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Instructions to Contributors

1. *Bat Research News* is published four times per year, each year consisting of one volume of four numbers. Publication dates, February, May, August and November. Sometimes the numbers are combined. *Bat Research News* publishes short papers, general notes etc., which are rigorously edited and reviewed. Manuscripts dealing with original work should be submitted in triplicate following the latest *CBE Style Manual* or following the style used in Journal of Mammalogy. In addition, latest news on bat research, correspondence, book reviews, meeting announcements, reports and recent literature citations are included. Communication concerning all these matters should be addressed to Kunwar Bhatnagar. Reprints of articles can be purchased.
2. Subscriptions are U.S. $5.00 per year mailed 3rd class to U.S. addresses, 1st class to Canada and Mexico. All other countries, bulk rates unless $1.00 per issue air mail is prepaid.
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FRONT COVER

The most common five-bat (pronounced as 'Wu Fu') design surrounding an artistic Chinese character of longevity can be seen on every door in the Imperial Palace in Beijing (Peiking). The five bats stand for health, wealth, long life, good luck and harmony. See the article by Philip Jen on page . . 6

BAT RESEARCH NEWS

VOL. 23 22 FEBRUARY 1982 NO. 1

EDITORIAL

I should like to begin my new responsibility by thanking Brock Fenton and Roy Horst for their confidence in me for handing over a task which appears lur-ingly simple, yet which is quite complex in execution. I am hoping that with the assistance of our readers and contributors I will be able to complete my term and pass on the reins to the next editor. Along with the past editors (Drs. Wayne Davis, Robert Martin, and Stephen Humphrey) Brock Fenton and Roy Horst deserve our best compliments and praise for infusing newer and newer life into Bat Research News.

The Bat Research News will continue to be issued in four numbers per year. However, depending on the availability of publishable material, individual numbers may sometimes be combined. I am anxious to add a cover photograph with each issue. Suitable black and white glossy photographs, approximately 7 × 7 inches in size, and dealing with any aspect of bat research will be gratefully received for the consideration of publication. With this call I expect to be flooded with high quality photographs. If not, I hope you are prepared to marvel at bat stamps on the cover! Seriously, please search your files. You are likely to turn up some relevant photograph which you have been waiting ever since to share with your colleagues all around the globe. In addition to the above, the following materials will be very welcome for consideration of publication:

- original papers and notes (these will be rigorously edited and reviewed)
- letters to the editor
- bat biologists in the news; reports from laboratories, museums etc.
- suitable writeups (with recent photographs) to eulogize renowned bat researchers and other notable personages on the occasion of their landmark dates. I am very enthusiastic to include such laudatory notes. Additional names for this column are hereby solicited
- reports on honors and awards received, meetings, excursions and expeditions
- announcements
- requests for materials, exchanges etc.
- newspaper clippings
- books for review
- advertisements
- citations of theses and dissertations
- citations of recent literature (on 3 × 5 cards)

Let me tell you that Bat Research News has always fascinated me. No sooner was it received than it was read from cover to cover. Who made that possible? The editors yes, but not entirely. The contributors also deserve compliments. Without your help we cannot paint the bright picture that we want. At my end I promise to do the very best I can. At yours, my only request is that if you are one of our regular readers, your obligation is not fulfilled until you have made your *yearly* contribution to the journal so dear to your heart. We have changed the looks of Bat Research News. I will also be grateful to receive critical comments on how you continue to perceive the future issues.

For the excellent logo on the cover and the mast head, I record my grateful appreciation to my colleague Dr. Fritz K. Hilton, Department of Anatomy, University of Louisville. Perhaps it is not just a matter of coincidence that the well known five-bat 'Wu Fu' design is appearing on the cover of this issue. It is offering health, wealth, long life, good luck and harmony not only to the Bat Research News itself, but to its distinguished readers all around the world. The editor and staff of the Bat Research News wishes each one of you many happy new years ahead.

K.P.B.

NEWS AND VIEWS

ROBERT MARTIN (University of Maine at Farmington) has sent me several numbers of Myotis, Nyctalus, and Lutra. Also enclosed were two newspaper clippings. The one from New York Times of June 16, 1981 reported investigations by Drs M. Brock Fenton and James Fullard on the discoveries of moths evolving jamming devices to thwart enemy bats. The other note by Bob Niss (Maine Sunday Telegram, August 23, 1981) amply thanks our nocturnal friends while declaring that "All things considered, the bat is a more lovely and gentle creature than the human."

RICHARD and MARGARET LaVAL are well in Monteverde, Costa Rica. They wrote in September 1981 about "their photographing bats and netting occasionally with ERIC DINERSTEIN and JILL ZARNOWITZ, who have a two year bat research project here that will take them next to the LeSelva field station, after a year here in the Monteverde cloud forests. They are looking at adaptations to various elevations in the tropics, and at the factors that influence the structure of the local bat frugivore guild. In addition to identifying seeds and pulp from fecal samples, they are studying the phenology of bat dispersed plants, nutritive value of bat fruits, and food selection among bats confined to large flight cages and offered a variety of known bat fruits.

In the process of netting and marking a couple of thousand bats here, they have captured a number of species not previously reported from Monteverde, most of which are lowland species. Students of bat distribution will be interested to know that they have caught *Antrozous dubiaquercus* and *Lasiurus cantaneus*, both very rare bats not previously collected in Costa Rica."

DICK and MEG, your 'reports' are very welcome to the readers of BRN. We hope to hear from you again.

ARTHUR GREENHALL's monograph on HOUSE BAT MANAGEMENT is being published by the Fish and Wildlife Service, U.S. Department of the Interior (Resource Publication 143). 'This manual is expected to provide a compendium of facts and techniques to respond to the problem of house bat management and to guide future bat management activities. Art has emphasized nonlethal control as preferable to lethal control. The bat proofing techniques described in this work provide numerous alternatives to lethal chemicals for dealing with house bats. This long-awaited manual should be more than welcome to a wide range of users such as homeowners, biologists, public health officials, physicians, veterinarians, conservationists, architects, building contractors, urban planners, pest control agencies and others dealing with bats and the problems caused by them.' The manual is moderately priced.

VIRGINIA TIPTON (Biology, Radford University, Virginia) reporting on the Eighth International Congress of Speleology (Western Kentucky University, Bowling Green, July 18-24, 1981) sent information on the following three bat papers:

Des Marais, D.J., J.M. Mitchell, W.G. Meinschein and J.M. Hayes. 1981. Molecular isotopic analyses of bat guano hydrocarbons and the ecology of the insectivorous bats in the region of Carlsbad, New Mexico, USA. pp. 200-202.

Hill, S.B. 1981. Ecology of bat guano in Tamana cave, Trinidad, W.I., pp. 243-246.

Martin, B.J. 1981. The community structure of arthropods associated with bat guano and bat carcasses in Tumbling Creek cave, Missouri. p. 3. REF: Proc. Eighth Intl. Cong. Speleology. B.F. Beck, Ed. Dept of Geology, Georgia Southwestern College, Americus, Georgia, 31709, USA.

The last free issue of the AUSTRALIAN BAT RESEARCH NEWS (No. 17, March 1981) just arrived. It has an attractive cover depicting intelligent representation of echolocation calls of several species. The editor, Dr. Richards should be complimented for the very informative issue which includes:

I. Regional bat workshop/seminar—Canberra, October 1980, arranged around a seminar by Dr. M. Brock Fenton. Papers Presented:
   1. Reproduction and thermal physiology of *Nyctophilus gouldi*—Bill Phillips, ANU
   2. Aspects of the environmental physiology of a community of bats in the A.C.T. ranges—Simon Inwards, ANU
   3. A new Australian bat fossil—Mike Archer, U-NSW
   4. Isozyme variation between populations of *Miniopterus schreibersii*—Sue Hand, U-NSW
   5. Proposed taxonomic changes to the genus *Nyctophilus*—Greg Richards and Harry Parnaby, Monash University
   6. The Australian bat banding scheme—David Purchase, CSIRO
   7. Utilization of artificial nest boxes by forest dwelling bats—Harry Parnaby, Monash University

8. Recapture study of a coastal bat community—Dedee Woodside, CCAE
9. The use of monitoring bat echolocation in ecological studies—M. Brock Fenton, Carleton University, Canada

II. Static Displays
III. The Chillagoe expedition—Report #1—Les Hall, Uni of Queensland
IV. Current Australasian literature (12 references)
V. NEWS FLASH:
Phoniscus papuensis is NOT extinct
MURINA—a new bat genus for Australia
The rare and controversial *Nyctophilus walkeri* is alive.
A new *Eptesicus* resembles *E. regulus*.

Australian Bat Research News can be ordered at an annual subscription of $ A 3.50 or $ A 4.00 from the editor, Dr. G.G. Richards, Division of Wildlife Research, CSIRO, PO Box 273, Atherton, QLD 4883, Australia.

COMING UP IN THE NEXT ISSUE

First recorded accidental transatlantic bat transport—A.M. Voute, Utrecht, The Netherlands

INTERNATIONAL BAT CONFERENCE

THE SIXTH INTERNATIONAL BAT RESEARCH CONFERENCE was held at the University of Ife, Nigeria, August 31—September 31, 1981. There were only five participants from four countries outside Nigeria together with approximately 15 from the University of Ife. The following papers were presented. (Some additional papers were scheduled but not given and there were a few substitute papers given by students at the University that are not listed here):

Studies on the breeding cycle of the fruit bat, *Eidolon helvum*—Eyo E. Okon, E.A. Claxton-Martins, M. Opara.

In vitro rearing of the tse-tse flies on bat's [*Eidolon helvum*] wing membrane—R.A. Balogun.

Bats [*Eidolon helvum*] as a local source of research materials—J.O. Folayan.

Effect of piperine on the bat [*Eidolon helvum*] and mouse vasa defferentia—O.A. Fasanmi, V.O. Marquis.

Bat ringing in Kenya—F.A. Mutere, I.R. Aggounday, A.N. McWilliam.

A Progress Report on the Systematics of African *Scotophilus* (Chiroptera, Vespertilionidae)—K.F. Koopman.

Pharmacological analysis of the responses of the isolated ileum of the fruit bat, *Eidolon helvum*—V.O. Marquis, O.F. Cole.

The inhibitory action of piperine on the smooth muscles of the gastro-intestinal tract of the fruit bat, *Eidolon helvum*—O.F. Cole. O.A. Fasanmi, V.O. Marquis.

Early development, implantation, and amniogenesis in the mouse-tailed bat, *Rhinopoma hardwickei hardwickei*—K.B. Karim.

Histochemical studies of the tongue of the fruit bat, *Eidolon helvum*—A.E. Caxton-Martins, G. Tabansi, E.E. Okon.

The ultrastructural and biochemical basis of pituitary metabolism in the fruit bat, *Eidolon helvum*—A.E. Caxton-Martins, G. Tabansi, E.E. Okon.

Chromosomes of some Indian bats—B. Dulic.

Aside from the meagre attendance, the meeting was a great success. Accommodations and general hospitality, as arranged by Dr. Okon and other University personnel were excellent. The large number of papers dealing with *Eidolon* reflects the large colony which roosts in trees on the campus, an experience I would not have missed.

Plans for the Seventh International Bat Research Conference are still somewhat tentative. However, it will almost certainly be held in Europe, probably in East Germany.

29 December 1981

Karl F. Koopman
American Museum of Natural History
New York

Sticky Fly Traps that also Trap Bats: A New Public Health Problem. Fly Stik Fly Traps® recently disabled bats in 4 California localities, prompting administration of post-exposure antirabies prophylactic treatment to one person and the quarantine or destruction of several animals potentially exposed to rabies. These incidents came to the attention of the Infectious Disease Section (IDS) by chance. Since additional incidents can be anticipated, the IDS reported these episodes to alert the public to this potential hazard." (California Morbidity, A Weekly Report from the IDS, State Department of Health Services, October 2, 1981, #38). Four episodes have been reported. Species by episode: (1) the first of the two chewed bats was either *Myotis californicus* or *M. leibii*, and the second was either *M. yumanensis* or *M. lucifugus*, both mature males; the third bat was destroyed at capture; (2) two immature females and one mature female *M. yumanensis*; (3) mature female *M. evotis*; (4) mature male *M. yumanensis*. Not mentioned in the report is a badly focused photo from the manufacturer of what appears to be an *Eptesicus fuscus* stuck on a fly trap in an unreported locality in California.

The manufacturer in Phoenix, Arizona has been referred to Dr. Cockrum at the University of Arizona for help in developing a product that will not disable bats. It appears that the adhesive on the Fly Stik Fly Trap® (a 2-inch by 24-inch plastic tube, covered with a reportedly nontoxic, non-drying, clear, rubber-cementlike material) asphyxiates the bats after it fills the mouth and plugs the nostrils of the animals. However, contaminated wings become hopelessly glued shut. A light was

adjacent to only one of the traps, so it seems likely that trapped, probably noisy insects attracted the bats. Birds, including hummingbirds, have also been trapped, according to the manufacturer.

"The IDS has notified the manufacturer (Farnam Companies Inc., of Omaha, Nebraska, distributors of the described fly traps nationally) of these incidents and it appears that improvements in product design will be forthcoming. Until then, the IDS suggests *not using* these insect traps where bats may have access."

January 13, 1982

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Bats in Chinese Art and Superstition

Throughout human history, bats have been creatures of much interest, speculation and superstition because of their unique characteristics and nocturnal habits. The paucity in understanding these animals makes ordinary people describe them as "flying like birds, biting like beasts, hiding by day, and seeing in the dark". They have been considered as the ugliest animals by some and the cutest creatures by others; regarded as a symbol of evil and misery by some races and a symbol of luck and fortune by others.

Among the Chinese, bats are held in high regard. In the Chinese language, the characters for bat and luck are different but they are both pronounced as 'Fu'. By substitution, the figure of a bat stands for happiness and good luck. Thus, it is frequently worked into designs in Chinese art, handicrafts, embroidery, jewelry, utensils, vases, incense burners, doors, and gates. A design of five bats surrounding an artistic character of longevity (pronounced as 'Sou') or a peach with two leaves (a philosophical symbol of longevity) can be seen on a carved Chinese bowl of jade or on embroidered traditional clothes. These five bats stand for health, wealth, long life, good luck and harmony; the five aspects of happiness much sought for by all men. Next time, when you eat at a decent Chinese restaurant, look for such a design on the plates or rice bowls!

Conventionally, the patterns used in Chinese art are rather few. A traditional brush painting mainly consists of figures or designs of symbolic value. For instance, a mountain-water painting may consist of a mountain, a creek, a hut, a simple wooden bridge, a pine tree and a scholar reading a book or playing a flute. In addition, calligraphed poems are written on the side of the painting together with the writer's signature and seal. Another painting may contain an old, bald man with a goatee, holding a beautifully carved wooden stick, standing by a pine or a peach tree and accompanied by a deer or a lonely flying bat. For the old man, pine or peach tree, deer and bat respectively represent authority, peace, and longevity. The old saying is: "May your peach tree bear fruit for one thousand years!"

In October, 1980, I visited the Imperial Palace inside the Forbidden City of Beijing (Peiking), People's Republic of China. There was on display a classical drawing of the portrait of the notorious (as far as the Chinese people are concerned) late Empress Dowager of the last Manchu dynasty. There she was, wear-

ing a silk embroidered robe covered with countless bats. The throne and the four bronze incense burners also were covered with bats and peaches. What a bat lover she was! In her palace, the five-bat design could be seen on almost every window, door, table and chair (see the cover).

Since the founding of the People's Republic, the superstitious customs in the so-called old culture have been systematically wiped out. My experience during my last visit told me that the younger generation has been brought up completely ignorant about the symbolic meaning of bats. In fact, it was I who pointed out to my official guide, that there are so many "bats" in the Imperial and Summer Palaces.

Whether bats are beautiful or ugly; represent luck or misfortune, is indeed irrelevant. After all, beauty is in the eye of the beholder and superstition is in the mind of men. Such an abstract concept may change with individuals, time, and generations. However, one fact should remain true. That is, bats are creatures of our world and scientifically they are the most fantastic and fascinating animals to study.

February 1, 1982

Article invited by Editor

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RECENT LITERATURE
ANATOMY

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BAT RESEARCH NEWS

VOLUME 23 NO. 2 MAY 1982

BAT RESEARCH NEWS

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BAT RESEARCH NEWS

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Enclosed with this issue of *Bat Research News* are:
title transmission form
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These forms have not been included to subscribers outside the United States, Canada, and Mexico or to institutional subscribers. If you plan to attend please contact me and I will provide this material air mail.

FRONT COVER

The rat-tailed bat, *Rhinopoma microphyllum* with suckling young clinging to its mother. Inset shows the Man-mandir, a six-towered palace of King Mansingh, 1486-1516, in the historic Gwalior Fort (525 A.D.), Gwalior, India, which housed a large colony of these bats. Photographed in June 1974 by Kunwar Bhatnagar.

BAT RESEARCH NEWS

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A SYNOPSIS OF THE FAMILIES OF BATS — PART I

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Dr. Bhatnagar has urged me to write a series of pieces for **Bat Research News** that would summarize the characters of the various bat families and say something of their range of diversity and geographical distribution. I have decided to try a cladistic approach, first enumerating what seem to me to be the primitive characters of bats in general and later when characterizing the various families to present these as departures from the primitive condition. At the end of this series I will try to present a key to the families, based, if possible, on these characters.

I am assuming a monophyletic origin for the Chiroptera since I am convinced that the complex of unique shared derived characters in the bat wing far outweigh any derived character of either Megachiroptera or Microchiroptera associating them more closely with some other order of mammals. I will therefore summarize what I believe to be the primitive characters of bats.

The wing would be relatively short and broad (low aspect) supported by four well-developed digits. Both the first and second digits would be clawed and the tail would be long. The interfemoral membrane would be present, but probably not extensive though this is not certain, since the related Dermoptera do have an extensive interfemoral membrane. The head of the humerus would be round, and the trochiter and trochin poorly developed, thus giving considerable freedom of shoulder movement. There would be little rib or vertebral fusion. The skull would in most respects resemble that of a primitive tree shrew with moderately elongate rostrum, but lacking postorbital processes. The premaxillary bones would have well developed nasal and palatal branches, would not be fused to the maxillaries, but would have at most only limited movement with them. The periotic bone would be sutured to the rest of the skull. The dental formula, i 2/3, c 1/1, p 3/3, m 3/3 = 38, the molar teeth with a W-shaped ectoloph, the whole dentition being adapted for chopping up relatively soft bodied insects. The rhinarium would be a primitive one without nasal modifications, the external ears simple, probably with a small tragus.

The first family to be considered, and by far the most dinstinctive is the Pteropodidae, the Old World fruit and nectar feeders. These differ from the primitive chiropteran morphotype in several ways. While the second digit normally

bears a claw, this has been lost in several genera. The tail is greatly shortened except in the Pacific island *Notopteris* and often lost altogether. The interfemoral membrane is absent or poorly developed. The humerus, ribs, and vertebrae are essentially unmodified. The rostrum may remain primitive or be considerably lengthened or shortened. Postorbital processes are always present, occasionally forming a postorbital bar. The premaxillae lack palatal branches but the periotic is unmodified. The dental formula is always reduced, at least to i 2/2, c 1/1, p 3/3, m 2/3 = 34, and often much further. The molar teeth are so highly modified in connection with fruit eating that cusp homologies are highly uncertain. The rhinarium is generally unmodified but the nostrils are tubular in *Nyctimene* and *Paranyctimene,* while *Hypsignathus* has elaborate modifications of the nasal region though hardly a true noseleaf.

With 40 genera and approximately 152 species, this is one of the larger bat families, occupying the fruit and nectar-feeding niches in virtually the entire Old World tropics from West Africa to the Cook islands in the central Pacific and occupying many islands in the Indian and Pacific oceans. A few species reach warm temperate areas both north and south of the equator. Two subfamilies are recognized, the more generalized, largely fruit-eating Pteropodinae, occupying the entire family range and the specialized nectar-feeding Macroglossinae, which are confined to the Indo-Australian region except for the tropical African *Megaloglossus.* There are several lesser taxonomic groups with a more restricted distribution, such as the Epomophorini confined to tropical continental Africa and the Cynopterine (including the Nyctimenina) confined to the Indo-Australian tropics.

(to be continued)

Received 10 March 1982.

FIRST RECORDED ACCIDENTAL TRANSATLANTIC BAT TRANSPORT

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On 28 November 1980 a container loaded with timber and coming from Canada, was being unloaded in a furniture factory in the town of Culemborg, province of Utrecht, the Netherlands. During this process, employees of the factory found a hibernating bat which was brought to our laboratory on 1 December. The bat was a male *Eptesicus fuscus* (Palisot de Beauvois). I was provided with the following data about the container: In autumn 1980 the container was loaded with timber in Alliston, (ca. 45 miles northwest of Toronto, Ontario) and transported to Halifax (Nova Scotia), where it was loaded on board the **M.V. Kolnischer Express.** On 14 November the vessel left Halifax and arrived in Holland on 26 November. The bat was discovered two days later when the container was taken to Culemborg, and emptied at the factory. The bat was kept alive in our laboratory for more than 8 months.

Since *Eptesicus fuscus* often roosts and hibernates in buildings and is active in urban areas (Barbour and Davis, 1969), it is not surprising to find one in a container

of lumber. Their ability to enter torpor would ensure survival during transport at a time when temperatures were cool but not, for extended periods below freezing.

Several publications report bats which either drifted as migrants or which were transported by human agency from North America to Iceland. The possibility of storm-blown or even actively flying specimens of the American species *Lasiurus cinereus* (Palisot de Beauvois), which were found on Iceland some 200 years ago, are mentioned by Krzanowski (1977). More recent discoveries of migrant bats to Iceland are given by Hayman (1959) and Koopman and Gudmundsson (1966). According to the latter it appears that *Lasiurus cinereus* almost certainly reached Iceland by natural means, but for *Myotis lucifugus,* there is strong circumstantial evidence that it was brought by ship. There are also a few references, all concerning the same specimen of *Lasiurus cinereus* which was presumably found on the Orkney Islands, north of Scotland, in 1847 (Koopman and Gudmundsson, 1966; Corbert, 1970; Van den Brink, 1978). I am unaware of any other data about North American bats which drifted across the Atlantic or were transported there by human agency.

This appears to be the first record of the big brown bat found in the Netherlands whose unintended transportation to Europe has definitely been established. Highly intensified traffic between Europe and North America may result in the transportation of more bats by ship or even by aircraft from America to Europe and vice versa. Very recent information (Dr. M.B. Fenton, Canada, personal communication) revealed that the crew of the **M.V. Avon Forest** already for several years were aware of the fact, that on some of their summer crossings from Dalhousie, New Brunswick, to Rotterdam, there were bats on board which often left the vessel in Rotterdam. Investigtion showed that the bats were *Myotis lucifugus* which boarded the vessel in Dalhousie. Work in Dalhousie revealed that the bats, which are common in the area around the wharf apparently used the vessel as a night roost. Since it took about 5 days to load the vessel, the bats had enough time to become accustomed to using it as a roost, so that when the vessel left for Europe, there were often some bats on board. In May 1980 some of these bats were still on board at Southampton, England.

Although as far as I know in Holland nobody ever heard anything about the above mentioned migrant bats, they still pose a question which must be kept in mind carefully, because of possible implications concerning public health. It might also be possible that bats, transported in sufficient quantities and more or less equal numbers of males and females would be able to settle permanently in the Netherlands.

Acknowledgements

I am grateful to Dr. C. Smeenk of the Museum of Natural History, Leiden for his indispensable assistance with the identification and for critical reading of the manuscript; to Mr. Th. de Jong, who informed me about the bat and brought it to our laboratory; to the Furniture Factory (C.S.F. Ltd.) at Culemborg for invaluable cooperation in tracing all relevant data concerning the transportation of the container, and to Dr. M.B. Fenton, Carleton University, Ottawa, Canada, for giving very useful supplementary information and critically reading the manuscript.

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Submitted 14 October 1981. Revised 18 January 1982. Accepted 18 February 1982.

A 20-YEAR RECOVERY RECORD FOR *MYOTIS LUCIFUGUS*

WAYNE DAVIS (University of Kentucky, Lexington, KY 40506) wrote to BROCK FENTON: "It has been a long time since I have banded a bat up your way so recoveries from the Northeast have become infrequent. Although it is not a longevity record, a report that Harold Hitchcock and I recently received may be of interest to readers of BRN. A male*Myotis lucifugus* that Hitchcock and I banded in the old iron mine 2 mi NE Paradox, Essex Co., N.Y. on October 8, 1961 was found injured on the shore of Paradox Lake, Essex Co., N.Y. on October 18, 1981, by C.M. Crossman, P.O. Box 116, Paradox Lake, N.Y. 12858."

NEWS and VIEWS

Thirteenth Annual North American Symposium on Bat Research

The Bat Symposium will meet October 14-16, 1982 in Louisville, Kentucky. Our host institution will be the University of Louisville. Kunwar Bhatnagar will chair the Local Committee.

We have reserved rooms at the Rodeway Inn in downtown Louisville, just a few blocks from the campus. The inn has given us firm discount rates of $32.00 single, $40.00 for two people, and $48.00 for three. Reservation cards are included with this issue and should be returned before September 1, 1982.

Louisville has excellent air service by American, US Air, Continental, Delta, Eastern, and T.W.A. As of April 1982, there were 90 arrivals and 87 departures each day (suggesting that planes are accumulating in Louisville at a rate of 3 per day?).

Registration will be all day Thursday, October 14 with formal sessions beginning Friday, October 15, and ending Saturday afternoon, October 16th. There will be a no-host cocktail party on Thursday evening and a banquet-type dinner on Friday evening.

We are very interested in special sessions on some unifying theme, and Brock Fenton is organizing one such session on conservation. An in-depth treatment of some appropriate anatomical or physiological subject would be most welcome. The "evolution group" might also get together. Echolocation has been well-served but other

topics would benefit from such in-depth treatment. Leaders, volunteer your services and contact me at your earliest convenience.

In the past we have discussed giving an award to the best presentation by a student, and this year there are funds available to give two prizes of $100 and $50. Details are included on the title submission form.

Many meetings now include in their programs poster sessions (such as the American Society of Mammalogists). This year we will try this approach. We can accommodate up to 20 poster presentations, each poster to be set up for one day. Since we are a small group, the author(s) and audience can easily make contact, negating the necessity of the author(s) constantly standing by their posters. Reports with significant quantities of graphic data such as range studies, anatomical investigations, or systematic studies are often ideal candidates for poster presentation. The poster boards will be 1 meter x 2 meters, well-illuminated and in a lobby next to the meeting room. Details are included on the submission of title form. Title transmission forms will be due on August 15 (along with an abstract) and pre-registration is at the reduced rate of $15.00 until September 15, after which date registration will be $20.00.

We are very eager to receive an invitation for the 1983 symposium. We will have been in the last 3 years, in California, New York, and Louisville; the Rocky Mountain states would seem the logical region for 1983. This year perhaps we can include the invitations on the program, discuss them in advance and vote our choice at the business meeting.

I look forward to seeing all of you in Louisville.

G. Roy Horst
Program Chairman

NATIONAL CAVE MANAGEMENT SYMPOSIUM, 1982

Call for papers

The 1982 National Cave Management Symposium is scheduled to be held at the Sheraton Inn in Harrisonburg, Virginia, 4-7 November. Several special sessions will be devoted to helping public agencies and their staffs manage publicly owned caves. Other sessions will be devoted to commercial cave conservation and management. A four-day training session will also be conducted on all aspects of speleology. Ginny Tipton was volunteered to conduct a "Basic Cave Course on Bats: their identification, ecology, and conservation." Anyone wishing to help her with this training course is encouraged to contact her as soon as possible. Anyone wishing to give any sort of cave bat presentation should also contact her. Most of the participants at this symposium will have a minimal knowledge of bats. Call Ginny Tipton at (703) 731-5191 or write: Dr. Virginia M. Tipton, Biology Department, Radford University, Radford, VA 24142.

FIRST EUROPEAN SYMPOSIUM ON BAT RESEARCH (March 16-20, 1981, BONN, WEST GERMANY): A BRIEF REPORT

About 100 scientists from 18 countries attended the First European Symposium on Bat Research in Bonn. In the 35 platform presentations and 10 posters a great variety of topics were discussed. Most of the papers are published in a special issue

of *Myotis*. The central theme of the symposium was the protection of bats in Europe. During a discussion and in a number of presentations it became obvious that bats belong to the most endangered species. Some, especially *Rhinolophus hipposideros,* are at the verge of extinction in central Europe. The participants drafted a resolution through **I.U.C.N.** to the European governments, urging complete protection of all bat habitats. In a final discussion it was agreed to continue these symposia on bat research, and five scientists were elected to organize the second European symposium in Berlin East (GDR). The symposium ended with an excursion to bat caves in Southern-Limburg, Netherlands, where a number of species could be observed hibernating.

Uwe Schmidt
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Bonn, Poppelsdorfer Schloss, 53 Bonn March 3, 1982

PROCEEDINGS OF THE FIRST EUROPEAN SYMPOSIUM ON BAT RESEARCH (H. Roer, Ed.), *Myotis*, vol. 18-19, 1980-81, 199 pp. Zoologisches Forschungsinstitut und Museum Koenig, D5300 Bonn.

STEPHEN KERN, Program Manager, BAT CONSERVATION INTERNATIONAL (c/o Milwaukee Public Museum, Milwaukee, Wisconsin, 53233 USA): 'To let you know what we have been accomplishing, I enclose a complimentary reprint entitled 'BATS AND PUBLIC HEALTH'. This paper is the most complete, up-to-date review of the subject. We hope it will go a long way towards educating conservationists, medical, and veterinary health officials on the value of bats and the hazards of bat extermination. Even 'non-bat' mammalogists are surprised to learn that bats are not true carriers of rabies. Upon Dr. Tuttle's return from Panama (B.C.I.) in 6 weeks we will complete a public education brochure, and a description of B.C.I.'s accomplishments, such as mailing copies of 'Bats and Public Health' to the nation's health officials in each state. We also have protected or helped negotiate the purchase of several critical cave habitats here and abroad." This 11-page paper (M.D. Tuttle and S.J. Kern 1981. Milwaukee Public Museum Contri. Biol. Geol., No. 48) emphasizes the need to educate the public toward the 'desirability of coexistence of man and bats' and covers histoplasmosis, rabies (geographic distribution and infection rates, transmission to humans, transmission to wildlife, prevention of human exposure, evaluation and treatment of human exposure), and hazards of mismanagement. The bibliography contains 96 references. The Bat Conservation International is expected to be fully functional within a few months. Merlin Tuttle and Robert Stebbings are the project coordinators.

Dr. K. B. KARIM has been promoted as Reader in Zoology, Institute of Science, Nagpur, Maharashtra, India.

"RABID FOR ROCK 'N ROLL? Rock singer Ozzy Osbourne has been treated for a possible case of rabies after biting the head off a *bat* during a concert in Des Moines, Iowa, hospital officials said. Osburne has a reputation for sticking birds and other things into his mouth during performances."

- The Louisville Times, January 22, 1982

COMING UP IN THE NEXT ISSUES

A report on bat-boxes by Pheobe Wray

Dr. A. Gopalakrishna — a tribute by K. B. KARIM

ERRATUM

Volume 22 (2-3): Book review by Robert M. Herd.

Page 16. "It is loosely organized . . . Chiroptera' . . ." should read "It is loosely organized into four sections: preface, contributed papers (29); and two symposia, 'Phylogeny of the Chiroptera' . . ."

Page 17. "the strong behaviour in vampire bats, . . ." should read "the strong social behaviour in vampire bats, . . ."

Page 19. 'Robert N. Herd" should read "Robert M. Herd".

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BAT RESEARCH NEWS

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BAT RESEARCH NEWS

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FRONT COVER

Nycteris grandis from Mana Pools National Park, Zimbabwe. Photo by M. Brock Fenton.

BAT RESEARCH NEWS

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A SYNOPSIS OF THE FAMILIES OF BATS - PART II

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In the first part, I discussed the approach I am using in this synopsis, enumerated what I believe to be the more significant primitive characters of bats and discussed the derived characters of the family Pteropodidae. In part 2, I will try to do the same for the three microchiropteran families which are probably most primitive on the whole. These are currently grouped in the superfamily Emballonuroidea, which is probably monophyletic in the broad sense, but may not be in the narrow Hennigian (holophyletic) sense.

The Rhinopomatidae constitute a small Old World insectivorous family. Like all Microchiroptera, the claw has been lost from the second digit of the wing, but two distinct bony phalanges are retained. The tail remains long, but the interfemoral membrane is narrow (though this may be primitive). The trochiter is somewhat enlarged but does not extend beyond the rounded head of the humerus to contact the scapula. The ribs and vertebrae are essentially unmodified. The rostrum is considerably shortened, but there are no postorbital processes. The premaxillary bones retain well-developed nasal branches but the palatal branches are shortened and some movement is possible. The periotic is more or less freed from surrounding bones. The dental formula is reduced to i-1/2, c-1/1, p-1/2, m-3/3 = 28, but the pattern of the molar teeth is largely unmodified. There is some ridging over the nostrils but not a true noseleaf. There is a small tragus unlike the Pteropodidae.

The Rhinopomatidae, consisting of a single genus *Rhinopoma* with three currently recognized species, ranges from northwestern Africa to Sumatra, chiefly in the southern edge of the Palearctic and northern edges of the Ethiopian and Indo-Malayan regions, much of the range being in semi-arid areas.

The Craseonycteridae, with a single insectivorous species confined to a small area of Thailand, have lost all but one phalanx of the second digit of the wing. The interfemoral membrane is extensive but the tail is lost. The trochiter is larger than that of the Rhinopomatidae, extending beyond the rounded head of the humerus and making contact with the scapula. The lumbar vertebrae are fused, but there is no modification of the ribs or anterior vertebrae. The rostrum is considerably shortened but there are no postorbital processes. The premaxillary bones resemble those of the Rhinopomatidae but the palatal branches are elongated so as to meet dorsal to the nasal aperture, considerable movement being possible on the maxillary bones. The periotic is probably more or less freed from surrounding bones. The dental for-

mula is the same as that of the Rhinopomatidae and the molar tooth pattern is essentially unmodified. The muzzle shows no special modifications and there are large tragi in the large ears.

The Emballonuridae constitute a fair-sized pan-tropical insectivorous family. The second digit of the wing has lost all its bony phalanges, retaining only a metacarpal. The tail has been reduced in length so that it does not reach the edge of the fairly extensive interfemoral membrane. The trochiter does not extend beyond the head of the humerus (which is oval rather than round) and thus does not articulate with the scapula. The muzzle is shortened and there are usually well-developed post-orbital processes. The premaxillae retain palatal branches, but have lost the nasal ones, and are only loosely attached to the maxillae. The periotic bone retains a close association with surrounding skull bones. The dental formula is always reduced to at least i-2/3 c-1/1 p-2/2 m-3/3 = 34 and often further, but the molar pattern is essentially unmodified. The fleshy part of the muzzle may be somewhat prolonged but there is no noseleaf. A tragus is retained.

This family has 12 genera and some 47 species and has a wide distribution in tropical and subtropical regions of both hemispheres. In the Old World emballonurids extend throughout sub-Saharan Africa, across southern Asia and east to Samoa and Australia, including many islands in the Indian and Pacific oceans. In the New World, they are virtually confined to Middle America and tropical South America. Of the two subfamilies, the very peculiar Diclidurinae are confined to tropical Middle and South America but the Emballonurinae are found in both hemispheres. The genera, however, in these two areas are different, four genera being confined to the Old World and six to the New.

Received May 11, 1982 (to be continued)

TRAINING BATS FOR BEHAVIOURAL STUDIES IN THE LABORATORY

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With the study of bat behaviour increasing in importance and complexity, it is evident that field studies can be augmented with detailed observations of individuals under controlled laboratory conditions. Still, many researchers hesitate to work with captive bats, citing various reasons such as a- captive bats perform only a limited number of simple and rigorously conditioned exercises; b- training bats to perform consistently in the lab requires an extraordinary amount of time, effort, and equipment and many bats are simply untrainable; c- bats are difficult to maintain in captivity without specialized and expensive dietary and housing facilities.

My experience with *Myotis lucifugus, Eptesicus fuscus* and *Antrozous pallidus* has shown me that laboratory studies can be relatively simple, efficient, and systematic means of assessing an individual bat's abilities to respond to a variety of designated tasks. The idea that bats can perform only simple, rigourously conditioned exercises is not congruent with my experience, namely that a bat is only as ingenious as the experimental design. An unresponsive bat may tell you more about the lab setup and training methods than about its own abilities. The species I worked with were eager performers over a wide range of tasks involving spatial memory, learning from other bats, and response to moving targets and to audible and visual cues. No conditioning was necessary beyond an initial exercise in which

bats were reinforced to fly across a room, pick up a food reward from a target, and return to the starting point.

The preparatory training is critical. If the bat is not motivated enough to respond consistently to straight-forward target exercise, then it is unlikely it will provide consistent and realistic data in a more challenging situation. Training, however, does not have to be "difficult", "tedious", or "impossible" - words I often used when I first ventured into this work. At that time two months of painstaking reinforcement were required to make each bat fly closer and closer to the target. When I realized that the bats themselves were their own best teachers, the procedure was streamlined into two weeks. The extent to which bats learn from other bats only became apparent during efforts to train *Antrozous,* a species that until then had seemed untrainable. After noting that when there was more than one bat in the room each bat often responded to the sounds of the others eating, I restrained one individual on the target and fed it mealworms. This led to immediate and repeated flights to the target by the other bats, and after one or two weeks each bat was flying individually and consistently to the target in the absence of any cues. Later experimentation indicated that all three species could repeat the performance of previously trained bats after periods of one to four days. In the absence of trained conspecifics, another trained species could be used to some extent as a teacher. However, it is preferable to isolate the major stimulus to which the species responds (e.g., chewing, or feeding buzzes, etc.), and to initially associate it with the target. Often simply scratching the target will serve to attract a bat's attention. The specifics of training will vary depending upon the species used and the ultimate intent, and only critical observation of each species will provide the clue to development of a means of facilitating training. The advantages of swift and concentrated training are evident. It limits the effects of laboratory conditions on the bats' performance, and decreases the term of maintenance while increasing the number of meaningful trials each bat can run.

The above training regime will prepare bats for a variety of stimulus response formats involving target discrimination and the location of randomly placed targets. The initial conditioning serves to remove inhibitions and to habituate the bat to the experimental chamber as a feeding area, thus motivating it to employ all available faculties to search for and respond to cues for rewards. Importantly, these sessions allow the experimenter to weed out individual bats whose temperament renders them unsuitable for the rigours of laboratory work.

Though initial training may be the single most important element in obtaining consistent and motivated responses, there are at least two circumstances in which a bat cannot be expected to give an accurate indication of its true ability. The first is when a bat is overweight and thus unmotivated by food. A general rule of thumb is to maintain the captive bat at two thirds of its normal weight. Allowing a captive's weight to increase can be a serious problem, particularly in species such as *E. fuscus* which is reluctant to risk those few extra grams by expending energy when food is offered in limited quantities, and can maintain weight for several weeks by substantially decreasing its level of activity. The second important factor is feeding the bat exclusively in the experimental chamber. Between experiments it is better to continue to feed the bat after it flies in the chamber as even brief returns to the leisure of cage feeding can mean a lengthy period of retraining. Motivation and ultimate performance levels will decrease if bats are treated to a more inviting alternative than working for their food.

The final barrier to laboratory work is the sheer mechanics of maintaining bats in captivity. Though some bats cannot survive conditions in captivity, maintaining

some species in the short term is relatively easy if adequate attention is paid to diet, humidity, and temperature. Large and expensive flight cages are not essential, and a holding cage only needs to provide adequate roosting and feeding space. I found that my bats got enough exercise in the training sessions and that a flight room 2.7 by 2 by 2 m was adequate. I modified the room by lining it with acoustic foam. Diet is a crucial element although many insectivorous species will thrive on mealworms (*Tenebrio* larvae) and vitamin supplement. Long term maintenace requires a more critical approach, including a thorough search of the available literature concerning the "natural" diet of the species in question. For the minumum of energy required, laboratory work by the bats should not be overlooked as an important element in behavioural studies; its potential is limited only by one's imagination.

DR. A. GOPALAKRISHNA - A TRIBUTE

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At 60, Dr. A. Gopalakrishna has had a long and fruitful career in teaching and research at the Department of Zoology, Institute of Science, Nagpur, Maharashtra, India. Dr. A. Gopalakrishna, D.Sc. (born October 20, 1922) at Chamarajanagar, Mysore State, India, had all his early schooling and formal University education at the Central College, Bangalore. He obtained the B.Sc. Honours Degree in Zoology with specialization in mammalian reproduction in 1942 and was placed first in all the examinations throughout his University career. After completing courses in Anatomy, Physiology and Biochemistry at the Medical College, Mysore, he began his research work in 1945 on reproduction and embryology of bats under Professor A. Subba Rau. He joined Mysore University and Intermediate College, Bangalore in February 1946 as lecturer in Zoology, but in September 1946 was appointed lecturer in Zoology at the College of Science, Nagpur. He was awarded the Research Fellowship by the National Institute of Sciences of India in 1954 for carrying out research on reproduction of bats living in arid climates. In 1955 he received a visiting research fellowship for two years from the Population Council, Rockefeller Institute, New York. During the tenure of this fellowship he worked with Dr. Richard S. Blandau at the Department of Anatomy, University of Washington, Seattle, and for shorter periods with Dr. William A. Wimsatt, Cornell University, Ithaca and with Dr. H. W. Mossman, Department of Anatomy, University of Wisconsin, Madison. He was elected to membership by the American Association of Anatomists in 1956. He received the D.Sc. Degree from Mysore University in 1958 on a treatise entitled "Foetal membranes in some Indian Microchiroptera."

He was appointed Professor of Zoology at the Government College of Arts and Science at Aurangabad and was later posted as Research Professor at the Institute of Science, Nagpur in 1965. From 1971 until April 1981 he was the Director, Institute of Science, Nagpur. At present he is an Emeritus Scientist at the Institute of Science, Nagpur. After retirement he has continued his researches and is the leader of a research project on reproduction, embryology and ecology of Indian Chiroptera under the sponsorship of the University Grants Commission, New Delhi.

For the past 37 years he has been carrying out research work on various aspects of anatomy, reproductive biology and embryology of bats and has studied representatives of all the families of bats native to India. He is a pioneer in the field of reproductive biology and embryology of bats and has not only established an internationally recognized school of research in mammalian reproduction and embryology (with special reference to bats) at the Department of Zoology, Institute of Science, Nagpur but also established a large library of microscopic slides on bat reproduction and embryology (about 600,000 slides) covering over 25 species of bats belonging to 8 families. This would appear to be one of the largest slide libraries of any mammalian order in the world, and is the most valuable collection of embryological stages of a large number of bat species. These slides are available to any one wanting to study them.

Dr. Gopalakrishna has guided the research work of about 30 students for the Ph.D. degree and has published numerous research papers on the reproduction and embryology of bats in national and international journals, and these have been extensively quoted in current literature on these subjects. His findings have also been incorporated in advanced specialized texts and serial publications.

Dr. Gopalakrishna is currently the President of the Indian Society of Life Sciences. He is also a Fellow and member of the Indian Academy of Sciences, Zoological Society of India and Academy of Zoology and a member of the National Academy of Sciences, Current Science Association, Indian Society of Comparative Endocrinology, International Advisory Committee on Population Programme and Indian Science Congress Association. He was the recipient of the State Award for 1979 for his outstanding contribution to education, scientific research and social work.

Apart from teaching and research, Dr. Gopalakrishna has attained a place of eminence in various other fields as well. During his student days he distinguished himself as a good sportsman, having reached the State level in both cricket and football. He is an accomplished musician and plays Veena and Sitar (stringed plucking instruments of South and North India respectively). Widely travelled, well read and well informed, he is at ease in any company with a fund of information which he can present with stunning eloquence. Dr. Gopalakrishna has guided and inspired generations of students over a long period. We hope that future generations of students will derive guidance and inspiration from his life and work.

A REPORT ON RESEARCH WORK AT THE ZOOLOGY DEPARTMENT, INSTITUTE OF SCIENCE, NAGPUR, INDIA

K.B. Karim

The Department of Zoology, Institute of Science, Nagpur, Maharashtra state, India is engaged in extensive researches on bats under the tutelage of Professor Dr. A. Gopalakrishna, the Batman of India, for the past four decades or so. The simple statement by his Professor, Dr. Subba Rau, that the order Chiroptera is one of the

largest orders of mammals and India is very rich in bats and hence they would provide a virgin field for research, enthused the young Gopalakrishna who started his research at the College of Science (now Institute of Science), Nagpur in 1946. The first paper was published from this laboratory by him in 1947 on the 'reproduction and breeding seasons in the South Indian vespertilionid bat, *Scotophilus wroughtoni (Scotophilus temmincki)* (Thomas). Since then not only numerous papers have been published on reproduction and embryology of Indian bats but the Department of Zoology, Institute of Science, Nagpur has become an internationally recognized school for research on reproduction and embryology of Indian bats.

India is represented by 8 of the 17 families of bats. Dr. Gopalakrishna and his students have studied the following representatives of all the 8 families:

Pteropidae

Cynopterus sphinx gangeticus
Rousettus leschenaulti
Pteropus giganteus giganteus

Emballonuridae

Taphozous longimanus
Taphozous melanopogon
Taphozous kachensis

Megadermatidae

Megaderma lyra lyra

Rhinolophidae

Rhinolophus rouxi

Molossidae

Tadarida aegyptiaca
Tadarida plicata plicata

Rhinopomatidae

Rhinopoma kinneari
Rhinopoma hardwickei

Hipposideridae

Hipposideros bicolor pallidus
Hipposideros fulvus fulvus
Hipposideros speoris
Hipposideros lankadiva
Hipposideros ater ater

Vespertilionidae

Scotophilus temmincki
Pipistrellus ceylonicus chrysothrix
Pipistrellus dormeri
Pipistrellus mimus mimus
Scotophilus heathi
Pipistrellus babu
Miniopterus schreibersii fuliginosus

The aim of this school is to study the various aspects of anatomy, reproductive physiology, and embryology of Indian bats. Apart from these, research on the structure of pituitary, alimentary tract, adrenal gland, and pancreas of bats is also being carried out in this laboratory.

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(Editor's note: Dr. Karim has enclosed a six-page long list of publications and dissertation titles from the Department of Zoology, Nagpur. Many of these may be unknown to workers outside India. If interested in obtaining this list please send 40¢ in stamps to the editor to cover postage.)

The Gerrit S. Miller, Jr. Award: a brief history

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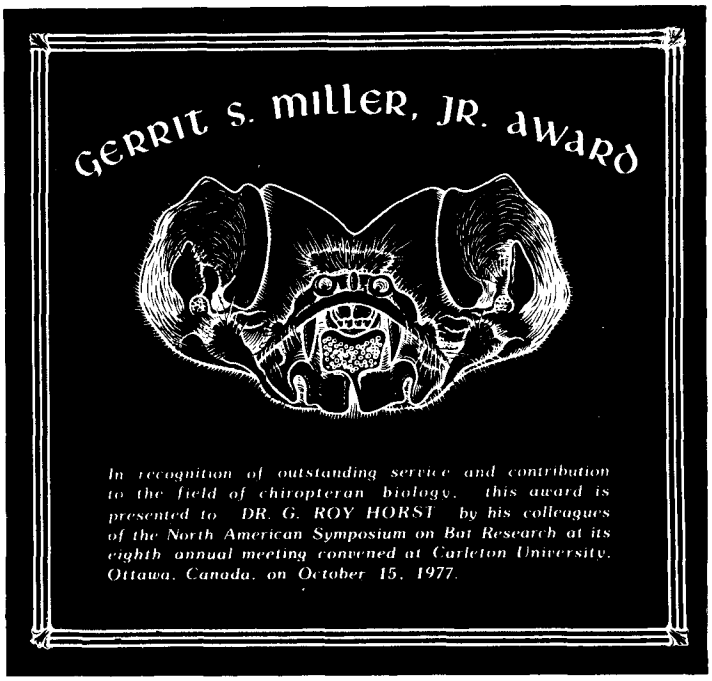

At the eighth annual North American Symposium on Bat Research in Ottawa in 1977, a group of the participants led by James Dale Smith and James S. Findley initiated a tradition among the membership to make an occasional special award to an individual for outstanding service. This award was named in honor of the late Gerrit S. Miller, Jr. a student of bat biology who was active in the early years of this century. The award, illustrated above, was first presented to G. Roy Horst in recognition of his services to the community of bat biologists, primarily for his efforts in arranging, staging, and otherwise keeping together the first eight symposia from 1970 in Tucson to 1977 in Ottawa. This was no small feat since the group annually "votes itself out of official existence." (The recipient must add that this task remains almost all reward and satisfaction with but a minimum of effort). Dr. Horst received his Ph.D. from Cornell University in 1968 under the direction of William A. Wimsatt. His research interests are in renal structure and function in xeric mammals, including bats from the neotropics.

The Gerrit S. Miller Award was also presented to Dr. Karl F. Koopman at the meeting in Ottawa in recognition of his many contributions to our understanding of chiropteran systematics. Dr. Koopman earned his Ph.D. from Columbia University in 1950 under the direction of Theodosius Dobzhansky. Dr. Koopman continues to be one of the premier chiropteran systematists, and is currently contributing a series of short articles in these pages (26-27) on the taxonomic characters of each family of the Chiroptera.

At the tenth Symposium in 1979 in St. Louis the Gerrit S. Miller Award was presented to Dr. Donald R. Griffin in recognition of his pioneering work in echolocation, and his continuing contributions to our understanding of this complex subject. Dr. Griffin earned his Ph.D. from Harvard University in 1942 under the direction of Professor K.S. Lashley. He continues to contribute to this rapidly expanding discipline and is also widely acclaimed for his recent works on the fascinating question of animal awareness.

In 1981 at the twelfth Symposium in Ithaca the 4th Gerrrit S. Miller Award was presented to Dr. William A. Wimsatt in recognition of his voluminous contributions to our understanding of chiropteran reproductive morphology and physiology. Dr. Wimsatt earned his Ph.D. from Cornell University in 1943 under the direction of Professor Howard Adelmann. Dr. Wimsatt's three volumes on the "Biology of Bats" has become a classical source and reference work for bat biologists around the world. He continues to contribute to many topics in anatomy and physiology with emphasis on ultrastructural relationships of maternal and fetal membranes of the placenta.

The author must point out that none of the above all too brief "biographies" are by any means complete. Space does not allow me to list the nearly 200 publications by these scholars nor is there room to name the more than 70 graduate students who have earned their degrees under their direction. These achievements and their other contributions will hopefully be the subject of longer articles by authors who can do them justice.

The Gerrit S. Miller award will be presented on occasion in the future to deserving candidates who have made major contributions to the subject of chiroptology and who are nominated for this award by their colleagues in the study of bats. The nominees will be reviewed and the award will be made by a "committee" consisting of the previous recipients. Nominations may be made at any time to any member of the "committee." Nominations should be accompanied by an inclusive narrative and should be supported by letters from three other workers in the broad area known as bat biology. The awards will be announced and presented at the following Symposium on Bat Research. There are many scholars among our ranks who are deserving of this award and we hope to receive several nominations for consideration in the coming years. We (the awardees) are confident that this pleasant tradition has a bright future.

Received July 7, 1982

NEWS AND VIEWS

THE ZIMBABWE CHRONICLE

In January and February 1982, a group of bat people spent some time in the field in Zimbabwe. Included in the party were Dr. Rod Suthers and one of his graduate students (Jeff Wenstrup) from Indiana University, David Thompson from the Rockefeller University, Dr. Robert Barclay from the University of Manitoba, and Brock Fenton and two graduate students (Marty Leonard and Connie Gaudet) from Carleton University. Also in the field with the party was Dr. Pat Weatherhead from Carleton University, busy on various ornithological endeavours. Through the kind co-operation of Zimbabwe's National Parks and Wildlife Department, we were able to spend almost all of our time in the field, in spite of British Airways and the weather in Europe. Dave Thompson was sending up radio microphones on kite

balloons to measure the activity of bats at different altitudes over the woodland. As it happened, his supply of helium lasted as long as one of the kite balloons. Rod Suthers and Jeff Wenstrup worked on some aspects of pulse production in some species of rhinolophoids, concentrating mainly on *Rhinolophus hildebrandti.* They also did some single unit recordings from the brain of *Scotophilus leucogaster,* one of the common vespertilionids in the area. Both Rod and Jeff became well versed at avoiding lions and rhinos. Connie and Marty spent a good deal of their time watching for crocodiles, in addition to working on prey location and handling behaviour in two species of *Nycteris, N. grandis* and *N. thebaica.* Robert and Brock spent most of their time radio-tracking *Scotophilus leucogaster* to find out more about their roosting and feeding habits. Apart from the theft of a small cassette tape recorder used to make field notes, presumably by a hyena, there were few exciting adventures during the expedition.

4 April 1982

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WILFRIED SCHOBER (DDR-705 Leipzig, Freidrich-Dittes-Strasse 8, GDR) enclosing a paper by M. Wilhelm and U. Hiebsch (Die Kliene Hufeisennase - eine vom Aussterben bedrohte Fledermausart. Naturschutzarbeit, 23:50-56, 1981) wrote: I am sending you an article about the most endangered species of our country - *Rhinolophus hipposideros.* In contrast to the report of Hubert Roer concerning this species in West Germany, in our country (GDR) the number of *R. hipposideros* has also dropped. But around Dresden at present we have 10 summer colonies. The following Table summarizes the data since 1969:

Colonies observed in	1969	1970	1980	1982
Summer	18	-	8	10
Winter	-	8	2*	-

*very often one individual was seen

The decline of bats in the summer roosts is quite remarkable. The reasons for this decline appear to be the loss of suitable roosts, use of toxic materials and disturbance by people, and reduction of food supply.

BAT RESEARCH NEWS, vols 1-11 with only one or two missing numbers are available through the courtesy of Arthur F. DiSalvo, M.D. If you could use these, address your letter offering postage to: AFD, Chief, Bureau of Laboratories, Box 2202, Columbia, SC 29202 USA, tel: 803-758-4491.

VIRGINIA TIPTON (Biology Department, Radford University, Radford, Virginia 24142 USA, Tel: 703-731-5091) would greatly appreciate receiving bat skins and skulls for enriching her department's mammal collection. If you have some specimens that might qualify as extras please get in touch with her.

PHOEBE WRAY sent the following information on the Endangered Species Newsletter: Federal budget cuts have drastically reduced readership of the "Endangered Species Technical Bulletin," a publication of the U.S. Fish and Wildlife Service containing news and information about endangered species and regulations covering them. To insure that this information is available to the public, The Center for Action on Endangered Species, a not-for-profit international environment group, is distributing the "Technical Bulletin" on a subscription basis. The cost of a one year (one volume) subscription is $14.00, which covers 12 issues and the index. The Center for Action will also include amplifying material from time to time to Bulletin subscribers. For more information, or to subscribe to this unique publication, contact The Center for Action on Endangered Species, Inc., 175 West Main Street, Ayer, MA 01432 USA, Tel. 617-772-0445.

KEIR STERLING is editing a *Biographical Dictionary of North American Environmentalists,* designed to cover most leading naturalists and environmentalists active in Canada, the U.S., and Mexico from early colonial times down to 1970. These will include mammalogists, among others. He welcomes nominations of suitable subjects, particularly native Mexicans or those active in that country from 1500 on. Nominees must have been deceased prior to 31 December 1970. Names of individuals willing to write sketches of these subjects would also be most helpful. Sterling is also editing an *International History of Mammalogy.* It is hoped that the first volume will be ready in time for the IIIrd International Theriological Congress in Helsinki in August, 1982. Authors are still needed to write chapters describing developments in mammalogy in a number of African, Asian, and Latin American nations for future volumes. Some chapters have been written by more than one author. Please communicate with Sterling at 31 Chestnut Street, Rhinebeck, N.Y., 12572.

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NOTICE

13th BAT SYMPOSIUM-LOUISVILLE

As announced in the last issue of Bat Research News, the 13th Annual North American Symposium on Bat Research will be held on October 15-16, 1982. Our host will be Dr. Kunwar Bhatnagar of the University of Louisville. The "Official hotel" wil be the Rodeway Inn which is giving us a much reduced group rate of $32.00 single, $40.00 double. Check the May issue of Bat Research News Vol 23:2 pp. 18-19 for details. The following dates should be marked on your calendar!

The official program with titles and authors will be mailed on September 3, 1982.

SOME DATES AND DEADLINES

August 15, 1982. Titles and abstracts are due. (Send to Horst)
(extended to Aug. 31st) GRH.

September 1, 1982. Hotel reservation cards should be sent to Rodeway by this date.

September 15, 1982. Last date for pre-registration at $15.00. After this date registration will be $20.00 (Send to Horst)

October 14, 1982. Thursday, arrival and registration, cocktail party at 8:00 p.m.

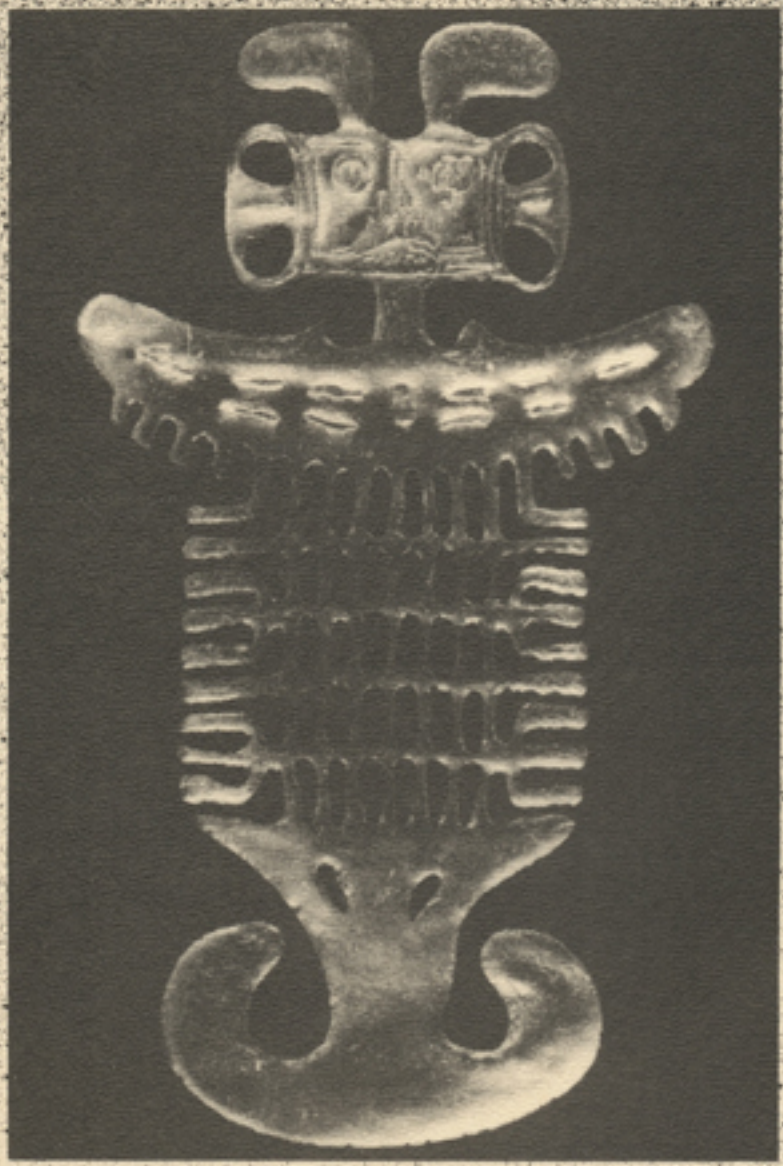
October 15, 1982. Friday formal sessions Banquet Friday evening.

October 16, 1982. Saturday formal sessions, adjournment.

If you need a title transmission sheet, conference registration form, or a hotel reservation card, write or call me and I'll send them to you by return mail. These forms were included in May issue of Bat Research News.

G. Roy Horst
Department of Biology
State University College
Potsdam, NY 13676

BAT RESEARCH NEWS



VOLUME 23 NO.4 NOVEMBER 1982

BAT RESEARCH NEWS

Instructions to Contributors

1. *Bat Research News* is published four times per year, each year consisting of one volume of four numbers. Publication dates, February, May, August, and November. Sometimes the numbers are combined. *Bat Research News* publishes short papers, general notes, etc., which are rigorously edited and reviewed. Manuscripts dealing with original work should be submitted in triplicate following the latest *CBE Style Manual* or following the style used in Journal of Mammalogy. In addition, latest news on bat research, correspondence, book reviews, meeting announcements, reports and recent literature citations are included. Communications concerning all these matters should be addressed to Kunwar Bhatnagar. Reprints of articles can be purchased.

2. Subscriptions to individuals are U.S. $6.00 per year mailed 3rd class to U.S. addressed, 1st class to Canada and Mexico. All other countries, bulk rates unless $1.00 per issue air mail is prepaid.

3. Institutional subscriptions are U.S. $10.00 each world wide

4. Communication concerning dues, subscriptions, advertisement rates, or back issues should be addressed to Roy Horst.

Typeset by Victoria Varengo

Mailed at Potsdam, New York 13676 USA

BAT RESEARCH NEWS

Vol. 23 No. 4 November 1982

Contents

FRONT COVER

"Pectoral quiropteriforme-precolombiano". Original artifact in gold. Currently in the Museo de Oro, Banco de la Republica, Bogota, Colombia. The figure is a gold chest pendant about 4 inches in length of procolombian (presumably Inca) origin. It represents a bat, possibly a phyllostomatid (see what appears to be a noseleaf in the facial impression), but this is only a guess. William A. Wimsatt

(Editor's Note: a beautiful color photograph of a similar cast gold pectoral in the Tolima style appears as jacket illustration and in the book "The Search for El Dorado" by John Hemming, Dutton, NY, 1978. This book has other photographs of anthropomorphic figurines of cast gold having wings and bat-like noses.)

BAT RESEARCH NEWS

Vol. 23 30 November 1982 No. 4

NEW RECORDS OF WYOMING BATS

Mark R. Stromberg
The Nature Conservancy
1732 Pearl Street, Denver, Colorado 80203

Since Long's work on Wyoming mammals was published, few new records of Wyoming bats have appeared. I collected data on bats in Wyoming from 1979 to 1981 (Stromberg, 1981). Specimens were collected with mist nets from various locations in Wyoming. Additionally, I collected material from the State Veterinarian Laboratory at the University of Wyoming from 1980-81.

The Wyoming State Veterinary Laboratory receives from 200 to 500 bats each year from throughout the state for examination for suspected rabies. These bats are sent by various village veterinarians. The laboratory froze all bats until I could examine them. Data for these bat specimans reported here are those which document new distributional records since Long (1965). Species with statewide distributions or large numbers of Wyoming specimans (Long, 1965), are not reported here. Locality data were recorded for those specimans collected by the veterinarians. I requested specific locality information on bats through an article in the laboratory's newsletter which is distributed statewide. Other workers are urged to take advantage of such situations in other states to increase our knowledge of bat distribution, for usually these valuable specimans are routinely destroyed.

Table 1 includes data for three species new to the fauna of Wyoming and two species confirmed by second records. These new records are of relatively rare species. In 1980, no accurate records were kept, but the veterinary laboratory destroyed over 100 *Myotis lucifugus* and about 50 *Eptesicus fuscus.* These were also frequently collected in mist nets throughout the state. In 1981, the laboratory received 8 *Myotis subulatus,* 19 *Lasionycteris noctivagans,* 41 *Eptesicus fuscus,* 6 *Myotis volans,* 2 *Myotis evotis* and approximately 80 *Myotis lucifugus.*

Habitat data are available for some species. *Lasiurus borealis* (MRS-328) was shot from a cottonwood tree along a reservoir in a sage (*Artemisia*)steppe. *Antrozous pallidus* were collected from a large group in a vacant country road shop, surrounded by rolling shortgrass prairie. The *Tadarida brasiliensis* was found dead on a parade ground lawn in the early morning by a child. The parade ground was surrounded by old barracks, a small riparian area and generally, a shortgrass prairie. *Lasiurus cinereus* was found in a wide variety of habitats from low alkaline greasewood (*Sarcobatus*) flats to Ponderos pine woodlands. *Lasionycteris noctivagans* was found only in urban areas. The other species were collected from ranches, generally in isolated, rural areas.

TABLE 1. New Records of Wyoming Bats

SPECIES/FIELD NUMBER	MUSEUM	COLLECTION LOCALITY AND COMMENTS	
Lasiurus cinereus			
MRS-215*	UW	Alkali Draw, Sweetwater Co.†	11 Jul 1980
MRS-329*	UW	Cheyenne, Laramie Co.	15 Jun 1981
MRS-333	BS/FC	Squaw Peak, Albany Co.	19 Sep 1981
MRS-412	BS/FC	Shoshone, Fremont Co.	7 Aug 1981
Lasionycteris noctivagans			
MRS-319	BS/FC	Cheyenne, Laramie Co. Several specimans	June-Sept., 1979-81
MRS-377	BS/FC	Shawnee, Converse Co.	5 Aug 1981
MRS-379	BS/FC	Casper, Natrona Co.	29 Sep 1981
MRS-386	BS/FC	Burns, Laramie Co.	31 aug 1981
MRS-387	BS/FC	Rock Springs, Sweetwater Co.	5 Sep 1981
Lasiurus borealis			
MRS-328	BS/FC	Rawlins, Carbon Co. Female with 4 embryos	27 May 1981
MRS-413	BS/FC	Laramie, Laramie Co. Only one other record exists for Wyoming (in Long, 1965) but I could not locate that specimen in the U.S. National Museum during visits in 1979 and 1981.	4 Sep 1981
Myotis yumanensis			
MRS-335	BS/FC	Sheridan, Sheridan Co. Determined by M. Bogan. New record for Wyoming.	3 Jul 1981
Tadarida brasiliensis			
MRS-421	BS/FC	Cheyenne, Laramie Co. Warren Air Force Base New record for Wyoming.	7 Jul 1981
Antrozous pallidus			
MRS-436-439	BS/FC	Torrington, Goshen Co. Range extension (500 km) from Flaming Gorge, Wyoming, see Durrant and Dean (1960).	20 Aug 1981
Myotis californicus			
MRS-440	BS/FC	Powell, Park Co. Determined by M. Bogan. New record for Wyoming.	31 Aug 1981

Those with (*) were mist netted, others were collected by veterinarians. † Co. - County

Specimans cited above are deposited in either the U.S. Fish and Wildlife Museum at Fort Collins, Colorado (BS/FC) or at the Museum of Vertebrate Biology, Department of Zoology and Physiology, University of Wyoming, Laramie (UW).

Curatorial assistance from Mark Boyce and Bob Finley is appreciated. Michael Bogan identified the problematic *Myotis*. The Nature Conservancy, Wyoming Natural Heritage Program, provided financial support for this work.

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Durrant, S.G., and N.K. Dean. 1960. Mammals of Flaming Gorge Reservoir Basin. In Woodbury, A.M. (ed.), Flora and Fauna of Flaming Gorge Reservoir Basin, Utah and Wyoming. Univ. Utah Anthro. Pap. No.48:210-230.

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Submitted 25 May 1982. Revised and Accepted 30 June 1982

DR. BERNARDO VILLA-RAMIREZ, CHIROPTOLOGIST, MAMMALOGIST, FRIEND: A TRIBUTE

William A. Wimsatt
Division of Biological Sciences, Cornell University
Ithaca, New York 14850

From improbable origins sometimes spring great men and superlative human beings. High in the remote cordilleras of central Guerrero State in Mexico-in Teloloapan, a small town only reachable until recently via a 70 kilometer barranca-skirting dirt and stone track, was born on May 4, 1911 to S. Andres Villa-Brito and his wife, a son, duly christened *BERNARDO VILLA-RAMIREZ*. The young Bernardo might easily have pursued the rural agrarian life-style of his Aztecan antecedants, but he chose another route. He became a teacher, his first assignment a rural school in Yerba Buena, a tiny town near his birth place. In tribute to his youthful dedication and drive it should be recorded here that Bernardo not only taught the children of Yerba Buena, but he built the school with his own hands-presumably with some assistance from his older pupils and local townspeople; this edifice was still intact when in the early sixties he and I, while on a bat collecting trip, passed that way on the open bed of a large truck-for the road was quite impermeable to smaller vehicles.

Aspiring to self improvement, and having somewhere along the way developed an intense interest in nature and wildlife, Bernardo eventually enrolled in a degree program in biology at the National University (U.N.A.M.) in Mexico City and in 1944 was awarded the Maestro in Ciencias degree. By then he had developed a major interest in mammals, bats in particular, and seeking oppurtunity to broaden his perspectives he undertook a graduate program at the University of Kansas, where he was appointed Assistant Professor of Comparative Anatomy in 1945. After receiving a Master of Arts degree in Zoology at Kansas in 1947, Bernardo returned to Mexico and U.N.A.M. where he became Assistant Professor of Zoology, and in 1960 Professor of Comparative Anatomy. His research degree, Doctor of Biology, was awarded him at U.N.A.M. in 1961.

Bernardo's activities as a student, researcher, and teacher during these busy years by no means exhausted his determination and energies. From 1948-55 he was Head of the Department of Biology, Game Department, Former Direccion Forestal y de Caza, SAG, and in 1950 founded one of the first national Game Reserves, "San Cayetano", in Edo. de Mexico, west of Mexico City. It was also during this time that he authored and codified the game laws and licensing procedures still in effect throughout Mexico. In 1948 he initiated and subsequently built up at U.N.A.M. the first major systematic mammal collection in Mexico, and he was the first to put

the study of mammalogy on a sound professional footing in his country. He was Head of the Section of Mammalogy at the Instituto de Biologia at U.N.A.M. from 1957 to 1967, and continues currently as Chief of the Laboratory of Mammalogy in new facilities completed in the early seventies. From 1968-1971 he also served a term as Head of the Department of Zoology, Instituto de Biologia at U.N.A.M.

These and other activities elevated Bernardo to a position of eminence both in his own country and abroad. In 1967 he served as Consultant Mammalogist to the Pan American Sanitary Bureau, FAO, in Argentina and Brazil, addressing ecological and public health problems associated with mammalian vectors of disease, especially vampire bat transmitted rabies. From 1970-1972 he served as Director, Direccion General de la Fauna Silvestre, Subsecretaria Forestal y de la Fauna, SAG, which placed upon him the primary responsibility for managing all forests and wild animal resources of Mexico. It was through his cooperation, for example, that the splendid Big Horn Sheep exhibited at the famous Arizona-Sonora Desert Museum near Tucson, Arizona were secured from northern Mexico.

Bernardo has long been a member of various national and international professional societies and has held high office in several of them; he is a member of the Board of Directors of the American Society of Mammalogist; a charter member of the Marine Mammal Society; founder and first President of the Soc. Mexicana para el est. de los mamiferos Marinos, A.C.; President, Bioconservacion, A.C.; member of the Conservation Committee of the International Union for the Conservation of Nature and Natural Resources - to mention but a few.

Bernardo has been s prolific contributor to the literature of mammalogy, having authored or coauthered over 155 papers in professional journals. Additionally he has authored two large

monographs, "*The Wild Mammals of the Valley of Mexico*" (in Spanish) published in 1953, and, of special interest to chiroptologists, "*The Bats of Mexico, their Importance to Economy and Public Health and their Systematic Classification*" (in Spanish) published in 1966. A third major work "*The Mammals of Mexico and Central America*" (in Spanish) is currently in preparation.

A mere listing of Bernardo's accomplishments fails to convey the true timbre of the man. It is probably safe to say that few vertebrate biologists who have worked in Mexico have not been assisted in significant ways in their enterprises by this generous and cooperative scientist, whether it be helping in the procurement of permits, identification of appropriate collecting sites, as an indispensible field companion and interpreter on extended field trips, in the hospitable sharing of the facilities of his laboratory - and in at least several instances the writer knows of, protecting the physical welfare of visiting scientists who through intent or inadvertance violated the mores or sensibilities of local campesinos or officials. Bernardo Villa-R is a simple, affectionate, uncomplicated man of great determination, energy and good will, straightforward and honest in his relationships, and endowed with an infectious sense of humor that has eased many a tense sense situaton. Chiroptologists are fortunate to be able to include this productive scientist and humanist among their ranks.

Received 17 August 1982

NEWS and VIEWS

A LETTER TO THE EDITOR

I have been a subscriber to BRN for a number of years and have noted that many papers on the ectoparasites of bats have not been included in the "Recent Literature" section. My wife and I compile a newsletter for specialists working on fleas. A copy of the latest issue is included for your information. If you are interested, we would be happy to provide you with the current citations of papers dealing with bat fleas for inclusion in BRN.

Also, I would appreciate it if you could include an appeal in your next issue. Mammalogists in general seldom collect ectoparasites from the mammals with which they work. As a result a major aspect of the specialty is largely overlooked. World-wide there are currently 19 genera and 102 species of ischnopsyllid fleas plus a myriad of polyctenids, nycterbiids, streblids, cimicids, arixenids, mites and ticks that depend on bats as hosts. In the order of Diptera alone, Marshall (1981) lists three families which are exclusively associated with bats. I am currently revising the siphonapteran family Ischnopsyllidae and one of the problems is lack of material. Such genera as *Coorilla, Dampfia, Mitchella, Rothschildopsylla* and *Serendipsylla* are known from fewer than ten specimans each, some fewer than five. It seems to me that chiropterists are missing out on making a major contribution to their own specialty, as well as entomology and parasitology in general, by ignoring the ectoparasites. Perhaps the inclusion of this letter in BRN would stimulate more interest in these fascinating organisms.

June 25, 1982

Robert E. Lewis
Curator, Iowa State University Insect Collection
Ames, Iowa 50011

(Dr. Lewis has been invited to provide current citations as well as a brief note on the collection and preservation techniques for ectoparasites of bats. This article should appear in the May 1983 issue of BRN - Editor.)

NEW BOOK ON BATS

A new book *Ecology of Bats* (Thomas H. Kunz, editor; $49.50 U.S. and Canada / $59.40 foreign) is now available from Plenum Publication Corporation, 233 Spring Street, New York, NY 10013. The contents are: Roosting ecology of bats (T.H. Kunz). The ecology of reproduction (P.A. Racey). Growth and survival of bats (M.D. Tuttle & D.E. Stevenson). Evolutionary alternatives in the physiological ecology of bats (B.K. McNab). Ecological aspects of bat activity rhythms (H.G. Erkert). Ecological signficance of chiropteran morphology (J.S. Findley & D.E. Wilson). Ecolocation, insect hearing, and foraging ecology of insectivorous bats (M.B. Fenton). The foraging strategies of plant-visiting bats (T.H. Fleming). Coevolution between bats and plants (E.R. Heithaus). The ecology of insects ectoparasitic upon bats (A.G. Marshall). Index. (Reviewed by D.W. Morrison in *Science*, 219: 961-962, 25 February 1983).

FOURTEENTH ANNUAL NORTH AMERICAN SYMPOSIUM ON BAT RESEARCH

The Fourteenth Annual North American Symposium on Bat Research will be held in Fort Collins, Colorado on October 21-22, 1983 at the invitation of Dr. Michael Bogan. Further details appear on page 85 of this issue.

SEVENTH INTERNATIONAL BAT RESEARCH CONFERENCE
Aberdeen, Scotland, Aug-Sept, 1985

Preliminary announcement

The Seventh International Bat Research Conference will be held at the University of Aberdeen in 1985. Dr. Paul Racey will be the host. The delegates of the Thirteenth Annual North American Symposium on Bat Research at Louisville greeted Drs. Racey and Uwe Schmidt's proposal with enthusiasm and unanimously voted in favor of it. Further details and preliminary registration information will appear in a later issue of *Bat Research News*. For enquiries please contact: Dr. Paul A. Racey, Department of Zoology, University of Aberdeen, Tillydrone Ave., Aberdeen, AB9 2TN, Scotland.

(I should like to propose than an organizing committee for International Bat Symposia be established. We could either ask for one nominee from each of the continents [Africa, Asia, Australia, Europe, Eastern block countries, North America, and South America], or by general consensus approach the obvious personages to accept the responsiblity. Please address your views on this issue to the editor.)

SECOND EUROPEAN SYMPOSIUM ON BAT RESEARCH
Bonn (FRG), September 21-25, 1983

The second European Symposium will be held at the Zoological Institute of the University of Bonn just before the annual meeting of the German Mammal Society to be organised by the Museum Alexander Koenig as Bonn. Platform and poster sessions will be arranged. Participants are encouraged to send preliminary registration to Prof. Uwe Schmidt, Zoolocial Institut, Poppelsdorfer Schloss, D-5300 Bonn (FRG) giving your name, address, and preliminary title of your platform or poster contribution. Details will be announced by Dr. Schmidt in January 1983. Please note that the deadline for the final registration was April 15, 1983. The abstracts should be sent no later than June 30, 1983.

FOURTH INTERNATIONAL THERIOLOGICAL CONGRESS, 1985

The IV ITC will take place August 13-20 on the campus of the University of Alberta in Edmonton. The purpose of this notice is to solicit names for a preliminary mailing list of potential participants, and to request comments and suggestions.

The names of all who attended any of the first three congresses will be placed on the provisional mailing list for IV ITC, but, if your address as listed inthe Transactions of the Congress you attended is no longer correct, please send a current address.

If you have not attended any of the previous congresses but have any intention of coming to Edmonton in 1985, please send your name and address to the undersigned so that you will receive the first mailing, probably early in 1983.

It is expected that IV ITC will follow the general format adopted at Helsinki. If you have comments or suggestions for improvement please pass them along. Finally, if you have suggestions for symposia or workshops or plenary speakers please pass them along too. We are particularly interested to hear from anyone with a burning desire to organize, or help to organize a symposium or workshop.

November 8, 1982

W.A. Fuller
IV ITC
P.O. Box 632
University of Alberta
Edmonton, T6G 2EO
Canada

ROBERT L. MARTIN would greatly appreciate being contacted by anyone in charge of an institutional or private collection which includes specimens of *Noctilio leporinus* who has not already been contacted by him (Biology Section, Univ. of Maine at Farmington, Farmington, ME 04938).

ON THE *BAT RESEARCH NEWS*: OUR READER'S VIEWS

PATRICIA BROWN, Los Angeles: You have done a good job - good format and marvelous stamp on cover. I'll try to find some pictures for you.
DENNY CONSTANTINE, Berkeley: You have assumed quite a chore in taking the editorship, and you deserve the gratitude of many workers. The best of success to you in this and your other work.
M. BROCK FENTON, Ottawa: The new letterhead looks fantastic! My copy of the August 1982 *Bat Research News* arrived today; it looks just great; very polished and professional. Congratulations.
THOMAS KUNZ,Boston: Congratulations on doing such a nice job with the BRN. It is clearly the best such newsletter put out. Perhaps it is time to consider changing the title to something like "Chiroptera". Maybe it's worth a discussion at the business meeting.
ROBERT MARTIN, Farmington, ME: Your work on BRN is outstanding. I know how much time it must take, remembering how much time it took me in a simpler format. The cover photos are nice, and I'm glad to see them back.

PAUL RACEY, Aberdeen, Scotland: Congratulations on your first two issues of BRN. They are splendid, and I particularly like your idea of including author's addresses with recent literature. This makes it very convenient to write for reprints.
ALDO VOUTE, Utrecht, Netherlands: I think the *Bat Research News* is looking wonderful now. The changed look and style improved it considerably. BRN has reached international standards. There may be one suggestion concerning the general layout of BRN. On each pair of opposite pages is printed for instance, Volume 23: No. 2, May 1982. Adding *Bat Res. News* or in full *Bat Research News* may be quite helpful. When somebody wants to copy one or several pages from BRN he does not have to write the name of the journal on every page.
(The editor and the managing editor are thankful for your kind expressions and encouragement. A new name for BRN is in our mind too. Your suggestions are welcome.)

LITERATURE RECEIVED

Natur und Museum, Band 112: 1-4, 5-8, 9-12 (1982)

Mondo sotterraneo rivista semestrale del circdo speleologico e idroligico friulano, nuova serie anno V-n.2-ottobre 1982; VI-n.1-2-aprile-ottobre 1982.

The NSS Bulletin, 44: 1-4 (1982)

House Bat Management - A.M. Greenhall

Flea News 24 (May 1982). Compiled by Robert E. and Joanne H. Lewis, Iowa State University, Ames, Iowa 50011 USA

Endangered Bats of Arkansas: disribution, status, ecology, and management. - M.J. Harvey, J.J. cassidy and G.G. O'Hagan. 137 pp. (Ecological Res. Center, Department of Biology, Memphis State University, Memphis, TN 38152 USA).

BAT CONSERVATION INTERNATIONAL brochures - M. Tuttle

Bat protection campaign posters, leaflets, and literature of the Netherlands Department of Cultural Affairs - A.M. Voute

ACTA THERIOLOGICA, 27 (1-12), July 1982 - Polish Academy of Sciences

EDITOR'S ACKNOWLEDGEMENTS

The editor is grateful to the following persons who reviewed manuscripts for volume 23 (1982) of the *Bat Research News*:

Sydney Anderson, Michel Bogan, M. Brock Fenton, G. Roy Horst, J . Knox Jones, Jr., Karl F. Koopman, Charles A. Long, John J. Rasweiler, IV, and William A. Wimsatt.
Grateful thanks to: P. Brown, M. Brock Fenton, K.B. Karim, C.M. Senger, V. Tipton and H. Walley for assistance with the Recent Literature section in *Bat Research News*, volume 23 (1982).

ERRATUM

Volume 23 (3), page 34: The correct telephone number of Dr. Tipton is 703-731-5191.

RECENT LITERATURE

ANATOMY

Cliff, W.J., and P.A. Nicoll. 1981. The lymphatics of the bats wing - an *in vivo* and electron microscope study. IN Festschrift for F.C. Courtice (ed. D. Garlick), pp. 175-184, University of New S. Wales, 252 pp. (Australian National University, Dept. Exptl. Pathol., Canberra, ACT 2601, Australia).

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Pentney, R.P., and J.R. Cotter. 1981. Organization of the retinofugal fibers to the dorsal lateral geniculate nucleus of *Pteropus giganteus*. Exp. Brain Res., 41: 427-430. (Anatomy, State University of New York at Buffalo, 317 Farber Hall, Buffalo, NY 14214 USA).

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Abstracts alphabetically by first author

Luteinizing Hormone Releasing Hormone Immunoreactive Cells and Fibers in the Forebrain of the Little Brown Bat, *Myotis lucifugus lucifugus* Edythe L.P. Anthony, Joan C. King, Alvar W. Gustafson, David A. Damassa, Department of Anatomy and Cellular Biology, Tufts University Schools of Medicine, Boston, MA 02111.

Luteinizing hormone releasing hormone (LHRH) was identified by the peroxidase-antiperoxidase method of immunocytochemistry in the forebrains of 29 adult male and 12 adult female little brown bats. Morphology and distribution of LHRH-immunoreactive neuronal cell bodies and processes were determined at the light microscopic level using both post-embedding immunocytochemistry in paraffin sections (10-20 um) and pre-embedding immunocytochemistry in Vibratome sections (50 um). Thin sections of resin-embedded Vibratome sections were used for electron microscopic analysis of immunoreactive neurons. The primary antiserum used in these immunocytochemical procedures was anti-LHRH #29, prepared by Dr. I.M.D. Jackson (Tufts New England Medical Center). Neurons containing immunoreactive LHRH were rounded unipolar or ovoid bipolar cells and often exhibited a cytoplasmic swelling at the origin of a cell process. In these cells, conspicuous secretory granules and other immunoreactive organelles (rough endoplasmic reticulum, Golgi apparatus) were distributed in a thin rim of cytoplasm. The majority of LHRH-immunoreactive cells was located within the basal hypothalamus in the region of the arcuate nuclei in both male and female bats. LHRH cells were also found dispersed in more rostral forebrain areas: anterior hypothalamus, preoptic areas, septum, and diagonal band of Broca. Occasionally, cells were identified in the habenula, amygdala, olfactory bulb, pineal, and cingulate cortex. Terminals of LHRH neuronal processes, containing immunoreactive secretory granules, were most abundant in the median eminence of the hypothalamus and in the proximal portion of the pituitary stalk. Extrahypothalamic projections of LHRH fibers were especially numerous in the stria medullaris and medial habenula, and were also seen within the stria terminalis, which projects to the amygdala. In addition, scattered fibers were consistently located throughout the areas which contained LHRH cell bodies, and were occasionally observed in olfactory areas, the pineal, the organum vasculosum of the lamina terminalis, and the subfornical organ. Concentration of LHRH cells in the basal hypothalamus in *Myotis l. lucifugus* closely resembles the pattern of cell dispersion described in primates (Barry and Carette, Cell Tissue Res. 164:163), but differs considerably from that observed in rodents (King et al., J. Comp. Neurol., in press). Also unlike rodents, extrahypothalamic projections are prominent in both *M.l. lucifugus* and primates. Terminals in the median eminence are primarily neurovascular contacts for the release of LHRH, which induces pituitary luteinizing hormone secretion. LHRH released from terminals of extrahypothalamic projections may function primarily as a neurotransmitter or modulator of neuronal function, and may integrate the actions of widely separated areas within the central nervous system that control reproduction. Interspecific variations in dispersion of LHRH cells and fibers may reflect phylogenetic variations in regulation of LHRH secretion and reproductive function.

Female Reproductive Cycle in the Mouse-Tailed bat, *Rhinopoma hardwickei hardwickei*. Shibani Banerjee and K. B. Karim, Department of Zoology, Institute of Science, Nagpur, India.

At and near Agra, in Uttarpradesh, India, *Rhinopoma hardwickei hardwickei* experiences an annual reproductive cycle. The present study is based on the observation of 324 females collected over a period of two years. The female genitalia are morphologically bilaterally symmetrical and form a 'Y' shaped structure. The ovary is surrounded by the fimbriated funnel leaving only a small opening on the median side of the ovary. The lumina of the two uterine cornua become confluent at their caudal ends and open by a common cervical canal at the tip of a long cervix which extends to about a third of the length of the vagina and expands into a distinct bulb at its distal end at about the middle of the length of the vagina. Copulations in the colony occur during the latter half of February and the first week of March, however, ovulation does not occur until the 11th of March. All the females in the colony do not conceive synchronously. Some of the females which conceive later in the season, deliver the young ones late in July. Gestation lasts for 95-100 days and deliveries occur during the latter half of June or the beginning of July. Ovulation may occur from either ovary with nearly equal frequency, and a single young is borne during each cycle. The lactation period extends for a period of about two months. The corpus luteum remains within the confines of the ovary until the embryo reaches the uterus when it becomes extrovert. It persists until the early limb-bud stage of development of the embryo after which it disappears. The females of *Rhinopoma hardwickei hardwickei* reach sexual maturity when they are 9 to 9 1/2 months old.

Controlling Bats in Buildings. Robert M. R. Barclay; University Field Station; University of Manitoba; Portage la Prairie, Manitoba, Canada R1N 3A1

Countless means have been used in an attempt to control the use of human dwellings by bats, but in most cases, these measures are less than a total success and occasionally only serve to compound the problem. Bat/human contacts in buildings are due to two different phenomena: permanent nursery colonies involving many bats, and transient individuals. Tests in Ontario, Quebec and Manitoba have shown, logically enough, that sealing out the bats is the most effective and permanent solution to the nursery colony problem. This is also not as difficult as often envisaged. Transient bats present a more difficult problem, however. In these cases, bat/human contacts occur most frequently during the late summer and early fall when the young are newly volant and bats are moving from summer to winter roosts. Public education often helps eliminate perceived problems involving these temporary visitors.

Foraging Strategies of Lasiurines at Delta, Manitoba. Robert M. R. Barclay; University of Manitoba Field Station; Box 8; Site 2; RR 1; Portage la Prairie, Manitoba, Canada R1N 3A1

Preliminary information regarding the foraging behavior and ecology of three lasiurines was collected this summer using ultrasonic detectors and period meters, trapping, direct observation and fecal and insect sampling. Red (*Lasiurus borealis*) hoary (*L. cinereus*) and silver haired (*Lasionycteris noctivagans*) bats are present in the area although only the latter two are resident all summer. The bats all feed primarily over a long narrow forested ridge at tree-top height or higher, rather than at lower levels or over the marsh and lake on either side of the ridge. This area of feeding activity corresponds to the area of greatest insect abundance, which shifts from one side of the ridge to the other depending on the prevailing wind. Although chironomids dominate the nocturnal insect fauna all summer, both in terms of numbers and biomass, preliminary fecal analysis indicates the bats feed extensively on other prey: *Lasiurus cinereus* and *L. borealis* on moths and *Lasionycteris noctivagans* on a range of insects. The diets of *Lasiurus cinereus* and *Lasionycteris noctivagans* in particular, correspond to these bats foraging behaviors. Whereas *L. noctivagans* commonly feeds rapidly in a small area on swarms of insects, *Lasiurus cinereus* moves rapidly and attacks insects only occasionally although they are highly territorial at some prey patches such as in the lee of the ridge and at lights. Observations of adult female *L. cinereus* with young indicate that these family units remain together at diurnal roosts long after the young are flying and feeding themselves although the individuals feed independently. A variety of factors may select for this extended maternal care.

Neonatal Hematological Development in the Pallid Bat, *Antrozous pallidus*. John E. Bassett and Curt A. Wiederhielm, Department of Physiology and Biophysics, SJ-40, University of Washington, Seattle, WA 98195.

The high oxygen uptake necessary for flight in bats is supported in part by an elevated blood oxygen capacity relative to that of similar-size, nonflying mammals. The high blood oxygen capacity results from elevated red blood cell (RBC) counts, hematocrits (Hct), and hemoglobin concentrations ([Hb]); no difference in hemoglobin-oxygen affinity exists between bats and similar-size, nonflying mammals. The hematological changes occurring in the bat between birth and maturity leading to the elevated blood oxygen capacity are described here. The pallid bat matures morphologically by 40 days of age; weaning and first flight begin simultaneously between days 35 and 42. RBC count increases from 5 X 10^6/mm^3 at birth to the adult level of 12 X 10^6/mm^3 by day 84, Hct increases from 54% at birth to the adult level of 60% by day 84, and [Hb] increases from 14.8 g/dl at birth to the adult level of 18.0 g/dl by day 84. RBC count is highly correlated with body weight ($r = 0.94$, $P < .001$), and Hct and [Hb] are also highly correlated with each other ($r = 0.96$, $P < .001$). Mean corpuscular volume and mean corpuscular hemoglobin decrease from 110 μm^3 and 30 pg respectively at birth to the adult level of 50 μm^3 and 15 pg by day 42. Mean corpuscular hemoglobin concentration increases from 27% at birth to 30% in the adult. RBC diameter also decreases from 8.5 μm at birth to the adult diameter of 6.5 μm by day 42. As the pallid bat matures, the number of RBCs increases, but the diameter, volume, and hemoglobin content of each cell decrease. With maturity the packed cell volume and hemoglobin content of whole

blood increase, and the concentration of hemoglobin in the packed cell volume also increases. Blood oxygen capacity of the neonatal pallid bat is approaching that of the adult when the animal experiences its initial need for an elevated oxygen delivery with the onset of flight. Hematological development in the pallid bat is also similar to that of other altricial small mammals.

Sensory Flexibility in a Gleaning Bat *Macrotus californicus.* Gary P. Bell, Department of Biology, Carleton University, Ottawa Canada K1S 5B6.

I studied the feeding behavior and sensory ecology of the California leaf-nosed bat *(Macrotus californicus)* in the laboratory. The bats were observed under various lighting conditions, including total darkness using a Night Vision Scope under infrared sources, and monitored for the use of echolocation using a very sensitive bat detector. I also tested the bats' responses to the sounds of prey by presenting them with the tape-recorded calls of crickets. *Macrotus californicus* captured stationary prey on the ground in direct approaches in a manner similar to another gleaning bat, *Antrozous pallidus.* Prey were apparently located at fairly close range (0.5m). In total darkness the bats always used echolocation, but under illumination the bats shut off their echolocation system and relied mainly upon vision. Vision was used preferentially at illumination levels below that of bright moonlight. These bats also responded to the sounds of prey, including the calls of crickets. Subsequent tests on the visual acuity of *M. californicus* using the optokinetic response revealed that this species has the finest visual acuity of any bat tested to date, and sensitivity comparable with other visual, nocturnal mammals.

Foraging in the Hawaiian Hoary Bat, *Lasiurus cinereus.* *J.J. Belwood*
University of Florida Gainesville, Florida 32610

The Hawaiian hoary bat, *Lasiurus cinereus,* is the only bat in the Hawaiian Islands. Since it lacks interspecific competitors for food resources it should exhibit a broader range of prey selection than mainland *L. cinereus,* which are 'moth strategists'. The feeding and foraging behaviour of this bat were investigated in Kokee State Park, Kaua'i, Hawaii in August 1982. Dietary preferences were determined by quantitatively comparing insect remains in bat feces with insects available as prey, and by identifying culled insect fragments that were dropped by the bats as they foraged. General foraging behaviour was determined by direct observation of the bats. Hawaiian hoary bats foraged by lights at sea level and at an elevation of 4000' and were active under most weather conditions including moderate rain, full moon, and temperatures as low as 14° C. Foraging aggregations of up to six animals were common although each bat foraged in a territory that was defended against other bats. Small flies and small moths (8mm wing length) were the most common insects available to the bats as prey. While the bats fed on a variety of insects, large moths (10 mm BL) made up the bulk of the diet. Over half of these belonged to two species, *Elydna nonagrica* and *Haliophyle euclidias,* neither of which were abundant in insect trap samples. In terms of prey selection, the Hawaiian hoary bat appears to have deviated little from the mainland *L. cinereus.*

Feeding Rates of Frugivorous Phyllostomatic Bats in Parque Nacional de Santa Rosa, Costa Rica. Frank Bonaccorso and Thomas Gush, Department of Biology, University of Miami, Coral Gables, FL 33124; and Ecology and Evolution Department, State University of New York at Stony Brook, Long Island, NY 11794

The feeding rates and handling times for consumption of selected food items of five species of frugivorous phyllostomatid bats from Tropical Dry Forest of northwestern Costa Rica are reported. Fruits preferred by free-roaming bats, including *Ficus ovalis, Muntingia calabura,* and *Piper amalago,* were offered to captive bats in a 4 x 2 x 2 m flight cage in Parque Nacional de Santa Rosa. Two distinct feeding rhythm patterns were evident in the bat species tested. *Carollia subrufa, C. perspicillata,* and *Glossophaga soricina* fed in intermittent short bouts through the night mixed with longer inactive roosting periods. Within a typical feeding bout one to five fruits were consumed. During roosting periods these bats generally were quiescent but did occasionally self-groom, defecate, or socially interact with other individuals in a roosting cluster. By contrast, *Artibeus phaeotus* and *A. toltecus* typically exhibited constant feeding when observed for up to five hours. Each 1-2 g fruit handled by *A. phaeotus* and *A. toltecus* took 5-20 min. to consume whereas *C. subrufa, C. perspicillata,* and *G. soricina* consumed the same types of fruits in 0.2-1.5 min. It is hypothesized that the rate of feeding in these five bat species is a response to selective pressures dictated by the abundance, distribution, and biomass of fruit resources in the environment. Our findings are consistent with optimal foraging theory. *C. subrufa, C. perspicillata,* and *G. soricina* rapidly handle and consume several high quality fruits in an early evening feeding bout. The preferred food resources such as *Piper amalago* and *Muntingia calabura* in wet season months of May-August are limited in abundance and biomass and are significantly depleted early in a night by intra- and interspecific exploitation competition. *Piper amalago* produces 3-4 mature fruits per plant per night, and *Muntingia calabura* plants have a standing crop of about 100 fruits per night. From 80 to 100% of the mature fruits of these plant species are harvested in a given dusk to dawn period. *A. phaeotis* and *A. toltecus* forage at a slow rate per food item, consuming a superabundant food resource, primarily several species of *Ficus* (figs), that is negligibly depleted by nocturnal animals in the course of a night. For example, individual *Ficus ovalis* trees produce a crop of approximately 100,000 fruits that mature over a 7-12 night period, and less than 10% of the mature figs available each night are harvested before dawn.

The Bats of Chinese Art. Carl Brandon, Vermont Technical College, Randolph Ctr., Vermont 05061.

Following the article "Bats in Chinese Art and Superstition" by Philip Jen (BRN. Feb. 1982) I visited China in May-June, 1982. I was able to photograph a large number of art objects, furnishing and buildings which used bats in their decorative motif. The many photographs will give an idea of the wide ranging use of bats in the art and architecture of old China.

Activity Patterns and Foraging Behavior in *Antrozous pallidus as Determined by Radiotelemetry*. Patricia Brown, Department of Biology, University of California Los Angeles, Los Angeles, CA 90024 and Robert Berry, U.s. Naval Weapons Center, China Lake, CA 93555.

Pallid bats on Santa Cruz Island off the Southern California coast and at Coso Hot Springs in the Mohave Desert were collared with AVM SM-1 radio transmitters weighing less than two grams and tracked using tuned receivers (150-151 MHz) to determine their activity patterns and foraging behavior. The data were gathered between June and August during the breeding season. Chemoluminescent (cyalume) tagging was employed to visually track the bats for short periods. The coastal subspecies, *Antrozous pallidus pacificus,* foraged along stream channels and brushy hillsides primarily searching for Jerusalum crickets and large beetles which were captured on or near the ground and brought back to a night roost in a large barn. For some of the males, this was also the diurnal retreat. Other males roosted singly in shallow rock crevices in the surrounding mountains, appearing to choose a roost site near where they found themselves at dawn. The females day roosted with their babies in a barn adjacent to the night roost. All telemetered bats left their roosts with in 30 minutes after sunset, each heading to different areas within one to two km of the day roost. They flew about thirty meters above the surface directly to the foraging areas before descending to one to two meters to search for prey. Within two hours they converged on the night roost. The males would remain there until an hour before dawn, when they left for a final foraging period. The social importance of the night roost was demonstrated by a male that day roosted and foraged over 2 km from the night roost, but returned there each night. The lactating females remained in the night roost about an hour before returning to the barn with their young. Two or three more foraging periods would follow, in between which they would be in the day roost site. At Coso Hot Springs, the desert pallid bat, *Antrozous p. pallidus,* hunted for sphinx moths and scorpions among creosote bush scrib. They roosted in old buildings, but also in crevices in the granite boulders on the surrounding hills, either singly or in small groups. One nomadic male roosted in a different crevice each night, often separated by ten km. The telemetered bats spent more time foraging and travelled farther than did the Santa Cruz Island bats. They did not all converge on a single night roost, but rather congregated in smaller groups in buildings and rock crevices.

Architecture of the Pararhinal Sebaceous Gland Complexes of the Little Brown Bat, *Myotis lucifugus lucifugus*. G. C. Chari and A.W. Gustafson, Department of Anatomy and Cellular Biology, Tufts University Schools of Medicine, Boston, Massachusetts 02111.

The gross and microscopic anatomy of the large sebaceous gland "nests" on the muzzle of *Myotis lucifugus lucifugus* was examined in fetal, immature and adult animals. In both male and female little brown bats a prominent glandular complex was located on each side of the muzzle between the nostril (anteriorly), the eye (posteriorly), the upper labial margin (laterally) and the 1-2 millimeter dorsal midline (medially). Each complex was longest in the rostrocaudal direction (primary axis); and although the mediolateral axis was greater than the dorsoventral axis which was compressed between overlying skin and underlying bone, the latter axis was sufficiently prominent to account for the obvious muzzle swellings that demark these glands grossly. Each glandular complex opened onto the surface of the muzzle

skin by means of two separate apertures, one medial and one lateral, which were located at the anterior margin of each complex near the nostrils. The medial openings on each side were positioned slightly anterior to the lateral ones which in turn were located just anterior to the position of the maxillary canines. Although the openings could be visualized with the unaided eye, they were especially well delimited when slight compression was applied to the middle of the glands so that a small amount of whitish-yellow secretion was expressed into these apertures. Projecting through each aperture was a single coarse hair. Microscopically, each bilateral glandular complex consisted of two separate but intimately associated pilosebaceous units which were found to arise from their own individual primordia during development in fetal life. Each individual unit had its longest axis parallel to that of the entire complex as a whole, so that a medial unit and a lateral unit on each side of the muzzle corresponded to the medial and the lateral apertures of the bilateral complexes, respectively. Each unit was elaborately divided into lobes and further into lobules. The cells at the periphery of each lobule were plump and regular in size with distinct cell boundaries. In contrast, those cells near the lumina were disintegrating and became the products of the secretion, a sequence thus representing a holocrine mode of secretion. The duct systems in the medial and the lateral units of each complex were organized in an identical way. Secondary or accessory ducts drained the secretion from the lobules and joined together to form a common duct which ran anteriorly and opened into the hair follicle of each unit. Connective tissue and well developed bands of skeletal muscle enveloped the complex and also were intercalated between the lobules of each gland. Although the precise function of these glandular complexes remains to be determined, behavioral observations suggest that the secretion of these glands may be important for the lubrication of the wing membranes. In addition, the presence of abundant skeletal muscle suggests that voluntary control is an important factor in the release of secretory product.

Bat-Insecticide Problems: An Update Donald R. Clark, Jr., U.S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Laurel, MD 20708.

The gray bat maternity colony at Bat Cave 2-3, Franklin County, Missouri, disappeared in 1979 after experiencing dieldrin mortality in 1976, 1977, and 1978. The colony was still absent when the caves were checked in 1982. In 1980 and 1981, dieldrin-killed gray bats were found at Hunter and Devil's Icebox Caves, Boone County, Missouri. These caves are 120 km west-northwest of Bat Cave 2-3, with virtually no interchange of bats. Therefore, the sources of contamination are thought to be different. The free-tailed bats of Carlsbad Caverns are heavily contaminated with DDE. Residue data from monitoring studies and surveys (starlings, duck wings, songbirds, and fish) show high DDE levels in this area of New Mexico and in another area in Arizona. Certain of the data, plus observations, indicate that DDT is still being used.

Estimation of Number of Hibernating Indiana Bats Using Mark-Recapture Techniques. Richard L. Clawson and Steven L. Sheriff, Missouri Department of Conservation, 1110 College Avenue, Columbia, Missouri 65201.

An experiment was conducted in Missouri in 1979 to test the applicability of mark-recapture techniques for estimating the size of a hibernating population of Indiana bats (*Myotis sodalis*). During the late-swarming/early-hibernation period (1-13 October), 1,442 Indiana bats were banded at Onyx Cave in east-central

Missouri. Of these, 1,153 (80%) were males and 289 (20%) females. Due to differential sampling vulnerability between the sexes, only the data for male bats was analyzed and will be presented in this report. We used a computer program called "CAPTURE" (Otis, D.L., K.P. Burnham, G.C. White and D.R. Anderson, 1978. Statistical inference from capture data of closed animal populations. Wildl. Monog. No. 62. 135pp) to analyze the data. The population model in which capture probabilities vary with time and behavior was selected by the program as best fitting our data. Unfortunately, no population estimator is available for that model. Only after eliminating the nights with the highest and lowest numbers of captures could the confounding influences of both time and behavior be reduced to one variable. An estimate was generated by that model but was well below the population observed 10 weeks later during a winter census at the hibernaculum. During the census and effort was made to account for the bats that were banded during the experiment. Only 42% of the banded bats were found. The apparent loss or disappearance of 58% of the banded sample over so short a period of time could not be explained. Although the experiment failed to produce a direct and accurate estimate of the Indiana bats hibernating in Onyx Cave, it may prove useful in several regards. The findings of this study may be summarized as follows: During the late-swarming/early-hibernation period the male Indiana bat population is closed and available for sampling at the hibernaculum entrance. Female Indiana bats apparently arrive at the hibernaculum and soon enter hibernation, thus reducing their availability for capture. Behavioral response (trap shyness) and changes in availability over time confound the data and make accurate population estimates difficult. Finally, the unexplained loss of bands or disappearance of banded bats during a period in which very little mortality should have occurred makes the usefulness of mark-recapture techniques for population estimation, survival, or mortality studies subject to question.

Behavioral Audiograms of Four Insectivorous Bats. Vanda Cuccaro, Department of Biology, Carleton University, Ottawa, Canada K1S 5B6.

From June to September of 1982 I used behavioral responses to determine the hearing sensitivity of four species of insectivorous bats, (*Antrozous pallidus, Macrotus californicus, Eptesicus fuscus,* and *Myotis lucifugus*), to sounds ranging from 0-40 Khz. By varying the intensity of pure tone pulses, I obtained sensitivity threshold readings for each frequency tested. Preliminary results seem to indicate that the gleaning bats *Antrozous pallidus* and *Macrotus californicus* respond to lower intensities and frequencies. However, the overlap in the range of low frequency sounds used by the gleaners and the non-gleaners was greater than anticipated. Since there is some evidence which strongly suggests that a non-gleaning bat, i.e. *Eptesicus fuscus,* may use low frequency sounds, at least in part while foraging, a critical comparison of the four species may illucidate differences in auditory sensitivities between gleaning and non-gleaning bats. Moreover, this may contribute to the understanding of their respective foraging strategies.

The Sinoatrial Node of the Bat: A Quantitative Ultrastructural Study. L.S. D'Agrosa & M.B. Laskowski; Department of Physiology; St. Louis University School of Medicine; St. Louis, MO 63104

The sinatrial node (SAN) of the bat, *Pipistrellus subflavus,* is capable of generating a wide range of spontaneous activity varying from 20 beats per minute when hibernating to bursts of 800 beats per minute during active flight. Electrophysiological studies have shown an absence of arrhythmias even below 4°C body temperature. In order to determine whether these physiological capabilities are based upon unique ultrastructural features of the bat SAN, the present study was conducted. We found that the structure of the SAN of the bat is typically mammalian. Diameters of all three cell types in the SAN (nodal, transitional and atrial) are much smaller than those observed in any other mammalian species and are shown below. A morphometric analysis of cell junctions reveals that nodal-nodal cell contacts are primarily undifferentiated with few nexuses. Transitional-transitional cell contacts have an increased proportion of intermediate type junctions. Atrial-atrial cell contacts have a dominance of intermediate junctions with a small area left undifferentiated. The number and length of junctions are shown below:

	Nodal Cells	Transitional Cells	Atrial Cells
Diameter (μm)	1.45 ± 0.77 (a) (101)	2.66 ± 1.52* (34)	5.32 ± 1.79* (32)
No. of Junctions per cell	1.05 ± 1.35 (100)	1.15 ± 1.52* (34)	1.04 ± 1.61 (32)
Length of Junction (μm)	0.196 ± 0.121 (102)	2.27 ± 1.04* (37)	6.5 ± 7.81* (24)

(a) data represents means ±1 S.D. Numbers in parentheses indicate sample size.

* indicates a significant difference from Nodal Cells, based upon Student's t-test for unpaired sample sizes, p=0.05.

These observations are discussed with respect to the SAN of other mammals and the possible contribution of these data toward explaining the physiology of the heart of a hibernating mammal.

The Evolution of Echolocation. Fenton, M.B.; Department of Biology; Carleton University; Ottawa, Canada K1S 5B6

Although an animal's acuity in echolocation can be measured by its ability to detect targets, this does not mean that the animal regularly uses echolocation to collect information about targets. In other words, an echolocating bat (bird, shrew, etc.) may use echolocation to build a sound picture of its environment and rely on other sensory modes to find specific targets, namely food. Many species of Microchiroptera, however, use echolocation to locate specific food items. The implications of this situation are explored in the context of trying to understand the evolution of echolocation and the factors influencing an animal's design of its orien-

tation calls. I propose that echolocation is an exaptation (*sensu* Gould and Vrba 1982, Paleobiology, 8:16-30), a feature arising from a system evolved for other purposes, namely sounds for communication. Data on the echolocation of bats and their behavior while hunting are reviewed in this context.

'Bat Walks' M.B. Fenton, Department of Biology, Carleton University, Ottawa, Canada K1S 5B6.

In co-operation with the National Capital commission in Ottawa, for the last four years we have run a bat interpretation program we call 'Bat Walks'. A combination of some living *Myotis lucifugus,* some light tags, and bat detectors, serves to give people some first hand experience with bats. A short slide presentation is used at the end to help broaden the audience's appreciation of the diversity of bats. We start by giving people in the audience a chance to look a little brown bat in the eye, to feel its fur and touch its wings. We then attach light tags to some of these bats and release them, while eavesdropping on them with bat detectors wired to a public address sytem. By taking a short walk around a typical city park in Ottawa, we can usually hear big brown and hoary bats feeding, and their calls can be compared to those of the little brown bats. The audience at a successful bat walk may number up to 150 people; most attract at least 50. The combination of live bats (which do not bite hard), light tags and bat detectors is very potent.

Feeding Behavior of the Bats *Nycteris grandis* and *Nycteris thebaica* (Nycteridae) in Captivity. M. B. Fenton, C.L. Gaudet and M.L. Leonard; Department of Biology; Carleton University, Ottawa, Canada K1S 5B6

We observed the feeding and hunting behavior of *Nycteris grandis* and *N. thebaica* in captivity at the Sengwa Wildlife Research Area in Zimbabwe in January and February 1982. Both species preferentially selected katydids and beetles over moths and *N. grandis* readily caught and consumed frogs and bats. Both species relied heavily on acoustic stimuli emanating from prey to detect targets, although *N. Grandis* appeared not to use the calls of male frogs or the echolocation calls of other bats to locate prey. Both species produced echolocation calls during attacks on prey, increasing the rates of pulse repetition as they closed with targets and suggesting the use of echolocation in hunting. The echolocation calls of *N. grandis* are described along with general observations of the behavior of both species.

The Potential of Chiroptera for Elucidating Mammalian Feeding Mechanisms Dale R. Fish, Robert F. Majewski, Frank C. Mendel and Frank C. Kallen, Departments of Physical Therapy, Oral Biology and Anatomical Sciences, Schools of Medicine and Dentistry, State University of New York at Buffalo, Buffalo, NY 14214.

The firing patterns of masticatory muscles in *Myotis lucifugus* and *Eptesicus fuscus* correlate quite precisely with observed jaw movements during trituration of mealworms. Comparative anatomy suggests that similar patterns could account for observed jaw movements in a form as diverse as *Pteropus gigantus* (Czarnecki and Kallen, '80). But it has been noted (Hiiemae, '78) that the behavior of the pterygoids in

Myotis differs from all other mammals investigated to date, including the opossum, *Didelphis virginiana* which, like these vespertilionids, has tribosphenic molars. We found even more striking differences in another animal with tribosphenic dentition, the common tree shrew, *Tupaia glis*; most muscles that could close the jaws were in fact active during opening and the anterior digastrics displayed consistent low-level activity throughout the power stroke and beyond, until a terminal burst signalled fast opening. *Tupaia* differs from our vespertilionids in exhibiting prominent, and apparently forceful, tongue activity during opening, presumably working against the active resistance of the jaws. Nevertheless, when *Myotis, Eptesicus* and *Tupaia* drink, similar changes in muscle activities are seen relative to mastication. The tongue movements of *Pteropus* while chewing are even more prominent than in *Tupaia*. We presently believe that the dentition is the principal guiding mechinism for masticatory muscle sequencing only when the tongue is relatively unimportant in food reduction, and that any basic activity patterns that might exist in mammals generally will only be found when they still have a common food type, while nursing on mother's milk. We hope soon to have electromyographic results from *Pteropus* to determine whether it may chew more like *Myotis* because it is another bat, or like *Tupaia*, probably because of the activity of its tongue during food reduction. If the latter, the broad spectrum of food types and tongue activities in other bats could make them most useful in more precisely determining specific factors that influence an adult pattern of mastication. Supported by United Way of Buffalo and Erie County, Inc., N.S.F.#GB-6521X, and NIH/BSRG #2507 RR07066.

Temperature Effects on Lactate Dehydrogenase Activity in Big Brown Bat, *Eptesicus fuscus*. Margaret L. Fonda and Robert W. Cuddihee, University of Louisville Medical School, Louisville, KY 40292.

The effect of temperature on the activites of M_4 and H_4 lactate dehydrogenases (LDH, E. C. 1.1.1.27) isolated from the big brown bat (*Eptesicus fuscus)* was examined. Temperature effects were dependent on the concentrations of all four LDH substrates, pyruvate, lactate, NADH, and NAD. Arrhenius plots of Ln v_i vs reciprocal of absolute temperature were linear for all but the lowest substrate concentrations. The slopes of these Arrhenius plots were used to calculate the temperture effect parameter (μ). Substrate-dependent temperature effects for M_4 and H_4 LDH were described by an equation for a rectangular hyperbola,

$$\mu = [E_\beta S + E_\alpha K_+]/[K_+ + S].$$

The parameters E_α (μ at infintely low substate concentration), E_β (μ at infinitely high substrate concentration), and K_+ (the concentration of substrate when $\mu = [E_\alpha + E_\beta]/2$) can be used to describe the temperature dependence of LDH activity at any substrate concentration and to compare the substate-dependent temperature effects on the two isoenzymes. Significantly different E_β and K_+ values for pyruvate-dependent temperature effects and different E_β, E_α, K_+ and E_β-E_α (the range of possible μ values) for lactate-dependent temperature effects were found between M and H LDH isoenzymes. High lactate concentrations inhibited bat H_4 LDH activity to a greater degree at low temperatures than high temperatures. Thus substate inhibition plays an important role in the effect of temperatue on the activity

of H-type LDH at high lactate concentrations. Substrate-dependent temperature effects on bat LDH activity were the result of temperature effects on the apparent K_m value of the respective substrate. Since both the apparent K_m for pyruvate and the K_i for the competitive inhibitor oxamate decreased with decreasing temperature, the substate-dependent temperature effects observed for pyruvate probably resulted from an increased affinity between pyruvate and the LDH-NADH complex with decreasing temperature. The rectal temperatures, steady state concentrations of lactate and pyruvate, and the LDH isoenzyme compostion in the heart, liver, and pectoral muscle of hibernating and arousing *Eptesicus fuscus* were measured. Bat rectal temperature increased from 8.86 to 33.1 °C during arousal. Steady state concentrations of pyruvate and lactate increased significaltly in the tissues, however they remained generally below the level necessary to saturate LDH at the respective temperature. M_4 is the predominant LDH isoenzyme in bat liver and H_4 is the main form in bat heart and pectoral muscle. The value of μ for the LDH isenzymes increased during arousal but remained significantly lower than E_β. The parameters E_β-E_α, E_α, and $K_\dagger$ are particularly important in describing the temperature dependence of LDH activity in tissues of the arousing bat.

Biochemical and Morphometric Studies of Heart, Liver, and Skeletal Muscle in the Bat, *Eptesicus fuscus*, During Arousal from Hibernation. Margaret L. Fonda and George H. Herbener, Departments of Biochemistry and Anatomy, University of Louisville, Louisville, KY 40292.

The transition from the hibernating to the aroused state has been reported to involve alterations in enzyme activities, the concentration of various metabolites, and the ultrastructure in several organs of various species. Much of the ultrastructural data is qualitative and is not addressed specifically to arousal. Further, the few correlated biochemical and structural studies are contradictory. We have quantitated several enzyme activities and structural parameters of heart mitochondria of *Eptesicus fuscus* at selected times during and after arousal from hibernation. In addition, we have measured the activities of several mitochondrial enzymes in the liver and the pectoralis major muscle during arousal. Eastern big brown bats were captured in their hibernarium during January-March. The animals were taken to the laboratory, placed in a light-proof box, provided water *ad libitum* and kept at approximately 5 °C. Bats were used from 2 to 8 weeks following capture. They were killed by decapitation without anesthetic prior to arousal, or at 7.5, 15, 30, 60 and 120 minutes after initiation of arousal. An additional group was maintained for 1 month after arousal and killed. Left ventricular walls and intraventricular septa were isolated and divided for the biochemical and electron microscopic studies. The liver and pectoralis major muscles were also studied biochemically. The activities of the mitochondrial enzymes, citrate synthetase, succinic dehydrogenase and cytochrome c oxidase, and the cytoplasmic enzyme lactate dehdyrogenase were assayed. In addition, the distributions of the lactate dehydrogenase isoenzymes were determined. No consistent significant differences were observed for a given enzyme activity in a given tissue during arousal. Using stereological techniques electron microscopy three heart mitochondrial structural parameters were measured and found not to change. These were volume density, i.e., the fractional volume of cytoplasm occupied by its mitochondrial component; the numerical density, i.e., the number of mitochondria per 10 μm^3 of cytoplasm; and the volume of the average mitochondrion (μm^3). Lastly, the volume density of lipid droplets was measured and found to undergo a significant, transient reduction during arousal.

Electrophysiological Analysis of the Chiropteran Somatosensory Cortex B.C. Fowler and J.M. Zook, Coleman Laboratory, University of California, San Francisco, CA 94143.

In the attempt to determine the basis of a flying bat's ability to avoid obstacles in the dark, 19th century investigators discovered a well-developed sensory innervation to the wing. Following the demonstration of echolocation, studies have focused on the auditory contribution to the orientation of a flying bat. However, the role of somatosensory systmes in bat behavior remains unknown. Electrophysiological recordings have been collected from the somatosensory cortex of *Antrozous pallidus* as part of a study of this role. Receptive fields were mapped in the postcentral region of anesthetized bats with closely spaced microelectrode penetrations. Stimuli were delivered to the skin surface by a hand-held glass probe or by air puffs from a glass pipette. Preliminary observations reveal the presence of an elaborate array of sensory hair structures, morphologically identified as *Haarscheiben,* distributed over both surfaces of the wing. Recordings from cortex and primary afferents have been slowly adapting, typical of the *Haarscheibe* response. Some responses could only be elicited upon stimulation of the hair structures and not the interlying epithelium. This is the first report of *Haarscheibe* input to mammalian cortex but histological evidence is required for further confirmation. Mapping of the wing representation in cortex reveals a topographically ordered projection of both dorsal and ventral surfaces; though less than 50 μ in thickness, the patagial membrane is able to convey distinct output from its two surfaces. Light puffs of air were used to distinguish between units receiving dorsal or ventral projections. Although the epithelial surface overlying digits and patagia is continuous, the cortical representation is divided into separate digital and patagial regions. Receptive fields of the patagium are roughly circular with the exception of some narrow elongated fields located along both edges of the arm. The chiropteran somatosensory system appears to be specialized for a role in the detection and analysis of air flow around the wing providing feedback for the sensorimotor mechanisms of flight. Cortical specializations include: 1) a capacity to discriminate between dorsal and ventral stimulation of the wing; 2) segregation of digit and patagium representations; 3) predominance of slowly adapting activity; 4) representation of *Haarscheibe* activity. Further study will be directed towards a quantitative description of the neural activity associated with encoding stimulus parameters.

Latitudinal Comparison of Postnatal Growth Rates in Free-Living *Myotis lucifugus lucifugus*. Marty Fujita, Department of Biology, Boston University, Boston, MA 02215

A consequence of mammalian hibernation is that the processes of reproduction and growth must be compressed into the few favorable months of spring and summer. Young of the season are especially vulnerable to the shorter growing seasons of high latitudes as they must grow, become proficient at foraging and sequester enough fat to last their first and most critical hibernation season. Do compensatory adjustments in growth rates to shorter growing seasons occur within species with wide latitudinal ranges? This study examines this question by comparing the postnatal growth rates of free-living *Myotis lucifugus lucifugus* from populations in Peterborough, New Hampshire (45 °N) and Edmonton, Alberta (55 °N). Growth rates were estimated based on measurements of weight, forearm length and epiphyseal gap length of known-age, banded neonates. Preliminary results indicate that Albertan bats are larger at birth and have initially faster growth rates than bats

from New Hampshire. In addition, the age at which individuals were capable of thermoregulating effectively was established for both populations. While New Hampshire juveniles can maintain high (approximately 37 °C) adult-like deep body temperatures by about 21 days of age when incubated for 2 hours at 10 °C, Albertan juveniles attain this level of thermoregulatory independence by 16 to 18 days of age. This suggests that the acquisition of thermoregulatory independence at an earlier age coupled with faster growth rates may increase the time available for fat deposition prior to hiberation.

Echolocatory and Agonistic Vocalizations of the Hawaiian Hoary Bat, *Lasiurus conereus.* James H. Fullard, Department of Biology, Erindale College, University of Toronto, Mississauga, Ontario, Canada L5L 1C6.

Individual *Lasiurus cinereus* were recorded as they foraged near lights at a missile-tracking station in Kokee State Park on the island of Kaua'i. Echolocation signals appear typically vespertilionid, consisting primarily of harmonically-complemented, FM (frequency modulated) components with peak frequencies between 27 and 30 kHz. The range of frequencies swept in the signals is variable and may be the result of the absence of other species of bats. Individuals foraged around particular sites (lights) and would aggressively chase other bats which entered into their areas. During an agonistic encounter, both bats emit short, FM signals with peak frequencies at 9 to 10 kHz. The audible nature of these sounds allowed for an assessment of agonistic behaviour amongst the bats. Individuals vocalized most often during times of low insect abundance and appeared to defend hunting areas more vigorously at these times. Warm nights where insects (particularly moths) were more plentiful experienced greater numbers of foraging bats, fewer agonistic vocalizations and generally less defined individual hunting areas.

Roost Preferences of House Bats. Arthur M. Greenhall, Office of Scientific Authority, U.S. Fish & Wildlife Service, Washington, D.C. 20240

It is known that some bat species prefer to roost in man-made structures rather than their natural roosts, favoring attics, walls, chimneys, and belfries. Bats are now confronted with changes in building materials and construction, such as less use of roof spaces, hollow concrete walls, and modern churches without belfries. A question of interest to biologists, architects, building contractors, and those retrofitting to prevent heat loss or bat-proofing, is why bats prefer one structure to another although both structures may appear superficially similar in all respects. While some requirements for bat roost preferences are known, less understood are the factors that determine the roost selection. Some of these include compass orientation of the structure, climate, vegetation, etc. the physical characteristics of the house may prove to be important. Bats appear to prefer older structures to more modern buildings. Available data reveals little and generally states simply that bats occupy buildings, barns, churches but provide generally vague information as to what part of the building is selected. It would be useful to know the architectural details of the common, older houses. Each detail may be important, some subtle, and often it is the combination of details that collectively determine the "style" of a house. There are about twelve basic house styles. Houses of a pure style may be recognizeable but

many home builders and architects have tried different combinations of traditional styles, which have gradually changed over the years in different parts of the country. Some common house styles are Colonial, Salt box, Cape Cod, Georgian, Federal, Greek, Gothic, Mansard, Queen Anne all having been built between the years 1690 to 1910. Many of these house styles have been altered during the years in keeping with uptodate fad throughout the United States. Today one is likely to find various combinations of styles representing different periods of time. Fortunately there are some basic details that will be described which may indicate what is an original house style and what has been added. Thus the details which comprise the style and vintage of a house may suggest some of the factors which affect the roost preferences of house bats.

Nutritional Analyses and Digestibility of the Wet Season Fruits Consumed by *Carollia perspicillata* in Parque Nacional Santa Rosa, Costa Rica. Lawrence H. Herbst, Department of Biology, University of Miami, Coral Gables, Florida 33124.

This study determined the nutritional quality of the pulp of 5 of the 7 fruit species for which the feeding preferences of the short-tailed fruit bat, *Carollia perspicillata,* are known and determined the apparent digestibility of one of these fruit species. Fruit of *Cecropia peltata, Chlorophora tinctoria, Ficus ovalis, Muntingia calabura,* and *Piper amalago* were collected, dried, and their seeds and stems removed. Dry pulp was analyzed for gross caloric content and composition, e.g., ash/organics, neutral detergent fiber, total carbohydrates, lipids, and nitrogen. Fruits species can be ranked according to the content of each nutritional component. The relative amounts of soluble energy and nitrogen are positively correlated with the bats' preference for each fruit species as determined by pair-wise food choice experiments (Lockwood et al., unpublished). It seems likely that fruit choice by frugivorous bats is influenced by the nutritional quality of the pulp. Because bats are small, highly active mammals that must eat daily to survive, soluble energy should be important. Fruits of *Chlorophora tinctoria* were fed to captive bats in order to estimate apparent digestibility. Dry matter mean digestibility was 61% (N = 6 bats). This is comparable to digestibilities estimated for other mammals fed on low quality forage. Bats absorbed about 50% of the water in ingested *Chlorophora* pulp. Water content of the pulp is about 80%. This is sufficient to maintain bats for long periods without drinking. Bats absorbed 53% of the total ingested energy, 71% of soluble matter, 60% of lipids, 95% of total carbohydrates, and only 6% of total nitrogen. Given the rapid gut passage times of these animals, it is apparent that they are quite efficient at extracting energy and nutrients from fruit.

Taxonomic Status and Ecology of *Myotis lucifugus* and *Myotis yumanensis* in the Okanagan Valley, British Columbia Robert M. Herd; Department of Biology; Carleton University; Ottawa, Canada K1S 5B6

In the Okanagan Valley of British Columbia *Myotis lucifugus* and *Myotis yumanensis* are sympatric and some bats are intermediate between the typical morphology of either species. Previous studies in the Unites States have suggested that these bats of intermediate appearance may be hybrids. In a survey of the electrophoretic variation at selected protein loci I did not detect hybids confirming the two species do not share a common gene pool and are distinct biological species. This study was conducted in an attempt to understand the nature of the morphological variation within the two species and to observe differences in their

ecology. From May to August 1982 I trapped over 1,000 bats, visually assessed their reproductive condition, and banded them with both an individually numbered bat band and a reflective colored band. The latter band facilitated subsequent identification of foraging bats. Major reproductive events in females *M. yumanensis* occurred more than two weeks ahead of similar events in *M. lucifugus*. At the start of June 79% of *M. yumanensis* females examined had palpable pregnancies compared to 33% of *M. lucifugus* females, and by July virtually all *M. yumanensis* were either pregnant (66%) or lactating (31%) compared to only 55% of*M. lucifugus* (50% pregnant, 5% lactating). From July onwards virtually all *M. yumanensis* examined had bore young whereas about a quarter of *M. lucifugus* appeared non-parous. The fur of non-parous *M. lucifugus* was noticeably darker and duller than that of parous *M. lucifugus*. I suggest the earlier partuition observed in *M. yumanensis* allows the female young to reach sexual maturity during their first fall whereas female young of *M. lucifugus* do not reach sexual maturity until their second fall, and that the duller, non-parous females observed in this study are the progeny of the previous year. This suggestion is supported by the observation that all female *M. lucifugus* (n©9) banded two years ago in a previous study and recaptured after June 10, this year, were parous and had typical pelage. *Myotis yumanensis* were only captured or observed along the floor of the Okanagan River Valley, whereas*M. lucifugus* were trapped both on the floor and in the hills above the river. Premliminary analysis of observations on foraging bats suggest *M. yumanensis* forage mainly over water (still and flowing) whilst *M. lucifugus* tend not to forage over flowing water and to prefer forage over still water and on rocky hillsides.

A Simple Antibody Test for Identification of *Myotis lucifugus* and *Myotis yumanensis* in the Field Robert M. Herd; Department of Biology; Carleton University; Ottawa, Canada K1S 5B6

My ecological studies on sympatric populations of *Myotis lucifugus and Myotis yumanensis* require that I can reliably determine the specific status of bats whose external morphology is intermediate and does not allow assignment to either species with confidence. I herein report on a simple antibody test which rapidly determines the specific status of these bats, does not harm the bat and is suitable for field use. The basis of the test is the time taken for lysis of erthrocytes in a small sample of blood from the bat in question by antibodies produced against erthrocytes of *M. lucifugus*. Antibodies were raised in guinea pigs by giving them intraperitoneal injections of erthrocytes from *M. lucifugus*. Heparinized blood samples from the guinea pigs are centrifuged and the plasma carefully removed to avoid inclusion of cellular material. This is the only purification step necessary. Plasma containing the "anti-lucifugus" antibodies was stored at -20°C and has retained its activity for 7 months to date. In the field 2x5ul blood samples are taken under sterile conditions from a small incision in the interfemoral vein. One sample is mixed with saline as a control, the other with a test solution of guinea pig plasma diluted with saline (usually x20) to produce lysis of erthrocytes from *M. lucifugus* in about 10 minutes. The erthorcytes of *M. yumanensis* presumably offer fewer binding sites for the "anti-lucifugus" antibodies and the time taken for their lysis is typically twice that for erthrocytes of *M. lucifugus*. Processing time for each bat is about 5 minutes and the bat need only be held until lysis is complete (usually less than 30 minutes). Equipment required in the field is minimal-some small glass tubes, micropipettes, razor blades, alcohol, antibody,

saline and wristwatch. Preliminary results indicate the "anti-lucifugus" antibodies will distinguish the erthrocytes of several other species of North American bats. With the production of appropriate antibodies this test should be useful in the field separtion of morphologically similar groups of vertebrate species when conventional morphological methods are inadequate.

Interyear Comparisons of Growth Rates in *Pipistrellus subflavus*. Karen M. Hoying and Thomas H. Kunz; Department of Biology; Boston University; Boston, MA 02215

A two year study on the growth rates of free-living *Pipistrellus subflavus* was conducted in eastern Massachusetts. Temperature and insect abundance were markedly different between the two years providing an opportunity to test how these environmental parameters affect juvenile growth within a colony. Temperature and insect abundance were significantly lower in May and June of 1982--the period of prenatal growth. The 1982 juveniles were born later and weighed less than the juveniles born in 1981. Forearm was slightly smaller at birth and epiphyseal gap size was similar indicating that the harsh spring of 1982 did not affect the prenatal growth of bone to the extent that body mass was affected. This indicates that forearm and epiphyseal gap size regression equations are the most reliable for estimating age of unknown-aged individuals. There was no significant difference in temperature and insect abundance or in postnatal growth rates for July and August of both years.

Processing of Species-Specific Echolocation Signals by the Cerebellum of the Bat Philip H.-S. Jen, Xinde Sun and Tsutomu Kamada, Division of Biological Sciences, University of Missouri, Columbia, Missouri 65212.

The echolocation signals of bats consist mainly of a frequency modulated component alone (FM) or a constant frequency component followed by a short frequency modulated component (CF-FM). For example, the big brown bat, *Eptesicus fuscus,* uses multiple-harmonic FM signals for echolocation, while a mustache bat, *Pteronotus parnellii,* uses multiple-harmonic long CF plus short downward sweeping FM signals. In the past, neurophysiological studies have demonstrated that the auditory system of a bat is adapted for processing species-specific echolocation signals. We present data here to demonstrate that such species-specific auditory sensitivity also exists in the cerebellum of the bat. A large number of cerebellar neurons responding to acoustic stimulus could be isolated from the cerebellar vermis and hemispheres of both *Eptesicus fuscus* and *Pteronotus parnellii.* The majority of these neurons were isolated at a depth less than 1500 microns from the surface of the brain. Most neurons are tuned to a very wide band of frequency so that their tuning curves are very broad with either simple triangular or multiple-peaked shapes. Thus, their Q -dB values are generally less than 20. However, cerebellar neurons of the mustache bat with a best frequency tuned at around 61 kHz, which is the frequency of the predominant CF component of the echolocation signals of the bat, have extremely narrow tuning curves with Q -dB values as high as 400. These neurons also exhibited typical off responses which are similar to those neurons in the auditory system of this bat. Among all the neurons sampled from *P. parnellii* there are a large number of neurons that are tuned at around 61 kHz, but such a disproportionate representation of a specific group of neurons is not found in the cerebellum of *E. fuscus.*

A Spectacular Range Extension for *Philetor* (Vespertilionidae): A Lesson in Zoogeographical Humility. Karl F. Koopman; American Museum of Natural History; Department of Mammalogy; New York, NY 10024

Prior to 1966, the genus *Philetor* was known only from the New Guinea mainland. Since then the genus (and apparently single species) has been found from the Bismarcks to Malaya and Sumatra. It is here recorded from Nepal. The species shows considerable geographical variation but its pattern is unclear. What is surprising is that within 20 years what was thought to be a New Guinea endemic has been found over an area encompassing a large part of the Indo-Malayan and Australian regions.

Bats and Man: A Plea for More and Better Public Education Thomas H. Kunz; Department of Biology; Boston University; Boston, Massachusetts 02215

People are largely uninformed on the varied life-histories and on the ecological and economic importance of bats. Others are either grossly misinformed or prejudiced by cultural misgivings. As the most informed group of biologists, we as bat researchers should be obliged to improve the public image of bats. Increased participation is needed in public lectures, workshops, and other forms involving both slide and live presentations, appearance on radio and TV talk shows, and interviews with newspaper and magazine writers. The preparation and distribution of interesting and factual information about the lives of the bats should be an important part of contacts with the media and the public. Advantages and disadvantages of giving live vs. pretaped TV and radio appearances, telephone vs. personal interviews with newspaper and magazine writers, and to give or not to give lectures with live bats are discussed.

Time-Activity Budgets for the Little Brown Bat *(Myotis lucifugus):* Nightly Emergence Behavior Thomas H. Kunz and Edythe L. P. Anthony; Department of Biology; Boston University; Boston, Massachusetts 02215; and Department of Anatomy and Cellular Biology; Tufts University Schools of Medicine; Boston, Massachusetts 02111

As an important component of time-activity budgets, nightly emergence behavior, was studied at five maternity colonies of *Myotis lucifugus* in southern New Hampshire. Flight counts and results of trapping were used to determine the effects of colony size, reproductive condition, age, and environmental conditions on the onset, duration, and rates of emergence. The onset of nightly emergence coincided with seasonal changes in sunset time. The interval between sunset time and the appearance of the first bat decreased from spring through early summer, but then increased in length in late summer and early autumn. Onset of emergence was delayed on cloudy nights and by precipitation. The duration of emergence was influenced by the length of twilight, precipitation, exit configuration, colony size, reproductive condition, and age. Rates of emergence varied among colonies, with the largest colony exhibiting the fastest and most variable emergence rates. During the parturition period, pregnant females usually emerged sooner than lactating females. When young bats began to fly (16 days of age), they emerged later than adults but converged upon the adult pattern within two weeks. Among young bats older individuals emerged earlier than younger ones during the fledging period.

The Effects of Reproductive Condition, Age, Clustering and Wooden Roosts on Thermoregulation in the Little Brown Bat, *Myotis lucifugus* Allen Kurta, Department of Biology, Boston University, Boston, MA 02215.

The thermoregulatory ability of freshly captured little brown bats, *Myotis lucifugus,* was investigated between 14 May and 12 August 1982. The body temperature (T_B) of over 250 different bats, caged as singles or in groups of 7 to 12 animals, was taken after exposure to 22 or 32 °C. In general, clustered bats exhibited higher T_Bs, with less variability, than did singles. Lactating females tended to have lower T_Bs than did pregnant or post-lactating individuals. Clustered post-volant juveniles at 32 °C had higher T_Bs than did singles, but there was no difference at 22 °C. Thermoregulatory patterns of bats housed in simulated roosts (wooden cages) differed from those kept in hardware-cloth cages. The T_B of clustered bats at 22 °C was correlated with pre-dawn ambient temperature measured on the day of capture.

Bone Remodeling and Its Regulation in *Myotis Lucifugus.* Gary G. Kwiecinski, Section of Genetics and Development, Cornell University, Ithaca, New York 14853.

The careful regulation of extracellular calcium ion concentration is essential to the stability of a variety of biologica processes. The calcium ion control system includes the plasma pool, gastrointestinal, renal, endocrine and skeletal components. The skeleton is the major reservoir from which calcium may be released when the body is on calcium-depriving regimes. Previous attempts to demonstrate the influence of season and activity on bone have shown that hibernating mammals undergo progressive bone loss with an abrupt renewal upon arousal. Morphological studies of calcitonin producing thyroid C-cells and parathyroid glands in hibernating mammals indicate concommitant regulatory endocrine functions correlating with bone remodeling. Studies of summer active bats demonstrate sex differences in renewal of skeletal mineral reserves; post-arousal females achieve a greater mineral density than males in a much shorter time. Bone loss in summer females in associated with pregnancy and lactation. Although C-cells maintain maximal activity throughout the summer period, the hyperactivity of the parathyroid glands accounts for bone demineralizations during pregnancy and lactation. Patterns of bone remodeling and renewal indicate a short period after hibernation before the initial demands of a fetus on maternal skeletal reserves are expressed, and that during that brief post-reproductive period preceding hibernation bone renewal is not as rapid or substantial as that following arousal. Summer active male bats do not lose bone and achieve greater mineral density prior to hibernation.

Factors Influencing the Efficiency of Mist Nets at Capturing Bats in Riparian Habitat Michael J. Lacki and Theodore A. Bookhout; Ohio Cooperative Wildlife Research Unit; The Ohio State University; Columbus. OH 43210.

Little quantitative information is presently available on the physical and environmental variables that most affect the efficiency of mist nets at capturing bats foraging in riparian habitats. This paper examines the relative importance of several variables in capturing bats over midwestern streams including temperature, humidity, time of year, canopy closure and stream

width. Mist nets were placed at 163 locations on 93 nights during the summers of 1979 and 1980 along five watersheds within Wayne National Forest, Ohio. Eight species of bats were captured and data for all are pooled in the analyses. Capture rate increased significantly with both temperature and humidity, however, these differences appeared less pronounced once conditions reached a critical level. Time of year was also important as capture success was significantly higher in July and August. Since young bats become volant in mid to late-summer the improved success may be a response to density effects as well as increased activity. Although results for canopy closure were inconclusive, data for stream width suggests bats prefer to forage over wider, more spacious sections of streams.

Influence of Moonlight on Time-budgeting by a Neotropical Bat, *Artibeus jamaicensis* Elise Mayrand and Georg Baron, Departement des Sciences biologiques, Universite de Montreal, Montreal, Que. H3C 3J7 Canada.

The activity patterns of a group of four to seven individuals of *Artibeus jamaicensis* were studied from April to August 1981 at the Centre de Recherches caraibes, on Martinique Island. The animals were kept in an outside enclosure so that the light conditions, temperature, and humidity were the same as those of their natural environment. Various kinds of fruits, such as bananas, mangos, etc. were provided *ad libitum*. The exact amount of time each animal spent in any particular activity was recorded. Examples of types of behavior recorded were feeding, grooming, exploration, climbing or walking, flight, social interaction, hanging still (which included both sleep and rest), and the like. In order to determine the possible influence of moonrise and moonset on the onset and duration of activity, the activity-cycle was referred to a time system based on the lunar rather than on the solar cycle. Previous studies have shown that moonlight has the effect of reducing activity in several phyllostomatid bats including *Artibeus jamaicensis* (Erkert 1974, Morrison 1978). Activity begins just after sunset, decreases after moonrise, and reaches a second peak before dawn. The second question concerned the influence of various lunar phases, such as new moon, full moon, etc. on the amount and the temporal distribution of overall activity, and on the variability of the various categories of behavior. Previous studies (id.) have shown that foraging activity of bats is almost continuous during the "dark phase", of the moon but it is reduced and even interupted during the bright phase, especially when the moon is nearest its zenith. In general, there is a negative correlation between light intensity and foraging activity. The aim of the present study was to determine whether the time budgets allowed to different behavioral activities are affected in the same way by lunar phase.

Non-Random Nursing and Genetic Variation in Maternity Colonies of the Mexican Free-Tailed Bat *Tadarida brasiliensis mexicana* Gary F. McCracken and M.K. Johansen; Department of Zoology; University of Tennessee; Knoxville, TN 37916

Female mexican free-tailed bats (*Tadarida brasiliensis mexicana*) aggregate in enormous maternity colonies that often exceed several million individuals. Parturition is highly synchronous and within hours of birth each female deposits her single baby in a large mass (creche) with other babies. Mothers generally roost apart from their babies, but return to the creche and nurse in the early evening and morning, before and after their

nightly foraging flights. Previous studies have stated that when females return to the creche they do not relocate and selectively nurse their own babies, and that nursing within creches is indiscriminate. We have employed genetic (allozyme) analysis of nursing female-baby pairs captured in large maternity roosts in south-central Texas to establish if nursing actually does occur randomly in regard to female-baby relatedness. Our data demonstrate that nursing in *T. b. mexicana* is, in fact, **non-random** and that it occurs selectively relative to nursing female-baby genotypes. However, this study also shows that females frequently do nurse babies that **could not** be their offspring. At this time, we cannot distinguish whether a female 1) nurses her own baby most of the time and occasionally nurses others to which she is randomly related, or 2) if she selectively nurses her own baby and those of kin. Since lactation is energetically expensive, nursing a baby other than her own must be costly to females, and our current research involves evaluation of the selective factors and mechanisms which could account for the evolution of this behavior. This study also demonstrates that the colonies of *T. b. mexicana* examined carry an enormous amount of genetic variation. From 27 scorable loci, individual heterozygosity (proportion of loci heterozygous in an average individual) is estimated at approximately 0.13. This estimate is at the extreme high end of heterozygosities reported for other mammals.

The Phylogeny of *Sturnira* Species Robert D. Owen; Department of Zoology; University of Oklahoma; Norman, OK 73019

The genus *Sturnira* is a widespread neotropical frugivorous group with uncertain affinities to other genera in the family Phyllostomidae. No comprehensive review of interspecific relationships has been undertaken since de la Torre's (1961) Ph.D. dissertation, in which he recognized eight species. Since that time, several new forms have been described, and the number of species believed valid has grown to 12 (Honacki, Kinman, and Koeppl, 1982). Neither the species nor their taxonomic limits are agreed upon by all authorities, and much is yet to be learned about the evolution of *Sturnira*. In this study I examined phylogenetic relationships between the 12 currently recognized species (Honacki, Kinman and Koeppl, 1982). For several individuals of each species, I recorded values for 30 external, cranial, dental, and post-cranial multi- or two-state characters. I used additive binary recoding to transform each multi-state character into a series of two-state characters. Because most *Sturnira* species carry more than one state for a number of these characters, I used a parsimony algorithm which allows for retention of polymorphism along one or more segments of the phylogenetic tree. As with most phylogenetic studies, determination of the primitive state of all characters is difficult. In recent years outgroup analysis has been well documented and often used. However, determination of the appropriate out-group may require some prior knowledge of the relationships of the group under study. If *Sturnira* is the sister taxon to the other stenodermatines, a non-stenodermatine phyllostomid is the proper out-group. For this, I chose *Macrotus,* a relatively non-derived phyllostomatine. If, however, the sturnirine form was derived from another stenodermatine clade, a primitive stenodermatine is more desirable as an out-group. My preliminary analyses of the subfamily indicate that the middle-sized *Artibeus* such as *hirsutus* may be the sister group to the remaining stenodermatines. These analyses further suggest that *Sturnira* may have been derived through an *Enchisthenes* -like ancestor. I will use each of these

three possible out-groups -- *Macrotus, Artibeus hirsutus,* and *A. (Enchisthenes) hartii* -- in separate analyses of the data, and also combine the available information into what I will argue to be the best estimate of the ancestral form. If the resultant phylograms are very different I will discuss the implications for the place of *Sturnira* in the phyllostomid-stenodermatine phylogeny. Finally, I will present a working estimate of the phylogeny of *Sturnira.*

Systematic Variation in the Molossid Bats of the *Tadarida pumila-limbata* Complex. Randolph Lee Peterson, Department of Mammalogy, Royal Ontario Museum, 100 Queen's Park Cresc., Toronto, Ontario M5S 2C6 Canada.

Population samples and the holotype specimens of most of the named forms allied with this complex of smaller species of *Tadarida (Chaerephon* of author) have been examined, measured and subjected to various multivariate analyses. The systematic status of the following named forms are discussed: *T. pumila, T. limbata, T. leucogaster, T. gambianus, T. pusilla, T. hindei, T. websteri, T. naivashae, T. frater, T. cristata, T. elphicki, T. nigri, T. langi* and *T. faini,* as well as *T. chapini, T. shortridgei* and *T. lancasterii.*

Mystacina **is a Phyllostomatoid Bat** E.D. Pierson;Museum of Vertabrate Zoology & V.M. Sarich, Depts. of Anthropology & Biochemistry; University of California; Berkeley, CA 94720: J.M. Lowenstein; Department of Medicine; University of California; San Francisco, CA 94143: M.J. Daniel; Ecology Division; DSIR; Private Bag; Lower Hutt, New Zealand

New Zealand has only two endemic mammals, both of which are bats. One, *Chalinolobus tuberculatus,* is a vespertilionid, which probably arrived in New Zealand during the Pleistocene and is closely related morphologically to other *Chalinolobus* species in New Caledonia and Australia. *Mystacina tuberculata,* on the other hand, like the kiwi and tuatara, is an "archaic endemic" of unknown origins, and since Gray's initial description in 1843 has been a taxonomic mystery. Based on morphology, it has variously been associated with the emballonurids, molossids, vespertilionids, mormoopids, noctilionids, and phyllostomatids. Miller gave *Mystacina* family status in 1907, and in 1945 Simpson included it in the Superfamily Vespertilionoidea. This classification has been generally accepted since that time. We have assessed the phylogenetic relationships of *Mystacina* by quantitative immunology, using microcomplement fixation and radioimmunoassay. In both methods a serum protein (albumin or transferrin) of one species is reacted with antibodies against itself and other species. Measurable differences in immunological reaction then provide a relative index of relatedness: the stronger the reaction, the closer the phylogenetic relationship. Biochemical evidence on *Mystacina* places it unequivocally as an early offshoot of the phyllostomatoid lineage. Although it does not show a close relationship with any of the nine families tested -- thus confirming its early divergence -- it is significantly closer immunologically to all three recognized phyllostomatoid families than to any others. Furthermore, reexamination of the morphological evidence indicates that several characters which it shares with the phyllostomatoids are derived, whereas features which have linked it with other groups are likely to be primitive or convergent. Thus both the biochemical and morphological evidenced argue for placing *Mystacina* in the Phyllostomatoidea.

Autonomic Control of Heart Rate of the Bat at Low Body Temperature J.M. Puccinelli and L.S. D'Agrosa, Department of Physiology, St. Louis University School of Medicine, St. Louis, MO 63104.

Experiments were performed to assess the relative contribution of the autonomic nervous system (ANS) to heart rate control in bats capable of hibernation, *Pipistrellus subflavus,* at low body temperature (T_B). Three experimental groups were designated: one group was given propranolol (1.0 mg/kg i.m.) to elicit beta adrenergic/sympathetic blockade (SNS blocked), one group given atropine (5.0 mg/kg i.m.) to elicit muscarinic/parasympathetic blockade (PNS blocked), and one group left with the ANS intact (control). The bats from all three groups were passively rewarmed from a T_B of 5.0 to 21.0°C, during which time an electrocardiogram was recorded and analyzed at every 1.0°C change in T_B. The mean heart rates from each group were compared at 5.0°C and every 1.0°C increment in T_B to 21.°C. Similarly, the mean PR, QRS, and QT intervals of each group were compared at matched heart rates. Throughout the passive rewarming range, the mean heart rates of SNS blocked groups were significantly lower than control, and the mean heart rates of the PNS blocked group were significantly higher than control. It was concluded that both limbs of the ANS were functionally able to control heart rate in bats passively rewarmed from a low T_B. Furthermore, the QRS And PR intervals of the atropine blocked group were significantly longer than control at various heart rates where the T_Bs were less than 20°C, but were not different than control at T_Bs greater than 20°C. It was concluded that the PNS may have a facilitative effect on conduction at low body temperature.

Milk Composition and Mammary Gland Development in *Myotis lucifugus* and *Eptesicus fuscus* Holly Stack and Thomas H. Kunz, Department of Biology, Boston University, Boston, MA 02215, Elizabeth Pierson, Museum of Vertebrate Zoology, University of California, Berkeley, CA 94720, Robert Jenness, Department of Biochemistry, University of Minnesota, St. Paul, Minnesota 55108.

In order to refine energy budgets for *Myotis lucifugus* and *Eptesicus fuscus* and to fully evaluate maternal investment in female bats, milk composition was determined during lactation, and mammary gland composition and development were characterized throughout pregnancy and lactation. No significant differences in fat, lactose, protein, or energy content were evident during lactation for *M. lucifugus.* The percentage of fat, lactose, and protein averaged 13.5, 3.3, 7.4 respectively for *M. lucifugus,* and 16.4, 2.5, 6.2 respectively for *E. fuscus.* Energy content of milk averaged 7.32 kJ/g for *M. lucifugus* and 8.37 kJ/g for *E. fuscus.* The percentage of lactose in milk from *M. lucifugus* was significantly greater than in *E. fuscus,* but there were no significant intraspecific differences in percentages of fat or protein. The two species also differed significantly in content of five out of nine fatty acids. Variations in mammary gland composition during pregnancy were due primarily to fluctuations in water and fat content. Wet mass, water content and lean dry mass rose dramatically in the first week of lactation and remained elevated through mid-lactation. In late lactation, there was a rapid regression of mammary gland tissue. Energy content of mammary glands was highest during the greatest demand for milk by juveniles.

Microbial Involvement in Bat Scent Production Eugene H. Studier, Kathleen H. Lavoie, and Sandra L. Drake; Department of Biology; University of Michigan-Flint; Flint, MI 48503

Noctilionid bats possess inguinal pits which emit an odor characteristic of this species. Histological examination of these specialized pits in both noctilionids show no specialized glandular structures. Under high magnification, objects resembling bacteria appear to be embedded in the stratum corneum. Cultures of swabs from the pits of *Noctilio leporinus* yielded a mixed flora of predominantly gram positive cocci and gram negative rods. Certain pure cultures, which were grown anaerobically on a fat-containing medium produce odors similar to those characteristic of the species. These findings suggest that certain bat species may be symbiotically associated with specific microbes which produce or modify fatty glandular secretions into volatile compounds responsible for characteristic bat odors. Cultures will be available for smelling and comments.

Rabies in North American Bats C.V. Trimarchi; Center for Laboratories and Research; New York State Department of Health; Albany, New York 12201

Rabies virus continues to be identified in most species of North American insectivorous bats. In the United States in 1981, which was typical of other recent years, bats were the most widely distributed and the second most frequently reported rabid animal, with 46 states reporting 858 cases. In 1981 there were 38 confirmed rabid bats in Canada, reported from five provinces from British Columbia to Nova Scotia. The prevalence of rabies virus in bat populations, as revealed by samplings, is generally reported to be a fraction of 1%. Among bats submitted for examination, which includes a high proportion of abnormally behaving bats, about 5% of big brown bats (*Eptesicus fuscus*) and 1% of little brown bats (*Myotis lucifugus*) are rabid. Evidence suggests that bats are not acting as a reservoir of rabies for wildlife. Rabies transmission from bats to terrestrial mammals is apparently very rare. However, recent cases in New York and Massachusetts indicate the potential, especially to unvaccinated cats. Early reports of bats as asymptomatic carriers of rabies have not been substantiated. There have been a total of 10 cases of bat-transmitted rabies in humans in North America. Unprovoked attacks by bats are rare. The public health significance of bat rabies lies in the number of persons who require rabies vaccination after contact with suspected or confirmed rabid bats.

Dispelling Myths About Bats Merlin D. Tuttle; Vertebrate Division, Milwaukee Public Museum; Milwaukee, WI 53233

To win public support for bat conservation, we must correct myths, place exaggerated claims of public health hazards in perspective, and provide interesting facts regarding the sophistications and values of bats. Simple techniques for substituting respect and admiration for fear and dislike, and for encouraging a sensation-hungry media to more interest in truth rather than myth will be discussed. Stories about bats will continue, but favorable changes in content require input from bat researchers.

Determination of target velocity by the fish-catching bat, *Noctilio leporinus.* Jeffrey J. Wenstrup and Roderick A. Suthers; Medical Sciences Program, Indiana University, Bloomington, Indiana 47405.

Two fish-catching bats (*Noctilio leporinus*) were trained to perform two discrimination tasks in order to investigate their ability to detect and measure target movement. In the first experiment each animal performed a discrimination between sequentially-presented targets moving parallel to the animal's flight path and differing in the velocity of movement. Both subjects successfully chose the correct target speed when the velocity difference between the two targets was as low as 35-45 cm/sec. The bats continued to perform the discrimination in darkness, and when possible cues related to size of wake, motor sounds, or target position were eliminated. A second experiment was conducted to determine if the animals used Doppler shift information to perform the first discrimination task. The bats, situated on a platform, were presented with artificial echoes of their own sonar vocalizations, and were trained to make a left/right choice based on the amount that the echo was shifted in frequency (simulated Doppler-shift). The bats were able to discriminate differences in the frequency shift of the echoes as low as 570 to 830 Hz, corresponding to velocity differences of 1.7 and 2.5 meters/sec., respectively. Since the ability of fishing bats to determine target velocity is much better than their ability to sense Doppler shifts, we conclude that these animals do not use Doppler shift information to determine target velocity. We suggest, based on these two discriminations, that the bats determine velocity by comparing target range information derived from successive pulse-echo delays.

Dynamics of Harem Polygynous Social Structure in *Carollia perspicillata.* Charles F. Williams, 1009 Mobile, Norman, OK 73069

Carollia perspicillata (Phyllostomidae) at Parque Nacional Santa Rosa, Costa Rica is harem polygynous. One to two percent (13 to 18 males in the main study population) of the roosting male population defend exclusive territories in which up to 20 females may settle. Female philopatry averages 62% at the primary territory. Harem males reside on territories an average of 277 days (SD = 160 days). Northwestern Costa Rica experiences a seasonal rainfall pattern that is mirrored by fluctuations in male and female numbers in harems. In the wet season, May to November, harem size and number of occupied territories are highest; in the wet season, lowest. During periods of low female numbers, many harem males roost with all-male bachelor groups, although roost disturbance may cause these males and associated females to return to harem territories. Males on "preferred" territories (those likely to attract the greatest number of females in the breeding season) are less likely to roost away from harem territories in the dry season. Harem males spend some additional time and energy in defense of territories instead of foraging at night. By roosting on the periphery of female groups or alone in defense of marginal territories, they may also lose thermoregulatory benefits of grouping. The observed dry season behavior of roosting with bachelor males may enable harem males to regain energy during periods when territorial defense is less critical. The ability to maintain a positive energy balance while defending a harem territory is probably a determinant of male status. Greater weight and age are both attributes of harem males and may confer energetic benefits through stored reserves and greater foraging efficiency through experience.

On Time Allocation Among Patches of Prey by *Euderma maculatum* Ken K.Y. Wong and M. Brock Fenton; Department of Biology, Carleton University; Ottawa, Canada K1S 5B6

One aspect of a predator's behavior, the exploitation of clumped prey, is considered by optimal foraging theory. Given that the predator must visit several patches of prey during a foraging bout, optimal foraging theory offers models by which the predator may allocate its time among the patches to maximize energy intake. The spotted bat, *Euderma maculatum,* offers the opportunity of testing for optimal foraging behavior in an insectivorous bat. Individual bats forage alone by orbiting areas in clearings in ponderosa pine forests. Apparently, the bats are perceiving patches of prey in these clearings. The foraging activity of these bats can be monitored with relative ease because of their audible echolocation calls. Since there is no method of determining capture success for feeding buzzes heard, this study attempted to determine if *Euderma* maximizes encounters with prey when foraging. The study sites were located in the Okanagan Valley of British Columbia, Canada. Observations from May to August of 1982 totaled to over 700 encounters with *Euderma.* Preliminary analysis of over 400 feeding buzzes suggests that the bats do not use any of the simple models, provided by optimal foraging theory, to maximize encounters with prey. The bats seem to leave a patch of prey when their encounter rate with prey is below a certain threshold, but this threshold is not strictly followed within the same patch nor among several patches. Such a result indicates that *Euderma* forages suboptimally in terms of encountering prey. It does not rule out the possibility that the bats optimize in terms of energy intake or some other currency.

Echolocation of Stationary and Revolving Targets by the Big Brown Bat, *Eptesicus fuscus.* Weiping Zhang and Philip H.-S. Jen; Division of Biological Sciences; University of Missouri; Columbia, Missouri 65212

Four big brown bats, *Eptesicus fuscus* were trained to echolocate and approach a presented stationary or revolving target. The targets were of semicircular shape and were made of thin copper plate with a diameter of 3.2 cm and a thickness of 0.05 mm. Stationary and revolving targets were randomly and simultaneously placed in the direction of two of a three-ramp platform. The distance between a bat and each of the targets ranged from 30 to 100 cm. At each distance, the ratio of the number approaching the revolving target to that of approaching the stationary one was measured. The results showed that all bats approached the revolving target more frequently than the stationary one. When the bat-to-target distance was between 75 and 85 cm, the preference of approaching a revolving target was statistically significant. During the test, the echolocation signals emitted by the bats were recorded when the targets were placed at a distance of 40 and 80 cm respectively. Analysis of these signals showed that there was no significant difference either in signal duration, interpulse intervals or frequency contents of the signals recorded at the above two distances. A partial lesion was made electrically in the right cerebellar hemisphere of one bat. After recovery, echolocating ability of the bat was tested. The results showed that such lesions did not cause a significant difference in the bat's emitted signals and its preference in approaching a revolving target.

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NOTICE: DATED MATERIAL
PLEASE GIVE THIS YOUR EARLY ATTENTION

Dear Chiroptologist:

As you may already know, the Fourteenth Annual North American Symposium on Bat Research will meet at Colorado State University on Friday and Saturday, October 21 and 22, 1983. Dr. Michael Bogan will be our host. We will use the Rockwell Hall Conference Center at the university for our formal meetings and activities.

Mike and I extend a cordial invitation to you to share your research findings and ideas with your colleagues at the Symposium. The Conference Center has approximately 40 guest rooms available at rather modest rates, and there are numerous motels within a short distance of campus.

Since our mailing list of past paticipants and others who are interested in bat biology has grown to nearly a thousand names, I have decided in the interest of economy to mail transmission of title forms, registration forms, motel accommodation forms, maps, etc., only to those people who request them.

If you are interested in attending the Symposium, fill in the information on the accompanying form (enclosed) and return it to me at your earliest oppurtunity. I will then forward to you all the forms, information, etc., that you will need to register, submit a title and abstract, reserve a room, etc.

I will be in the tropics from August 8 to September 1, so please make every effort to mail this form as soon as possible. In the event that your letter does not reach me by early August, I'll mail the "stuff" to you upon my return in early September. In the mean time please plan to have a title and abstract to me no later than September 6, 1983.

I look forward to hearing from you in the very near future.

Truly yours,

G. Roy Horst

Mail to:

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