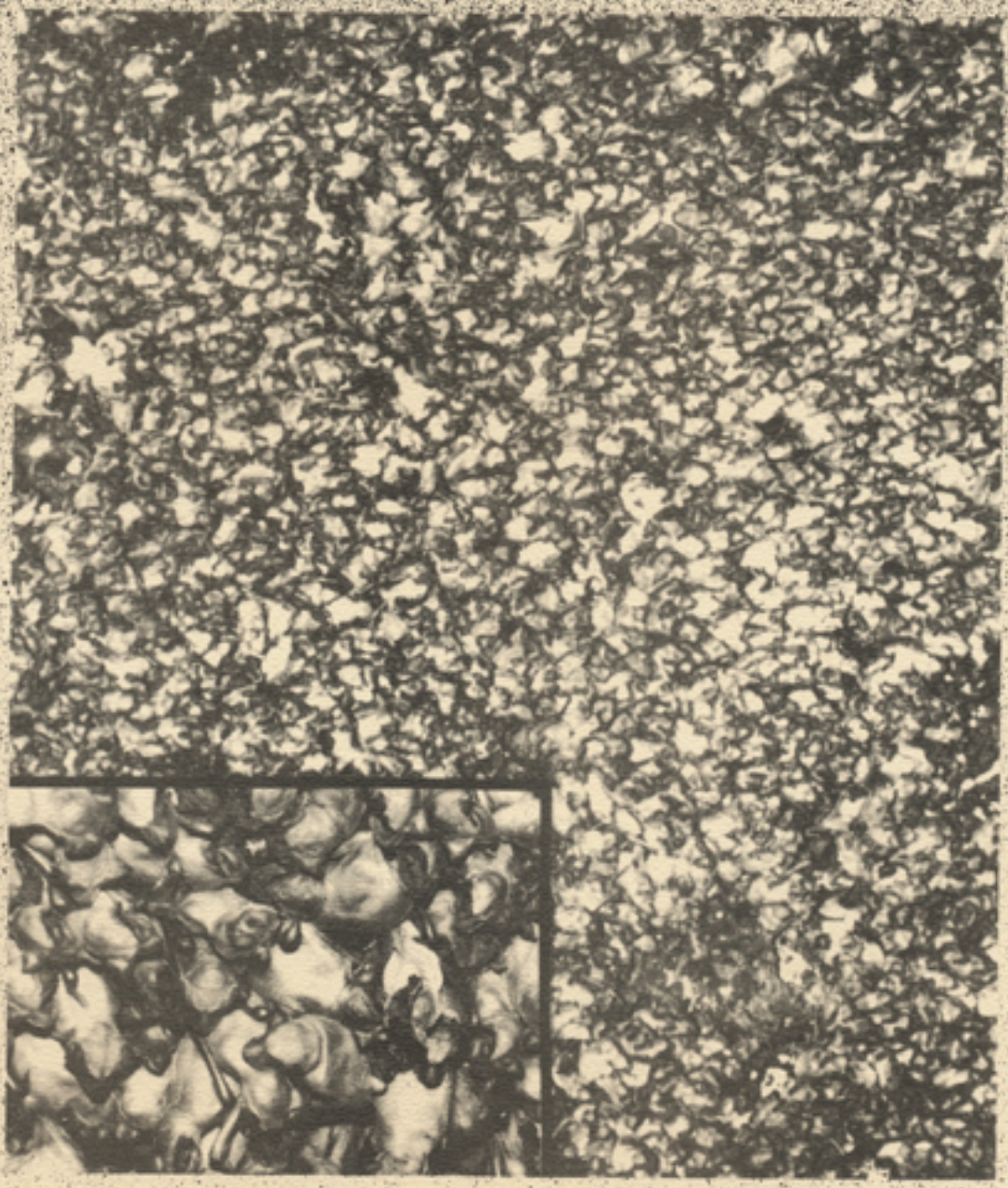
BAT RESEARCH NEWS



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BAT RESEARCH NEWS

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BAT RESEARCH NEWS

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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.

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BAT RESEARCH NEWS

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CONTENTS

FRONT COVER

Maternity roost of the mexican free-tailed bat, *Tadarida brasiliensis mexicana* in James River Cave, Mason Co., Texas. The larger photo encompasses approximately $2m^2$ of the roosting area. Inset is a closeup of the nursery "creche." Each spring an estimated 4 to 5 million pregnant mexican free-tail bats assemble in this cave where they give birth and nurse their babies. Photographed in June 1982 by Gary F. McCracken. (University of Tennessee, Knoxville, TN 37996 USA).

BAT NEWS RESEARCH

Volume 24 25 February 1983 No. 1

A SYNOPSIS OF THE FAMILIES OF BATS-PART III, Superfamily Rhinolophoidea

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In the first two parts, 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 and the three families currently included in the superfamily Rhinolophoidea. This Old World group is almost certainly monophyletic, even in the strict Hennigian (holophyletic) sense.

The Nycteridae constitute a small Old World largely tropical family. All phalanges have been lost from the second digit of the wing leaving only the metacarpal. The tail remains long and is entirely enclosed in a broad interfemoral membrane (which may be either primitive or derived). The trochiter is fairly small, extending only slightly beyond the head of the humerus, and not contacting the scapula. The seventh cervical vertebra is partly fused with the first thoracic vertebra and the first rib is noticeably strengthened, but there are no other skeletal modifications in this region. The rostrum is somewhat shortened and postorbital processes are present, though obscured by the great development of a frontal shield which supports a deep fossa. The nasal branches of the premaxillaries have apparently been completely lost but the palatal branches, though rather loosely attached, fill the space between the maxillaries. The periotic is more or less freed from surrounding bones. The dental formula has been reduced to i2/3 c1/1 p1/2 m3/3 = 32, but the pattern of the molar teeth is largely unmodified. There is a deep frontal fossa margined by complex cutaneous outgrowths but no true noseleaf. The ear bears a small tragus.

The Nycteridae, consisting of a single genus *Nycteris* with some 14 currently recognized species ranges over most of Africa as well as Madagascar and small areas on the western side of the Arabian peninsula; also, extreme southeastern Asia out in the Malay archipelago at least as far as Celebus. They are mostly insectivorous but occasionally carnivorous.

The Megadermatidae constitute another small Old World tropical family. They are more primitive than the Nycteridae in retaining a single phalanx in the second digit. The tail, however, is short or absent and the interfemoral membrane, though rather extensive, is considerably shorter than in the Nycteridae. The proximal end of the humerus and the anterior thoracic region show a very similar degree of modification to that found in the Nycteridae. The rostrum is shortened to about the same degree as in the Nycteridae, but there may or may not be postorbital processes, which, if present, are likewise partly obscured by a frontal shield, though, since there is no frontal fossa, it is probably related to the well-developed, rather backwardly directed noseleaf. The premaxillaries are almost completely lost, at most vestigial remnants remaining. The periotic is more or less freed from surrounding bones. The dental formula is considerably reduced to i0/2 c1/1 p2/2 m3/3 = 28 and may be further reduced by loss of

all upper premolars except the last, though the molar pattern remains fairly primitive. There is a well-developed, but simple, noseleaf, that can be quite large. The ears, which are extremely large and joined across the forehead, have tragi which are very large and bifurcate.

There are four genera and five species of megadermatids ranging across the Old World tropics from west Africa to tropical Australia, but absent from Madagascar and southwestern Asia. Diets range from purely insectivorous to purely carnivorous.

The Rhinolophidae constitute a large widespread Old World family, which is frequently broken into two families, but here is regarded as one. They agree with the Nycteridae in lacking phalanges from the second digit of the wing, retaining only the metacarpal (thus being more derived than the Megadermatidae). The tail always shows some shortening and may be greatly reduced. The interfemoral membrane is always considerably shorter than that of the Megadermatidae. The trochiter rises above the head of the humerus and is more derived than either of the other rhinolophoid families in articulating with the scapula. The anterior thoracic region is highly modified with the seventh cervical vertebra, first (and sometimes second) thoracic vertebra, first rib, presternum, and at least the ventral half of the second rib fused into a solid ring of bone. The rostrum is somewhat shortened, but there are no postorbital processes. The premaxillaries have lost their nasal branches, and the palatal branches are loosely attached and reduced so that they do not fill the space between the maxillaries. The dental formula is always reduced at least to i1/2 c1/1 p2/3 m3/3 = 32, and may be further reduced by loss of an additional upper premolar or further loss of another lower premolar. The noseleaf varies greatly in morphology but it is always structurally complex. The ear has lost its tragus.

Ten genera with approximately 125 species are currently recognized ranging from western Europe and west Africa to Japan and the New Hebrides. All are insectivorous, but two families are frequently recognized, both widespread. However, the Rhinolophinae, consisting only of the genus *Rhinolophus* is absent from Madagascar and the islands east of the Bismarks. The Hipposiderinae, on the other hand occur in those two areas but are absent from Europe, northern Asia, and southeastern Australia, where *Rhinolophus* occurs. Two tribes may be recognized in the Hipposiderinae, the Hipposiderini occupying the entire range of the subfamily, but the Coelopsini being confined to the Indo-Malayan region.

Received October 5, 1982

(to be continued)

BIRTH OF TRIPLETS IN THE PALLID BAT, *Antrozous pallidus*

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Orr (1954) reviewed previous reports of and presented additional data on the number of embryos found in pregnant pallid bats (*Antrozous pallidus*). In general most females carried two embryos while an occasional female carried a single embryo. Very rarely, a female was found to be carrying three embryos. Orr reported both single and twin births in the bats he studied and presented previous work in which only single and twin births were found. He neither observed nor could find literature reports of triple births in this species. Barbour and Davis (1969) presented no subsequent reports of triple births in their review of the reproductive biology of the pallid bat.

We would like to report the first documented live birth of triplets in the pallid bat. A captive female pallid bat gave birth in our laboratory to three young, all males, on June 15, 1982. The female was a member of a group of pregnant bats captured on May 25, 1982, in an attic roost near Napa (Napa Co.), California, and transported by air to our laboratory in Seattle. The bats were housed in

the laboratory as a group in a cage with inside dimensions of 1 m by 0.8 m by 0.7 m. The cage was constructed from an old incubator which was lined with plexiglass. Nylon screening was hung at each end of the cage to provide the animals a place to land and hang up, and heating coils were installed in the cage wall under the top of the screening. Air temperature at the top center of the cage was maintained between 24 and 27°C. The animals were able to select their preferred ambient temperature by moving up or down the screening. Normal roosting interactions and clustering occurred with this housing arrangement. The bats were fed mealworms daily in dishes placed on the floor of the cage and were given water ad libitum. The animals readily ate mealworms presented in this manner. The mealworm diet was supplemented twice weekly with an orally administered vitamin supplement. Each animal was given approximately 0.2 ml of the liquid supplement, which consisted of an over-the-counter children's multivitamin syrup diluted sixfold with water and mixed with a powdered multimineral supplement and ascorbic acid, from an eyedropper. The offspring born in the laboratory were utilized in a chronic study of neonatal peripheral vascular development.

The set of triplets born in the laboratory are the first we have encountered during a four year study of peripheral vascular development. Between 1979 and 1982, 61 females gave birth in our laboratory; 23% of these births produced a single offspring, 75.4% produced twins, and 1.6% produced triplets. After reviewing the literature, Barbour and Davis (1969) concluded that twins occur in 80% of births and single offspring occur in the other 20% of births. Our experience with the pallid bat in the laboratory would support this conclusion. The occurrence of triple births also appears to be a rare event.

The triplets were smaller in size than the normal newborn pallid bat. At birth the forearm lengths in the triplets were 18.14 mm, 16.00 mm, and 15.62 mm. All subsequent data for the triplets will be given with the animals in this order to allow comparison of individual animals. The mean forearm length at birth of the 34 other bats born in our laboratory in 1982 was 19.78 ± 0.16 mm ($\bar{X}$ ± SE). The smallest bat in this group had a forearm length of 17.62 mm. At birth the body weights of the triplets were 4.18 g, 3.50 g, and 3.00 g. The mean body weight at birth of the other bats born in 1982 was 4.84 ± 0.09g, with the smallest bat in the group weighing 3.52 g. The triplets were smaller than the average newborn bats; their body size was at the lower end of the range of values for animals from single and twin births. However, the largest of the triplets was larger than the smallest animal from the more common single and twin births.

At the age of 65 days, the triplets had grown to forearm lengths of 53.06 mm, 52.68 mm, and 50.40 mm and body weights of 21.80 g, 19.40 g, and 18.90 g. At the same age, the 17 remaining animals in the group of bats from single and twin births had an average forearm length of 56.44 ± 0.46 mm and an average body weight of 25.48 ± 0.60 g. The smallest forearm length in this group was 53.24 mm and the smallest body weight was 21.40 g. The pallid bats reared in our laboratory matured anatomically by 40 days of age; forearm length and body weight had reached stable, adult values by this time. Adult forearm length in this species ranges from 48 to 60 mm (Barbour and Davis, 1969). At maturity the triplets remained at the lower end of the size range of the animals from single and twin births. The triplets, however, had adult forearm lengths which were above the lower limit recognised for the species. The three small newborn bats matured into small, but normal, adult animals.

Throughout growth and development, normal mother-young interaction occurred. The female recognized all offspring as her own and would retrieve any of them when the offspring was removed from the mother. Newborn pallid bats attach to the mother's nipple for the first 10 to 14 days of life. The two smaller bats invariably shared one nipple while the largest bat of the trio occupied the other nipple. The two bats which attached to one nipple appeared to have as sound attachment to the mother as the largest member of the trio did on the other nipple. The two bats on the same nipple appeared to each have half of the nipple plus some surrounding fur in their mouths. All three young augmented this hold with their thumbs. While the mother of the triplets was not observed flying with them, other females with one or two young have been observed flying from side to side in their cage - a distance of about one meter with no difficulty. Based on daily weight records the two bats on the single nipple appeared to alter-

nate days nursing that nipple, while the remaining member of the trio appeared to nurse daily.

Orr (1954) questioned the ability of an animal with two nipples to raise three young, especially when attachment to the nipple is vital for survival in the first days after birth. As reported here, this task can be accomplished in the laboratory. Whether a female pallid bat in the wild can raise three offspring to maturity remains unanswered. The food intake required to maintain a lactating female in the wild and to provide her offspring with the energy necessary for growth would be considerably higher than that required by the captive female described here. Lactating females of the genus *Lasiurus* which presumably face energetic problems in the field similar to those faced by the pallid bat successfully raise more than two young at a time. *Lasiurus*, however, has four nipples while the pallid bat has only two. All members of a set of triplets from the genus *Lasiurus* would have their own individual attachment to the mother and would be able to nurse without competition from one of their siblings. Two members of a set of pallid bat triplets must share their attachment to the female and thus their food supply. The fate of pallid bat triplets born in the wild will also be difficult to determine because of the infrequent occurrence of the event.

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ON THE BAT IN THE BLAZON OF THE CITY OF VALENCIA, SPAIN

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A bat adorns the crown on the blazon of Valencia, a city of the old Aragonese monarchy (see page five). Aragon was one of the kingdoms which formed the present Spanish state (Spain). The main feature of the blazon of the Aragonese monarchy was four red bars on a golden background. Moreover, Peter IV, King of Aragon, also known as "the Ceremonious" introduced a winged dragon on the top of the blazon of his kingdoms in 1343-1344 (Vives y Liern, 1900). The decision of Peter IV about the introduction of the winged dragon in the Aragonese royal blazon is related to the 7th chapter of the Prophecy of Daniel, the 12th and 17th chapters of the Book of the Apocalypse of St. John, and the Belief of the Liberation of Jerusalem by a universal emperor (Ivars Cardona, 1923; Orts i Bosch, 1979). These ideas influenced western European heraldry during the 13th and 14th centuries. About three centuries after the introduction of the winged dragon in the Aragonese royal shield, this dragon was replaced by a bat in the blazon of Valencia. There are at least two reasons cited for this change: one, the similarities between the dragon and the bat made the common people confuse the winged dragon on the blazon with a bat (Orts i Bosch, 1979), and the other, according to a popular legend based on several prophecies written during the 13th and 14th centuries, the bat symbolized the christian king who had to perform the "Reconquest" of Spain from the Arabs and the unification of its kingdoms (Ivars Cardona, 1923; Orts i Bosch 1979). This was accomplished when Ferdinand, husband of Isabella of Castille,

became King of Aragon in 1479 (Smith, 1968). The appearance of the bat on the blazon of Valencia is not unique, however, in the old Aragonese monarchy, since a bat in also depicted in the blazons of Barcelona and Palma of Majorca (Vives y Liern, 1900).

The authors thank P.M. Orts i Bosch for advice and help.

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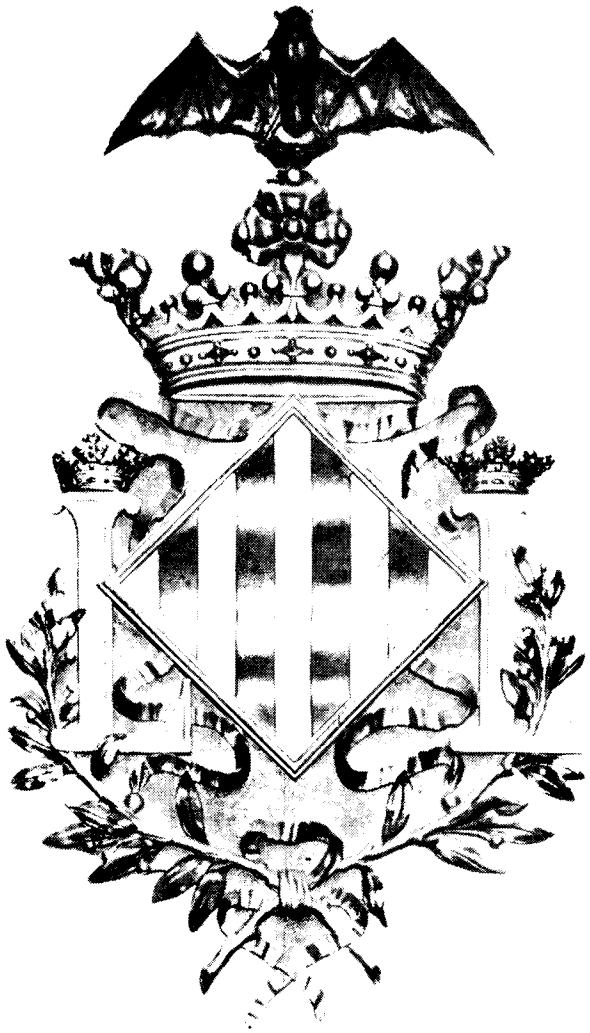
Received May 21, 1982



The blazon of the city of Valencia

THE NATION WIDE BAT PROTECTION CAMPAIGN INTRODUCED BY THE NETHERLANDS - A REPORT

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Bat research in the Netherlands started about 1937. Since that time it appeared that several of our native bat species decreased dramatically (Daan, 1980). In order to try to stop this decrease the Dutch government protected by law all bat species occurring in our country. It appeared, however, that legal protection of bats was not enough to save bat populations. People were still scared of bats, killing them or doing them harm. Bats were still threatened by the use of chemical wood preservatives, cutting down of hollow trees and restoration of old buildings. To fight these

threats the Department of Cultural Affairs, Recreation and Social Welfare in cooperation with the Committee for Bat Protection started the protection campaign in 1980 (Lina, 1980-1981) by producing 200,000 leaflets and 30,000 posters giving basic information about life history, habits and measures for protection. These were distributed all over the country. Nearly all leading newspapers and one of our TV stations announced the campaign.

The stick-on labels, such as the one shown, are meant to be displayed on automobiles of bat loving people in the Netherlands. The words given in these labels translated mean "Bats need your protection. P.O. Box 5406, 2280 HK Rijswijk." When somebody wants basic information about bats or bat protection, or wants to know what he is allowed to do with bats in his home, he simply writes to this address and the authorities give him advice.

So as to further this campaign, the Wild Life Fund and the Department donated more than *F* 200,000 (about $75,000) to create bat hibernation reserves in abandoned caves, ice cellars, and World War II block-houses and old fortresses. One reserve for bats (*Nyctalus noctula*) living exclusively in hollow trees was established. Special protection measures were taken regarding the highly endangered summer roosts of the pond bat, *Myotis dasycneme* (Voûte, 1980, 1981).

Obviously, this protection campaign should only be considered to be a start of a prolonged effort to give bat species the oppurtunity to regain population densities of former days. That this not only counts for the Netherlands, but for all European countries, may become clear from the resolution passed during the First European Symposium on Bat Research:

> "Scientists representing 16 European countries meeting at the First European Symposium on Bat Research in Bonn 16-20 March 1981, are critically concerned about the rapid decline in bat populations. In all areas of Europe bats are becoming extremely rare and some are close to extinction. The main causes of the decline are the loss of roosts such as caves and mines, hollow trees, suitable buildings together with changes in land use. Bat colonies are being destroyed by pesticides used for wood preservation. Because of the highly specialized roosting requirements, and because bats gather from wide areas,often across international boundaries, the participants of this Symposium urge European governments to offer immediate protection for all bat roosts. The attending scientists will provide all necessary advice to implement protection. Bonn, 20 March 1981."

Undeniably, bat protection will only be successful when it is based on thorough research. It is highly frustrating, that when bat research is needed more than ever, economizing governments irresponsibly cut university expenses concerning research on bats. In the Netherlands, this implies that the biologist working on bat ecology is almost certainly compelled to give up his research.

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Received September 21, 1982

PROFESSOR DR. ANTON KOLB - A TRIBUTE

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Professor Anton Kolb was born at Erasbach (Oberpfalz, Bavaria) on November 5, 1915. Between 1940 and 1945 he studied Biology and Philosophy at the well known University of Erlangen. He completed his studies leading to certification for high school (Gymnasium) teaching. He received the degree of Doctor rer. nat. in 1945. His thesis entitled "Observations on the Biology of Native Bats" was published in "Zoologische Jahrbucher Abt. Systematik-Okologie" in 1950. From 1945-1951 he was associated with the Zoological Institute of the University of Erlangen as an assistant. In 1954, Dr. Kolb was appointed as Privatdozent after completing his inaugural dissertation (Habilitation). During this period he supervised the biology education at the Academy, now University, of Bamberg. He was elected to the Chair of Professor (Extra-Ordinarius) in 1954 and as Full Professor (Ordinarius) in 1959.

During the last 25 years he has established new concepts concerning biology education and has organized an Institute for teaching and research. He is also the Director of the Museum of Natural History of the Bamberg University.

Professor Kolb has published more than 50 papers on various aspects of biology, ecology and paleontology. More than 30 of these publications deal with the biology of European bats.

Professor Anton Kolb's researches on bats are characterized by his new and challenging viewpoints and by his ability to combine field work, observations in captivity and experimental work in the laboratory. His thesis, published in 1950, contains a lot of new observations on the ethology of *Myotis* and *Rhinolophus* and analyzes the question of accumulation and segregation in colonies. In *Rhinolophus*, he discovered the occurence of pubic nipples ("Haftzitzen", "organ de fixation") which are utilized by the young for holding on to the mother. In many detailed articles, Professor Kolb has published observations and experiments dealing with many misunderstood problems on the biology of bats. Among others, I will emphasize his contributions on parturition, communication between mother and young, his studies on searching for food and mechanisms of feeding, on the capability of sensory systems, on methods of cleaning and his success with scientific films on bats.

Professor Kolb is one of those few scientists who have established new dimensions to the field of Chiroptology in our country and we hope, that he will continue to contribute much valuable research on this interesting group of mammals.

Received November 23, 1982

A 23-YEAR RECOVERY RECORD FOR *Myotis lucifugus*

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On 23 June 1982, we captured a banded pregnant female *Myotis lucifugus* at the State Fish Hatchery, 1.6 km S, 3.2 km E, Manchester, Delaware Co., Iowa. She had been banded by Richard F. Myers at the same site on 4 July 1959, hence was at least nearly 23 years old. According to Griffin and Hitchcock (J. Mamm., 46: 332, 1965), the probable longevity record for this species is 24 years. This female gave birth in the holding cage and was placed with her young in a tree. The next morning both mother and young were gone, so hopefully she will survive to reproduce for a few more years.

29 November 1982

[The current longevity record among bats is held by an Ontario little brown bat which in 1979 had survived more than 30 years in the wild (Fenton, M.B. *IN*: *Just Bats*. p. 108. University of Toronto Press, 1983). Editor.]

NEWS AND VIEWS

LETTERS TO THE EDITOR

I would like to comment on the article by A.M. Voute (First recorded accidental transatlantic bat transport, *Bat Research News*, 23: 16-18, 1982). There are two European bats which are both very rare and of uncertain taxonomic position, namely *Eptesicus sodalis* and *Myotis nathalinae*. My surmise is that the two American bats, *Eptesicus fuscus* and *Myotis lucifugus*, could have been accidentally introduced into Europe, say 100 years ago, and became locally established. Later, *M. lucifugus* has been redescribed as *M. nathalinae* and *E. fuscus* as *E. sodalis*. However, under present conditions I am unable to verify this suspicion. Only a careful comparison of *nathalinae* with *lucifugus* and *sodalis* with *fuscus* could settle this point.

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9 February 1983

On 23 February 1983 I found a banded bat in Mt. Aeolus cave, Bennington County, Vermont. The bat had probably died this past fall. Although the head and most of the body had been eaten by a weasel that habitually scavenges this cave, it appeared to be a *Myotis lucifugus*. Previous bands that I have recovered from this cave have been US Fish and Wildlife Service bands and the banding information has been easy to acquire. This band, however, has no identification other than the number "093". It has flanged ends () rather than straight () as most small bird bands have.

Is there an established procedure for tracking down banding data from bat bands that are not part of the Bat-Banding Office system? Is there any clearing house for the coordination of current bat banding activities? There is certainly a need for some sort of data recovery mechanism. Don Griffin and Harold (Al) Hitchcock have previously banded many bats in the Mt. Aeolus cave but the band mentioned above is not one of theirs. I would greatly appreciate any leads or assistance in

tracking down the identity of this band.

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10 March 1983

(The readers, knowledgeable of bat banding programs, are requested to respond to this request by writing to the editor as well as to Dr. French.)

Seventh International Bat Research Conference

Dr. Paul Racey has sent us a provisional date for the Seventh International Conference. His dates are September 23-27 (Monday-Friday) 1985. I have suggested to Dr. Racey that a large number of us would have difficulty taking leave of our classes for that period. I also suggested that if the meeting would be held in August (as we North Americans recommended in Louisville) a much larger number of North Americans could attend. It is reasonable to estimate that this difference could approach or even exceed one hundred participants. The meeting should not conflict with the International Theriological Conference in Canada (Aug 13-20, 1985) or the XII International Anatomical Conference in London (Aug 11-17, 1985). Suggested alternate dates would be August 5-9 or 26-30, 1985. It is possible that the Annual North American Symposium on Bat Research would not meet independently in 1985 but that we could combine the two groups as we did so successfully in Albuquerque in 1978.

A decision will be made as soon as possible and the definitive date will be announced at the earliest opportunity. Please call me or drop me a note before September 1, 1983 if you have any suggestions or comments concerning these dates.

G. Roy Horst

REMEMBER!

THE FOURTEENTH ANNUAL NORTH AMERICAN SYMPOSIUM ON BAT RESEARCH

The symposium will be held on October 21 and 22, 1983 at the Rockwell Conference Center, Colorado State University, Fort Collins, Colorado. For information about the program, registration, or presenting a paper contact G. Roy Horst. For information concerning rooms at the conference center or local motels contact Caroline Frye.

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RECENT LITERATURE

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BAT RESEARCH NEWS

VOLUME 24 No 2-3 MAY-AUGUST 1983

BAT RESEARCH NEWS

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FRONT COVER

A nursery colony of Gray Myotis (*Myotis grisescens*, an Endangered Species) clinging to the ceiling of the city storm sewer in Pittsburg, Crawford County, Kansas. Photographed in June 1977 by Scott Howard and submitted by Horace A. Hays, Biology Department, Pittsburg State University, Pittsburg, Kansas. See the article on page 22.

BAT RESEARCH NEWS

Volume 24 Nos. 2-3

A SYNOPSIS OF THE FAMILIES OF BATS - PART IV, Superfamily Phyllostomoidea

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In the first three parts, I discussed the approach used, enumerated important primitive characters, and discussed derived characters of the Pteropodidae and the six families of the superfamilies Emballonuroidea and Rhinolophoidea. In part 4, I will try to do the same for the three families currently included in the superfamily Phyllostomoidea. This New World group has only recently been recognized in its present form, the Noctilionidae having previously been associated with the Emballonuroidea (presumably based primarily on shared primitive characters). Also, the Mormoopidae, previously included (as the subfamily Chilonycterinae) in the Phyllostomidae, are now recognized as a separate family, whereas the previously recognized family Desmodontidae is now usually included in the Phyllostomoidae. Since there appear to be sound phylogenetic reasons for these changes, the superfamily Phyllostomoidea would certainly seem to stand as a monophyletic group in the broad sense and very likely in the narrow Hennigian (holophyletic) sense, unless some additional family (e.g., *Mystacinidae*) should be added to it.

The Noctilionidae form a small Neotropical family. The second digit of the wing has been reduced to the metacarpal and greatly reduced first phalanx. The tail is considerably shortened so that it does not reach the edge of the extensive interfemoral membrane. The trochiter remains fairly small, extending barely beyond the head of the humerus and making only a slight and indefinite contact with the scapula. The anterior thoracic area and associated vertebrae remain unmodified. The rostrum is somewhat shortened, but no postorbital processes are present. Both nasal and palatal branches of the premaxillae (the latter considerably reduced) are present, but are fused to one another and to the maxillaries in adults. The periotic is freed from surrounding bones. The dental formula has been reduced to i 2/1 c 1/1 p 1/1 m 3/3 = 28, but the pattern of the molar teeth is largely modified. The lips are very full forming a sort of cheek pouch and the nostrils are somewhat tubular, but there is no noseleaf. The ears are large, slender, and pointed with a well-developed tragus.

The Noctilionidae consist of the single genus *Noctilio* with two species ranging over most of Middle America and the West Indies as well as tropical South America. The diet ranges from insectivorous to piscivorous.

The Mormoopidae form another small chiefly Neotropical family. The second digit of the wing is reduced to the well-developed metacarpal and a single small phalanx. The tail and interfemoral membrane are much as in the Noctilionidae. The trochiter is small and does not impinge on the scapula and there are no special modifications of the anterior thoracic region. The rostrum is not especially shortened, though it may be highly

modified by being bent upward in relation to the braincase. Both nasal and palatal branches of the premaxillae are present but fused to one another and to the maxillaries in the adult. The periotic is freed from surrounding bones. The dental formula is reduced to i 2/2 c 1/1 p 2/3 m 3/3 ^{5} 34. but the molar pattern is relatively unmodified. There are cutaneous outgrowths around the nostrils (and also lower lip) but it is doubtful that these can be considered a true noseleaf. The ears are variable in form with well-developed tragi.

Two genera and eight species are currently recognized in this purely insectivorous family. The range is from southern North America to tropical South America and through most of the West Indies.

The Phyllostomidae constitute a large and extraordinarily diverse, chiefly Neotropical family. The second digit of the wing is represented by a well-developed metacarpal and a single small phalanx. The primitive condition of the tail and interfemoral membrane is almost certainly similar to that of the Noctilionidae and Mormoopidae, but there is considerable diversity in the family with the tail varying from long to absent and the interfemoral membrane from very broad (even if the tail is absent) to absent. The trochiter is well-developed and impinges on the scapula, but there is no special modification of the anterior thoracic region. The rostrum is primitively somewhat elongate but there is a great deal of diversity in this character going from enormously elongated to tremendously shortened. There are no post-orbital processes. Both nasal and palatal branches of the premaxillae are present but are fused together and with the maxillae in adults. The periotic is freed from surrounding bones. The dental formula is almost always reduced to i 2/2 c 1/1 p 2/3 m 3/3 (*Anoura* has three upper premolars but this is almost certainly secondary) and may be much further reduced by loss of additional upper or lower incisors, upper and lower premolars, and upper and lower molars. Molar pattern also shows tremendous diversity from a primitive condition (hardly different from the primitive pattern for Microchiroptera) to a broad crushing polycuspidate tooth or, alternatively, to a reduced molar that retains almost none of the original cusp pattern. Primitively, a small simple noseleaf has been developed (therefore derived over the primitive bat condition) but it may be either enlarged or reduced or in one case (*Centurio*) so highly modified as to be almost unrecognizable. The ears vary greatly in size, but a tragus is always present, though showing some diversity in form.

The Phyllostomidae include some 46 currently recognized genera and some 137 species. The range extends from southern North America through Middle America and the West Indies to tropical and subtropical South America. With the exception of *Brachyphylla* and the Phyllonycterinae (which are confined to the West Indies) all major groups (which are very much in a state of flux at the moment) have distributions which encompass most of the range of the family. Primitively insectivorous, many speceies have become frugivorous or nectarivorous, while few are carnivorous or sanguivorous.

(to be continued) Received January 25, 1983

TERMS COMMONLY USED AND MISUSED IN THE LITERATURE PERTAINING TO BATS

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Our purpose in preparing this glossary is to attempt to clarify and establish some uniformity in terminology that is commonly used in the literature pertaining to bats. We have drawn from a variety of sources in formulating our definitions, including original literature, standard reference works, and suggestions from various colleagues. We especially thank Edythe Anthony, Brock Fenton, Allen Kurta, Gary McCracken, Paul Racey, and Bill Wimsatt for their commments. Some terms refer specifically to bats whereas others are of a more general nature but are included here for clarification. We have listed what we believe to be the most appropriate definition or usage of the terms. Where there are differences of opinion we encourage readers to challlenge our own thinking and/or to add terms not included here. Additions or suggestions should be addressed to Kunz.

adults: Males and females which are sexually mature.

antitragus: A small fleshy projection on the postero-ventral margin of the pinna of some bats.

aspect ratio: Forearm length (elbow to wrist) + wing tip (wrist to tip of digit III)/length of fifth finger.

bachelor colony: A group of pre- and post-pubertal males that roosts seperately from females, usually during the reproductive period (includes non-harem males).

basal metabolic rate: Rate of energy expenditure while at rest, post-absorptive, and at thermoneutrality; expressed as kJ. $g^{-1}h^{-1}$. (see **roosting metabolic rate**).

bat detector: Electronic device sensitive to ultrasonic and audible sounds produced by bats (e.g. QMC mini bat detector, Holgate bat detector, leak detector).

bat pass: One pass by one individual through air space as sampled with a bat detector. (see **feeding buzz**).

breeding season: The period beginning with courtship and ending with weaning. (see **mating, parturition**).

calcar: A cartilaginus process in the calcaneum bone that contributes to the support of the uropatagium.

call structure: Pattern of frequency change over time in vocalizations; sonograph or peroid meter display.

CF: Constant frequency (pure tone) component of ultrasonic pulses produced by some echolocating bats (used for ranging and judging velocity and direction of movement).

carnivory: The habit of eating flesh (e.g. insects, fish, amphibians, reptiles, birds, mammals).

cohort life table: A life table constructed from a mortality schedule of individuals that started life together.

communal roost: A roost used simultaneously by more than one individual.

chiropterophily: Mutualistic associations between flowers and flower-visiting bats.

circadian: Relating to a period of approximately 24 hours.

cluster: A group of roosting bats.

colony: Usually a specified aggregation of bats (e.g. maternity colony, hibernating colony, bachelor colony, etc.).

crepuscular: Pertaining to the twilight periods of dawn and dusk.

dactylopatagium: The part of the wing membrane between the 2nd and 3rd digits.

daily energy budget (DEB): Amount of energy assimilated or expended daily to sustain free-living existence.

day roost: A site or structure used by bats during the day.

delayed development: A condition where the blastocyst implants without delay after entering the uterus but subsequent embryonic development ceases temporarily or proceeds slowly. (see **delayed implantation**).

delayed fertilization: See **delayed ovulation.**

delayed implantation: A condition where the blastocyst remains in the uterine lumen for a variable period before it implants.

delayed ovulation: A condition in which ovulation is postponed for a period of time following copulation and where spermatozoa are stored in the female reproductive tract (excluding *Miniopterus*). In temperate regions this period is prolonged by hibernation (also called delayed fertilization).

dispersal: Usually refers to the movement of an individual away from its place of birth or origin, but also can refer to movements of individuals away from a roost for foraging purposes.

ecomorphology: Inferential relationships between morphology and ecology.

echolocation: Use of echos of sounds produced by animals for orientation and prey capture.

estrus: A period when females allow males to mate with them (specifically near the time of ovulation, except in temperate zone hibernators-but excluding *Miniopterus*).

false nipples: Supernumerary (pubic) nipples that function as "holdfasts" for suckling young, and which are present in several species of some Old World families.

fat index: The ratio of grams of fat/grams of lean dry mass.

feeding buzz: A rapid series of pulses made by an echolocating bat in its final approach to a prey item. (see **bat pass**).

feeding roost: A site used by bats to consume prey too large to consume during flight and as a night-time refuge from predators. (see **night roost**).

fledging period: Time when young bats begin to make foraging flights.

flock: An assemblage of bats in flight.

FM: Frequency modulated pulses produced by some echolocating bats (mostly used for the discrimination of size and shape).

frugivory: The habit of eating fruit.

gestation: Length of time from fertilization until birth.

gleaning: A foraging tactic used by some bats whereby prey items are taken from a surface (e.g. ground, leaves, tree trunk, etc.).

guano: Fecal and urinary waste that accumulates within or below a roost.

harem: A group of females associated with a single adult male.

heterothermy: The ability to regulate body temperature physiologically, but temperature is not regulated precisely or at the same level at all times.

hibernaculum: Type of roost used by temperate zone bats in winter (e.g. caves, mines, buildings).

hibernation: The assumption of a state of greatly reduced core temperature for prolonged periods of time during cold seasons by an animal which has an active body temperature near 37°C, yet it retains the ability to spontaneously arouse without absorbing heat from the environment.

homeothermy: regulated maintenance of the body temperature near 37°C.

homing: Refers to the return of individauls to their place of birth or origin.

immature: An animal which has attained adult dimensions but not sexual maturity.

insectivory: The habit of eating insects.

juvenile: An animal which has not reached adult physical dimensions; characterized by unfused epiphyses. (see **immature**)

kilohertz: kHz (1,000 cycles per second).

kilojoule: kJ (4.19 x kcal).

light-sampling: Behavior associated with the onset of nightly emergence where one or more individuals fly in the vicinity of the exit before emergence.

lunar phobia: Avoidance response to bright moonlight, where flght activity either becomes reduced or ceases.

lek: An assembly area used by adult males for courtship display and copulation with females.

maternity colony: An aggregation of female bats during pregnancy and lactation.

maternity roost: A site used by females during pregnancy and lactation.

mating: The pairing of a male and female during courtship and copulation.

migration: Regular seasonal movements.

monotocous: Production of one young per pregnancy.

monestrous: Pertains to species that have a single estrous cycle per year.

nectarivory: The habit of feeding on nectar.

neonate: A newborn young.

net nights: The product of the number of mist nets and the number of nights that nets are employed for the purpose of capturing bats (the size of nets should be designated).

night roost: Roost site used at night for resting, consuming and digesting prey, and predator avoidance.

nulliparous: Pertains to a female which has not given birth (includes individuals which are: immature, mature but not inseminated, mature and primigravid).

omnivory: The habit of feeding on a mixed diet (feeding across two or more trophic levels).

opportunistic feeding: Pertains to a feeding habit where individuals consume the most abundant prey items.

parous: Pertains to a female which has given birth (may include females which have been inseminated, not inseminated, pregnant, or lactating).

parturition: The act or process of giving birth to offspring.

parturition period: The time of year when females give birth to young.

patagium: Membrane which forms the wings and uropatagium.

pelage: Collective term pertaining to body hair.

piscivory: The habit of eating fish.

philopatry: The seasonal return of a bat to its place of birth or to the same hibernaculum.

plagiopatagium: Membrane which forms the part of the wing that extends laterally from the fifth digit of the wing to the ankle.

polyestrous: Pertains to species that have two or more estrous cycles per year.

polygyny: A mating system involving the access of a single male to more than one female during a mating season.

post-partum estrus: An estrus immediately following birth (see **polyestrous**).

pubertal: Pertains to a male undergoing spermatogenesis for the first time, or a female undergoing first estrus.

polytocous: Producing more than one young per pregnancy.

post-lactating: Reproductive state of a female when lactation has ceased and milk can no longer be expressed from the nipples.

propatagium: The membrane between the wrist and the body that forms the leading edge of the wing.

refuging species: Pertains to species in which members form roosting aggregations.

roost: Site used by bats when not in flight.

roost fidelity: The tendency of a bat to return repeatedly to a certain roost (e.g. cave, tree hollow, barn) or general area (foliage).

roosting metabolic rate: Rate of energy expenditure under natural or semi-natural conditions (includes costs associated with specific dynamic action, movements, clustering, grooming, social interactions, etc.).

sanguivory: The habit of feeding on blood.

silent heat: The occurrence of ovulation without fertilization, prior to behavioral estrus and insemination (e.g. *Miniopterus*).

swarming: The activity of bats (males and females) from mid-summer through early autumn at sites that ultimately are used as hibernacula (the latter part of this interval is coincident with mating in temperate regions).

synanthropy: The association of bats with man.

tent-making: The modification of leaves for use as roosts.

time-activity budget: The amount of time allocated to various activities (e.g. day roosting, night roosting, flight, rest, grooming), expressed in absolute time units or by percent of total activity.

torpor: A state in which an animal's body temperature is depressed below homeothermic levels and that results in a lowered metabolic rate and an inability to perform normal locomotor function (e.g. flight).

thermal conductance: A measure of the insulative properties of the skin and/or pelage, usually expressed as $cm^3O_2.g^{-1}h^{-1}{}^{\circ}C.^{-1}$

thermoneutrality: The ambient temperature at which the basal metabolic rate of a homeotherm is minimal.

transient roost: Temporary roost used by bats enroute during migration.

tragus: The fleshy projection from the lower medial margin of the pinna in most microchiropteran bats.

trap-lining: A foraging behavior characteristic of some nectarivorous bats wherein regular and repeated visits are made to flowers along a fixed route.

ultrasonic: Pertains to sound frequencies above the audible range (usually frequencies greater than 20 kHz).

uropatagium: Membrane extending between the tail and hind legs (also called interfemoral membrane).

water index: The ratio of grams of water/grams of lean dry mass.

weaning: Time when a juvenile begins to take food other than its mother's milk.

whispering bat: A species which emits low intensity echolocation pulses (e.g. *Plecotus, Megaderma, Nycteris*).

wing-loading: The ratio of body mass (g)/wing area (cm^2).

yearling: An animal at the beginning of its second year of life.

zeitgeber: An environmental clue (e.g. light) that synchronizes, entrains, or modifies a circadian rhythm.

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A REPORT ON THE GRAY MYOTIS (*Myotis grisescens*) IN THE STORM SEWERS OF PITTSBURG, KANSAS

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A maternity colony of Gray Myotis (*Myotis grisescens*), occupying the storm sewers of Pittsburg, Crawford County, Kansas, has been monitored for the past twenty years (since Summer, 1962). These bats, known primarily to inhabit caves in the southeastern part of the United States, are an endangered species and constitute the only known colony of the bats in Kansas (Figure 1). The first record of the Gray Myotis in Kansas was a male taken on 29 July 1958 near Ford Street in Pittsburg by Bertram J. Brown, a graduate student in Mammalogy at Pittsburg State University, and reported in the Journal of Mammalogy by Charles A. Long (1961). The second specimen reported from Kansas was collected on 14 October 1962, in "Jesse James Cave" one mile south of Galena, Cherokee County (Jones and Downhower, 1963). In 1964 Hays and Bingman reported finding the maternity colony of Gray Myotis in the storm sewers.

The storm sewer occupied by the bats is 6 feet high and was built in 1925. The ceiling is rounded and the floor slopes toward the middle from both sides. A small stream of water flows down the middle. The upper part of the sewer, constructed of brick, is lined with concrete inside and out. Four different roosting sites have been located where the ceiling is rough, in dark areas where there are no cracks or holes for the admission of light.

The females usually arrive in the sewer in March or early April and the young are usually born in the early part of June. The males arrive later and are usually not found in numbers until August. The females are the first to leave in the fall, usually in late October or early November. Evidence based on the recovery of banded bats indicates that the primary hibernacula for these bats is located in the Ozark Plateau Region of Missouri. An analysis of data obtained from Thomas Kunz indicates that 2408 Gray Myotis have been banded

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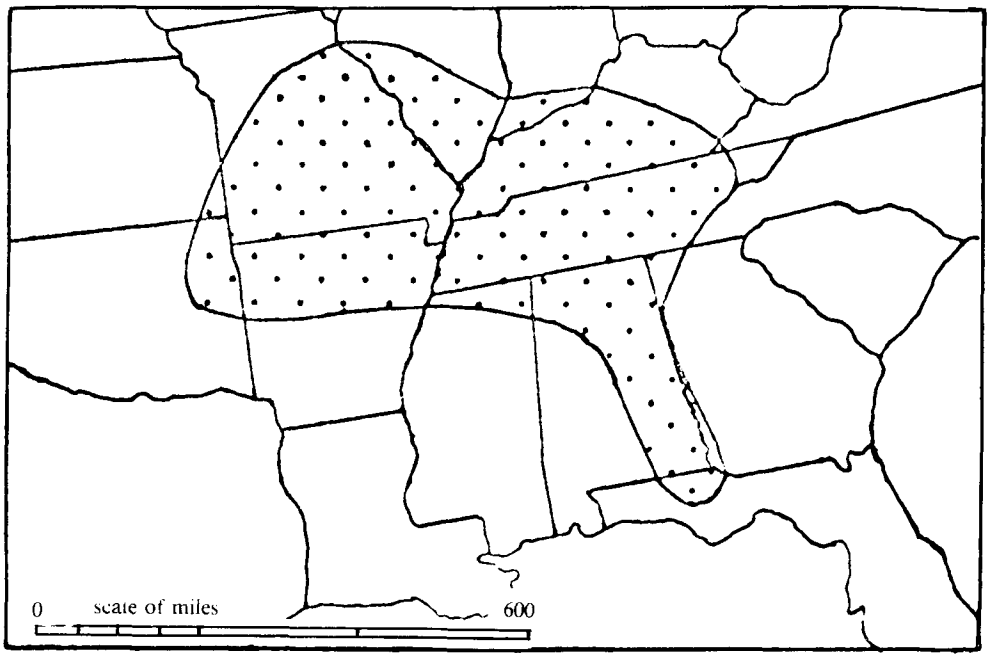

FIGURE 1. The distribution of *Myotis grisescens* in the United States.

in Pittsburg (1046 males, 1362 females). This number includes 698 bats that were banded by Everett Grigsby during his two year study of these bats. A total of 170 recaptures have been reported (61 males, 109 females), 126 of which were recaptured in the sewer, 38 from caves in Southern Missouri, 1 each from caves in Arkansas and Oklahoma, and 4 from the vicinity of Pittsburg.

The estimated number of bats occupying the sewer have varied from year to year. The more conservative estimates in the 1960's placed the number between 5,000 and 6,000 bats. Some estimates were considerably higher. However, in more recent years estimates have placed the number between 2,000 and 3,000. The highest count in 1982 based on flight counts as the bats departed the sewer at dusk was 3,058 on September 1.

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THE COLLECTION AND PRESERVATION OF ECTOPARASITES OF BATS - AN APPEAL

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Near the end of my course in insect systematics, one of my students recently asked, "Is it my imagination, or do bats have an inordinate number of ectoparasites?" It was not her imagination! In addition to the myriad of tick and mite species associated with bats, they are also parasitized by insects belonging to four orders, as shown in Table I.

Table I

Order	Family	Genera	Species
Dermaptera	Arixeniidae	2	5
Hemiptera	Cimicidae	12	63
	Polyctenidae	5	32
Diptera	Mystacinobiidae	2	2
	Chiropteromyzidae	1	1
	Streblidae	31	221
	Nycterbiidae	12	256
Siphonaptera	Pulicidae	1	1
	Ischnopsyllidae (Fig. 1)	19	99

While most of these groups are well known from a taxonomic point of view, there have been three new genera of bat fleas described in the past ten years. Additional new species are being discovered each year, even in areas as well worked as North America. As a result, researchers working with bats are in an excellent position to add to our knowledge of these fascinating insects, as well as contributing to a better understanding of the interrelationships between bats and their parasite fauna. To this point I have been asked by the editor to summarize collection and preservation techniques for ectoparasites, and to suggest the names of institutions and specialists likely to yield quick and accurate identifications upon request.

By far the majority of ectoparasites listed in Table I occur continuously on the body of the host

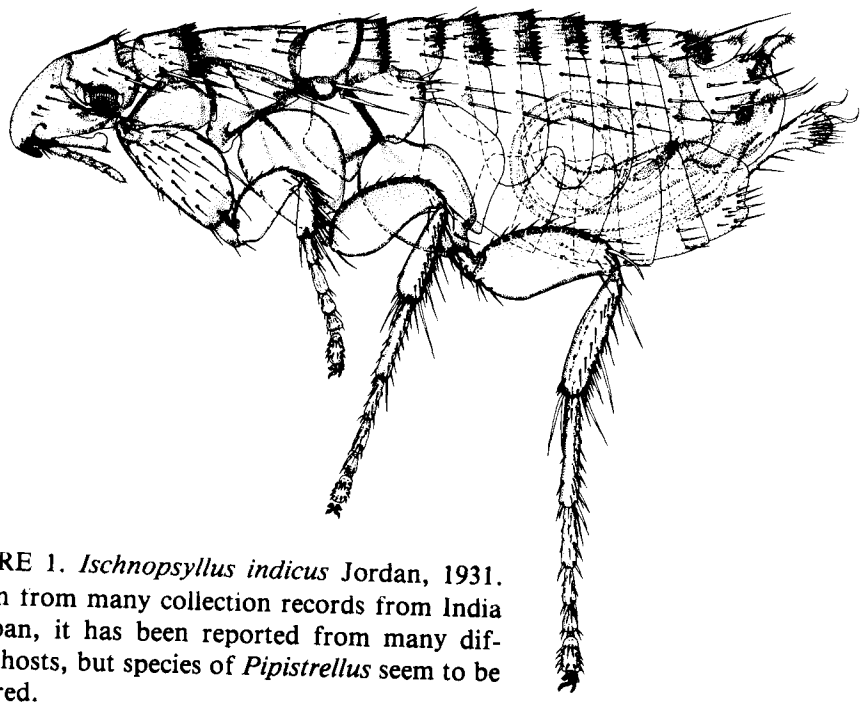

FIGURE 1. *Ischnopsyllus indicus* Jordan, 1931. Known from many collection records from India to Japan, it has been reported from many different hosts, but species of *Pipistrellus* seem to be preferred.

bat, leaving only briefly to oviposit or larvaposit. Polyctenids, streblids, nycterbiids and fleas are usually quite obvious when present and may readily be removed with forceps from the body of the living or dead host. Dead bats can be fumigated with chloroform for a few minutes, which makes the collection of their stunned ectoparasites much easier.

Most bat roosts are relatively inaccessible to collectors and cannot be closely inspected. Where they are accessible, cracks and crevices in the area should be examined for cimicids, the puparia of the streblids and nycterbiids, and the larvae and pupae of fleas. Strips of double-sided sticky tape frequently capture dozens of fleas when placed on cave walls between the bat roost and the guano pile beneath the roost.

The guano pile under the bat roost is frequently a microcosm of insect life. Most of the species are either coprophagous forms or their predators. However, arixeniids have been associated with the guano of *Cheiromeles torquatus*, and it is thought that the larvae of many species of bat fleas use guano as a source of food. Collections of guano taken back to the laboratory frequently yield hundreds of adult bat fleas over a long period of time when kept moist and in a covered container at room temperature.

Most of the insects listed in Table I require special preparation before they can be identified by specialists. The preservative of choice is 75% ethyl alcohol, although vodka, gin, or some other medicinal alcohol will suffice in an emergency. Formalin or formaldehyde-based preservatives should be avoided, as they tend to fix the tissues which inhibits clearing with caustic potash. Either the host collection number or the collection data should be enclosed in the vial with the parasites. Data should be in India ink on a good quality paper.

While museums are usually the ultimate repository for most ectoparasite collections, few of them have specialists in the groups under consideration. It is much more expeditious to send your collections directly to a researcher who specializes in that group, particularly if prompt identification is expected. To include a list of names and addresses of such specialists would unduly protract this article but the information is available upon request. More detailed instructions for collection, preservation and study of mammalian and avian ectoparasites is also available upon request.

Received August 27, 1982

NEWS AND VIEWS

NOBEL NOMINATION FOR A BAT MAN. Did you know that Charles A.R. Campell, M.D., the inventor of bat-towers, was nominated for the Nobel Prize in 1919 by an act of the Texas State Legislature! The entire story of Dr. Campell's remarkable experiment reappeared in an article by W.D. Swearingen [*American Heritage*, 33 (4): 110-112, 1982]. An earlier issue of the magazine [33 (3): 93-94, 1982] contained another article on bats. **Submitted by** Robert Martin, 23 September 1982, University of Maine at Farmington, Farmington, ME 04938, along with two other clippings entitled "Rabid Bat Bite Called Fluke" (Kennebec Journal, Augusta, May 19, 1982) and "Bats Stir Statehouse Commotion" (Morning Sentinal, August 25, 1982), amply justifying Bob's involvement with bat problems in the public sector.

RABIES KILLS GIRL, 5; TOLD OF BAT BITE. Ann Arbor, Mich. (AP) -"A 5-year-old girl who said she was bitten by a bat last fall has died of rabies, the first rabies death in Michigan in 35 years, officials say. The girl was admitted to Hillsdale Hospital on February 5 with a suspected bone infection suffered in a fall while ice skating, but was transferred to Mott Hospital February 13 when her mental condition began to deteriorate. Doctors said the rabies diagnosis was confirmed Tuesday through body fluid tests analyzed by the Center for Disease Control, Atlanta. Nationally, two people died of rabies in 1981, the latest figures available, said a university spokesman. The hospital will offer free inoculations to patients in the intensive-care unit and hospital personnel who have come in contact with the girl. Officials will

screen at least 200 people for inoculations, but 'far fewer' would have to undergo the series of five inoculation shots, spread over 28 days." **Submitted by** Harlan D. Walley, 16 March 1983, Department of Biology, Northern Illinois University, Dekalb, IL 60115 USA. Source: *Chicago Tribune*, Friday, March 11, 1983.

BATS DO NOT DESERVE BRICKBATS (*The Animal Welfare Institute Quarterly*, 31: 5, 1982/83, Washington). This brief note emphasizes the good work being done by *Bat Conservation International*. **Submitted by** G.E. Cosgrove, 11 April 1983, Zoological Society of San Diego, CA 92112 USA.

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Schober, W. 1983. *Mit Echolot und Ultraschall*. Dei phantastische Welt der Fledertiere. 211 pp. Edition Leipzig. Cloth, 9.5 x 10.5 inches, color plates.

SEVENTH INTERNATIONAL BAT RESEARCH CONFERENCE

and

THIRD EUROPEAN BAT RESEARCH SYMPOSIUM

We plan to hold the Seventh International Bat Research Conference to coincide with the Third European Bat Research Symposium in Aberdeen between the middle of August and the beginning of October 1985. We have rather arbitrarily chosen the dates of 23-27th September, principally to avoid juxtaposition with the 4th International Theriological Conference which will be held in Alberta 13-20th August, and coincidence with the Offshore Europe Exhibition which occupies every spare bed in Aberdeen, including all those in the University residences.

If you plan to attend the Aberdeen Bat Conference, please return the enclosed provisional registration form at your earliest convenience. We particularly wish to know whether the dates we have chosen are convenient, and whether you wish to publish the proceedings. Alternative dates at the time of writing are between 21st August and 8th September and between 14th September and 3rd October. While it is clear that participants at such international meetings like to have a record of the proceedings, they are often expensive to produce, and despite the best efforts of editors are frequently a long time appearing. Personally, we would prefer to see bat papers containing new data appear in relevant journals.

The Conference will be accommodated in Aberdeen University Halls of Residence and sessions will be held in one of the science departments on campus. We are particularly keen to encourage as many students as possible to attend this meeting, and the Department of Zoology will award a prize of £100 to the best student presentation.

Aberdeen is very well served by all forms of public transport, with direct flights to an increasing number of European destinations, and an excellent service with both London airports. There are daily flights to most other British airports, including Prestwick (for transatlantic charters). Full details of how to reach Aberdeen by road, rail and air will be circulated with the final registration forms in a year's time, with the particular emphasis on the cheaper forms of transport likely to be of interest to graduate students.

We very much hope you will plan to come to Aberdeen, and look forward to acting as your hosts.

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ERRATUM

Stromberg, M.R. 1982. New records of Wyoming bats. Bat Res. News, 23: page 43, Table 1:

Lasiurus cinereus

MRS-329* "15 June 1981" should read "29 May 1981"

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OBITUARY

Louis D'Agrosa

We are saddened to learn that Louis D'Agrosa died suddenly on July 23, 1983. He suffered a fatal heart attack and died instantly. An associate professor of physiology at St. Louis University and an adjunct associate professor in the university's School of Nursing, he also was secretary of the Medical Faculty Committee and a founding member of the University Faculty Senate. Dr. D'Agrosa was a cardiovascular specialist and had written numerous research papers in the field. He was active in the St. Louis Heart Association and was a former president of the local chapter of Sigma Xi, a scientific research society. His primary research concerned the control of abnormal heartbeats, using various experimental drugs. In the 1960's, he was one of the first researchers in the country to abandon the use of frogs in blood circulation studies and replace them with bats. The tiny blood vessels in the wings of Missouri brown bats could be stretched for study without suffering damage and without requiring anesthetics.

The son of Italian immigrants, Dr. D'Agrosa was reared in Brooklyn and attended City College of New York. He moved to St. Louis to attend St. Louis University, where he got his doctorate in physiology in 1962. He joined the university's faculty that year. He is survived by his wife Maria DeDentro D'Agrosa; six children, Andrea of Shrewsbury, David of Clayton, Louis R., Paul, Maria B. and Rosemary, all of University City; and a brother, Joseph of Patchogue, New York.

Lou has attended several of our Bat Symposia including Albuquerque in '78, St. Louis in '79, and Louisville in '82. We will miss him.

(I am grateful to Dr. Natalie Connors for providing much of the above information.)

G. Roy Horst

BAT RESEARCH NEWS

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BAT RESEARCH NEWS

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BAT RESEARCH NEWS

Vol. 24 No. 4 November 1983

CONTENTS

FRONT COVER

The rather unsociable *Rhinolophus luctus beddomei* is a rare species represented in western India by a small number of individuals only. The lone male weighing 19.2 g with a wing span of 365 mm was taken on 20 September 1981 from a corridor of the delapidated Panala fort near Kolhapur in western Maharashtra. In the dungeon below the corridor a large colony of *Hipposideros speoris* and *H. fulvus* was present. Collected and photographed by Dr. A. Gopalakrishna, Institute of Science, Nagpur, India, and submitted by Dr. K.B. Karim.

BAT NEWS RESEARCH

Volume 24 29 November 1983 No. 4

A SYNOPSIS OF THE FAMILIES OF BATS - PART V, Superfamily Vespertilionoidea

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In the first four parts, I discussed the approach used, enumerated important primitive characters, and discussed derived characters of the Pteropodidae and the nine families of the superfamilies Emballonuroidea, Rhinolophoidea, and Phyllostomoidea. In part 5, I will try to do the same for the superfamily Vespertilionoidea. This is an extremely widespread group (occuring nearly everywhere that bats are known). Unless, as has recently been suggested, the Mystacinidae should go elsewhere, the superfamily is probably monophyletic even in the narrow Hennigian (holophyletic) sense.

The Natalidae constitute a small Neotropical family. The second digit of the wing is reduced to the metacarpal. The tail remains long reaching the edge of the extensive interfemoral membrane. The trochiter is large and makes a definite articulation with the scapula. The anterior thoracic area and asssociated vertebrae remain unmodified. The rostrum remains long and no postorbital processes are present. The premaxillae retain both nasal and palatal branches but are fused to the maxillaries and with each other in adults. The periotic is freed from surrounding bones. The dental formula remains primitive and the pattern of the molar teeth essentially unmodified. There is no noseleaf, but the ears are large and funnel-shaped, though the tragus is small.

The Natalidae consist of the single genus *Natalus* with some five species. It ranges widely over Middle America and the West Indies, but in South America is restricted to the northern and eastern coastal areas. The diet is strictly insectivorous.

The Furipteridae constitute another small Neotropical family. The second digit of the wing is reduced to the metacarpal (as in Natalidae). Tail slightly shortened so that it does not quite reach the edge of the extensive interfemoral membrane. Trochiter not as well developed as in the Natalidae with at most a slight articulation with the scapula. The anterior thoracic area and associated vertebrae remain unmodified. The rostrum remains relatively long and there are no postorbital processes. The premaxillae retain both nasal and palatal branches (the latter greatly reduced) but are fused to the maxillaries in the adult. The periotic is freed from surrounding bones. The dental formula remains primitive except for the loss of a single upper premolar and the pattern of the molar teeth remains essentially unmodified. There is a small noseleaf, the ears are large and funnel-shaped and the tragus is well developed.

The Furipteridae consist of two monotypic genera, largely confined to tropical South America, but extending north to Costa Rica. They are insectivorous.

The Thyropteridae constitute yet another small Neotropical family. The second digit of the wing is even more reduced than in the Natalidae and Furipteridae, being represented by only an in-

complete metacarpal. The tail remains long reaching a short distance beyond the edge of the extensive interfemoral membrane. The trochiter is large and articulates with the scapula. Except for the fusion of the first and second thoracic vertebrae, the anterior thoracic area remains unmodified. The rostrum remains long and there are no postorbital processes. The periotic is freed from surrounding bones, but the dental formula remains primitive as does the pattern of the molar teeth. Though there is a small wart-like projection above the nostrils, there is no true noseleaf. The ears are large and funnel-shaped with well developed tragi.

The Thyropteridae consist of a single genus (*Thyroptera*) of insectivorous bats. The two species range from southern Mexico to tropical South America and are probably confined to areas where there is a steady supply of large leaves which have not yet unfolded, since the suckers on wrists and feet are specially adapted to this kind of roost.

The Myzopodidae includes a single monotypic Malagasy genus. The second digit of the wing is reduced to the metacarpal alone. The tail remains long and extends well beyond the extensive interfemoral membrane. The trochiter is large and articulates with the scapula. The anterior thoracic region and associated vertebrae are relatively unmodified. The rostrum is somewhat shortened but there are no postorbital processes. The premaxillae retain both nasal and palatal branches but are fused to the maxillaries and each other in adults. The periotic is freed from surrounding bones. The dental formula remains primitive and the molar tooth pattern essentially unmodified. There is no noseleaf and the ears are large and somewhat funnel-like. The tragus is well-developed but is fused to the ear conch.

Though known fossil from the Pleistocene of East Africa, *Myzopoda*, as represented by its single living species, is now confined to Madagascar. While much more poorly known ecologically than *Thyroptera*, the common possession of suckers on the wrists and feet imply restriction to smooth leaves as roosts. They are presumably insectivorous.

The Vespertilionidae constitutes a large cosmopolitan family. The second digit of the wing is reduced to a metacarpal and a single small phalanx. The tail remains long, reaching the edge of the extensive interfemoral membrane. The trochiter is large and makes an extensive articulation with the scapula. The anterior thoracic region and associated vertebrae remain unmodified. The rostrum is quite variable in length being primitively long in some genera but greatly shortened in others. There are no postorbital processes. The premaxillae lack palatal branches and are separate from one another but fused with the maxillaries in adults. The periotic is freed from surrounding bones. The dental formula may remain primitive but is usually reduced to a greater or lesser degree by loss of upper and lower premolars, and upper and (rarely) lower incisors, the extreme being i1/2 c1/1 p1/2 m3/3 = 28. The molar tooth pattern remains essentially unmodified in all but a very few genera and then not to any great extent. Only rarely (as in *Pharotis imogene*) is a noseleaf present. The ears remain primitive, become enlarged (sometimes funnel-shaped) or be reduced. A tragus is always present, but shows great diversity in size and form.

The geographic range of the family Vespertilionidae is almost coextensive with that of the order Chiroptera. While many species are tropical, particularly in the eastern hemisphere, various members extend to the limits of bat distribution in the northern and southern hemispheres. All verspertilionids are insectivorous except for a few piscivores and one or two very large species that are suspected of being at least partially carnivorous. Of the six currently recognized subfamilies (including 32 genera and approximately 320 species), the Vespertilioninae have distribution coextensive with that of the family. The Nyctophilinae (probably not a natural group) occupy North America (including Cuba) and the Australian region. The Kerivoulinae and Miniopterinae are confined to the warmer parts of the eastern hemisphere. The Murininae range from eastern Asia to the Australian region. Finally, the monotypic Tomeatinea are confined to western Peru.

The Mystacinidae includes a single (probably monotypic) New Zealand genus. The second digit of the wing is reduced to a metacarpal and a single minute phalanx. The tail is considerably shortened and does not reach the edge of the fairly extensive interfemoral membrane, though it does project some distance free from its dorsal side. The trochiter is large and makes an extensive articulation with the scapula. The anterior thoracic region

and associated vertebrae are essentially unmodified. The rostrum remains relatively long and no postorbital processes are present. The premaxillae have both nasal and palatal branches but are fused to the maxillaries in adults. The periotic is freed from surrounding bones. The dental formula is reduced by loss of incisors and premolars to i1/1 c1/1 p2/2 m3/3 = 28, but the molar teeth, noseleaf and the ears remain relatively primitive with well-developed tragi.

The single genus, *Mystacina*, probably with a single species, is confined to New Zealand. Mystacinids are primarily insectivorous but also take fruit, nectar, and pollen and may, on occasion, be scavengers.

The Molossidae constitute a fairly large widespread family. The second digit of the wing is reduced to the metacarpal and a single vestigial phalanx. The tail remains long but the interfemoral membrane is less extensive so that the tail extends far beyond it. The trochiter is large and makes an extensive articulation with the scapula. The anterior thoracic region remains essentially unmodified except that the last cervical vertebra is fused with the first thoracic. The rostrum may be relatively long or much shortened, but there are no postorbital processes. Premaxillae with nasal branches, but palatal branches may be greatly reduced and in any case are fused with the maxillaries in adults. The periotic is freed from the surrounding bones. The dental formula is always reduced by the loss of an upper incisor and an upper and lower premolar and may be further reduced, the extreme being i1/1 c1/1 p1/2 m3/3 = 26. However, the molar tooth pattern remains essentially unmodified. There is no noseleaf, but the ears may either remain rather primitive or be greatly broadened or lengthened. A tragus is present but small.

This family with 12 genera and some 79 currently recognized species has a distribution second only to the Vespertilionidae in extent. It occurs throughout the Ethiopian and southern Palearctic regions (including Madagascar and the Mascarenes) and east to Australia and the Fijis. In the New World it occurs in the southern Nearctic and throughout the Neotropical region, including the West Indies but absent from extreme southern South America. As far as is known, all species are insectivorous. No subfamilies are recognized.

(to be continued) Received 10 October 1983

WING CULLING OF INSECT PREY BY THE GRAY BAT (*MYOTIS GRISESCENS*)

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Many species of insectivorous bats increase feeding efficiency by various prey manipulations, including the culling of wings or other appendages. Coutts, Fenton, and Glen (J. Mamm., 54:985-999, 1973) found that captive *Eptesicus fuscus* culled various part dependent upon the degree of chitinization of the parts, the size of the insect, and the number of insects eaten. To our knowledge, no one has described this culling technique, and several bat biologists who were questioned did not know how it was accomplished. We report here a method used by female *Myotis grisescens* to remove wings from coleopteran prey before ingestion.

In early June 1979, during studies of *M. grisescens* in southern Missouri, a female, although apparently uninjured, refused to fly upon release after capture. It was decided to keep and feed her until she would again fly. She was fed a variety of insects captured with a flourescent black light and a funnel trap. She was offered live insects while she was held in one hand with the wings folded next to the body. The bat ate well when fed in this manner, although the position was not entirely natural. However, the wings would normally be engaged in flight and unavailable for most prey manipulations. A variety of insects, including Coleoptera, Lepidoptera,

Trichoptera, Diptera, and Ephemeroptera, were offered. Although the insects eaten were not quantified, it became apparent that beetles, particularly click beetles (Elateridae), and to a lesser extent snout beetles (Circulionidae), were more readily accepted than other types of insects. Lepidoptera were frequently rejected. Undesirable insects were rejected by flipping them away with a jerk of the head. Insects up to 2 cm in length were accepted and eaten without apparent difficulty.

Since the bat was hand held, all prey manipulation was by mouth. Prey was nearly always eaten head first, and if the insect presented posterior end first, it would be accepted and quickly rotated 180° before consumption. The prey was consumed by a continuous and rapid mastication, which slowly engulfed the entire insect. Mastication of anterior portions of the thorax resulted in an opening of the elytra at an angle of 30° to 60° from the plane of the insect's body. This was probably due to contraction of the mashed elytra muscles. Consumption of the prey continued posteriorly, severing the elevated elytra. This wing clipping procedure was quite effective (wings were clipped an estimated 85% of the time), and yet took no special effort or energy expenditure on the part of the bat, except the initial positioning of the prey so that it was eaten head first. Leg-clipping was much less frequent than was wing-clipping but was achieved by the same passive mechanism.

These observations indicate that manipulations of relatively small prey for appendage removal may frequently entail simply positioning of the prey with the mouth, so that it may be eaten head first. Thereafter, the benefits of elytra and leg removal are derived passively without further expenditure of time or energy.

This study was conducted under the authority of Endangered Species Permit No. PRT-8-31-C and a cooperative agreement between the U.S. Fish and Wildlife Service and State of Missouri. Bobby Witcher was a constant companion. Harmon P. Weeks, Jr. reviewed an earlier manuscript.

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A NOTE ON AN ALBINO *ROUSETTUS LESCHENAULTI*

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Fig. 1. An albino female *Rousettus leschenaulti*

An albino female *Rousettus leschenaulti* (Figure 1) was collected from an abandoned manganese mine tunnel at Kandri, Ramtek, near Nagpur, India on 22 March 1982. The female probably died during transportation to the laboratory but the young attached to the mammary teat was alive. The combined weight of the mother with its young was 90 g. Apparently the delivery took place a day before capture. This species breeds twice in a year in quick succession. It exhibits post-partum oestrus. The observation of the genitalia *in situ* showed the post-partum condition of the right cornu and an early pregnancy in the left cornu.

Whereas albino bats of other species have been reported in the literature, e.g., *Miniopterus schreibersii* (Kahrau, 1972) and *Myotis lucifugus* (Smith, 1982; also see Allen, 1939 for other albino species), this is the first specimen of an albino bat that I came across during the past 16 years that I have been collecting, and the first albino specimen of *R. lechenaulti* in over 3,000 specimens collected for studying various aspects of reproductive biology. According to G.M. Allen (1939:154), an albino occurs perhaps once in several thousand bats. It would be interesting to take these specimens alive and breed them for genetic studies.

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Received 3 March 1983; Revised and Accepted 27 August 1983

SECOND EUROPEAN SYMPOSIUM ON BAT RESEARCH
BONN, September 21-25, 1983

At the Second European Bat Symposium that was held at the Zoological Institute of the University of Bonn about 140 scientists of 15 European countries participated. In 52 oral and 20 poster contributions a wide spectrum of research was covered.

The first day was dedicated to bat protection and distribution. In Central Europe the decline of some species, especially *Rhinolophus hipposideros*, seems alarming. During a panel discussion possible conservation methods were considered. The presentations of the second day dealt with orientation; during the third day ethological, morphological, and systematic problems were discussed. The symposium terminated with a visit to the bat exhibition in the Frankfurt Zoo.

The participants decided to have regular meetings at 2 year intervals. The Third European Bat Symposium will be organized, as a joint meeting with the Seventh International Bat Research Conference, in 1985 by Paul Racey in Aberdeen.

PROGRAM

Thursday, 22 September

Welcome and Opening of the Symposium

Stebbings, R.E. (Abbots Ripton, U.K.): Bat conservation in Europe and world-wide - a perspective.

Lina, P.H.C. (Den Haag, The Netherlands): Further conservation measures to bats and their present occurrence in the Netherlands.

Horacek, I. (Prague, CSSR): On the causality of population decline in European bats.

Richarz, K. (Munchen, F.R.G.): Ergebnisse und Erfahrungen mit einem Fledermausschutzesprogramm in Oberbayern.

Roer, H. (Bonn, F.R.G.): Die gegenwartige Situation des Fledermausschutzes in der Bundesrepublik Deutschland.

Willig, A. (Solingen, F.R.G.): Ruckblicke auf dreijahrige ehrenamtliche Tatigkeit des Arbeitskreises Fledertierschutz.

Carrol, J.B. (Trinity, Jersey Islands): The conservation and wild status of the Rodrigues Fruit Bat, *Pteropus rodricensis*.

Glas, G.H. (Arnhem, The Netherlands): Current distribution maps of some bat species in the Netherlands.

Jensen, B. (Aarhus, Denmark): Seasonal occurrence of hibernating *Myotis* in some Danish chalk mines.

Urbanczyk, Z. (Poznan, Poland): Winterquartiere von Fledermausen in Westpolen.

Klawitter, J. (Berlin-West): Uberwinterungsverhalten einiger Fledermausarten in der Spandauer Zitadelle, Berlin (West).

Nagel, A., H. Frank, and H. Weigold. (Tubingen, F.R.G.): Distribution of hibernating bats in Wuerttemberg, South Germany.

Roer, H. (Bonn, F.R.G.): Zur Bestandssituation von *Rhinolophus ferrumequinum* und*Rh. hipposideros* im westlichen Mitteleuropa.

Swift, S.M., and P.A. Racey. (Aberdeen, U.K.): The residual effect of timber treatments on bats.

Avery, M. (Aberdeen, U.K.): Winter activity of pipistrelle bats.

Gebhard, J. (Basel, Switzerland): *Nyctalus noctula*: Beobachtungen an einem traditionellen Winterquartier im Fels.

Gaisler, J. (Brno, CSSR): Bats of northern Algeria and their winter activity.

Podium Discussion:
Practical aspects of bat protection.

Friday, 23 September

Neuweiler, G. (Munchen, F.R.G.): Echolocation sound patterns, audiograms and foraging in echolocating bats.

Heilmann-Rudolf, U. (Tubingen, F.R.G.): Frequency discrimination on the Greater Horseshoe Bat, *Rhinolophus ferrumequinum*.

Rubsamen, R. (Munchen, F.R.G.): Control of echolocation pulses in the CF-FM-bat *Rhinolophus rouxi*: Neuroanatomical and neurophysiological investigations of the function of the brain stem motor nuclei innervating the larynx, the nucleus ambiguus.

Schnitzler, H.-U. (Tubingen, F.R.G): Echolocation behavior of insect-hunting *Rhinolophus rouxi*.

Kulzer, E. (Tubingen, F.R.G.): Echoortung und Beutefang bei der australischen Gespenstfledermaus, *Macroderma gigas*.

Joermann, G. (Bonn, F.R.G.): Acoustic discrimination of spatial parameters in the vampire Bat.

Tupinier, Y. and Y. Biraud. (Lyon, France): Signaux croisiere de *Myotis daubentoni*.

Surlykke, A. (Odense, Denmark): The influence of synthetic arctiid clicks on bat echolocation.

Mohl, B. (Aarhus, Denmark): A target simulator for experiments in bat echolocation.

Ahlen, I., L. Pettersson, and A. Svardstrom. (Uppsala, Sweden): An instrument for detecting bat and insect sounds.

Rother, G. and U. Schmidt. (Bonn, F.R.G.): Ontogeny of vocalization in *Phyllostomus discolor*.

Norberg, U.M. (Goteborg, Sweden): Bat wing form as related to the ecology.

Aldridge, H. (Bristol, U.K.): Multiflash and high-speed photographic analysis of bat flight manouvers.

Baagoe, H.J. (Copenhagen, Denmark): Field studies of bat flight.

Kurten, L. and U. Schmidt. (Bonn, F.R.G.): On the anatomy and physiology of the noseleaf in the vampire bat, *Desmodus rotundus*.

Konstantinov, A. (Leningrad, USSR): On the origin of echolocation in bats.

Konstantinov, A. and N.V. Burikova. (Leningrad, USSR): Organization of auditory pathways in the bat *Myotis blythi*.

Discussion Groups:
1. Line transects and other methods for monitoring bat fauna (oganizer: I. Ahlen)
2. Flight habits and feeding behavior of bats (oganizer: U.M. Norberg)

Helverson, O.von (Erlangen, F.R.G.): Coadaptation und Coevolution von Fledermausblumen und Blumenfledermausen in Sudamerika/Coadaptation and coevolution in bat pollinated flowers and glossophagine bats.

Saturday, 24 September

Bruns, V. (Frankfurt, F.R.G.):Structural diversity of the inner ears of bats.

Grol, B.P.F.E. ('s-Gravenhage, The Netherands): Multivariate analysis of morphological characters of *P. pipistrellus* and *P. nathusii* from the Netherlands.

Stutz, H. (Zurich, Switzerland): Grobmorphologische und histologische Untersuchungen am Verdauungstrakt mitteleuropaischer Fledermausarten.

DeGueldre, G. and F. DeVree. (Antwerpen, Belgium): Cineradiographic analysis on chewing in *Pteropus giganteus*.

Davies, N. (Bristol, U.K.): The food of the Greater Horseshoe Bat in South West Wales.

Racey, P.A., and S.M. Swift. (Aberdeen, U.K.): Resource partitioning in two roost species of bats occupying the same roost.

Thompson, M.J.A. (Wigginton, U.K.): Brown Long-Eared Bat *Plecotus auritus* predator prey relationship.

Haussler, U. and A. Nagel. (Tubingen, F.R.G.): Remarks on seasonal group composition turnover in captive noctules, *Nyctalus noctula* (Schreber 1774).

Gerell, R. (Lund, Sweden): Social structure in a pipistrelle population.

Degn, H.J. (Ringkobing, Denmark): Automatic registration of activity at a big hibernaculum, Monsted limestone cave.

Voute, A.M. (Utrecht, The Netherlands): Activity rhythms in some indigenous bat species.

Avery, M. (Aberdeen, U.K.): Emergence times of pipistrelle bats.

Volleth, M. (Erlangen, F.R.G.): Karyological evidence for the separation of the genera *Pipistrellus* and *Eptesicus*.

Van Cakenberghe, V. (Antwerpen, Belgium): Preliminary results on the systematics of the Nycteridae Dobson 1875.

Hanak, V. (Prague, CSSR): Systematics of *Myotis daubentoni* and some comments to sibling species in bats.

Horacek, I. and V. Hanak. (Prague, CSSR): Comments on systematics and phylogeny of *Myotis nattereri*.

Vierhaus, H. (Bad Sassendorf-Lohne, F.R.G.): Verbreitungsmuster einiger Fledermausarten in Westfalen.

Aellen, V. (Geneve, Switzerland): Migrations de chauves-souris en Suisse. Note complementaive.

Meeting - European Bat Research Organization

Dinner at the Stucco Hall
Poppelsdorfer Schloss

Sunday, 25 September

Excursion

Poster Presentation

Baeten, B. and F. DeVree. (Antwerpen, Belgium): Contribution to the bat fauna of Rwanda.

Breuls, T. (Kanne, Belgium): Hibernation in limestone caves.

Czeczuga, B. and A.L. Ruprecht. (Bialowieza, Poland): Seasonal changes of the carotenoid content in bats.

Dulic, B. and M. Mrakovcic. (Zagreb, Yuogoslavia): Morphological characteristics of a population of *Pipistrellus savii* from some Adriatic Islands.

Harmata, W. (Krakow, Poland): The time of emergence of the Serotine Bat, *Eptesicus serotinus*.

Heller, K.-G. (Erlangen, F.R.G.): The echolocation calls of the five European *Rhinolophus* species.

Horacek, I. (Prague, CSSR): Internal structure of a population of *Myotis myotis*.

Klawitter, J. (Berlin-West): Bau von Fledermauswinterquartieren - Methoden und Erfahrungen.

Legendre, S. (Montpellier, France): Molossidae: Phylogenie et biogeographie.

Lehmann, R. (Helsingfors, Finland): *Myotis mystacinus* and *Myotis brandti* in Finland.

Miller, L.A. (Odense, Denmark): Arctiid moth clicks and bat echolocation.

Noblet, J.-F. (Meylan, France): Les migrations de la pipistrelle de Nathusius.

Radike, S. (Munchen, F.R.G.): Interconnections of auditory cortex and thalamus in the bat, *Rhinolophus rouxi*.

Rybar, P. (Pardubice, CSSR): Activity in hibernating bats.

Schmidt, S., B. Turke, and B. Volger. (Munchen, F.R.G.): Behavioral audiogram from the bat *Megaderma lyra* (1-100 kHz).

Schober, W. and M. Wilhelm. (Leipzig/Dresden, G.D.R.): Zur Bestandsentwicklung und Verbreitung der Kleinen Hufseisennase (*Rhinolophus hipposideros*) in der DDR.

Strelkov, P.P. (Leningrad, USSR): The pecularities of seasonal distribution of *Vespertilio murinus* in acid regions.

Stutz, H. and M. Haffner. (Zurich, Switzerland): Nachweise von Wochenstuben des Grossen Mausohrs *Myotis myotis* (Borkhausn 1779) in der ostlichen Schweiz.

Vetten, M. (Dusseldorf, F.R.G.): Moglichkeiten und Grenzen des ehrenamtlichen Fledertierschutzes in Nordrhein-Westfalen.

Voute, A.M. and P.H.C. Lina. (Utrecht, The Netherlands): A new possibility to create artificial bat hibernacula in town-planning.

(Printed abstracts were available at the meeting).

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Received 22 November 1983

NEWS AND VIEWS

INVESTIGATOR NEEDS INFORMATION on bat hematology; specifically

(1) bat blood types and intraspecific blood type compatability data, and

(2) bat blood coagulation properties and its control via anticoagulants including heparin, streptokinase, etc.

Please send information to: Dr. Stephen P. Thomas, Department of Biological Sciences, Duquesne University, Pittsburgh, PA 15282 USA, Tel: 412-434-6320.

Received 29 July 1983

NEW BOOK ON BATS

KEY TO THE BATS OF ARGENTINA by Arthur Greenhall, Rexford Lord and Elio Massioa, 103 pp., illustrations. Pan American Health Organization, CEPANZO, Buenos Aires, Argentina, 1983. U.S. $4.00. A Spanish version is also available.

ANNOUNCEMENT

Bat Conservation International wishes to contact anyone having knowledge of bat conservation needs in underdeveloped countries. Please send us names and addresses of biologists, conservationists, or potentially cooperative laymen who may be interested. We want to help but must first develop contacts and knowledge of local needs.

We also wish to announce the availability of our new slide/cassette tape program "Saving America's Bats." It contains 49 beautiful slides by Merlin Tuttle and a 19 minute tape (sound-beeped advance, side 1; magnetic advance, side 2). The price is $55.00 (USA), ($35.00 BCI members) postage included.

Please send orders, names, or suggestions to: Ms. Heidi Zogg or Mrs. Bonnie Sumner, Bat Conservation International, c/o Milwaukee Public Museum, Milwaukee WI 53233 USA. Telephone 414-278-2775.

Merlin Tuttle

EDITOR'S ACKNOWLEDGMENTS

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RECENT LITERATURE

ANATOMY

Cabezudo, L., F. Antolicandela and J. Slocker. 1983. Morphological study of the middle and inner ear of the bat - *Myotis myotis*. *IN*: Modern Perceptives in Otology, pp. 28-38 (B.H. Colman and C.R. Pfaltz, eds.), Advances on Oto-Rhino-Laryngology, vol. 31, Karger, Basel, 252 pp., $118.75 (Ctr. Especial Ramon Cajal, Dept. OtoRhinoLaryngology, Carretera Colmenar KM9, 100, Madrid 34, Spain).

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The Fourteenth Annual North American Symposium on Bat Research was held at Colorado State University on October 21 and 22, 1983. There were ninety-four registered participants. Michael Bogan was the symposium host and Roy Horst arranged the program. The abstracts of the papers presented are given below in alphabetical order of first author. The participants elected to meet October 19 and 20, 1984, at Rockford College in Rockford, Illinois. Larry Forman will host the symposium and Roy Horst will make the organizational arrangements.

Foraging Behaviour of the African Insectivorous Bat, *Scotophilus leucogaster*. Robert M.R. Barclay, University of Manitoba Field Station, Box 38, RR2, Portage la Prairie, Manitoba, R1N 3A2 Canada.

Scotophilus leucogaster, a 20 g African vespertilionid, was studied during January and February (the normal season) 1982 in Zimbabwe. Populational and individual foraging behaviours were studied using radiotelemetry, light-tagging, roost site observations, mist netting and fecal analysis. The bats roosted singly or in small groups (10) in narrow crevices in mopane trees. Most individuals dispersed from the roost area at dusk to feed and were subsequently found in several habitats although most commonly over shallow rivers. The radiotagged bats spent an average of one hour (n = 5 bats, 29 bat-nights) away from the roost during this feeding period and mist netting indicated this was typical of the population in general. Although individuals occassionally left their roost again during the night, this was associated with movements from roost to roost and not with feeding. The total time spent foraging thus appears to be one hour, a short period compared to other insectivorous bats. This may be related to the risks the bats face from aerial predators.

The bats fed primarily on hard-bodied insects and all individuals had eaten both coleoptera and hemiptera although an average of five insect taxa were found in each individual bat's feces. Individual variation in diet, as well as foraging behaviour, was evident indicating that flexibility is an important component of this species's foraging strategy. Other than saying that *S. leucogaster* feeds primarily on hard-bodied insects, a greater degree of "specialization" is not evident.

"Circannual" Cycles of Testosterone in *Antrozous pallidus*. Laura J. Beasley and Erla R. Smith, Department of Psychology, University of California, Berkeley, CA 94720 and Department of Physiology, Stanford University, Stanford, CA 94305.

Captive pallid bats (*Antrozous pallidus*) which were housed at 23 °C in long (LD 14:10) or short (LD 10:14) photoperiods for 12 months exhibited endogenous rhythms of plasma testosterone. Adult male *A. pallidus* collected in April-May were bled via an interfemoral vein at approximately monthly intervals. In September, bats in long days had significantly higher titers than bats in short days. This effect confirms previous work in this species that photoperiod influences the timing of spermatogenesis (Beasley and Zucker, in press). It is likely that photoperiod influences an endogenous annual (circannual) mechanism. Short day exposure accelerates the attainment of autumnal reproductive condition (e.g. regressed testes and epididymal sperm). Bats manifested initial peaks in plasma testosterone (40.15-187.00 ng/ml) in the summer (July-Sept.) and reached second peaks in the spring (Feb.-April). Baseline values were relatively high (1.27-24.96 ng/ml). Circannual cycles in size of the scrotal sac paralleled the changes in plasma testosterone. The summer peak in testosterone was comparable to the hormonal pattern of pallid bats recently collected from the field. Field-collected bats showed low values of testosterone (10 ng/ml) in the spring when the testes were undergoing spermatogenesis. The increased levels of testosterone in captive animals in the spring may reflect an acceleration in the circannual rhythm due to the effects of temperature and/or nutrition. Bats were maintained at warm

temperatures with *ad libitum* access to mealworms during the winter. Male pallid bats kept in constant laboratory manifest "circannual" rhythms of plasma testosterone as well as of body weight. The period of testosterone cycles was approximately 4 to 7 months (112 to 245 days). Photoperiod, temperature and/or nutrition act as zeitgebers to synchronize these cycles with the external geophysical cycle.

Feeding Behaviour and Sensory Ecology of *Hipposideros ruber* (Hipposideridae). Gary P. Bell and M. Brock Fenton, Department of Biology, Carleton University, Ottawa, Ontario, Canada K1S 5B6.

We studied wild *Hipposideros ruber* as they foraged for insect prey at a black (*i.e.* ultraviolet) light at a field site in northwestern Zimbabwe. The bats were presented with tethered moths of different size classes and at different distances from a background to determine their feeding responses and sensory behaviour under different controlled circumstances. Echolocation calls were monitered with a very sensitive tuneable detector. We also recorded the success rate of bats attempting to capture grounded and flying moths.

In this study *H. ruber* appeared to feed selectively on moths, but took prey of a wide range of sizes. These bats spent approximately equal time capturing prey in aerial pursuit and gleaning, and were equally successful in either mode. The bats missed approximately 60% of all prey attacked using either strategy. In both modes the bats made fast, direct approaches towards their prey, and seized it in the mouth or scooped it in wing membranes.

Echolocation calls were produced during all attacks on prey, and observations of the bat's behaviour suggested that these calls were highly directional. In tether experiments the bats took equal time to locate prey regardless of distance from the background, and treated it with equal care. Similarly there is no difference in locatability or prey of different sizes, however larger prey take longer to capture once located, however, this is largely a function of the erractic flight of larger prey on tethers.

During attacks on grounded and tethered prey, *H. ruber* always broke off attacks on insects which ceased to flutter their wings, and never attacked stationary prey. The bats attaacked an electrical insect but ignored prey fluttering behind glass. Combined with additional observations these data suggest that *H. ruber* use echolocation, but do not rely upon vision or acoustic cues to locate prey. These results support the theory that CF, Doppler-shift compensation echolocation is used as a motion detection, clutter rejection system, enabling bts to locate and capture prey under a variety of circumstances.

Roost Selection and Foraging by Radio-tagged Big Brown Bats (*Eptesicus fuscus*). R.M. Brigham, Department of Biology, Carleton University, Ottawa, Ontario, Canada K1S 5B6.

The resource of space includes roosts and foraging areas. I used radio-telemetry to investigate the use of this space by big brown bats and here report some of the preliminary results. From May to September of 1983 I attached radiostransmitters to 38 individuals; of these, 26 were adult females, 4 were adult males and 8 were juveniles. The tags weighed approximately 1.0 gram and generally had ranges of between 600 and 800 meters. By clipping fur and using Skin-Bond Cement® the best and longest attachment was achieved (Epoxy x = 3.79 days n = 24, Skin-Bond x = 11.42 days n = 12). *E. fuscus* were monitered at 5 colony sites in and around a small town (pop. 3000) near Ottawa. A comparison of the foraging times (time spent away from a roost) sowed that lactating females spent longer than did pregnant females (x = 95.25 minutes n = 12 vs. x = 61.84 minutes n = 49). In the early part of the summer (May and June), tagged individuals invariably returned to the same roost by dawn (55 of 57 bat nights). The roosting behaviour changed in July and August, when on 19 of 64 bat nights an individual day roosted away from the roost at which it was captured and tagged. On 39 nights loyalty was maintained and on 6 occasions tagged individuals disappeared permanently. One of the 4 colonies was virtually abandoned by thge middle of July. The order of departure of known individuals was significantly different from random (order maintained 34 of 39 times) implying a level

of social organization in the colonies. In August when one colony was sealed, the 6 tagged individuals remained close to the roost. Five of the 6 day roosted in a Sugar Maple tree in a nearby (50m) forest. After 3 days the 5 bats moved into a previously unused house to roost, 50 meters from the original roost. One of the 6 tagged individuals stayed in the original roost despite efforts to seal it out. I was able to remain in contact with some individuals as they foraged. Some preliminary trends from this data indicate that animals travelled as far as 2 kilometers to and from feeding areas. The direction taken by individuals was not always constant, nor were the areas where individuals fed.

The Effect of Right Ovariectomy on Implantation in *Myotis lucifugus*. G.D. Buchanan, Faculty of Health Sciences, McMaster University, Hamilton, Ontario.

Although ovulation may occur from either ovary in *Myotis lucifugus*, implantation is confined to the right uterine horn. Whether the factors governing implantation are inherent in the right horn or involve some preferential hormonal stimulation of that horn via a non-systemic route is unknown. To study whether the right ovary exerts a local effect on the right uterine horn, female *M. lucifugus* were right ovariectomized at the beginning of hibernation, kept active 7-10 days to permit healing, then placed in an artificial hibernaculum until mid-April. Bats were killed by cervical dislocation 28-40 days after removal from hibernation and the reproductive tracts examined grossly and histologically.

In four of five nulliparous bats relevant to this study, the pre-ovulatory follicle could not be identified at surgery. However, histological examination of the excised right ovaries showed that none contained pre-ovulatory follicles. None of the nulliparous bats were pregnant at autopsy and examination of the left ovaries revealed that none had ovulated, although two ovaries contained luteinized follicles. In one nulliparous bat, the left uterine horn was longer than the right at autopsy and in three other bats the left ovaries were hypertrophied.

Four parous bats which originally had pre-ovulatory follicles in the right ovary had corpora lutea in the left ovary at autopsy. One of these bats had a normal late-somite-stage embryo implanted in the right uterine horn. The other three bats appeared implanted as the right horns were enlarged and hyperemic. Histological examination, however, showed that resorption had taken place.

Luteinized follicles were found in the left ovaries of two of three parous bats which bore pre-ovulatory follicles in the left ovary at the time of surgery. The third bat had ovulated and showed evidence of resorption in the left uterine horn.

The results indicate that the site of implantation in *M. lucifugus* is not controlled by a local effect from the right ovary, since in all but one ovulated bat, implantation still occurred in the right uterine horn. At the same time, the subsequent resorption in most implanted bats and the superior development of the left uterine horn in one of the nulliparous bats suggests that there is some direct stimulation of the uterine horn by the ipsilateral ovary. Similar effects have been shown in both rats and mice and may well be common among mammals.

The failure of any nulliparous bats to ovulate was unanticipated. However, data obtained since these experiments were initiated indicate that a significant proportion (30-40%) of nulliparous hibernating bats are not sexually mature. In addition, several workers have suggested that the first ovulation in *M. lucifugus* is more likely to come from the right ovary. Such a phenomenon occurs in some mammals (e.g., seals). Thus, failure to ovulate in right ovariectomized nulliparous bats may not be surprising. On the other hand, the recruitment of a new ovulatory follicle in bats from which the pre-ovulatory follicle was removed was surprising. In other mammals, beyond a certain stage, unilateral ovariectomy does not cause compensatory ovulation in the remaining ovary. The pre-ovulatory follicle of *M. lucifugus* is so highly modified (size, glycogen in the granulosa cells) that one would think the critical point had been passed. It is suggested, therefore, that *M. lucifugus* may be an excellent model for investigation of the factors governing ovulation.

The Cervical Vertebrae of Some Bats. M.B. Fenton and L.M. Crerar. Department of Biology, Carleton University, Ottawa, Canada K1S 5B6.

We examined cervical vertebrae of the following bats: *Penthetor lucasi, Micropteropus pusillus, Hypsignathus monstrosus, Rhinopoma hardwickei, Taphozous melanpogon, Noctilio leporinus, Nycteris thebaica, Rhinolophus affinus, Hipposideros armiger, Macrotus waterhousii, Glossophaga longirostris, Artibeus jamaicensis, Myotis lucifugus, Otomops martiensseni,* and *Molossus molossus* to identify specializations associated with dorso-ventral flexibility. The specializations of the cervical vertebrae of Megachiroptera and Microchiroptera were distinctly different, and none of the species we examined showed evidence of an 'intermediate' condition . Specializations included the thickness of the neural arches, the plane of articulation between adjacent centra, the ventral interlocking of adjacent centra, and the angles of articulation reflected by anterior zygapophyses. Neural arches were thick in the Megachiroptera and often very thin in the Microchiroptera. Planes of articulation between adjacent centra were perpendicular to the long axis of the vertebral column in the Megachiroptera, and acute in the Microchiroptera. In the microchiropterans, some species showed development in a posteriorly projecting process from the central surface which fitted into a socket on the next posterior vertebra; this feature was lacking in the megachiropterans we examined. The angle of articulation between anterior and posteriorzygapophyses was parallel to the main axis of the neck in the megachiroptera. There were also differences in the atlases between the two suborders. The specializations we observed correlate with roosting postures of the bats.

Raptor Predation on Bats in Northeastern Borneo. Charles M. Francis, Game Branch, Forest Dept., P.O. Box 311, Sandakan, Sabah, Malaysia.

Avian predators were observed feeding on bats at Gomantong Caves in northeastern Sabah, Malaysia. *Tadarida plicata* (population 600,000) frequently formed spectacular flocks which spiralled out into the sky high over the forest. Other species of bats formed flight streams close to the cave walls heading down into the forest. Bat Hawks (*Machaerhampus alcinus*) were the major predators with up to 11 seen at once, but six other species of birds were seen catching *Tadarida*. Bat Hawks captured bats by stooping on flocks or chasing scattered lone bats. They swallowed the prey whole allowing rapid feeding - one hawk ate 8 bats in 5½ minutes. Peregrins (*Falco peregrinus*) also stooped on flocks of bats although they were less adept at pursuing lone bats. They ate their prey on the wing but tore it to pieces. Rufous-bellied Eagles (*Hieraaetus kienerii*) and hawk-eagles (*Spizaetus* spp.) "ambushed" the bats just after they left the cave, either from a perch or from slow flight. They returned to a perch to feed. One hawk-eagle caught 6 bats in 28 minutes and Rufous-bellied Eagles had similar capture rates. When the *Tadarida* dispersed out the cave entrance after dark instead of flocking, only the Bat Hawks continued to prey on bats. They would fly in one side of the cave entrance and out into the bat flight stream. They continued to feed after dark, especially in the moon was shining. Capture rates were high but hard to determine as there were several Bat Hawks at once. The prey species composition probably reflected the diversity of bats in the caves, not just *Tadarida plicata*.

The Bat Hawks thus appeared to be specialized for catching bats, while other raptors oppurtunistically adapted their usual foraging behaviour in response to the *Tadarida* behaviour. The greatly increased mortality incurred by the *Tadarida* when they flock must be offset by other factors, perhaps increased foraging efficiency.

Commensal Bats in New York State: Defining the Issues. Stephen C. Frantz, New York State Department of Health, Center for Laboratories and Research, Albany, NY 12201.

Each year, the New York State Department of Health receives hundreds of inquiries regarding commensal bats and bat-related problems from the public and private sectors. With the exception of rabies diagnostic cases, this information previously has not been systematically recorded for analysis and application to bat management and rabies prevention. It is generally accepted that education and exclusion techniques will provide the most effective long-term control of commensal bat populations roosting in buildings. However, in order to provide sound management strategies that encourage bat conservation while protecting human health and solving nuisance problems, it is

necessary to more thoroughly understand the issues, including: human and pet populations at risk, bat species involved, roost preferences, client attitudes, and control measures utilized. Early this year, a systematic methodology was initiated for recording information gathered through telephone inquiries and on-site investigations. Thus far, inquiries for 62 sites have been recorded in accordance with the new system, 17 of these were visited. Buildings were divided into two groups according to human patterns of occupancy: 40 full-time (FTO = dwellings) and 22 part-time (PTO = outbuildings, offices, etc.). The anticipated significance of this division was with regard to the potential risk of bat contact with people and pets.

With few exceptions, buildings in the sample were more than 50 years of age and half of these were estimated to have more than 50 bats each. Three-fourths of all inquiries regarded bat colonies; however, individual bats in PTO buildings have gone unnoticed. recurring incidents comprised 82% of all inquiries. A recurring problem with bat colonies was most reported (69% of all inquiries) while single events involving individual bats were not common (10%). Contact with bats was reported only for FTO's: 3% and 15% involving humans and pets respectively. Ninety-five percent of the clients actually saw bats: 44% only observed bats while 39% killed one or more. Bat signs were found at 60% of the sites; odor, noise, guano, and stains were reported in descending order of requency. Eighty-five percent of the FTO's and 59% of PTO's were occupied by single families; the significance of this regards the number of people exposed to bat roosting sites and the complexity of effectively managing the situation. Most clients were calm and cooperative (68%) in their discussions about bats, but there was an even split between those sympathetic and those unsympathetic with bat conservation. Only 37% of the clients employed regular bat managment practices; 18% obtained services or advice from professional pest control operators.

Of nine FTO structures visited, seven were suburban and two rural in location; the average resident population was comprised of 2.7 adults, 1.4 children, 0.8 dogs, and 1.5 cats. All of these buildings were owned by the residents, and most (7/9) were of wood-frame construction. Although all of the stuctures were judged "bat-proofable" (needing only minor repairs to exclude bats), exclusion methods were not effectively or widely practiced. In all sites visited, the presence of bats was confirmed by direct observation or by signs; the apparent primary roost was in the attic or top floor of the structures. The species distribution for FTO buildings was: 6 *Myotis lucifugus* and 3 *Eptesicus fuscus*; for PTO buildings it was 6 *M. lucifugus* and 2 *E. fuscus*. Mixed-species infestations may have been present, but were not obvious at the time of the visits.

Additional details and the range of problems, real or perceived, are discussed in order to help define the various issues regarding commensal bat infestations. These findings will be utilized to refine the reporting procedure for further investigations and to compare sites with and without rabies involvement.

Mother-pup Recognition Among Mexican Free-tailed Bats. Deborah Gelfand, Department of Psychology, University of Tennessee, Knoxville, TN 37916.

After wintering in central Mexico, Mexican free-tailed bats (*Tadarida brasiliensis mexicana*) migrate in spring to the southwestern United States. In some areas, such as Texas and Oklahoma, millions of bats roost in single caves. About 95% of the bats in these roosts are pregnant females. During a two week period in June, most pregnant females give birth to a single pup. Within several hours after birth, mothers leave pups in a creche with other pups. Mothers usually roost apart from pups but return to the creche twice a day to nurse a baby. Using allozyme genetic markers, McCracken (in review) has demonstrated that *T. b. mexicana* nurse selectively (although not exclusively) with respect ot the female-pup nursing pair genotypes. The mechanisms which enable recognition among a mother and a pup she nurses may include location, odor, or audition. Although spatial and olfactory cues are probably involved, the focus of this study is to examine whether auditory cues aid individual recognition. Nursing female-pup pairs were removed from two Texas caves and kept in cup-size ice cream containers for two to four days during experimentation. The female and pup were separated several times a day to induce calling from the pup. The vocalizations of 21 pups were successfully recorded. A recording of the female's pup, another pup, and blank tape were each played back to 16 of the captive females. The fre-

quency and latency of calls by the female in response to the playbacks were observed. Preliminary sonagraphic analysis of pup calls indicates the existence of individual vocal signatures. In a preliminary analysis of the playback experiments, females did not respond differentially to their own pup versus another pup or to their own pup versus blank tape.

A Character Which Should Provide a Basis for Recognition of Infraorders in Microchiroptera. Karl Koopman, American Museum of Natural History, New York, NY 10024.

In most mammals, the premaxillary bones are neither fused nor moveable with the maxillaries. In bats, however, both these derived conditions may be found. In Megachiroptera, all three conditions are known and their taxonomic distribution is certainly erratic. In Microchiroptera, however, the premaxillaries are moveable (unless greatly reduced) in all Emballonuriodea (as currently defined) and Rhinolophoidea, but are fused to the maxillaries in adults of all Phyllostomoidea and Vespertilionoidea. It is proposed that these two derived characters may be used to define two infraorders whose members share them. These may be known as the Yinochiroptera and Yangochiroptera respectively.

Size and Development State at Birth: A Comparison of Bats with Other Mammals. Thomas H. Kunz, Elizabeth Pierson, and Allen Kurta; Department of Biology, Boston University, Boston, MA 02215; Museum of Vertebrate Zoology, University of California, Berkeley, CA 94720; Department of Biology, Boston University, Boston, MA 02215.

Differences in life history patterns can be elucidated by examining relative sizes and developmental states at birth. In this study we summarize the relationships between maternal and neonatal body mass, forearm length, and litter size for approximately 90 chiropteran species, representing two suborders and nine families. Data for body mass and litter size of one are compared with similar results from other eutherian mammals. The neonatal mass of bats scales significantly higher than other eutherian mammals (i.e. bats are larger at birth). Even when all eutherian mammals having a litter size of one are compared, bats are still significantly larger at birth. The neonatal mass and litter mass for members of the suborders Megachiroptera and Microchiroptera scale proportionately, yet the body mass at birth for those species having a litter size on one averages 16% and 26% of maternal mass for the two suborders, respectively. Compared with vespertilionids, phyllostomids are proportionately larger at small maternal masses, but smaller at larger maternal masses. Members of the Hipposideridae have the smallest relative neonatal mass (18%) among the Microchiroptera whereas neonates of the Rhinolophidae exceed all other families in relative mass at birth by at least 10%. The total relative neonatal mass of vespertilionids having a litter size of two approaches 35%. which is comparable to the upper extreme of relative neonatal mass for microchiropterans (e.g. rhinolophids) having a litter size of one. Additional data are needed for a thorough analysis of relative body mass at birth for the Chiroptera.

Social Dispersion and Genetic Variation in *Saccopteryx leptura* and *S. bilineata*. Gary F. McCracken, Department of Zoology, University of Tennessee, Knoxville, TN 37996-0810.

Saccopteryx leptura and *S. bilineata* are closely related, sympatric species of neotropical bats that exhibit marked differences in social organization and dispersion patterns. *S. leptura* is monogamous with roosting populations subdivided into many finely dispersed groups with an average size of 2.6 (range 1-5) individuals/group. *S. bilineata* is harem-polygamous with more coarsely dispersed groups that average 8.1 (range 1-42) individuals/group. Allozyme genetic studies of individuals from Trinidad, W.I. demonstrate that both species carry substantial amounts of genetic variability with heterozygosity and polymorphism levels as high or higher than those reported for other temperate and tropical bats. Although significant genetic heterogeneity was observed among geographical populations of *S. leptura*, there is no evidence for either species that social structuring leads to inbreeding and the loss of heterozygosity, or that it promotes the development of genetic heterogeneity among social units that could accelerate the evolutionary diversification of these taxa. These results do not support a

recently proposed hypothesis that social structuring in mammals has these affects.

Observed intercolony genetic heterogeneity was greater among adult male than adult female *S. bilineata*. This is attributed to greater dispersal and intergroup movements of females and the recruitment of males into their parental colonies. These results suggest that the adult males within a colony may be genetic relatives while adult females in a colony are only randomly related.

Zoogeography of Malagasy Chiroptera. R.L. Peterson, Department of Mammalogy, Royal Ontario Museum, 100 Queen's Park Cresc., Toronto, Ontario, Canada M5S 2C6

The mammalian fauna of Malagasy includes a number of endemic groups including the Tenrecidae, Lemuridae, Indridae, and Daubentonidae. Among the Chiroptera, Myzipodidae is its most distinctive endemic. The genera *Pteropus* and *Emballonura* reach their western limit on Malagasy and some adjacent islands but to date appear entirely absent from the African mainland.

Of the eight *Miniopterus* taxa now known to occur on the island, only one has its closest relative occuring in Africa, with the remaining seven having their closest allies either on the island or great distances to the east.

Malagasian representatives of *Rousettus, Scotophilus, Mormopterus* and *Otomops* likewise have their nearest relatives occurring to the east rather than in Africa. One of the two known taxa of Malagasy *Pipistrellus* appears almost equidistantly between Eurasian and Indonesian related taxa.

Multivariate and other analyses of a number of "species" groups indicate that the faunal affinities of Malagasy bats are almost equally divided between African related taxa and those occurring in the Indo-Malaysian-Australasian region. Endemic taxa include differentiation at the subspecies, species, generic and family levels.

Maps with OTU population samples plotted and with minimum spanning tree networks superimposed (including measures of distances), produce a number of surprising and intriguing patterns of zoogeographic/phylogenetic relationships.

Antigenic Variants of Rabies Virus in Pennsylvania Wildlife. C.E. Rupprecht, School of Veterinary Medicine, University of Pennsylvania, 3800 Spruce St., Philadelphia, PA 19104.

Antigenic variants of rabies virus were detected from 34 positively-infected wildlife specimens originating from 14 Pennsylvania counties during 1981-83. The nucleocapsid antigen of 11 raccoons, 10 skunks, and 13 bats representing four different species, was characterized by flourescent antibody procedures with a panel of 36 hybridomas specific for rabies virus. The glycoprotein antigen of five raccoons, four skunks, and 13 bats was similarly compared by a panel of 44 virus-neutralizing monoclonal antibodies. Species-typical patterns on reactivity were observed, not wholly related to temporal or geographical origin. Bat strains displayed wide heterogeneity, but specific antigenic markers clearly differentiated them from raccoon and skunk isolates, suggesting largely independent bat and terrestrial rabies cycles.

Genealogy of the New World Nectar-Feeding Bats Reexamined. James Dale Smith, Department of Biology, CSU Fullerton and Natural History Museum of Los Angeles County and Craig S. Hood, Department of Biology, Texas Tech University, Lubbock, Texas.

Griffiths (1983, Syst. Zool., 32: in press) challenged our (1982, Syst. Zool., 31: 241-251) assessment of his (1982, Amer. Mus. Novit., 2742: 1-45) work concerning the phylogenetic relationships of the New World nectar-feeding bats (Family Phyllostomidae: Glossophaginae). In light of this, we have thoroughly reexamined his study and found that our original assessment was quite charitable. We encountered a disturbing number of ambiguities, contradictions, and, in some cases, inaccuracies in his character analysis. We will comment briefly on some of these, but our primary concern in this paper will be his phylogenetic analysis and systematic conclusions. A more detailed account of this reexamination will be published in Systematic Zoology volume 33 (1984).

Natural History of the Brazilian Free-tailed Bat in the San Luis Valley of Colorado. Peggy L. Svoboda, Museum of the High Plains, Fort Hays State University, Hays, Kansas 67601. *

A colony of Brazilian free-tailed bats, *Tadarida brasiliensis mexicana*, was discovered in south-central Colorado in August of 1968. At that time, the size of the colony was estimated at 9,000 or more. A more recent estimate of the size of the colony in August is about 100,000 bats. Casual observation of the colony between 1978 and 1981 suggested that it consists primarily of males with only a few breeding females. Interest in the colony stemmed not only from its size and sexual composition but also from its location in a high montane valley to the north of other colonies east of the Continental Divide. A two-year field investigation of the colony was initiated in 1982 by the Colorado Division of Wildlife. Bats caught in mist nets during the outflight throughout the summer of 1982 were primarily males. The number of females caught increased in September, and by mid-October adult females outnumbered males. The main part of the colony departed in September, and no bats were active in the roost by mid-November. The same trend in size and composition of the colony has been ascertained thus far during 1983. Size of the colony has been estimated using a photoestimation technique. Data are being gathered to determine the feeding ecology of the colony and to identify its genetic relationships with other populations located farther south or to the southwest

*This paper won the award, a prize of $100.00, for the best presentation by a graduate student.

Reproductive Tactics in Seasonal Tropical Environments: Can African Fruit Bats Optimize Reproduction Across Their Range? Don Thomas, Biology Department, Carleton University, Ottawa, Canada.

Across the majority of Africa spanning a variety of vegetation and climatic zones, pteropodid bats (excluding *Eidolon helvum*) exhibit bimodal polyestry with the two birth peaks being separated by six months. In this paper I ask the question "Can this reproductive pattern be 'optimally' timed to correspond with rainfall and fruit abundance peaks in all areas?" In the forest zone and peripheral savannas parturition is timed such that the peak energy and protein demands of lactation coincide closely with seasonal rainfall and fruit maxima. However, along a forest to dry savanna axis, the rainfall peaks become progressively closer together and one annual parturition/lactation period in increasingly out of phase with the associated maximum of fruit availability. In the extreme cases where the two rainfall peaks fuse, one reproductive period appears to be dropped altogether in the case of *Rousettus aegyptiacus*. I argue that the pteropodids are able to time only one reproductive period to correspond with maximum fruit availability and the timing of the second, if it occurs at all, is determined by a relatively inflexible five to six month gestation period.

Activity patterns of a maternity colony of *Plecotus townsendii virginianus*. Virginia M. Tipton, Biology Department, Radford University, Radford, VA 24142

A single cave was observed one night each weekend from 19 March 1983 through 8 October 1983. Observations began about 30 minutes before sunset and ended about sunrise. A prototype ITT night vision scope was used to watch bats. Later in the summer, a video camera with a newvicon tube and video tape recorder were added tothe setup. The bats were counted as they entered and left the cave; flights were totaled every 10 minutes. We wanted to disturb the bats as little as possible, so we entered the cave infrequently for recording temperatures and looking for bats. We also recorded ambient air temperatures, rainfall, windspeed, light levels, barometric pressures, and cloud cover. The bats started arriving in mid-March and were mostly gone by mid-October. There was a peak in population numbers during the first week of May, followed by a decrease in late May/early June, and a later increase during the first week of August (at the time the young would be volant). During June, the majority of bats left the cave after sunset, stayed out all night, and returned just before sunrise. During the first several weeks in July, the flight pattern was bimodal with a peak number out at about 10:00 p.m. followed by a return of some of the bats and then another peak number out at about 2:00 a.m. This pattern coincides with the young beginning to fly (Bagley and Jacobs, pers. comm.) or perhaps

with the earlier time of lactation just before parturition. There seemed to be increased nightly activity (more flights into and out of the cave) when the foraging pattern became bimodal. During August, the bimodal pattern disappeared, and the bats started trickling in just after the maximum number had emerged about 9:30 p.m., and by 3:00 a.m., almost half of the bats were back in the cave. During the entire month of August, more bats entered than left the cave each night. This could possibly represent some males finally joining the colony, or perhaps the colony has an alternate cave where it spends some time. The bats partitioned their flights at the entrance to the main passage, exiting primarily through the upper quarter and entering in the middle. There was a negative correlation in the maximum emergence and light levels, with 50% of the bats emerging from the main passage at about 2 x 10 ⁴ footcandles.

Blood Sharing by the Vampire Bat, *Desmodus rotundus*: A Case for Reciprocity and Kin Selection. Gerald S. Wilkinson, Department of Biology, C-016, University of California, San Diego, La Jolla, CA 92093.

Two competing hypotheses, reciprocity and kin selection, for the evolution of altruism were tested by observing blood sharing among wild and captive vampire bats, *Desmodus rotundus*. Of the 110 instances of blood regurgitation which my assistants and I observed within hollow tree day roosts during 26 months of field work, 33 cases did not involve mothers feeding dependent young. Because all individuals were color-marked, we were able to estimate both a pairwise degree of relatedness using matrilineal pedigrees (paternity was excluded with allozyme analyses) and an estimate for the proportion of time each recipient bat spent roosting in association with all other bats in its tree at the time of a feeding. When entered into a logistic regression these two indices both proved to be significant predictors, independent of their correlation, of which bat usually donated blood. Experiments on unrelated captive roostmates from two populations show both that bats which are starved for one night are fed exclusively by a member of the same population and that blood sharing is reciprocated between roostmates. Because females live in stable groups for as long as 18 years and 14% of adult bats fail to feed on average each night, numerous oppurtunities for food sharing exist during the lifetime of a vampire bat. Estimates of the ratio of cost to benefit of sharing blood in terms of probability of survival are not sufficiently great for kin selection alone to be an economically viable explanation for this behavior. I therefore conclude that food sharing persists in this species because indiviuals reciprocally exchange blood in addition to feeding relatives.

The Influence of Diet on Kidney Structure and Function in Neotropical Bats. Don E. Wilson, Eugene H. Studier, and Carleton J. Phillips. U.S. Fish and Wildlife Service, National Museum of Natural History, Washington, DC 20560; Department of Biology, University of Michigan-Flint, Flint, Michigan 48503; Department if Biology, Hofstra University, Hempstead, New York 11550.

Bats that are primarily frugivorous or nectarivorous possess kidneys with relatively thin and undivided medullae; those species with other feeding preferences possess kidneys with relatively thick medullae, which are subdivided into inner and outer zones. Renal indices involving the relative thickness of the medullae and inner medullae are closely correlated with mean maximum urine concentrating ability. Natural urine osmotic pressures in frugivorous phyllostomids are less than in other phyllostomids, which in turn, are less than in insectivorous bats. Renal indices are similar between insectivorous bats inhabiting mesic and wet habits but are lower than those of bats inhabiting arid regions. The statistical relationships between renal index and body weight is enigmatic in bats, but all species have renal indices that differ according to foods habits. Renal morphology and maximum urine concentrating ability in bats are primarily a function of diet and secondarily related to environmental dehydration pressure.

Retinofugal Projections of a Neotropical Fruit Bat. John R. Cotter, State University of New York at Buffalo, Buffalo, NY. 14216

The connections from the retina to the central nervous system were studied in *Artibeus jamaicensis* using anterograde degeneration and standard autoradiographic techniques following unilateral enucleations and uniocular injections of radioactive amino acids. Although the retina projected bilaterally to the brainstem, the number of silver grains in the autoradiographic emulsion overlying the optic tracts indicated that 97% of all fibers in the optic nerve crossed at the optic chiasm and entered the contralateral optic tract. Ipsilaterally, a prominent portion of the projection ended at the level of the chiasm in the suprachiasmatic nucleus. Caudal to the suprachiasmatic nucleus, the amount of label in other ipsilateral target nuclei was so small, in comparison to that observed on the contralateral side, that grain counts were necessary to determine the projections of the retina to the ipsilateral dorsal and ventral geniculate nuclei, the ipsilateral nucleus of the optic tract and the ipsilateral pretectal olivary nucleus. Contralaterally, the retina projected to the suprachiasmatic nucleus, dorsal and ventral geniculate nuclei, the nucleus of the optic tract, the pretectal olivary nucleus, the posterior pretectal nucleus, the superficial gray layer of the superior colliculus and the nuclei on the accessory optic system. Grain counts were performed when there appeared to be regional differences in the density of silver grains. The number of silver grains in lateral versus medial areas of the dorsal lateral geniculate nucleus was approximately 2:1. The silver grains in the lateral aspect in the nucleus formed two dense bands while grains in the medial portions of the nucleus were fewer and more uniformly distributed. There was a direct relation between the pattern of grain distribution and the density of cells in this nucleus. This was in contrast to the superior colliculus where examination revealed an inverse relationship between the number of silver grains and cells, so that the less cellular upper half contained twice the number of silver grains in the more cellular lower half. The results of this study when compared to results obtained with insectivorous species (Crowle, 1974, 1980; Pentney and Cotter, 1976; Cotter and Pentney, 1979) revealed several similarities in that the projection was largely crossed in the species studied and the same brainstem areas, e.g., the hypothalamus, were involved in the projection. However, some differences are that the projection is larger in frugivorous versus insectivorous bats, the projection is more extensive in frugivorous bats, and finally visually related structures structures such as the superficial layers on the superior colliculus, are better developed in the frugivorous bats. In megachiropterans, a greater proportion of fibers crossed to the ipsilateral brainstem and the projection was larger, the projection was more extensive and the visual centers of the brainstem better developed (Crowle, 1974; Cotter and Pentney, 1979, Cotter, 1981) than that observed in *Artibeus*. Such differences may be related to the relative importance of vision in the behavior on insectivorous and frugivorous microchirpteran species.

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