to thank the animal behavior group at the University of Minnesota for discussions of ideas that contributed to this paper. A. Kurta and G. McCracken made helpful criticisms of an earlier draft of the manuscript.

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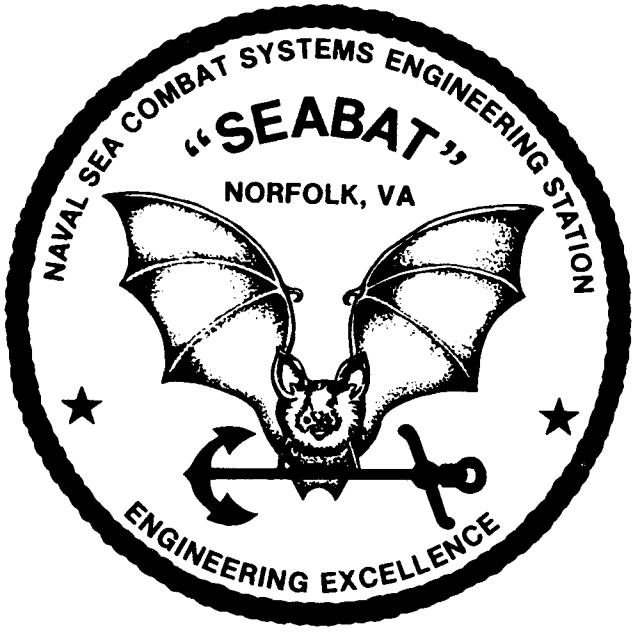
Dept. of Exotica, Erotica, Etcetera



So far as I have been able to determine this is the only official military ensignia that carries the likeness of a bat. It was given to me by Lt. Ray Horton, a retired Navy engineer. If onyone else collects bat paraphernalia, souvenirs, etc., and would like one for their collection, I can obtain one of these for you. GRH

A Convenient Device for Tagging Bats in the Field

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In the field, tracking of bats is generally accomplished by marking and tagging the individuals. Researchers have used a vast array of different tagging devices such as metallic numbered bands, plastic split rings, reflective bands, necklaces, battery operated light tags, chemical light tags, beta light tags and radio transmitter tags (Barclay and Bell, 1988). Necklaces, one of the common devices, are generally found suitable to tag some species of bats. The advantage of this device is that the necklace is very simple in design and the percentage of shedding of tags and removal by bats is much less.

During the past three years, we have undertaken an intensive mark-recapture program using a novel device for tagging in a relatively big colony of Indian False Vampire bats, *Megaderma lyra* roosting in a temple at Krishnapuram (8o 44' N lat; 77o 42' E long, Southern India). Plastic color beads and elastic rubber rings are used for making this necklace type of tag. Numbers zero to 9 are given to ten beads of different colors in the following order: 0 -black, 1 -light green, 2 -ivory, 3 -yellow, 4 -dark green, 5 -orange, 6 -red, 7 -white, 8 -brown and 9 -blue. The elastic rubber ring is cut at one point, a knot is made at one end leaving a gap for three beads to be inserted and for a reef knot to secure the ends. Three beads are inserted in the numerical order through one end and a necklace is made by securing the ends in a reef knot. The elasticity of the necklace enables it to slide along the head of the bat quite smoothly. Using a maximum of three beads, it is possible to make 999 combinations which can be individually identified. For example, if the necklace consists of three beads in the order ivory-yellow-white, it is read as 237. The knot does not allow movement of beads hence it is easy to identify and read the beads from one end.Beads and elastic rings are available in all stationary shops at a cheap price: ten elastic elastic rings for one Indian rupee (US 2.8 cents) and 10 g of beads (about 500 in number) for two rupees. The diameter of the bead is about 5 mm and the total weight of the tag is 0.2348 g which includes three beads and a ring. The weight of the tag is much less than the body weight of *M. lyra* which is 36.3 ± 0.2 g (± SE n = 27). As per the limit recommended for minimal behavioral distortion, the tag must be below 5% of the body mass of the flying animal (Barclay and Bell 1988; Brander and Cochran 1969).

Adults and neonates numbering some 400 bats have been successfully tagged and recaptured for the past three years. The false vampire bats became accustomed to their tags without notable stress. The aim of our study is to obtain information on growth rate, weaning age, attainment of sexual maturity, gestation period, survival rate, mortality, dispersal of individuals, colony composition during different seasons of the year, sexual segregation, mating systems and so on. So far, we have experienced success in collecting data using this device. It is simple, light weight, easy to make, inexpensive and causes little or no inconvenience to the bat. It is our opinion that this device is a good alternative to the commercially available tag and is worth trying.

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A New Task for an Old Tool: Using Crochet Hooks to Remove Bats from Mist Nets

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One problem facing bat researchers is removing their study animals from mist nets. Because fingers are orders of magnitude larger than the strands of a mist net, time is wasted struggling clumsily with tangled bats, birds, and insects. A more serious, though rare, consequence of clumsy handling is inadvertent injury to small and delicate animals (Kunz and Kurta, 1988). Particularly troublesome are thoroughly entangled bats (e.g., spinning *Artibeus*), birds (especially when wet or with entangled tongues), and large beetles. In these cases, obtaining the slack required for removing one strand often results in tightening others. Sometimes the only recourse is cutting the net (Kunz and Kurta, 1988), and this may require use of a sharp edge near the animal. Handling animals such as vampire bats, large phyllostomids, and large pteropodids, which present risks to fingers that stray too close to teeth, provides further incentive to ease the task of untangling bats.

Our solution is a small stainless steel crochet hook, or "bat pick." Steel crochet hooks are approximately 12 cm long and 2-3 mm in diameter. They taper to less than 1 mm in diameter at one tip, where there is a small, shallow notch. The smooth, slender tip slides easily under the net threads without harming delicate bat or bird skin, while the notch captures strands of net for removal from the entangled animal. Strands can easily be released by a twist of the shaft. Crochet hooks, used skillfully, can disentangle difficult cases while keeping clumsy fingers out of reach of large, sharp teeth or beaks and at a distance from tiny and fragile birds and bats. Fingers are better at some disentangling tasks, and we find that we alternate between use of the crochet hook and the fingers alone. Bats that bite the crochet hook usually release it immediately with no damage to their teeth, but very gentle handling of the crochet hook is required if the bat does not reject the shaft immediately. The problem of what to do with a crochet hook when it is not needed is probably the greatest drawback; one solution is to attach it to a string tied to the shirt or looped around the neck.

We have had experienced bat biologists and neophytes test the bat pick informally for eight years. Neophytes usually find bat picks invaluable, as those new to bats can be intimidated by a large, unhappy *Pteropus*, an alert *Desmodus*, or even a small *Eptesicus*. Most veteran researchers have found the hooks useful, although some consider them too much trouble to carry.

Crochet hooks come in a variety of lettered (made from wood, plastic, or metal) and numbered (usually made from stainless steel) sizes. We find all of the lettered crochet hooks too large. We have used sizes 13-20 of the stainless steel hooks, and prefer sizes 15-17. The smaller tips (sizes 19-20) sometimes puncture human skin when forgotten in a pocket, and they may bend under pressure; the larger sizes (13-14) can be more difficult to slip under a tight strand. Individual researchers differ slightly in their size preferences. As crochet hooks are easy to drop and can be impossible to find, particularly at night, we usually carry two or three at a time.

Faculty and staff members of Sillman University in the Philippines played central roles in the development of the bat pick, and one of them may have provided the original suggestion. To all of them, and in particular to E. Alcala, O. Delalamon, C. Lumhod, R. Utzurrum, and L. Dolar, we are grateful.

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Practical Approaches to Housing Bats for Captive Studies

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Although for many types of studies it would be desirable to utilize captive bats, this is often precluded or complicated by a lack of suitable caging facilities. Most commercially available cages are designed for housing the common laboratory or domesticated species and really are not ideal for the long-term maintenance of bats. More appropriate cages can often be constructed from wood and wire or plastic netting, but this generally requires some carpentry skills, access to appropriate power tools, and the investment of considerable time. Furthermore, wood is less resistant to regular washing and disinfectants than some metal or plastic materials. The alternative approach of having metal cages custom-made would frequently be a costly proposition.

Recently the author took a new approach to constructing cages for a laboratory colony of short-tailed fruit bats, *Carollia perspicillata,* that may also have considerable utility in a number of other research programs. Each of the cages, which measure approximately 170 cm wide x 81 cm high x 77 cm deep, consists of an open feeding area and a darkened roosting box. Although very similar to a wood and wire design utilized previously for small phyllostomid bats (Rasweiler and Bonilla, 1974; Rasweiler, 1977), the new cages were constructed almost entirely of metal (15/16" square hollow aluminum tubing, 1/4" galvanized wire mesh, and galvanized sheet metal). These cages were designed to facilitate the daily, non-injurious handling of many of the bats for certain types of reproductive studies. Despite their complexity, the cages were readily assembled in the laboratory with the assistance of only simple hand tools (a rubber mallet, a regular electric drill, a reversible variable-speed battery-powered drill, a 1/4" hex nut driver, and a pair of tin snips). All of the metal parts for the cages were precut, and much of the wire mesh was bent to fit correctly within the frames, by the manufacturer (Corners Limited, 424 Harrison Street, Kalamazoo, Michigan 49007). For the most part, the frames were assembled simply by pounding molded plastic corner pieces into the hollow tubing. In a few locations, the plastic connectors holding together portions of the frame had to be attached instead with self-tapping screws. The wire mesh, door hinges and door latches were also fastened to the framing with such screws. These were easily inserted with the variable speed, battery-powered drill. In the case of the sheet metal used to darken the diurnal roosting boxes, holes slightly larger than the shanks of the screws were drilled before attaching the pieces to the cage frames.

This approach to building bat cages would seem to have many advantages. The manufacturer has a number of reasonably -priced, basic cage designs (including large rectangular, hexagonal and octagonal flight cages) that are either already suitable, or could be easily modified, to house bats for a variety of experimental purposes. A problem with the cages as presently offered (for the purpose of holding birds) is that the openings in the wire mesh are too large for many small bat species; however, different mesh can be provided by the manufacturer or purchased separately. The framing elements are light and can be shipped at reasonable cost. Assembly of the cages does not require much time or skill, and this facilitates the construction of large units (e.g., flight cages) from smaller modules. The cages are durable and easily cleaned, although the acid rinses which are commonly used on rodent cages must be avoided to prevent damage to the finish on the aluminum tubing. Finally, it would seem that the cages might be constructed at even lower cost by using plastic netting rather than metal wire mesh. Durable, heavy duty plastic netting is presently produced in a variety of mesh sizes for use in aquaculture (Duronet by Naltex, 203 Colorado Street, Austin, Texas 78701). This netting was initially brought to the

attention of the author by Paul D. Heideman (pers. comm.).

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Insects in Flying-Fox Diets

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Are Megachiropterans insectivorous? As far as the literature is concerned the answer to this question is a resounding "No" (Ratcliffe, 1932; Marshall, 1983; among others) although there is no evidence to show they are not insectivorous. In a recent project both spat-out and faecal droppings from colonies of Grey-headed Flying-foxes, *Pteropus poliocephalus* were analyzed (Parry-Jones and Augg, 1991a). Numerous insects were found in the droppings; in particular intact and undigested thrips were found mixed with empty pollen grains, probably ingested inadvertently as the bat fed from flowers. However this does not mean that larger insects are not, from time to time, intentionally added to Grey-headed Flying-foxes diet, especially as insects are such a good source of protein.

Like most Megachiropterans, Grey-headed Flying-foxes spit out most of the fibrous part of their food. In the case of insects this would mean that most of the hard chitinous material would be spat-out, rather than ingested, probably at the point of capture. There has been one report (Parry-Jones and Augee, 1991b) of a flying-fox exhibiting this behaviour after hawking a cicada, *Cyclochila australasiae.*

Droppings were collected in January 1990 from under a colony of a least 50,000 Grey-headed Flying-foxes, at the Jamberoo site, south of Sydney in New South Wales, Australia. Faecal and spat-out droppings are easily distinguishable visually and were collected separately. When the faecal droppings were analyzed according to the method outlined in Parry-Jones and Augee (1991a), a large percentage of the samples showed parts of the insect trachea called the taenidida which are bands which spiral around the trachea (Fig.1). "If a trachea be teased out the intima will tear between the taenidida and the latter will uncoil after the fashion of an unwound wire" (Imms, 1925).

The faecal and spat-out analysis of the droppings at the Jamberoo colony site in January 1990 are graphed in Fig. 2. No insect parts were found in the spat-out droppings. So the insects were not caught in the colony site nor were they transported back in whole state for eating there. Subsequently four very small (<3mm) pieces of insect were found when the 20 faecal samples from this site were seived. These pieces were identified as being from a Christmas Beetle (probably *Anoplognathus sp.* - Coleoptera, Scarabaeidae, Rutelinae, E. Archer, pers. comm.).

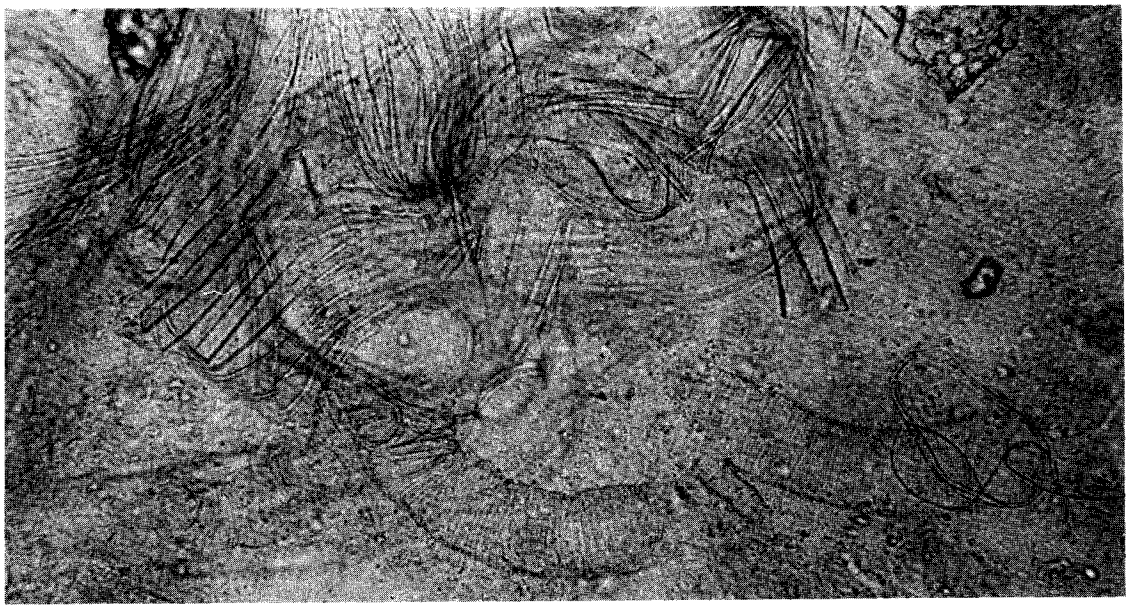

Fig. 1. Taenidida spirals from insects found in faecal droppings from Jamberoo colony site 3 Jan 1990.

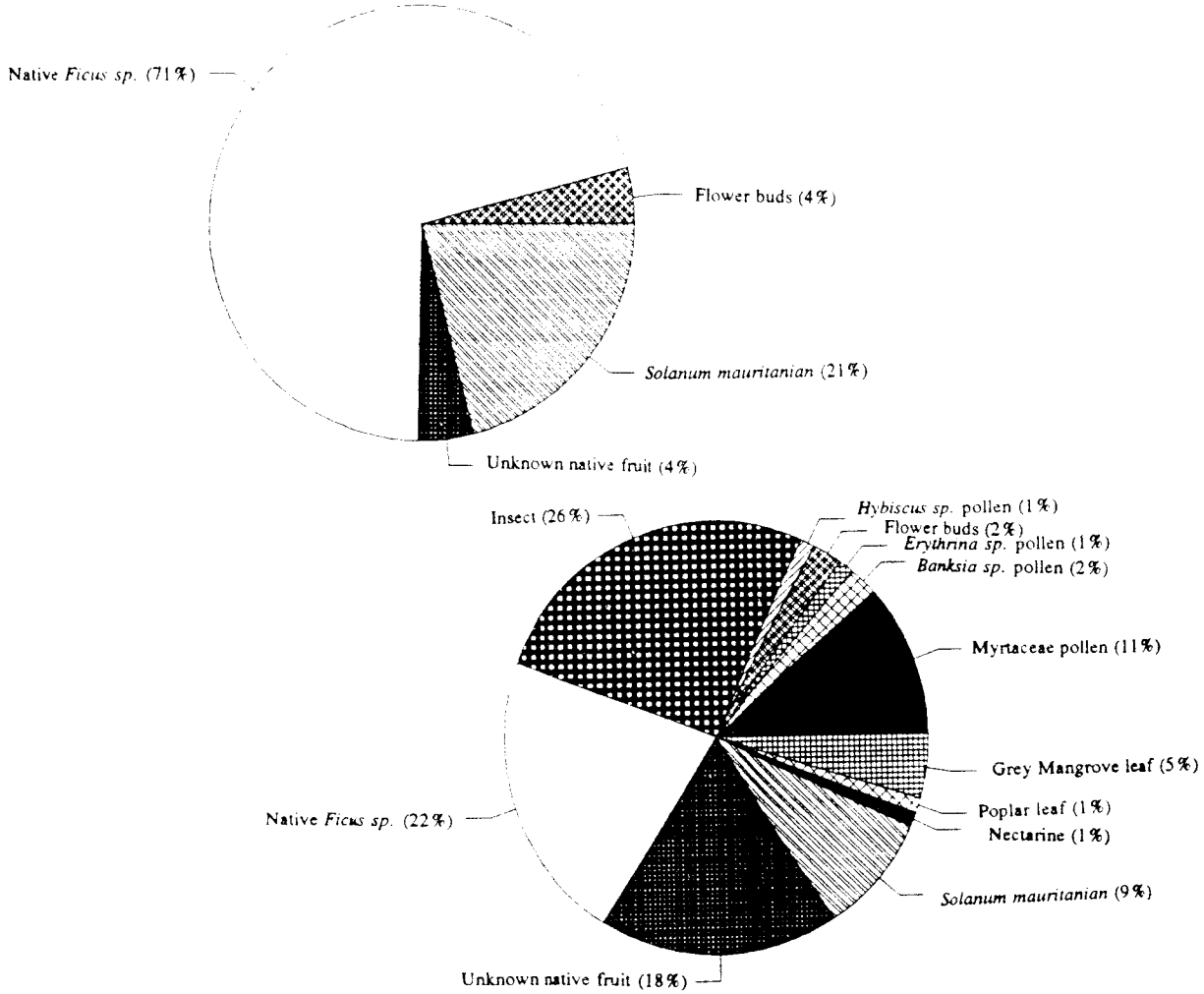

Fig. 2. Diet analysis from Jamberoo site, 4 January 1990: spat-out analysis (top), and faecal analysis (bottom).

Myrtaceae and *Banksia* pollen constitute a large proportion of the diet of Grey-headed Flying-foxes (Parry-Jones and Augee, 1991a) and must be major sources of protein for these animals. In general large colonies of flying-foxes congregate where there is a good supply of suitable blossom, but at the Jamberoo site in January 1990 there was very little blossom available. January is at the height of the Australian summer when big insects such as Christmas Beetles are abundant, so it is likely that during this time Christmas Beetles were providing an alternative source of protein for the 50,000 flying-foxes in residence at Jamberoo.

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A Note on the Longevity of Two Indian Bats

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While going through the voluminous collection diary, laboratory records and personal notes of Prof. A.Gopalakrishna interesting data concerning the longevity of *Rousettus leschenaulti* and *Megaderma lyra lyra* became available to me. The following notes are reproduced from his field diary (endnotes 1 through 4 are added by me).

"24 and 25 July 1965 - 146 specimens of *Rousettus* and 87 specimens of *Megaderma* were ringed. 21 gauge sitar[1] copper wire rings were slipped on to the ankles of the specimens. The ring was put on the right ankle of adults and on the left ankle of juvenile specimens. The specimens were released in the respective roosts (Bawdi[2] and Teen Mori[3])....."

"17 February 1979 - 14 specimens of *Megaderma* were captured from Teen Mori. 2 females had rings on the left ankle - both were pregnant in the left horn. Of the remaining specimens which had no rings, 9 were females (7 pregnant in left horn, 2 non-pregnant) and 3 males....."

"18 February 1979 - 21 specimens of *Rousettus* were captured from an underground tunnel near Pan Chakki[4]. Two females and one male had ring. One female and a male had the ring on the right ankle, one female on the left ankle. Both females were pregnant (right horn). Of the female specimens without rings, 12 were pregnant (7 in right horn, 5 in left horn). Of the 6 males, 5 were adults and one was juvenile.... "

From the above data, it is evident that both *Rousettus leschenaulti* and *Megaderma lyra lyra* have a longevity of at least 14 years, perhaps more.

Endnotes

[1]The sitar is a stringed musical instrument.

[2]Bawdi: a wide well near Bibi-ka-Mukbara, which is a Taj Mahal-like monument at Aurangabad.

[3]Teen mori: a tunnel under Bibi-ka-Mukbara.

[4]Pan Chakki: a tourist spot about one air kilometer from Bibi-ka-Mukbara.

News From around the World

Please take a few minutes to write up a paragraph or two about what you and/or your students are doing with, to, or about bats these days. Have you conducted any workshops, field trips, seminars or other intersting things lately? Let us know about it. We are all interested in your work. I also call your special attention to the very intersting note from Stuart Perlmutter. We need more ideas like this. Please help make this column a success. You will find a handy form enclosed for your use.

Poland

From Cracow, Poland, Joanna Godava writes..."I am currently working on my Ph. D. degree studying the phenetic relationships of recent and fossil bats of the genus Myotis from the Palaearctic Region. My work is based on both metric and non-metric skull features. I am also studying the distribution of bats in southeastern Poland. Prsemysl's Fortress complex was built in the last century and this large fortification includes Fort San Soglio, which contains a winter colony of about 100 *Barbastellus barbastellus*, which I first discovered in 1988. This is one of the largest winter colonies of this species in Poland. I am searching for roosting colonies in this area, using my experiences gained from the first European workshop on bat detection which was organized the Netherlands Bat Research Foundation, and held in Holland on July 1-5, 1991. Thirty -five visitors from 12 countries learned to recognize sounds of bats during lectures and nightly field trips. The instructors(Dutch) taught us how to find bat's flight pathways and then to find their roosts. Thirty six roosts of seven species were found in the three nights during the workshop.

I am also studying the distribution of bats in Ojcow National park and its surroundings near Cracow, where there are a lot of small caves. A survey 30 years ago demonstrated the presence of 14 species of two families: Rhinolophidae and Vespertilionidae. Because of the extreme environmental pollution, the number of bats has decreased catastrophically, and the population of *Rhinolophus hipposideros* has been reduced about one hundred fold during the last 40 years. In 1950 there were more than 300 Rhinolophus hibernating in Raclawicka cave, but now only a few remain. In order to avoid the total extinction of some species we are undertaking various actions to popularize bats inform the public about their particular plight.

Joanna Godava
Institute of Systematics and Animal Evolution
31 - 016 Cracow
Slawkowska 17
Poland.

South Africa

The bat group in the Department of Zoology and Entomology at Rhodes University in Grahamstown comprises Dr. Ric Bernard and Tina Bojarski, and Dr. Chris Brown. Ric and Tina are looking at the role of the anterior pituitary in the control of delayed implantation in long-fingered bats Miniopterus schreibersii. The approach combines immunocytochemical studies of gonadotroph and mammotroph activity with assays of plasma hormone concentrations and experimental hormone manipulations. The aim of this work is to establish whether prolactin terminates delayed implantation by activating the corpus luteum as is the case in some small canivores.

Chris Brown is examining aspects of the thermal biology of long-fingered bats and two rhinolophids, R. capensis and R. clivosus which co -occupy caves in our area. We hope that differences in thermal biology may help explain the different patterns of intercave movement and reproduction that these three species show.

Ric Bernard
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South Africa

Puerto Rico

During this year I have been surveying bat caves in northern Puerto Rico to assess species composition and climatic conditions. Two undergraduate students have been assisting me with field-work and three more a re likely to join soon. Recently some speleological societies, churches and private foundations have requested talks on bats. These opportunities have provided and excellent forum dispel erroneous notions about bats. Other relatively recent "bat activities " in Puerto Rico include data gathering visits by Ulla and Aka Norberg, and later by Tom Kunz, More recently I have been involved in the capture of some Brachyphylla cavernarum for the Lubee Foundation.

The neotropics could rightly be called Bat-Land, however it is seldom heard from locals doing work with bats in south America. One reason is obviously economic. I submit that among its many hats, Bat Research News could become a facilitater for the development of bat research in "the Land of Bats". I have been corresponding with people from various Latin American countries and the lack of literature, among other things seems to be a pressing problem. Any of you have any feedback?

Armando Rodriguez Duran, Chairman
Department of Natural Sciences
Inter American University
Minillas Industrial Park
Bayamon, PR 00959

Oregon, USA

Much has been written of late about the failure of American public education to properly educate students in science and math. As a biology teacher in the public schools, I am well aware of the deficiency of a system that tends to cram volumes of facts at students but does little to provide them with a real understanding of how science really works. For science education to be successful students should be afforded the opportunity of exploring a subject in detail. In addition, high school teachers are rarely given a chance to conduct research in their area of interest. All too often we are trapped within the confines of the classroom walls and are unable to take students into the world of biology.

This spring I will offer twelve students at Springfield High School in Springfield, Oregon, the opportunity to be active participants in a census research on bat populations in the Willamette National Forest. This project has been made possible through a challenge cost-share grant from the Forest Service and with the support of the administration of the high school. Starting in April these students will accompany me and other forest personnel on five overnight trips to sample bat populations in various districts within the Willamette National forest. Students will be trained in using mist nets, how to properly identify bat species and use data based computer programs to organize and analyze the data from this work. In addition, students will learn the various aspects of bat ecology including roost selection and foraging strategies. To broaden the aspect of this project students will explore the importance of the old-growth ecosystem to bats and other wildlife. Each student will keep an ongoing journal of their activities. These journals will provide the basis of articles they will submit to local newspapers about their experiences of field work. The final aspect of this project will involve teams of two students going to other schools in the district and presenting slide/live bat presentations on the importance of bats to the ecosystem.

It is my hope that this bat project will accomplish four objectives. First, it will offer students a more meaningful approach to biology then the traditional classroom recipe by offering students a window on the issues and value of doing wildlife research rather than just talking about it. This project will require students to integrate biology, math, computer science, writing, and communication skills in one project. Second, I hope this project will convince our district administrators that retaining teachers in the profession may involve providing their staff(these teachers) with the flexibility to incorporate their own research interests into the normal public school routine. Third, I hope the success of this project will show other state and federal wildlife agencies that valuable wildlife data can be collected through similar joint efforts with public schools. Finally, through this project we hope to provide the Forest Service with much needed data about how bats use old-growth areas and other habitats in the forest.

Stuart Perlmutter
Springfield High School
Springfield, Oregon
97477

Ed. note: This sounds like a fantastic experience for all concerned. Is anyone else trying anything like this? Let us know about it. GRH

Queensland, Australia

Hugh Spencer at the Cape Tribulation Field Study Centre sends along the following for those of us who might be interested in working in Australia in the future. This has appeared in slightly different form some issues ago, but it is timely and of special interest in that some of us will be in Australia at the Theriological Congress in 1993.

Cape Tribulation Field Study Centre is a not-for-profit research and educational facility on the coast, midway between Mossman and Cooktown, in far-north Queensland. It was established in order to redress the lack of facilities for research in the lowland wet tropics in Australia.

The research station is situated on 8.5 hectares of regenerating pasture land and rainforest in the Mt. Sorrow basin at the base of Cape Tribulation, and is surrounded by the Cape Tribulation National

Park, and also by areas of private land on which long-term research can be carried out in a wide variety of habitats. It is within half a kilometer of the coral Sea Coast and is adjacent fringing reefs, mangrove and Melaleuca communities. Mt. Sorrow(750m) and Mt. Hemmant(1000m) offer opportunities to establish altitudinal transects from primary coastal rainforest to mountain top communities.

A rainforest interpretation building, "the Bat -house" on Cape Tribulation road caters for the tourist and backpacker traffic in the area, and in the evening serves as a lecture room for the research center.

The Centre has laboratory and accommodation facilities plus a range of research equipment such as balances, spectrophotometer, microscopes, radio-tracking equipment, limited biochemical and histological equipment, survey gear, etc.

Although established only in 1989, the Cape Tribulation Field Study Centre already has a number of long-term research programs on aspects of the ecology of the lowland tropical rainforest of the area and its pollinators.

The Centre is a member of the United States based Organization of Biological Field Stations and is informally affiliated with James Cook University in Townsville.

The Centre, will be providing a limited number of scholarships for post-graduate researchers to carry out research leading to the M.Sc. or Ph.D. qualifications, in subject areas relevant to the aims of the Centre.

Researchers wishing to use the facilities of the Centre should contact Dr. Hugh Spencer or Brigitta Flick, at the address below.

Hugh Spencer
Cape Tribulation Field Study Centre
Private mail Bag 5
Cape Tribulation via Mossman
Queensland 4873
Australia

Great Britain

As part of an ongoing research project, we are looking at the behaviour and population ecology of the serotine bat *Eptesicus serotinus* in Great Britain. Little is known about the serotine, one of Britain's largest bats, with a forearm ranging from 48 -55mm and body weight 15-35 grams. The serotine seems to be almost exclusively dependent on buildings which is intriguing because one wonders where the species lived before these were available. Also, the species' apparent dependence on human dwellings presents a severe conservation problem not shared by any other British mammal species. Its conservation depends on how seriously we wish to accommodate these animals in our homes and perhaps foregoing some types of property renovations such as chemical timber treatments. It seems likely that bats spend all the year in buildings, although in winter they are rarely found, presumably due to their crevice dwelling habits.

Field work began in the summer or 1989, in south eastern England concentrating on the following objectives:

a. To investigate the number and variety of roosts used by each colony(for definition see Stebbings1988), and establish the incidence of inter-specific roosting associations.

b. To investigate nightly and seasonal activity patterns and how they are related to climate, prey availability and reproduction.

c. To examine nightly and annual foraging behaviour, home ranges for individuals and colonies, identify preferences for feeding habitat, and examine territoriality, intra- and inter-colonially.

d. To determine prey consumption.

e. Evidence will be sought to establish whether there have been changes in population size and distribution in Britain, and attempts made to explain the limited distribution.

f. To establish the variation in population dynamics between colonies.

g. To assess the impact of roost and habitat loss on population dynamics.

h. To estimate the potential for disease transmission for this species for which several European countries have recorded bat rabies.

Identifying key aspects of the species life history will enable a long term conservation plan to be produced.

By the use of radio-tracking and searching roof spaces, many new serotine roosts have been located. A single colony has been found to use over 20 roosts each selected depending upon the weather conditions and season. They prefer warmer sites during pregnancy and lactation in May, June, and July and cooler sites in August, September, and October. Radio-tracking has proved a very successful technique for studying their movements and behaviour, with bats carrying 2.0gm tags from 5 to 75 days. A total of 34 bats have been radio-tagged so far. The bats spend most of their time over pasture and woodland, which shows the importance of these habitats for feeding.

Mark is pursuing aspects of the work towards a doctoral thesis to be presented at the University of Cambridge in 1992. It is hoped that some of the work will be continued by us for several more years, in particular the population dynamics of the species in different parts of its range,

We are most grateful to the Ministry of Agriculture, Fisheries and Food who fund most of this work.

Mark F. Robinson and Dr. Robert E. Stebbings
The Robert Stebbings Consultancy, Ltd.
74 Alexandra Road
Peterborough PE1 3DG
England

Mark Robinson can also be contacted at:
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Cambridge, CB2 1QS
England

Pennsylvania

Lois Sakolsky has sent along the following addition or update to her article on caring and feeding baby bats (Sakolsky,L., BRN 32:1, pp 9-10, 1991)

Since my short article on animal care for bats in the lab last spring, I have received a few replies which I would like to share with you. Les Stocker(St. Twiggywinkles,U.K.) wrote emphasizing Halothane™ as the primary anesthetic used[for bats]. This was confirmed by veterinarians. Richard Wagner VDM suggested holding [injured] animals very gently by the wing tips to check for injuries; if it struggles unevenly there may be injury to that side. If [the bat] flies to one side, the injury is likely on that side.

A great idea for exercising bats is placing a fan in the hallway, creating a home-made wind tunnel. This can be a good method for exercising both well and injured animals.

My own addition [to improved bat care] is to mix any powdered medication with strawberry jam; the consistency makes it easy to feed and it is more palatable. At the symposium in Austin I noted that the Canadian workers have an inexpensive outdoor flight cage utilizing the common screened tent that one usually uses to cover a picnic table when camping. These generally come in 8x8 or 10x10 ft sizes and fold up for storage. I also heard many of the "old-timers" at the convention telling how they carried bats in the field in old socks, tied with rubber bands. This is still the handiest bat carrier. In order to continue this idea of committing ourselves to the best possible care for wildlife in laboratory situations, please send me any hints, ideas or "new tricks" that you use and we will include them in our next update. I would enjoy hearing from you.

Lois Sakolsky
Flying Mammal WRC
221 Parker Drive
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Maryland

The American Bat Conservation Society, a relatively new organization dedicated to the conservation of bats and the preservation of their habitats has asked that this announcement be included in the *NEWS* section.

"The American Bat Conservation Society is producing several popular publications on North American bats. We are looking for color transparencies of the following: roosting bats, bat roost structures(occupied and unoccupied), bat faces, bats in flight, bats and their prey. Photographers will be paid standard photo rates. We are soliciting submissions of duplicate slides only(no originals). We request that interested photographers enclose information about the images(species, location, photographer and date(and a self addressed stamped envelope to facilitate the return of the transparencies.

The Society has also organized a bat roost registration project. We are encouraging the public to tell us where bats are roosting-- in their attics, under bridges, in caves or behind their shutters. The project has received considerable publicity and the data are trickling in.

The Society is currently producing a directory of bat experts willing to speak to the news media and or willing to present slide-illustrated programs. We will screen all calls to clarify "the who, what, when, where, how and why," minimize the hassles and make the whole process mutually rewarding(good for you and good for bats). Send a self-addressed stamped envelope for a questionnaire. There is no charge for this service.

Those interested in learning more about the American Bat Conservation Society are invited to contact:

Heidi Hughes
American Bat Conservation Society
P.O.Box 1393
Rockville MD 20849
TEL 301-424-7289
FAX 301-424-3938

RECENT LITERATURE

Authors are requested to send reprints of their papers to the Editor (Tom Griffiths, Dept. of Biology, Illinois Wesleyan Univ., Bloomington, IL. 61702-2900, U.S.A.) for inclusion in this section. Receipt of reprints will facilitate complete and correct citation. Our Recent Literature section is based on several bibliographic sources and for obvious reasons can never be up-to-date. Any error or omission is inadvertent. Voluntary contributions for this section, especially from researchers outside the United States, are most welecome.

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The 6th European Bat Research Symposium

Evora, Portugal, August 22 to 27, 1993.

Evora is an historical town, included in the World Heritage system, located about 150 km west of Lisbon in the province of Alentejo, a beautiful region of vast plains and rolling hills covered with fields of wheat and cork oak woodlands and dotted with many unspoiled towns. Convenient major airports are in Lisbon and Evora, but the area is easily reached by train and bus.

The Symposium will consist of oral presentations, poster presentations, and evening discussions, all presentations will be in English. Suggestions for special sessions, workshops, or discussion groups are welcome. University accommodations will be available at very reasonable rates, but in Evora there are numerous fine hotels and a campsite. A short field trip is planned during the meetings and a longer post-symposium excursion is being organized.

Preliminary circulars and registration forms can be obtained by contacting either Jorge Palmeirim or Luisa Rodrigues, the Organizers of the Symposium. Their address is: Dept. de Zoologia, Faculdade de Ciencias, Universidade de Lisboa, P-1700 Lisboa, Portugal. FAX 351-7597716 They wold like all preliminary registration forms returned by September 1, 1992. A second circular with final details will be mailed in the Autumn, to all who send in a preliminary registration.

This is a wonderful opportunity to meet our European colleagues, learn first-hand more about what they are doing, exchange ideas, and perhaps visit some bat habitats and roosts not seen in the western hemisphere. It will also be a great opportunity to see a lovely and historic part of the continent, and most of all make new friends with biologists of like interests and kindred spirits. Please make every effort to be part of this truly international group.

By this date we presume that everyone knows that the

22nd ANNUAL NORTH AMERICAN SYMPOSIUM ON BAT RESEARCH

Will convene on October 21to 24, 1992, and our Host Institution will be the Universite de Sherbrooke. The location of the Symposium will be at the Chateau Frontenac, Ville de Quebec, Quebec, Canada. Don Thomas will be our Host and in Charge of local arrangements and Roy Horst will arrange the program.

Registration, which includes program, abstracts, and refreshments at coffee breaks will be $40.00 for everyone, except for full-time students, who may register for $30.00. Late registration, after September 7, will include a $5.00 surcharge. There will be a banquet and tickets will cost $ 25.00 (gratuity included) each.

Spouses and friends who attend the sessions are considered as participants and are requested to register. A single day registration will be available at the registration desk for visitors who are not regular participants for $15.00 each day. There will be a reception on Wednesday evening , a banquet on Friday evening, and paper and poster presentations on Thursday, Friday, and Saturday.

The Hotel Chateau Frontenac is giving us reduced rates, so when you register be sure to tell them that you are with the "North American Bat Association", the name they have assigned to us. Rates are approximately $100 per room, all taxes included, per night, and up to three people can stay in each room for that total price. Please make your hotel reservations directly with the hotel. **All prices given here are in U.S. Dollars**

Contact:

Directeur des Reservations(Reservation Manager), Le Chataeu Frontenac,
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1-800-268-9411 from rest of Canada
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FAX #418-692-1751

If you have not received any of the registration materials and would like to attend please contact either Roy Horst or Don Thomas at your earliest convenience. (Horst will be in the tropics From August 1 to 24)

Roy Horst
Dept. of Biology
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Dept. Biologie
Universite de Sherbrooke
Sherbrooke, Que.
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FAX: 819-821-8049.

We are looking forward to seeing you in Quebec.

BAT RESEARCH NEWS

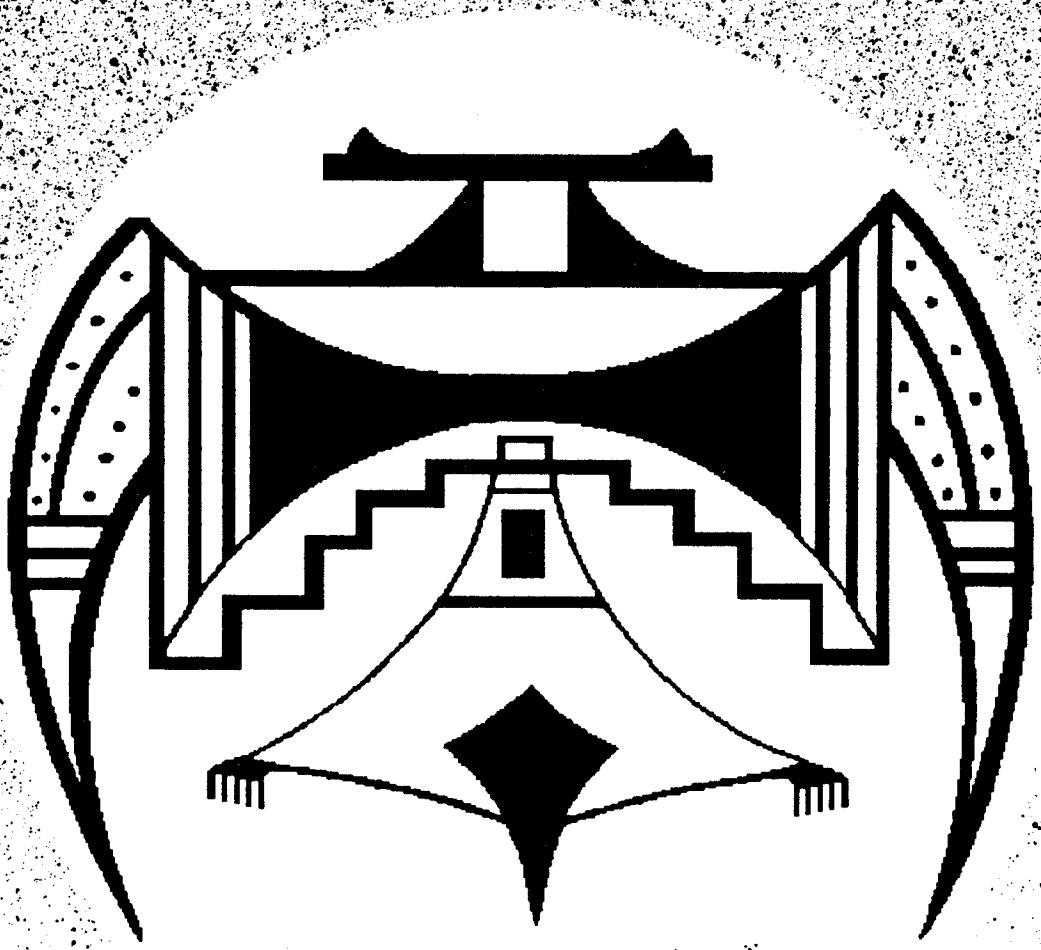
Volume 33 **Spring, 1992** **Number 1**

CONTENTS

FRONT COVER

The line drawing on the front cover is an illustration of the birthing position of *Plecotus auritus*, which appeared in the book by Andre Brosset, *La Biologie de Chiropteres,* published by Masson et Cie, Editeurs, Paris, 1966. The drawing was originally by Martin Eisentraut.

BAT RESEARCH NEWS



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BAT RESEARCH NEWS

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BAT NEWS RESEARCH

Volume 33 Summer - Fall 1992 Number 2 & 3

Nyctinomops macrotis in South Carolina

Arthur F. Di Salvo, Hans N. Neuhauser and Rudolph E. Mancke

South Carolina Dept. of Health and Envirnomental Control, Columbia, SC 29202 ,
The Georgia Conservatory Savannah, GA 31410,
and South Carolina State Museum, Columbia, SC 29211

Bats submitted to the South Carolina State Laboratory for rabies examination are often a source of significant new information about their distribution in a state in which chiropterans are poorly known (Golley, 1966; Neuhauser and Di Salvo, 1972). A new state record for the big free-tailed bat, Nyctinomops macrotis, is presented here. The specimen was negative for rabies, as determined by the fluorescent antibody method, and is now housed at the South Carolina State Museum (SCSM #86.106.3). Measurements were taken from the ethanol-preserved specimen, and age was determined by the degree of fusion of the phalangeal epiphyses.

This specimen, an adult male, was found on the ground in the rural piedmont community of Stoney Hill, near Prosperity, Newberry Co., on 22 November 1983. Selected external measurements (in mm) are: total length, 130.5; tail length, 52.3; length of hind foot, 11.2; height of ear, 25.5; and length of forearm, 61.0. Nearby structures included a mobile home, an old house under renovation, and three outbuildings. We visited the site on 14 December 1983, from 1530 to 1900 hours (approximately 1.75 h after sunset) to search for further specimens. The examination failed to reveal evidence of any bats, although residents claimed to frequently see some bats foraging about an outside utility light.

Nyctinomops macrotis ranges from Uruguay and northern Argentina, northward into the southwestern United States. Extralimital records in North America are widely distributed and include British Columbia, Iowa, and Kansas (Hall, 1981; Milner et al., 1990). The South Carolina specimen represents the first known occurrence of the species east of the Mississippi River. The late autumn collection date is consistent with other observations of long-distance flights being made by this species after the young have been weaned (Barbour and Davis, 1969).

Hugh H. Genoways confirmed the identification of the specimen.

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Present Address of AFD: Nevada State Health Lab., 1660 N. Virginia St, Reno, NV 89503; and of REM: South Carolina Educational Television, Drawer L, Columbia, SC 29250

News

From Costa Rica

Dick LaVal from San Jose, Costa Rica...

"I am co-authoring a book on the mammals of The Braulio Carrillo Conservation Area in Costa Rica, covering about 90% of the mammals of the entire country. I am doing the bats of course, of which there are over 90 species in the area covered by the book. It will be in English and Spanish, with color plates of all species. It could be out as early as late 1993, but no promises. By the way we are up to about 110 species for the country, with the recent addition of *Thyroptera discifera.*

My major bat work is with classes of biology students from the United States who come to the Monteverde to study tropical biology. I give them lectures on bats and do field problems locally, usually involving mist-netting. They are sponsored by the Monteverde Institute - we had 19 different groups last year, here for as long as ten weeks.

this is an inexpensive and effective away for your field class to learn tropical biology firsthand. For information write the Monteverde Institute, Apdo10165, San Jose, Costa Rica.

GRADUATE ASSISTANTSHIP

A graduate assistantship will be available to investigate the migratory be-havior of the endangered nectivorous lesser long-tongued bat, *Leptonycteris curasoae* using mtDNA sequence information. this project involves collaboration between the Universities of Maryland and Miami and the Arizona Department of Game and Fish. appointment combines teaching and research assistantships with a 12 month stipend of at least $11,300 plus an annual research allowance of about $3,000, health benefits, and waiver of tuition and fees. Prospective students should apply to the Department of Zoology Graduate Program, University of Maryland, College Park, MD 20742 and contact: Dr. Jerry Wilkinson;301-405 -6942; e-mail 209196@umdd.umd.edu before 1 March, 1993. Research will commence in June 1993.

A.A.Z.K. GRANTS AVAILABLE

The American Association of Zoo Keepers announces the availability of two $750 research grants in the field of zoo biology. Interested applicants should direct their inquiries to Sue Bernard, Chairperson, A.A.Z.K. Research Grants Committee, Zoo Atlanta, Department of Herpetology, 800 Cherokee Ave., SE, Atlanta, Georgia 30315. Deadline for receipt of applications is March first, 1993.

A Request from the Publisher

Please take a few minutes to send us a short item for our news section. We are interested in anything that concerns bats, your work on or with bats, your students or colleagues or your own new or current projects, field trips, conferences, adventures in the field, notes on techniques, suggestions, even interesting anecdotes are welcome(perhaps especially so). If ***Bat Research News*** is going to survive as a newsletter, we need your contributions. I am becoming ever more frustrated by the complaint, heard more frequently each year, that ***"Bat Research News* doesn't contain any news!"** Please be a contributor. As an added incentive, I will personally donate a free banquet ticket at the Bat Symposium in Gainesville next October to the each of the first three respondents to this request(as determined by post-mark date). So start those cards and letters rolling in.

G. Roy Horst

An Important Notice Concerning Mist Net Problems

Mary Beth Pickett
Avinet, Inc., Dryden, NY

In September of 1991, under pressure from the Wild Bird Society of Japan, the Japanese government enacted a law prohibiting the export of mist nets. Exceptions for scientific users were granted to Avinet Inc., and Manomet Bird Observatory in the U.S.A., and to the British Trust for Ornithology in England after a long and very thorough examination process. In theory this action is commendable and is much needed to stop the unethical use of mist nets, but the result has been to deprive legitimate researchers of the tools of their trade.

We must apply for an export license to the Japanese Ministry of International Trade and Industry (MITI) every time we place an order with our manufacturer. MITI allowed one very small order of 300 nets to be exported to us in April of 1992, but no orders have been released since then: thousands of our nets remain with our manufacturer pending issuance of export licenses. Manomet Bird Observatory and the British Trust for Ornithology are having similar problems.

MITI has refused to tell us when the licenses will be issued or the reason for the delay. We have heard that the licenses will be issued "soon" for over six months. The International Council for Bird Preservation and the Bird Banding Lab of the United States Fish and Wildlife Service are attempting to help us but so far have not been successful.

The exceptions allowed by the new legislation were tailored to ornithologists. According to Japanese law, we are allowed to sell mist nets only to permit holders. Therefore any bat researcher who presently does not have a state, provincial or national collecting permit, with mist net authorization, would be wise to obtain one before ordering nets. Selling nets to researchers without permits might jeopardize our ability to obtain an export license.

An additional problem that researchers should be aware of is that Japanese manufacturers are no longer making certain types of nets. Our supply of seven-foot-high monofilament nets is totally exhausted and only a few three-foot-high monofilament nets remain. Although we have a few nylon nets of 30 denier and Terylene nets of 50 denier available in odd sizes, the Japanese are currently making nylon nets of only 50 denier or greater and Terylene nets of 75 denier or greater. They have no plans to make any monofilament or smaller denier nets in the future.

Some of these problems may be resolved very shortly, but if they are not, the future of obtaining high quality Japanese mist nets is uncertain.

Researchers wishing more information about this problem are encouraged to contact: Mary Beth Pickett, Avinet, Inc., Dryden, NY 13053-1103 U.S.A., or call 607-844-3277. The same number 607-844-3277 is used for FAX messages.

RECENT LITERATURE

Authors are requested to send reprints of their papers to the Editor (Tom Griffiths, Dept. of Biology, Illinois Wesleyan Univ., Bloomington, IL. 61702-2900, U.S.A.) for inclusion in this section. Receipt of reprints will facilitate complete and correct citation. Our Recent Literature section is based on several bibliographic sources and for obvious reasons can never be up-to-date. Any error or omission is inadvertent. Voluntary contributions for this section, especially from researchers outside the United States, are most welcome.

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The 6th European Bat Research Symposium

The Symposium will be held in the historic city of Evora, Portugal from August 22 to 27, 1993. The convenors are Jorge Palmeirim and Luisa Rodrigues.

The Symposium will consist of oral presentations, posters and evening discussions. All the presentations will be in English. Suggestions for special sessions, workshops, or discussion groups are welcome. University accommodations will be available at very reasonable rates, but in Evora there are a number of fine hotels at reasonable prices as well, and there is a campsite nearby. A short field trip is planned during the meetings and a longer post-meeting excursion is being organized.

Preliminary circulars and registration forms can be obtained by contacting either Jorge Palmeirim or Luisa Rodrigues at the Depart. de Zoologia, Faculdade de Ciencias, Universidade de Lisboa, P-1700, Lisboa, Portugal. Their FAX # is 351-7597716. They would like to have all preliminary forms returned as early as possible. A second circular with final details will be mailedin the near future to all who send in a preliminary registration.

This is a wonderful opportunity to meet our European colleagues, learn first hand what research they are doing, exchange ideas, and visit some roost sites as well as see some bat habitats not seen in the western hemisphere. Jorge and Luisa are eager to welcome you and be your hosts.

A Directory of Subscribers to Bat Reseach News

I am receiving an increasing number of telephone inquiries asking if I have the address of some particular bat researcher. I am delighted to talk with those of you who call, but calls can be expensive and I am not always in. It seems a worthwhile effort to make available a directory of those bat workers who subscribe to ***Bat Research News.*** This will be a large undertaking and would take up many pages, even when set in very small type, so I have decided to do it in installments, beginning with our colleagues from North and Central America in this issue and those from other countries in the next issue. Telephone numbers might be considered confidential by some, so lacking specific permission to list telephone numbers, I have not done so. If an address is known, it is a simple matter to obtain the phone number from *directory information.* To save space, abbreviations were used wherever possible: if some of these are confusing, please accept my apologies. Finally, these addresses reflect all notifications of any change of address received as of November 1, 1992. There are also approximately 200 libraries, museums, and other institutions among our subscribers. Those may appear in a later installments. The list is divided into two parts, those from North America, PART ONE, and all others, PART TWO. I hope that you find this "directory" useful.

G. Roy Horst

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Preliminary Announcement of the 23rd Annual North American Symposium on Bat Research

The twenty-third annual meeting of the North American Symposium on Bat Research will meet October 17 to 20, 1993 at The University of Florida in Gainesville, Florida. Our host institutions will be the Lubee Foundation and The University of Florida. The host committee will be chaired by John Seyjegat, Keith Atkinson and Frank Bonnacorso. The program will be arranged by Roy Horst. The meetings will be held in the Ritz Memorial Union on campus and negotiations are underway for special conference rates at the Holiday Inn, which is directly adjacent to campus. This is the same hotel that served as our host at the seventh meeting in 1976. A "field trip" is planned to the Lubee Foundation Facilities only a few miles distant from campus.

If you are interested in arranging a special topics section, a workshop, or would like to serve as chair a regular session, please contact Roy Horst at your earliest convenience. Forms for registration submission of titles and abstracts, consideration for student honors, etc., will be mailed on or about April 15, 1993.

A new feature of the program this year is that funds have been made available for an award to the best paper by a student, either graduate or undergraduate. This is an award in addition to the customary awards for the best presentations, and is intended to make it possible for a student to attend who otherwise may not be able to afford the cost of travel to Florida. However, demonstration of financial need is not a requirement. The amount of the award is 400 dollars plus free registration and a banquet ticket. The applicants will need to submit their paper(not merely an abstract) to the review committee no later than August 15,1993. The winner will be notified no later than September 15,1993. This paper will be the first presentation on the program. Interested applicants should contact Roy Horst for additional information and instructions.

Additional information about travel to Gainesville, extended stays in Florida, trips to Epcot Center, etc., etc., will be published in each succeeding issue of Bat Research News. Specific questions about the symposium that concern the program should be addressed to Roy Horst at 315-267-2259, or FAX # 315-267-3001. Questions concerning travel arrangements or local issues should be addressed to John Seyjegat at 809-485-1250. GRH

Notes:

Volume 33:4 Coming in the next issue (soon, we promise)
Proceedings and abstracts of the 22nd Symposium in Quebec City

Volume 34:1 The abstracts of all the papers presented at the
Ninth International Conference in India

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More details about the meeting in Evora, Portugal, in August 1993: the 23rd Symposium in Florida in October, and early plans for the combined Tenth International and Twenty-fifth North American Symposium in Boston in 1995. We are also in the initial planning stages of a possible meeting of the North American Symposium in Mexico in 1994.

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We are in the process of assembling E-mail numbers for a directory to be published in a future issue. John Speakman is gathering numbers from our colleagues in Europe, and we would like to publish the first installment soon. If you wish to have your E-mail number listed please sent it to Horst at you earliest convenience.

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We are planning a series of review articles (several pages in length) on some special aspect of chiroptology to include in future issues of **BRN.** There may be some small amount of compensation for such review articles to help cover your costs of preparation. If you are interested in making such a contribution to the continuing success of **BRN**, Please contact Horst.

****

In the mean time send us a few lines of news so we can continue to function under the title of **Bat Research NEWS.** If we don't receive any news from you in the next three months, we may begin printing obituaries(we have a few already prepared). The Editors

BAT RESEARCH NEWS

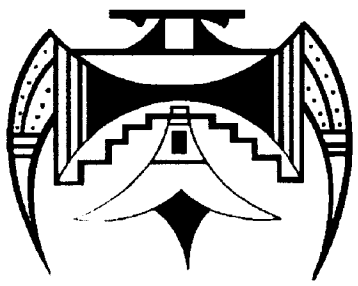
Volume 33 **Number 2 / 3**

Summer / Fall, 1992

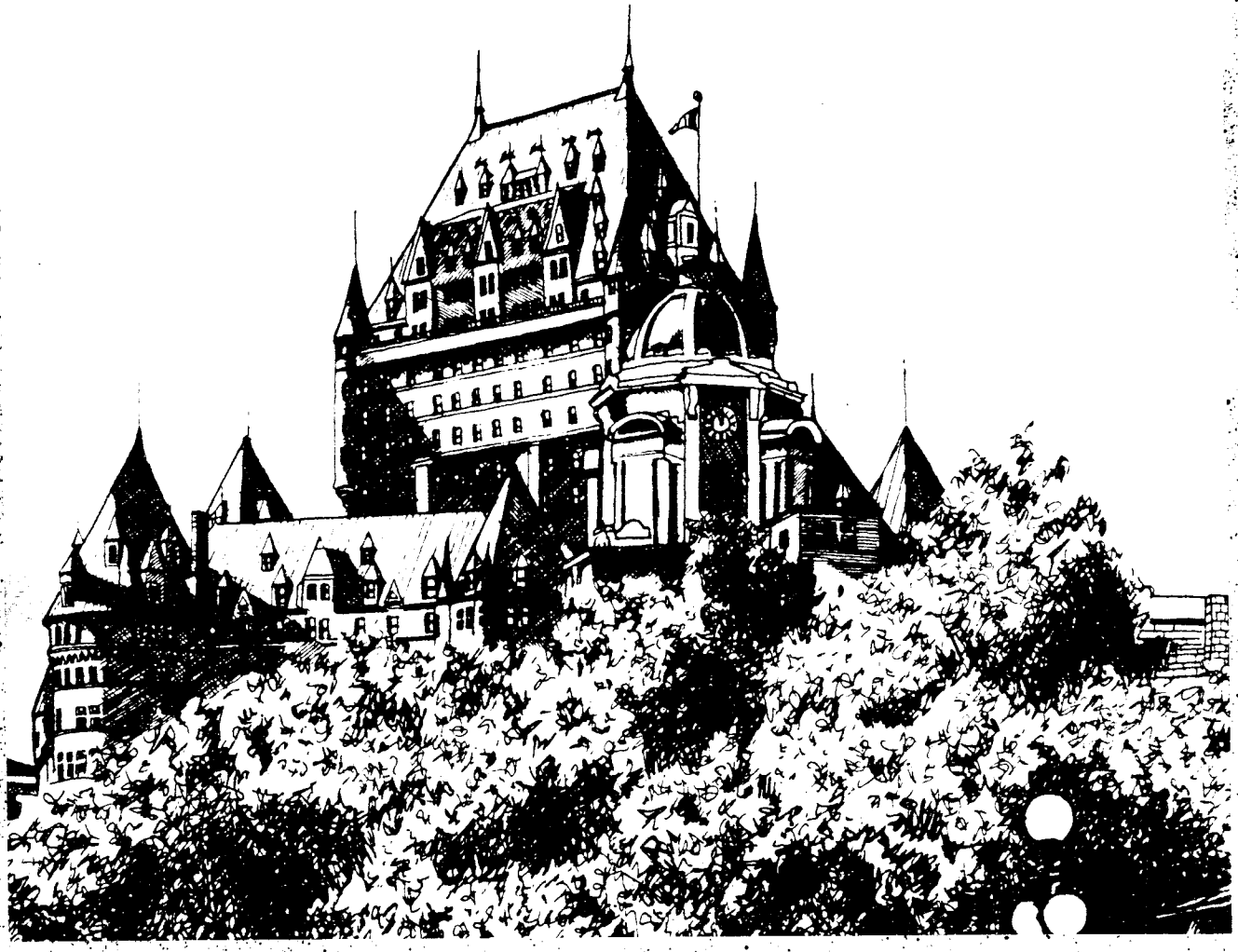
CONTENTS

Front Cover

The stylized bat on the front cover was provided, with slight modifications, by Dan Williams of California State University, Stanislaus, in Turlock, California. It is an ancient design taken from pottery, and was first believed to represent a bird. The original figure, more obviously a bird, appears below.



BAT RESEARCH NEWS



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Volume 33 Winter 1992 Number 4

Late Eocene Southern Asian Record of a Megabat and Its Inferences on the Megabat Phylogeny

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A terrestrial vertebrate fauna has been recovered from coal deposits in the Krabi Basin of southern Thailand. According to faunal comparisons (Ducrocq et al., 1992), its age is considered as Late Eocene (ca. 40 to 37 My; all geochronologic data in this paper are from Aubry et al., 1988). Among the Krabi mammal remains, an isolated small lower premolar displays a morphology much closer to that of extant megachiropterans (="megabats") than to that of other groups. For this reason this tooth (probably a p3) is attributed to a representative of these bats. Comparisons with the different extant megabats show that the Krabi premolar is a quite simple, derived type (as found in, for example *Micropteropus, Epomops,* and *Epomophorus*) rather than a more complex, conservative molariform type (as found in, for example *Dobsonia* or *Pteropus*). In a general way, the molar morphology of megabats has evolved much more radically than that of premolars.

The Krabi species notably extends downwards the geologic record for the megabats, so far quite restricted, including the still questionable *Archaeopteropus transiens* from Early Oligocene beds of Northern Italy (see Habersetzer and Storch, 1987), various pteropodids from the Neogene of Southern Europe, Eastern Africa, and Eastern Asia (see Sigé and Aguilar, 1987), and excluding the East African Early Miocene Propotto leakeyi whose previous attribution to primates seems to be correct. The Krabi premolar thus supports the predicted antiquity of the Megachiroptera and the assumption, deduced from biogeography, of their South Asian center of dispersion (Butler, 1984). By its derived premolar condition, the Thai fossil reveals that a major dichotomy occurred long ago in the dental evolution of the Megachiroptera, and that the megabat common ancestor is clearly much older than Late Eocene. This ancestor possessed conservative (molariform) posterior premolars.

It is interesting to consider this evidence in the context of the fervently discussed hypothesis about megabat phylogeny. Several archeonycteridid archaic bats from the Early and Middle Eocene (ca. 57 to 40 My) possess molariform posterior premolars, and this character was presumably generalized and more pronounced among still older representatives. Such archaic bats would be adequate, in terms of dental morphology, as ancestors of megabats. The fossil data and the dental morphology of the extant megabats thus support the classically assumed monophyletic origin of bats as a whole. Furthermore, they allow us to approximate in chronology the megabat divergence: this event could reasonably have taken place during the Late Paleocene - Early Eocene time

span (ca. 62 to 52 My). These data agree well with the anatomical and biochemical data recently provided in favor of bat monophyly (for example Baker et al., 1991; Bailey et al., 1992).

On the contrary, although there is a rich and increasing primate fossil record, no early primate known so far displays a molariform condition of the posterior premolars extending to P3/3, and no possible stem-group for megabats can be seen among fossil primates. The fossil data and the dental morphology thus do not support the recently advocateded close relationship of megabats and primates and the resulting diphyletic hypothesis of the origin of bats (Pettigrew et al. 1989).

These results are developed further in an in press study (Ducrocq et al.).

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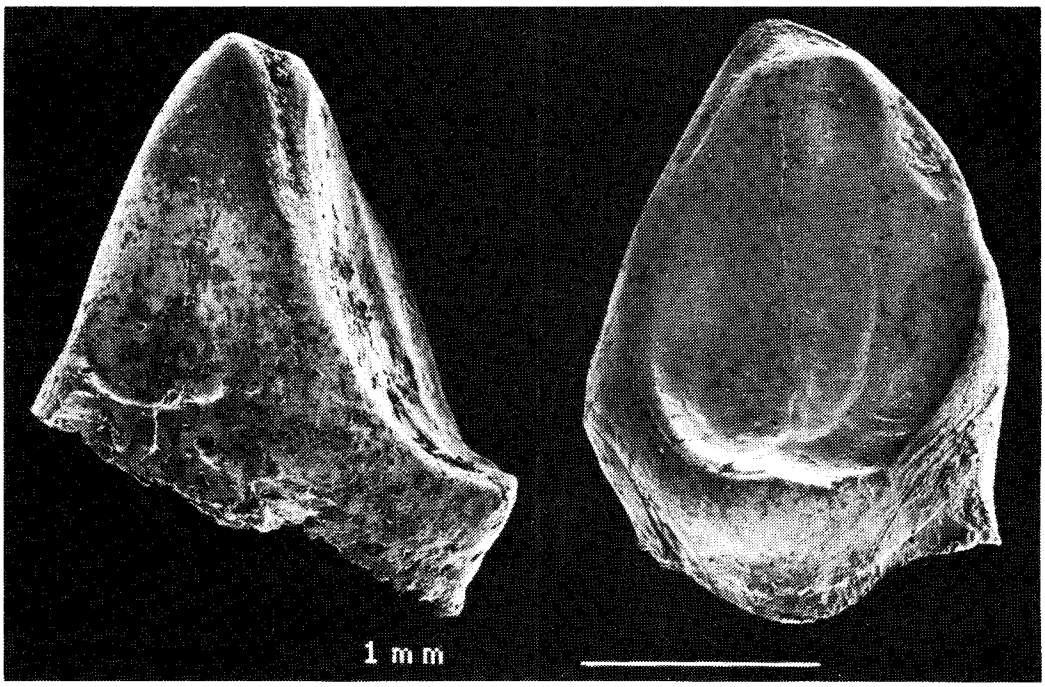

Thai Fossil Megabat Tooth: Family Pteropodidae, genus and species indeterminate. From Late Eocene, Wai Lek Mine, Krabi Basin, Southern Thailand. Specimen TF 2661, right lower premolar (p3 or p4). SEM lingual (left) and distal (right) views, magnification X32.

Status of the Eastern Pipistrelle *Pipistrellus subflavus* at its Southern Range Limit in Eastern United States

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The eastern pipistrelle *Pipistrellus subflavus* reaches its southern range limit in eastern United States in Florida. Hall (1981) and Fujita and Kunz (1984) showed the range as including the entire state on the basis of an individual observed on Sugarloaf Key, Monroe County (Hardin, 1974). Other than this record, which is not supported by a specimen or photograph and almost certainly represents a rare straggler (Layne, 1974, Lazell and Koopman, 1985), the southernmost locality in the state is Basinger, Okeechobee County, in the south-central part of the peninsula (Davis, 1957, 1959). This record is based on a skin in the American Museum of Natural History (AMNH 149429) collected in March 1907. The extreme southern localities and the nearest localities at which breeding pipistrelles were collected in an intensive statewide survey of bats in 1954-1957 were about 40 and 150 km, respectively, north of the Basinger site (Jennings, 1958). On the basis of these data, it is not clear whether the species is an accidental visitor, regular migrant, or permanent resident in southern peninsular Florida.

This report documents an established population of eastern pipistrelles in south-central peninsular Florida, approximately 35 km SW of the Basinger locality. Observations were made at and near the Archbold Biological Station, 13 km S of the town of Lake Placid, Highlands County. The species was not recorded in an earlier study of mammals in this locality (Rand and Host, 1942). Specimens from Highlands County were compared with skins of *P. s. subflavus* and *P. s. floridanus* in the Florida Museum of Natural History and agreed with floridanus in lacking a reddish tone to the guard hairs, the major characteristic separating the two subspecies (Davis, 1957, 1959).

METHODS

Most data were obtained from bats roosting in nine concrete basement units beneath the main building of the Station. Basement units were 14.2 m long by 3.8 m wide by 2 m high and opened to the outside at each end; openings were 1.8 m wide by 0.7 m high. The bottom edge of the opening was 1.1 m above the basement floor and at ground level on the outside of the building. The openings at one end were permanently closed by a screen, whereas those at the other end had screened doors for access. During the period of observation, doors were kept open to allow bats to enter and leave. The basement units were dimly lit during the day. Although well ventilated, they were noticeably warmer in winter, cooler in summer, and had a narrower daily temperature range than outside. For example, on a day in late November, maximum and minimum temperatures outside were 28.3 and 10.6oC, respectively, compared to 23.3 and 18.9oC in a basement unit. Habitats in the vicinity of the building included landscaped ground with scattered pines and oaks, patches of shrubs, mowed lawns, widely spaced buildings and natural low scrub vegetation with an open stand of pines.

Basement units were checked for bats at irregular intervals from 1968 to 1978, with about the same number of searches each month for the entire period. More intensive monitoring, ranging from twice daily (during the day and at night) to once each week, was conducted from February 1972 to February 1973. Thirteen bats were banded and recaptured 52 times, and three others were collected as voucher specimens. In addition, three individuals were recorded outside the basement units within 2 km of the building between 1972 and 1992.

RESULTS

Seasonal occurrence.--Bats were present in the basement units in every month except May. The 16 bats (7 males, 9 females) recorded in the units were originally captured in January (1), February (14), and April (1). Combined numbers of captures and recaptures in each month were: January (4), February (21), March (1), April (2), June (2), July (1), August (1), September (3),October(2), November (2), December(1). These frequencies suggest a seasonal trend, with a major peak in January and February, low use in summer, and a slight increase in autumn.

Of 17 monthly occurrences of females,

one individual was present in October, three in January, and 13 in February. Males exhibited less seasonal variation in use of the units, with ten occurrences from December to February and 13 from March to November. The most regular occupant was a male recorded 39 times between February 1972-February 1973; he was present every month except April and May. The three pipistrelles recorded outside the basement units included a male found dead on the porch above the basement units in July 1972, a female caught inside a mobile home in February 1975, and a male captured in a house in January 1992.

Longevity. Three of five males and six of eight females banded were recaptured (includes occasions when individuals were identified but not handled) from 2 to 39 times each ($x = 7.6$). Males were recaptured over periods of 8, 20, and 46 months ($x = 24.7$), and females over intervals of 2, 9, 12, 13, 25, and 25 months ($x = 14.6$).

Roost-site selection. All bats were found hanging from basement ceilings. More than two individuals never occupied a unit at the same time, and there were only four cases of double occupancy. These included two males spaced about 30 cm apart in June, a widely separated male and female in January and February, and two females together in a shallow depression in the ceiling in February.

Of three recaptured males, one was in the same unit both times he was recorded, one used three units but was in the same one four out of six times, and one recorded in six units occurred in the same unit 30 out of 39 times. Of five recaptured females, one recorded twice was in a different unit each time, two present on two occasions and one recorded three times were in the same unit each time, and the fifth individual used two units but occurred in the same one two out of three times. These data suggest that males exhibit somewhat greater site fidelity than females.

As reported for caves by Barbour and Davis (1969), pipistrelles tended to roost in specific locations within the basement units. The roost site of one male in early September was circled with chalk and his location checked 10 times during the day and five times at night (2100-2400 h) over a 55-day period. He was absent from the basements on three days, within the circle on five days, and in same spot 15 cm from the circle twice. He was within the circle on one of the five night searches and not present in the basements the remaining nights. These data indicate that during the 55-day period the bat was regularly leaving the basements and returning to the same roost site. Another male was found in the same shallow depression in the ceiling of a unit in September and November, three years apart. The same depression was used by at least four different individuals over a period of seven years.

Measurement and mass. Means and extremes (in parentheses) of external measurements (mm) of four males and two females were, respectively: total length, 78.8 (73-84), 85.5 (82,85); tail length, 39.4 (37-46), 38.5 (27,40); hind foot length, 7.5 (6-9), 9.5 (9,10); ear from notch, 12.5 (12-13), 11.5 (11,12); forearm, 33.3 (33-34), 34.5 (34,35). Compared with three males from the type locality (Davis, 1957, 1959), the Highlands County males averaged smaller in total length (78.7 vs. 86) and hind foot length (7.5 vs. 9.7) but agreed closely in other measurements. Mean measurements of southern Florida males did not differ significantly from 14 males from Alachua County in north-central Florida ($t \leq 1.86$, $P \geq 0.08$).

Means ($\pm$SE) and extremes (in parentheses) of body mass of seven males and nine females in January (1), February (13), and April (1) were, respectively, 5.1$\pm$0.3 g (4.4-6.7) and 5.7$\pm$0.2 g (5.0-6.5); the difference in means was not significant ($t = 1.82$, $P = 0.09$). Sealander and Young (1955) found a difference of similar magnitude between mean mass of males (5.2 g) and females (5.8 g) in a sample of 345 wintering pipistrelles in Arkansas.

Mean body masses of two males weighed two to four times during midday in January-February and June-September were 5.3 and 6.2 g in winter and 6.1 and 5.8 g, respectively, in summer. A third male had the same mass (5.4 g) in February and September. A female weighed in February and October was 6.5 g in both months. These limited data suggest that pipistrelles in southern Florida do not exhibit a pronounced winter build-up of body fat as do populations in northern Florida (McNab, 1974).

Reproduction. Testes of single males necropsied in February, April, and July ranged from 1.5 by 1.0 mm to 2.0 by 1.0 mm. Live males with enlarged cauda epididymides indicative of breeding status were recorded in February, April, and September. Single females necropsied in January and February showed no visible pregnancy, and sperm were not detected in a microscopic examination of the uterine contents of the January specimen. While a male and two females were held in a

jar for banding in early February, the male mounted one of the females lying on the bottom of the jar and appeared to effect insertion. He gave copulatory thrusts at inervals and occasionally nosed the female's nape and upper back region while she remained motionless with tail arched. After several minutes, the male dismounted, crawled around the jar, then mounted the same female again. These fragmentary data suggest the possibility of a late winter-spring breeding season. Jennings (1958) observed copulation in November in caves in northern Florida.

DISCUSSION

Excluding the presumed accidental record from the Lower Florida Keys, these observations extend the southern range limit of *P. subflavus* in Florida approximately 24 km and confirm the existence of an established population in the region. The presence of the same individuals in the basement units throughout the year indicates that at least some males are permanent residents. The appearance of females only in the months of January, February, and October might indicate that they are not in the area during spring and summer, perhaps migrating northward to breed. It seems more likely, however, that females also are permanent residents but have simply escaped detection in summer because of the apparently small population and the low probability of locating summer roosts away from the basements.

McNab (1974) stated that *P. subflavus* was an obligate hibernator and was limited in its southern distribution by the availability of caves with sufficiently cool temperatures to permit hibernation. On this basis, he concluded that the southern range limit in Florida coincided with that of the cave region at the latitude of Tampa. The present data show that the established range extends south of the cave region and that the southern population apparently does not hibernate in the sense of undergoing seasonal rather than daily torpor.

Winter temperatures in the study area are relatively mild, monthly mean minimums for December-February ranging from 8.7 to 9.5°C, with only occasional brief periods of below-freezing weather (Abrahamson et al., 1984). Flying insects occur on most nights throughout winter. The relatively exposed basement sites allowed the bats to synchronize their activity to outside temperature so that they became active on warm nights when insects were flying and remained dormant on cold nights, a pattern similar to that described by Hayes et al. (1992) for *Plecotus auritus*. Observations by Mark Deyrup (pers. comm.) at the Archbold Biological Station have shown that flying insects are unusually abundant during warm nights immediately following a cold spell, which would allow bats to quickly restore any energy reserves lost during the brief period of torpor. Even on cold nights, the early evening may be warm enough for foraging. For example, over a 10-year period (1969-79) mean hourly nighttime temperatures in January ranged from 21 to 15°C from 1800 to 2200 h and did not reach the lowest point (12°C) until 0100.

Although present evidence is inconclusive, the possibility exists that the absence of hibernation in southern Florida is associated with breeding in late winter-spring, rather than fall, as is typical of more northern cave bat populations. If so, this would place the eastern pipistrelle in the same category with other climatically widespread, temperate, cave bats, such as Myotis austroriparius (Rice, 1957) and *Miniopterus schreibersii* (McNab, 1974), that do not hibernate and mate primarily in spring in the southern part of their range. However, as evidence suggests that hibernation is not essential to maintain viability of stored sperm (Racey, 1982), regular winter activity of pipistrelles in the southern part of the range would not necessarily preclude persistence of fall breeding and delayed fertilization.

ACKNOWLEDGMENTS

I thank C.E. Winegarner and R. Thomason for aid in monitoring and banding bats in the basement units; R. Archbold, R. Hanson, and G.E. Woolfenden for capturing or collecting specimens at other locations; and L. Wilkins for permission to examine specimens in the mammal collection of the Florida Museum of Natural History.

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VI European Bat Research Symposium

The Sixth European Bat Research Symposium will convene August 22 to 27, 1993, at the University of Évora in Évora, Portugal. The scientific sessions will start on the morning of 23 August. Registration at the conference is 11,000 Portugese Escudos (PTE) or approximately $76 in U. S. funds. Housing is available in a nearby hotel, in university dormitories, at a nearby hostel, or at local campgrounds(in descending order of costs, depending on one's budget. Housing at the hotel will be approximately 9,600 PTE per day single room, and 5,900 per day double occupancy. Other prices range downward to about 1,000 PTE per day at the campground.

All posters and oral papers must be accompanied by an abstract, which has to be submitted before 1 May, 1993. The abstracts should not have more than 16 lines of text, excluding the heading, and should have the following structure: title(in upper case), author *a*, address of author *a*, author *b*, address of author *b*, ..., text. The abstracts will be scanned, so be sure that they are printed clearly with good contrast.

Oral papers are allowed ten minutes for presentation with an additional five minutes for discussion. Since the main conference room is large, slides are preferable to overhead projections. Poster display boards are 84 cm wide and 124 cm high. Please use type characters at least 24 point in size so posters can be read from a convenient distance. Both posters and oral presentations have to be in English. The proceedings will be published in a special issue of *Myotis*. Authors wishing to include their papers in this issue should turn in the manuscript during the symposium and follow the structure of *Myotis*. Papers should be less than 18 printed pages, and figures have to be easily reproducible. It is anticipated that the abstracts of the oral presentations and posters will be printed in Volume 34:3 (early fall, 1993) of *Bat Research News*.

A post-conference workshop on bat detectors will take place in southern Spain on August 29-31. The workshop will be held in Grazalema National Park near Cadiz, Spain. This post-symposium workshop is being organized by Antonio Guillén and Carlos Ibañez, Estación Biologica de Doñana (CSIC), Apartado 1056; 41080 Sevilla; España. FAX 34-5-4621125. Arrangements for the workshop can also be made with Jorge Palmeirim.

For further information about either the symposium or the workshop contact the organizers: Jorge M. Palmeirim or Luisa Rodrigues, Dept. de Zoologia, Faculdade de Ciências, Universidade de Lisboa, P-1700 Lisboa, Portugal. FAX 351-1-7597716.

Abstracts of Presentations at the 22nd Annual North American Symposium on Bat Research, Chateau Frontenac, Quebec City, Quebec, October 21-24, 1992

[abstracts are arranged in alphabetical order by first author]

Are Ears Valuable to Moths Flying Around Lights?

Lalita Acharya, York University, North York, ON, Canada

At Pinery Provincial Park, Ontario, *Lasiurus cinereus* and *L. borealis* forage around street lights which are the foci of insect activity. At this site, these two species feed almost exclusively on moths. Heavy predation on moths occurs despite the fact that most of the species attacked possess ears that are sensitive to the calls of echolocating bats. I tested the hypothesis that moths with ears have no survival advantage over moths without ears around the lights at Pinery. In July and August 1992, I released 38 deafened (tympanic membrane of ears punctured) moths and 105 "eared" moths around the lights where *L. cinereus* and *L. borealis* were foraging. The bats had significantly fewer successful attacks on eared moths (64%, n = 133 attacks) than on deaf moths (97.6%, n = 38 attacks). These data suggest that moths with ears escaped being eaten 36% of the time; however, because there were often multiple attacks on the same moth (by the same bat, or by a different bat simultaneously), only 20% of the eared moths released escaped "completely" (by hitting the ground or flying into trees). Observations of naturally occurring bat-moth interactions around the lights indicated that *L. cinereus* and *L. borealis* were successful on 56.3% of attacks (*L. cinereus:* n = 405 attacks; *L. borealis*: n = 240 attacks). Bats attacking released, eared moths had significantly higher foraging success than bats attacking free-flying moths, suggesting that the handling and release process did affect the moths. I also examined the effect of light intensity on bat foraging success. A second similar-sized site within the park had street lights that were almost twice as bright as the above site. There was no significant difference in foraging success between the two sites for either bat species (*L. cinereus*: Site 1 n = 405 attacks, Site 2 n = 237 attacks; *L. borealis*: Site 1 n = 240 attacks, Site 2 n = 234 attacks). *This paper was chosen as an outstanding presentation by a student, and the author received one of the student honoraria.*

* * * * *

Home Range and Habitat Selection of an Endangered Vespertilionid Bat, *Plecotus townsendii virginianus*, in Daniel Boone National Forest, Kentucky

Michael D. Adam and Michael J. Lacki
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Radiotelemetry was used to determine summer home range size and habitat selection of the endangered Virginia big-eared bat, *Plecotus townsendii virginianus*, in Daniel Boone National Forest, Kentucky. Bearings were obtained using both permanent and mobile tracking stations, synchronized by hand-held radios. Signals were surveyed at 20-minute intervals to maintain independence among individual fixes. Sixty Virginia big-eared bats, 30 males and 30 females, were fitted with transmitters, with animals divided equally among three sampling periods coinciding with various stages of the female reproductive cycle: pregnancy, lactation, and volant young. Males were tracked during 1990 and females in 1991. Home range estimates were calculated using the minimum convex polygon method, with ≥ 20 fixes required per individual to calculate a home range size. Habitat selection was tested using the method of Neu et al. (1974; J. Wildl. Manage. 38:541-545), with cover type availability calculated from topographic maps and

aerial photographs. An error polygon of 0.94 ha was estimated with the equipment used for the study area, and was used as the grid cell size for assigning blocks of available habitat to cover types. Mean home range size for females (121.9 ha) was larger than for males (87.4 ha), but the difference was not significant ($P = 0.49$). Female home range size expanded as the reproductive cycle progressed, being significantly larger after young became volant than the previous two periods ($P < 0.05$). Habitat analyses demonstrated a strong preference for cliff-line habitat for both males and females, while remaining habitat types (clearings, corridors, and enclosed forest) were avoided. Protection of the cliff-lines and their adjacent habitats is essential for the long-term survival of Virginia big-eared bats in the Daniel Boone National Forest.

* * * * *

Density Dependent Effects and the Ontogenetic Niche in *Myotis lucifugus*

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Body size is manifestly one of the most important attributes of an organism from an evolutionary and ecological perspective. The effects of size are an important organizing force of populations and communities due to the constraints they impose on how organisms interact with abiotic and biotic components of their environment. Surprisingly, however, ecologists have virtually ignored intraspecific interactions within size-structured populations even though the body dimensions manifested ontogenetically often exceed the size differences observed to isolate strongly competing species. The purpose of this study is to integrate the fields of development, morphology, and ecology to construct a comprehensive picture of the ontogeny of niche space and its effect on population dynamics in *Myotis lucifugus*. I quantify morphogenesis of the wings and correlate stages of development with foraging ability in a mosaic habitat setting. Results indicate that population density may dictate intensity of intraspecific interactions between age groups during foraging bouts. Adults utilized different foraging strategies dependent upon colony density. Under high density conditions, adults changed foraging pathway from open areas before the young became volant to cluttered areas after juveniles were capable of flight. Under low density conditions, adults did not alter their foraging paths in response to the advent of juvenile volancy. Juveniles on the other hand appeared unaffected by population density and maintained almost identical foraging patterns from year to year. For juveniles, aspect ratio and wing loading are important factors in flight ability and consequent foraging ecology. Hypothetically, juveniles traverse an ontoecological landscape as they develop. The peaks of the landscape may represent adaptive developmental morphologies which correspond with flight ability and perhaps increases selective pressures on this population.

* * * * *

Luis Albuja and P. Mena
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The tropical rain forests of West Colombia and Northwestern Ecuador are called "Choco's Association" and are the sites of pleistocene refuges. In spite of the biological importance of this area the fauna is poorly known compared to the other areas of Ecuador. During four years, beginning in 1984, we made surveys of the bat and other fauna in about 30 locations situated from sea level to 1300 meters on the slopes of the Andean ridge. The results show a high bat diversity but less diversity than the Amazon basin. Seventy two species of bats from six families were recorded; equivalent to 60 % of the total species recorded in Ecuador. Four species belonging to the genera *Sturnira* and *Lonchophylla* were previously undescribed and will be published proximately. Seven species previously unknown to Ecuador were added the Ecuadorean fauna (*Micronycteris minuta, M. hirsuta, Anoura cultrata, Choeroniscus periosus, Vampyressa*

nymphaea, Chiroderma trinitatum, and *Artibeus watsoni*). The geographic range was extended for several other species. Among endemic species of the Pacific Province we have recorded *Choeroniscus periosus, Rhinophylla alethina, Balantiopteryx infusca* and the four new species cited above. *Choeroniscus periosus* apparently is rare and was collected in a swamp forest dominated by heliconian trees. *Rhinophylla alethina* is one of the most common bats of the area, especially in the 200-600 meter range of the Cotacachi-Cayapas Ecological Reserve. *Rhinophylla alethina* live principally in undisturbed forest. The Ecuadorean Northwestern Zone is threatened, especially those areas close to the coast and great rivers. Special effort is needed to preserve this ecosystem and this bat fauna.

* * * * *

Effects of Spatial and Qualitative Variation in Food Availability on Time Budgets in *Pteropus vampyrus*

April L. Allgaier
Boston University, Boston, MA

A captive colony of *Pteropus vampyrus* was presented with four feeding regimens combining homogeneous versus heterogeneous diets (chopped fruit vs. whole fruits) and homogeneous vs. heterogeneous spatial food presentation. A time-budget analysis was done to compare captive behavior patterns with natural ones and to determine whether more natural behavior could be induced through modifying the feeding regimen. Heterogeneous spatial presentation was accompanied by significantly higher levels of climbing. Aggression peaked before and during feeding bouts, and food which varied in quality was accompanied by higher levels of aggression. Feeding and roosting were complementary activities in all situations, while levels of climbing remained relatively constant throughout the activity cycle. Dominant males began feeding first and continued feeding longer than females and subordinate males. In general, feeding peaked immediately after the food was presented and declined gradually throughout the night; a bimodal feeding pattern as has been reported in the wild was observed only when whole fruit was presented in a heterogeneous spatial arrangement. This regiment induced activity patterns closest to those found in the wild.

* * * * *

Use of Torpor by Males and Females of the African Insectivorous Bat Scotophilus borbonicus During the Reproductive Season

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In temperate regions, male and female bats employ torpor as an energy saving mechanism, but to different degrees. Males regularly use torpor while females rarely do during the reproductive season, possibly as a way of maximizing the growth rate of their young. Much less is known about the thermoregulatory strategies of tropical bats. We studied the thermoregulatory behavior of male and female *Scotophilus borbonicus,* a 20 g insectivorus bat, In Zimbabwe during the rainy season. The bats roosted in small tree hollows. We used temperature-sensitive radiotransmitters to monitor body temperature and roost temperature. All individuals, including males and pregnant and lactating females, had several foraging bouts per night. Between foraging bouts, all individuals maintained a high body temperature even when roosting periods lasted for several hours. However, they all fell into shallow torpor (body temperature between 15 and 25°C) after the final foraging bout near dawn. Torpor lasted for several hours while the roosts were cool. The bats passively rewarmed to active body temperatures as ambient temperatures in the roosts increased. During the heat of the day, body temperatures occasionally rose above 40° C. Under

most circumstances, the short bouts of torpor these bats use would not be energetically profitable due to the high costs of rewarming. Be rewarming passively, the bats eliminate those costs. Since all the bats, including lactating females, used torpor, it would appear that the small energetic savings realized are important. Presumably the benefits in terms of reduced foraging time (with its risk of predation) outweigh the costs in terms of slowed growth of the young.

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Comparative Energetics of Nectarivorous Bats from the Suborder Megachiroptera and the Suborder Microchiroptera

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Rates of metabolism, body temperatures, and thermal conductance are presented for five species of nectarivorous bats: *Syconycteris australis* and *Macroglossus minimum* (Megachiroptera: Pteropodidae: Macroglossinae) from Papua New Guinea, and *Glossophaga longirostris*, *Leptonycteris curasoae*, and *Choeroniscus godmani* (Microchiroptera: Phyllostomidae: Glossophaginae) from Venezuela. Nectarivorous phyllostomids exhibit rates of metabolism that down to 10°C. Below the thermoneutral zones, phyllostomid species have thermal conductances that are slightly high for mammals but within the range of values found in other bats. In contrast, nectarivorous pteropodids from lowland elevations, though similar in body mass to phyllostomid approximate mass-specific expected rates for mammals and are good thermoregulators at least nectar-feeders, have rates of metabolism that are much lower than expected for their body mass. Nectarivorous "flying foxes" do not thermoregulate well, and in most instances resting bats only maintain a body temperature that is 3-5° C above ambient. A population of *S. australis* from 2,000 meter elevation moss forest, however, is exceptional in having rates of metabolism that approach expected mammalian values and thermoregulates body temperature at least down to ambient temperatures of 10°C.

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Maintaining Fiber-Flow from the ESSF and ICH of WADF and its Impact on the Distribution and Abundance of Insectivorous Bats

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University of Calgary, Calgary, AB, Canada

The purpose of this paper is to solicit the input of this auspicious group with respect to a project begun in 1992 facilitated by Forestry Canada and the B. C. Ministry of Forests. In English, the purpose of the project is to 1) assess the impact of various forest harvesting processes (e.g., clear-cut logging and selective cutting) on the distribution, abundance, roost site selection and foraging behavior of insectivorous bats, and 2) make recommendations regarding the harvesting regimes that will best allow the maintenance of bat diversity and abundance. To our knowledge, there are virtually no data on the effects of logging on bats. The study will take place in the West Arm Demonstration Forest (WADF), an area of approximately 14.5 thousand hectares near Nelson, British Columbia, where logging is limited to an area of 30 ha annually. The precise site and the harvesting process to be employed is flexible. Our study is scheduled to run for at least three years and incorporates an experimental component in that we will have prior knowledge of where cut-blocks will be and can assess the biology of bats in these sites before harvesting takes place. We intend to collect data using mist nets, bat detectors, radio-telemetry, diet analysis, and

insect sampling to meet the objectives of the study. Preliminary field work in 1992 using nets and bat detectors indicated that at least six species of bats were present at lower elevations (650-1000 meters above sea level) within the study area.

The Activity Patterns and Diet of *Noctilio leporinus* on the Island of Culebra, Puerto Rico

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Thirty *Noctilio leporinus* from one roost were implanted with individually numbered passive transponders in May, 1991, on Culebra Island, Puerto Rico. As each bat passed through a wire coil mounted at the roost entrance, its tag number was read and time of exit or entrance was recorded by computer. Comparable activity data on four bats was collected from late December, 1991 to early January, 1992 and August, 1992. The weather in December was the most severe of the year: heavy rain showers and strong winds were accompanied by a yearly low temperature of 16° C. During this time, two large males spent an average of 4 hours out of the roost, two adult females spent an average of 2 hours out of the roosts. In August, 1992 nights were clear, calm, hot and humid with a low temperature of 26 ° C. The same two males were absent from the roost an average of 2 hours 30 minutes, while the same two females were absent an average of 5 hours. During both December and August bats foraged primarily for insects. In December and January 57 76 % of guano contained insect remains (moths and beetles) and 24-43 % of guano was fish remains. In contrast, during August 84-88 % of guano contained insects and the remaining12-16 % was fish. Females give birth to a single young in mid-June suggesting a relatively synchronous estrous. The number of copulations observed peaked in November (five copulations during a 2 hour period in three "harem groups") although copulations were also observed in September and October. The short time that large males were absent from the roost in August suggests that 1) they are defending individual territories within the roost and 2) that prey is abundant. While females continue to lactate until September, young bats begin to fly in August. The increased amount of time females spend away from the roost in August may encourage young to forage independently.

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Foraging Behavior of *Plecotus townsendii* on Santa Cruz Island, California

Patricia E. Brown, Robert Berry, Cathi Brown and Karen Pluff
Ridgecrest, CA

Foraging and activity patters of Townsend's big-eared bat (*Plecotus townsendii*) on the east end of Santa Cruz Island were studied in August 1992 utilizing radio-telemetry. Six bats (3 females and 3 males) were tagged from a building roost at Scorpion Ranch, and tracked for six nights. Instead of foraging near the lush exotic vegetation surrounding the ranch, they travelled 3 to 7 kilometers from the roost to feed among native oak and endemic ironwood forests. Individual bats had preferred foraging areas. Night roosts were located near the foraging areas, and the bats usually did not return to the day roost until dawn. On the first morning after tagging, 5 of the 6 bats did not return to the building, but all were present by the second morning. On a few nights after this, individual bats spent a day roosting in shallow rock caves near their foraging sites.

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Wood Duck Predator Guards Used as Roosts by Little Brown Bats

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In recent years, interest in artificial roosting structures for bats in North America has increased tremendously. Most of the information currently available, however, concerns wooden structures designed to be mounted on buildings, posts, or trees. In June 1992, we studied a colony of little brown bats (*Myotis lucifugus*) on the Duck Creek Wildlife Management Area in southeastern Missouri. The colony roosts under sheet metal wrapped around bald cypress (*Taxodium distichum*) trees standing in Pool 1, a reservoir that holds water for waterfowl management. The sheet metal strips serve as predator collars to protect wood duck nest boxes mounted on the trees. These collars apparently imitate bark exfoliating from the trees, or perhaps, tree cavities. Bats have lived under the predator guards at least since the 1960s. Some of the bats in the Duck Creek bat colony were banded in the early 1970s, but roost selection by this colony of bats never has been documented. By boat we visited all 51 trees with predator guards on Pool 1. At each we recorded: 1) evidence of bat use, 2) species of bat, 3) status of the tree (living or dead), 4) type of sheet metal, 5) width of the sheet metal strip, and 6) how tightly the metal was wrapped around the tree. The bat colony consisted of male, female, and juvenile little brown bats, but we also found one male Keen's bat (*M. keenii*). We examined data collected at the predator guards for correlation of bat use with the physical characteristics of the collars and the trees on which they were placed. We also found bats roosting in a few trees which had no predator guards, but we did not systematically search for such trees. This is the only bat colony in North America of which we know that uses sheet metal predator guards as roost habitat. Sheet metal or other materials that mimic the exfoliating bark of trees clearly have potential to provide roosts where such habitat is missing or limited. These artificial roosts also may be valuable for species such as the endangered Indiana bat (*M. sodalis*) which have not been documented to use other artificial bat roosts.

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The Use of Daily Torpor During the Breeding Season by Common Poorwills *Phalaenoptilus nuttallii*

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Common Poorwills *(Phalaenoptilus nuttallii)* are ecologically similar to many species of bats in that they are nocturnally active, insectivorous, and have the ability to enter daily torpor. It is well known that reproductively active female bats, although capable, resist entering torpor during pregnancy and lactation. From a comparative standpoint, it is of interest to know if poorwills are similarly constrained and resist using torpor during the breeding season. Since poorwills are monogamous and share incubating and brooding responsibilities, I predicted that the non-incubating or brooding bird would enter torpor on climatically unfavorable nights. During the summer of 1991 and 1992, I caught reproductively active birds in the Cypress Hills of Saskatchewan and outfitted them with temperature sensitive radio transmitters. This study site represents virtually the northern extent of the distribution of this species. Night time temperatures regularly approach 0°C and it would be expected that torpor could be used to energetic advantage regularly. I found evidence that like bats, these birds, apparently resist using torpor as an energy saving strategy during the breeding season except on rare occasions. It appears that the presence of eggs may restrict the use of torpor. I suggest that the distribution of poorwills may reflect areas in which they can maintain a positive energy balance during the breeding season while only entering torpor under extreme conditions. Therefore, regular cold, wet weather cannot be tolerated by breeding birds.

Photographic Analysis of Moth Evasive Flight Behavior

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Ultrasonic hearing systems have evolved independently a number of times in the Lepidoptera. In response to pulsed ultrasound, moths perform a variety of evasive flight maneuvers. To assess and quantify this behavior, I took a series of multi-flash long exposure photographs of moths flying in response to a stationary source of ultrasound (a "bat gun") in a 4.5 x 2.8 x 2.1 m room. Trains of ultrasonic pulses at 40 kHz constant frequency (5 ms pulses at 100 pulses/s) were activated once the moth flew into range of the bat gun. There were no predictable species-specific flight patterns seen in response to the bat gun for individuals of three families of moths (Noctuidae, Geometridae, and Pyralidae) photographed.

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A New Approach to Presenting Bats at the Biodôme de Montréal

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On June 19, 1992, the Biodôme de Montréal officially opened to the public. This first "living" museum of natural sciences attempts to reproduce as accurately as possible four major ecosystems of the planet including the Tropical Rainforest. In these ecosystems, we couldn't leave out some of the world's most important and diversified mammals, the bats. The geomorphological concept of the Tropical Rainforests lends itself to the presentation of these species. A unique kind of cave was developed to give the visitor a real sense of being underground. A calcareous cave of Costa Rica was reproduced by Larson Company. It has a surface area of 82 m^2 - 875 ft^2 and is traversed by a glassed-in corridor.More than 250 specimens of three species are exhibited *Carollia perspicillata, Artibeus jamaicensis and Glossophaga soricina.* Three major factors were kept in mind during the design process. 1. The biological requirements of bats (physical parameters). 2.The expectations of visitors (good viewing of the bats, sense of being below ground). 3. The technical requirements of the zookeepers (easy maintenance, easy access, etc.)

* * * * *

Palatability of Arctiid Moths to Captive Bats

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Little brown bats (*Myotis lucifugus*) and big brown bats (*Eptesicus fuscus*) presented with live moths in a small cage eat fewer arctiids than moths of other families. However, captive bats eat a larger proportion of available arctiids than do free-flying red bats (*Lasiurus borealis*). Thus, it appears that arctiids are more palatable to captive bats than to free-flying ones, or that those bat species whose responses have been tested in captivity find arctiids more palatable than do red bats. The bats rejected the insects during most interactions observed between captive little brown bats and intact arctiids moths, though some of the moths were eventually caught and eaten each evening. This occurred whether or not the moths clicked. There was no significant correlation between palatability and clicking propensity. In the wild, each moth probably would have escaped after a rejection interaction. In contrast, the bats at least tried to catch the insects during most interactions with intact moths of other families (mainly Noctuidae and Geometridae) and usually were successful. Thus, it appears that the greater apparent palatability of arctiid moths to captive bats is a consequence of repeated interactions between the bats and the same individual moths.

Habitat Use and Foraging Behaviour of Greater Horseshoe Bats, *Rhinolophus ferrumequinum.*

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Greater horseshoe bats are rare in Great Britain, numbering some 2,500 to 3,000 in total, and have declined substantially during the past one hundred years. They are restricted to southwest England and Wales, and currently only about a dozen nursery sites are known. The later are protected, but the bats' feeding sites are not well documented and do not receive any measure of protection. The present study is carried out at four sites, three of which are breeding colonies. Radio-tracking is concentrated at two sites. While the animals are being followed, their diet and availability of prey items are simultaneously monitored by using light traps and regular faecal collections. Bats tagged in the fall are found foraging in different habitats, in a different fashion and for longer periods of time (both absolute and as a percentage of night length) when compared to those tagged in the spring. Bats were found foraging in a perch-feeding style in the Fall far more often than in the Spring. Time spent foraging and perching were monitored for several bats, as well as the type of perch used and its distance from the ground and hedges. Due to the bats being followed continuously, the amount of time spent on each feeding area, and the distances travelled throughout the night were calculated. To date (June,1992), 50 feeding areas have been identified at the main study site and the land management practices in force within them identified. The activity patterns show that the tagged bats do not always forage with activity peaks at dusk or dawn, or both. Several of the bats forage in the early hours of the morning, and some foraging bouts at these times lasted several hours. This activity is discussed in relation to the dietary ecology of Greater Horseshoe bats.

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The Effect of Insect Larvae Infestation on Fruit choice in *Sturnira ludovici*

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In the neotropics, many plants produce fleshy animal-dispersed fruits that can be infested by pulp-mining insect larvae. Larval presence may not effect seed viability but can alter fruit characteristics such as color, smell or taste. The larvae may provide an extra nutrient source for proteins and fats, elements potentially scarce in the diets of obligate frugivores. To test whether fruit bats had a preference for infested or noninfested fruits, I captured 21 *Sturnira ludovici* in Monteverde, Costa Rica during July and August, 1992. In 126 trials individuals were presented with equal quantities of infested and noninfested *Acnistus arborescens* fruits. The animals consistently distinguished between the two and showed a significant preference for the non-infested fruits. *S. ludovici* may avoid infested fruits because of chemical changes in the pulp caused by the larvae. Fruit bats of this family have a keen sense of smell and may be able to detect those changes using olfactory cues. Changes in fruit characteristics possibly serve to protect the larvae from mortality via frugivory.

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Roost Ecology of the Brown Long-Eared Bat *Plecotus auritus*

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I aimed to examine whether variation in colony success, as indicated by life history parameters, is related to physical features of the roosts and their surroundings. *Plecotus auritus* commonly roosts in houses in Britain, and is therefore amenable to such a study. To evaluate features of roosts which might be important, I documented internal and external features for known roosts (n=56), and compared 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) and the absence of direct disturbance. 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 using radio-tracking, which revealed that bats concentrated their foraging close to the roosts. Radio-tracking has also demonstrated that *P. auritus* forages in both deciduous and coniferous woodland. Further study of roost features has concentrated on the local microclimate in bat roosts, in comparison to random buildings and external ambient conditions. A ringing program at a series of 20 roosts with discrete colonies has demonstrated that there are considerable variations in some population parameters between roost sites. The number of bats using each roost, the degree of roost fidelity (both within years and between years), the fecundity (% breeding) and the social composition appear to vary. The next stage in this work will be to relate differences in population parameters in different roosts to the important roost features (including local habitat and roost microclimate) at each site. It is hoped that this will separate out more clearly the key aspects of roosts that may affect colony success.

This paper was chosen as an outstanding presentation by a student, and the author received one of the student honoraria.

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A Low Cost Frequency Modulated(FM) Ultrasonic Stimulator

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Researchers in biosonar and auditory physiology often use simulated ultrasonic signals. Although complex waveforms can be generated with computers, many researchers rely on function generators to produce constant frequency (CF) tones which are chopped into pulses and then shaped to avoid transients. Except for some bats, CF signals are rarely used or encountered by organisms in the wild, and thus may be inappropriate signals for auditory and/or echolocation experiments. Commercial frequency modulated (FM) sweep generators can be prohibitively expensive and often do not provide the user with all the necessary controls to produce biologically relevant signals (e.g. extremely short duration FM sweeps). Herein we describe a circuit built with commonly available integrated circuits (ICs) and electrical components to produce frequency modulated FM ultrasonic pulses of variable duration (100 μs - 50 ms) and broad bandwidth (5-125 kHz). The FM signals that are produced can be swept up or down in frequency, and if desired, the circuit will also produce CF signals. Details of the circuit schematic and construction will be presented. Briefly, the circuit can be divided in 6 parts: (1) An integrator which generates a linear voltage ramp--the basic element of the FM sweep. (2) A monolithic waveform generator which produces a sinusoidal signal from the voltage ramp. (3) Window discriminators to gate the starting and stopping frequencies of the ramp. (4) Feedback circuitry to compensate for changes in either the pulse duration and/or window discriminator settings of the voltage ramp. (5) Two independent timing circuits to provide control over the duration of the pulse and the pulse repetition rate (i.e. internal triggering). Additionally, pulses can be triggered externally from a push-button

or from a TTL pulse from a computer. (6) A shaper circuit which uses an analog multiplier to give the pulses a trapezoidal appearance. The shaper circuit has been specifically designed to provide the user with independent control over the rise and fall times, thus pulses can be shaped asymmetrically. This circuit is a stand alone device and was designed to free up your computer for on-line data acquisition and analysis instead of stimulus production. It can be built to be mounted in a laboratory rack, or with a few modifications, it can be made battery operated, portable, and thus suitable for field use. Applications to neuroethology, echolocation research, and auditory physiology will be presented.

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Raptors and Bats: Threats and Opportunities

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Three species of raptors attacked bats in woodland settings (2 attacks in 10 samples), and around building (3 in 39 samples) and bridge colonies (54 in 32 samples), and were successful in 51% of the 59 attacks. Wahlberg's Eagles and Hobby Falcons attacked by stooping at flying bats while African Goshawks pursued them in flight. The birds almost always took each captured bat to a perch to consume it and 30 to 300 sec after capture, the raptor had eaten and resumed hunting. The sizes of the bats and the successes of the birds demonstrated that bats could form a significant portion of the diet of opportunistic raptors. Bats responded to attacks or potential attacks whether they were roosting, emerging from a roost, or flying, apparently using vision and/or vocalizations to detect danger. For colonies of < 100 bats, there was no evidence of a relationship between emergence time and colony size, while bats emerged significantly earlier from colonies of > 100 individuals. By adjusting the times and durations of their emergencies, individual bats could decrease their risk of attack from raptors. The data are used to develop models illustrating the opportunity bats present to raptors and the threats raptors pose to bats.

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Vertical Stratification of Bats in Malaysian Rainforest

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I used ropes to set mist nets and harp traps at ground level, and in the subcanopy (up to 30 meters high) to measure relative abundance of bats at different heights in lowland rainforest in peninsular Malaysia and Sabah. Very few frugivorous bats were captured in understorey mist nets, especially in comparison with similar communities in Neotropical forests. In contrast, fruit bats were caught in large numbers in mist nets in the middle storey and lower canopy. This may be due to the scarcity of understorey fruiting trees, and/or the relative high density of vegetation near ground level hindering flight of the visually oriented Megachiroptera. The aerial nets captured large numbers of several species previously thought to be very rare, including one with very unusual reproductive biology. In contrast to the netting success for frugivorous bats, harp-trapping of insectivorous species was much more effective at ground level than in the subcanopy. However, this probably reflects mostly differences in the effectiveness of the traps, due partly to the geometry of the vegetation, rather than differences in abundance of the bats. Alternative methods, such as sampling with bat detectors at different heights may provide a more reliable comparison.

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Persistence of Auditory Sensitivity in Moths that have Evolved in Bat-Free Environments

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The islands of French Polynesia have never possessed bats in their 6-12 million year history and are home to endemic species of moths that have consequently evolved in the absence of bat selection pressures. Assuming that bat-detection forms the primary purpose for ears in moths, I tested the prediction that polynesian moths would exhibit reduced auditory function by neurophysiologically monitoring the ears of eight endemic and twelve immigrant species of noctuids. Moths were collected from sites on Moorea, Tahiti (Society Is.) and Hiva Oa (Marquesas Islands) and were examined using standard extracellular techniques. Preliminary results indicate that endemic moths possess ears of comparable sensitivity to those of immigrants although endemics are more deaf at high frequencies (>50 kHz). The persistence of ears in endemic moths is explained by one or more of the following hypotheses: 1. Endemic moths have not been genetically isolated for a long enough time to exhibit significant changes in their ears (phylogenetic inertia), 2. Moths on Pacific islands have developed non-bats use for their ears.

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Geographic and Habitat Characteristics of the Echolocation Calls of the Hawaiian Hoary Bat

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The echolocation calls of the Hawaiian hoary bat (*Lasiurus cinereus semotus*) were analyzed to test three hypotheses regarding the evolution and ecology of this bat. First, the calls of a population recorded in an open foraging site (Pohakuloa, island of Hawaii) were compared to those recorded in a similar site in central Canada (Delta Marsh, Manitoba) to test if the Hawaiian subspecies uses the same design of call as its presumed ancestral taxon. Second, the calls from the Hawaiian site were compared to those recorded from a similar site on another island (Koke's, Kaua'i) to test for inter-island similarities. Finally, the calls from the Hawaiian open site were compared to those from closed sites on the same island (Manuka and Kalopa parks) to test whether the Hawaiian bat is as acoustically flexible as its diverse foraging behavior predicts.

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Populations of Cave-Dwelling Bats in West Virginia

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Hibernating populations of cave-dwelling bats were censused in 131 caves in 15 counties in West Virginia between 1976 and 1992. A total of 93,400 individual bats were counted in the 131 caves surveyed. Only five caves contained no bats. One cave harbored all eight species of bats known to hibernate in West Virginia caves and contained 61,791 or 66.16% of the total number of bats tallied. The most abundant species was *Myotis lucifugus*, comprising 68.35% of the total and found in 64.12% of caves. *Pipistrellus subflavus* comprised 15.53% of the total but

was found in 92.37% of the caves. *Plecotus townsendii virginianus*, a federally endangered species, comprised 8.26% of the total and was found in 15.27% of the caves. *Myotis sodalis*, another federally endangered species, comprised 6.86% of the total and was found in 15.27% of the caves. *Eptesicus fuscus* comprised 0.86% of the total and was found in 51.5% of the caves. *Myotis leibii* comprised 0.08% of the total and found in 16.79% of the caves. *Myotis septentrionalis* comprised 0.06% of the total and was found in 25.19% of the caves. Two individuals of *Myotis grisescens* a federally endangered species, were found in one cave and represent the first recent record of this species in West Virginia. Data are presented on changes since the 1950's of hibernating bat populations in West Virginia.

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Foraging Ecology of *Myotis grisescens*: A Comparison of Numbers and Types of Echolocation Calls in Aquatic and Terrestrial Habitats

Travis Hill Henry, Troy L. Best, Leslie A. Rueter, Amy B. Goebel,
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In recent years there has been an increase in aquatic vegetation in lakes along the Tennessee River in the southeastern United States. The Tennessee Valley Authority (TVA) is investigating the possibility of reducing the amount of aquatic vegetation in these lakes. In an effort to assist the TVA in determining the impact of reduction of this vegetation on the endangered gray bat *Myotis grisescens*, we monitored feeding activity via recordings of echolocation calls in three aquatic and two adjacent terrestrial habitats at Guntersville Reservoir, Jackson Co., Alabama. Our objectives were to determine which habitats the bats forage in most often and to ascertain how much the foraging pattern varied throughout the night and throughout the summer. We placed five recording stations in each of five habitats; each station consisted of a Mini II Bat Detector and a small Realistic tape recorder. From June through September 1991, we monitored activity in each habitat for three consecutive nights at two-week intervals (seven sampling periods). A total of ca. 5,200 h of data was obtained. There were two primary periods of activity in each habitat; peaks times in July were at 2000 and 0400 h. As the summer progressed, these peaks moved to 1900 and 0500 h and were reduced in magnitude. Aquatic habitat with no vegetation was used more by gray bats than other habitats. In addition, the second peak of activity each night in this open-water habitat was of similar magnitude to the first peak earlier in the evening. In the other habitats, the second activity peak was much less pronounced than the first peak. Terrestrial habitats were used by gray bats, but not as extensively as aquatic habitats. These preliminary data support previous reports that nonvegetated aquatic habitat is used extensively by gray bats, but bats also are active and forage in all habitats in the vicinity of the Tennessee River.

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Unique Contractile Proteins and Muscle Specialization in the Vampire Bat *Desmodus rotundus* : Correlations with Phylogeny

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In this study, we seek to assess whether the muscle histochemical properties and the myosin isoform composition of the primary flight muscles of *Desmodus rotundus* correlate with phylogenetic patterns thought to exist in the family Phyllostomidae, a sister group of the Desmodontidae. While the pectoralis muscle of the Jamaican fruit bat *Artibeus jamaicensis*, con-

-tains two predominant fiber types (Hermanson and Foehring, 1988. J. Morph. 196:353), the vampire pectoralis contains at least four fiber types distributed in a non-homogeneous pattern. One of these fiber types, here termed IIc, can only be elucidated by ATPase histochemistry combined with reactions against anti-fast and anti-slow myosin antibodies. These observations indicate a well developed specialization of function within the muscle. In parallel, analysis of native myosin isoforms and myosin heavy chain isoforms indicate two points. Firstly, the histochemical type "IIc" fiber is predominant in cranial portions of the muscle and exhibits a unique electrophoretic mobility not exhibited in the myosin isoforms of more traditional laboratory animals. Secondly, the type I fibers are confined to the pectoralis abdominis muscle and a small adjacent region of the caudal part of the pectoralis. The pattern of type I fiber distribution is considered a derived character state compared to muscle histochemical phenotype and isoform composition in the pectoralis muscles of other phyllostomids we have studied (*Artibeus jamaicensis, A. lituratus, Carolina perspicillata*). We relate this to the unique locomotory needs of *Desmodus* while feeding. The type IIc fiber may represent a convergence of synapomorphic character state compared to the histochemical pattern seen in other phyllostomids, including *A. jamaicensis*. The use of isoform and histochemical character state data can make an important contribution to understanding the phylogenetic status of bats at several taxonomic levels.

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Foraging Site Fidelity and the Influence of Prey Density on the Use of Space by Hoary Bats, *Lasiurus cinereus*

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Models of risk-sensitive foraging suggest that an animal's foraging decisions should be based not only on the mean rate of prey intake but also on the variance around this mean. When prey density is high relative to an animal's energetic requirements, it should select the foraging option that yields the lowest variance for a given mean prey intake rate. When prey density is low relative to an animal's energetic needs, a forager should select the option that yields the highest variance for a given mean prey intake rate. Between May and August 1988, 1989, and 1990, I examined foraging site fidelity and the influence of prey density on the foraging behavior of hoary bats. I captured 37 hoary bats as they foraged at street lights surrounding camp offices at Pinery Provincial Park, Ontario and attached a unique combination of color bands to their forearms. I used a hand-held spotlight to observe the foraging behavior of banded bats and determine their unique color band combinations. Twenty-eight of the 37 banded bats (>75%) were resighted at least once during the summer (where a resighting is one bat sighted at a foraging site on one night). Twenty-three of the bats that were resighted were resighted only at the site where they were first captured and never at any of the other foraging sites in the park. Over 90% of individual resightings (n-268 resightings) were at the foraging site where the bats were originally banded. In 1989 and 1990 I used radiotelemetry to document the use of space by 21 bats for a total of 61 bat-nights. When prey density was high (517 $\pm$ 192 moths per sample) bats spent most of their time foraging in or near the park and spent only 17 $\pm$ 30 minutes out of range of our radio tracking station. In contrast, when prey density was low (164 $\pm$ 64), 2 bats spent less time foraging in or near the park and spent 88 $\pm$ 133 minutes out of range of our radiotracking station. Foraging over a wider area and when prey density is low may increase the variation in prey intake rate. These data suggest that free-flying hoary bats adopt a risk-sensitive approach to foraging.

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Weather and Age: The Effects on Reproductive Success and Overwinter Survival of Big Brown Bats in Southeastern Alberta

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During a two year field study of reproductive strategies of *Eptesicus fuscus* in southeastern Alberta, adult females were found to use torpor more during pregnancy than during the lactation period. As well, torpor was used more often during both the pregnancy and lactation periods during the first season consequently resulting in a significant difference in the birth dates, growth rates, and fledge dates of pups between seasons. The effect of later fledge dates in the first field season may result in different over-winter survival rates of young bats as the time between fledging and hibernation would have been reduced leaving less time for young bats to build critical fat reserves. As well, the different climatic conditions between the two seasons may result in significantly different proportions of nonreproductive females in the population although relative age classes may also explain the variation in the number of reproductive individuals.

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Foraging Strategies and Prey Selection in the Hawaiian Hoary Bat *Lasiurus cinereus semotus*

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The Hawaiian hoary bat, *Lasiurus cinereus semotus*, utilizes both fast, unmaneuverable flight and slow, more maneuverable flight. Since maneuverability decreases as flight speed increases, this bat must detect prey at greater range when using fast flight than when using slower flight. However, echolocation call features used to enhance detection range, may reduce the detectability of small insects. Size selection of prey in aerial insectivorous bats may therefore result from differential prey detectability rather than from active selection among alternative prey sizes. In open habitats, with an insect fauna of large body length and low population density, the Hawaiian bat used fast, unmaneuverable flight to feed on large moths. In closed habitats, with an insect fauna of relatively smaller body length and lower population density, the bat used slower, more maneuverable flight to feed on a variety of insects of smaller body length. Bats at the open site did not respond to real or artificial prey similar to the median size taken by bats in the closed habitat, suggesting that small insects are unavailable to the bat when using fast, unmaneuverable flight. Utilization of fast flight in a bat that has the option of slow, maneuverable flight suggests that fast flight may be more efficient for exploiting large insects of low population density. Although prey selection may be passive once a bat chooses a particular strategy, choice of an appropriate strategy may maximize its rate of energy intake. Further examination of energy intake may also be achieved within a particular strategy as indicated by the Hawaiian bat's ability to alter its pursuit times in response to changing prey densities in open habitats.

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Indiscriminate Prey-Capture in an Opportunistic Gleaner, the Pallid Bat *Antrozous pallidus*

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Pallid bats (*Antrozous pallidus)* caught grey slugs in grasslands in central coastal California and dropped them either in flight or at the feeding roost. I counted 16 deep cuts in one slug 5 cm long, and a total of four slugs (3.5 to 6 cm) were found dead within a 12 meter radius of the

evening roost of 19 individuals during five nights of observation during July and August of 1991. I did not find any rejected slugs during four nights of observation during the following months of September and October. Other gleaners such as the Indian false vampire bat (*Megaderma lyra*) also pick up mollusks and reject them, Doris Audet (per. comm.). Studies on the sensory information that pallid bats use to locate prey suggests that these gleaners often use passive sounds produced by the prey species themselves. Orthopterans (a common prey group in the southwest U.S.) produce low frequency sounds while walking on the ground or presumably rustling in debris. Bell (1982) describes pallid bats first flying over their prey echolocating while navigating before they return, using only passive listening for prey detection. However, Krull (1992) suggests that echolocating may play a role in the final stages of flight just prior to landing before prey capture. These models are somewhat conflicting, and to date, no predation model for gleaners sufficiently accommodates the detection of mollusks. To listen for possible sounds generated by grey slugs, I placed two live specimens (4 and 6 cm) in separate quart-sized jars with grasses and kale and pressed the jar to my head around my ear. I could not detect sounds made by the slugs' forward motion on the plant material. I did hear rhythmic, low frequency sounds while these slugs grazed on the kale with their radulae. I observed discarded slugs only during the mid to late summer when young bats are volant. During this time 93.8% of the prey remains under the roosts were Jerusalem crickets. Young pallid bats may confuse the low frequency sounds of slugs' radulae grazing on plants with the sound of Jerusalem crickets feeding on plants. My hypothesis is that orthopterans' grazing sounds are commonly used for prey detection by gleaning bats. I would also like to investigate: (1) why slugs were not released immediately; (2) what are the learning strategies of the young; and (3) is there missing information regarding the sensory ecology of prey detection by gleaners?

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The Influence of Wing Loading on Habitat Selection by Female Little Brown Bats *Myotis lucifugus*

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The purpose of my study was to compare habitat use by female *Myotis lucifugus* with different wing loadings associated with changes in morphology due to reproduction. I tested the prediction that as wing loading increases and manoeuverability decreases, due to the increased mass associated with pregnancy, female bats will tend to forage in areas where the number of obstacles to detect and avoid is lower (e.g., less cluttered habitats). The habitats used by the bats in my study were ranked subjectively by the degree of clutter into 1) open areas over grassland, 2) open areas over water, 3) the airspace within 1 m of trees or shrubs and 4) cluttered space within the foliage of trees or shrubs. I measured the habitat use of different reproductive classes (non-reproductive, pregnant, lactating, post-lactating) by observing the flight of light-tagged foraging individuals. Continuous descriptions of habitat use were made into microcassette recorders which allowed me to calculate the actual time spent in each habitat type. Concurrently, I measured the availability of flying insects in each habitat type using light-suction traps. Preliminary analysis of the trap catches suggests that there is a higher density of insects in more cluttered habitats and thus a selective advantage to bats foraging there. The light-tagging data support the prediction that the degree of clutter associated with *M. lucifugus* foraging habitats does vary amongst reproductive classes as non-reproductive bats foraged predominantly in areas of clutter while pregnant and lactating bats foraged mainly in areas at the edge of trees.

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Monophyly of Bats Inferred from DNA-DNA Hybridization

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The monophyletic-diphyletic origin of bats remains one of the major controversies in mammalian systematics. The systematic relationships among Microchiroptera, Megachiroptera, Primates, and Insectivora were examined by phenetic analysis of estimates of genetic divergence derived from DNA-DNA hybridization of a single-copy DNA representing the entire genome. Although several traditional measurements of sequence divergence used in DNA-DNA hybridization studies were not usable because of the extent of divergence when examining taxa at the ordinal and subordinal level, measurement of normalized percent hybridization was used to estimate the sequence divergence among taxa. Phylogenetic relationships were inferred from Fitch-Margoliash trees constructed from both a matrix of trimmed mean values of sequence divergence corrected for nonreciprocities and bootstrap analysis of trimmed estimates of sequence divergence. All trees were rooted with an outgroup, an Edentata. Trees generated from analysis of mean estimates of genetic divergence demonstrated either an unresolved tricotomy among Primates, Microchiroptera, and Megachiroptera or a sister taxa relationship between Microchiroptera and Megachiroptera with Primates the sister taxon to the two suborders of bats. Although bootstrap analysis demonstrated a clustering of Megachiroptera, Microchiroptera, and Primates in every tree, 54% of the trees clustered the Primates with the Megachiroptera whereas 42% of trees clustered the Megachiroptera with the Microchiroptera. We conclude that bats are monophyletic and that flight in mammals evolved only once, however, we conclude that primates are more closely related to bats than the Insectivora. We suggest that the visual pathway shared between Primates and Megachiroptera is a derived character that was present in primitive Microchiroptera, but that this character state reverted to the ancestral character state in the microchiroptera with the development of echolocation and a reduction of the importance of the visual system.

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Alloparental Care: Helper-Assisted Birth in the Rodrigues Fruit Bat, *Pteropus rodricensis* (Chiroptera: Pteropodidae)

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Observations of parturition in most mammals, either in the wild or in captivity, are rare. We report observations of parturition and alloparental care, or epimeletic ("care-giving") behavior, exhibited by one female toward another, before, during, and after giving birth, in the bat *Pteropus rodricensis* (Chiroptera: Pteropodidae). Interactions between the expectant mother and other conspecifics from the onset to the completion of birth were observed continuously over a period of nearly three hours. An attending female assisted the expectant mother by 1) intermittently grooming her anovaginal region, 2) "tutoring" the mother how to assume a "feetdown" birthing position, 3) grasping and wrapping the expectant mother with her wings, 4) grooming the emerging pup, and 5) assisting the mother in maneuvering the pup to a suckling position. Although various forms of alloparental care have been reported for bats, this is the first report of extensive alloparental assistance given by one female to another during birth. We suggest that the recipients of this behavior may be common in highly social species such as in the Megachiroptera, especially among primiparous or inexperienced females and/or when an expectant mother experiences difficulty during labor and parturition.

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Do Indiana Bats Require Shaded Maternity Roosts?

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Earlier work with the endangered Indiana bat *Myotis sodalis* suggested that this tree-roosting species locates its maternity roosts in areas of high canopy cover, presumably to avoid thermal stress associated with solar radiation. During a recent bat survey in Cass Co., Illinois, we discovered a maternity colony of endangered Indiana bat in a hollow sycamore (*Platanus occidentalis*). This sycamore was located in a heavily grazed pasture and was totally unshaded. Despite the lack of shade, the tree was occupied continuously throughout July and August when maximum air temperature often exceeded 32° C. A flight count of 95 bats on 13 July 1992 indicated that this colony was equal in size to the largest ever reported for Illinois. Recent discoveries of unshaded maternity roosts in Michigan, Kentucky, and now Illinois, suggests that the species may be more adaptable than previously thought.

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Morphology and Function of the Abdominal Wall in *Pteronotus parnellii*

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Abdominal musculature plays an important role in posture, movements of the torso and changes of intra-abdominal pressure. The latter is especially important in the control of vocalization, and bats, as highly vocal animals, are appropriate subjects for anatomical and physiological studies of this musculature. Dorsally and laterally, the abdominal wall of *Pteronotus parnellii* is composed of three sheet-like muscles typically found in mammals. The external abdominal oblique is a thin, variably distributed layer of muscle and aponeurotic fibers. In the more completely developed internal abdominal oblique, cranial and caudal attachments are usually thin and aponeurotic, while the muscular midsection is 100 to 200 µm thick. The most extensively developed layer is the transversus abdominis. Dorsally, it spans the entire length of the abdominal wall as a muscular layer ranging in thickness from 200 to 300 µm. Ventrally, muscle fibers of all three layers terminate along a margin which follows a broad arc, concave with respect to the ventral midline, and extends from the caudal border of the pectoralis to the caudal extremity of the rectus abdominis. Ventral to this margin, the wall consists solely of a dense 60 to 100 µm thick aponeurosis, which contributes to the sheath of the rectus abdominis. The abdominal aponeurosis contains numerous elastin fibers of various orientations. The rectus abdominis extends from the border of the pelvic outlet caudally, approximately to the fifth rib cranially. In that the two well developed muscle layers of the lateral abdominal wall attach directly to a single abdominal aponeurosis, it is not clear how the layers could function separately. Electromyographic activity in lateral wall muculature was found to consistently precede ultrasonic vocalizations in stationary bats. No correlative activity was seen in the rectus abdominis in association with pulse emission. However, a strong burst from both areas preceded audible calls. Optimum correlation with vocalization was obtained from bats hanging in a cage without overt body movements. Recordings from different points on the abdominal wall yielded differences in the degree to which motion related electrical activity would obscure activity related to vocalization. This could indicate differential activity among muscle layers, or regional specialization within the muscle mass. This work was supported by USPHS grant DC00114 to O.W. Henson, Jr.

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Encephalization, Adaptation and Evolution of Bats: Statistical Evidence for the Monophyly of Chiroptera

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The monophyletic origin of bats has recently been challenged on the basis of visual pathways, but other characters as diverse as mtDNA and rRNA sequences, skull morphology, nerve insertions, and immunology support the monophyly of bats. Brain data therefore represents the major piece of evidence in favor of the diphyletic hypothesis. But what if Pettigrew's scenario is true? What if the brain provides good phylogenetic characters to understand bats? We have approached this problem using a new data set of 120 species of primates (40), megabats (20) and microbats (60) to compare the two competing hypotheses. For each species, the volume of 12 brain components were measured and transformed into size indices for further analyses. A tree was derived from the brain quantitative data and compared to the monophyletic and diphyletic models to assess the statistical significance of each hypothesis. Different phylogenetic reconstruction techniques, as well as partial tests, were computed to reduce methodological biases and to account for the "adaptation effect". Our results corroborate the monophyletic scenario in every situation, including cases where a molecular clock is assumed, as well as instances where species adaptations have been controlled for. The diphyletic model, on the other hand, was found to be as likely as a random phylogeny would be.

* * * * *

Notes on Triplet Births of *Pipistrellus abramus* in Taiwan

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The reproduction biology of *Pipistrellus abramus* was studied in northern Taiwan from 1989 to 1990. During May, June, and July 1989, twelve adult female *P. abramus* were collected by mist nests from a colony located in Kuantu. Eight individuals were pregnant and the other four were in non-reproductive condition judged by their outer characteristics. After dissection, five of the eight pregnant individuals were found carrying three embryos and the other three bats had two embryos in their uterine horns. Embryos of bats collected in May were in early development and those from individuals of June were close to their late stages. However, two females dissected on June 26 were still carrying small and less developed embryos. On June 23, on pregnant bat gave birth to three male young, but the young all died in two days. they were approximately on third of their mother's postpartum mass. Parturition of *P. abramus* in northern Taiwan is estimated to occur around the first three weeks of June. The proportion (63%) of pregnant female *P. abramus* having three embryos, even with this small sample size, is unusual for pipistrelles which have been reported to produce one young or twins in most cases. Since Taiwan is a subtropical area, this result is interesting and worth further study.

* * * * *

This Place Bugs Me! Roost Switching in Pallid Bats

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Changing daytime roost locations has several potential costs, including time and energy to find a suitable new roost, exposure to predators while searching, and the destabilizing effect of

roost switching on social organization. Yet, in a review of 43 species of bats, 58 percent of the species frequently change their diurnal roost site. Pallid bats (Antrozous pallidus) roosting in rock crevices in central Oregon were studied with radiotelemetry to determine what factors were associated with low roost site fidelity. Both pregnant and lactating pallid bats frequently changed their diurnal roost location. Lactating females travel shorter distances between consecutive roosts. Roost switching was not correlated with daily variations in weather conditions or with characteristics of the roost site, although switching may allow bats to maintain familiarity with several roosts that may vary in microclimate. Roost switching was positively correlated with parasite load. Since high ectoparasite levels were associated with lower body weights in lactating females, roost switching may be a strategy to decrease costly parasite loads by interrupting parasite reproductive cycles. The behavior of pallid bats in Oregon can be contrasted with that of pallids in Arizona, where females switch roosts in spring and fall, but remain faithful to maternity roosts during late pregnancy and lactation. I propose that the differences are due to variations in the relative costs and benefits of roost switching in the two populations.

* * * * *

Time Budgeting and Foraging Behavior in Common Vampire Bats

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In order to determine the time allocated for foraging by common vampire bats (*Desmodus rotundus*), radio transmitters were placed on 19 bats. A preliminary analysis of the data collected shows that the bats spend an average of three hours out of the roost each night. Female bats show less variability than males in this aspect. Bats tended to forage prior to moonrise or after moonset. Data collected at the foraging sites show that among bats, there is some variability in total foraging time, however, individuals seemed to be fairly consistent in terms of foraging location, total time out of the roost and time spent at feeding sites. Further studies will be conducted to better determine the amount of time vampires spend searching and feeding once they arrive at a site. Data will also be collected on bat visitation to calves which have been identified as preferred prey items; this will be done using a combination of radio tracking and observation of the calves.

* * * * *

Non-Energetic Maternal Investment in the Brown Long Eared Bat

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Most previous analyses have used energy as a currency to measure maternal investment. However, other maternal behaviors such as retrieval, grooming of the young and thermoregulatory behavior may also be important to offspring survival. In this study, I examined maternal investment through these indirect maternal inputs and compared maternal behavior with that of nonpregnant individuals. I used infra-red video recording of captive free-flying colonies to investigate maternal input throughout lactation. Only one of 17 individuals gave birth. In the first three weeks, the mother spent 82 percent of the day in contact with the young; the mother groomed the young frequently; carrying behavior occurred only in the first 21 days; the mother visited the roost box frequently during the night (mean = 10) to groom and suckle the young. These maternal behaviors were reduced in late lactation: contact time was 30 percent by day 43; grooming of the young feel to 5 percent; the mother did not carry the young. The mother switched from early emergence to late emergence, as lactation proceeded. Grooming of the young was added to self-grooming in early lactation and the mother showed reduced total grooming behavior after 25 days.

The mother received significantly more input from allogrooming than any other individuals. Allogrooming interactions were asymmetric. It was unknown whether this asymmetry was due to relatedness or reciprocal altruism. In conclusion, this study revealed a range of maternal behaviors other than energetic investment which may be significant to the measurement of maternal investment. These other maternal behaviors occurred predominantly early in lactation when the young is most dependent on the mother.

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Variation in the Echolocation Calls of *Lasiurus cinereus* and *L. brachyotis* on the Galapagos Islands

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Lasiurus cinereus and *L. brachyotis* occur together on two islands in the Galapagos (Santa Cruz and San Cristobal), whereas on three other islands that were surveyed (Isabela, Floreana, Santiago) *L. cinereus* occurs but *L. brachyotis* is apparently absent. Echolocation calls made by both species while foraging were recorded in 1990 and 1991 using QMC 8-200 and Ultrasound Advice S-25 bat detectors set on countdown mode. All *L. cinereus* calls analyzed to date were within a frequency range of 17.6 to 31.2 kHz, with call durations ranging between 9-12 ms. All *L. brachyotis* calls have been within a frequency range of 32.8 to 61.6 kHz, with call durations ranging from 6-8 ms. There appears to be considerable variation among the calls of different individuals of both species. Analysis of this variation is difficult because all recordings were from unmarked individuals. However, consistent differences are noted in the calls of *L. cinereus* from islands where *L. brachyotis* is present versus islands where *L. brachyotis* is absent. On Santa Cruz and San Cristobal (*L. brachyotis* present) the calls of *L. cinereus* have not exceeded a maximum frequency of 25.6 kHz (Y = 23.2 kHz). On Isabela and Floreana (*L. brachyotis* absent; calls from Santiago have not been analyzed at this writing), the maximum frequency of the calls of *L. cinereus* typically exceeds 30 kHz (Y = 30.7 kHz), and maximum frequencies have never been as low as those observed in any *L. cinereus* calls from Santa Cruz or San Cristobal. This pattern is as expected if competitive interactions with *L. brachyotis* have influenced the vocalization of *L. cinereus*.

* * * * *

The Energetics of Pteropodid Bats

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Studies in Papua New Guinea on the energy expenditure and temperature regulation of bats belonging to the genera *Paranyctimene, Nyctimene, Rousettus, Dobsonia,* and *Pteropus* are reported. These bats generally have effective temperature regulation, except at masses less than 50 g, when temperature regulation becomes variable. They are uniformly characterized by high basal rates of metabolism. At the largest masses *Pteropus* can conserve energy at low ambient temperatures by behavior means. This reduction in energy expenditure does not involve a reduction in core temperature, but appears to depend on peripheral vasoconstriction to diminish heat loss to the environment. Similar behavior is found in the red panda, tree-kangaroos, arboreal viverrids, lemurs, and a few tropical birds.

What, If Anything, Do Vampire Bats Have to Do With Screwworms?

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Opinions of both researchers and farmers vary as to the type and extent of relationships that exist between the common vampire bat *Desmodus rotundus* and the screwworm fly *Cochliomyia ominivorax*. In a survey of 25 cattle farms in three regions of Costa Rica, conducted from May 1992 and continuing through February 1993, I am collecting data concerning incidences of vampire predation and screwworm infestation (myiasis). Data includes sex, age and breed of cattle; habitat type in which the animal was located; and, for myiasis incidences, type of original wound in which the infestation occurred. Preliminary analysis indicates that of all vampire bites, (N = 1907) 0.87% were infested by the screwworm. Of all recorded cases of myiasis to date (N = 83) 19.27% occurred in vampire bites, 16.87% in the umbilicus of newborn calves, and 20.48% in wounds of unknown origin. The farms involved in this study are located in various Holdridge life zones, and further analysis will examine differences within similar zones.

* * * * *

Systematic Variation in Species of *Miniopterus* from Madagascar with Comparison to Some African Taxa

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Multivariate analysis of eight external and 17 cranial characters of *Miniopterus* from Madagascar and Africa indicated five groups based on size. Twenty-seven taxa were examined, nine from Madagascar and 18 from Africa. The largest group of *Miniopterus* includes *M. inflatus* from East and West Africa, *M. africanus* which is sympatric with *M. inflatus*, and a new species from Madagascar. *Miniopterus schreibersi* on Madagascar is represented by *M. s. majori*, but *M. natalensis* is not represented. One Madagascar taxon resembles *M. fraterculus* of Malawi and South Africa. Similar to *M. fraterculus* is an unnamed form, comparable in size to *M. vicinoir* of Zaire. Finally, the group of small *Miniopterus* includes five taxa from Madagascar, *M. manavi* and four unnamed taxa.

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Current Status of Mexican Free-tailed Bat Colonies (*Tadarida brasiliensis mexicana*) from Northern Mexico

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Mexican free-tailed bats migrate seasonally between the United States and Mexico and depend primarily on caves for their summer and winter roosts. Bat surveys were conducted at northern Mexico cave roosts during the winter of 1990 and summer of 1991 to determine at what time of year the roosts were being used and to document current colony size as compared to historical estimates. Results showed that five of ten colonies had declined by at least 90 %. It was surmised by evidence found in the caves that population declines were due to human activity in the caves and deliberate vandalism. An educational campaign has now been planned to target communities living near the five caves surveyed. Details of the cave surveys and the educational program being developed to protect the most affected colonies will be presented.

* * * * *

The Influence of Moonlight on the Activity of Little Brown Bats (*Myotis lucifugus*)

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Although it has often been reported that activity by insectivorous bats is negatively affected by moonlight for reasons of increased predation, there is little published data that directly evaluates this idea. The purpose of my study was to test the hypothesis that the activity levels of little brown bats (*Myotis lucifugus*) change with lunar conditions. I predicted that if bats perceive an increased risk of predation under conditions of brighter moon illumination, then their activity levels should be lower. Bat activity was assessed by monitoring echolocation calls using an ultrasonic bat detector in the Cypress Hills of Saskatchewan. The study site was chosen due to the fact that there are virtually no artificial light sources in the area. Since, some insects eaten by bats are known to be influenced by the lunar condition, I concurrently measured insect availability using sticky and suction traps located near bat activity sites to determine if activity patterns were correlated with changes in insect activity. Preliminary analysis of my data suggest that bright moon illumination does not negatively affect bat activity. Nights with low bat activity are more likely the result of low temperatures and the negative impact on insect availability. I conclude that oft cited idea of insectivorous bats reducing activity during bright moonlight due to an increased risk in predation may not be the case.

* * * * *

The Effect of Different Backgrounds on the Call Structure of a Gleaning Bat, *Macrotus waterhousii*

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Members of the genus, *Macrotus*, will use vision to locate prey despite having echolocation calls which are ideal for locating a hard target on a hard background. The use of cues other than echolocation to find prey is common among many other "whispering" gleaners, and it has been suggested that continued use of echolocation may be to assess the background on which they land. In this study, captive *Macrotus* were recorded as they approached food rewards surrounded by different amounts of clutter. An analysis of their echolocation calls in terms of repetition rate, call length, and power spectrum will attempt to test the hypothesis that the increased vigilance required to land on a cluttered surface will be reflected in a higher duty cycle, and increased intensity of the calls. A similar analysis will be made of their calls under varying light conditions to determine if any changes occur in call structure when visual cues are available.

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The Fundamental Form of the Chiropteran Skull

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The microchiropteran echolocative call may be emitted through either the nose or through the mouth. Embryos of these nasal and oral emitting forms are indistinguishable early in development, but differential growth of the brain and the pharynx eventually "distorts" the facial component of the skull by rotating the rostrum (palate) either below the basicranial axis to align the naso-pharynx with the direction of flight (nasal emission) or above the basicranial axis to align the oropharynx with the direction of flight (oral emission). The resulting dichotomy between oral and

nasal emitting skull forms is pervasive in light of the tremendous morphological diversity within the Order. Nasal emission has evolved independently in several Old World (*Rhinolophoidea*) and New World (*Phyllostomatoidea*) microchiropteran taxa. Quantitative osteological analyses show that developmental pathways and the subsequent shape of the adult skulls are grossly different between and within groups, however, radiographic cephalometry indicates that both groups share the same cranial infrastructure. Because this fundamental form of the nasal emitting skull is established *in utero*, I suggest that developmental heterochrony of the anterior basicranium has been a key innovation in the evolution of the Chiroptera.

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Foraging Activity Patterns of *Lasiurus cinereus* (Hoary Bats) and *L. borealis* (Red Bats)

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The foraging activity patterns of *Lasiurus cinereus* and *L. borealis* were monitored at Pinery Provincial Park, Ontario. Recordings of echolocation calls were made as the two species foraged around street lights within the park. The recordings were analysed to determine if there was temporal partitioning of foraging activity between the two species. My data indicate that *L. cinereus* and *L. borealis* foraged together during the night (n = 281, 15 minute samples between June and August 1992). Both species were most active as determined by the number of passes and feeding buzzes) between temperatures of 16 and 20oC. Although both species foraged together during the night and fed on similar insect types (mostly moths), competition for food was limited because *L. cinereus* feeds on larger prey items than *L. borealis*.

* * * * *

Changing the Look of High School Biology: Can Students Do Bats?

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Can high school age students become involved in field research? As a biology teacher interested in bat ecology, I wanted to offer students an opportunity to participate in bat research. Through a challenge cost-share grant arrangement with the U.S. Forest Service, students from Springfield High School were afforded the opportunity to assist in a preliminary census of bat populations for the Willamette National Forest in Oregon. The first phase of this project was to provide the Forest Service with some baseline data on the types and numbers of bats found at selected sites. The second phase will investigate day roosting patterns of several sensitive and threatened species to determine if roost site selection is dependent on Pacific Northwest old-growth forest. Understanding bat roosts selection sites should enable forest officials to make prudent wildlife decisions prior to timber sales. The first phase of the project succeeded in training students in the methods of sampling bats and locating adequate old-growth sites for radio tracking. Numerous bridges were identified as night roosting sites. These night roosting sites allow for sampling bats with minimal disruption. Backtracking from these night roost sites, with the aid of radio transmitters and light tags, we plan to monitor diurnal roost characteristics and activities at these roosts. The project has also resulted in the location of a large *Plecotus townsendii* maternity roost (approximately 60 females) on private property and we have secured protection of this site from future human disturbance. The advantages of carrying out this research with high school students are many. These include providing students with a window into the world of field

research or "real-world" experience, a pool of eager and competent researchers at a significantly reduced cost to the Forest Service, and providing students with the opportunity to educate other students and the public about the role of bats in the forest ecosystem. The project success can be measured in the fact that students assisted in the training of over fifteen Forest Service personnel in techniques for sampling and identifying bat populations. In addition, their presentation to the regional Forest Service managers was instrumental in renewing funding for continuation of this project in the future.

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The Effects of Typhoons on Flying Fox Populations in Samoa

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The Samoan Islands in the South Pacific have experienced two severe typhoons in less than two years, resulting in serious declines in the populations of the two Samoan flying fox species, *Pteropus samoensis* and *P. tonganus*. It was our expectation that *P. tonganus*, the more abundant species, and a taxon with a broad distribution in the southern Pacific, would have a higher survival rate than the rarer endemic, *P. samoensis*. Data collected after the storms strongly suggest the opposite--that populations of *P. tonganus* have likely declines by more than 90%, and those of *P. samoensis* by about 50%. The primary source of mortality for both species appeared to be increased predation, by people and domestic animals, after the storms. Four factors may partially explain the higher mortality rate for *P. tonganus*: 1) this species tends to form large, conspicuous aggregations, making it more vulnerable to hunting at roost sites than *P. samoensis*, which roosts in pairs or small groups; 2) hunger stressed *P. tonganus* were far more likely than *P. samoensis* to enter villages, where foraging on fallen fruit increased its vulnerability to humans, dogs, cats and pigs; 3) *P. samoensis* is partially folivorous, whereas *P. tonganus* does not appear to be, giving *P. samoensis* access to leaves as an emergency food resource at a time when most flowers and fruits were destroyed; 4) one of the primary food resources for *P. samoensis* is a forest liana, *Freycinetia reineckei*, which reaches peak flowering and fruiting during the hurricane season, and survived the storms largely intact. By contrast, a major food resource for *P. tonganus* during this season are the flowers of *Syzygium inophylloides*, a forest canopy tree, which was heavily damaged by the storm, and had already been greatly reduced by clearing of lowland forest. Cyclones are a recurring phenomenon in the Pacific, and thus a factor in the evolutionary history of island wildlife populations. Extensive clearing on Pacific islands, however, has reduced the extent of forest refugia, and wildlife populations are often depleted by other pressures (e.g., human hunting, introduced predators, and possibly introduced pathogens). In this context, the deleterious effects of cyclones are enhanced.

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Effect of Lactation and Milk Accumulation on Mammary Cell Differentiation in Lactating Bats

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Mammary cell differentiation was determined in lactating pipistrelle bats (*Pipistrellus pipistrellus*) by assay of key enzyme activities, and by measurement of protein and lactose synthesis rates in short-term tissue cultures. The degree of differentiation of mammary cells did not change significantly with the stage of lactation, but depended on the extent to which the gland was filled with milk. Key enzyme activities and *in vitro* synthesis rates were significantly higher in glands suckled immediately before tissue collection, compared with contralateral glands that

were engorged with milk. This indicates that mammary cell differentiation in lactating pipistrelles is regulated locally within each gland by a mechanism sensitive to milk accumulation, to an extent which obscures any underlying effect of stage of lactation.

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Bats in Hollow Redwoods: Seasonal Use and Role in Nutrient Transfer Into Old Growth Communities

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Guano deposition in suspended debris traps revealed extensive use by bats of basal hollows in living fire-scarred coast redwoods (*Sequoia sempervirens*) along stream corridors near Carmel, California. Though gross visual inspection of hollow litter *in situ* infrequently detected bat guano, all traps in an initial sample of 24 trees yielded some guano during the interval July-December 1991. The mass of guano recovered was positively correlated with tree diameter. Guano deposition (sampled biweekly) declined from late July to mid-December, but small amounts (0.01-3.67 g/interval) were still recovered from the subset of trees in mid-December. Torpid *Eptesicus fuscus* were found in crevices within several hollows in December 1990. A nursery colony of *Myotis yumanensis* (estimated at > 500) was observed in a large (476 cm DBH) redwood in July 1991. The array of guano morphotypes recovered suggest several additional species, notably *Antrozous pallidus*, occupy hollows at this site. Substantial fluctuations in deposition between sequential samples at a single tree indicate movement of bat aggregations among trees. Bat guano deposition could enhance the nutrient status of regularly occupied living trees and (as suggested by Kunz 1982), on a larger spatial scale, communities which offer bat refugia. Bats are not the only animals depositing excreta in or on hollow redwoods, but their numbers and daily foraging movement on a scale of kilometers, suggest they play, at least locally, a quantitatively significant role in upslope nutrient transport (10^1-10^2 g/tree/yr of guano containing 10% nitrogen against a background flux of approximately 2-3 g $N/M^2/yr$) into remaining old growth redwood habitats.

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Observations on Tent Construction by *Cynopterus brachyotis* and Comparisons with Tents Made by New World Bats

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Modification of leaves to form tents used as diurnal roosts has been reported for 14 New World bat species, all members of the phyllostomid tribe Stenodermini, one Old World pteropid, and one vespertilionid. During two brief visits to Baluran National Park in East Java, Indonesia, I observed tents made by a second pteropid, *Cynopterus brachyotis*. Tents were made on an understory palm, *Livistonia* sp., and on juvenile *Corypha* sp. palms. Both palms have very large, fan-shaped leaves, but differ in the development of the midrib; in *Corypha* a thick, well-defined midrib extends for a half to two-thirds of the length of the leaflets; in *Livistonia* there is little or no midrib. This difference in leaf structure is reflected in the form of the tent; *Corypha* tents are cut in a "long-necked flask" shape, whereas *Livistonia* tents are cut in a roughly circular or polygonal shape. The similarity between these Old World bat tents and some New World tents is striking. In Mexico and Guatemala, *Artibeus phaeotis* constructs tents from several fan palms, including *Crysophila argenteae* and, occasionally, *Sabal morrisiana.* Leaves of *Crysophila* lack a developed

midrib, whereas *Sabal* leaves have a thick midrib extending almost the entire length of the leaflets. The resulting tent shapes are roughly circular or polygonal on *Crysophila*, and "long-necked flask" shape on *Sabal*. *Artibeus phaeotis* has previously been reported to make tents from banana and heliconia leaves. Several species of tent-making bats show considerable plasticity in tent construction, using a variety of native and nonnative plants with different leaf shapes. For these species, tent structure appears to be a function of the leaf form and venation, rather than an innate response by the bat.

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Radio-Telemetric Assessment to Determine the Home Range and Foraging Areas of the Endangered Gray Bat (*Myotis grisescens*)

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In recent years there has been an increase in aquatic vegetation in lakes along the Tennessee River in the southeastern United States. The Tennessee Valley Authority (TVA) is investigating the possibility of reducing the amount of aquatic vegetation in these lakes. In an effort to assist the TVA in determining the impact of reduction of this vegetation on the endangered gray bat (*Myotis grisescens),* we monitored movement of bats among habitats using radiotelemetric techniques at Guntersville Reservoir, Jackson and Marshall counties, Alabama. Our objectives were to determine which habitats are used by the bats, to estimate the size of foraging areas, and to ascertain how much these foraging areas vary through the summer months. During five sampling sessions each summer, we attached 0.8 g radiotransmitters (Holohil Systems Ltd.) to 6-8 bats. Bats were monitored with radioreceivers (Wildlife Materials, Inc.) from five locations on the reservoir. Location , time, and weather conditions were noted for each bat detected. Although the data are too preliminary to determine preferences for specific foraging areas, data on movements indicate bats forage over a wide area each night. We have recorded movements of individual bats of >60 km/night and have determined that bats regularly move between caves that are >30 km apart.

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Neuroanatomical Studies of the Flight Muscles in the Little Brown Bat *Myotis lucifugus.*

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The sensory and motor systems of flying bats demand precise integration in order to accomplish the split-second maneuvers required to capture aerial prey and avoid obstacles. Our long-term goal is to elucidate the motor control system of the bat forelimb and make comparisons with the avian flight apparatus and those of terrestrial mammals. Here we present a preliminary test of the "motor control conservatism hypothesis". It is hypothesized that the motor control system of vertebrates will retain the same basic pattern regardless of the specialization of the limbs for tasks such as running, swimming or flying. Implicit in this hypothesis is the prediction that the motoneuron pools supplying the locomotor muscles are arranged topographically in a position similar to one another within the ventral horn of the spinal cord. As a preliminary test of this prediction, we used the neuronal tracer horseradish peroxidase(HRP) to selectively label all the motoneurons supplying the pectoralis and the deltoids of the little brown bat. The pectoralis muscle is the major depressor of the wing and its motoneuron pool lies in a longitudinal column of cells extending from the cervical spinal segments IV to a point just caudal to segment VII.

The motoneuron pool of the upstroke muscles (the deltoids) is positioned cranial and dorsolateral to the pectoralis pool, between segments III and VI. Although bats and birds acquired adaptations for flight independently, the motor control conservatism hypothesis predicts that the organization of the nervous input to the muscular system will be evolutionarily conserved and reflect that both groups evolved from reptilian ancestors whose neuro-muscular system was designed for terrestrial locomotion. For comparison, the pectoralis motoneuron pool of a terrestrial mammal, (*Mus musculus*) is located in the same topographic region of the spinal cord as that of *Myotis* despite major modifications of the forelimb in bats. Likewise pectoralis motor pool of the European starling,*Sturnis vulgaris*, lies in the comparable region of the spinal cord, with respect to the brachial plexus, lending support to the motor control conservative hypothesis.

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Utilization of Abandoned Mines by Bats in the Ouachita National Forest

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Twenty-seven abandoned mine drifts constitute one of the most unique habitats in and adjacent to the Ouachita National Forest, an area devoid of solutional caves. Nine species of bats have been found to utilize these mines during some portion of the year as sites for hibernation, night roosting, fall swarming activity, or day roosting prior to maternity colony formation. Diurnal and nocturnal examination of mine interiors during all seasons of the year, mist netting entrances, and use of double-frame harp traps have revealed the presence of the Southeastern bat (*Myotis austroriparius*), unreported from the area since 1955; the first record of the Seminole bat (*Lasiurus seminolus*) in the Ouachita Mountains; and a far greater presence of the Northern long-eared bat (*Myotis septentrionalis*) than suggested by extensive mist netting of riparian areas. Because these abandoned mines play an important role in the ecology of bats in the Ouachita National Forest and allow additional insight into the natural history and occurrence of bat species inhabiting the forest, a program to establish gates at the entrances of mines has been initiated in an effort to better manage and protect this unusual subterranean habitat and the associated bat resource.

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New International Center Established to Train Future Bat Conservation Leaders

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In April, 1991, Texas A&M University and Bat Conservation International signed an agreement to create the International Center for Bat Research and Conservation. This unique collaboration between a major academic institution and a specialized bat conservation organization will utilize the resources and talents of both to accomplish what neither could alone. Fundraising for operations is currently underway and the Center will endow faculty chairs, student fellowships, and research. The Center's approach to bat research and conservation will be innovative, utilizing a variety of disciplines to ensure its practical application. Center programs will include conservation biology, conservation education, public health, conservation policy and legislation, critical site identification and management, Latin American vampire bat control, biotechnology and human benefits, and information resources and training. The Center will produce well-trained conservation biologists who appreciate the human dimensions and complex economic factors involved in bat conservation issues. Center plans and current projects will be discussed.

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A Study of the Reproductive Success of Maternity Colonies of *Rhinolophus hipposideros*, The Lesser Horseshoe Bat, in Two Contrasting Roosts

Henry W. Schofield
University of Aberdeen, Aberdeen, Scotland

Rhinolophus hipposideros, the lesser horseshoe bat, is one of the most endangered European bats. Efforts to conserve this species have centered on the protection of its summer roosts, which are typically found in 19th 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 site roosts 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 temperatures within the roosts and within clusters of adults were measured hourly using Grant Squirrel data-loggers, additional information on climatic conditions over the study period was gathered from a local weather station. General observations were made in respect of the clustering behavior of the adults prior to, and following parturition. During the 1992 season, births were earlier and the young grew faster than in the previous year. This may be related to climatic factors, particularly the mean monthly temperatures from March to August. 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. This study will be continued over the 1993 season when the quality of the availability of feeding habitat around roost will also be investigated.

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Preliminary Anatomical Studies on the Chiropteran Hindlimb: Does the Digital Flexor Retinaculum Help Bats Get the Hang of It?

William A. Schutt, Jr.
Cornell University, Ithaca, NY

Hanging behavior in bats is a familiar phenomenon to chiroptologists and laymen alike. Most bats utilize their feet to suspend themselves in a head down or pendant position. Schaffer (1905 investigated the mechanisms involving in hanging and in an elegant and oft-quoted study, described a passive lock, employed upon contact of the hind claws with the substrate. Localized areas of digital flexor muscle tendons, studded with tubercles, were described. During digital flexion, the studded surfaces of the flexor tendons engaged transverse ridges located within the tendon retinaculum creating a passive lock and thereby eliminating the requirement for energy consuming muscular activity by the digital flexor muscles during hanging. Schaffer examined a total of seven microchiropteran species (from three families) with regard to the gross and microscopic anatomy of the thumb and third of fifth hindlimb digit. Oddly, Schaffer looked at the thumb of a single megachiropteran (where he described a similar passive hanging mechanism) but he did not report on the hindlimb digits. In this study, I describe the presence of digital flexor retinacula in the hindlimb of *Pteropus giganteus*. Additionally, I report on the hindlimb and digits of additional megachiropterans including, *Eidolon helvum, Hypsignathus monstrosus, Rousettus, sp.* and *Cynopterus sphinx*, comparing and contrasting these structures with those of representative microchiropterans. My aims in this study were: 1) to describe and compare the anatomy of the digital flexor retinaculum and related chiropteran hindlimb structures; 2) to re-examine the role of these structures in hanging behavior; and 3) to determine whether the presence of digital flexor retinacula represents a synapomorphy uniting the two chiropteran suborders. Data collected in this study are used to investigate the ecomorphology and biomechanics of the bat

hindlimb. I seek to determine whether observed variations in hindlimb morphology (such as those seen in the digital flexor retinaculum) can be correlated with ecological factors such as feeding and roosting behavior and/or biomechanical constraints imposed by variables such as body weight.

* * * * *

Activities Patterns of Northern Bats *(Eptesicus nilsonii)* in Northern Norway at 69°N, in the Continuous Mid-summer Daylight

J. R. Speakman, J. Rydell, P, I, Webb, G. C. Hays, J. P. Hayes, I. Hulbert, and R. McDevitt
University of Aberdeen, Aberdeen, Scotland and University of Lund, Lund, Sweden

Peak densities of insects are flying during the day, yet insectivorous bats are almost universally nocturnal. Adaptive explanations of chiropteran nocturnality include tradeoffs with the predation risk from diurnal predators, competition from aerial insectivorous birds and the risk of hyperthemia. In northern Norway, the northern bat *(Eptesicus nilsonii)* extends to at about 71°N (300 km north of the Arctic circle). During the summer at this latitude, it is continuously light for about 6 weeks around the summer solstice. In continuous light the advantages of darkness are absent and bats might then be expected to shift their activity to times when insects are most abundant. We visited an area south of Tromso at 69°N in July 1991 where we located two colonies of bats--at least one of which was a nursery colony (the first confirmed breeding record for bats in the Arctic). We recorded the activity patterns of the bats in these colonies, along with the activity cycles of bank swallows *(Riparia riparia)* at a nearby sand quarry, raptorial birds, aerial insects (by sweep netting) and physical factors such as temperature and light levels. Aerial insect availability was greatest in mid-morning 0700h and reached a minimum between 2200h and 0400 h. There was no clear cycle in activities of raptorial birds although slightly more than average were recorded between 0600 and 1200h. Bank swallows had a very clear diurnal rhythm with no birds out of the nest burrows between 2300 and 0300 and birds out of the burrows between 0300 and 0500 only sitting around preening. Between 0600 and 2200 feeding activity was almost constant. We only recorded bats active between 2200 and 0300h, coincident with the lowest aerial insect availabilities and the lowest activity of insectivore competitors. This may suggest competition from aerial insectivores was the primary factor influencing the activity patterns of these bats. However light levels were also lowest when the bats were active and the bats were extremely sensitive to increases in light levels during this period. We cannot therefore, discount the possibility that diurnal variations in predation risk is the primary factor. Risk of hyperthermia was an unlikely explanation for the observed patterns.

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Ecology of Blossom (*Macroglossus minimus, Synconycteris australis)* and Tube-Nosed Bats *(Nyctimene robinsonii)* (*Pteropodidae*) in Lowland Tropical Rainforest of Australia

Hugh J. Spencer and Brigitta H. Flick
Cape Tribulation Tropical Research Station
Cape Tribulation, Queensland, Australia

The recently proclaimed Wet Tropics World Heritage Area of far-north Queensland, Australia, is home to 6 genera of pteropodid bats, three of which are flying foxes, and the other three are the small blossom and tube nosed bats, and are relatively abundant, but their natural history remains almost completely unknown. Both blossom bats are virtually identical in size (15-17 gm), color and general appearance and appear to have much the same food preferences, both

nectar, pollen, fruit, and leaves, in defiance of the dogma. *Myctimene* (50 gm) is a fruit specialist, and there is no evidence of it visiting flowers, and it probably does not compete with the blossom bats. We have been observing the feeding and behavioral ecology of these animals over the last four years using mark-release studies and night-scope observation. It is evident that the blossom bats partition some feeding resources (chiefly flowers) but share other (fruit), but observing and tracking these animals in lowland rainforest is an almost intractable problem.

* * * * *

Rediscovery of Australia's Rarest Bat, *Murina florium*, the Insectivorous Tube-Nosed Bat in Lowland Rainforest in Far North Queensland, Australia

Hugh J. Spencer, Natasha Schedvin, and Brigitta H. Flick
Cape Tribulation Tropical Research Station, & Melbourne, Victoria, Australia

Murina florium, a vespertilionid bat that has only recently been captured in Australia in the upland rainforests of the wet tropics to the west of Cairns (Richards et al. 82) is considered to be the rarest vespertilionid bat in Australia and probably represents a relatively new arrival from New Guinea. The five previous captures of this bat have been at altitudes well over 1000 meters (approximately 3300 ft) and it has been considered that they were restricted to this altitude range and were specifically adapted to existence in cloud forests (manner of roosting, etc.). During a bat survey undertaken in December 1991-January 1992 in Rossville, Cedar Bay area of the We Tropics World Heritage area of far north Queensland, two of these bats were captured at an altitude of 200 meters in rainforest and about 250 km north of the earlier capture sites, thus, greatly extending the geographic altitudinal range of these most unusual bats, and indicating that much of the presumed rarity of animals and plants in this region stems from undercollecting.

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The Development of an Automatic Radiotracking System for Bats, Birds, and Small Mammals

Hugh J. Spencer*, Frank Saviglio and C. J. Kikkert,
*Cape Tribulation Tropical Research Station, Cape Tribulation, and
James Cook University, Townsville, Queensland, Australia

Following and plotting the movements of animals using radio tracking is conventionally done by two or three observers taking simultaneous bearings on an animal carrying a radio-tag, using directional antennas, and plotting the animal's position by triangulation. For fast moving animals such as bats and birds, one can't take bearings fast enough to get accurate locations unless the animals are stationary. To overcome this, we are developing an automatic radio-tracking system which can track up to five animals simultaneously to produce a map of movements which can be superimposed on an aerial photograph of the study area. It is based on the combined use of phase and time-of-arrival information from the free-running transmitters on the animal to compute their distances from the receiving stations.

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Infestation of a Spectacles Flying Fox *Pteropus conspicillatus*) Colony By Paralysis Ticks (*Ixodes holocyclus*) in Far-North Queensland, Australia

Hugh J. Spencer, Brigitta Flick and *Ann Johnson
Cape Tribulation Tropical Research Station, Cape Tribulation
and*Millaa Millaa, Queensland, Australia

Spetacled flying foxes are virtually restricted to the Wet Tropics World Heritage Area of far-north Queensland, centered around Cairns. Because of loss of habitat through clearing of the rain- and Melaleuca forests, and through roost destruction and shooting in colonies and orchards; these bats are now considered to be threatened. In 1986 dead and dying bats were found at an upland colony site, but these deaths were ascribed t agricultural chemicals. Four years later, it was found that the bats were infested by paralysis ticks, a tick endemic to Australia. In the summer of 1992-92, over 1,500 bats were recorded as dying from tick paralysis in one colony, Zilly Falls. The period of tick infestation coincides with the birth period, and it is considered that the bats acquire the ticks by being forced to forage on or close to the ground during times of food shortage, made worse by the fact that the area has been in drought for the last five or more years.

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Mass Changes in Hibernating Big Brown Bats, *Eptesicus fuscus*

Christine Sutter and George S. Bakken
Indiana State University, Terre Haute, IN

We have monitored the activity level and mass changes in a population of tagged big brown bats, *Eptesicus fuscus*, for the past two winters. The bats are tagged with subcutaneous electromagnetic transponders that contain a unique identifying number. An electromagnetic reader, stationed a the single entrance/exit hole, records every entrance/exit event of each tagged bat. In conjunction with the reader, weighs the bats as they enter and exit the hibernacula. These two pieces of data provide us with mass changes for individual bats on both a daily and a seasonal basis. Bats generally gained mass between exiting and reentering the hibernacula but consistently lost mass over the season.

* * * * *

Wing Bone Function and the Evolution of Skeletal Design: Results From an *In Vivo* Strain Analysis of *Pteropus poliocephalus*

Sharon M. Swartz[1], and Michael B. Bennett[2] and David R. Carrier[1].
[1]Brown University, Providence, RI, & [2]University of Queensland, Brisbane, Australia

Structural design can best be interpreted with empirical information concerning normal performance of bones during typical locomotor maneuvers. To better understand how the structural specialization of the bat wing skeleton related to its functional performance during flight, we measured the strains developed *in vivo* during normal, unrestrained flight. We attached rosette strain gauges to the dorsal and ventral midshafts of the humerus and radius of four wild-caught gray headed flying foxes (*Pteropus poliocephalus*; 400-750 g). We simultaneously recorded wing kinematics on videotape and bone strains via computer during flights along the length of a 30 m cage. There are three peaks in strain magnitude during each wingbeat cycle; this triphasic pattern is unique among vertebrates studied to date. The largest peak occurs at the middle of the downstroke, and it is followed by a second, somewhat smaller peak at the bottom of the downstroke and a third smaller peak at the top of the upstroke. Strain values for each wingbeat

reach their minimum values at approximately the middle of the upstroke and near the beginning of the downstroke. Principle strain orientation (mean of 20° off the bone's long axis for the humerus and 39° off axis for the radius) indicate that torsion is a critical element in the normal loading regime of these bones. This loading pattern appears to relate directly to structural features of bat wing bones; our comparative allometric analysis shows that some bat wing bones have larger diameters than would be predicted by body size alone. Furthermore, proximal wing elements (humerus and radius) have much thinner bone cortices than is typical for mammals, closely mimicking the pattern seen in birds and pterosaurs. Both of these features directly improve the ability of bat bones to resist torsional stresses, and suggest that thin cortical bone in wings may be as much an adaptation to resist torsional stress due to weight.

* * * * *

Foraging Ecology of the Little Brown Bat (*Myotis lucifugus*) at Chautauqua, NY

Daphne M. Syme
York University, Toronto, ON, Canada

There is increased concern about the decline of a large Little Brown Bat (*Myotis lucifugus*) population at Chautauqua, NY. The population is now estimated at around 10,000 individuals, though anecdotal evidence suggests it was larger 20 or more years ago. One possible reason for this decline is a decrease in food availability. I examined the current availability of food by collecting insects in emergence traps at three sites around Lake Chautauqua from June 25 to August 18, 1991 and 1992. The size of the total bat population was determined by locating all the roost sites and counting each colony as it exited its roost at dusk. The area in which these bats were feeding was determined through bat activity surveys of light tagged and reflective tagged bats using bat detectors. Since bats' energy requirements depend on their age, sex and reproductive state, the insect biomass required by the total bat population was determined by weekly trappings of bats to find out the sex ratio, age structure and reproductive state. To determine if the bats were feeding on the insects in emergence traps, faeces were collected from bats in the morning after insects were sampled. Also sticky traps and light traps were used to see if there were large numbers of insects with non-aquatic larval stages available to the bats. The insect samples indicate insufficient insect biomass to support the present bat population at Chautauqua. This low level of food, and the loss of roosts due to house renovation, may both contribute to the decline in the bat population.

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Predicting Fat Content from Body Volume or Density

Joseph A. Teramino
Eastern Michigan University, Ypsilanti, MI

Fat content is a potentially important predictor of a bat's daily thermoregulatory strategy, overwintering success, and perhaps reproductive success. Unfortunately traditional methods of determining fat content requires the death of the animal. Although instruments that measure fat content based on whole-body electrical conductivity are available, they are expensive and, at present are not reliable at body masses below 40 g. The only other in vivo method appears to be that of Kodoma and Pace which predicts the fat content based on measurements of volume and density. I explored the use of this technique with the big brown bat *Eptesicus fuscus*. Forty six bats were gathered from their roosts, at dawn, between may and August. they were sacrificed, weighed and vulomes were determined. The carcasses were then dried and fat extracted with petroleum ether. Preliminary analysis of the data suggests only moderate correlations between percent fat or total body fat and whole-body volume or density, with correlation coefficients ranging from 0.50 - 0.75.

Bat Conservation Internationl Progress Report

Merlin D. Tuttle
Bat Conservation International, Austin, TX

Bat Conservation International celebrated its 10th anniversary this year. Major achievements included the CBS airing of *Secret World of Bats,* significant progress toward establishing the New International Bat Research and Education Center with Texas A&M University, and completion of our Bracken Cave purchase. Graduate student research relevant to tropical rain forest conservation was supported in five countries. Twenty high chiefs and other government officials from American Samoa were hosted on a national parks tour to promote better understanding and cooperation for the Samoan national park project that will protect flying foxes. A collaborative effort to save bat colonies in mines was launched. New audiovisual and other materials were produced in both English and Spanish, symposia and workshops were hosted, and widespread media education continued.

* * * * *

Requisite Input for Detailed Computer Simulation of Bat Flight

Philip Watts
McGill University, Montreal, QC, Canada

There are many varied reasons why bat flight is of interest to zoologists and engineers. Clearly, the importance of bat flight engenders more and more detailed analyses of various aspects of flapping flight. One proposed project involves a detailed computer simulation of a flying bat wing. Such a project requires many inputs before any single species of bat can be properly simulated in flight. These inputs can be outlined as: 1) the skeletal structure of the wing, shoulder and leg with permissible articulations; 2) the points of attachment and relative sizes of muscles used to fly; 3) stress-strain constitutive relations for the deformation of skin membranes and bones in the wing; 4) the relative motion of the wing joints during the sequence of flapping flight to be simulated; 5) and quantified information on any outstanding physiological features that assist in flight. Apparently, the entire set of input data is currently unavailable for any single species of bat. Despite the lack of input data, it would be even more important if bat experts were to choose a handful of species that cover the spectrum of known bat species--for example, a species that typically hovers when feeding along with another that catches prey in flight. In this manner, the power of a potential computer simulation could provide valuable information on the comparative dynamics and energetics of a cross-section of bat species.

* * * * *

Natural History of the Indiana Bat in Michigan

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

In 1991, we discovered the first Indiana bat (*Myotis sodalis*) maternity colony in Michigan, only 15 km from the northern edge of the species' range. Throughout 1991 and 1992, we monitored patterns of roost-site selection. We discovered 8 roost trees in 1991 and 7 in 1992. All roost trees were green ash (*Fraxinus pennsylvanica*) despite the fact that 19% of the apparently suitable trees (based on the presence of loose and peeling bark) were silver maple (*Acer saccarhinun*). Average D B H of roost trees was 39 $\pm$ 2 (SE) cm; this was significantly greater and significantly less variable than the average D B H of nonroost green ash. Indiana bats more fre-

-quently used roost trees with high suitability values (Gardner, et al., 1991) than trees with low suitability ratings. Mean distance from a 1991 roost to the nearest roost in 1992 was 27 $\pm$ 7 m; overall distance from a roost to its nearest neighbor, regardless of year, was 22 $\pm$ 4m. Despite the closeness of all roosts, the bats in 1992 rarely used the 1991 roosts. We also monitored emergence behavior and how it was affected by population size and environmental variables.

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Vocal Advertisement and Group Foraging in Greater Spear-Nosed Bats

Gerald S. Wilkinson
University of Maryland, College Park, MD

Because greater spear-nosed bats *Phyllostomus hastatus*, have been reported to produce loud audible calls while foraging in flocks around sapacaia nut trees and swarming termites, I hypothesized that such calls given outside of a nursery roost might recruit conspecifics and possibly represent a rare example of active information transfer. I tested this idea by conducting playback experiments in Trinidad during April and May, 1992, outside of Guanapo cave, which contained over 500 adult *P. hastatus*. Each trial consisted of 5 min of silence, 5 min of playback from speakers positioned 20 m to the left or right of the cave mouth and 5 m above ground, and a final 5 min of silence. Two types of playbacks were tested: bat screech calls and screech owl (*Otus choliba*) calls both of which were recorded outside the cave. On a given night, we randomized playback type and position between trials and never conducted more than four trials at 30 min or greater intervals. During each five min period, we recorded number of calls and bat passes by the speaker using IR illumination. Both response variables exhibited significant increases during bat, but not owl, playbacks. Video and sound records made at the cave mouth show that *P. hastatus* departures and screech calls occur in clusters throughout nights without playbacks. Spectrographic analysis indicates that screech calls have a broad bandwidth with little variation in frequency, but substantial variation in inter-note interval. The possibility that these calls convey information about individuals and coordinate departures of unrelated females from the same roosting group will be discussed.

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Tree Roost Interactions of *Desmodus rotundus* with Several Frugivorous Bat Species

Tim Wohlgenant
Yale School of Forestry and Environmental Studies, New Haven, CT

The common vampire, *Desmodus rotundus*, is known to share cave and tree roosts with many species of frugivorous and insectivorous bats. Where caves are uncommon, hollow trees serve as the principal roosting resource for Neotropical bats. In many areas of Latin America, tree roosts may be scarce due to human agricultural and grazing pressures. In such areas, tree roosting bats may compete for roosts and for preferred space within roosts. Through captive experiments and field observations, I studied the roosting interactions of *Desmodus rotundus* with several common frugivorous bat species in Guanacaste, Costa Rica; *Phyllostomus discolor, Carollia perspicillata, Artibeus jamaicensis, and Sturnira lilium*. In a 3 x 5 x 3 meter flight enclosure containing artificial 'tree' roosts, I observed that no bat species shared roosts when 'preferred' roosts types were available. However, when roosts were limited, captive vampires displaced *Sturnira lilium* but shared roosts with the similarly-sized *Phyllostomus* species. Field observations revealed a low frequency of roost sharing between vampires and other bat species although the vast majority of hollow trees encountered along forest transects were occupied by bats. In order to quantify vampire roost preference parameters, measurements were made of all 44 tree roosts encountered.

News from our subscribers and colleagues

From The Netherlands

Wim Bergmans sent us the following very interesting piece on "Bats in Fiction."

In 1952 Leonard Dubkin wrote the novel "The White Lady", in which an albino *Myotis lucifugus* is the dominant character. The book was published by G. P. Putman's Sons, New York. It may not be a very good novel as such, but of course I enjoyed reading it. Its structure is very simple and it does not go beyond a quiet episode in the life of a quiet young man who, living in Chicago, discovers a bat colony while walking his dog, and witnesses the birth of an albino bat, which by its colour enables him to recognize it during later visits to the colony and study its habits. To prevent his later wife from saying, as his mother had often done "that it was unnatural for a grown man to leave a good comfortable home to spend the evening with bats" he abandoned his interests in bats. Much earlier, I don't know when, Charles Derennes wrote a book in French which also appeared in translation in 1924 as "The Life of the Bat", published by Harper and Brothers in New York and London. Like Dubkin, Derennes undoubtedly makes use of personal observations and study. But his book is less a novel: it is rather a philosophical narrative in which encounters with bats frequently lead to deep thoughts about human life and destiny. A third example of bats in fiction is Don DeLillo's "Ratner's Star"(published by Alfred A. Knopf, Inc., in 1976, and by Vantage, London etc., in 1991). Many modern writers make mention of bats to add a touch of mystery or indeed, horror, to particular events described by them. DeLillo's use of bats, or actually bat research - the Zoologist Maurice Wu observing *Megaderma* and its cannibalistic habits in a cave system - may possibly be taken as a metaphore for the search of science or mankind, for the final truth: Maurice Wu gets stuck when trying to crawl through a narrow passage in the cave, panics, and finally frees himself easily by squeezing backward. Personally, I would appreciate very much to hear about other works of fiction in which bats play an important role, and I hope to report on others in the future.

From Saskatchewan

Mark Brigham informs us that;

Ryan Csada is scheduled to defend his M. Sc. on the use of torpor by breeding poorwills by the end of February and is then planning on heading east to York University where he will pursue a Ph. D. degree in September with someone named Fenton.

Matina Kalcounis finished off her honours thesis on habitat use by pregnant *Myotis lucifugus* before Christmas. She intends to begin an M. Sc. here beginning in May, working on natural cavity site selection by *Eptesicus* in the cypress Hills.

Rick Espie will be completing his field work towards his M. Sc. studying the impacts of fluctuating water levels on a population of endangered Piping Plovers at Lake Diefenbaker, SK.

Glenn Sutter is getting ready to begin field work for his Ph. D. He is looking at the effects of ecological crunches(in this case drought) on passerines. It is likely that some form of Longspur will be the primary focus of his study.

Kaili Wang has recently joined the lab from the Peoples Republic of China. She will be working in the cypress Hills and plans on looking at habitat use by poorwills.

Scott Grindal presently harassing orangutans somewhere in Borneo will be returning to begin work on an M.Sc. project sponsored by Forestry Canada. He will be looking at the impact of logging on bats in a demonstration forest near Nelson, BC. This project is being done in collaboration with Robert Barclay of Calgary who will also have students involved.

Don Thomas of Universite de Sherbrooke visited for four days at the end of February as a plenary lecturer for the 27 Annual Prairie University Biology Seminars meeting held at the University of Regina February 26 to 28. Over 100 registrants from Universities in Manitoba, Saskatchewan, and Alberta attended. Don also presented a seminar to the department and hung around for four days enlightening all. Fears that the poor and innocent students exposed to four days of ovine jokes might have been forever warped were happily unfounded!

From Albuquerque, New Mexico

A course titled **BATS** (pronounced "baaaaaats") is being offered this spring semester at the University of New Mexico's Department of Biology. The course is being taught by graduate student Mike Balistreri and the Museum of Southwestern Biology's collection manager Bill Gannon. Guest lecturers include Scott Altenbach, Jim Findley, and Ted Fleming. The most surprising part of this course is that the instructors estimated enrollment would be about 10-12 "hardcore" bat students, but currently there are 26 biology students(11 graduate and 15 advanced undergrads) enrolled. The undergraduate students are learning about various completed and ongoing research projects in bat ecology, evolution, systematics, and natural history. These participants are expected to read scientific papers, complete a research project in an area of interest to them, and take part in field research projects. Graduate students are expected to report on their research progress to the class in the form of a presentation. They have selected and supplied material to the class to lead discussions of their research topic. All students are asked to attend regular lectures, learn key characters of bat families of the world and bat species of the southwest, and to produce a paper at the end of the term. The natural history aspect of the course encourages the dissemination of knowledge of bats to the general public. We intend to be able to respond to questions and other queries of the general public and also to investigate reports of bats and their activities. This course is open to all students, those interested in research in bat biology, and those students wishing to become familiar with these mammals that may otherwise be mysterious to them. Look for a few Mammalian Species accounts, and an increase in both article and notes submissions to journals this summer and fall. Bat Biology is alive in New Mexico.
Submitted by Bill Gannon.

We would like to hear more news about this exciting program, and hopefully a few presentations as well at the Symposium in Gainesville in October. GRH.

From Poland

W. Harmata informs us that he is continuing to work on the hibernating bats in "Fortress Cracow" and is presently preparing some of his findings for publication. His observations cover the time period from 1954 to 1992, and include observations on the ecology, ethology and phenology of the bats hibernating in this underground fortification near the city of Cracow. He has found ten species of bats hibernating from September to May in this hibernaton site. We look forward to the appearance of this work with great interest. GRH.

From Florida

Carlos Iudica sends the following...

"I recently participated in a project which was a component of an "Integrated Conservation Program of the Yungas in Argentina"- part of the CRCYT/CONICET "Biodiversity of the Vertebrates of the Yungas Forest Program." The primary objective of my research was to determine how the structural patterns of the bat community are affected by human disturbance. The purpose was accomplished by conducting a comparative study of bat communities present in different habitat types(disturbed and undisturbed forests) during the dry season and the rainy season in Las Yungas, Argentina. A secondary but no less important goal of this project, throughout the field research, was to begin a informal training course in ecology field techniques. Before going to Argentina, I made a short stop in Panama where Rafeal Samudio(a graduate student at the University of Florida) very kindly gave me some valuable "hands on" practice with bats(a first time for me) of various sizes and temperments.

The study site was in the sub-tropical rain forest in Jujuy Province, Argentina, close to the Bolivian border. Each month beginning in July, 1992 and ending in December(except August when I was ill), we sampled the bat community in each forest type for six or seven nights using five or six mist nets each night. My field assistants and I have characterized two distinct physiognomies; undisturbed forest and human-disturbed forest most commonly found in areas where foraging activities take place. Floristic composition(to assess fruit availability) and structural characteristics of the vegetation (to estimate flyways, and roost-

ing and feeding sites) provided data to evaluate the importance of these attributes for the bat community.

Throughout the field work phenological data [spatial and temporal variation in fruit production, flowering and fruiting phenology, and fruit availability] was recorded every fifteen days along transect lines on each forest type to assess seasonal availability of fruit resources. Temperature, barometric pressure, and rainfall were periodically recorded for all sample sites. We also collected fecal pellets of insectivorous bats, assessed insect availability and proportion by taxa, and collected seeds from fecal samples and ripe fruit for later identification in the lab.

All of the above described tasks were used as part of the training course in field techniques. This organization of the field research gave the students the opportunity to receive an informal training course in ecological field techniques, and simultaneously provide me with assistance in the field. The student-assistants also had the opportunity to identify study topics for future graduate dissertations. I was especially interested in involving Argentinean biologists who were interested in ecology and the conservation of montane rain-forest ecosystems. Two undergraduate students participated in the field work and informal course and it was my intention the project would culminate with an intensive independent study project, planned and implemented by each participant. Armed with such skills and experience, I hoped to encourage participants to pursue further their own research in the region as graduate students.

During this time I also gave lectures to teachers and professors in the area about ecology, conservation and the importance of bats in the local ecosystems. I also contributed three radio-TV interviews and published three articles in local newspapers.

The results obtained from this study will be helpful in efforts in bat conservation in these areas and to the general understanding of these interesting and threatened eco-systems. Furthermore, these results will pro-vide a foundation from which conservation efforts of biological resources can be pursued more effectively. It will encourage future conservation activities in Argentina's sub-tropical montane rain forest as well. Hopefully it will stimulate the local people, the state and federal governments, and conservation organizations to take a greater interest in the perpetuation of biodiversity in the Yungas region.

From South Dakota

The U. S. Forest Service is currently surveying and evaluating potential roosting sites for bats, primarily represented by mine sites and natural caves, within the Black Hills National Forest(Nemo Ranger District, South Dakota). Goals of the program are to determine locations of key roosting habitat, species associated with each site, site usage (hibernaculum/maternity/ nursery, etc.), and development of long term management plans. Methods of collecting data are interior survey of sites (where possible), netting, banding, and monitoring with ultrasonic bat detectors. Additionally, specific plans for sites deemed hazardous will be prepared. Recent ad -ditional funding from South Dakota's Department of Game Fish and Parks will increase the scope of the project enabling a more complete assessment of bats in the northern Black Hills. A preliminary report has been prepared. Additional information may be obtained by contacting William Aney or Joel Tigner at Nemo Ranger District, Black Hills National Forest, P.O. Box 407, Deadwood, SD 57732-0407. Submitted by Joel Tigner

REQUEST

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

Tom Griffiths and Roy Horst

FREE BANQUET TICKET

The first person to send in a NEWS item after this date will receive a free banquet ticket at the next Symposium in Gainesville, Florida in October. GRH.

RECENT LITERATURE

Authors are requested to send reprints of their papers to the Editor for Recent Literature (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.

ANATOMY

Anthony, E. L. P., K. Neel, M. E. Cicione. 1992. Fine structural characteristics of the zone of contact between the lower infundibular stem and the pituitary pars distalis in the little brown bat, *Myotis lucifugus*. Anatomical Record, 234: 116-128. [Dept. Biol., Rhode Island College, 600 Mt. Pleasant Ave., Providence, RI 02908]

Bhatnagar, K. P., I. H. Fentie, and J. R. Wible. 1992. Are the mandibular lateral incisors of the hairy-legged vampire bat, *Diphylla ecaudata*, really 7-lobed? Mammalia, 56: 251-254. [Dept. Anatomical Sci. & Neurobiol., Univ. Louisville School Med., Louisville, KY 40292]

Freeman, P. W. 1992. Canine teeth of bats (Microchiroptera): size, shape and role in crack propagation. Biological Journal of the Linnean Society, 45: 97-115. [Div. Zool., Univ. Nebraska State Mus., Lincoln, Nebraska 68588-0514]

Kucuk, B., and K. Abe. 1992. Microstructures of the osseous spiral laminae in the bat cochlea - a scanning electron microscopic study. Archives of Histology and Cytology, 55: 315-???. [Abe: Dept. Anat., Hokkaido Univ. School Med., Kita 15, Nishi 7, Kita Ku, Sapporo, Hokkaido 060, Japan]

Perrin, M. R., and J. J. Hughes. 1992. Preliminary observations on the comparative gastric morphology of selected Old World and New World bats. Zeitschrift fur Saugetierkunde, 57: 257-268. [Dept. Zool. & Entomol., Univ. Natal, POB 375, Pietermaritzburg 3200, South Africa]

Sevick, S. H., and E. H. Studier. 1992. Change in forearm curvature throughout the summer in female big brown bats. Journal of Mammalogy, 73: 866-870. [Dept. Biol., Univ. Michigan at Flint, Flint, MI 48502-2186]

BEHAVIOR

Balcombe, J. P., and G. F. McCracken. 1992. Vocal recognition in Mexican free-tailed bats: do pups recognize mothers? Animal Behaviour, 43: 79-87. [People for the Ethical Treatment of Animals, PO Box 42516, Washington, DC 20015]

Faure, P. A., and R. M. R. Barclay. 1992. The sensory basis of prey detection by the long-eared bat, *Myotis evotis*, and the consequences for prey selection. Animal Behaviour, 44: 31-40. [Div. Ecol., Dept. Biol. Sci., Ecol. Group, Univ. Calgary, Calgary, Alberta, Canada T2N 1N4]

Lewis, S. E. 1992. Behavior of Peter's tent-making bat, *Uroderma bilobatum*, at maternity roosts in Costa Rica. Journal of Mammalogy, 73: 541-546. [Dept. Ecol., Evol., & Behav., 318 Church St., Univ. Minnesota, Minneapolis, MN 55455]

Wilkinson, G. S. 1992. Communal nursing in the Evening bat, *Nycticeius humeralis*. Behavioral Ecology and Sociobiology. 31: 225-236. [Dept. Zool., Univ. Maryland, College Park, MD 20742]

CONSERVATION / REHABILITATION

Barnard, S. M. 1992. How to artificially hibernate bats. Wildlife Rehabilitation Today, Winter '92: 44. [Dept. Herpetology, Zoo Atlanta, Atlanta, GA or 6146 Fieldcrest Dr., Morrow, GA 30260

Barnard, S. M. 1992. Rehabilitating bats: caring for orphans. Wildlife Rehabilitation Today, Spring '92: 45-47.

Barnard, S. M. 1992. Caring for non-releasable adult bats. Wildlife Rehabilitation Today, Summer '92: 20-27.

Barnard, S. M. 1992. Rehabilitating bats: emergency and temporary care. Wildlife Rehabilitation Today, Fall '92: 46-49.

Barnard, S. M., and N. Sachs. 1992. The successful hand rearing of two orphaned vampire bats (*Desmodus. rotundus*). Animal Keeper's Forum, 19: 280-288.

Palmeirim, J. M., and L. Rodrigues. 1992. Plano Nacional de Conservação dos Morcegos Cavernícolas (National Cave Bat Conservation Plan). Estudos de Biologia e Conservação de Natureza 8 SNPRCN, Lisboa. (ISBN 972-9034-92-3) [Rodrigues: Ministério do Ambiente e dos Recursos Naturais, Serviço Nacional de Parques, Reservas e Conservação da Natureza, Rua da Lapa 73, 1200 Lisboa, Portugual]

Sheffield, S. R., J. H. Shaw, G. A. Heidt, and L. R. McClenaghan. 1992. Guidelines for the protection of bat roosts. Journal of Mammalogy, 73: 707-710. [Guidelines prepared by the Protection of Bat Roost Guidelines Subcommittee of the Conservation of Land Mammals Committee of the American Society of Mammalogists]

CYTOLOGY / BIOCHEMISTRY

Bergum, P. W., and S. J. Gardell. 1992. Vampire bat salivary plasminogen activator exhibits a strict and fastidious requirement for polymeric fibrin as its cofactor, unlike human tissue-type plasminogen activator - a kinetic analysis. Journal of Biological Chemistry, 267: 17726-17731. [Gardell: Dept. Biol. Chem., Merck, Sharp, & Dohme, Ltd., West Point, PA 19486]

Fernandez, A. M., E. Muniz, R. R. Gragera, and R. Martinez-Rodriguez. 1992. Immunocytochemical localization of GnRH in the hypothalamus of the bat *Miniopterus schreibersii schreibersii*. Journal für Hirnforschung, 33: 195-202. [Dept. Cell Biol., Complutense Univ. Madrid, Planta 12, Ciudad Univ. S-N, E. 28040 Madrid, Spain]

Hare, T. R., and S. J. Gardell. 1992. Vampire bat salivary plasminogen activator promotes robust lysis of plasma clots in a plasma milieu without causing fluid phase plasminogen activation. Thrombosis and Haemostasis, 68: 165-169. [Gardell: Dept. Biol. Chem., Merck, Sharp, & Dohme, Ltd., West Point, PA 19486]

Hernandez, A., and C. M. DelRio. 1992. Intestinal disaccharidases in 5 species of phyllostomid bats. Comparative Biochemistry and Physiology B: 103: 105-112. [Fac. Ciencias, Univ. Guadalajara, Jalisco, Mexico]

Kratzschmar, J., B. Haendler, P. Bringmann, H. Dinter, H. Hess, P. Donner, and W. D. Schleuning. 1992. High-level secretion of the four salivary plasminogen activators from the vampire bat *Desmodus rotundus* by stably transfected baby hamster kidney cells. Gene, 116: 281-284. [Schleuning: Schering AG, Inst. Cellular & Molecular Biol., Res. Labs., Postfach. 650311, W-1000 Berlin 65, Germany]

Singer, G. A. M., T. Kleinschmidt, J. D. Pettigrew, and G. Braunitzer. 1992. Communication on hemoglobins .166. The primary structure of the hemoglobin from the tomb bat (*Taphozous georgianus*, Microchiroptera). Biological Chemistry Hoppe-Seyler, 373: 937-???. [Kleinschmidt: Max Planck Inst. Biochem., Am Klopferspitz, W-8033 Martinsried, Germany]

DEVELOPMENT

Adams, R. A. 1992. Comparative skeletogenesis of the forearm of the little brown bat (*Myotis lucifugus*) and the Norway rat (*Rattus norvegicus*). Journal of Morphology, 214: 251-260. [Dept. Environmental, Population, & Organismic Biol., Univ. Colorado, Boulder, Colorado 80309]

Funakoshi, K., Y. Fukue, and S. Tabata. 1992. Tooth development and replacement in the Japanese greater horseshoe bat, *Rhinolophus ferrumequinum nippon*. Zoological Science, 9: 445-450. [Biol. Lab., Kagoshima Keizai Univ., Kagoshima 89101, Japan]

DISTRIBUTION / FAUNAL STUDIES

Ibanez, C., A. Guillen, R. Fernandez, J. L. Perez, and S. I. Guerrero. 1992. Iberian distribution of some little known bat species. Mammalia, 56: 433-444. [CSIC, Estacion Biol. Donana, Apartado 1056, E-41080 Seville, Spain]

Robinson, M. F. 1992. Distribution of the serotine bat in Cambridgeshire, past and present. Nature in Cambridgeshire, 34: 24-27. [Sub-department of Veterinary Anat., Univ. of Cambridge, Tennis Court Rd., Cambridge CB2 IQS, England]

Stebbings, R. E., and M. F. Robinson. 199?. The enigmatic serotine bat - a case of human dependency. British Wildlife, ??: 261-265. [see address for Robinson given above]

ECHOLOCATION

Jones, G., T. Gordon, and J. Nightingale. 1992. Sex and age differences in the echolocation calls of the lesser horseshoe bat, *Rhinolophus hipposideros*. Mammalia, 56: 189-194. [Dept. Zool., Univ. Bristol, Woodland Rd., Bristol BS8 1UG, Avon, England]

Maekawa, M., D. Wong, and W. G. Paschal. 1992. Spectral selectivity of FM-FM neurons in the auditory cortex of the echolocating bat, *Myotis lucifugus*. Journal of Comparative Physiology A, 171: 513-522. [Wong: Dept. Anat., School of Med., Indiana Univ, Indianapolis, IN 46202]

Shannon-Hartman, S., D. Wong, and M. Maekawa. 1992. Processing of pure-tone and FM stimuli in the auditory cortex of the FM bat, *Myotis lucifugus*. Hearing Research, 61: 179-188. [Wong: Dept. Anat., School of Med., Indiana Univ, Indianapolis, IN 46202]

Tanaka, H., D. Wong, and I. Taniguchi. 1992. The influence of stimulus duration on the delay tuning of cortical neurons in the FM bat, *Myotis lucifugus*. Journal of Comparative Physiology A, 171: 29-40. [Wong: Dept. Anat., School of Med., Indiana Univ, Indianapolis, IN 46202]

Vater, M., H. Habbicht, M. Kossi, and B. Grothe. 1992. The functional role of GABA and glycine in monaural and binaural processing in the inferior colliculus of horseshoe bats. Journal of Comparative Physiology A, 171: 541-???. [Inst. Zool., Univ. Regensburg, Universistrasse 31, W-8400, Regensburg, Germany]

Vater, M., M. Kossi, and A. K. E. Horn. 1992. GAD-immunoreactivity and GABA-immunoreactivity in the ascending auditory pathway of horseshoe and mustached bats. Journal of Comparative Neurology, 325: 183-206.

ECOLOGY

Brigham, R. M., H. D. J. N. Aldridge, and R. L. Mackey. 1992. Variation in habitat use and prey selection by Yuma bats, *Myotis yumanensis*. Journal of Mammalogy, 73: 640-645. [Dept. Biol., Univ. Regina, Regina, Saskatchewan, Canada S4S 0A2]

Clark, D. R., Jr., and C. M. Bunck. 1991. Trends in North American small mammals found in common barn-owl (*Tyto alba*) dietary studies. Canadian Journal of Zoology, 69: 3093-3102. [U.S. Fish and Wildlife Serv., Patuxent Wildlife Res. Ctr., Laurel, MD 20708]

Dunning, D. C., L. Acharya, C. B. Merriman, and L. Dal Ferro. 1992. Interactions between bats and arctiid moths. Canadian Journal of Zoology, 70: 2218-2223. [Dept. Biol., West Virginia Univ., P. O. Box 6057, Morgantown, WV 26506]

Fenton, M. B. 1992. Wounds and the origin of blood-feeding in bats. Biological Journal of the Linnean Society, 47: 161-172. [Dept. Biol., York Univ., North York, Ontario, Canada M3J 1P3]

Fenton, M. B., L. Acharya, D. Audet, M. B. C. Hickey, C. Merriman, M. K. Obrist, D. M. Syme, and B. Adkins. 1992. Phyllostomid bats (Chiroptera: Phyllostomidae) as indicators of habitat disruption in the neotropics. Biotropica, 24: 440-446.

Fischer, E. A. 1992. Foraging of nectarivorous bats on Bauhinia ungulata. Biotropica, 24: 579-582. [Inst. de Biologia, Univ. Estadual de Campinas, 13081 Campinas, São Paulo, Brasil]

Foster, M. S. 1992. Tent roosts of Macconnell's bat (*Vampyressa macconnelli*). Biotropica, 24: 447-454. [Nat. Ecol. Res. Ctr., Fish & Wildlife Service, National Mus. Nat. Hist., Washington, D.C. 20560]

Grindal, S. D., T. S. Collard, R. M. Brigham, and R. M. R. Barclay. 1992. The influence of precipitation on reproduction by *Myotis* bats in British Columbia. American Midland Naturalist, 128: 339-344. [Dept. Biol. Sci., Div. Ecology, Behav. Ecol. Grp., Univ. Calgary, Calgary, Alberta, Canada T2N 1N4]

Hays, G. C., J. R. Speakman, and P. I. Webb. 1992. Why do brown long-eared bats (*Plecotus auritus*) fly in winter. Physiological Zoology, 65: 554-567. [Dept. Zool., Univ. Aberdeen, Aberdeen AB9 2TN, Scotland]

Kurta, A., and J. A. Teramino. 1992. Bat community structure in an urban park. Ecography, 15: 257-261. [Dept. Biol., Eastern Michigan Univ., Ypsilanti, MI 48197]

Maier, C. 1992. Activity patterns of pipistrelle bats (*Pipistrellus pipistrellus)* in Oxfordshire. Journal of Zoology, 228: 69-80. [24 Chestnut Ave., Oxford, England]

Navo,K.W., J. A. Gore, and G. T. Skiba. 1992. Observations on the spotted bat, *Euderma maculatum*, in northwestern Colorado. Journal of Mammalogy, 73: 547-551. [Colorado Div. Wildlife, 6060 Broadway, Denver, CO 80216]

Rydell, J. 1992. Occurence of bats in northernmost Sweden (65o N) and their feeding ecology in summer. Journal of Zoology, 227: 517-???. [Dept. Ecol., Univ. Lund, S-22362 Lund, Sweden]

Schwarting, H. 1992. Ansiedlungversuch von Fledermäusen in Streuobstwiesen. Natur und Museum, 122: 164-166. [Königsberger Str. 69, D-6452 Hainburg, Germany]

Schwarting, H. 1992. Eine reviertreue Mausohr-Fledermaus. Natur und Museum, 122: 187-191.

Whitaker, J. O., and B. Lawhead. 1992. Foods of *Myotis lucifugus* in a maternity colony in central Alaska. Journal of Mammalogy, 73: 646-648. [Dept. Life Sci., Indiana State Univ., Terre Haute, IN 47809]

GENETICS

Baker, R. J., M. Maltbie, J. G. Owen, M. J. Hamilton, and R. D. Bradley. 1992. Reduced number of ribosomal sites in bats: evidence for a mechanism to contain genome size. Journal of Mammalogy, 73: 847-858. [The Museum, Texas Tech Univ., Lubbock, TX 79409]

MANAGEMENT IN CAPTIVITY

Barnard, S. M., and S. M. Soloway. 1992. A note on the castration of two giant Indian fruit bats (*Pteropus giganteus*). Animal Keeper's Forum, 19: 398-400. [Dept. Herpetology, Zoo Atlanta, Atlanta, GA or 6146 Fieldcrest Dr., Morrow, GA 30260]

PALEONTOLOGY

Habersetzer, J., and G. Storch. 1987. Klassifikation und funktionelle Flügelmorphologie Paläogener Fledermäuse (Mammalia, Chiroptera). Courier Forsch., Inst. Senckenberg, 91: 117-150. [Forschungsinst. Senckenberg, W-6000 Frankfurt, Germany]

Habersetzer, J., and G. Storch. 1987. Ecology and echolocation of the Eocene Messel bats. Pp. 213-233 in V. Hanák, J. Horácek, and J. Gaisler, Eds. European Bat Research, Charles Univ. Press, Praha.

Habersetzer, J., and G. Storch. 1992. Cochlea size in extant Chiroptera and Middle Eocene microchiropterans from Messel. Naturwissenschaften, 79: 462-466. [Forschungsinstitut Senckenberg, W-6000 Frankfurt, Germany]

PARASITOLOGY

Guerrero, R. 1992. Catalog of Labidocarpidae (Acarina, Listrophoroidea), parasites of Neotropical bats (Mammalia, Chiroptera) [rough translation from title in Spanish by E. Garcia]. Studies on Neotropical Fauna and Environment, 27: 19-42. [Fac. Ciencias, Inst. Zool. Tropic., Univ. Cent. Venezuela, Apdo. 47058, Caracas 1041A, Venezuela]

PHYSIOLOGY

Ando, K., and S. Arai. 1992. Neuropeptide-Y innervation of cerebral arteries in microchiropteran bats. Zoological Science, 9: 823-???. [Biol. Lab., Kyushu Sangyo Univ., Higashi Ku, Fukuoka 813, Japan]

Law, B. S. 1992. The maintenance nitrogen requirement of the Queensland blossom bat (*Syconycteris australis)* on a sugar pollen diet - is nitrogen a limiting resource. Physiological Zoology, 65: 634-648. [School of Biol. Sci., Univ. Sydney, Sydney, NSW 2006, Australia]

Mathieu-Costello, O., J. M. Szewczak, R. B. Logemann, and P. J. Agey. 1992. Geometry of blood-tissue exchange in bat flight muscle compared with bat hindlimb and rat soleus muscle. American Journal of Physiology, 262: R955-R965.

POPULAR STUFF

Brooke, A., and J. Scott Altenbach. 1992. Sure-footed bats. Natural History, 101, 60-63. [text by Brooke; photos by Altenbach]

Couffer, J. 1992. Bat Bomb - World War II's Other Secret Weapon. Univ. Texas Press, Austin, 288 pp. [$24.95]. [Thanks to Arthur Greenhall for sending this in.]

Ezzell, C. 1992. Cave creatures - peering into the murky world of one of North America's most common bats. Science News, 141: 88-90.

REPRODUCTION

Badwaik, N. 1992. Seasonal migration of 2 species of Microchiroptera in relation to breeding cycles. Mammalia, 56: 287-290. Inst. Sci., Dept. Zool., Nagpur 440001, Maharashtra, India]

SYSTEMATICS

Ammerman, L. K., and D. M. Hillis. 1992. A molecular test of bat relationships: monophyly or diphyly? Systematic Biology, 41: 222-232. [Dept. Zool., Univ. Texas at Austin, Austin, TX 78712-1064]

Koopman, K. F. 1992. Taxonomic status of *Nycteris vinsoni* Dalquest (Chiroptera, Nycteridae). Journal of Mammalogy, 73: 649-650. [Dept. Mammalogy, Amer. Mus. Nat. Hist., Central Park West at 79th St., New York, NY 10024]

Linares, O. J., and A. Escalante. 1992. A new species of the South American flat-headed bat (*Neoplatymops mattogrossensis*) from southern Venzuela. Mammalia, 56: 417-424. [Dept. Estudios Ambientales, Univ. Simon Bolivar, APDO 89000, Caracas 1080, Venezuela]

Morielleversute, E., V. A. Taddei, and M. Varellagarcia. 1992. Chromosome banding studies of *Chrotopterus auritus* (Chiroptera, Phyllostomidae). Revista Brasileira de Genetica, 15: 569-574. [Dept. Zool., Univ. Nacional Estadual Sao Paulo, Caixa Postal 136, BR-15055 Sao Jose Rio Pre, SP, Brazil]

Novacek, M. J. 1992. Fossils, topologies, missing data, and the higher level phylogeny of Eutherian mammals. Systematic Biology, 41: 58-73. [Dept. Vert. Paleontol., Amer. Mus. Nat. Hist., Central Park West at 79th St., New York, NY 10024]

Van Den Bussche, R. A. 1991. Phylogenetic analysis of restriction site variation in the ribosomal DNA complex of New World leaf-nosed bat genera. Systematic Zoology, 40: 420-432. Dept. Biol. Sci., Texas Tech Univ., Lubbock, TX 79409]

TECHNIQUES FOR STUDYING BATS

Kalcounis, M. C., R. D. Csada, and R. M. Brigham. 1992. Axle grease as an alternative adhesive for use on sticky traps. The Canadian Entomologist, May/June '92: 561-562. [Dept. Biol., Univ. Regina, Regina, Saskatchewan, Canada S4S 0A2]

Watt, E. M., and V. M. Watt. 1992. DNA fingerprints from minimal blood volumes. Molecular Ecology, 1: 131-132. [V. M. Watt, Dept. Physiol., Univ. Toronto, Medical Sciences Bldg., Room 3360, 1 King's College Circle, Toronto, Ontario, Canada M5S 1A8]

Position Announcement

The Cincinnati Museum of Natural History seeks a research biologist to oversee the Museum's bat research program. This program is centered around a free-living bat colony that is incorporated into the Museum's limestone cavern exhibit. Duties will include maintenance of the colony, development of educational programs relating to bats, and an active reserch program on the colony and bats of the Cincinnati area. Applicants for this half-time position should have an advanced degree. Send a letter of interest, curriculum vitae and the names and addresses of three references by May 1, 1993 to:Dr. Robert S. Kennedy Deputy Director for Collections & Research, Cincinnati Museum of Natural History
1720 Gilbert Ave., Cincinnati, OH 45202
Tel. 513 - 345 - 8510

Request for Information

Dr. Brian Krafthefer of the Systems and Research Center of Honeywell Inc., is eager to communicate with anyone who can provide him with information concerning the development of lung carcinoma in bats. He has been studying radon levels and ventilation in cave systems and is wondering if any bat researchers who have spent so much time in caves have ever investigated either radon levels or lung cancer in bats? He would appreciate hearing from anyone who might share information with him or who is interested in this topic. His address is:
Dr. Brian C. Krafthefer, Honeywell Inc.,
1660 Technology Drive, Minneapolis, MN 55418.
FAX 612-951-7438 or TEL 612-951-7629

¡¡OOPS!!

Sooner or later, Merlin was bound to win! He predicted that if I put one of his bat houses above my computer, bats would move in: I did and they did. Some of their guano fell into my computer and caused a terrible mistake in the previously announced (in Volume 33:2/3 of Bat Research News) dates for **the 23rd Annual North American Symposium on Bat Research to be held in Gainesville. The correct dates are Wednesday, October 13th to Saturday October 16th, 1993.** We are not too concerned about this slight misinformation as none of you read these dates anyway until about two weeks before the deadlines, but the correct dats are as given above. Sorry for the confusion. ***G.R.H.***

Error number two

The cover of the previous issue of Bat Research News read Volume 3 Number 2-3 Summer-Fall 1992. It should have read **Volume 33:No.2-3 Summer-Fall 1992.** (Obviously this boy needs help) GRH

23rd Annual North American Symposium on Bat Research

The pre-registration material for the 1993 Symposium will be mailed in May to all subscribers to Bat Research News, and to all those who attended any of the last three symposia in either Lincoln, Austin, or Quebéc. All others need only to request the registration materials from Horst, and those forms, etc., and all other pertinent information, will be sent upon request. GRH

BAT RESEARCH NEWS

Volume 33 **Number 4**

Winter, 1992

CONTENTS

Front Cover

We generally try to use photos of bats or bat art for our cover but we are "fresh out" of pictures, so we substituted the cover of the program for the symposium in Quebéc. Those of us who were there enjoyed the grand old Chateau Frontenac and won't mind being reminded again of the great time we had there. If you have a photo that you would like to see on the front cover of some future issue of Bat Research News, send it to Horst and if it is satisfactory we will use it. Please do not send color photos, slides, (or self-portraits); we can use black and white only, preferrably about 4" x 5". You may include a caption if you wish. Photos will not be returned unless requested.