BAT RESEARCH NEWS

VOLUME 29: No. 1-2 Spring-Summer 1988

BAT RESEARCH NEWS

Volume 29: Numbers 1–4 **1988**

Original Issues Compiled by Dr. G. Roy Horst, Publisher and Managing Editor of *Bat Research News*, 1988.

Bat Research News is ISSN # 0005-6227.

BAT RESEARCH NEWS

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BAT RESEARCH NEWS

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Institutional subscriptions are $15.00 worldwide.

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

Typeset by Tracy L. Robertson
at St. Lawrence University, Canton, New York
and
LWC Desktop Publishing, Bloomington, Illinois

Layout by G. Roy Horst

Mailed at Potsdam, New York, 13676, USA

BAT NEWS RESEARCH

Volume 29 Spring–Summer Number 1–2

Present Status of Bat Research in Poland

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First reports concerning bats in Poland appeared in the second half of the 19th century. They included data on distribution of bats within our lands. In the years that followed, most of the papers were faunistic contributions. The character of research in Poland remained the same until the period after World War II. This study constitutes a brief introduction to the fundamental topics in chiropterological research pursued in the last few decades in Poland. It includes a survey of selected literature (Appendix A) and information about the largest collections of fossil and recent bats housed in scientific institutions of Poland (Appendix B). The study concludes with a list of names and addresses of Polish specialists in bat biology (Appendix C).

Trends in past bat research

After WW II, most of the research concentrated on basic aspects of faunistics and focused above all on the determination of ranges of species which reached the limits of their distribution in Poland (38, 52, 54, 58, 116, 122, 129, 142, 147, 158, 160, 164, etc.). Much informatkion was obtained from studies of food consumed by owls, particularly by the species *Tyto alba* (9, 11, 122, 135, 136). Summaries of this type of research may be found mainly in papers No. 81 and 139. The technique of bat ringing allowed the study of bat migrations and of numerous details of their biology (38, 41, 78, 79, 92). Some studies were conducted outside Poland, for example in Algeria (21, 77, 82), Korea (121), Mexico (168) and Mongolia (73).

Interest in bat ecology was intense, though the majority of papers in this area were concerned with hibernation (2, 4, 35, 36, 40, 43, 44, 45, 51, 58, 81, 91, 94, 99, 132, 117, 120, 161, etc.).

Among the taxonomic contributions, the morphologic-diagnostic aspects of research dominated. Particular attention was paid to "twin" species (*Plecotus auritus* and *P. austriacus, Myotis brandtii* and *M. mystacinus)* and the analysis of intra- and inter-populational variation in *M. daubentoni* (6, 109, 126, 127, 129, 130, 138, 140, 143, 146). Karyological studies included research on several vespertilionid bat species (15, 16, 17, 18, 19, 20, 115). Possible mechanisms of chromosome formula changes within the family Vespertilionidæ were discussed (18).

Palæontological and palæoccological research focused mainly on material from the Holocene and Pleistocene periods (3, 63, 66, 67, 69, 71, 72, 76, 150, 157, 159, 162). Bat species new to science were described from early Pleistocene bone breccia of Podlesice: *Myotis podlesicensis, M. danutæ, and M. dasycneme subtilis* (62). Studies of this kind were also carried out in Bulgaria (166), Czechoslavakis (65, 75), Cuba (163, 167, 168) and China (80).

Much attention was devoted to the disastrous decrease in the numbers of bats in recent years (49, 57, 59,

84, 88, 90, 93, 98, 108, 114, 119). The creation in 1980 of the first bat reserve in Poland in the Miedzyrzecki Fortified Region (western Poland) may be seen as a remarkable success. The most recent surveys reveal that some 20,000 bats of 12 species regularly use this shelter for their hibernation. Unfortunately, this remarkable place is to become a site for nuclear waste disposal (50, 111).

Several workers have studied different aspects of bat parasites, including Trematoda (149, 172, 173, 174, 175, 176, 178, 179, 181), Cestoda (149, 176, 180), Nematoda (144, 149, 177, 179) *Acanthocephala* (144), Acarina (26, 28, 29, 30, 31, 32, 33, 34, 37), Siphonaptera (25, 33) and Diptera (27).

Other studies which have been completed include such miscellaneous topics as: attack by a bat on an owl (86), bibliography of bat papers (103), carotenoid contents (12, 13, 14), color aberrations (89, 125), dental abnormalities (134, 165), diurnal and seasonal activity patterns (36, 61, 87), economy (8, 107, 170), ethology (35, 47, 151, 170), evolution (97), geographical distribution (102, 104, 105, 110), hematology (23, 156), introduction of foreign species (83, 96, 100), longevity (48), morphology (123, 124), rabies (55, 152, 155), regeneration (7, 137), and temperature relationships (10, 40, 45).

Museology

The largest collections of recent bats in Poland are housed in four institutions: the Institute of Systematic and Experimental Zoology of the Polish Academy of Sciences (ISEZ PAS); the Mammals Research Institute of the Polish Academy of Sciences (MRI PAS); the Institute of Systematic Zoology of A. Mickiewicz University (ISZ AMU); and the Institute of Zoology of the Polish Academy of Sciences (IZ PAS) (see Appendix B1 for addresses). Most of the material is preserved as prepared dry skins and skulls, skulls, and cadavers in alcohol. Fossil and subfossil specimens, which form an important part of the bat collection in the ISEZ PAS, are listed in Appendix B2. The MRI PAS, ISEZ PAS, and ISZ AMU include material from pellets that is not reported in this paper.

The list of bats in Appendix B1 is not complete. It does not include about 500 specimens of 22 species collected in North Africa, mostly Algeria (ISEZ PAS collection), and part of a collection from Poland and Bulgaria kept in the ISZ AMU at Poznan that were being studied at the time of writing this account.

Acknowledgements — Many thanks are due Mrs. B. Dziurdzik M. Sc. and Mr. P. Rachowiak M. Sc. for making available the information concerning the collections they directly supervise.

Appendix A
Selected References

1. Bagrowska, E., and Z. Urbanczyk. 1976. The station of Bechstein's bat *Myotis bechsteini* (Kuhl) in the Lubuskie lake district. Przegl. zool., 20:367-369. (in Polish, with English summ.)
2. Bagrowska-Urbanczyk, E., and Z. Urbanczyk. 1983. Structure and dynamics of a winter colony of bats. Acta theriol., 28: 183-196.
3. Bochenski, Z., M. Mlynarski, A. Nadachowski, E. Stworzewicz, and B. W. Woloszyn. 1983. Upper Holocene fauna from the Duza Sowa Cave (preliminary notes). Przegl. zool., 27:437-456. (in Polish, with English summ.)
4. Bogdanowicz, W. 1983. Community structure and inter-specific interactions in bats hibernating in Poznan. Acta theriol., 28: 357-370.
5. Bogdanowicz, W., and Z. Urbanczyk. 1983. Some ecological aspects of bats hibernating in City of Poznan. Acta theriol., 28: 371-385.
6. Bogdanowicz, W., and A. M. Wojcik. 1985-1986. Morphological and electrophoretic differentiation between *Myotis daubentoni* (Kuhl, 1819) and *Myotis nathalinæ* Tipinier, 1977. Myotis, 23-24:17-30.
7. Bogdanowicz, W., and Z. Urbanczyk. 1986. A case of self-healing of a broken forearm in *Myotis brandtii* (Eversmann, 1845). Acta theriol., 31:180-181.
8. Burzynski, J. 1971. Application of the complex biological method of forest protection in Poland. Sylwan, 65 (11):47-53. (in Polish, with Russian and English summs.)
9. Cais, L. 1963. Investigation on the food of some owls' species. Zesz. nauk. Univ. Adama Mickiewicza Poznan, Biol., 44(4):3-21. (in Polish)
10. Cena, K., and B. W. Woloszyn. 1966. Investigations on the diurnal changes of the skin temperature in bats. Folia biol., Krakow, 14:195-203.
11. Czarnecki, Z., J. Gruszczynska, and E. Smolenska. 1955. Investigations on the composition of the food consumed by the barn-

owl (*Tyto alba guttata* [C.L.Br.]). Prace Kom. mat.-przyr., Poznan, 16(3):1-37. (in Polish with English and Russian summs.)
12. Czeczuga, B., and A. L. Ruprecht. 1980-1981. Carotenoid content in the bat at start and at end of the hibernation. Myotis, 18-19:163.
13. Czeczuga, B., and A. L. Ruprecht. 1982. Carotenoid contents in mammals. II. Carotenoids of some *Vespertilionidæ* from the seasonal variation aspect. Acta theriol., 27:83-96.
14. Czeczuga, B., and A. L. Ruprecht. 1985. Contents of carotenoids in mammals III. Carotenoids in specimens of six species of *Vespertilionidæ*. Nyctalus (N.F.), 2(2):186-190.
15. Fedyk, A., and S. Fedyk. 1970. Karyotypes of some species of vespertilionid bats from Poland. Acta theriol., 15:295-302.
16. Fedyk, S., and A. Fedyk. 1971. Karyological analysis of representatives of the genus *Plecotus* Geoffroy, 1818 *(Mammalia: chiroptera)*. Caryologia, 24:483-492.
17. Fedyk, S., and A. L. Ruprecht. 1976. Karyotypes of *Pipistrellus pipistrellus* (Schreber, 1774) and *P. nathusii* (Keyserling and Blasius, 1839) *(Chiroptera: Vespertilionidæ)*. Caryologia, 29: 283-289.
18. Fedyk, S., and A. L. Ruprecht. 1983. Chromosomes of some species of vespertilionid bats. I. Banding patterns of *Eptesicus serotinus* chromosomes. Acta theriol., 28:159-170.
19. Fedyk, S., and A. L. Ruprecht. 1983. Chromosomes of some species of vespertilionid bats. II. Evolutionary relationships of plecotine bats. Acta theriol., 28: 171-182.
20. Fedyk, S., and A. L. Ruprecht. 1985. Chromosomes of some species of vespertilionid bats III. Banded chromosomes of *Vespertilio murinus* L., 1758. Nyctalus (N.F.), 2(2):119-126.
21. Gaisler, J., and K. Kowalski. 1986. Results of the netting of bats in Algeria *(Mammalia: Chiroptera)*. Vest. csl. zool. Spol., 50:161-173.
22. Graczyk, R. 1974. Study on population of bats *(Chiroptera)* settled in sawdustconcrete hatching boxes in forests. Pr. Kom. Nauk. roln. lesn., Poznan, 37:89-94. (in Polish, with English summ.)
23. Grundboeck, M., and A. Krzanowski. 1957. Morphological investigations on the blood of some European species of bats. Zoologica Pol., 8:349-368.
24. Haitlinger, R. 1976. Bats of Lower Silesia. Przegl. zool., 20:124-134. (in Polish, with English summ.)
25. Haitlinger, R. 1977. External parasites of Lower Silesian bats. I. *Siphonaptera*. Wiad. parazyt., 23:441-451. (in Polish, with English summ.)
26. Haitlinger, R. 1977. Parasitological investigations on small mammals of Gory Sowie (Middle Sudetes). V. *Acarina (Trombidiformes, Ixodides, Sarcoptiformes)*. Polskie Pismo ent., 47:377-427.
27. Haitlinger, R. 1978. External parasites of Lower Silesian bats. II. *Nycteribiidæ (Diptera)*. Wiad. parazyt., 24:467-474. (in Polish, with English summ.)
28. Haitlinger, R. 1978. External parasites of Lower Silesian bats. III. *Spinturnicidæ, Argasidæ, Ixodidæ (Acarina)*. Wiad. parazyt., 24:475-490. (in Polish, with English summ.)
29. Haitlinger, R. 1978. External parasites of Lower Silesian bats. IV. *Macronyssidæ, Dermanyssidæ, Veigaiaidæ (Acarina)*. Wiad. parazyt., 24:707-718. (in Polish, with English summ.)
30. Haitlinger, R. 1978. Four new species of the genus *Acanthophtirius* Perkins, 1925 *(Acarina, Myobiidæ)* from bats of Poland. Polskie Pismo ent., 48:41-47.
31. Haitlinger, R. 1979. External parasites of Lower Silesian bats. V. *Trombidiformes, Sarcoptiformes (Acarina)*. Wiad. Parazyt., 25:105-117. (in Polish, with English summ.)
32. Haitlinger, R. 1979. External parasites of Lower Silesian bats. VI. *Acarina, Siphonaptera, Diptera (Nycteribiidæ)*. Wiad. parazyt., 25:119-140. (in Polish, with English summ.)
33. Haitlinger, R., and A. L. Ruprecht. 1977. Contribution to the ectoparasites fauna of bats from the Bialowieza Primeval Forest. Przegl. zool., 21:3320338. (in Polish, with English summ.)
34. Haitlinger, R., and A. L. Ruprecht. 1982. *Spinturnix acuminatus* (Koch, 1836) *(Acarina, Spinturnicidæ)* a new mite species for the fauna of Poland. Przegl. zool., 26:171-172. (in Polish, with English summ.)
35. Harmata, W. 1960. Ethological and ecological observations made on bats *(Chiroptera)* of the Wolski forest near Cracow. Zesz. nauk. Univ. jagiellonsk., 33, Pr. zool., 5:163-203. (in Polish, with English and Russian summs.)
36. Harmata, W. 1962. Seasonal rhythmicity of behaviour and the ecology of bats *(Chiroptera)* living in some old buildings in the district of Krakow. Zesz. nauk. Univ. jagiellonsk., 58, Pr. zool., 7:149-179. (in Polish, with English and Russian summs.)
37. Harmata, W. 1967. The incidence of *Trombicula (Leptotrombidium) russica* Oudemans, 1902 *(Acarina, Trombiculidæ)* on bats *Barbastella barbastellus* (Schreber, 1774). Wiadom. parazyt., 13:267-270. (in Polish, with English summ.)
38. Harmata, W. 1968. Fernfund einer Kleinen Hufeisennase *(Rhinolophus hipposideros)* in Polen. Myotis, 6:26-27.
39. Harmata, W. 1969. Summer colony of Bechstein's bat *Myotis bechsteini* (Kuhl) in Szymbark near Gorlice, Rzeszow district. Remarks about biology and occurrence. Przegl. zool., 13:233-238. (in Polish, with English summ.)
40 Harmata, W. 1969. The thermopreferendum of some species of bats *(Chiroptera)*. Acta theriol., 14:49-62.
41. Harmata, W. 1971. Zum Vorkommen des Grauen Langohrs *(Plecotus austriacus)* (Fischer, 1829) in der Umgebung von Krakow (Polen). Myotis, 9:18-20.
42. Harmata, W. 1971. Vorläufige Ergebnisse der Fledermaus-Beringung in den Höhlen des Krakao-Czestochowa-Jura (Polen)

in den Jahren 1954-1968. Decheniania Beihefte, 18:57-61.
43. Harmata, W. 1973. Bats *(Chiroptera)* of the Chrzanow district. Part I. The bats of caves and buildings. Studia Osr. Dok. fizjogr., 2:109-127. (in Polish, with Russian and English summs.)
44. Harmata, W. 1973. Observations on bats *(Chiroptera)* in caves of the Crakow-Czestochowa Upland. Roczn. Muz. Czestochowa, 3:13-33. (in Polish, with Russian and English summs.)
45. Harmata, W. 1973. The thermopreferendum of some species of bats *(Chiroptera)* in natural conditions. Zesz. nauk. Univ. jagiellonsk., 332, Pr. zool., 19:127-141.
46. Harmata, W. 1979. Bats *(Chiroptera)* of the Chrzanow district. Part II. Bats of forests and coppices. Studia Osr. Dok. fizjogr., 7:243-255. (in Polish, with English summ.)
47. Harmata, W. 1980. Behaviour of the bats *Pteropus giganteus giganteus* Brünn *(Pteropodidæ, Megachiroptera)* in captivity. Zesz. nauk. Univ. jagiellonsk., 572, Pr. zool., 26:41-51. (in Polish, with Russian and English summs.)
48. Harmata, W. 1981. Longevity record for the lesser horseshoe bat. Acta theriol., 26:507.
49. Harmata, W. 1981. The changes of bat populations *(Chiroptera)* in some caves of the Krakow-Czestochowa Upland in the years 1945-1979. Roczn. Muz. Okreg. Czestochowa, 5, Przyr., 2:23-30. (in Polish, with English summ.)
50. Harmata, W. 1985. "Nietoperek"—a nature reserve unique on a global scale. Chronmy Przyr. ojcz., 41 (3):21-27. (in Polish, with English summ.)
51. Harmata, W. 1985. The length of awakening time from hibernation of three species of bats. Acta theriol., 30:321-323.
52. Harmata, W., and J. Trzaska. 1958. New posts of the bat *Myotis emarginatus* Geoffroy in Southern Poland. Zesz. nauk. Univ. jagiellonsk., 19, Pr. zool., 3:223-228. (in Polish, with English summ.)
53. Harmata, W., and R. J. Wojtusiak. 1963. The greater horseshoe bat, *Rhinolophus ferrumequinum* Schreber *(Chiroptera)*, a species new to the fauna of mammals in Poland. Przegl. zool., 7:154-157. (in Polish, with English summ.)
54. Kokurewicz, T. 1987. New data on the occurrence of Lesser Horseshoe Bat *(Rhinolophus hipposideros* Bechstein, 1800) in East Sudetes. Przegl. zool., in press. (in Polish, with English summ.)
55. Komorowski, A., Z. Szankowska, and A. Ramisz, 1974. The first case of rabies in a bat in Poland. Przegl. epidem., 28(1):41-43. (in Polish, with English summ.)
56. Kowalski, K. 1951. *Myotis emarginatus* Geoffroy *(Chiroptera, Vespertilionidæ)* a new bat in Polish fauna. Fragm. faun., 6:165-167. (in Polish, with English summ.)
57. Kowalski, K. 1953. Cave dwelling bats in Poland and their protection. Ochr. Przyr., 21:58-77. (in Polish, with English summ.)
58. Kowalski, K. 1953. Material relating to the distribution and ecology of cave bats in Poland. Fragm. faun., 6:541-567. (in Polish, with Russian and English summs.)
59. Kowalski, K. 1955. Our bats and their protection. Zakl. Ochr. Przyr., Pol. Akad. Nauk, 11:1-76, Krakow.
60. Kowalski, K. 1955. The cave fauna of the Polish Tatra Mountains. Ochr. Przyr., 23:283-333. (in Polish, with English summ.)
61. Kowalski, K. 1955. The daily rhythm of activity of the mouse-eared bat *Myotis myotis* Borkhausen. Folia biol., Krakow, 3:55-64. (in Polish, with Russian and English summs.)
62. Kowalski, K. 1956.. Insectivores, bats and rodents from the early Pleistocene bone breccia of Podlesice near Kroczyce (Poland). Acta palæont. pol. 1:331-394.
63. Kowalski, K. 1959. A catalogue of the Pleistocene mammals of Poland. Pol. Akad. Nauk, Inst. Zool., 267 pp., Warszawa-Wroclaw. (in Polish, with English and Russian summs.)
64. Kowalski, K. 1960. Bats, their banding and protection. Chronmy Przyr. ojcz., 15 (6):11-14, 54. (in Polish, with English summ.)
65. Kowalski, K. 1962. Bats of the early Pleistocene from Koneprusy (Czechoslovakia). Acta. zool. cracov., 7:145-156.
66. Kowalski, K. 1962. Fauna of bats from the Pliocene of Weze in Poland. Acta. zool. cracov., 7:39-51.
67. Kowalski, K. 1962. Les micro-mammifères du Pliocène et du Pléistocène inférieur de la Pologne. *In* Problèmes actuels de Paleontologie (Évolution des Vertébrés). Colloq. intern. Cent. nat. Rech. Sci., Paris, 104:409-416.
68. Kowalski, K. 1962. Mammals. Pp. 365-388, *in* The Tatra National Park, by Szafer, W., (ed.). Zakl. Ochr. Przyr., Pol. Akad. Nauk, 675 pp., Krakow. (in Polish, with English summ.)
69. Kowalski, K. 1964. Palæoecology of mammals from the Pliocene and early Pleistocene of Poland. Acta theriol., 8:73-80.
70. Kowalski, K. 1964. Bats. 1. History of investigations in Poland. Zesz. probl. Postep. Nauk roln., 45:211-220. (in Polish)
71. Kowalski, K. 1967. Pleistocene fauna of Poland. Pp. 72-82, *in* Quaternary of Poland, by Galon, R. & J. Dylik (eds.). Panstw. Wyd. Nauk., 527 pp., Warszawa. (in Polish)
72. Kowalski, K. 1967. The fauna of vertebrates. Pp. 16-24, *in* A study of the deposits of the rock-shelters in Zytnia Skala (Beblo, Krakow district), by Kowalski, K et. al., Folia quatern., 25:1-48. (in Polish, with English and Russian summs.)
73. Kowalski, K. 1968. New data on the distribution of mammals in the Mongolian People's Republic. Acta. zool. cracov., 13:1-11.
74. Kowalski, K. 1971. European Upper Pliocene and Quaternary Mammal Faunas [table 29A]. Stratigraphically arranged, with first and last appearances. Pp. 748-750, *in* Glacial and Quaternary Geology, by Flint, R. F. (ed.). J. Wiley and Sons, 892 pp., New York.
75. Kowalski, K. 1972. *Chiroptera* from Stránská Skála near Brno. Anthropos, 20 (n.s):71-75.
76. Kowalski, K. 1972. Studies on Raj Cave near Kielce (Poland) and its deposits: fossil fauna. Folia quatern., 41:45-59.

77. Kowalski, K. 1982/1983. Les chauves-souris cavernicoles de l'Algérie. Spéléol. algérienne, 43-56.
78. Kowalski, K., and R. J. Wojtusiak. 1951. Homing experiments on bats. Part I. Bull. int. Acad. Sci. Lett., Bii:33-56.
79. Kowalski, K., A Krzanowski, and R. J. Wojtusiak. 1957. Report on bat banding in Poland in the years 1939-1953. Acta theriol., 1:109-158. (in Polish, with Russian and English summs.)
80. Kowalski, K., and Li Chuan-kuei. 1963. Remarks on the fauna of bats *(Chiroptera)* from Locality 1 at Choukoutien. Vertebr. palasiat., 7:144-150. (in Chinese, with English summ.)
81. Kowalski, K., and A. L. Ruprecht. 1981. Bats—*Chiroptera*. Pp. 101-154, *in* Keys to Vertebrates of Poland. Mammals, by Pucek, Z. (ed.). Panstw. Wyd. Nauk., 367 pp., Warszawa. (corrected and revised edition in Polish in 1984)
82. Kowalski, K., J. Gaisler, H. Bessam, C. Isaad, and H. Ksantini. 1986. Annual life cycle of cave bats in Northern Algeria. Acta theriol., 31:185-205.
83. Krzanowski, A. 1954. On the need to introduce new species of bats into our forests. Sylwan, 48:96-99, 222. (in Polish, with English summ.)
84. Krzanowski, A. 1955. A new type of boxes for bats. Chronmy Przyr. ojcz., 11 (3):25-27. (in Polish)
85. Krzanowski, A. 1956. The Bats *(Chiroptera)* of Pulawy. List of species with biological observations. Acta theriol., 1:87-108. (in Polish, with Russian and English summs.)
86. Krzanowski, A. 1958. Bat attacking an owl. Przegl. zool., 2:44-45. (in Polish, with English summ.)
87. Krzanowski, A. 1959. Daytime activity of *Nyctalus noctula* Schreb. Acta theriol., 2:283-284.
88. Krzanowski, A. 1959. Ergebnisse des Waldfledermausschutzes auf Grund fremder und eigener Erfahrungen. Waldhygiene, 3:99-105.
89. Krzanowski, A. 1959. Interesting tawny specimen of the long-eared bat *(Plecotus auritus* L.). Acta theriol., 2:285-286.
90. Krzanowski, A. 1959. On the need for safeguarding cave-dwelling bats in Poland. Chronmy Przyr. ojcz., 15 (6):17-18, 54. (in Polish, with English summ.)
91. Krzanowski, A. 1959. Some major aspects of population turnover in wintering bats in the cave at Pulawy (Poland). Acta theriol., 3:27-42.
92. Krzanowski, A. 1960. Investigations of flights of Polish bats, mainly *Myotis myotis* (Borkhausen, 1797). Acta theriol., 3:175-184.
93. Krzanowski, A. 1961. The results of hanging up the boxes for bats in the National Park of Bialowieza (Poland). Chronmy Przyr. ojcz., 17 (4):29-32, 56. (in Polish, with English summ.)
94. Krzanowski, A. 1961. Weight dynamics of bats wintering in the cave at Pulawy (Poland). Acta theriol., 4:249-264.
95. Krzanowski, A. 1963. The complete list of *Chiroptera* of the town of Pulawy (Poland). Przegl. zool., 7:284-286. (in Polish, with English summ.)
96. Krzanowski, A. 1965. Ideas on useful introductions of bats as insect destroyers. Bat Res. News, 6 (4):33.
97. Krzanowski, A. 1967. The magnitude of islands and the size of bats *(Chiroptera)*. Acta zool. cracov., 12:281-346.
98. Krzanowski, A. 1969. The protection of bats. Lynx, 10 (n.s.):41-44.
99. Krzanowski, A. 1971. Niche and species diversity in temperate zone bats (*Chiroptera)*. Acta zool. cracov., 16:683-693.
100. Krzanowski, A. 1971. Zur Frage der Einbürgerung nordamerikanischer Chiropteren in Europa. Myotis, 9:8-10.
101. Krzanowski, A. 1973. Numerical comparison of *Vespertilionidæ* and *Rhinolophidæ (Chiroptera: Mammalia)* in the owl pellets. Acta zool. cracov., 18:133-140.
102. Krzanowski, A. 1976. Possible early reference to bat guano deposits in New Zealand. New Zealand J. Zool., 3 (2):159.
103. Krzanowski, A. 1977. Bibliography of bats *(Mammalia: Chiroptera)*, 1958-67. Rheinische Friedrich-Wilhelms-Universität, 599 pp., Bonn [Mimeographed].
104. Krzanowski, A. 1977. Contribution to the history of bats on Iceland. Acta theriol., 22:272-273.
105. Krzanowski, A. 1977. The easternmost occurrence of bats in Polynesia. Acta theriol., 22:271-272.
106. Krzanowski, A. 1977. Weight classes of Palearctic bats. Acta theriol., 22:365-370.
107. Krzanowski, A. 1978. Bats and the injurious insects. Pp. 383-386, *in* Biological control of plant pests, by Boczek, J. & J. J. Lipa (eds.). Panstw. Wyd. Nauk., 594 pp., Warazawa. (in Polish)
108. Krzanowski, A. 1980. Bats. Bibl. Wiedzy Wspolcz. Omega No. 359, Wiedza Powsz., 236 pp., Warszawa. (in Polish)
109. Krzanowski, A. 1983. Hypothesis on taxonomical status of *Eptesicus sodalis* and *Myotis nathalinæ*. Bat Res. News, 24:8.
110. Krzanowski, A. 1984. Causes of depauperation of the molossid fauna in the Indo-Australian region. Bat Res. News, 25:5-6.
111. Krzanowski, A. 1985. Poland's bats in trouble. Bats, Milwaukee, 2 (1):2-3.
112. Krzanowski, A. 1986. A comparison of numbers of taxa in the recent mammalian fauna of the Old and New Worlds. Acta theriol., 31:207-220.
113. Kubik, J., H. Leniec, and W. Sitkowski. 1984. Analysis of the mammal fauna of the Lublin Coal Basin based on owl pellets. Acta theriol., 29:167-173.
114. Kubisz, D. 1982. On the protection of bats *Chiroptera*. Chronmy Przyr. ojcz., 36 (6):114-122. (in Polish, with English summ.)
115. Leniec, H., S. Fedyk, and A. L. Ruprecht. 1987. Chromosomes of some species of vespertilionid bats. IV. New data on the plecotine bats. Acta theriol., in press.
116. Lesinski, G. 1980. New stations of *Myotis myotis* (Borkhausen) in the Masovian Lowland Region. Przegl. zool., 24:215-220.

(in Polish, with English summ.)
117. Lesinski, G. 1983. Bats in the caves of the Wielun Upland. Przegl. zool., 27:465-478. (in Polish, with English summ.)
118. Lesinski, G. 1983. The Tawny owl, *Strix aluco* L. hunts bats. Przegl. zool., 27:371-372. (in Polish, with English summ.)
119. Lesinski, G. 1984. An appeal for the protection of the winter quarters of bats in the Szachownica Cave in the Wielun Upland. Chronmy Przyr. ojcz., 40 (2):52-55. (in Polish)
120. Lesinski, G. 1986. Ecology of bats hibernating underground in central Poland. Acta theriol., 31:507-521.
121. Nadachowski, A., Z. Szyndlar, and T. Tomek. 1982. The terrestrial vertebrate fauna of Korean Peninsula. Przegl. zool., 26:79-92. (in Polish, with English summ.)
122. Nikodem, Z. 1982. Materials to the bat fauna *(Chiroptera)* of Lublin region (south-eastern Poland). Przegl. zool., 26:197-205. (in Polish, with English summ.)
123. Romankowowa, A. 1961. The sesamoid bones of the autopodia of bats. Acta theriol., 5:125-140.
124. Romankowowa, A. 1963. Comparative study of the skeleton of the hyoid apparatus in some bat species. Acta theriol., 7:15-23.
125. Ruprecht, A. 1965. A rufous specimen of *Eptesicus serotinus* (Schreber, 1774). Acta theriol., 10:239-240.
126. Ruprecht, A. 1965. Methods of distinguishing *Plecotus austriacus* Fisher, 1829 and new stations of this species in Poland. Acta theriol., 10:215-220.
127. Ruprecht, A. L. 1969. Taxonomic value of mandible measurements in the genus *Plecotus* Geoffroy, 1818. Acta theriol., 14:63-68.
128. Ruprecht, A. L. 1970. *Nyctalus lasiopterus* (Schreber, 1780)—a new species in the fauna of Poland. Acta theriol., 15:370-372.
129. Ruprecht, A. L. 1971. Distribution of *Myotis myotis* (Borkhausen, 1797) and representatives of the genus *Plecotus* Geoffory, 1818 in Poland. Acta theriol., 16:95-104.
130. Ruprecht, A. L. 1974. The occurrence of *Myotis brandtii* (Eversmann, 1845) in Poland. Acta theriol., 19:81-90.
131. Ruprecht, A. L. 1975. Bat collection from Pulawy of I. K. Tarnani in the collections of the Museum of the Zoological Institute, Academy of Sciences of the USSR in Leningrad. Przegl. zool., 19:356-360. (in Polish, with English summ.)
132. Ruprecht, A. L. 1976. New observations on bats *(Chiroptera)* of Bialowieza. Przegl. zool., 20:115-123. (in Polish, with English summ.)
133. Ruprecht, A. L. 1977. Über die Verbreitung der Rauhhautfledermaus, *Pipistrellus nathusii* (Keyserling & Blasius, 1839) in Polen. Myotis, 14:25-29.
134. Ruprecht, A. L. 1978. Überzählige Schneidezähne bei der Breitflügelfledermaus, *Eptesicus serotinus* (Schreber, 1774). Säugetierk. Mitt., 26 (3):235-236. (in German, with English summ.)
135. Ruprecht, A. L. 1979. Bats *(Chiroptera)* as constituents of the food of barn owls *Tyto alba* in Poland. Ibis, 121:489-494.
136. Ruprecht, A. L. 1979. Food of the barn owl, *Tyto alba guttata* (C.L.Br.) from Kujawy. Acta orn., Warsz., 16:493-511.
137. Ruprecht, A. L. 1981. Fälle von Selbstausheilung von Unterkieferbrüchen bei Kleinsäugern aus dem Lebensraum. Säugetierk. Mitt. 29 (4):79-80. (in German, with English summ.)
138. Ruprecht, A. L. 1981. Variability of Daubenton's bat and distribution of the *nathalinæ* morphotype in Poland. Acta theriol., 26:349-357.
139. Ruprecht, A. L. 1983. *Chiroptera*. Pp. 62-82, maps 0012-0032, *in* Atlas of Polish mammals, by Pucek, Z. & J. Raczynski (eds.). Panstw. Wyd. Nauk., 2 vols:188 pp. and 90 maps, Warszawa. (in English and Polish)
140. Ruprecht, A. L. 1983. Criteria for species identification in the genus *Plecotus* Geoffroy *(Chiroptera, Vespertilionidæ)*. Zool. Zh., 62:1252-1257. (in Russian, with English summ.)
141. Ruprecht, A. L. 1986. A key for mandible identification of Polish bats. Przegl. zool., 31:89-105. (in Polish, with English summ.)
142. Ruprecht, A., and S. Tarczynski. 1965. New localities of *Myotis myotis* (Borkhausen, 1797) in North Poland. Acta theriol., 10:221-224.
143. Ruprecht, A. L., and A. V. Yablokov. 1977. Patterns of patagium venation in two species of the genus *Plecotus* Geoffroy, 1818 *(Chiroptera, Vespertilionidæ)*. Zool. Zh., 56:1366-1371. (in Russian, with English summ.)
144. Rutkowska, M. 1980. The helminthofauna of bats *(Chiroptera)* from Cuba. I. A review of nematodes and acanthocephalans. Acta parasit. pol., 16:153-186.
145. Rzebik-Kowalska, B., B. W. Woloszyn, and A. Nadachowski. 1978. A new bat, *Myotis nattereri* (Kuhl, 1818) *(Vespertilionidæ)*, in the fauna of Iraq. Acta theriol., 23:541-545.
146. Serafinski, W. 1958. *Nyctalus noctula noctula* (Schreber, 1774) und *Nyctalus noctula princeps* Ognev, 1923 in Mittel- und Osteuropa. Acta theriol., 1:309-331. (in Polish, with German and Russian summs.)
147. Skuratowicz, W. 1939. Materialen zur Chiropteren-Fauna des Zamoyski-Majorats. Fragm. faun., 4:227-235. (in Polish, with German summ.)
148. Skuratowicz, W. 1948. Notes on the protection of certain mammals. Chronmy Przyr. ojcz., 4 (3/4):8-18, 64-65. (in Polish, with English summ.)
149. Soltys, A. 1959. The helminth fauna of bats *(Chiroptera)* of Lublin Palatinate. Acta parasit. pol., 7:599-613.
150. Sulimski, A., A. Szynkiewicz, and B. Woloszyn, 1979. The Middle Pliocene micromammals from central Poland. Acta palæont. pol., 24:377-403.

151. Sych, L. 1960. Sensitivity of the large mouse-eared bat, *Myotis myotis* (Borkhausen) to air currents in laboratory conditions. Folia biol., Krakow, 8:135-147.
152. Twardowski, H., and M. Barancewicz. 1986. Cases of rabies in the rat and in the bat. Medycyna wet., 42:15-16. (in Polish)
153. Urbanczyk, Z. 1981. Fledermäuse *(Chiroptera)* in der Nahrung des Marders *(Martes* sp.). Säugetierk. Mitt, 29 (1):77-79.
154. Urbanczyk, Z. 1983-1984. Massenquartiere überwinternder Fledermäuse in alten Befestigungsanlagen des 2. Weltkrieges in Westpolen. Myotis, 21-22:113-115.
155. Wachnik, Z. 1982. Rabies in insectivorous bats. Medycyna wet., 38:201-203. (in Polish)
156. Wolk, E., and W. Bogdanowicz. 1987. Hematology of hibernating bat: *Myotis daubentoni*. Comp. Biochem. Physiol., in press.
157. Woloszyn, B. W. 1961. Die postglazialen Fledermäuse *(Chiroptera)* aus der Zimnahohle in der Hohen Tatra. Hohle, 12:90-91.
158. Woloszyn, B. W. 1962. Bats from the cave of the Gory Swietokrzyskie mountains (Poland). Przegl. zool., 6:156-162. (in Polish, with English summ.)
159. Woloszyn, B. W. 1963. *Mammalia Chiroptera*. Pp. 12-19, *in* The postglacial fauna from Jozefow in the Bilgoraj district, by Kowalski, K. et al., Folia quatern., 14:1-26. (in Polish, with English and Russian summs.)
160 Woloszyn, B. W. 1964. New observations on bats from the caves in Gory Swietokrzyskie mountains. Przegl. zool., 8:286-292. (in Polish, with English summ.)
161. Woloszyn, B. W. 1968. Investigations on bats of Lower Silesia. Przegl. zool., 12:208-220. (in Polish, with English summ.)
162. Woloszyn, B. W. 1970. The Holocene chiropteran fauna from the Tatra caves. Folia quatern., 35:1-52. (in Polish, with English and Russian summs.)
163. Woloszyn, B. W. 1973. El vampiro fosil de Cuba. Actas Acad. Cienc. Cuba, 3:54-55.
164. Woloszyn, B. W. 1976. Bemerkungen zur Populationsentwicklung der Kleinen Huffeisennase, *Rhinolophus hipposideros* (Bechstein, 1800) in Polen. Myotis, 14:37-52.
165. Woloszyn, B. W. 1978. Dental abnormalities in bats. Pp. 165. II Congress Theriol. Intern., 20-27 June 1978. Brno, Czechoslovakia.
166. Woloszyn, B. W. 1982. Animal remains. *Chiroptera*. Pp. 40-45, *in* Excavation in the Bacho Koro Cave (Bulgaria), by Kozlowski, J. K. (ed.). Panstw. Wyd. Nauk., 172 pp., Warszawa.
167. Woloszyn, B. W., and N. A. Mayo. 1974. Postglacial remains of a vampire bat *(Chiroptera: Desmodus)* from Cuba. Acta zool. cracov., 19:253-266.
168. Woloszyn, B. W., and G. Silva Taboada. 1977. Nueva especie fosil de *Artibeus (Mammalia: Chiroptera)* de Cuba, y tipificación preliminar de los depósitos fosiliferos cubanos contentivos de mamiferos terrestres. Poeyana, 161:1-17.
169. Woloszyn, D., and B. W. Woloszyn. 1982. Los mamíferos de la Sierra de La Laguna, Baja California Sur. Consejo nac. Cienc. Tecnol., 168 pp., Mexico.
170. Wozniakowska, M. 1957. La capacité du discernement des degré du gris chez les chauves-souris *(Myotis myotis* Borkhausen). Zesz. nauk. Univ. jagiellonsk., 10, Pr. zool., 1:123-134. (in Polish, with Russian and French summs.)
171. Zaborowski, S. 1976. Untersuchungen über die Fledermäuse vom Gesichtspunkt ihrer Stellung in der Herd-Komplex-Forstschutzmethode aus. Pr. badaw. Inst. badaw. Lesn., 506:137-145. (in Polish, with Russian and German summs.)
172. Zdzitowiecki, K. 1967. *Acanthatrium (Acanthatrium) tatrense* sp.n. *(Digenea, Lecithodendriidæ)*—the first representative of the genus *Acanthatrium* Faust 1919 in Europe. Bull. Acad. pol. Sci., Cl. II, Ser. Sci. biol., 15:273-276.
173. Zdzitowiecki, K. 1967. *Czosnovia joannæ* g.n., sp.n. *Lecithodendriidæ)*, a new trematode species from the bat, *Myotis daubentoni* (Kuhl, 1819). Acta parasit. pol., 14:405-408.
174. Zdzitowiecki, K. 1969. Helminths of bats in Poland. II. Trematodes of the subfamily *Lecithodendriinæ*. Acta parasit. pol., 16:207-226.
175. Zdzitowiecki, K. 1969. Helminths of bats in Poland. III. Trematodes of the family *Lecithodendriidæ*, except for *Lecithodendriinæ*. Acta parasit. pol., 16:227-237.
176. Zdzitowiecki, K. 1970. Helminths of bats in Poland. I. Cestodes and trematodes of the family *Plagiorchiidæ*. Acta parasit. pol., 17:175-188.
177. Zdzitowiecki, K. 1970. Helminths of bats in Poland. IV. Nematodes. Acta parasit. pol., 18:255-265.
178. Zdzitowiecki, K. 1980. *Nudacotyle quartus* sp.m. *(Trematoda, Nudacotylidæ)*, the parasite of insectivorous bats from Cuba. Acta parasit. pol., 26:215-218.
179. Zdzitowiecki, K., and A. L. Ruprecht. 1982. Helminth parasites of bats from the genus *Plecotus* Geoffroy, 1818 from Kujawy. Wiad. Parazyt., 28:445-448. (in Polish, with English summ.)
180. Zdzitowiecki, K., and M. Rutkowska. 1980. The helminthofauna fo bats *(Chiroptera)* from Cuba. II. A review of cestodes with description of four new species and a key to *Hymenolepididæ* of American bats. Acta parasit. pol., 16:187-200.
181. Zdzitowiecki, K., and M. Rutkowska. 1980. The helminthofauna of bats *(Chiroptera)* from Cuba. III. A review of trematodes. Acta parasit. pol., 26:201-214.

APPENDIX B1
Recent Chiroptera
in the most important Polish collections of bats

Species	ISEZ PAS	MRI PAS	ISZ AMU	IZ PAS	Country
Epomops franqueti				1	?Chad
Rousettus sp.				2	Zambia
Balantiopteryx plicata	24				Mexico
Saccopteryx bilineata		6			Surinam
Nycteris sp.				5	Zambiz
Cardioderma cor		2			Kenya
Aselia tridens				1	Egypt
Hipposideros sp.				6	Burma
Rhinolophus euryale		1		9	Czechoslovakia, U.S.S.R., Bulgaria, Hungary
R. hipposideros	24	2		5	Poland, Austria
R. ferrumequinum		1		1	Albania, Yugoslavia
R. mehelyi				1	Bulgaria
Rhinolophus sp.				1	Zambia
Noctilio labialis		1			Surinam
Mormoops megalophulla	11				Mexico
Pteronotus davyi	1				Mexico
Artibeus planirostris		2			Surinam
Carollia perspicillata		18			Surinam
Choeronycteris mexicana	14				Mexico
Desmodus rotundus				1	Panama
Glossophaga soricina		2			Surinam
Glossophaga sp.				2	French Guiana
Leptonycteris sanborni	48				Mexico
Phyllostomus discolor				1	French Guiana
P. hastatus				1	French Guiana
Pygoderma bilabiatum				1	Panama
Natalus stramineus	45				Mexico
Antrozous pallidus	43	2			Mexico, U.S.A.
Barbastella barbastellus	24	58	59	3	Poland, Bulgaria
Eptesicus fuscus	53	4			Mexico, U.S.A.
E. nilssoni	16	4		3	Poland, Czechoslovakia, U.S.S.R.
E. serotinus	11	96	2	12	Poland, Austria, U.S.S.R.
Lasionycteris noctivagans		1			U.S.A.
Lasiurus borealis	37	2			Mexico
L. cinereus	6				Mexico
L. ega	58				Mexico
Miniopterus schreibersi		1		13	Bulgaria, Czechoslovakia, Burma
Myotis bechsteini	2	3		1	Poland, Switzerland
M. blythi	1	1		6	Bulgaria, Czechoslovakia, Malta
M. brandtii		9		1	Poland
M. californicus	65				Mexico
M. dasycneme	2	5	1	2	Poland
M. daubentoni	10	80		13	Poland, Bulgaria U.S.S.R.
M. emarginatus	10		1	1	Poland, France
M. frater				1	Korea

Species	ISEZ PAS	MRI PAS	ISZ AMU	IZ PAS	Country
M. grisescens		2			U.S.A.
M. keenii		1			U.S.A.
M. lucifugus		3			U.S.A.
M. myotis	94	138	8	1	Poland
M. mystacinus (s.l.)	24	1		6	Poland, Czechoslovakia, U.S.S.R.
M. nattereri	8	28	1	8	Poland
M. sodalis		2			U.S.A.
M. velifer	158	2			Mexico, U.S.A.
M. vivesi	2				Mexico
M. volans	8				Mexico
Nyctalus lasiopterus		1			Poland
N. noctula	10	90	1	59	Poland, U.S.S.R., Bulgaria
N. leisleri	1	12		7	Poland, Bulgaria
Pipistrellus hesperus	51				Mexico
P. nanus		5			Kenya
P. nathusii	2	11	1	11	Poland, U.S.S.R., Austria
P. pipistrellus	4	72	1	44	Poland, U.S.S.R., Austria, Malta
P. savii				1	France
P. subflavus		3			U.S.A.
Plecotus auritus	29	55	5	10	Poland, U.S.S.R.
P. austriacus	11	17			Poland
P. townsendi	15				Mexico
Scotophilus dinganii		2			S. Africa, Kenya
Scotophilus sp.				4	Zambia
Tylonycteris pachypus				2	Burma
Vespertilio murinus	5	17		11	Poland, U.S.S.R.
Molossus ater		2			Surinam
M. molossus		4			Surinam
Tadarida aegyptiaca		2			Kenya
T. brasiliensis	62	3			Mexico, Argentina
T. condylura		2			Kenya, Tanzania
T. femorosacca	44				Mexico
T. molossa	7				Mexico
T. pumila		3			Kenya
Tadarida sp.				1	Ghana

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MRI PAS — Mammals Research Institute, Polish Academy of Sciences, 17-230 Bialowieza
ISZ AMU — Institute of Systematic Zoology, A. Mickiewicz University, Fredry 10, 61-701 Poznan
IZ PAS— Institute of Zoology,Polish Academy of Sciences, Wilcza 64, 00-679 Warszawa (collection of bats deposited at the Mammals Research Institute in Bialowieza)

APPENDIX B2
Fossil and subfossil Chiroptera
in the collection of
the Institute of Systematic and Experimental Zoology PAS,
Slawkowska 17, 31-016 Krakow

Species	Epoch	Country
Rousettus aegyptiacus	Holocene	Lebanon
Megaderma lugdunensis	Miocene	France
Hipposideros collongensis	Miocene	France
Rhinolophus annosus	Pliocene	Poland
R. delphinensis	Miocene, Pliocene, Pleist.	France, Poland
R. euryale	Pleistocene	Bulgaria
R. ferrumequinum	Pleistocene	Bulgaria, Yugoslavia
R. f. nippon	Pleistocene	Japan
R. cf. ferrumequinum	Pleistocene	China
R. hipposideros	Holocene	Poland
Rhinolophus sp.	Pliocene, Holocene	Poland, Bulgaria
Desmodus rotundus	Holocene	Mexico
Phyllops vetus	Holocene	Cuba
Barbastella barbastellus	Pleistocene	Poland, Czechoslovakia
B. cf. schadleri	Pleistocene	Bulgaria
Eptesicus serotinus	Holocene	Czechoslovakia, Bulgaria
Ia io	Pleistocene	China
Miniopterus schreibersi	Pliocene, Pleistocene	China, Poland, Bulgaria
Myotis cf. aemulus	Pliocene	Poland
M. bechsteini	Pleistocene, Holocene	Bulgaria, Czechoslovakia, Poland
M. blythi oxygnathus	Pleistocene	Bulgaria
M. danutae	Pliocene	Poland
M. dasycneme	Pleistocene, Holocene	Bulgaria, Poland
M. d. subtilus	Pliocene	Poland
M. daubentoni	Pleistocene	Poland
M. cf. daubentoni	Holocene	Poland
M. cf. emarginatus	Pleistocene	Poland
M. cf. exilis	Pleistocene	Poland
M. keenii	Pleistocene	U.S.A.
M. myotis	Pleistocene, Holocene	Bulgaria, Poland
M. mystacinus	Pleistocene, Holocene	Poland
M. nattereri	Pleistocene, Holocene	Bulgaria, Czecholslovakia, Poland
M. cf. nattereri	Pleistocene	Poland
M. cf. lucifugus	Pleistocene	U.S.A.
M. podlesicensis	Pliocene	Poland
M. velifer	Holocene	Mexico
Myotis sp.	Pleistocene, Holocene	Yugoslavia, Poland
Pipistrellus pipistrellus	Pleistocene, Holocene	Bulgaria, Poland
Plecotus cf. abeli	?	Austria
P. auritus	Pleistocene, Holocene	Czechoslovakia, Poland
P. cf. auritus	Pleistocene	Bulgaria
P. crassidens	Pliocene	Poland
Vespertilio murinus	Pleistocene	Bulgaria

APPENDIX C

A Short List of Polish Chiropterologists

1. M. Sc. Wieslaw Bogdanowicz (Mammals Res. Inst., Polish Acad. Sci., 17-230 Bialowieza)
2. Prof. Bazyli Czeczuga (Dept. General Biol., Medical Acad., Kilinskiego 1, 15-089 Bialystok)
3. Dr. Stanislaw Fedyk (Lab. Genetics & Evolut. Biol., Warsaw Univ., Branch in Bialystok, Sosnowa 64, 15-887 Bialystok)
4. Dr. Ryszard Haitlinger (Inst. Biol. Found. Anim. Prod., Agric. Acad., Cybulskiego 20, 50-205 Wroclaw)
5. Dr. Wincenty Harmata (Dept. Zoopsychol. & Anim. Ethol., Jagiell. Univ., Karasia 6, 30-060 Krakow)
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8. Prof. Adam Krzanowski (Inst. Syst. & Exp. Zool., Polish Acad. Sci., Slawkowska 17, 31-016 Krakow)
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14. Prof. Waclaw Skuratowicz (Inst. Syst. Zool., A. Mickiewicz Univ., Fredry 10, 61-701 Poznan)
15. M. Sc. Zbigniew Urbanczyk (Os. Jana III Sobieskiego 26D/142, 60-683 Poznan)
16. Dr. Bronislaw W. Woloszyn (Inst. Syst. & Exp. Zool., Polish Acad. Sci., Slawkowska 17, 31-016 Krakow)
17. Dr. Krzysztof Zdzitowiecki (Inst. Parasit., Polish Acad. Sci., Pasteura 3, 02-093 Warszawa)

CALIBRATION OF THE C-14 CLOCK USING BAT GUANO: A REQUEST FOR SAMPLES

The radioactive isotope carbon-14 is widely used for the dating of prehistoric archaeologic sites and other Quaternary deposits. The measurement of the amount of C-14 in a sample of organic matter can be used to determine the absolute age of the organic material, *if* we also know what was the C-14 activity of "modern" organic matter at the time that the sample was formed. That is, we must have a calibration curve of apparent age in "C-14 years" versus the true age in calendar years for some independently datable samples. Up to now this has been done by using wood of old, living trees in which tree-rings could be counted. The tree rings give the calendric age and this is then compared with the apparent C-14 age. For times beyond the age of living trees, we use older dead wood whose tree-ring records can be overlapped with younger samples. This method allows calibration back to about 9000 years B.P. (before present).

It would be possible, in principle, to extend this calibration further back in time by use of organic matter which is found associated with some inorganic deposit that can be dated by some other precise radioactive clock such as the decay of uranium-234 (U-234) to thorium-230 (Th-230). The U/Th clock has been used successfully to date calcite deposits from caves, and, thanks to recent improvements in the method, the precision of dating is as good as that of C-14 dating. Furthermore, U/Th dating does not have to be calibrated by some independent dating method since it is based on the decay of a radioactive isotope (Th-230) whose initial activity is known (unlike C-14).

One possible way to make such an intercomparison of C-14 and U/Th dates is to measure the C-14 activity of bat guano that is trapped between two layers of cave-deposited calcite (speleothem). This "guano sandwich" would allow us to obtain at least one point on the C-14 calibration curve. We would use the U-Th method to determine the precise age of the upper and lower calcite layers; supposing that these were not very far apart in age, the guano's age would have to lie between them. Insectivorous or frugivorous bats carry into the cave carbon atoms which have the normal, "modern" C-14 activity at the time they are alive. Traces of organic matter in the guano would also share this contemporary C-14 activity and could be used to determine the C-14 activity as a function of the age of the guano (as determined from the U/Th age of the calcite).

We are therefore looking for samples which we could use for this calibration process. The samples must include bat guano or other bat-derived material sandwiched between two layers of calcite. The calcite should be quite pure and free of detrital contamination (dust, silt, sand, mud, etc.). The calcite and bat deposits should be less than 50,000 years old, as it is unlikely that we would be able to determine the C-14 activity in older samples than that. There is no younger limit, although we are especially interested in finding samples that range between 9000 and 50,000 years in age. Younger

samples would be needed to check that the method is working.

Caves in subtropical regions are the most likely to provide suitable samples. In temperate regions the climate was so cold over the time region of interest (pre-9000 years B.P.) that not much bat or calcite depositional activity was taking place. The samples should probably come from moderately deep inside the cave to avoid contamination of the calcite by detritus washed in or blown into the cave.

To carry out the C-14 analyses we only need a few grams or even a few tens of milligrams of guano. The dating will be done using an atomic accelerator, which allows us to analyze only a few mg of carbon. The U/Th dating requires about 100 grams of calcite (of which a few grams of the purest material will be used for the actual dating).

If you know of a site where such materials could be found, please write to:

Professor H. P. Schwarc
Department of Geology
McMaster University
Hamilton, ON, L8S 4M1, Canada

The best samples will probably turn out to be stray "hits" of guano that are plastered on a growing stalagmite mound or sheet of flowstone. Large accumulations of guano are unlikely to have closely-associated, datable calcite layers, except, perhaps, at the edges of the guano deposits. A good place to look for such deposits is in man-made cuts through cave-deposits such as along pathways in show-caves. These will reveal the presence of trace splotches of guano intercalated with otherwise pure calcite layers. Any samples should be accompanied by a complete description of the collection site. If the samples occur in a stratigraphic sequence, the top and bottom of the sequence should be indicated on the samples. If you think you have a potentially useful site and require more information before collecting samples, please write to me at the above address.

You may be interested to know that the C-14 calibration is of importance not only to archaeologists and geologists, but also to astrophysicists. C-14 atoms in the atmosphere are generated by cosmic rays that arrive from relatively small numbers of stellar explosions (supernovæ) in our galaxy. Fluctuations in the number of C-14—producing cosmic rays will tell us a great deal about the long-term frequency of such stellar events and therefore help to determine what produces cosmic rays. Bats can help teach us about the evolution of the galaxy!

NATULUS STRAMINEUS KILLED BY KATYDID

by
Richard K. LaVal and T. James Lewis
Costa Rica Expeditions
Apartado 6941
San Jose, Costa Rica

On 9 March 1987 a male *Natalus stramineus* was found hanging dead in a Palo Verde tree (*Parkinsonia aculeata*) at Parque Nacional Palo Verde in Guanacaste, Costa Rica. Surrounding habitat is seasonal marsh in which occurs an island of limestone hills covered with Tropical Deciduous Forest. Small caves in the area host a variety of cave bats, including *Natalus*.

The bat, which apparently had been dead for only a few hours, probably died of water loss in the hot and dry seasonal climate, as its mouth was propped open at an angle of approximately 120° by the hind tibia of a katydid (probably *Ancistrocercus inficitus*). Although the femur and tarsus were still attached, only the barbed tibia actually served as the fatal prop. Morphologically, *Natalus* is an aerial insectivore, not a gleaner. We think it probably caught the heavy insect in flight. The tibia may have jammed the bat's mouth open on impact with the insect subsequently breaking free of its trapped leg. Or, the bat may have grasped the katydid by the head or thorax, with the leg becoming jammed and breaking free as the insect kicked violently to escape. In either case, the barbs prevented the leg from being extracted by the bat, which was left with a serious and apparently insoluble problem.

Alternatively, the tibia may have become stuck later while the bat was attempting to eat the katydid. However, this seems unlikely as bats are generally proficient at handling and rejecting insect body parts that they cannot masticate or choose not to eat for other reasons.

We are not aware of any similar incident of accidental bat death reported in the literature, although other kinds of accidents, such as entanglement in barbed wire fences, are commonly reported.

Tentative identification of the katydid was supplied by Don Wilson.

Book Review

Payne, J., C. M. Francis, and K. Phillips. *A Field Guide to the Mammals of Borneo*. The Sabah Society, printed in Kuala Lumpur (available from World Wildlife Fund, P.O. Box 10769, 50724 Kuala Lumpur, Malaysia), 332 pp., illustrated, 1985. Price $20.00 U.S. (cloth), $15.00 U.S. (paper).

This excellent field guide is effectively laid out, well illustrated, and easy to use. The text includes basic measurements of mammals, including body masses for many of the species. The bat section of the book will be of particular interest to the readers of *Bat Research News*. Until I examined the plates, I had not realized that *Megærops wetmori* has such a spectacular collar. The impressive array of bats left me with an urge to go and meet some of them first-hand. As one might expect, there are few data on the biology of most of the bats; my urge to visit Borneo increases!

The book includes a useful index, a list of local names with their English equivalents, and a gazetteer. It is relatively easy to translate the comments on distribution to reality on the map. One could have hoped for more distribution maps but it is clear that individual maps would simply show isolated specimen localities. The combination of a written description and a gazetteer is a practical alternative to maps.

I will finish by highly recommending this useful book to anyone who is interested in the mammals of Borneo or to anyone who is addicted to good field guides. Charles Francis, in a fit of perfectionism, has asked me to note that on Plate 9 (page 53), Figure 1b and Figure 2 are transposed. The same is true for Figures 22c and 22e on page 199. The dental formulæ for *Penthetor* and *Megærops* should show one pair of lower incisors. These minor perturbations do not detract from the quality or usefulness of this fine book. — M. Brock Fenton, *Department of Biology, York University, North York, Ontario, Canada M3J 1P3.*

EIGHTEENTH NORTH AMERICAN BAT RESEARCH SYMPOSIUM

13–15 October 1988

University of Calgary
Calgary, Alberta, Canada

Local Organizing Committee:

Dr. Robert M. R. Barclay
Dr. Anthony P. Russell
Various students of the above

Biological Sciences
University of Calgary
Calgary, Alberta, Canada
T2N 1N4

403–220–3564 (Barclay)
403–220–5198 (Russell)
403–220–5261 (General Office)

Registration, technical sessions and social gatherings will be held on the campus of the University of Calgary. Accommodation has been arranged at extremely reasonable rates in the new facilities constructed for the athletes of the Winter Olympics.

Registration will be held on Thursday 13 October from 1800–2200 h in the residence complex and prior to the technical sessions the following morning. Technical sessions will tentatively run from 0900–2300 h on Thursday and a banquet on Friday night.

As usual, the Friday morning session will be devoted to student presentations entered in the Student Paper Competition. There will likely be a few cash prizes for the best contributions.

A workshop, tentatively dealing with techniques for teaching about echolocation, is being planned by Brock Fenton.

Calgary (population 650,000) is located in south central Alberta, approximately 45 minutes from the Rocky Mountains and one hour from Banff National

Park. The city is served by various airlines with direct flights from Los Angeles, San Francisco, Denver, Salt Lake City, Chicago and numerous Canadian cities. We will be happy to transport people from the airport to the campus during "normal" hours on Thursday. Please let us know your flight number and arrival time. For those arriving at abnormal hours, taxi service to the campus will be approximately $15–20 Canadian. Alternatively, a bus ride connecting to the light rail transit (LRT) train will get you to the University Station for $1.25.

If you watched the Olympics you know that Calgary weather is rarely predictable. In mid-October you can expect dry conditions with daytime temperatures of 5–10• C and nighttime temperatures just below 0• C. It could of course be 10• C on either side of those! Sunshine tends to be the order of the day, however.

Calgary has numerous attractions including a first rate zoo (unfortunately the pandas will have gone by October), the Glenbow Museum, a planetarium, assorted professional sports teams, etc. In addition, the Tyrell Museum of Paleontology in Drumheller (1.5 hours' drive) is superb.

The University itself is in the northwest quadrant of the city and an easy LRT ride from downtown and the zoo. For those who wish to exert themselves, arrangements can be made to use racquet courts, a 200 m indoor track, an indoor speed skating track, pool, etc. Meals will be available on campus at various student-style eateries and there are a number of restaurants within walking distance. Hot breakfasts are included as part of the accommodation on campus.

We will be dealing in Canadian dollars which makes things all the more inexpensive for those of you coming from the US. At present, one US dollar buys you approximately 1.35 Canadian dollars. We suggest you purchase Canadian dollars at a bank before your arrival.

Registration is $20 Can. if paid by 1 September 1988 and $30.00 if received after that date. Banquet tickets are $20.00 each and you should not expect to be able to get tickets at the last minute since we have to set numbers days in advance.

RECENT LITERATURE

ANATOMY

Cotter, J.R., and L.K. Laemle. 1987. Distribution of somatostatinlike immunoreactivity in the brain of the little brown bat. *(Myotis lucifugus)*. Amer. J. Anat., 180:280-294. [Laemle: Dept. Anatomy, Univ. Med and Dent., New Jersey Med School, 100 Bergen St., Newark, NJ 07103]

Gopalakrishna, A., and N. Badwaik. 1986. The vascular pattern in the placenta of the bat. Trends Life Sci. (India), 1:149-155. [Dept. Zool., Inst. Sci., Nagpur-440 001, India]

Lester, K. S., and S. J. Hand. 1987. Chiropteran enamel structure. Scanning Microscopy 1:421–436. [Westmead Hospital, Dental Clinic. School, Westmead, N.S.W. 2145,Aust.]

Stephan, H., H. D. Frahm, and G. Baron. 1987. Brains of vespertilionids. 3. Comparative cytoarchitectonics of the hippocampus. Zeitschrift zool. System. Evol., 25:205-211. [Max Planck Inst. Brain Res., Deutschordenstr. 46, D-6000 Frankfurt, Fed. Rep. Germany]

Pandey, S. D., and C. J. Dominic. 1987. Gular gland of the Indian sheath-tailed bat. Acta Theriologica, 32:83-94. [Dept. Zoology, Banaras Hindu Univ., Varanasi 221005, Uttar Pradesh, India]

BAT CONTROL

Clark, D. R., and B. A. Rattner. 1987. Orthene toxicity to little brown bats *(Myotis lucifugus)*: acetylcholinesterase inhibition, coordination loss, and mortality. Environ. Toxicol Chem., 6:705-708. [U.S. Fish and Wildlife Serv., Patuxent Wildlife Res. Ctr., Laurel, MD, 20708]

BEHAVIOR

McCracken, G.F., and M K. Gustin. 1987. Batmon's daily nightmare. Nat. Hist., 96:66-73.

Mcwilliam, A. N. 1987. Territorial and pair behaviour of the African false vampire bat, *Cardioderma cor* (Chiroptera, Megadermatidæ), in coastal Kenya. J. Zool., 213:243-252. [Dept. Zool., Univ. Aberdeen, Aberdeen AB9 2TN, Scotland]

CYTOLOGY

Chakravarty, A. K., and B. N. Paul. 1987. Analysis of suppressor factor in delayed immune responses of a bat, *Pteropus giganteus*. Devel. Comp. Immunol., 11:649-660. [Center for Life Sci., Immunology, and Cell Biol., Univ. N. Bengal, Raja Rammohanpur 734430, W. Bengal, India]

Danguy, A., G. Lenglet, R. Kiss Jr., Y. de Launoit, Mauka Lawasaka Na Kongo, and R. Kiss Sr. 1987. Distribution of flourochrome-coupled lectins in the gastro-intestinal tract of African bats. Archives Biol., 98:53-66. [Unive. Libre de Bruxelles, Faculty of Science, Biol. Histol. Comparee Lab, CP 160, 1050 Brussls, Belgium]

Gardner, R. A., D. H. Molyneux, and R. E. Stebbings. 1987. Studies on the prevalence of haematozoa of British bats. Mammal Rev., 17:75-80. [Molyneux: Dept. Biol. Scil, Univ. Salford, Salford M5 4WT, Lancs., England]

Wightman, J, J. Roberts, G. Chaffey, and N. S. Agar. 1987. Erythrocyte biochemistry of the grey-headed fruit bat *(Pteropus poliocephalus)*. Comp. Biochem. Physiol. B, 88:305-307. [Dept. Physiol., Univ. Queesland, St. Lucia, Queensland, Australia]

DISEASE

Anonymous. 1987. Bat rabies 'established in Europe.' Veterinary Record, 121:291.

DISTRIBUTION

Manning, R. W., J. K. Jones, Jr., R. R. Hollander, and C. Jones. 1987. Notes on distribution and natural history of some bats on the Edwards Plateau and in adjacent areas of Texas. Texas J. Sci., 39:279-285. [The Museum, Texas Tech Univ., Lubbock TX 79409]

ECHOLOCATION

Hartley, D. J., and R. A. Suthers. 1987. The sound emission pattern and the acoustical role of the noseleaf in the echolocating bat, *Carollia perspicillata*. J. Acoustical Soc. Americ, 82:1892. [School of Med., Indiana Univ., Bloomington, IN., 47405]

Reimer, K. 1987. Coding of sinusoidally amplitude modulated acoustic stimuli in the inferior colliculus of the rufous horseshoe bat, *Rhinolophus rouxi*. J. Comp. Physiol. A, 161:305-313. [Zoologisches Inst., Univ. Munchen, Luisenstr. 14, D-8000 Munchen 2, Fed. Rep. Germany]

Rubsamen, R. 1987. Ontogenesis of the echolocation system in the rufous horseshoe bat, *Rhinolophus rouxi* (Audition and vocalization in early postnatal development). J. Comp. Physiol. A, 161:899-???. [Inst. Zool., Univ. Munich, Luisenstr. 14, D-8000 Munich 2, Fed. Rep. Germany]

Schnitzler, H. -U., E. Kalko, L. Miller, and A. Surlykke. 1987. The echolocation and hunting behavior of the bat, *Pipistrellus kuhli*. J. Comp. Physiol. A, 161:267-274. [Univ. Tubingen, Lehrberiech Zoophysiol., D-7400 Tubingen 1, Fed. Rep. Germany]

Thomas, D. W., G. P. Bell, and M. B. Fenton. 1987. Variation in echolocation call frequencies recorded from North American vespertilionid bats: a cautionary note. J. Mamm., 68:842-847. [Dept. Biologie, Univ. Sherbrooke, Sherbrooke, Quebec, Canada]

ECOLOGY

Aldridge, H. D. J. N., and I. L. Rautenbach. 1987. Morphology, echolocation, and resource partitioning in insectivorous bats. J. Anim. Ecol., 56:763-778. [Dept. Biol., York Univ., Downsview, Ontario, Canada M3J 1P3]

Bonaccorso, F. J., and T. J. Gush. 1987. Feeding behaviour and foraging strategies of captive phyllostomid fruit bats—an experimental study. J. Anim. Ecol., 56:907-920. [Dept. Zoology, Univ. Florida, Gainesville, FL 32611]

Brack, V., Jr., and G. R. Finni. 1987. Mammals of southern Clermont County, Ohio, with notes on the food habits of 4 species of bats. Ohio J. Sci., 87:130-133. [WAPORA, Inc., 5700 Hillside Ave., Cincinnati, OH 45233]

FLIGHT

Norberg, U. M., and J. M. V. Rayner. 1987. Ecological morphology and flight in bats (Mammalia: Chiroptera): wing adaptations, flight performance, foraging strategy and echolocation. Phil. Trans. Royal Soc. Lond., Ser. B, 316:335-427. [Dept. Zoology, Goteborg Univ, Box 25059, S-400 31 Goteborg, Sweden]

Rayner, J. M. V. 1987. Vertebrate flapping flight mechanics and aerodynamics, and the evolution of flight in bats. Pp. 27-74 *in* Biona Report no. 5, Bat Flight—Fledermausflug (W. Nachtigall, ed.). Stuttgart: Gustav Fischer.

Scholey, K. D. 1986. The evolution of flight in bats. Pp. 1-12 *in* Biona Report no. 5, Bat Flight—Fledermausflug (W. Nachtigall, ed.). Stuttgart: Gustav Fischer.

GENETICS

Volleth, M., and H. S. Yong. 1987. *Glischropus tylopus*, the first known Old World bat with an X-autosome translocation. Experientia, 43:922-924. [Dept Human Genetics, Schwabachanlage 10, D-8520 Erlangen, Fed. Rep. Germany]

KARYOLOGY

Bickham, J. W. 1987. Chromosomal variation among seven species of lasiurine bats (Chiroptera: Vespertilionidæ). J. Mamm., 68:837-842. [Dept. Wildlife Fisheries Sci., Texas A&M Univ., College Station, TX 77843]

MIGRATION

Gerrell, R. 1987. Do Swedish bats migrate? Fauna Flora (Stockholm), 82:79-83. [Ekol. Inst., Lund, Sweden]

Gopalakrishna, A. 1985-1986. Migratory patterns of some Indian bats. Myotis, 23-24:223-227. [Dept. Zool., Inst. Sci., Nagpur 440 001, India]

PARASITOLOGY

Gardner, R. A., and D. H. Molyneux. 1987. *Babesia vesperuginis*: natural and experimental infections in British bats (Microchiroptera). Parasitology, 95:461-470.

Nguyen, H. T., and D. D. Myers. 1987. Filaroid nematodes in the central nervous system of free-tailed bats *(Molossus ater)*. Laboratory Anim. Sci., 37:672-???.

Uchikawa, K. 1987. Myobiid mites (Trombidiformes: Myobiidæ) associated with the vampire bats (Chiroptera: Phyllostomatidæ) and information on host taxonomy deduced from them. J. Parasitol., 73:640-645. [Dept. Parasitology, Shinshu Univ. School of Medicine, Matsumoto, Nagano 390, Japan]

PHYSIOLOGY

Cook, R. A., D. Halpern, J. Tast, and E. P. Dolensek. 1987. Electrocardiography of the short-tailed, leaf-nosed bat *Carollia perspicillata*. Zoo Biol., 6:261-263. [New York Zoological Soc., 185th St. and Southern Boulevard, Bronx, NY 10460]

Kleinschmidt, T., B. Koop, and G. Braunitzer. 1986. The primary structure of a mouse-eared bat (*Myotis velifer*, Chiroptera) hemoglobin. Biol. Chem. Hoppe-Seyler, 367:1243-1249. [Max Planck Inst. Biochem., Prot. Chem. ABT, Klopferspitz, D-8033 Marinsried, Fed. Rep. Germany]

Kleinschmidt, T., B. F. Koop, and G. Braunitzer. 1987. The primary structure of the pallid bat (*Antrozous pallidus*, Chiroptera) hemoglobin. Biol. Chem. Hoppe-Seyler, 368:1197-1202.

Kleinschmidt, T., K. P. Ruchnagel, R. E. Weber, B. F. Koop, and G. Braunitzer. 1987. Primary structure and functional properties of the hemoglobin from the free-tailed bat *Tadarida brasiliensis* (Chiroptera). Biol. Chem. Hoppe-Seyler, 368:681-690.

Kurta, A., K. A. Johnson, and T. H. Kunz. 1987. Oxygen consumption and body temperature of female little brown bats *(Myotis Lucifugus)* under simulated roost conditions. Physiol. Zool., 60:386-397. [Dept. Biology, Boston Univ., Boston, MA 02215]

Studholme, K. M., S. Yazulla, and C. J. Phillips. 1987. Interspecific comparisons of immunohistochemical localization of retinal neurotransmitters in four species of bats. Brain Behav. Evol., 30:160-173. [Dept. Neurobiol. and Behav., SUNY at Stony Brook, Stony Brook, NY 11794]

Twente, J. W., and J. Twente. 1987. Biological alarm clock arouses hibernating big brown bats, *Eptesicus fuscus*. Canadian J. Zool., 65:1668-1674. [Div. Biol. Sci., Univ. Missouri, Columbia, MO 65211]

Wolk, E., and W. Bogdanowicz. 1987. Hematology of the hibernating bat: *Myotis daubentoni*. Comp. Biochem. Physiol., A, 88:637-639. [Mammals Res. Instl, Polish Acad. Sci., PL-17230 Bialowieza, Poland]

REPRODUCTION

Chari, G. C., and A. Gopalakrishna. 1984. Morphogenesis of the foetal membranes and placentation in the bat, *Miniopterus schreibersii fuliginosus* (Hodgson). Proc. Indian Acad. Sci. (Anim. Sci.), 93:463-483. [Dept. Zool., Inst. Sci., Nagpur-440 001, India]

Gopalakrishna, A., N. Badwaik, S. Sandhu, and G. Rajgopal. 1987. Atypical follicles in the ovaries of some Indian bats. Proc. Natl. Acad. Sci. India, 57(B), II, 100-104. [Dept. Zool., Inst. Sci., Nagpur-440 001, India]

Gopalakrishna, A., and D. Bhatia. 1983. Breeding habits and associated phenomenon in some Indian bats. Part VII - *Hipposideros speoris* (Schneider) (Hipposideridæ) from Chandrapur, Maharashtra. J. Bombay Nat. Hist. Soc., 79:549-556.

Gopalakrishna, A., and G. Chari. 1985. Early development, implantation of the blastocyst and amniogenesis in the bat, *Miniopterus schreibersii fuliginosus* (Hodgson). Proc. Natl. Acad. Sci. India, 55(B), II, 1-9.

Gopalakrishna, A., and P. A. Ramakrishna. 1982-83. Some preimplantation stages of development of the embryo of the rufus horse shoe bat, *Rhinolophus rouxi* (Temminck). J. Shivaji Univ. (Sci.), 21:189-194.

Gopalakrishna, A., and V. M. Sapkal. 1986. Breeding biology of some Indian bats - a review. J. Bombay Nat. Hist. Soc., 83 (supplement):78-101.

Gopalakrishna, A., A. T. Varute, V. M. Sapkal, A. R. Unune and G. C. Chari. 1982?. Breeding habits and associated phenomena in some Indian bats. Part XI—*Miniopterus schreibersii fuliginosus* (Hodson)—Vespertilionidæ. J. Bombay Nat. Hist. Soc., 82:594-601.

Kwiecinski, G. G., D. A. Damassa, A. W. Gustafson, and M. E. Armao. 1987. Plasma sex-steroid binding in Chiroptera. Biol. Reprod., 36:628-???. [Dept. Biochem., 420 Henry Mall, Univ. Wisconsin, Madison, WI 53706]

Pendharkar, Y. D., and A. Gopalakrishna. 1982-83. Observations on the early development and implantation of the blastocyst of *Tadarida plicata plicata* (Buchanna)—Molossidæ. J. Shivaji Univ. (Sci.), 21:179-188. [see address for Gopalakrishna above]

Racey, P. A., J. R. Speakman, and S. M. Swift. 1987. Reproductive adaptations of heterothermic bats at the northern borders of their distribution. South African J. Sci., 83:635-???. [Dept. Zool., Univ. Aberdeen, Aberdeen AB9 2TN, Scotland]

Vandermerwe, M. 1987. Adaptive breeding strategies in some South African bats between 22-degrees-S and 28-degrees-S. South African J. Sci., 83:607-???. [Mammal Res. Inst., Univ. Pretoria, Pretoria 0002, South Africa]

Vandermerwe, M., S. R. Giddings, and I. L. Rautenbach. 1987. Post-partum oestrus in the little free-tailed bat, *Tadarida (Chaerephon) pumila* (Microchiroptera, Molossidæ) at 24-degrees-S. J. Zool., 213:317-326.

SYSTEMATICS

Bogdanowicz, W., and A. M. Wojcik. 1985-1986. Morphological and electrophoretic differentiation between *Myotis daubentoni* (Kuhl, 1819) and *Myotis nathalinæ* Tupinier, 1977. Myotis, 23-24:17-30. [Mammals Res. Inst., Polish Acad. Sci., 17-230 Bialowieza, Poland]

Chimimba, C. T., and D. J. Kitchener. 1987. Breeding in the Australian yellow-bellied sheath-tailed bat, *Saccolaimus flaviventris* (Peters, 1867) (Chiroptera: Emballonuridæ). Rec. West Australia Museum, 13:241-248. [Mus. Malawi, PO Box 30360, Blantyre, Malawi]

Gopalakrishna, A., and G. C. Chari. 1983. A review of the taxonomic position of *Miniopterus* based on embryological characters. Current Sci., 52:1176-1180. (proposing that *Miniopterus* be placed in its own family) [Dept. Zool., Inst. Sci., Nagpur 440 001, India]

Herd, R. M. 1987. Electrophoretic devergence of *Myotis leibii* and *Myotis ciliolabrum* (Chiroptera: Vespertilionidæ). Canadian J. Zool., 65:1857-1860. [Dept. Agriculture, New South Wales, Trangie 2823, Australia]

Hill, J. E. 1987? A note on *Rhinolophus pearsonii* Horsfield, 1851 and *Rhinolophus yunanensis* Dobson, 1872 (Chiroptera: Rhinolophidæ). J. Bombay Nat. Hist. Soc., 83 (supple.):12-18. [Dept. Zool., British Museum, Cromwell Rd., London SW7 5BD, England]

Phillips, C. J., T. Nagato, and B. Tandler. 1988. Comparative ultrastructure and evolutionary patterns of acinar secretory product of parotid salivary glands in neotropical bats. Pp. 213-229 *in* Studies in neotropical mammalogy: essays in honor of Philip Hershkovitz (B. D. Patterson and R. M. Timm, eds.). Fieldiana, n.s. no. 39.

Pumo, D. E., E. Z. Goldin, B. Elliot, C. J. Phillips, and H. H. Genoways. 1988. Mitochondrial DNA polymorphism in three Antillean island populations of the fruit bat, *Artibeus jamaicensis*. Mol. Biol. Evol., 5:79-89. [Dept. Biol., Hofstra Univ., Hempstead, New York 11550]

Stangl, F. B., Jr., and E. M. Jones. 1987. An assessment of geographical and seasonal biases in systematic mammal collections from two Texas universities. Tesax J. Sci.,

39:129-138. [Dept. Biol., Midwestern State Univ., Wichita Falls, TX 76308]

Wible, J. R. 1987. The eutherian stapedial artery: character analysis and implications for superordinal relationships. Zool. J. Linnean Soc., 91:107-136. (presents evidence that Mega- and Microchiroptera form a monophyletic group) [Dept. Anat., Univ. Chicago, Chicago, IL 60637]

REQUEST FOR PHOTOGRAPHS

I need three black and white close-ups of bat faces showing the eyes clearly. The three pictures I need are:

1. *Rhynchiscus naso* or *Saccopteryx bilineata* or *Saccopteryx leptura*
2. *Chiroderma villosum* or *Vampyrops helleri*
3. *Pteronotus rubiginosa* or *Pteronotus davyi* or *Mormoops megalophylla*

Send to:

Dr. Julia Chase, Biology Department,
Barnard College, Columbia University,
New York, N.Y. 10027-6598

Photographers will be gratefully acknowledged in the article.

REQUEST FOR PHOTOGRAPHS

For a field guide entitled *Mammals, Reptiles, and Amphibians of the Adirondacks* (to be published in April 1989), quality color slides of the following species are needed: big brown bat, eastern pipistrelle, hoary bat, Keen's myotis, little brown myotis, red bat, silver-haired bat, and small-footed myotis.

Please submit slides to:

James J. Gould, Professor of Humanities
Paul Smiths College
Paul Smiths, N.Y. 12970.

Return correspondence will include payment and acknowledgement conditions.

A NEW FIELD STUDIES STATION CAPE TRIBULATION, QUEENSLAND, AUSTRALIA

The Cape Tribulation Field Study Centre, which is expected to open in mid 1988, will be Australia's first research centre designed primarily for the scientific investigation of wet tropical ecosystems.

The Field Study Centre will provide laboratory space, housing, research facilities, and in time, a comprehensive reference collection of the fauna and flora of the area.

The Centre will be formally affiliated with the James Cook University in Townsville through the newly established Institute for Tropical Rainforest Studies, and also with the School of Biological Sciences, and will serve as its wet tropical field station. It will also be open to other members of the scientific community, both from Australia and overseas, who wish to pursue research related to wet-tropical ecology.

The Field Study Centre, while affiliated with James Cook University, will be a private, non-profit institution.

Location of Field Study Centre

The centre is situated on a 24 acre site about 1 km north of Mossman, and approximately 35 km north of the Daintree River.

It is located on abandoned grazing land adjacent to the Cape Tribulation Raod, and is surrounded by the Cape Tribulation National Park, and backed by the Mount Sorrow escarpment (2,540' or 850 km).

The region encompasses lowland tropical rainforest ansd well as tropical rain forest extending up to the summit of Mt. Sorrow thus providing an accessable attitudinal transect of rainforest types. There is access to various types of forest nearby which are in private ownership, including stream-valley biotas, and in which long term research can be carried out.

The Centre is adjacent to the fringing coral reefs north and south of Cape Tribulation and 30 km to the south of the Centre are the extensive mangrove forests of the Daintree River.

To the west of the Centre are the granite uplands of Mt. Pieter Botte and Roaring Meg Creek, currently listed as Queensland Department of Forestry Timber reserves, which have had little systematic scientific study, while to the north is a wide range of forest types, including dry sclerophyll communities, along the Bloomfield road.

Facilities

While not all the facilities will be in place by next year, the Station will initially have two de-humidified laboratory buildings (each 120 m^2), well equipped workshop and limited accomodation for resident researchers (a youth hostel next door will accomodate additional people until all accomodation is completed). The laboratories will have essential laboratory equipment (microscopes, field equipment, etc).

There will be a resident director-manager and several permanent staff.

Since the Field Study Centre will have an important role as a provider of interpretive services for the area, a separate information and interpretation center building (situated distant from the Field Station, adjacent to the Cape Tribulation road) will initially provide lecture seminar facilities.

It is expected that all food will be supplied by the Centre, as no private cooking facilities will be available. However, the Centre's proximity to a large tropical fruit orchard, will, it is hoped, more than compensate for this!

The Centre, along with the rest of the area north of the Daintree river, presently lacks electricity or phone services, and will rely on generators, storage batteries and inverters to supply electricity, while heating will be gas and solar.

Aims of Cape Tribulation Field Study Centre

The Centre is a non-profit organisation established to:

a) provide research and accommodation facilties for visiting Australian and overseas teams to work in the area on any aspect of wet tropical ecosystems.

b) perform interpretive services to the general publlic on the area, through the provision of a small museum, 36-seat theaterette, bookstore and the provision of accessible 'nature walks' and guided tours of varying complexity in the area.

c) carry out long term 'base-line' research on various aspects of the ecosystems that constitute the area — floral and faunal surveys, research on pollinator and plant relationships, productivity and micrometerology of the forest areas. In the pursuit of this aim the Centre is actively seeking the involvement of volunteer researchers through Earthwatch and similar organisations.

d) encourage young researchers to take an active interest in research on ecosystems, and tropical ecosystems in particular.

e) run intensive courses on aspects of tropical ecosystems and related methodology.

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EIGHTH INTERNATIONAL BAT RESEARCH CONFERENCE

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continued

Location & Date

All scientific sessions will be held on the campus of the University of New South Wales, located in the inner Sydney suburb of Kensington. The University is 5 km from the city center and 1 km from Coogee Beach. Public transport is readily available. The conference will open with an informal buffet on Sunday evening 9 July and the last session will close Friday afternoon, 14 July 1989.

Scientific Program

Papers are invited on any topic of bat research. Papers may be either spoken or poster. Spoken papers will be allotted 10 minutes for presentation and 5 minutes for discussion. Projection facilities for 35 mm slides and overhead transparencies will always be available.

Poster papers will be displayed for extended periods, during which there will be set times when authors are expected to attend their posters for discussion. There is ample space to accomodate posters of any size or format.

Special Sessions

Special sessions are open to submitted papers with the same time limits as outlined above for general sessions. In addition, convenors of special sessions may invite keynote or review papers with allotted times up to 20 minutes. Suggestions for further topics are welcome, in addition to the sessions already planned.

Abstracts & Proceedings

Brief abstracts will be required for all spoken and poster papers. Forms will be included in the final brochure. The abstracts will be reproduced as supplied and distributed to participants at the start of the conference. Negotiations are underway for publication of the abstracts in a journal distributed internationally.

Selected full papers will be published in a proceedings volume to be produced as part of a series of special publications of the Royal Zoological Society of NSW. This volume will be organized around the special session topics, with the convenors of such sessions acting as editors for that topic. All papers will be fully refereed.

Language

The official language of the conference will be English. All communications and posters should be prepared in English. Abstracts and Proceedings will be published in English.

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FRONT COVER

The cover illustration is from **Traite de l'osteologie et de la myologie du *Vespertilio murinus*** by P. Maisonneuve, Paris 1878. This print is a 90% reduction of Dr. Maisonneuve's 1st plate, "Planche 1."

BAT RESEARCH NEWS

VOLUME 29 No. 3 Fall 1988

BAT RESEARCH NEWS

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Institutional subscriptions are $15.00 worldwide.

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

Typeset by Tracy L. Robertson
at St. Lawrence University, Canton, New York
and
LWC Desktop Publishing, Bloomington, Illinois

Layout by G. Roy Horst

Mailed at Potsdam, New York, 13676, USA

BAT RESEARCH NEWS

Volume 29 Fall Number 3

Trends in Reproductive Biology of some Bats in Colorado

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Eighteen species of bats are known to have distributions which include Colorado. Some Coloradan species are at the periphery of their distributional ranges (Armstrong, 1972) and therefore reproduction may not take place within the state. For even the most common Coloradan species, however, reproductive data are scarce. The purpose of this study was to compile all available data concerning the reproductive biology for bats living in Colorado and, in effect, offer a record of comparative data which could be used as a basis for further research.

METHODS

More than 400 individuals of nine species collected over thepast five years were dissected and examined to gain availablereproductive information. In addition, all available museumspecimens and field notes concerning information on batscollected in Colorado were examined and this information was compiled. Histological procedures were carried out on the testes of male *Eptesicus fuscus* in order to observe spermatogenic activity.

RESULTS AND DISCUSSION

Reproductive Patterns of Females

Myotis lucifugus.—The little brown bat is one of the best studied bats in North America. Many of these studies concern reproduction and development (Davis et al., 1965; Fenton, 1970*b;* Findley, 1954; Gould, 1971; Humphrey and Cope, 1976; Kunz, 1971; Racey, 1973; Schowalter et al., 1979. There is, however, a lack of information concerning reproductive habits for this species in the western part of its range. In general, nursery colonies are located in and around buildings (Fenton and Barclay, 1980) and exclude males and nonbreeding females. For specimens collected in Colorado the highest number of lactating females occurred in June (46%, Table 1). Of the 14 individuals examined in August none were lactating. No embryos were found in females collected from June to August, suggesting an early parturition date for this species in Colorado (Table 2).

Myotis californicus.—Of the 16 females examined, highest number lactating was in July (60%, Table 1). Pregnant females were collected in June (20%) and July (60%, Table 2). Krutzsch (1954) reported single births for this species.

Myotis volans.—Of the 51 females examined, lactating individuals were observed only in August (50%, Table 1). No lactating females were collected in previous months. Highest numbers of embryos were collected for this species in the month of July (44%) although August was also high (24%, Table 2). Druecker (1972) observed parturition in this species in New Mexico from May to August.

Myotis evotis.—This bat of higher elevations (Armstrong, 1972) had the highest number of lactating females in August (46%, Table 1). Other reproductively

Table 1. *-Numbers of lactating females/females captured by species per month. (Percentages of lactating females in parentheses.)*

Month	*Myotis lucifugus*	*Myotis evotis*	*Myotis volans*	*Myotis californicus*	*Myotis leibii*	*Eptesicus fuscus*	*Lasiurus cinereus*	*Antrozous pallidus*
June	6/10 (60%)	3/29 (9.6%)	0/10 (0%)	0/5 (0%)	0/4 (0%)	4/16 (25%)	2/4 (50%)	5/17 (29%)
July	0/2 0%)	11/34 (32%)	0/16 (0%)	0/10 (0%)	N/A	13/28 (46%)	1/3 (33%)	14/16 (87%)
August	0/5 (0%)	16/35 (46%)	12/25 48%)	1/1 (100%)	N/A	9/22 (41%)	0/2 (0%)	12/13 (92%)

Table 2. *-Numbers of embryos/females captured by species per month. (Percentages of embryos in parentheses; N/A = no animals captured during that month.)*

Month	*Myotis lucifugus*	*Myotis evotis*	*Myotis volans*	*Myotis californicus*	*Myotis leibii*	*Eptesicus fuscus*	*Lasiurus cinereus*	*Antrozous pallidus*
May	N/A	N/A	N/A	N/A	1/1 (100%)	N/A	N/A	N/A
June	0/10 (0%)	3/29 (10%)	1/10 (10%)	1/5 (20%)	3/4 (75%)	3/16 (19%)	4/4 (100%)	8/17 (47%)
July	0/2 0%)	13/34 (38%)	7/16 (44%)	6/10 (60%)	N/A	2/28 (7%)	2/3 (75%)	0/16 (0%)
August	0/5 (0%)	N/A	6/25 (24%)	0/1 (0%)	N/A	9/22 (40%)	0/2 (0%)	0/13 (0%)

Table 3. *-Numbers of scrotal males/males captured by species per month. (Percentages are given in parenthesis; N/A = no animals captured during that month.*

Month	*Myotis evotis*	*Myotis volans*	*Myotis yumanensis*	*Myotis leibii*	*Eptesicus fuscus*	*Lasionycteris noctivagans*	*Lasiurus cinereus*
June	N/A	N/A	N/A	N/A	6/11 (55%)	N/A	N/A
July	3/7 (43%)	1/2 (50%)	4/4 (100%)	6/6 (100%)	9/11 (82%)	8/ 9 (89%)	7/9 (78%)
August	28/30 (93%)	20/22 (91%)	5/5 (100%)	5/5 (100%)	26/30 (87%)	11/12 (92%)	8/8 (100%)
Sept	3/5 (60%)	N/A	N/A	5/5 (100%)	N/A	3/4 (75%)	7/8 (87%)

active females, however, were collected throughout the months of June and July. Highest number of embryos for this species was found in females collected in July (38%) with a significantly smaller number observed in June (10%, Table 2). No embryos were found in females captured in August.

Eptesicus fuscus.—One of the more common species in Colorado, the big brown bat had the highest proportion of lactating females in July (46%, Table 1). Lactating individuals were collected from June to September. Christian (1956) reported lactation terminating for females collected in late June/early July in Maryland, but this does not seem to be the case in Colorado. No embryos were present in females captured in August, but in both June (19%) and July (7%) pregnant females were collected (Table 2).

Lasiurus cinereus.—Data collected for this species suggest that most lactating females are active during June (50%, Table 1) in agreement with the highest number of embryos present in the sample (100%, Table 2). The number of animals examined for this species, however, was low (n=7). Twins appear to be the rule in Colorado, as has been reported elsewhere (Gottschang, 1966; Provost and Kirkpatrick, 1952).

Antrozous pallidus.—The highest number of lactating females for the pallid bat occured during July (87%, Table 1). Pregnant individuals were most likely to be observed in June (47%, Table 2) as none of the 16 females captured in July were pregnant. Birth of twins appears to be common in Colorado as has been reported by Findley, et. al. (1975) in New Mexico and Herried (1961) in Texas.

Reproductive Patterns in Males

Myotis volans.—This species showed highest incidence of scrotal males in August (82%, Table 3). Schowalter (1980) reported that the males of this species can become reproductively active within the first year.

Myotis evotis.—The long-eared myotis also had a high number of scrotal males evident in August (93%, Table 3). The proportion of scrotal males dropped off in September.

Myotis leibii and *Myotis yumanensis.*—Data were inconclusive because of low sample sizes. For M. yumanensis all four males caught during July were scrotal as were the five individuals caught in August. For *M. leibii,* males that were scrotal were captured in September also (Table 3).

Eptesicus fuscus.—Largest available sample size was for this species with over 70 individuals examined throughout a three-month period. Highest number of scrotal males was in August (93%) with July a close

second (83%, Table 3). Average length of testes for this species in June, July and August was 0.79 mm, 0.88 mm, 0.88 mm respectively. Histology showed that first year males were not reproductively active.

Lasionycteris noctivagans.—For the silver-haired bat the highest number of captures was August, as was the highest number of scrotal males (93%), although high proportions were also recorded for July (88%, Table 3). Only four individuals in September were captured, with three of them scrotal.

Lasiurus cinereus.—Of the 17 males captured, highest number of scrotal males was found in August (100%). July, however, also exhibited high numbers (77%, Table 3). Average lengths of testes for eight males collected in Wyoming by Turner (1974) from mid-June to mid-July was 5.4 mm.

It should be noted that in at least some of the these species there exists the possibility that yearling males may drop the testes to a scrotal position, but still lack reproductive potency. I have determined that the testes of young male E. fuscus do drop into the scrotum, but when analyzed histologically the testes show no evidence of spermatogenesis, making these bats incapable of successful reproduction. The occurrence of this phenomenon in other bat species has yet to be determined.

Data from this study show some trends in the reproductive patterns of the bats that inhabit Colorado. Of the *Myotis* species studied, the little brown bat shows a distinctive reproductive pattern. Parturition occurred in late May or early June, with subsequent termination of lactation by the end of June. This is the earliest date for parturition thus far recorded for this species. All other bat species in this study showed a parturition date in early August. Why *Myotis lucifugus* should have such an early parturition date is unknown.

Of the females studied only *Myotis volans* and *Eptesicus fuscus* had pregnant females in August. All other species had given birth in July at the latest. Perhaps parturition must take place before autumn in order to counter the energetic stresses associated with gestation and lactation and allow the females to acquire brown fat needed for hibernation.

For male bats in this study, the reproductive pattern is simpler than that found in the females. All males came into reproductive condition in a somewhat synchronous pattern reaching a maximum number of scrotal individuals in August, or slightly before. Reasons for this relatively simple, synchronous reproductive pattern among the males and a more complex, asynchronous pattern among the females in this study may have to do with a dichotomy between the two sexes in terms of energetic cost.

Male and female vespertilionid bats spend large amounts of time in torpid states. Most of the metabolic expenses incurred by male vespertilionid bats may be manifested in terms of flight energetics. At certain times of the year, however, females must endure added levels of energetic stress in addition to those caused by flight. These additional stresses can be summarized in terms of gestation (including the added weight of carrying an embryo while foraging on the wing), parturition and lactation.

Anthony and Kunz (1977) have shown that pregnant female *M. lucifugus* consume 2.5 grams of insects per night while lactating females consume 3.7 grams of insects per night. Coutts, et. al. (1973) showed that captive male *M. lucifugus* consumed 1.22 grams of insects per day while post-lactating females consumed 0.93 grams per day. These data suggest that during pregnancy and lactation female *M. lucifugus* must find and consume more food than normal, potentially resulting in high levels of physiological stress.

Perhaps it was selection pressures which resulted in the species specific patterns of female reproduction seen in this study. Indeed, the differences observed may have been due to competition for food resources at times of energetic stress. These differences in timing of reproduction may at first appear subtle, but under closer observation may prove to be extremely important for population survival among sympatric bat species.

I would like to thank Dr. David M. Armstrong for reviewing this manuscript and making suggestions that added greatly to the interpretation of data and the clarity of text.

LITERATURE CITED

Anthony, E. L. P., and T. H. Kunz. 1977. Feeding strategies of the little brown bat, *Myotis lucifugus* in southern New Hampshire. Ecology, 58: 775-786.

Armstrong, D. M. 1972. Distribution of mammals in Colorado. Monogr. Univ. Kansas, Mus. Nat. Hist., 3:1-415.

Christian, J. J. 1956. The natural history of a summer aggregation of the big brown bat Eptesicus fuscus fuscus. Amer. Midland Nat., 55:66-95.

Coutts, R. A., M. B. Fenton, and E. Glen. 1973. Food intake by captive *Myotis lucifugus* and *Eptesicus fuscus* (Chiroptera: Vespertilionidae). J. Mamm., 54:985-990.

Davis, W. H., M. D. Hassell, and C. L. Rippy. 1965. Maternity colonies of the bat Myotis l. lucifugus in Kentucky. Amer. Midland Nat., 73:161-165.

Druecker, J. D. 1972. Aspects of reproduction in *Myotis volans, Lasionycteris noctivagans,* and *Lasiurus cinereus.* Unpubl. Ph.D. Dissert., Univ. New Mexico, Albuquerque, 68 pp.

Fenton, M. B. 1970*b*. The deciduous dentition and its replacement in *Myotis lucifugus* (Chiroptera: Vespertilionidae) in Ontario. Canadian J. Zool., 48:817-820.

Fenton, M. B. and R. M. R. Barclay. 1980. Myotis lucifugus, Mammal. Species, 142.

Findley, J. S., A. H. Harris, D. E. Wilson, and C. Jones. 1975. Mammals of New Mexico. Univ. New Mexico Press, Albuquerque, 360 pp.

Findley, J. S. 1954. Reproduction in two species of myotis in Jackson Hole, Wyoming. J. Mamm., 35:434.

Gottschang, J. L. 1966. Occurrence of the hoary bat *(Lasiurus cinereus)* in Ohio. Ohio J. Sci., 66:527-529.

Gould, E. 1971. Studies of maternal-infant communication and development of vocalizations in the bats *Myotis* and *Eptesicus*. Comm. Behav. Biol., A5:263-313.

Herried, C. F., II. 1961. Notes on the pallid bat in Texas. Southwestern Nat., 6:13-20.

Humphrey, S. R., and J. B. Cope. 1976. Population ecology of the little brown bat, *Myotis lucifugus*, in Indiana and south-central Kentucky. Special Publ., Amer. Soc. Mamm., 4:1-181.

Kunz, T. H. 1971. Reproduction of some vespertilionid bats in central Iowa. Amer. Midland. Nat., 86:477-486.

Krutzsch, P. H. 1954. Notes on the habits of the bat, *Myotis californicus*. J. Mamm., 35:539-545.

Provost, E. E., and C. M. Kirkpatrick. 1952. Observations on the hoary bat in Indiana and Illinois. J. Mamm., 33:110-113.

Racey, P. A. 1973. Environmental factors affecting the length of gestation in heterothermic bats. J. Reprod. Fert., Suppl., 19:175-189.

Schowalter, D. B. 1980. Swarming, reproduction, and early hibernation of *Myotis lucifugus* and *Myotis volans* in Alberta, Canada. J. Mamm., 61:350-354.

Schowalter, D. B., J. R. Gunson, and L. D. Harder. 1979. Life history characteristics of the little brown bat *(Myotis lucifugus)* in Alberta, Canada. Canadian Field Nat., 93:243-251.

Turner, R. W. 1974. Mammals of the Black Hills of South Dakota and Wyoming. Univ. Kansas, Mus. Nat. Hist., Occas. Papers, 60:1-178.

Wimsatt, W. A. 1945. Notes on breeding behavior, pregnancy and parturition in some vespertilionid bats of the eastern United States. J. Mamm., 26:23-33.

BOOK REVIEW

Fenton, M. Brock, Paul Racey, and Jeremy M. V. Rayner, eds., *Recent Advances in the Study of Bats*. Cambridge University Press, Cambridge, 470 pp. 1987. Price $69.50 (cloth).

Recent Advances in the Study of Bats contains 20 research papers resulting from contributions to three symposia held during joint meetings of the Seventh International Bat Research Conference and the Third European Symposium on Bat Research at the University of Aberdeen, Scotland in August 1985. The book is divided into three sections: flight, echolocation, and social and reproductive biology.

Bats are the only flying mammals and it is flight, more than any other adaptation, that has had the most profound impact on the evolution of bats. The chapters in this section are diverse, but extremely well integrated. The first chapter is a short introduction to the symposium by its convenors, Rayner and Norberg.

The lead paper by Padian reviews the extensive literature on the evolution of flight in vertebrates. However, Padian's chapter is more than a simple review. It is an explicitly stated methodology for studying the evolution of convergent characters. By careful phylogenetic analysis of flight characters Padian shows that the evolution of flight is dependent on phylogenetic history. Natural selection can only operate on the raw materials present, and those materials are likely to differ among lineages. Padian concludes that the available evidence supports a bipedal, terrestrial ancestry for flight in birds and a gliding arboreal stage for bat flight.

The following chapters in this section deal with aerodynamics, morphology, and energetics of bat flight. Jeremy Rayner outlines a mathematical model for flapping flight in bats. He first provides an extensive review of the aerodynamics of flapping flight as studied by flow visualization techniques. Rayner then develops a model that can be used to predict total energy consumption in flight, the forces acting along the wings, and flight muscle activity. He compares fast and slow gaits in two species and demonstrates that at faster gaits, the upstroke becomes active in producing lift.

Ulla Norberg's chapter reviews the ecological correlates of wing shape. She provides a summary of the available information on flight speed of bats and relates

it to wing loading. Hans Baagoe goes a step further in his chapter on adaptive wing morphology in free ranging Scandinavian bats. Here, predictions of flight characteristics are generated based on four wing characters and several body-mass classes. Baagoe then goes to the field to determine how well actual free flight observations correlate with morphological predictions. This is one of the first attempts to integrate laboratory and field-based flight data. While field data are rough, the observations generally support predictions based on wing morphology.

Steven Thomas reviews literature on the energetics of bat flight. He then makes comparisons between bat and avian flight energetics. One of the most interesting observations concerns the correlation between breathing frequencies and wingbeat frequencies. Another is the observation that the amount of oxygen *Phyllostomus hastatus* extracts from its lungs is nearly identical to that extracted by some birds. Thomas' chapter covers a wealth of information including flight energetics, thermoregulation, ventilation, and cardio-vascular physiology.

The last paper in this series, by Scott Altenbach and John Hermanson, describes bat flight from the standpoint of functional morphology and muscle biochemistry. flight muscle histochemistry in *Tadarida* reveals that the primary downstroke muscles are entirely fast twitch, termed a "one-geared" system by Altenbach and Hermonson. *Artibeus*, in contrast, has two types of fast twitch fibers acting as a "two-geared" system. Differences in the muscle fiber populations in these two species reflect their markedly contrasting flight behaviors. In addition, Altenbach and Hermanson describe the functional morphology of the scapulohumeral lock, and modify Vaughan's original hypothesis concerning the shoulder lock in bats.

The second section contains six papers dealing with echolocation, along with an introduction by M. Brock Fenton, and an epilogue by G. Neuweiler. Roderick Suthers and Jeffrey Wenstrup open this section with a review of recent acoustic discrimination experiments, which are designed to determine how bats detect and track prey in the laboratory. They discuss spectral and temporal cues and caution that such highly controlled experiments do not necessarily reflect the relatively complex environment encountered by free-ranging bats.

The next three chapters, by Roald Roverud, William O'Neill, and Marianne Vater, respectively, describe the processing of echolocation calls by the brain. Roverud's contribution is particularly well written considering the complex technical details often associated with echolocation research. He reviews the components of bat echolocation signals, describes the stages of target-directed flight, and discusses neural adaptations associated with information processing. One of the most interesting lines of research attempts to understand how interfering artificial pulses are processed by acoustic neurons. O'Neill details the importance of temporal cues in processing information relating to prey range and prey identification. He reviews the evidence concerning range-tuned versus time window mechanisms for information processing, and discusses the current evidence for a cortical map of delay-tuned neurons. O'Neill honestly points out that workable models of neural processing are lacking, a problem that underscores the difficulty in interpreting the voluminous neurophysiological data that are available. Vater describes the physiology and anatomy of cochlear tuning in *Rhinolophus* and *Pteronotus*.

The last two papers take a refreshing approach to the study of echolocation. In one of the more interesting chapters in the volume, Hans-Ulrich Schnitzler describes the acoustical fingerprints by which bats gain species-specific information about potential prey. Echos from fluttering insects reveal that the largest amplitude echos are produced at right angles to the pulse beam, at a time when an insect's wings are at peak upstroke. Different species of insects produce different echo fingerprints. Schnitzler then goes on to show that some bats discriminate fluttering targets from stationary ones, and that certain wingbeat signatures (e.g., prey) are preferred by certain bats. James Fullard's innovative chapter on neuroethology completes the section on echolocation. Fullard brings his background as an entomologist to bear on the problem of how prey react to pulses emitted by foraging bats. Fullard proposes a model to describe how moth ears decode acoustic signals, and hypothesizes that selection has tuned the moth CNS to respond to predatory bats, while ignoring other sounds.

Chapter 16 introduces the last symposium topic: social and reproductive biology of bats. Gary McCracken leads off with an excellent review of social organization and its role in the genetic structure of bat populations. He examines three very different genetic and social structures in three bat species: *Phyllostomus hastatus*, *Desmodus rotundus*, and *Saccopteryx bilineata*. Although the social systems differ, each species would be expected to suffer some inbreeding within its kin group(s). However, inbreeding is apparently kept to a minimum by juvenile and adult dispersal (and possibly inbreeding avoidance). McCracken concludes that the Wilson-Bush model, which predicts rapid genetic divergence among social groups that have small effective population size and local inbreeding, does not operate in the three bat species described (and perhaps not in bats in general).

The chapter by Gerald Wilkinson considers altruism and co-operation as mechanisms that contribute to population and social structure in bats. He describes a simple model (modified version of Wright's island model), and then uses the model to estimate relatedness in five bat species. Wilkinson concludes that reciprocity and/or kin selection may be important in the establishment of co-operation in at least some bat species.

Andrew McWilliam's discussion of reproductive biology in Co*leura afra* is perhaps the most atypical chapter of the volume. While the other authors review themes or mechanisms that relate to the Chiroptera as a whole, McWilliams focuses on a single species. The conclusion, that tropical seasonality is important in the timing and ultimate reproductive success of *C. afra* is interesting, but hardly a new idea. Although somewhat out of place in this volume, this topic does provide an important contribution to our understanding of emballonurid reproductive ecology.

T. A. Uchida and T. Mori contribute a fascinating description of prolonged sperm storage in hibernating bats, focusing on the ultrastructure, location, and mechanisms of sperm storage and capacitation in the female reproductive tracts of nine species. Sperm is stored and actively nourished in the caudal isthmus of the oviduct and uterotubal junction. This review is clear, concise, and has important implications for further research on reproductive biology and sperm competition in bats.

Energetics is the focal point of the next two chapters, one by J. R. Speakman and P. A. Racey on reproductive energetics of *Plecotus auritus*, the other by Thomas Kunz concerning post-natal energetics. Speakman and Racey use double-labelled water (180) in free-ranging bats to measure daily energy expenditure, and they compare their findings to predictions derived from laboratory experiments. Kunz uses recently developed field aging techniques to study post-natal ontogeny in several species of bats. Suckling bats, like altricial birds, are poikilothermic, making the transition to homeothermy late in the preflight stage. Kunz suggests that this pattern of thermoregulatory ontogeny conserves energy for the energetically stressful weaning period. He also presents a simple model to describe the energy budget of suckling bats.

The final two chapters in this section examine bat reproductive biology from the standpoint of neuroendocrine function. Edythe Anthony reviews the contribution of the hypothalamus and anterior pituitary to the reproductive cycle. A major contribution provided by Anthony's chapter is the characterization of both the delivery routes of luteinizing hormone releasing hormone (LHRH) to gonadotropic hormones and the hypothesized "ultrashort" feed-back loops that may be involved. A. W. Gustafson and D. A. Damassa close this volume with a review of plasma testosterone binding to sex steroid-binding proteins, and the role of this process in modulating asynchrony of testes and accessory organ recrudescence.

Recent Advances in the Study of Bats is an extremely well organized and focused volume. Each chapter is well written and edited. There is little of the unevenness sometimes associated with independently written chapters. Typographical errors are few, and the only cosmetic drawback is the tendency to overreduce complex figures. Chapters are designed to review our current level of understanding of each topic and in this sense fulfill that role admirably. The new information, techniques, and models that appear throughout this symposium volume make it an indispensible work for bat biologists. I would hope that *Recent Advances in the Study of Bats* continues as a series, with perhaps the next volume focusing on systematics, biogeography, and the like. I suspect this book will have limited appeal to non-chiroptologists because of its limited focus and pricetag ($69.50). However, I recommend this volume to mammalogists at large because of its state-of-the-art treatment of bat flight, echolocation, and reproductive biology.

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Announcements

BIBLIOGRAPHY ON FRUIT BATS AVAILABLE

Craig Whitesell has written asking *BRN* to announce that the publication "Fruit Bats (Megachiroptera) of the World: A Bibliography" is available free of charge from: Institute of Pacific Islands Forestry, 1151 Punchbowl Street, Rm. 323, Honolulu, Hawaii 96813. The complete citation for the publication is

Morse, J. E., M. C. Falanruw, C. D. Whitesell, and J. A. Baldwin. 1987. Fruit bats (Megachiroptera) of the world: a bibliography. U.S. Dept. Agriculture, Bibliographies and Literature of Agriculture No. 58, iv + 38 pp.

BAT SUPPORT FUND FOR EASTERN EUROPE

An *ad hoc* committee of bat researchers from western Europe has been formed to set up a fund to assist

their eastern European colleagues in obtaining modern, up-to-date research equipment. Basic items such as bat detectors, collection equipment, banding equipment, etc., are difficult to obtain because they are not available locally. If imported, they must be purchased with foreign currency, to which eastern European researchers do not have access. The committee—consisting of Prof. Dr. Ingemar Ahlen, Uppsala; Dr. Hans J. Baagoe, Copenhagen; Peter H. C. Lina, Leiden; Prof. Dr. Gerhard Neuweiler, Munich; and Prof. Paul A. Racey, Aberdeen—is currently soliciting money or equipment to be passed to colleagues in Czechoslovakia, Poland, Hungary, the DDR, and the Soviet Union. Anyone wishing to contribute may send funds to: Bat Support for Eastern Europe, c/o Peter H. C. Lina, E. de Boer-van Rijkstraat, 23331 HH Leiden, The Netherlands.

NEWS

CANADA

McMaster University, Hamilton, Ontario: In response to your kind invitation, herewith find the latest from the "Great White North." Dr. Robert E. Garfield and I have continued our collaberative study of myometrial innervation in *Myotis lucifugus*. Recently, we examined *in vitro* myometrial responses to electrical field stimulation and the effects of a variety of autonomic agonists and antagonists during the annual cycle (Manuscript now *in contention)*. A senior biology student, Aleksander Stosich, and I have explored the effects of opioids on hibernal torpor. Alex has produced a detailed description of the arousal process and shown that, contrary to earlier reports, most *M. lucifugus* (males) employ shivering thermogenesis during arousal.

I did achieve one scientific breakthrough this last-winter. Field studies of the ice at the entrance to Craigmont Mine (latitude 45° 18' N) showed: weight bearing strength (WBS) < one chiroptologist fully clothed (CFC).

Correlated with, if not related to, my drug-related activities described above, I have been transferred to the Physiology and Pharmacology Division of the newly created Department of Biomedical Science. Last week I couldn't even spell Farmakologey, now I are one. [**G. Dale Buchanan**]

Royal Ontario Museum, Toronto: The ROM exhibit *The Bat Cave*, which opened on January 16, 1988, has received a very positive response from the Canadian press and public. For those of you who did not get a sneak preview at the Toronto bat meetings last fall, the exhibit is a realistic reconstruction of parts of St. Clair cave in Jamaica. Up to 12 visitors walk through the cave at a time. Each 15 minute tour allows visitors the experience of visiting a realistic tropical cave, complete with authentic bat calls, dripping water, and 3000 bats hanging and appearing to fly through the air. Particularly impressive is the "exodus" of bats at the end of the tour. Computer—controlled mirrors and strobe lights create a very realistic impression of thousands of bats exiting the cave. Visitors leaving the exhibit then may proceed to *Discovering Bats*, a related exhibit of graphics, models, specimens, and photos that illustrate habits and ecology of bats. [From a letter and press release sent by **Judy Eger**, and from my own visit to the exhibit—**TAG**]

FRANCE

Laboratoire de Paleontologie, Universite des Sciences et Techniques du Languedoc, Montpellier: In our lab in Montpellier we are involved in research dealing with fossil bats, mainly relating to systematics, phylogeny, evolution, and paleobiogeography. Students in our institute are mainly studying evolution processes (genetics, ecology), and one of them (postgraduate) is ready to look for a job concerned with bats. [**Bernard Sigé**]

UNITED STATES

CALIFORNIA

University of California, Davis: No active work with bats. I became an emeritus professor here on July 1, 1987. [**Walter E. Howard**]

COLORADO

University of Colorado, Boulder: I am working on the developmental biology and natural history of a maternal colony of *Myotis lucifugus* located at Fort Laramie National Historical site in Wyoming. I presented preliminary data on aspects of forelimb development in *Myotis* at the Bat Conference in Toronto last October. The current study is along the same lines, however, it is

much more detailed. Presently I have female bats in the lab giving birth to neonates, providing a timed post--natal sequence of development. Adult females are later returned to the maternity colony. [**Rick Adams**]

ILLINOIS

Illinois Wesleyan University, Bloomington: I spent ten days in April at the American Museum of Natural History in New York, finishing up my research on the hyoid anatomy of emballonuroid bats. I have one more genus to dissect this summer, and then will have looked at all genera of emballonuroids except *Craseonycteris*. The hyoid of emballonuroids is unexpectedly fascinating (to an anatomist), and I have some interesting observations on function and phylogeny which I will present in October in Calgary. I also spent time in the "wilds" of northwestern Illinois this summer, mist--netting bats with three Illinois Wesleyan students: Dynee Balleza, Pam Sponholtz, and Kellie Jones. After a seven year absence from field biology, it's been fun to get out and work with living bats again. To date, we have netted nine species, including three I had not previously seen alive: *Lasiurus cinereus, Lasionycteris noctivagans,* and *Nycticeius humeralis*. I also rediscovered the joy of ticks and chiggers (the bites are starting to heal, finally). [**Tom Griffiths**]

KANSAS

Fort Hays State University, Hays: I am directing a research project that is intended to reveal the foraging habitat of the gray bat *(Myotis grisescens)* in Kansas. The only known colony of this endangered species in Kansas is in the storm sewer beneath the city of Pittsburg in the southeastern corner of the state. The sewer has been designated by the state as critical habitat for the species, but foraging areas critical to the colony have not been determined. After the foraging areas have been identified, they will be added to the area recognized as critical habitat for the species in Kansas. Field investigations are being conducted by a graduate student, Jan Decher from West Germany, with the assistance of an experienced undergraduate, James Johnson. They visited the colony in June and found that females were still carrying their young during foraging flights. Therefore, trapping and banding were postponed until early July. Beginning in early July, bats exiting the colony were trapped and banded with plastic split rings covered with reflective tape. An ultrasound detector is being used to determine the existence of bats in all potential foraging areas, and a high—intensity spotlight enables recognition of banded bats. Decher and Johnson will continue identifying areas used by gray bats successively farther from the roost throughout the summer. Hopefully, we will be able to determine travel corridors as well as foraging areas so these can be protected also. The project is Jan's M.S. thesis study at Fort Hays State University.

After he graduates (probably in August of 1989), he intendes to move to another university to pursue Ph.D. studies related either to bats or to mammalian conservation and ecology in West Africa. He will summarize the results of the gray bat study at the annual meetings next spring of the Southwestern Association of Naturalists (in Arkansas) and the American Society of Mammalogists (in Alaska). [**J. R. Choate**]

MAINE

University of Maine, Farmington: Bob Martin has been busy promoting the welfare of bats in Maine. He has donated hundreds of hours of time speaking before wildlife groups and public school classes, writing articles for local Maine publications, and appearing on radio and television programs in defense of bats. Bob reports that his only "fee" for speaking to the 5000+ school children he has addressed to date is the requirement that one member of the school staff join Bat Conservation International. That way, the organization benefits and there is a continuing reminder of bats after he leaves. [Based on several letters to Tom Griffiths from **Bob Martin**]

MICHIGAN

University of Michigan, Flint: I am working on ADH receptors in several species of bats, and I am looking at the role of the pituitary in delay development in *Macrotus californicus*. I am also interested in the role of the pineal gland in the control of reproduction in bats. [**Bruce Richardson**]

NEW YORK

New York State Department of Health, Rabies Lab, Albany: We are continuing our work of rabies diagnosis in biting bats and bats that have come into contact with domestic animals. We continue to work on rabies epizootiology, especially the relation of bat rabies to rabies in terrestrial mammals. [**Charles Trimarchi**]

PENNSYLVANIA

University of Scranton, Scranton: I am finishing my post—doc at the University of Wisconsin—Madison, and have accepted an Assistant Professor position in the Department of Biology, University of Scranton to start

in August, 1988. I am currently working on bone/vitamin D and thyroid endocrinology problems. I have no students, and I *need* master's students at Scranton. For bat work, I am studying the annual thyroid—thyroxin cycle in *Myotis lucifugus* in relation to seasonal reproduction. Also, I am working on the relationship of Vit. D to endocrine system of *M.Lucifugus lucifugus* and have found that hibernating bats are hypovitaminosis D. I am especially interested in bat research on mineralized and reproductive tissues utilizing techniques of biochemistry, physiology, endocrinology, and microscopic anatomy. These interests include the biology and regulation of mineralized and reproductive tissues and the comparative morphology and physiology of tissue adaptation. [**Gary Kwiecinski**]

TEXAS

Texas Tech University, The Museum: I have two students in the Museum. Joaquín Arroyo—Cabrales is working on the systematics of *Dermanura (Enchisthenes) hartii*. Albert Kumirai is working on a comparison of cranial and post—cranial anatomy, studying systematics of Stenodermatinae. [**Robert D. Owen**]

UTAH

Brigham Young University, Provo: I have an urban bat project planned and beginning in 1989. I also plan to survey the status of the Hawaiian hoary bat, but over the next 4—5 years. [**Hal L. Black**]

RECENT LITERATURE

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

ANATOMY

Ando, K. 1988. Distribution and origin of vasoactive intestinal polypeptide (VIP)-immunoreactive, acetylcholinesterase-positive and adrenergic nerves of the cerebral arteries in the bent-winged bat (Mammalia: Chiroptera). Cell Tiss. Res., 251:345-351. [Biol. Lab., Kyushu Sangyo Univ., Fukuoka 813, Japan]

Bernard, R. T. F., J. Paton, and K. Sheppey. 1988. Relative brain size and morphology of some South African bats. S. African J. Zool., 23:52-58. [Dept. Zool. Entomol., Rhodes Univ., Grahamstown 6140, South Africa]

Bhatnagar, K. P. 1988. Ultrastructure of the pineal body of the common vampire bat, *Desmodus rotundus*. Amer. J. Anat., 181:163-???. [Dept. Anat. Sci. and Neurobiol., Univ. Louisville, Louisville, KY 40292]

Bishop, A. L., and O. W. Henson, Jr. 1987. The efferent cochlear projections of the superior olivary complex in the mustached bat. Hearing Res., 31:175- ???. [Henson: Dept. Anat., Univ. North Carolina, Swing Bldg. 217H, Chapel Hill, NC 27599]

Burda, H., J. Fiedler and V. Bruns. 1988. The receptor and neuron distribution in the cochlea of the bat, *Taphozous kachhensis*. Hearing Res., 32:131-???. [Inst. Zool., Univ. Frankfurt, Siesmayerstrasse 70, D-6000 Frankfurt, Fed. Rep. Germany]

Freeman, P. W. 1988. Frugivorous and animalivorous bats (Microchiroptera): dental and cranial adaptations. Biol. J. Linnean Soc., 33:249-272. [Div. Zool., State Mus., Univ. Nebraska, Lincoln, NE 68588]

Kawasaki, M., D. Margoliash, and N. Suga. 1988. Delay-tuned combination-sensitive neurons in the auditory cortex of the vocalizing mustached bat. J. Neurophysiol., 59:623-635. [Scripps Inst. Oceanography, Neurobiol. Unit, Univ. Cal. San Diego, A-002, La Jolla, CA 92093]

Kossl, M., M. Vater, and H. Schweizer. 1988. Distribution of catecholamine fibers in the cochlear nucleus of horseshoe bats and mustache bats. J. Comp. Neurol., 269:523-???. [Inst. Zool., Univ. Munich, D-8000 Munich 2, Fed. Rep. Germany]

Kovaleva, I. M. 1987. Structural and functional characteristics of the thorax in Chiroptera. Vestn. Zool., 4:70-74. [I. I. Shmalgauzen Inst. Zool., Akad. Sci. Ukraine SSR, Kiev, USSR]

Lester, K. S., S. J. Hand, and F. Vincent. 1988. Adult phyllostomid (bat) enamel by scanning electron microscopy—with a note on dermopteran enamel. Scanning Microscopy, 2:371-384. [School Dent. Clin., Westmead Hospital, Westmead, NSW 2145, Australia]

Ross, L. S., G. D. Pollak, and J. M. Zook. 1988. Origin of ascending projections to an isofrequency region of the mustache bat's inferior colliculus. J. Comp. Neurol., 270:488-???. [Pollak: Dept. Zool., Univ. Texas, Austin, TX 78712]

Ueda, W. 1986. Aspectos da morfologia lingual das três espécies de morcegos hematófagos (Chiroptera, Phyllostomidae). Rev. Brasil. Biol., 46:581-587. [Dept. de Zoologia, IBBMA, UNESP, Rubiao Junior, 18.610—Botucatu, São Paulo, Brasil]

BEHAVIOR

Bonaccorso, F. J., and T. J. Gush. 1987. Feeding behaviour and foraging strategies of captive phyllostomid fruit

bats: an experimental study. J. Anim. Ecol., 56:907-920. [Dept. Zool., Univ. Florida, Gainesville, Florida 32611]

Fujioka, K. K., and S. M. Gon, III. 1988. Observations of the Hawaiian bat *(Lasiurus cinereus semotus)* in the districts of Ka'u and South Kona, Island of Hawai'i. J. Mamm., 69:369-371. [Los Angeles Co. Health Dept., Vector Control Div., Los Angeles, CA 90012)

Gould, E. 1988. Wing-clapping sounds of *Eonycteris spelaea* (Pteropodidae) in Malaysia. J. Mamm., 69:378-379. [Dept. Mammals, Nat. Zool. Park, Washington, DC 20008]

Jappinen, J.-P. 1987. Wintering behavior of a colony of whiskered bats *(Myotis mystacinus* Kuhl). Luonnon Tutkija, 91:156-157. [Univ. Joensuu Dept. Biol., P. O. Box 111, SF-80101, Joensuu, Finland]

McWilliam, A. N. 1988. Social organization of the bat *Tadarida (Chaerephon) pumila* (Chiroptera, Molossidae) in Ghana, West Africa. Ethology, 77:115-???. [Dept. Zool., Univ. Aberdeen, Tillydrone Ave., Aberdeen AB9 2TN, Scotland]

Timm, R. M. 1987. Tent construction by bats of the genera *Artibeus* and *Uroderma*. Pp. 187-212 *in* B. D. Patterson and R. M. Timm (Eds.). Studies in Neotropical Mammalogy—Essays in Honor of Philip Hershkovitz. Fieldiana: Zoology, No. 39, 506 pp.

BOOKS ON BATS

Schober, W., and E. Grimmberger. 1987. Die Fledermaus Europas. 'Kosmos,' Franck'sche Verlagshandlung, W. Keller & Co., Stuttgart, 222 pp.

CARE AND CONSERVATION OF BATS

Clark, D. R., Jr., F. M. Bagley, and W. W. Johnson. 1988. Northern Alabama colonies of the endangered grey bat *Myotis grisescens:* organochlorine contamination and mortality. Biol. Conservation, 43:213-226. [Patuxent Wildlife Res. Ctr., US Fish and Wildlife Service, Laurel, MD 20708]

Uieda, W., and V. Fausto de Araujo. 1987. Manutenção dos morcegos hematófagos *Diaemus youngii* e *Diphylla ecaudata* (Chiroptera, Phyllostomidae), em cativeiro. An. Semin. Ci. Fiube, Uberaba, 1:30-42. [Dept. de Zoologia, IBBMA, UNESP, Rubiao Junior, 18.610—Botucatu, São Paulo, Brasil]

Wiles, G. J., and N. H. Payne. 1986. The trade in fruit bats *Pteropus* sp. on Guam and other Pacific islands. Biol. Conserv., 38:143-161. [Div. Aquatic Wildlife Resources, P.O. Box 2950, Agana, Guam 96910, USA]

CYTOLOGY

Laemle, L. K., and J. R. Cotter. 1988. Immunocytochemical localization of vasoactive intestinal polypeptide (VIP) in the brain of the little brown bat *(Myotis lucifugus).* J. Neurocytol., 17:117-129. [Dept. Anat., Univ. Med. Dent. N.J., New Jersey Med. School, 100 Bergen St., Newark, NJ 07103]

Laemle, L. K., and J. R. Cotter. 1988. VIP-like immunoreactivity in the anterior hypothalamic area of a hibernating bat varies with physiological state. Brain Res., 441:398-402.

Mikami, S-i, S. Chiba, H. Hojo, K. Taniguchi, K. Kubokawa, and S. Ishii. 1988. Immunocytochemical studies on the pituitary pars distalis of the Japanese long-fingered bat, *Miniopterus schreibersii fuliginosus.* Cell Tiss. Res., 251:291-299. [Dept. Vet. Anat., Iwate Univ., Morioka, Iwate 020, Japan]

Sgouros, J. G., T. Kleinschmidt, and G. Braunitzer. 1988. The primary structure of the hemoglobin of the Indian false vampire *(Megaderma lyra,* Microchiroptera). Biol. Chem. Hoppe-Seyler, 369:47-54. [Max Planck Inst. Biochem., D-8033 Martinsried, Munich]

DEVELOPMENT

Ledenev, S. 1987. Characteristics of the early prenatal development of the autopodium in Chiroptera. Vestn. Zool., 4:74-76. [I. I. Shmalgauzen Inst. Zool., Akad. Sci. Ukraine SSR, Kiev, USSR]

DISEASE

Akojie, F. O. B., and J. O. Folayan. 1988. Antisickling potential of bat interferon. Int. J. Pharmaceutics, 42:261-???. [Dept. Biochem., Univ. Benin, Benin City, Nigeria]

Boyd, I. L., D. G. Myhill, and A. J. Mitchell-Jones. 1988. Uptake of gamma-HCH (Lindane) by pipistrelle bats and its effect on survival. Env. Pollution, 51:95-???. [Inst. Terrestrial Ecol., Monks Wood, Abbots Ripton, Huntingdon PE17 2LS, England]

Prins, B., and K. Loewen. 1988. Bat rabies in British Columbia 1971-1985. Canadian Vet. J., 29:41-44. [Agr. Canada, Inst. Animal Dis. Res., PO Box 640, Lethbridge, Alberta, Canada T1J 3Z4]

Rosatte, R. C. 1987. Bat rabies in Canada: history, epidemiology and preventation. Canadian Vet. J., 28:754-756. [Research Sect., Rabies Unit, Ontario Ministry Nat. Resources, Wildlife Branch, PO Box 50, Maple, Ontario L0J 1E0, Canada]

DISTRIBUTION/FAUNAL SURVEYS

Alberico, M. S. 1987. Notes on distribution of some bats from southwestern Colombia. Pp. 133-136 *in* B. D. Patterson and R. M. Timm (Eds.). Studies in Neotropical Mammalogy—Essays in Honor of Philip Hershkovitz. Fieldiana: Zoology (n.s.), No. 39, 506 pp.

Anderson, S. 1985. Lista preliminar de mamiferos Bolivianos. Cuadernos—Academia Nacional de Ciencias de Bolivia, 65:5-16. [Dept. of Mammalogy, American Mus. Nat. Hist., Central Park West at 79th St., New York, NY 10024]

Constantine, D. G. 1987. Long-tongued bat and spotted bat at Las Vegas. Southwestern Nat., 32:392-???. [California Dept. Health Serv., 2151 Berkeley Way, Berkeley, CA 94704]

Gaisler, J., and K. Kowalski. 1986. Results of bat netting in Algeria (Mammalia: Chiroptera). Vestn. Cesk. Spol. Zool., 50:161-173. [Fac. Sci. Brno, Kotlarska, CS-61137, Brno, Czechoslovakia]

Gaisler, J., Z. Bauerova, M. Vlasin, and J. Chytil. 1988. The

bats of S-Moravian lowlands over 30 years—Rhinolophus and large Myotis. Folia Zool., 37:1-??.

Genoways, H. H., and R. J. Baker. *Lasiurus blossevillii* (Chiroptera: Vespertilionidae) in Texas. Texas J. Sci., 40:111-113. [Baker: The Museum, Texas Tech Univ., Lubbock, TX 79409]

Gerell, R. 1987. Distribution of *Myotis mystacinus* and *Myotis brandtii* (Chiroptera) in Sweden. Z. Saugetierk., 52:338-341. [Dept. Anim. Ecol., Ecol. Bldg., Univ. Lund, S-22362 Lund, Sweden]

Hackethal, H., and G. Peters. 1987. Notes on Macedonian (Yugoslavian) bats (Mammalia, Chiroptera). Acta Mus. Macedonici Sci. Nat., 18:159-176. [Mus. Naturkunde, Humboldt-Univ., Berlin, Invalidstrasse 43, Berlin 1040, DDR]

Happold, D. C. D., M. Happold, and J. E. Hill. 1987. The bats of Malawi. Mammalia, 337-414. [Dept. Zool., Australian Natl. Univ., Canberra, ACT 2601, Australia]

Hoffman, R. S., J. K. Jones, and J. A. Campbell. 1987. 1st record of *Myotis auriculus* from Guatemala. Southwestern Nat., 32:391. [Natl. Mus. Nat. Hist., NHB Stop 106, Washington, DC 20560]

Hollander, R. R., and J. K. Jones, Jr. 1988. Northernmost record of the tropical brown bat, *Eptesicus furinalis*. Southwestern Nat., 33:100. [The Museum, Texas Tech Univ., Lubbock, TX 79409]

Kock, D. 1988. Ungewöhnlicher Fund einer Nordfledermaus. Natur und Museum, 118:92-93. (reporting an unusual find of *Eptesicus nilssoni)* [Forschungsinstitut Senckenberg, Senckenberganlage 25, D-6000 Frankfurt a. M. 1]

Micklebaugh, S. 1987. Distribution and status of bats in the London area [England, UK]. London Nat., 66:41-91. [Fauna and Flora Preservation Soc., 8-12 Camden High St., London, NW1 0JH, England]

McCarthy, T. J. 1987. Distributional records of bats from the Caribbean lowlands of Belize and adjacent Guatemala and Mexico. Pp. 137-162 *in* B. D. Patterson and R. M. Timm (Eds.). Studies in Neotropical Mammalogy—Essays in Honor of Philip Hershkovitz. Fieldiana: Zoology (n.s.), No. 39, 506 pp.

Musser, G. G. 1987. The mammals of Sulawesi. Pp. 73-93 *in* T. C. Whitmore (ed.). Biogeographical evolution of the Malay Archipelago. Clarendon Press, Oxford. [contains accounts of 59 species of bats in six families]

Polaco, O. J. 1987. First record of *Noctilio albiventris* (Chiroptera: Noctilionidae) in Mexico. Southwestern Nat., 32:508-???. [Dept. Prehistory, Inst. Nacional Anthropol. and Hist., Moneda 16, 68Col. Ctr., Mexico City 06000, DF, Mexico]

Strelkov, P. P. 1988. Brown *(Plecotus auritus)* and grey *(P. austriacus)* bats (Chiroptera, Vespertilionidae) in the USSR .1. Zoologichesky Zhurnal, 67:90-101. [Inst. Zool., Acad. Sci. USSR, Leningrad, USSR]

Strelkov, P. P. 1988. Brown *(Plecotus auritus)* and grey *(P. austriacus)* bats (Chiroptera, Vespertilionidae) in the USSR .2. Zoologichesky Zhurnal, 67:287-292.

Taylor, R. J., M. G. O'Neill, and T. Reardon. 1987. Tasmanian [Australian] bats: identification, distribution, and natural history. Pap. Proc. Royal Soc. Tasmania, 121:109-120. [Dept. Zool., Univ. Tasmania, Sandy Bay, Tasmania 7005]

Torres, M. P., T. Rosas, and S. I. Tiranti. 1988. *Thyroptera discifera* (Chiroptera, Thyropteridae) in Bolivia. J. Mamm., 69:434-435. [Dept. de Ciencias Nat., Universidad Nacional de Rio Cuarto, 5800 Rio Cuarto, Cordoba, Argentina]

ECHOLOCATION

Ahlen, I. 1988. Sonar used by flying Lesser Horseshoe bats, *Rhinolophus hipposideros* (Bechstein, 1800) (Rhinolophidae, Chiroptera), in hunting habitats. Z. Saugetierk., 53:65-??. [Dept. Wildlife Ecol., Swedish Univ. Agricultural Sci., Box 7002, S-75007 Uppsala, Sweden]

Guppy, A., and R. B. Coles. 1988. Acoustical and neural aspects of hearing in the Australian gleaning bats, *Macroderma gigas* and *Nyctophilus gouldi*. J. Comp. Physiol. A, 162:653-???. [Inst. Zool., Univ. Munich, Luisenstrasse 14, D-8000 Munich 2, Fed. Rep. Germany]

Rubsamen, R. 1987. Ontogenesis of the echolocation system in the rufous horseshoe bat, *Rhinolophus rouxi* (audition and vocalization in early postnatal development). J. Comp. Physiol. A, 161:899-914. [Zoologisches Inst. Univ. Munich, Luisenstrasse 14, D-8000, Munich 2, Fed. Rep. Germany]

Schmidt, S. 1988. Evidence for a spectral basis of texture perception in bat sonar. Nature, 331:617-???. [Inst. Zool., Univ. Munich, Luisenstrasse 14, D-8000 Munich 2, Fed. Rep. Germany]

Suthers, R. A., D. J. Hartley, and J. J. Wenstrup. 1988. The acoustic role of tracheal chambers and nasal cavities in the production of sonar pulses by the horseshoe bat, *Rhinolophus hildebrandti*. J. Comp. Physiol. A, 162:799-???. [School Med., Indiana Univ., Bloomington, IN 47405]

ECOLOGY

Aldridge, H. D. J. N., and I. L. Rautenbach. 1987. Morphology, echolocation and resource partitioning in insectivorous bats. J. Anim. Ecol., 56:763-778. [Dept. Biol., York Univ., North York, Ontario, Canada M3J 1P3]

Freeman, J., and L. Wunder. 1988. Observations at a colony of the Brazilian free-tailed bat *(Tadarida brasiliensis)* in southern Colorado. Southwestern Nat., 33:102-???. [Div. Sci. Tech., Intern. Amer. Univ., Box 1293, Hayto Rey, PR 00919]

Graham, G. L. 1987. Seasonality of reproduction in Peruvian bats. Pp. 173-186 *in* B. D. Patterson and R. M. Timm (Eds.). Studies in Neotropical Mammalogy—Essays in Honor of Philip Hershkovitz. Fieldiana: Zoology (n.s.), No. 39, 506 pp.

Harmata, W. 1987. The frequency of winter sleep interruptions in two species of bats hibernating in limestone tunnels. Acta Theriol., 32:331-332. [Inst. Environ. Biol., Jagiellonian Univ., ul. Karasia 6, 30-060 Krakow, Poland]

Norberg, U. M., and M. B. Fenton. 1988. Carnivorous bats? Biol. J. Linnean Soc., 33:383-394. [Dept. Zool., Gothenburg Univ., S-40031 Gothenburg, Sweden]

Nunes, V. da Silva. 1988. Vocalizations of treefrogs *(Smilisca sila)* in response to bat predation. Herpetologica, 44:8-??. [Dept. Biol., Univ. SW Louisiana, Lafayette, LA 70504]

Ramirezpulido, J., and M. A. Armella. 1987. Activity patterns of neotropical bats (Chiroptera: Phyllostomidae) in Guerrero, Mexico. Southwestern Nat., 32:363- . [Dept. Biol., Univ. Autonoma Metropolitana, Unidad Iztapalapa, APDO Postal 55-535, Mexico City 09340, DF, Mexico]

Rieger, J. F., and E. M. Jakob. 1988. The use of olfaction in food location by frugivorous bats. Biotropica, 20:161-164. [Mus. Zool., Univ. Michigan, Ann Arbor, Michigan 48109-1079]

Yack, J. E. 1988. Seasonal partitioning of atympanate moths in relation to bat activity. Can. J. Zool., 66:753-???. [Dept. Zool., Erindale Coll., Univ. Toronto, 3359 Mississauga Rd., Mississauga, Ontario, Canada L5L 1C6]

FLIGHT

Aldridge, H. D. J. N., and R. M. Brigham. 1988. Load carrying and maneuverability in an insectivorous bat: a test of the 5% "rule" of radio-telemetry. J. Mamm., 69:379-382. [Dept. Biol., York Univ., North York, Ontario, Canada M3J 1P3]

GENETICS

Baker, R. J., J. C. Patton, H. H. Genoways, and J. W. Bickham. 1988. Genic studies on Lasiurus (Chiroptera: Vespertilionidae). Occas. Papers Mus., Texas Tech Univ., 117:1-15. [The Museum, Texas Tech Univ., Lubbock, TX 79409]

PALEONTOLOGY

Emslie, S. D. 1988. Vertebrate paleontology and taphonomy of caves in Grand Canyon, Arizona [USA]. Natl. Geographic Res., 4:128-142. [Point Reyes Bird Observatory, 4990 Shoreline Highway, Stinson Beach, CA 94970]

Gabuniya, L. K., and V. D. Gabuniya. 1987. On the first find of fossil bats (Chiroptera) in the Paleogene of the USSR. Soobshch. Akad. Nauk. Gruz. SSR, 126:197-200. [L. Sh. Davitashvili Inst. Paleobiol., Acad. Sci. Georgian SSR, Tbilisi, USSR]

Gingerich, P. D. 1987. Early Eocene bats (Mammalia, Chiroptera) and other vertebrates in freshwater limestones of the Willwood Formation, Clark's Fork Basin, Wyoming. Contr. Mus. Paleontol., Univ. Michigan, 27:275-320. [Mus. Paleontology, Univ. Michigan, Ann Arbor, Michigan]

Novacek, M. J. 1987. See under **SYSTEMATICS** below.

Thewissen, J. G. M., and G. R. Smith. 1987. Vespertilionid bats (Chiroptera, Mammalia) from the Pliocene of Idaho. Contr. Mus. Paleontol., Univ. Michigan, 27:237-245. [Mus. Paleontology, Univ. Michigan, Ann Arbor, Michigan]

PARASITOLOGY

Duszynski, D. W., D. W. Reduker, and B. B. Parker. 1988. Eimeria from bats of the world. II. A new species in *Tadarida femorosacca* from Sonora, Mexico. J. Parasitol., 74:317-???.

Fain, A., and J. O. Whitaker. 1987. *Acanthophthirius (Myotimiobia)* nycticeius, new species (Acari, Myobiidae), from the evening bat, *Nycticeius humeralis*, in the USA. J. Med. Ent., 24:248-251. [Inst. Royale Sci. Nat. Belgique, 29 Rue Vautier, B-1040 Bruxelles, Belgium]

Kock, D., and V. Aellen. 1987. Cimicidae parasites of Chiroptera in the Geneva Museum. Revue Suisse Zool., 94:873-???. [Forschungsinst. Senckenberg, Senckenberg Anlage 25, D-6000 Frankfurt, Fed. Rep. Germany]

Uchikawa, K. 1988. Myobiidae (Acarina, Trombidiformes) associated with minor families of Chiroptera (Mammalia) and a discussion of phylogeny of chiropteran myobiid genera. J. Parasitol., 74:159-???. [Dept. Parasitol., Shinshu Univ., School Med., Matsumoto, Nagano 390, Japan]

PHYSIOLOGY

Arevalo, F., G. Perez-Suarez, and P. Lopez-Luna. 1987. Hematological data and hemoglobin components in bats (Vespertilionidae) Comp. Biochem. Physiol. A, 88:447-450. [Dept. Biol. Anim., Fac. Ciencias, Univ. Alcala Henares, E-28801 Alcala Henares, Spain]

Ifuta, N. B., H. Gevaerts, and E. R. Kuhn. 1988. Thyroid hormones, testosterone, and estradiol-17B in plasma of *Epomops franqueti* (Tomes, 1860) (Chiroptera) in the rain forest of the equator. Gen. Comp. Endocrinology, 69:378-???. [Dept. Ecol., Univ. Kisangani, Kisangani, Zaire]

Jurgens, K. D., and J. Prothero. 1987. Scaling of maximal lifespan in bats. Comp. Biochem. Physiol. A, 88:361-???. [Zentrum Physiol., Med. Hsch. Hannover, D-3000 Hannover 61, Fed. Rep. Germany]

Metz, J., and J. van der Westhuyzen. 1987. The fruit bat as an experimental model of the neuropathy of cobalamin deficiency. Comp. Biochem. Physiol. A, 88:171-???. [Dept. Haematology, School of Pathology, S. African Inst. Med. Res., PO Box 1038, Johannesburg 2000, South Africa]

Prociv, P., and R. A. Tracey. 1987. Fecal synthesis of Vitamin B12 in Australian *Pteropus* species (Chiroptera: Pteropodidae). Australian Mamm., 10:5-11. [Dept. Parasitol., Univ. Queensland, St. Lucia, Queensland, Australia]

Speakman, J. R. 1988. Position of pinnae and thermoregulatory status in brown long-eared bats *(Plecotus auritus)*. J. Thermal Biol., 13:25-30. [Dept. Zool., Univ. Aberdeen, Aberdeen AB9 2TN, Scotland]

Unthank, J. L., and R. D. Hogan. 1988. Modulation of the spontaneous contractions of the initial lymphatics of the bat's wing by arterial and venous occlusion. Blood Vessels, 25:115-121. [Dept. Physiol. Biophys., Indiana Univ. School Med., Med. Sci. Bldg., 635 Barnhill Dr., Indianapolis, IN 46223]

van der Westhuyzen, J., R. E. Davis, G. C. Icke, and J. Metz. 1987. Tissue folates in fruit bats *(Rousettus aegyptiacus)* with nitrous oxide-induced vitamin B12 deficiency and neurological impairment. British J. Nutrition, 58:485-492. [Dept. Haematology, School of Pathology, S. African Med. Res. Ctr., Univ. Witwatersrand, PO Box 1038,

Johannesburg 2000, South Africa]

Wolk, E., and W. Bogdanowicz. 1987. Hematology of the hibernating bat, *Myotis daubentoni*. Comp. Biochem. Physiol. A, 88:637-640. [Mammals Res. Inst., Polish Acad. Sci., 17-230 Bialowieza, Poland]

Wright, P. G., and J. van der Westhuyzen. 1987. Peripheral nerve conduction in the fruit bat with nitrous oxide induced vitamin B12 deficiency. Comp. Biochem. Physiol. A, 88:253-???. [van der Westhuyzen: Dept. General Physiol., School of Dentistry, S. African Inst. Med. Res., PO Box 1038, Johannesburg 2000, South Africa]

POPULAR STUFF

Ackerman, D. 1988. A reporter at large—bats. The New Yorker, Feb. 29th Issue, pp. 37-62 (non-inclusive).

Martin, R. L. 1986. "There's a shortage of belfries." Maine Fish and Wildlife, 28:19-21. (includes plans for constructing an inexpensive bat house)

Moriarity, P. 1988. The Bats. Arizona Highways, 64:30-33. (nice write-up and some beautiful photos of bats by Merlin Tuttle)

REPRODUCTION

Bernard, R. T. F. 1988. Prolonged sperm storage in male Cape Horseshoe bats. Naturwissenschaften, 75:213-???. [Dept. Zool. Entomol., Rhodes Univ., Grahamstown 6140, South Africa]

Boyd, I. L., and D. G. Myhill. 1987. Variations in the postnatal growth of pipistrelle bats *(Pipistrellus pipistrellus)*. J. Zool., 213:750-???. [Monks Wood Experimental Station, Inst. Terrestrial Ecol., Huntington PE17 2LS, England]

Carter, F. D., and W. J. Bleier. 1988. Sequential multiple ovulations in *Macrotus californicus*. J. Mamm., 69:386-388. [Biol. Dept., Bismarck State Coll., Bismarck, ND 58501]

Currie, W. B., M. Blake, and W. A. Wimsatt. 1988. Fetal development, and placental and maternal plasma concentrations of progesterone in the little brown bat *(Myotis lucifugus)*. J. Rep. Fert., 82:401-407. [Dept. Anim. Sci., Cornell Univ., Ithaca, NY 14853]

Graham, G. L. 1987. [see under **ECOLOGY** above].

Kermott, L. H., and R. M. Timm. 1988. Scrotal melanins in bats (Chiroptera): description, distribution and function. J. Zool., Lond., 214:519-532. [Biol. Dept., St. Olaf Coll., Northfield, MN 55057]

Kurta, A., and T. H. Kunz. 1987. Size of bats at birth and maternal investment during pregnancy. Pp. 79-106 *in* Reproductive energetics in mammals (A.S.I. Loudon and P. A. Racey, eds.). Oxford Univ. Press, Oxford, 371 pp.

Manning, R. W., C. Jones, R. R. Hollander, and J. K. Jones, Jr. 1988. An unusual number of fetuses in the pallid bat. Prairie Naturalist, 19:261. [The Museum, Texas Tech Univ., Lubbock, TX 79409]

McWilliam, A. N. 1987. Polyoestry and postpartum oestrus in *Tadarida (Chaerephon) pumila* (Chiroptera, Molossidae) in northern Ghana, West Africa. J. Zool., 213:735-???. [Dept. Zool., Univ. Aberdeen, Aberdeen AB9 2TN, Scotland]

Moeschler, P., and J.-D. Blant. 1987. First accounts of reproduction of *Vespertilio murinus* (Mammalia, Chiroptera) in Switzerland. Revue Suisse Zool., 94:865-872. [Inst. Zool., Univ. Neuchatel, Chantemerle 22, CH-2000 Neuchatel, Switzerland]

Rasweiler, J. J., IV. 1988. Ovarian function in the captive black mastiff bat, *Molossus ater*. J. Rep. Fert., 82:97-112. [Dept. Obstetrics & Gynecology, College of Med., Cornell Univ. Med. Ctr., 515 E. 71st St., New York, NY 10021]

Son, S. W., M. H. Yoon, T. Mori, and T. A. Uchida. 1987. Sperm storage in the reproductive tract and prolonged survival of the Graafian follicle in the female orange whiskered bat, *Myotis formosus tsuensis*, of Korea. J. Mamm. Soc. Japan, 12:1-14. [Zool. Lab., Fac. Agriculture, Kyushu Univ. 46-06, Fukuoka 812, Japan]

SYSTEMATICS

Ando, K., M. Harada, and T. Uchida. 1987. A karyological study on five Japanese species of *Myotis* and *Pipistrellus*, with special attention to composition of their C-band materials. J. Mamm. Soc. Japan, 12:25-30. [Biol. Lab., Liberal Arts, Kyushu Sangyo Univ., Fukuoka 813, Japan]

Baverstock, P. R., M. Adams, T. Reardon, and C. H. S. Watts. 1987. Electrphoretic resolution of species boundaries in Australian Microchiroptera. III. The Nycticeiini—*Scotorepens* and *Scoteanax* (Chiroptera: Vespertilionidae). Australian J. Biol. Sci., 40:417-434. [Evol. Biol. Unit, S. Australian Mus., N. Terrace, Adelaide, SA 5000, Australia]

Handley, C. O. 1987. New species of mammals from northern South America—Fruit-eating bats, genus *Artibeus* Leach. Pp. 163-172 *in* B. D. Patterson and R. M. Timm (Eds.). Studies in Neotropical Mammalogy—Essays in Honor of Philip Hershkovitz. Fieldians: Zoology (n.s.), No. 39, 506 pp.

Harada, M., K. Ando, T. A. Uchida, and S. Takada. 1987. Karyotypic evolution of two Japanese *Vespertilio* species and its taxonomic implications (Chiroptera: Mammalia). Caryologia, 40:175-184. [Sch. Med., Experimental Anim. Lab, Osaka City Univ., Osaka 545, Japan]

Harada, M., K. Ando, T. A. Uchida, and S. Takada. 1987. A karyological study on two Japanese species of *Murina* (Mammalia: Chiroptera). J. Mamm. Soc. Japan, 12:15-24.

Herd, R. M. 1987. Electrophoretic divergence of *Myotis leibii* and *Myotis ciliolabrum* (Chiroptera: Vespertilionidae). Can. J. Zool., 65:1857-1860. [New South Wales Dept. of Agriculture, Trangie, 2823, Australia]

Leniec, H., S. Fedyk, and A. L. Ruprecht. 1987. Chromosomes of some species of vespertilionid bats. IV. New data on the plecotine bats. Acta Theriol., 32:307-314 + one plate. [Lab. Genetics Evol. Biol., Univ. Warsaw, Branch in Bialystok, Sosnowa 64, 15-887 Bialystok, Poland]

Novacek, M. J. 1987. Auditory features and affinities of the

Eocene bats *Icaronycteris* and *Palaeochiropteryx* (Microchiroptera, incertae sedis). Amer. Mus. Novitates, 2877:1-18. [Dept. Vert. Paleontology, American Mus. Nat. Hist., Central Park West at 79th St., New York, NY 10024]

Owen, R. D., and M. B. Qumsiyeh. 1987. The subspecies problem in the trident leaf-nosed bat, *Asellia tridens*—homomorphism in widely separated populations. Z. Saugetierk., 52:329-337. [The Museum, Texas Tech Univ., Lubbock, TX 79409]

Robbins, L. W., and V. M. Sarich. 1988. Evolutionary relationships in the family Emballonuridae (Chiroptera). J. Mamm., 69:1-13. [Dept. Biol., Southwest Missouri State Univ., Springfield, MO 65804]

Smithers, R. H. N., J. Meester, and I. L. Rautenbach. 1987. The type locality of *Pipistrellus (Romicia) kuhlii brooni* Roberts, 1948 (Chiroptera: Vespertilionidae). Mammalia, 51:463-???. [Meester: Univ. Natal, King George V Ave., Durban, S. Africa]

Wible, J. R., and M. J. Novacek. 1988. Cranial evidence for the monophyletic origin of bats. Amer. Mus. Novitates, 2911:1-19. [Dept. Anat., Univ. Chicago, Chicago, IL 60637]

Yoon, M. H. 1987. Identification of bats belonging to the Pteropodidae (Megachiroptera) collected from southeast Asia by the humeral characters. Korean J. Zool., 30:79-88. [Dept. Biol., Pusan Sanub Univ.]

BAT RESEARCH NEWS

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FRONT COVER

A solitary big brown bat *Eptesicus fuscus fuscus* hibernating in a cave in upstate New York. Photo by Tom Griffiths.

BAT NEWS RESEARCH

18th North American Symposium on Bat Research

VOLUME 29: No. 4 Winter 1988

BAT RESEARCH NEWS

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Instructions to Contributors and Subscribers:
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Subscriptions to individuals are U.S. $10.00 per year mailed 3rd class to U.S. addresses. All other countries, surface mail, printed matter, unless $10.00 per volume is prepaid for airmail 1st class to any address worldwide.

Institutional subscriptions are $15.00 worldwide.

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

Typeset by Tracy L. Robertson
at St. Lawrence University, Canton, New York
and
LWC Desktop Publishing, Bloomington, Illinois

Layout by G. Roy Horst

Mailed at Potsdam, New York, 13676, USA

BAT RESEARCH NEWS

Volume 29 Winter Number 4

NEWS

To all subscribers to *Bat Research News:* We need more news. Please take just a minute to sit down and type a brief paragraph about your research or conservation efforts, you bat-related travels, or the activities of friends, students, or colleagues. If *BRN* is to become a genuine newsletter (as so many of you told me you wanted it to be), I need your contributions. My address is on the inside front cover. Thanks to all of you who have participated to date, and to those of you who are inspired by this message to write something now. [**Tom Griffiths**]

CANADA

Université de Sherbrooke, Sherbrooke, QC: Yep! Canada has spawned yet another bat lab, this time in Quebec. For the past three years, I have been based at the Université de Sherbrooke. Although it is a francophone university, Sherbrooke has a number of English-speaking professors, so the door is open to those who have even a limited working ability in French and are willing to try a new environment. In my lab we are developing three main areas of research. In one, we are focusing on evaporative water loss in hibernating bats and questioning how this influences winter arousal rates and energy expenditure. Danielle Cloutier worked on laboratory-based measures of water loss in *Myotis lucifugus* and will finish her thesis by December 1988. In another area, we are continuing to look at frugivorous bats, seed dispersal, and nutritional ecology. We have made field measurements of *Carollia perspicillata* energy expenditure using doubly-labelled water and have recently established a small colony of *Carollia* in the lab. In a third area, we will be looking at how rainfall and foraging success affect the geographic distribution of reproductive male and female *Myotis* spp. [**Don Thomas**]

CZECHOSLOVAKIA

Institute of Systematical and Ecological Biology, Czechoslovak Academy of Science, Brno: From 1981 to 1983, I worked in Algeria as a Maitre de Conferences (equivalent of Associate Professor) at the University of Setif. While there, I studied the ecology and activity of the local bat fauna, both in northern (Mediterranean) and southern (desert) habitats, and collected bat specimens for further studies. The results are the subject of several papers, the citations of which have appeared in BRN. In October 1983, I became Docent of Zoology (again, equivalent to Associate Professor) at the Purkyne University in Brno, Czeckoslovakia. As of January 1, 1989, my position will be senior mammalogist at the Institute of Systematical and Ecological Biology, Czeckoslovak Academy of Science, Kvetna 8, 603 65, Brno.

Concerning the study of bats, I have studied the distribution and ecology of bats in S-Moravian lowlands for over thirty years. Results have appeared and will appear in the journal Folia Zoologica. I am also monitoring the abundance of the guild of bat populations hibernating in the caves of Moravian Karst. Data from this study were presented at the European Bat Research Symposium in Prague, August 1987. Finally, we are studying the behavior and ecology of the largest known nursery colony of *Myotis emarginatus*, located in the attic of a small hunting-castle near Lednice, S Moravia. Movements and age structure of that colony were originally followed using bat banding, but mass banding was stopped in 1980 and new techniques including sound detection (QMC Mini BD), mist-netting, reflective tape and light-tagging have or will be used in

the field research of that colony. Two undergraduates and one graduate student, Zdenka Bauerova, participated in the above-mentioned studies. Zdenka also carried out her own research on feeding strategies of insectivorous bats. She was a junior mammalogist at the Institute of Vertebrate Zoology in Brno, but unfortunately she died after a street accident early this year. This was a very sad event and a severe loss to both our mammalogy and nature conservancy programs, as Zdenka was deeply involved in the protection of nature and bats in particular.

At the kind invitation of Gordon Kirkland of Shippensburg University in Pennsylvania, I spent two months in the United States and Canada in the fall of 1988. Besides Gordie, other mammalogists who have supported my visit include V. M. Dalton, M. B. Fenton, K. F. Koopman, T. H. Kunz, M. D. Tuttle, and D. E. Wilson. I am much obliged to all of them. I visited several universities, museums, and field stations, and I participated in bat research using modern, top-level instrumentation. One of the goals of my visit was to continue my study of the morphology and behavioral ecology of the Nearctic *Myotis lucifugus* and the Palearctic *Myotis daubentoni*. The study was supported by my appointment as Short Term Visitor at the Smithsonian Institution. During my stay in the U.S., I also presented several lectures and seminars on bats and other mammals of Czechoslovakia for the public and for professionals and students of biology. [**Jiri Gaisler**]

EGYPT

U.S. Naval Medical Research Unit No. 3, Cairo: Under the leadership of the late Dr. Harry Hoogstraal, the Medical Zoology Department at the U.S. Naval Medical Research Unit No. 3 (NAMRU-3) in Cairo has had a long history of studies on the biology, distribution, ecology, and parasites of bats. Many of the studies, particularly those concerning infectious and parasitic agents associated with bats in North and East Africa and Southwestern Asia, continue. [**Andrew J. Main**]

SPAIN

Departamento de Biologia Celular, Universidad Complutense, Madrid: My students and I are studying the hypothalamus-hypophysis-mammary-gonadal axis as it changes in female bats during their annual sexual cycle. We use electron and optic microscopic-immunocytochemical techniques to study the various organs implicated in this axis. We've published our results on *Myotis myotis* in nine international reviews and five spanish ones, and we've presented our results at several congresses. We would be interested in receiving information from our colleagues on keeping species of Vespertilionidae alive in the laboratory. The information would be useful to us and would allow us to continue our work and obtain new results. [**E. Muñiz**]

SWITZERLAND

University of Berne and Neuchatel: Our small bat research group is predominantly involved in the bioacoustic investigation of Swiss bats. We are doing field work on acoustic species determination, and are investigating the flexibility of bat echolocation behaviour in the field. This activity has led to the development of precision broadband ultrasonic detectors and of a period meter. (The former is available as an add-on to the QMC S100 and S200 detectors or as a self-contained instrument.) Since 1988 we have also started to do bat conservation work in the canton of Berne. A Ph.D. student is developing a method for the determination of bat species by their echolocation sounds, and another graduate student is investigating the population dynamics of nursery colonies of *Myotis myotis* and its dependence on climatic factors. By 1990, Peter Zingg will probably be looking for a post-doc program. Several publications are on their way in the *Revue Suisse de Zoologie*. [**Karl Zbinden**]

UNITED STATES

CALIFORNIA

Natural History Museum, Los Angeles County: I am presently active in bat conservation, serving as the Chair of the National Speleological Society Fauna Protection Committee. The committee keeps tabs on bat conservation work and needs relating to caves and caving in the U.S. My research is in three areas. I am researching stable carbon isotope ratios in modern and fossil bat guanos, as a potential tool for paleoclimatic reconstruction. I am also studying heavy-metal records preserved in bat guano accumulations. Finally, I am researching community structure of tropical insular bat faunas using null-model simulation techniques. [**Donald A. McFarlane**]

MAINE

BATS in Maine, New Sharon: As reported in the last *BRN*, Bob Martin has continued to promote the welfare of Maine bats by speaking before live and media audiences, by urging people to construct bat houses, and by forming BATS in Maine, a conservation organization whose initials stand for "Bats Are Threatened Species." As part of his efforts to raise the consciousness of Maine

people, Bob founded "Maine Bat News" last June, a newsletter that addresses all bat-related issues in Maine. Bob writes: "With a group of former students, [I] founded a non-profit bat group here in Maine to try to stop the massive decline in bat populations and provide bat conservation information...Along with the bat programs I have given at cost to over 8000 youngsters in Maine since the fall of 1985, our major aim is promoting alternative housing for bats...we have had several recent large projects: 20 bat houses are going up in the Oyster River Bog thanks to the Oyster River Bog Association and the Camden-Rockport High School, 40 are going up on Mt. Desert Island/Acadia National Park thanks to Zack Klyver and the College of the Atlantic, and 100 are going up on Sugerloaf Mountain thanks to the Sugerloaf Mountain Corporation." Bob also reports that his organization is having some success at getting individuals to put up one or more bat houses. More power to you, Bob! [Based on several letters to Tom Griffiths from **Bob Martin**]

NEW YORK

Cornell University, Ithaca: I have been busy this summer with a number of activities, not the least of which included writing a grant proposal to get me back into bat flight research. Given the lag time of my last "quick" project with Bob Foehring on the histochemistry of *Artibeus jamaicensis* flight muscles (started in 1984 but just published in the *Journal of Morphology*), I'm hoping to get things moving and to have bats flying in the lab before the end of 1988. Hugh Aldridge visited Cornell in July which gave the two of us a good chance to argue over some current ideas concerning aerodynamics and motor control. Otherwise, most of my time has been devoted to a study of the morphology of shoulder muscles in horses. A primary objective of this work has been to elucidate the role of muscle compartments in postural as well as more dynamic equine activity (winning races, perhaps). Karyl Hurley, one of our second year veterinary students, has been working in the lab this summer doing much of the bench work and helping me with several other projects. [**John Hermanson**]

OREGON

Southern Oregon State College, Ashland: I am working on the local distribution of overwintering *Tadarida brasiliensis* in southern Oregon. I am also developing techniques for monitoring population size of a large maternity colony of *T. brasiliensis* in northern California. Finally, I am studying the impact of cave "renovation" and installation of air locks at Oregon Caves National Monument on the resident bat community (6 species). [**Stephen P. Cross**]

VERMONT

Vermont Institute of Natural Science, Woodstock: Margaret Barker, Program Director for VINS, has been giving educational presentations on bats throughout Vermont. She has spoken to a wide variety of persons, from adults to early elementary students. By all accounts, her educational programs have been effective in changing people's attitudes on bats. [from a letter by **Bob Martin** to Tom Griffiths]

RECENT LITERATURE

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

ANATOMY

Best, T. L. 1988. Morphologic variation in the spotted bat *Euderma maculatum*. Amer. Midl. Nat., 119:244-252. [Dept. Biol., Univ. New Mexico, Albuquerque, NM 87131]

Bhatnagar, K. P. 1988. fixation-preservation of bats in the field. Macroderma, 4:1-10. [Anat. Sci. Neurobiol., Univ. Louisville Sch. Med., Louisville, KY 40292]

De Gueldre, G., and F. De Vree. 1988. Quantitative electromyography of the masticatory muscles of *Pteropus giganteus* (Megachiroptera). J. Morph., 196:73-106. [Dept. Biol., Univ. Antwerp, 2610 Antwerp, Belgium]

Hermanson, J. W., and R. C. Foehring. 1988. Histochemistry of flight muscles in the Jamaican fruit bat, *Artibeus jamaicensis:* implications for motor control. J. Morph., 196:353-362. [Dept. Anat., NYS Coll. Veterinary Med., Cornell Univ., Ithaca, NY 14853]

Kawamoto, T. 1988. Distribution of muscle spindles in bat masticatory muscles and its significance. J. Stomatol. Soc. Japan, 55:87-105. [Sect. Anat., Inst. Stomatognathic Sci., Tokyo Med. Dent. Univ., Tokyo, Japan]

Kratky, J. 1988. The deciduous tooth morphology in the mystacine bat, *Myotis mystacinus* (Mammalia, Chiroptera). Vestn. Cesk. Spol. Zool., 52:22-27. [Gottwaldova 94, 289 12 Sadska, Czechoslovakia]

Taniguchi, I., O. Arai, and N. Saito. 1988. Functional laminar and columnar organization of the auditory centers in echolocating Japanese greater horseshoe bats. Neurosci. Letters, 88:17-20. [Dept. Auditory Disorders, Med. Res. Inst., Tokyo Med. Dental. Univ., 1-5-45 Yushima, Bunkyo-ku, Tokyo 113, Japan]

Wong, D., and S. L. Shannon. 1988. Functional zones in the auditory cortex of the echolocating bat, *Myotis lucifugus*. Brain Res., 453:349-352. [Dept. Anat., School Med., Indiana Univ., Medical Sci. Bldg. 204, Indianapolis, IN 46223]

Zook, J. M., and R. A. Dicaprio. 1988. Intracellular labeling of afferents to the lateral superior olive in the bat, *Eptesicus fuscus*. Hearing Res., 34:141-148. [Dept. Zool. Biomed. Sci., Ohio Univ., Irvine Hall, Athens, OH 45701]

BEHAVIOR

Wai-Ping, V., and M. B. Fenton. 1988. Nonselective mating in little brown bats *(Myotis lucifugus)*. J. Mamm., 69:641-645. [Dept. Biol., York Univ., North York, Ontario, Canada M3J 1P3]

BOOKS ON BATS

Greenhall, A. M., and U. Schmidt. 1988. Natural History of Vampire Bats. CRC Press, Boca Raton, fl, 272 pp.

Kunz, T. H. 1988. Ecological and Behavioral Methods for the Study of Bats. Smithsonian Inst. Press, Blue Ridge Summit, PA, 544 pp.

CONSERVATION

Brosset, A., L. Barbe, J. -C. Beaucournu, C. Faugier, H. Salvayre, and Y. Tupinier. 1988. Vanishing of *Rhinolophus euryale* in France. Examination of the factors. Mammalia, 52:101-???. [Ecol. Gen. Lab., Mus. Natl. Hist. Nat., 4 Ave. Petit Chateau, F-91800 Brunoy, France]

Clark, D. R., Jr. 1987. Selenium accumulation in mammals exposed to contaminated California irrigation drainwater. The Science of the Total Environment, 66:147-168. [U.S. fish and Wildlife Ser., Patuxent Wildlife Res. Ctr., Laurel, MD 20708]

Makin, D., and H. Mendelssohn. 1986. Reconsidering fumigation of bat caves. Israel—Land and Nature, 12:26-30. [Univ. of Tel Aviv]

CYTOLOGY

Nunez, E. A., R. F. Payette, H. Tamir, and M. D. Gershon. 1988. Ultrastructural immunocytochemical studies of the localization and distribution of somatostatin, calcitonin, calcitonin gene-related peptide, and substance P in the bat thyroid follicle. Anat. Rec., 221:707-713. [Dept. Anat. Cell Biol., College Physicians Surgeons, Columbia Univ., New York, NY 10032]

DISEASE

Banerjee, K., H. R. Bhat, G. Geevarghese, P. G. Jacob, and A. S. Malunjkar. 1988. Antibodies against Japanese encephalitis virus in insectivorous bats from Karnataka. Indian J. Med. Res., 87:527-530. [Natl. Inst. Virology, 20-A Dr. Ambedkar Rd., Pune 411001, India]

Botvinkin, A. D., A. V. Vakhrushev, and M. A. Selimov. 1988. Rabies virus has been isolated from a bat in western Siberia. Zh. Mikrob. Epidem. Immun. SSSR, 7:97. Min. Public Health Rsfsr, Nat. Focal Infect. Res. Inst., Omsk, USSR]

Okeke, C. N., and H. C. Gugnani. 1988. Isolation of *Exophiala jeanselmei* from bat guano. Letters Applied Microbiol., 6:97-98. [Dept. Microbiol., Univ. Nigeria, Nsukka, Nigeria]

DISTRIBUTION/FAUNAL STUDIES

Bergmans, B., and W. Bergmans. 1987. first record of *Dobsonia minor* (Dobson, 1879) from Sulawesi, Indonesia (Mammalia, Megachiroptera). Bull. Zool. Mus. Univ. Amst., 11:69-76. [Mus. Zoologicum Bogoriense, P.O. Box 110, Bogor, Indonesia]

De Roguin, L. 1988. Notes on mammals from Iranian Baluchistan. Rev. Suisse Zool., 95:595-606. [Mus. d'hist. Nat., case Postale 434, CH-1211 Geneve 6, Suisse]

Gaisler, J., and Z. Bauerova. 1985-86. The life of bats in a city. Myotis, 23-24:209-215. [Dept. Biol. Animals and Man, Faculty of Science, Kotlarska 2, 611 37 Brno, Czechoslovakia—but see new address in *NEWS*]

Happold, D. C. D., M. Happold, and J. E. Hill. 1987. The bats of Malawi. Mammalia, 51:337-414. [Dept. Zool., Australian Nat. Univ., Canberra, A.C.T. 2601, Australia]

Kokurewicz, T. 1987. New data on the occurence of lesser horseshoe bat *(Rhinolophus hipposideros* Bechstein, 1800) in East Sudetes (Poland). Przegl. Zool., 31:365-370. [Muz. Pryzrodnicze Uniwersytetu Wroclawskiego, ul. Sienkiewicza 21, 50-335 Wroclaw, Poland]

Samarra, F. X., and A. Carol. 1988. New specimens of the bat collection of the Barcelona Zoological Museum (Spain) from the last 30 years. Misc. Zool., 10:305-314. [Passeig Maragall 369, 08032 Barcelona, Spain]

Williams, D. F. 1986. Mammalian species of special concern in California. State of California Dept. of fish and Game, 86-1:1-112. [Dept. Biol. Sci., California State Univ. Stanislaus, Turlock, CA 95380]

ECHOLOCATION

Jen, P. H. -S., and D. Chen. 1988. Directionality of sound pressure transformation at the pinna of echolocating bats. Hearing Res., 34:101-119. [Div. Biol. Sci., Univ. Missouri, Columbia, MO 65212]

Menne, D. 1988. Is the structure of bat echolocation calls an adaptation to the mammalian hearing system? J. Acoust. Soc. Amer., 83:2447-2449. [Lehrbereich Zoophysiol.

Univ. Tubingen, D-7400 Tubingen 1, Fed. Rep. Germany]

Rübsamen, R. G. Neuweiler, and K. Sripathi. 1988. Comparative collicular tonotopy in two bat species adapted to movement detection, *Hipposideros speoris* and *Megaderma lyra*. J. Comp. Physiol. A, 163:271-285. [Neuweiler: Univ. Munich, Inst. Zool., Luisenstr. 14, D-8000 Munich 2, Fed. Rep. Germany]

Simmons, J. A., S. A. Kick, A. J. M. Moffat, W. M. Masters, and D. Kon. 1988. Clutter interference along the target range axis in the echolocating bat, *Eptesicus fuscus*. J. Acoustical Soc. America, 84:551-559. [Hunter Lab of Psychology, Brown Univ., Providence, RI 02912]

Sum, Y. W., and D. Menne. 1988. Discrimination of fluttering targets by the FM-bat *Pipistrellus stenopterus*? J. Comp. Physiol. A, 163:349-354. [Lehrbereich. Zoolphysiol., Inst. Biol. III, Auf der Morgenstelle 28, D-7400 Tuebingen, Fed. Rep. Germany]

ECOLOGY

Cross, S. P. 1986. Bats. Pp. 497-517 *in* A. Y. Coopereider, R. J. Boyd, and H. R. Stuart, eds. Inventory and monitoring of wildlife habitat. U.S. Dept. Interior, Bur. Land Management Service Ctr., Denver, CO, xviii + 858 pp. [Dept. Biol., Southern Oregon State College, Ashland, OR 97520]

Da Silva Nunes, V. 1988. Vocalizations of treefrogs *(Smilisca sila)* in response to bat predation. Herpetologica, 44:8-10. [Dept. Biol., Univ. Southwest. Louisiana, Lafayette, LA 70504]

Kowalski, K., J. Gaisler, H. Bessam, C. Issaad, and H. Ksantini. 1986. Annual life cycle of cave bats in northern Algeria. Acta Theriol., 13, 15:185-206. [Inst. Systematic Exper. Zool., Polish Acad. Sci., Slawkowska 17, 31-016 Krakow, Poland]

Norberg, U. M., and M. B. Fenton. 1988. Carnivorous bats? Biol. J. Linnean Soc., 33:383-394.

Perkins, J. M., and S. Cross. 1988. Differential use of some coniferous forest habitats by hoary and silver-haired bats in Oregon. The Murrelet, 69:21-24. [see address under Cross above]

Zubaid, Akbar. 1988. Food habits of *Hipposideros pomona* (Chiroptera: Rhinolophidae) from peninsular Malaysia. Mammalia, 52:134-137. [Fakulti Sains Hayat, Univ. Kebangsaan Malaysia, Jabatan Zool., Bangi 43600, Malaysia]

FLIGHT

Jones, G., and J. M. V. Rayner. 1988. flight performances, foraging tactics and echolocation in free-living Daubenton's bats *Myotis daubentoni* (Chiroptera: Vespertilionidae). J. Zool. (London), 215:113-132. [Dept. Zool., Univ. Bristol, Woodland Rd., Bristol BS8 1UG]

Rayner, J. M. V. 1988. The evolution of vertebrate flight. Biol. J. Linnean Soc., 34:269-287 [same address as above]

GENETICS

Qumsiyeh, M. B., R. D. Owen, and R. K. Chesser. 1988. Differential rates of genic and chromosomal evolution in bats of the family Rhinolophidae. Genome, 30:326-335. [Dept. Pharmacol., St. Jude Children's Res. Hospital, 332 N. Lauderdale, Memphis, TN 38101]

PALEONTOLOGY

Badgley, C., G. Qi, W. Chen, and D. Han 1988. Paleoecology of a Miocene, tropical upland fauna: Lufeng, China. Natl. Geographic Res., 4:178-195. [Mus. Paleontol., Univ. Michigan, Ann Arbor, MI 48109]

Menu, H. 1985. Morphotypes dentaires actuels et fossiles des chiroptères vespertilioninés 1st Partie: Etude des morphologies dentaires. Palaeovertebrata, 15:71-128. [U.A. 327 du C.N.R.S., Inst. des Sciences de l'Évolution. U.S.T.L., place Eugène Bataillon, 34060 Montpellier cedex, France]

Menu, H. 1987. Morphotypes dentaires actuels et fossiles des chiropteres vespertilionines 2nd Partie: Implications systematiques et phylogeniques. Palaeovertebrata, 17:77-150.

Woloszyn, B. W. 1987. Pliocene and Pleistocene bats of Poland. Acta Palaeontol. Pol., 32:207-325.

PARASITOLOGY

Gardner, R. A., and D. H. Molyneux. 1988. *Polychromophilus murinus:* a malarial parasite of bats: life history and ultrastructural studies. Parasitol., 96:591-606. [Molyneux: Dept. Biol. Sci., Ramage Labs, Univ. Salford, Salford M5 4WT, Lancs., England]

Kifune, T., I. Sawada, and M. Harada. 1987. Trematode parasites of Taiwanese bats: II. Med. Bulletin Fukuoka Univ., 14:279-284. [Dept. Parasitol., School Med., Fukuoka Univ., Nanakuma, Jonan-ku, Fukuoka, 814-01, Japan]

O'Connor, B. J., and J. S. H. Klompen. 1988. Occurence of the bat tick, *Ornithodoros kelleyi* (Acari: Argasidae), in Michigan. Great Lakes Entomologist, 21:93-??. [Mus. Zool., Univ. Michigan, Ann Arbor, MI 48109]

PHYSIOLOGY

Audet, D., and M. B. Fenton. 1988. Heterothermy and the use of torpor by the bat *Eptesicus fuscus* (Chiroptera: Vespertilionidae): a field study. Physiol. Zool., 61:197-204. [Dept. Biol., York Univ., North York, Ontario, Canada M3J 1P3]

Davis, M. J. 1988. Microvascular control of capillary pressure during increases in local arterial and venous pressure. Amer. J. Physiol., 254 (4 Part 2):H772-H784. [Dept. Med. Physiol., Texas A&M Univ., College Station, TX 77843]

Grant, J. D. 1988. Food-passage time in *Nyctophilus gouldi* (Microchiroptera: Vespertilionidae). J. Mamm., 69:653-655. [Dept. Zool., Australian National Univ., G.P.O. Box 4, Canberra, Australia Capital Territory 2601, Australia]

Kurta, A., and T. H. Kunz. 1988. Roosting metabolic rate and body temperature of male little brown bats *(Myotis lucifugus)* in summer. J. Mamm., 69:645-651. [Dept. Biol., Eastern Michigan Univ., Ypsilanti, MI 48197]

Schäfer, K., H. A. Braun, and L. Kürten. 1988. Analysis of cold and warm receptor activity in vampire bats and mice. Pflügers Archiv, 412:188-194. [Inst. Zoophysiol., Univ. Hohenheim, Garbenstr. 30, D-7000 Stuttgart 70, Fed. Rep. Germany]

Wakeham, N., R. P. Bogenschutz, and W. Caire. 1988. Electrophoretic investigation of urinary proteins in insectivorous bats. J. Mamm., 69:651-653. [Dept. Biol., Central State Univ., Edmond, OK 73060]

REPRODUCTION

Badwaik, N. K. 1988. The development and regression of the corpus luteum in two Indian bats. Proc. Not. Sem. Rep. Biol., 1988-77. [Dept. Zool., Inst. Science, Nagpur-440 001, India]

Buchanan, G. D., R. E. Garfield, and E. V. YoungLai. 1988. Innervation and gap junction formation in the myometrium of pregnant little brown bats, *Myotis lucifugus*. Anat. Rec., 221:611-618. [Fac. Health Sci., Repro. Biol. Res. Program, McMaster Univ., Hamilton, Ontario, Canada L8N 3Z5]

Buchanan, G. D., and E. V. YoungLai. 1988. Plasma progesterone concentrations in female little brown bats *(Myotis lucifugus)* during hibernation. J. Repro. Fertil., 83:59-65.

Horacek, I., and J. Gaisler. 1985-86. The mating system of *Myotis blythi*. Myotis, 23-24:125-129.

Krishna, A., and C. J. Dominic. 1988. Histological and histochemical observations on the corpus luteum of the Indian vespertilionid bat *Scotophilus heathi* Horsefield. Zool. Anzeig., 220:8-16. [Dominic: Dept. Zool., Banaras Hindu Univ., Varanasi 221005, Uttar Pradesh, India]

McWilliam, A. N. 1988. The reproductive cycle of male tomb bats, *Taphozous hildegardeae* (Chiroptera, Emballonuridae), in a seasonal environment of the African tropics. J. Zool., 215:433-442. [Dept. Zool., Univ. Aberdeen, Tillydrone Ave., Aberdeen AB9 2TN, Scotland]

SYSTEMATICS

Best, T. L., see under ANATOMY above.

Gopalakrishna, A., and N. Badwaik. 1987. Is *Rhinopoma* a rhinolophoid bat? J. Bombay Nat. Hist. Soc., 84:664-670. [Dept. Zool., Inst. Science, Nagpur-440 001, India]

Kitchener, D. J., B. Jones, and N. Caputi. 1987. Revision of Australian *Eptesicus* (Microchiroptera: Vespertilionidae) Rec. W. Austr. Mus., 13:427-500. [Western Australian Mus., Francis St., Perth, W. Australia 6000]

Parnaby, H. E. 1987. Distribution and taxonomy of the long-eared bats, *Nyctophilus gouldi* Tomes, 1858 and *Nyctophilus bifax* Thomas, 1915 (Chiroptera: Vespertilionidae) in eastern Australia. Proc. Linnean Soc. NSW, 109:153-174. [School Zool., Univ. New South Wales, P.O. Box 1, Kensington, Australia 2033]

Madkour, G. 1988. Faces of Microchiroptera from Egypt. Zool. Anzeig., 220:82-92. [Faculty Sci., Dept. Zool., Tanta Univ., Tanta, Egypt]

ZOOGEOGRAPHY

Griffiths, T. A., and D. Klingener. 1988. On the distribution of Greater Antillean bats. Biotropica, 20:240-251. [Dept. Biol., Illinois Wesleyan Univ., Bloomington, IL 61702]

Abstracts of Papers Presented at the Eighteenth Annual North American Symposium on Bat Research at the University of Calgary, Calgary, Alberta

Abstracts appear alphabetically by first author

A Morphometric Comparison of Limb Proportions in Phyllostomid Bats

Beverley Anderson
Department of Biological Sciences,
University of Calgary

A comparison of the wing proportions of phyllostomid bats was undertaken in order to determine if the leaping and terrestrial abilities of the common vampire bat (*Desmodus rotundus*) affect the intermembral indices (sensu Oxnard et al. 1981) in any way. The multivariate statistical method of multiple discriminant analysis was used to analyze 20 measures of limb proportions from 356 specimens representing 39 genera of phyllostomid bats as well as 1 genus of mormoopid bat. The morphometric analysis of the wing was compared to a similar analysis of several skull parameters of these genera in order to determine if modifications, associated with feeding, seen in the head region, are in any way reflected by wing morphology. This kind of analysis may be useful in determining phylogenetic relationships, or morphological similarities due to similar function. Using measurements of bones rather than wing outlines in a study of this kind may help to remove some of the error that is inevitably introduced when tracing wing membranes.

Foraging Strategies and Use of Space by the Indian False Vampire, *Megaderma lyra* (Megadermatidae)

D. Audet, D. Krull, G. Marimuthu, S. Sumithran, J. Bala Singh
Dept. of Biology, York Univ., Zool. Inst. Luisenstr., and Unit of Anim. Behav., Madurai Kamaraj Univ.

Although foraging strategies of bat species can be predicted from their morphologies, individuals can be flexible in their foraging behaviour. *Megaderma lyra* is expected to use a sedentary foraging strategy. The aim of this study was to investigate the foraging behaviour and use of space by free-living *M. lyra*. We radio-tracked 17 individuals (7 males, 10 females) from a colony of ca. 300 *M. lyra* in the Tirunelveli district, South India, between 9 March and 5 April 1988. Two of eight pregnant females gave birth while carrying transmitters. Two females were not pregnant nor lactating. The bats carried active tags for 153 bat days. On 42 occasions we were in contact with the bats in their foraging areas for over 60 min, and on 22 occasions we could follow individuals through the entire night. Individual bats used one or two non-exclusive foraging areas from 100 m to 4 km away from the colony. Successful hunting flights involved both short flights (within 20 m from a perch) and longer commuting flights (up to ca. 200 m). We observed individual variations in the nightly activity of the bats. These variations are discussed according to the sex and reproductive state of the bats.

Vocal Recognition in Mexican Free-tailed Bats

J.P. Balcombe
Department of Zoology, University of Tennessee

Twenty-five nursing pairs of Mexican free-tailed bats were collected from Davis Cave, Texas, during June and July 1988, and presented with playback choice experiments to test the hypothesis that mothers, and pups beyond a certain age, can recognize the calls of kin. Mothers and pups were tested in separate circular wire-screen areas measuring 46 (diam.) x 7.5cm and 38 x 7.5cm, respectively. On each side of the arena a speaker was placed just beyond the arena wall, and a stuffed cloth bat model just inside the wall. Bats crawled into the arena through a 5cm. diameter plastic tube. Each mother trial lasted 10 minutes; pup trials were 5 minutes. Bat responses were measured by comparing the amount of time spent in each side of the arena, and time spent in contact with each model. Control presentations were identical to experimental, except that blank tape noise emanated from each speaker. Mothers preferred calls of their own pup over those of a strange pup; pups showed no preference. These findings indicate a role of pup calls in mother-pup reunions by this species.

Roosting Behaviour of Hoary Bats (*Lasiurus cinereus*)

R.M.R. Barclay and C.E. Kochler
Biological Sciences, University of Calgary

Using radiotelemetry and visual observation of individually marked female hoary bats at Delta, Manitoba, we investigated roost selection, roosting home range and site fidelity. Lactating females roost with their young in the foliage of trees and select sites that appear to provide a direct flight path as well as shelter from wind, rain and sunlight. Family groups frequently move from one roost to another. Moves are generally under 100 m and may be caused by high winds, movement of newly-volant young or human disturbance. Females return to the same area and often the same trees each year. Very limited data suggests that yearling females also return to the area in which they were born. This may be important in terms of genetic makeup of the population.

Energy Monitoring by Frugivorous Bats: Sloppy or Tight Control of Food Intake?

Louis Breton, Biology, University of Sherbrooke

Frugivorous bats face diets that are relatively rich in energy but poor in protein when they feed exclusively on fruits. An unresolved question is: Do bats adjust their food intake on the basis of energy or protein requirement? We offered *Carollia perspicillata* semi-artificial diets in which energy levels were adjusted (low-normal-high) from a high quality diet we give the colony. On both reduced and enhanced diets bats increased that intake by 16% (enhanced) and 23% (reduced) relative to the basal diet. This greatly altered their total energy intake over the experimental period. We discuss the control of body composition and daily food intake in this experiment.

Foraging Strategies of Nocturnal Aerial Insectivores

R.M. Brigham
Biological Sciences, University of Calgary

The purpose of this study was to determine whether the prey detection system, wing gape morphology or prey availability determines the foraging strategies of common nighthawks (*Chordeiles minor*) and big brown bats (*Eptesicus fuscus*) in the Okanagan Valley of British Columbia. I predicted that relative to *E. fuscus* : 1) *C. minor* foraging bouts should be restricted in time and duration by light levels, 2) *C. minor* diet breadth and the size of prey should be larger, and 3) *C. minor* should feed in structurally less cluttered habitats. I found that *C. minor* forage for 1.5 hours per day in 2 bouts. The timing of bouts, but not the temporal pattern was correlated with light levels. *E. fuscus* flew for 1.5 to 3.0 hours per night with bouts occurring throughout the night. *C. minor* eat the same type and size of prey at the same rate as *E. fuscus*, with both species foraging at the same site 60% of the time. I conclude that at this study site, a rich prey patch, predictable in time and space, exerts the most influence on the foraging behaviour of both species.

Prey Selection, Foraging and Habitat Use by *Chrotopterus auritus* in Costa Rica

A.P. Brooke, Department of Zoology,
University of Tennessee

The feeding and hunting behaviour of *Chrotopterus auritus* was observed in captivity and by radio tracking at Biological Station La Selva, Costa Rica. In feeding behaviour experiments noise generated by prey was used to detect and catch selected animals. While searching for prey, *Chrotopterus auritus* scanned the surrounding area by continuously rotating its body through a 180° arc. Attack sallies were directed only at birds and bats when they flew; noise generated from flight and movement by beetles, katydids, lizards and toads was ignored. Radio tracking showed that the bat hunted in 4 ha. of swamp forest, an area characterized by scattered canopy emergent trees and low undergrowth. These results suggest that *C. auritus* has a "sit-and-wait" foraging strategy, hunting selected, active prey.

Activity Patterns and Foraging Behaviour of *Hipposideros turpis* on Iriomote Island as Determined by Radio-telemetry

P. Brown, R. Berry and S. Matsumura
Department of Biology, UCLA and the School of
Allied Health Sciences, Yamaguchi University

The Old World leaf-nosed bat, *Hipposideros turpis*, lives in manmade tunnels on mountainous Iriomote Island at the Southern end of the Ryukyu chain. This constant-frequency bat forages for beetles in the dense tropical forest. Observations with night vision goggles and a bat detector, suggest a flycatcher method of feeding similar to that of *Hipposideros commersoni* and *H. diadema*. As the result of a preliminary radio-telemetry study conducted in June 1988, it appears thaat individual bats have preferred foraging sites. They leave the roost at dusk, returning just before dawn, although several hours each night are spent hanging immobile in trees between foraging bouts.

Social Structure in Big Brown Bats

J.E. Cebek
Department of Biology, York University

Both theory and a limited amount of empirical evidence suggest that temperate zone bats mate and disperse randomly so there should be little of no genetic differentiation between subpopulations. In big brown bats, however, the results of exclusion experiments suggest that maternity colonies are discrete social units. I used enzyme electrophoresis to test the hypothesis that the members of one colony will be more closely related to one another than to members of other colonies 5 km to 100 km apart. Blood samples are collected from bats in six colonies in southern Ontario and at least eight polymorphic loci among 24 enzyme systems allowed me to compare the genetic similarity between and within the colonies.

The Indiana Bat and Gray Bat Comprehensive Plan for Missouri

R.L. Clawson
Missouri Department of Conservation

The Missouri Department of Conservation (MDC) has developed a comprehensive plan to coordinate enforcement, management, and research activities for endangered bats in Missouri. The ten-year plan specifies objectives, delegates responsibilities, and identifies strategies and tasks to be performed. The goals of the plan are: 1) to halt the decline of Indiana bats in Missouri, and 2) to increase populations of both Indiana bats and gray bats in Missouri by the end of the plan period. The plan describes an ambitious program of research, population monitoring, habitat acquisition and protection, and public education. It will allow MDC personnel to plan management and research activities, to allocate funding, and to set and prioritize annual work objectives. It also establishes criteria by which to measure progress toward meeting the stated objectives.

Pulmo-cutaneous Water Loss in Hibernating Bats

Danielle Cloutier
Biology, University Sherbrooke

This paper won first place in the graduate student competition.

For temperate zone bats, hibernation is the primary adaptation to long term reductions in winter food availability. Torpor itself is not energetically costly, however, arousal from torpor is. Factors that affect arousal frequency could play a key role in hibernation energetics. We measured total evaporation water loss (EWL) by placing bats in sealed chambers provided with different dry air flows. Water lost by torpid bats (2-4°C) was collected in a dessicant. Total EWL was in the order of 50.7mg body water day at 80% R.H. (Ta+2°C). Since Kallen (1964) indicated that a 6.0g *Myotis lucifugus* could lose up to 0.252g of water before needing to arouse, we can calculate that bats may arouse at intervals as short as 5 days to rehydrate if they roost solitarily. We also partitioned total EWL between pulmonary and cutaneous routes. Pulmonary losses were

estimated by measuring the tidal volume in a head-body plethysmograph. Tidal volumes were low (x=0.046ml± 0.002 SE) and bats breathed at extremely low frequencies. Bats breathed for periods of only 1.6 minutes, followed by bouts of apnea lasting for 31.6 minutes± 1.1 SE. Calculations of pulmonary losses indicated that this route contributes less than 1% of total EWL. Although bats frequently hibernate in caves or mines having greater than 90% R.H., numerous observations indicate that they can select sites with as low as 70% R.H. This study indicates that where R.H.'s are low, water may determine arousal frequency, and hence affect winter energy budgets. This study also underlines that clustering may play an important role in body water conservation.

Critical Habitat of the Gray Bat (*Myotis grisescens*) in Kansas

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Gray bats, *Myotis grisescens*, were trapped and banded as they emerged from the only known maternity colony for the species in Kansas. They subsequently were spotlighted in foraging areas to determine the critical habitat of the colony. Females were still carrying half-grown young in flight in late June, but young were on the wing by early July. The bats used riparian areas as flyaways in early summer but, as the colony size increased during late summer (possibly due to an influx of bats from colonies in Missouri), they began flying directly overland to their foraging areas. Gray bats were found within a 16 km radius of the storm sewer entrances. They appeared to be non-specific in their selection of foraging areas so long as water was present and dense forest cover or steep slopes afforded protection from wind. A more detailed analysis of habitat requirements as determined from circular plots is still in progress.

Prey Detection and Foraging Behaviour of the Long-eared Bat, *Myotis evotis*

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Department of Biological Sciences,
The University of Calgary

This paper won second prize in the graduate student competition.

Myotis evotis is a small, insectivorous bat that possesses the largest ears of any North American *Myotis*. This bat is commonly described as a gleaning species (Findley 1972, Norberg and Rayner 1987), and while morphological evidence suggests that *M. evotis* is ideally suited for this foraging style, observations (field or laboratory) of gleaning behaviour are lacking. I examined the foraging behaviour of *M. evotis* under laboratory conditions and investigated the sensory cues used by *M. evotis* for prey detection. Captive bats readily gleaned moths, but were also capable of capturing prey on the wing. Preliminary results indicate that prey generated sounds alone are sufficient for prey detection; *M. evotis* can locate fluttering moths without the use of visual or echolocation cues. Prey movement also appears to be an important sensory cue; stationary moths are not as readily detected. Additionally, attack sequences of *M. evotis* foraging for moths were recorded to determine whether or not echolocation was used while gleaning.

Variations in the Heads and Teeth of Bats: Implications for Foraging Behaviour

M.B. Fenton
Department of Biology, York University

I took measurements of body size (forearm length), head size (condylocanine length and mastoid width), and gape (tooth-row length and width) in 245 species of bats and used regression analysis of covariance to examine correlations between these features and foraging behaviour. In the analysis, "animal-eating" bats included Phyllostominae (15), Emballonuridae (18), Mormoopidae (6), Noctilionidae (2), Nycteridae (7), Megadermatidae (3), Rhinolophidae (25), Hipposideridae (17), Myzopodidae (1), Vespertilionidae (62), and Molossidae (38), while "other bats" were Phyllostomidae (29, including the three vampires) and Pteropodidae (22). In most situations, there were significant ($p > 0.001$) relationships between bat size and head size and length and width of the gape, and within the animal-eating bats, analysis of covariance showed significant ($p > 0.001$) differences between families. Bats using continuous aerial foraging tend to have smaller heads and teeth than those using sally foraging. The molossids and the hipposiderids are exceptions to this trend, the former have larger heads than predicted, the latter smaller ones. The larger heads and tooth-rows of most species of bats using sally foraging coincide with the selection of larger prey (> 5% of the bat's body mass).

Roosting and Foraging Behaviour of the Queensland Tube-nosed Bat, *Nyctiomene robinsoni*

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Field Study Centre

We studied the roosting and foraging behaviour of *Nyctiomene robinsoni* (Pteropodidae) at Cape Tribulation, North Queensland, in November and December 1987 using mist netting and radio telemetry techniques. Bats were captured under and around fruiting *Annona muricata* trees in a fruit orchard and cluster-fig trees (*Ficus* sp.) in abandoned pastures. Females outnumbered males in the orchard, but the sex ratio was 1:1 under fig trees. Median distance between day roost sites and capture locations was 506 m (range: 63 - 1012 m, n = 12 bats). Bats roosted solitarily in the foliage of canopy or understory trees, usually in primary forest, during the day. Most individuals roosted in the same small area for several consecutive days. Except for occasional visits to isolated fruiting trees, bats foraged within 200 m of their day roost at night.

The Effects of Load-carrying on the Flight Behaviour of *Macrotus californicus* and *Eptesicus fuscus*

B. Forbes
Department of Biology, York University

I examined changes in the flight behaviour of four *Macrotus californicus* and two *Eptesicus fuscus* when the bats were carrying different-sized food items in their mouths. These species are known to use different foraging strategies, with *M. californicus* often making short flights from perches to attack passing prey, and *E. fuscus* flying continuously while foraging, which results in their taking different sized prey. Sally foragers tend to take larger prey (relative to their body masses) than continuous aerial foragers. I used stroboscopic photography to examine the bats' flight patterns and used the results

to test some predictions about how these bats might accommodate their flight to front end loading. Specifically, in response to heavier front-end loading, I expected changes in the wings's paths during the downstroke, and differences in the attitude of the uropatagium to increase the wings' camber. I predicted that *Macrotus* should accommodate better to increased front-end loading than *Eptesicus*.

Composition of the Malaysian Rain Forest Bat Community

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I compared the flight characteristics of michrochiropterans caught in the understory of Malaysian rainforest with those of the total Malaysian fauna to test the hypothesis that forest bats are adapted to fly in a cluttered environment. I used ratios of linear wing measurements taken from museum specimens as indices of flight characteristics. Overall, bats caught in the forest had significantly lower aspect ratios than other species, but did not differ in wing loading. The differences in aspect ratio were due partly to the large number of species of *Rhinolophus* and *Hipposideros*, which have broad rounded wings, that were caught within the forest, and the presence of several molossids and emballonurids, with narrow pointed wings, outside the forest. However, there were similar differences within the Vespertilionidae, with more broad-winged species within the forest. I also compared rarely caught species with common species, to test whether the former may be better adapted to a different habitat. No differences were detected, but this does not rule out the possibility that some "rare" species normally inhabit another habitat, such as the forest canopy, that is also cluttered.

Size, Shape, and the Role of Crack Propagation in Bat Canine Teeth (Microchiroptera)

P.W. Freeman
University of Nebraska State Museum

Upper canines in microchiropteran bats come in a variety of cross-sectional shapes. The consistent feature of all the species studied here is that the tooth is edged and not simply rounded or oval. Prominent sharp edges are positioned in several directions but particularly antero-medially toward the incisors and posteriorly toward the premolars. These edges appear to direct the cracks made in food items to the incisors or to a continuous cutting edge from tip of canine to ectoloph of the molars. Size and shape analysis indicates that larger bats have slender canines for their height, not stouter, a condition which may be attributable to the nature of the prey. Most of the bats take prey that have little or no hard, brittle substances imbedded within. The compromises in shape for this tooth potentially revolve around being a predator with short, conical canines, which are involved with eating endoskeletal prey, as opposed to being a small flying predator with long, slender, edged canines that mostly process and capture exoskeletal prey. Foods with bone inside will blunt sharp teeth, while foods with a soft filling inside will not. Simple incuspid teeth and how they might function in food break-up have been overlooked in the literature and may help to understand how more complex teeth are functioning.

Echolocation Survey Estimates of the Distribution of the Endangered Hawaiian Bat (*Lasiurus cinereus semotus*) on the Island of Kaua'i

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The distribution of the Hawaiian hoary bat on the island of Kaua'i was estimated using a QMC Mini Bat Detector during dry (August 1987) and wet (March 1988) seasons. Surveys were made along roadways and paths leading into the forests of this island. Particular attention was paid to forest edges, river outlets and water reservoirs, habitats suggest to be favoured by this bat. My results indicate that this bat is uncommon and restricted to open areas near wet forests. There appears little difference in distribution patterns between wet and dry seasons and the bat appears to favour river outlets that connect with wet upland forests. These results suggest that *L. c. semotus*'s current endangered status is justified and that continued development of the Hawaiian islands for agricultural or tourism purposes will further threaten this species.

Echolocation Ecology of a Community of Insectivorous Bats in a Forest in South-western Australia

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The dry, eucalyp Perup forest of south-western Australia contains a community of nine insectivorous bats from two families and the echolocation signals of seven of these species were recorded. The predominent frequencies of these signals range from 15 kHz (*Tadarida australis*) to 84 kHz (*Nyctophilus gouldi*). Relationships between the echolocation parameters of these bats, their flight morphologies and observations of their foraging patterns suggest a habitat separation. We propose that the two molossids (*T. australia* and *Mormopterus planiceps*) use above-canopy hunting areas; three of the vespertilionids (*Chalinolobus gouldii*, *Eptesicus fuscus* and *C. morio*) use mid-forest zones and two other vespertilionids (*N. geoffroy* and *N. gouldi*) forage either very close to or actually glean from vegetation on the forest floor. The results from this study will be compared to those described for an Indian and a Panamanian community and generalities proposed.

Genetic Comparisons of Migratory and Non-Migratory Populations of *Tadarida brasiliensis* in the United States

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In the U.S. there are three distinctive sets of populations of free-tailed bats all generally considered members of the same species *Tadarida brasiliensis*. With some exceptions, populations in the eastern U.S. and California show local seasonal movements between roosts. Colonies of generally fewer than a few thousand bats roost in a diversity of sites. Southwestern

U.S. populations overwinter and mate in Mexico and typically migrate several hundred kilometers to summer maternity colonies which often include several million individuals. Despite substantial behavioral variation, morphological differences among these groups are subtle and systematic relationships are controversial. Here we report results of genetic studies on these populations using allozyme techniques. Samples were obtained from three eastern populations (Florida [2], Arkansas [1]) and two California populations for comparison with extensive genetic data available from the southwestern populations. We examined 22 loci of which 10 were polymorphic in one or more populations. All populations were genetically very similar. Average genetic similarity (Rogers, 1972) between the eastern and the southwestern populations was S = 0.947 whereas similarity between western and southwestern populations was S = 0.987. Comparisons between eastern and western populations showed an average S = 0.939. These estimates are typical of those seen between local populations of most species.

Evolution of the Hyoid Region of Emballonuroid and Other Bats

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The hyoid regions of emballonurid, rhinopomatid, and megadermatid bats contain some unexpectedly derived apomorphic features not found in other bats. In rhinopomatids, the sternohyoid is a reduced, weak muscle. In megadermatids, the sternohyoid-geniohyoid-hyoglossus complex has detached from the hyoid bones, paralleling the "free-floating" condition found in advanced phyllostomids. Most remarkable of all, in emballonurids the sternohyoid has become attached to the posterior larynx and apparently functions as an extrinsic laryngeal muscle rather than as a primary tongue retractor. In all three families, changes in muscle morphology were facilitated by a mediad shift of the origin of another muscle, the omohyoid. It is possible that the differences observes in feeding habits and echolocation calls of vinochiropteran bats (families Emballonuridea, Rhinopomatidae, and Megadermatidae) are in part the direct result of the shift of origin of a single muscle, the omohyoid, millions of years ago.

Non-cave Roosting Sites of the Endangered Gray Bat, *Myotis grisescens*, in Arkansas

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A gray bat maternity colony numbering ca. 7000 adults and young occupies a storm sewer in "downtown" Newark, Independence County, Arkansas, population 1100. The storm sewer is 155 m long, 1.1 wide, and 1.1 m high. It is located under the sidewalk and main street of the town and is ca. 4.3 km from the White River. Bats roost in a slightly domed area 10-15 m from the southeast end of the structure. Temperature near the roost site was 33°C. An abandoned mine in Boone County, Arkansas serves as a transient roost for groups of gray bats numbering as many as 1100. A few gray bats have also been observed hibernating in the mine.

Foraging Behaviour and Use of Torpor by the Hoary Bat (*Lasiurus cinereus*)

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I used reflective colour-bands to observe individual *Lasiurus cinereus* at their foraging sites in 1986 and colour bands and temperature sensitive radio transmitters to gather detailed data on their movements and use of torpor in 1988. In 1986 bats foraged for an average of 164 minutes per night (N-12) and lactating females foraged longer than post-lactating or non-reproductive females. Direct observation of encounters with prey revealed that *L. cinereus* were successful on 52% of their attempts and wings culled from their prey suggested that they preyed excusively on Lepidoptera. Between 20 June and 24 July 1988 I radio tracked three *L. cinereus* (one Lactating and two non-reproductive females) for a total of 9 nights and during this time they never used torpor, but the lowest night and day temperatures were 5° and 16° C respectively. These data do not support the hypothesis that bats in different reproductive states use torpor differently but the sample size is small and summer temperatures were warm.

Development of Free-Living Bat Colony as a Museum Exhibit

R.S. Kennedy and J.B Cope

Cincinnati Museum of Natural History and Department of Biology, Earlham College

The Cincinnati Museum of Natural History is planning to establish a free-living bat colony as part of its new limestone cavern exhibit in the Museum's future home in Cincinnati's Union Terminal in 1991. The enclosure will be 3.5 m wide, 1.6 m deep, and 6.6 m high with the capability of being partitioned into upper and lower chambers. It will be connected to the outside of the building by a 30 m long, 0.6 m diameter tube and will have environmental controls to provide temperatures [illegible] 38° to 100° F and relative humidity from 50 to 100%. Visitors will view the bats through two layers of glass and at two levels from within the cavern. Methods of introducing *Myotis lucifugus* will be discussed and future research necessary to establish and maintain the colony will be presented. The facility is viewed as a prototype that may one day be used to manage endangered bats.

Habitat Separation for Seven Species of Bats in the Sclerophyll Forests of Southwestern Australia

C. Koehler and J.H. Fullard
University of Calgary

Research was conducted at the Conservation and Land Management field station, Perup, near Manjimup, Western Australia. The station is situated in very dry sclerophyll forest. This environment is shared by nine species of insectivorous microchiropterans, seven of which will be considered. Bats were mistnetted as they came to waterholes at dusk. Measurements were taken, feces collected, and the bats were then flown in an enclosed area. Preliminary reflections on habitat partitioning with respect to flight morphology and feeding will be discussed.

The Foraging Behaviour of the Notch-eared Bat *Myotis emarginatus* (Vespertilionidae)

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From May to August in 1986 and 1987 we observed a nursery colony of 90 adult *Myotis emarginatus*. The colony roosted in a dim, cool attic of a church located about 60 km SE of Munchen where 14 bat species including 7 *Myotis* are sympatric. Foraging *M. emarginatus* were found up to two hours after emergence and one to two hours before dawn at three differently structured habitats within 200m from the nursery roost. In a cow-shed and at a willow tree they were gleaning insects from the walls and foliage. Over an unobstructed dung-pit *M. emarginatus* were hunting on the wing. Six adult *M. emarginatus* were tagged with 0.8 g transmitters. Three individuals could be followed for a total of 6 bat-nights. Their foraging areas and secondary dayroosts were 2 to 10 km away from the nursery roost. In average these bats spent 363 minutes out of their secondary roost and showed continuous flight activity in forrested areas. Feces analysis revealed a diet that consisted mainly of flies and spiders throughout the season. These results show that *M. emarginatus* belongs to the group of gleaning bats but is also able to switch to other foraging strategies.

Time Activity Budgets and the Economy of Harem Maintenance in the Greater Spear-Nosed Bat, *Phyllostomus hastatus*

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We used radiotelemetry and doubly labeled water to test the null hypotheses that there were no differences in the nightly foraging/commuting time and daily energy expenditure among male and female harem members of *Phyllostomus hastatus*, from Trinidad, West Indies. Our results indicate that harem females typically had one foraging/commuting bout (FCB) concentrated during the first 2-3 h of the night, averaging 151 min., whereas harem males made several short FCB's during the night, for a total foraging/commuting time of approximately 104 minutes. Using isotopically labeled animals that we simultaneously monitored using radiotelemetry, our results indicate that FCB's accounted for approximately 11% of a female's daily time budget and 53% of its daily energy expenditure (DEE). By contrast, FCB's accounted for about 7% of a harem male's daily time-budget and 34% of its DEE. Although nightly FCB's and associated energy expenditure were greater for harem females, DEE was greater for harem males. These results suggest that the additional DEE recorded for harem males reflects the activities associated with harem maintenance in the roost.

Reproductive Energetics and Water Flux in Free-ranging *Eptesicus fuscus*

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We used doubly-labeled water to examine the energetics and water flux of free-ranging big brown bats (*Eptesicus fuscus*) during pregnancy and lactation. The field metabolic rate was 1749 ± 144 (SE) ml CO_2/day for 16 pregnant females and 2770 ± 351 ml CO_2/day for five lactating females. These metabolic rates are equivalent to 17.6 ± 3.9 and 75.3 ± 9.54 kJ/day during pregnancy and lactation respectively. Estimates of chemical energy deposited as new tissue during pregnancy raised daily assimilated energy demand to 18.9 kJ/day; milk export raised mean energy expenditure during lactation to 105.1 kJ/day. Mean water flux was 8.47 and 17.07 ml H_2O/h for pregnant and lactating females, respectively. The primary source of water influx was preformed water in the diet, but both pregnant and lactating females obtained some water by drinking. Estimated urinary losses accounted for the largest proportion of daily water efflux.

Tent Construction and Use by *Uroderma bilobatum* in Coconut Palms (*Cocos nucifera*) in Costa Rica

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Tent construction and use, uniformity, and frond selection were studied in a population of *Uroderma bilobatum* roosting in coconut palms (*Cocos nucifera*) in northwestern Costa Rica during July, 1988. Palm leaflets were cut at the midrib in a line converging distally with the frond midrib and collapsed downward to form large, enclosed tents. Tree height, angle of orientation of cut fronds, and number of cut fronds hanging above a tent were recorded to ascertain if bats were selecting specific fronds. Tent height, number of leaflets cut, and angle between the line of cut leaflets and the midrib of fronds showed variability between tents. Bat tents were found in trees with a narrower range of heights than the overall tree population, and trees with tents were taller on average than trees without tents. The ecological and evolutionary significance of tent construction by *Uroderma* is discussed.

Cues Used for Spatial Memory of Big Brown Bats

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We report a series of experiments designed to investigate the type of cues big brown bats (*Eptesicus fuscus*) use to remember their location in space. Previous work showed that bats trained to come to a target for food within a small rectangular cage failed to do so when the cage and other proximal cues were rotated 180 degrees. It was proposed that the bats might have used some conspicuous distal feature of the testing room for spatial memory. This hypothesis was tested by training bats in small rooms where the available cues could be rotated singly or in combination. Cue rotation had no effect on the bat's ability to find the target except when all cues were rotated together. This indicates the possibility of some sort of "gestalt" memory of the bats of their surroundings. However, considerable variation in the performance of individual bats leaves open the possibility of idiosynchronic use of cues for spatial memory.

The Influence of Clutter and Noise on the Activity of Bats Over Water

R.L. Mackey and R.M.R. Barclay, Department of Biological Sciences, University of Calgary

To determine why some bats concentrate their activity over calm water as compared to turbulent water, we studied the effects of surface clutter and running water noise on the foraging activity of *Myotis lucifugus* (little brown bats) which commonly fly close to the water surface, and *Eptesicus fuscus* (big brown bats) which forage at greater heights, in southwestern Alberta, Canada. In paired experiments on calm water, artifical clutter reduced the activity of *M. lucifugus*, but not *E. fuscus*, compared to natural conditions. Playbacks of the sound of turbulent water reduced the activity of both *M. lucifugus* and *E. fuscus* in paired experiments over calm water. Clutter is an obstacle to flight and produces extraneous background echoes that must be discriminated from prey echoes. Water noise may also interfere with prey detection. The result may be reduced foraging efficiency by bats and a preference for calm bodies of water over turbulent ones.

Range Discrimination of Targets Using Normal and Time-Reversed Echoes

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The finding that bats can detect a time-reversed version of their echolocation sound as successfully as a normal, non-versed version (Mohl 1986) has cast doubt on the hypothesis that cross correlation is useful for describing bats' echolocation performance. Our experiments with *Eptesicus fuscus* confirmed Mohl's results for target detection. However, when bats were required to determine a target's range (rather than just its presence or absence) their performance was highly dependent on *whether* the echo waveform was reversed or not. Using a non-reversed, synthesized echo, bats' range discrimination was about 1 cm at a target distance of 75 cm. Reversing the normal echo resulted in discrimination threshold of 15 to 50 cm, i.e., much worse performance. These results are consistent with the possibility that a cross correlation-like detection process is involved in range determination. They are not consistent with simple energy detection.

Electrophoretic Analysis of the Mating System of Eptesicus fuscus

Frieder Mayer, Department of Zoology, University of Maryland

During the summers of 1987 and 1988 a total of 242 bats were color banded and blood sampled at four different maternity colonies in northern Missouri, U.S.A. At one colony 81% of adult females, 37% of juvenile females and no juvenile males returned the next year. By using eight polymorphic blood enzyme loci as independent genetic markers, significant differences in allele frequencies between adult females at different colonies, between juveniles from different years as well as between juveniles and adult females were discovered. Relatedness among 15 pairs of siblings was estimated to be 0.34 ± 0.08. These results suggest that mating in this bat is polygynous and that some females mate with more than one male.

Genetic Variation in the Bat *Tadarida brasiliensis mexicana* and in *Rhinoceros unicornis*, a large, Non-volant Mammal

G.G. McCracken
University of Tennessee

A data base of over 100 species shows that individuals in most mammalian populations have average heterozygosites (H_0) ranging from 0% to approximately 10%. Body mass and effective population size (N_e) have general correlations with H_0, with small, abundant mammals having higher heterozygosities, and large, rarer mammals the converse. *Tadarida brasiliensis mexicana* (body mass = 11–13g and N_e in the millions) and *Rhinoceros unicornis* (body mass = 1600–2100kg and N_e 100) contrast dramatically in these features. However, recent studies in my laboratory show that individuals in both species carry H_0's approaching the observed mammalian maximum. Such high H_0 in *T. b. mexicana* is not remarkable; however, the retention of similar heterozygosity in a critically endangered mega-mammal is unexpected and in contrast to results observed in other recent studies of endangered species.

Characteristics of the Visually Guided Escape Response in Mexican Free-tailed Bats

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Visually guided escape responses of wild adult Mexican free-tailed bats, *Tadarida brasiliensis mexicana*, were studied at various times in the day, at different light intensities, and at different wavelengths to determine the effect of such parameters on the escape response. Although *T. b. mexicana* is known to orient towards light throughout most of the day, there exists a reduction in this response at times in the morning that correspond to their return from foraging. Bats were also found to decrease their preference for light as the light intensity is increased. In fact, a reversal in response, a significant tendency to orient towards the dark, occurred when the light intensity was raised to the ambient daytime light level at the front of the cave. This result may explain why bats, when disturbed within the cave, fly towards the light but eventually circle back at the mouth of the cave. Adults were found to respond significantly to red light but not to far red light, suggesting that such lighting may affect the behaviour of these animals and thus should not be used for behavioral observations. The ontogeny of the response was studied by testing pups at various ages. Very young and non-volant pups were found to orient towards the dark, a strategy that would keep them closer to a thermoneutral environment. The point of transition in the response from dark orienting pups to light orienting adults was found to occur at about the age of seven weeks, a time at which the pups became volant.

An Educational Campaign About the Importance of Bats in Tropical America

P.A. Morton
Bat Conservation International

Tropical America is home for a rich bat fauna: the tiny country of Costa Rica records 103 species. Many of these are fruit bats which as agents of pollination and seed dispersal play key roles in maintaining the diversity of tropical forests and are also important to many plants with economic value. Yet bats are systematically destroyed due to fear and ignorance often because of vampire bat related problems, that in some

countries result in high economic losses. This educational campaign implemented in Costa Rica, frequently referred to as Latin America's model of conservation, used a grass roots, multi-media, multi-institutional approach to inform the Costa Rican public about bat diversity and their importance in tropical ecosystems and associated economies. Working with Costa Rican agencies and foundations, the campaign included the development of an educational package (book and poster) for distribution throughout Latin America, conservation articles in magazines and newspapers, a slide/tape program and teachers guide, literature on vampire bat identification and control, and interviews on radio and television.

Activity Patterns and Population Estimates — Implications for the Conservation of the Samoan Flying Fox, *Pteropus samoensis*

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The endemic Samoan flying fox, *Pteropus samoensis*, has shown alarming population declines in recent years, and is currently threatened with extinction. A large silhouette, diurnal flight activity, and protracted soaring make it particularly vulnerable to shooting. Although flight activity occurs during all daylight hours, in July it peaks in the late afternoon, when hunting pressure is greatest. Accurate population estimates are extremely difficult. Animals roost singly or in small groups in canopy trees. Ready confusion with the similarly sized, more common species, *Pteropus tonganus*, and particular flight characteristics (e.g., frequent aerial movements in and out of feeding trees, and between narrow, rugged valleys) create a tendency to overestimate population size.

Impact of Exploitation and Trade on Samoan Flying Foxes

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University of California

A range of evidence indicates that Samoan flying fox populations have declined severely. The two known species are the widespread *Pteropus tonganus* and the endemic *P. samoensis*. Rapid recent decline is linked to commercial hunting for export to Guam as a luxury food item. Both selective hunting and apparent differential vulnerability to shooting have helped to bring the rarer *P. samoensis* close to extinction. Licensed trade statistics underrepresent the commercial take, both because there is clandestine trade and because many animals shot are not recovered. Local recognition of flying fox declines led to protective legislation in American Samoa; similar regulations are under review in Western Samoa. These measures are an important step, but, given currently depleted bat populations, continued hunting for local recreation and subsistence, and continuing forest removal, careful monitoring will be required to assure the survival of *P. samoensis*.

Maternal Investment and Milk Composition in the Mexican Free-tailed Bat *Tadarida brasiliensis*

S.K. Robson, T.H. Kunz and O.T. Oftedal

Investigations of the changes in milk composition during lactation in *Tadarida brasiliensis* indicate that the fat content increases over a six week period, ranging from individual samples of 12% to 39%. This represents the highest fat levels known with the exception of the cetaceans and pinnepeds, and is far greater than that previously found in the chiroptera (approx. 12%). Unlike other species, the high fat content in the milk of *T. brasiliensis* is not correlated with a high growth rate. The implications of this to life history strategies and maternal investment in this and other mammalian species will be discussed.

Investigations on Vampire Bat Rabies

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As part of a study designed for bovine paralytic rabies control in Latin America, we have initiated basic research into applied aspects of this disease in the common vampire bat, *Desmodus rotundus*. Comparisons of Venezuelan vampire, domestic companion animal, and livestock rabies virus isolates by monochlonal antibodies revealed several geographically distinct strains. In a transmission experiment, naive vampires were placed in contact with cagemates inoculated IM with either CVS (10^{59} $MICLD_{50}$/0.03ml) rabies virus strains; or vampire-derived DR-19 (10^{52} $MICLD_{50}$/0.03ml) only inoculated bats succumbed to rabies. To test their immunogenic ability, groups of 3-4 vampires were inoculated IM on day 0 and 7 with either 10 μg, 5 μg, or 3 μg of BPL-inactivated, purified ERA rabies virus vaccine and were challenged IM on day 14 with 100 μl of rabies strain DR-19, as above. survival was independent of vaccines dose and the level of virus-neutralizing antibody present on the day of challenge. In order to test the efficacy of an attenuated rabies virus vaccine, groups of 5-6 bats were inoculated IM with either 100 μl of undiluted live ERA virus ((10^{51} $MICLD_{50}$/0.03ml), a ten- fold dilution of same, or PBS as control, and were challenged with 100 μl of DR-19 as above. All vampires, regardless of vaccination status, demonstrated clinical signs and succumbed to rabies within two-three weeks following immunization. These findings raise intriguing questions regarding the epidemiology and immuno-pathogenesis of rabies virus in vampire bat populations.

Immunocompetent Cell Types in the Bat *Pteropus giganteus*

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Previously we have shown that the Indian fruit bat, *Pteropus giganteus* has delayed immune responses despite having well developed secondary lymphoid organs and a possible B and T cell dichotomy. The delay did not appear to be caused by any serum borne factor or deficiency in the ratio of different immunocompetent cells which is comparable to those in other systems. So it was imperative to study the details of the immu-

nocompetent cells and a qualitative deficiency of the cellular components if any. Cellular morphology studied by SEM and TEM shows similarity to such cells in most other mammals. T cells were smooth surfaced, B cells had short microvilli on the surface which seem to be elongated on immunization possibly indicating a structural alteration of cell membrane from gel to sol state with activation. Unique structural deficiencies in the immunocompetent cells of bats have not yet been observed. This study may provide first hand detailed electron microscopic analysis of the immunocompetent cells of the bat. Further studies are in progress.

The Basis for Differential Habitat Use by Little Brown (*Myotis lucifugus*) and Long-legged (*Myotis volans*) Bats

M.B. Saunders
The University of Calgary

Myotis lucifugus and *M. volans* are morphologically very similar, occasionally occupy the same roosts, and are common in the same area, but apparently feed in different habitats. Flight style is an obvious mechanism that could lead to such a behavioural difference. Flight characteristics were assessed by direct morphological measurements (wing tracings, etc.) to compare wing loadings, aspect ratio, and wingtip shape between both species. Measured bats were then flown in a flight cage to determine manoeuverability. *M. lucifugus* have significantly greater wing loadings than *M. volans*, but both are capable of navigating the same interstring distance in the flight cage (i.e. the same minimum negotiable distance — MND). These bats were subsequently released with attached light-tags to observe and compare free-flight patterns. Prey availability, based on insect trapping, and dietary differences observed through fecal analysis will supplement the discussion.

Records of Longevity, Fecundity, and Asynchronous Reproduction for Pallid Bats in Southern Arizona

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Data collected at maternity sites of *Antrozous pallidus* have provided details of reproduction which are necessary for preparation of the species life table and for an understanding of their life history strategies. Presumably, in a species achieving maximum fitness, tradeoffs in fecundity and survivorship have been selected which resulted in the characteristic reproductive strategy of the species. This strategy involves reproductive life-span, litter size, interbirth interval, and reproductive capacity. Record measurements are presented for these reproductive variables which were obtained from field animals.

Maintaining a Little Brown Bat (*Myotis lucifugus*) Population in the Face of Roost Destruction

J.S. Taylor, York University

The success and failure of bat houses to provide alternate accommodation for large colonies of *M. lucifugus* will be included in this report on efforts to preserve the Little Brown Bat at the Chautauqua Institution in New York State.

Apnea and Non-Steady State Oxygen Uptake in Torpid and Hibernating Bats

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Biology, University of Sherbrooke

It is well known that hibernating or torpid bats have greatly reduced body temperatures and metabolic rates. It is less well known that the reduction of oxygen demand leads to an altered rhythm of pulmonary ventilation. At 5°C, *Myotis lucifugus* breathe in bouts lasting only 1.24 minutes and separated by periods of apnea lasting 40–130 minutes. This sporadic ventilation continually shifts the fractional O_2 concentration in open circuit metabolic chambers away from equilibrium or steady state conditions and renders conventional methods of calculating O_2 uptake inappropriate. We show that the conventional method over-estimates O_2 uptake by ca. 300% compared to the more appropriate instantaneous method of calculating O_2 uptake. To our knowledge, all studies on bats and other mammals published since 1951 have assumed steady-state conditions and so have over-estimated O_2 uptake in hibernation.

Progress at Bat Conservation International

M.D. Tuttle and P.B. Robertson
Bat Conservation International

Interest in bat conservation is growing rapidly as is BCI. Since mid-October 1987, membership has risen from 2600 to 7600, including individuals who are promoting bat conservation in 50 countries. More than 4000 requests for information or conservation assistance are processed monthly, resulting in numerous conservation initiatives, lectures and exhibits. News media publicity continues to educate hundreds of millions of people worldwide each year. Current major projects range from the production of a new audiovisual program, "Bats of America," to acquisition and protection of Bracken Cave. BCI is also lobbying for a national park in American Samoa and for a federal cave protection act in the United States.

The Use of Prey-Generated Sounds in Flycatcher-style Foraging by *Megaderma spasma*

K. Tyrell
Department of Ecology, Ethology and Evolution, University of Illinois

Megaderma spasma exhibits flycatcher-style foraging behavior in the laboratory. The bats pursue insects by making short forays from a stationary perch, capturing airborne prey while in flight. Results from my recent experiments show that these bats exhibit an hierarchy of cue utilization when approaching prey in flight. Both fluttering, and non-moving moths are captured. However, fluttering moths were approached more often than were still, silent moths. Paired-choice experiments revealed that sound generated by the beating wings of a moth (passive cue) is more effective in eliciting an approach than is the echolocation (active) cue provided by a moving (but silent) moth. In addition, bats appear to make a qualitative assessment of the insect-generated sound, approaching "more mothlike" sounds more frequently than "less mothlike" sounds. Thus, while *M. spasma* is capable of locating prey during mid-air capture using echolocation in the absence of prey-generated sounds, when such sounds are available, passive audition is utilized. These results suggest that passive audition may alert bats to the presence; location; and or identity of prey captured in this foraging situation. Previously I demonstrated that *M. spasma* also captures prey in surface gleaning. The use of passive and active audition in two distinct foraging strategies, surface gleaning and aerial capture, will be discussed.

Differential Germination of Seeds of *Ficus chrysolepis* Utilized by Old World Fruit Bats (Pteropodidae)

R.B. Utzurrum and P.D. Heideman

Germination tests of seeds of *Ficus chrysolepis* contained in fruit-bat fecal splats and ejecta, and in fallen fruits revealed high germination percentages for gut-passed seeds in contrast to non-gut-passed seeds: over 90% (N = 6; range 88-96%) of seeds from splats germinated, compared with an average of 48% (N = 6; range 3-87%) for those from ejecta and 57 % (N = 2; range 47-68%) for those from ripe syconia. These differences were statistically significant (Kruskal-Wallis Test H = 69.559, DF = 2, p 0.01). 95-100% of seeds contained in splats were intact and mature; no less than 30 % of seeds in ejecta or syconia were damaged, and many intact seeds per unit mass than did ejecta. All seeds were attacked by fungus, but fungal growth was unable to break down a thin, slippery, gelatinous coating of intact seeds.

Communal Nursing in the Evening Bat, *Nycticeius humeralis*

Jerry Wilkinson

Department of Zoology, University of Maryland

Nonparental nursing presents an evolutionary dilemma given that nursing is often considered the most energetically expensive period of mammalian parental care. Early studies by Watkins and Shump on the evening bat reported that adult females nursed young indiscriminantly. Here I present preliminary results that document the frequency and amount of communal nursing at a nursery colony in Missouri using three lines of evidence: 1) direct observations of nonparental nursing among color-banded individuals in an attic roost, 2) consistency between nursing young and putative mother genotypes assayed at five highly polymorphic blood enzyme loci and 3) occurrence of tritiated water in blood samples of offspring presumably unrelated to females injected with doubly-labeled water. Levels of relatedness, as estimated by regression analyses of genotypes from pairs of bats will be used to evaluate if nonparental nursing occurs within a colony at random or preferentially toward close kin.

Daily Time-Budget and Roosting Behavior of a Maternity Colony of Eastern Pipistrelle Bats *Pipistrellus subflavus*

J.M. Winchell

Biology Department, Boston University

The daily time-budgets and roosting behaviors of a colony of eastern pipistrelle bats *Pipistrellus subflavus* were recorded at a barn in Harvard, Massachusetts. Behaviors were monitored from mid May through mid August. Observations on the time spent engaged in various activities by individual bats were made both by direct observation as well as by analyzing video recordings of the colony during its most active periods: pre-emergence from the roost at dusk and post-return to the roost at dawn. Scan and focal sampling methods are currently being used to characterize the time-budgets for this colony. In previous field seasons, this colony was observed to roost solely in the barn until early August. This year the colony alternated between roosting in the barn and roosting along branches of a nearby spruce tree. Unlike previous field seasons, all of this year's offspring died prior to becoming volant.

THE CALGARY SYMPOSIUM

The 18th Annual North American Symposium on Bat Research met at the University of Calgary in Calgary, Alberta, Canada on October 13-15, 1988. Approximately 120 scientists from eight countries attended and 52 titles were presented. Twelve graduate students presented their research findings in the competition for awards "for the best work by a graduate student." First place went to Danielle Cloutier of the Department de Biologie of Universitie de Sherbrooke, Quebec. Her presentation was entitled "Pulmocutaneous water loss in hibernating bats." Her mentor for her graduate work is Don Thomas. Paul Faure, Department of Biology, University of Calgary also received recognition for his presentation on "Prey detection and foraging behaviour of the long-eared bat, *Myotis evotis*." His professor is Robert Barclay. Our congratulations to Danielle and Paul for their exceptionally fine work. The judges confessed to great difficulty in making these awards as all the papers by graduate students were very well done. Each of these papers is identified in the abstracts on the following pages.

Everyone in attendance was very enthusiastic in their praise of Robert Barclay and his crew on the local committee for the splendid job they did in making us feel welcome, comfortable, well-fed and watered. It was decided by the assembled participants that next year the 19th Annual Symposium would meet in Knoxville, Tennessee on October 12-14, 1989. Our co-hosts will be Gary McCracken of the University of Tennessee at Knoxville and Michael Harvey of nearby Tennessee Technical University. Gary and Mike have already arranged motels, meeting sites, visits to caves, and a tour of a local moonshine still. The formal announcements, call for papers, housing, dining, and travel information will be mailed to you in June. We look forward to seeing you in Knoxville.

G.R.H.

Due to printing of inadequate quality in the last issue, the editors would like to reprint the following article and beg the author's understanding.
— GRH

A NEW FIELD STUDIES STATION CAPE TRIBULATION, QUEENSLAND, AUSTRALIA

The Cape Tribulation Field Study Centre, which is expected to open in mid 1988, will be Australia's first research centre designed primarily for the scientific investigation of wet tropical ecosystems.

The Field Study Centre will provide laboratory space, housing, research facilities, and in time, a comprehensive reference collection of the fauna and flora of the area.

The Centre will be formally affiliated with the James Cook University in Townsville through the newly established Institute for Tropical Rainforest Studies, and also with the School of Biological Sciences, and will serve as its wet tropical field station. It will also be open to other members of the scientific community, both from Australia and overseas, who wish to pursue research related to wet-tropical ecology.

The Field Study Centre, while affiliated with James Cook University, will be a private, non-profit institution.

Location of Field Study Centre

The centre is situated on a 24 acre site about 1 km north of Mossman, and approximately 35 km north of the Daintree River.

It is located on abandoned grazing land adjacent to the Cape Tribulation Raod, and is surrounded by the Cape Tribulation National Park, and backed by the Mount Sorrow escarpment (2,540′ or 850 km).

The region encompasses lowland tropical rainforest ansd well as tropical rain forest extending up to the summit of Mt. Sorrow thus providing an accessable attitudinal transect of rainforest types. There is access to various types of forest nearby which are in private ownership, including stream-valley biotas, and in which long term research can be carried out.

The Centre is adjacent to the fringing coral reefs north and south of Cape Tribulation and 30 km to the south of the Centre are the extensive mangrove forests of the Daintree River.

To the west of the Centre are the granite uplands of Mt. Pieter Botte and Roaring Meg Creek, currently listed as Queensland Department of Forestry Timber reserves, which have had little systematic scientific study, while to the north is a wide range of forest types, including dry sclerophyll communities, along the Bloomfield road.

Facilities

While not all the facilities will be in place by next year, the Station will initially have two de-humidified laboratory buildings (each 120 m^2), well equipped workshop and limited accomodation for resident researchers (a youth hostel next door will accomodate additional people until all accomodation is completed). The laboratories will have essential laboratory equipment (microscopes, field equipment, etc).

There will be a resident director-manager and several permanent staff.

Since the Field Study Centre will have an important role as a provider of interpretive services for the area, a separate information and interpretation center building (situated distant from the Field Station, adjacent to the Cape Tribulation road) will initially provide lecture/seminar facilities.

It is expected that all food will be supplied by the Centre, as no private cooking facilities will be available. However, the Centre's proximity to a large tropical fruit orchard, will, it is hoped, more than compensate for this!

The Centre, along with the rest of the area north of the Daintree river, presently lacks electricity or phone services, and will rely on generators, storage batteries and inverters to supply electricity, while heating will be gas and solar.

Aims of Cape Tribulation Field Study Centre

The Centre is a non-profit organisation established to:

a) provide research and accommodation facilties for visiting Australian and overseas teams to work in the area on any aspect of wet tropical ecosystems.

b) perform interpretive services to the general publlic on the area, through the provision of a small museum, 36-seat theaterette, bookstore and the provision of accessible 'nature walks' and guided tours of varying complexity in the area.

c) carry out long term 'base-line' research on various aspects of the ecosystems that constitute the area — floral and faunal surveys, research on pollinator and plant relationships, productivity and micrometerology of the forest areas. In the pursuit of this aim the Centre is actively seeking the involvement of volunteer researchers through Earthwatch and similar organisations.

d) encourage young researchers to take an active interest in research on ecosystems, and tropical ecosystems in particular.

e) run intensive courses on aspects of tropical ecosystems and related methodology.

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BAT RESEARCH NEWS

Vol. 29 Winter 1988 No. 4

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FRONT COVER

The long-eared bat, *Myotis evotis,* is found in Alberta, host province of the 18th North American Symposium on Bat Research. This insectivorous bat was drawn by Janice I. Park for the symposium held at the University of Calgary in October, 1988.