

Nyctinomops macrotis. By Janie Milner, Clyde Jones, and J. Knox Jones, Jr.

Published 26 April 1990 by The American Society of Mammalogists

Nyctinomops macrotis (Gray, 1839)

Big Free-tailed Bat

Nyctinomops macrotis Gray, 1839:5. Type locality "Cuba," from the "hollow of a tree in the interior of the island" (Carter and Dolan, 1978:89).

Dysopes auritus Wagner, 1843:368. Type locality "Cuyaba [Cuaiabá, Mato Grosso], Brazil."

Nyctinomops megalotis Dobson, 1876:728. Type locality "Surinam."

Nyctinomops depressus Ward, 1891:747. Type locality "Tacubaya, D. F." [Distrito Federal], México.

Nyctinomops macrotis nevadensis H. Allen, 1893:171. Type locality "Nevada and California"; restricted to California by J. A. Allen (1894:236).

Promops affinis J. A. Allen, 1900:91. Type locality "Taguaga [Taganga, Magdalena], Colombia."

Nyctinomops macrotis: Miller, 1902:393. First use of current name combination.

Nyctinomops aequatorialis J. A. Allen, 1914:386. Type locality, "Chone, Manavi [Manabí], Ecuador."

CONTEXT AND CONTENT. Order Chiroptera, Suborder Microchiroptera, Family Molossidae, Genus *Nyctinomops*. A key to the four species of *Nyctinomops* is presented in Kumirai and Jones (1990). *Nyctinomops macrotis* is a monotypic species.

DIAGNOSIS. Upper incisors when viewed from the front nearly parallel (Fig. 1); skull large (usually >22 mm in greatest length), robust, with elongate, narrow rostrum (Fig. 2); length of shelf of bony palate measured from posterior edge of anterior palatine vacuity behind incisors >7 mm; breadth of braincase measured across roots of zygomatics usually >9 mm; skull with obvious, but low sagittal crest; basisphenoidal pits deep. Length of forearm usually is from 58 to 64 mm (Freeman, 1981; Hall, 1981; Hoffmeister, 1986).

GENERAL CHARACTERS. The dental formula is $i\ 1/2, c\ 1/1, p\ 2/2, m\ 3/3$, total 30. Average cranial measurements (in mm) of 11 females from Arizona (Hoffmeister, 1986) are (ranges in parentheses): greatest length of skull, 23.24 (22.90-23.80); zygomatic breadth, 12.60 (12.20-13.00); postorbital breadth, 4.08 (3.65-4.35); mastoidal breadth, 11.55 (11.25-12.05); breadth of braincase, 9.53 (8.95-10.10); depth of braincase, 7.98 (7.70-8.35); breadth of rostrum, 4.93 (4.75-5.10); length of maxillary toothrow, 8.86 (8.55-9.10); length of shelf of bony palate, 8.30 (7.80-8.35). Average (and range) of external measurements (in mm) of 11 females from Arizona (Hoffmeister, 1986) are: total length, 131.8 (120-139); length of tail, 50.45 (40-57); length of head and body, 81.2 (75-84); length of hind foot, 9.3 (7-11); length of ear, 27.2 (25-32); length of forearm, 60.01 (58.3-62.5). The wingspan ranges from 417 to 436 (Barbour and Davis, 1969), and the wing tips are extremely narrow as in other *Nyctinomops*. In Cuba at least, males tend to average slightly larger than females, both externally and cranially (Silva Taboada, 1979); weight of nine Cuban specimens averaged 20.6 g.

Nyctinomops macrotis is the largest member of the genus. The dorsal pelage is glossy, varying from a pale reddish brown to dark (mummy) brown and blackish. Individual hairs are bicolored, the basal portion being nearly white (Barbour and Davis, 1969; Hall, 1981).

The ears are large, nearly reaching the snout when laid forward, joined at the midline as in other species of *Nyctinomops*. The upper lip is deeply furrowed by wrinkles, and the muzzle is slender, concave between the ears. The nostrils are directed almost laterally, separated by a wide space with a vertical ridge at the midline; the face is

deeply grooved horizontally beneath the eye (Dobson, 1878). The mandible is long and delicate (Freeman, 1981).

DISTRIBUTION. This species ranges from southern Bolivia (Ibáñez and Ochoa G., 1989), Uruguay, and northeastern Argentina northward throughout the rest of South America east of the Andes (Koopman, 1982), except for records west of the Andes in northern Perú (Graham and Barkley, 1984), Ecuador (Albuja, 1983), and Colombia; it inhabits six of the nine South American faunal provinces recognized by Koopman (1982). The big free-tailed bat occurs on the Greater Antilles (Cuba, Hispaniola, Jamaica), presumably in Central America, and in México (Griffiths and Klingener, 1988; Jones et al., 1988). However, there are large areas in Central and South America from which no records of this species are available in the literature. In temperate North America, *N. macrotis* ranges from southern and western Texas to southern California and southeastern Nevada, and north to central Colorado and western Utah (Hall, 1981), and is migratory. There also are extralimital records of this bat from British Columbia, Iowa, and Kansas (Fig. 3). The known elevational range is from near sea level to about 2,600 m.

FOSSIL RECORD. A fossilized rostrum and mandible of *N. macrotis* were reported from a cave in Camaguey Province, Cuba (Koopman and Ruibal, 1955). These evidently represent late Pleistocene or early Holocene remains.

FORM AND FUNCTION. Among the Microchiroptera, *N. macrotis* is a versatile echolocator. In uncluttered spaces, these bats hunt with narrowband, short, constant-frequency signals with no frequency-modulated component. When pursuing potential prey, they drop the constant-frequency signal while adding a broadband frequency-modulated component; one harmonic accompanies this frequency-modulated sweep. In cluttered or confined situations, individuals employ a multiple harmonic signal with several harmonics that overlap somewhat (Simmons et al., 1978). *Nyctinomops macrotis* uses echolocation sounds that have most of their frequency below 20 kHz and that are audible to humans (Fenton and Bell, 1981), including loud, low-frequency clicks (Freeman, 1981).

The wings basically are adapted to rapid, enduring flight in areas where extreme maneuverability is not important. The long, narrow wing has a high aspect ratio and the chiroptagium is considerably longer than the plagiopatagium. Proportions of wings of *N. macrotis* are: area of chiroptagium/area of plagiopatagium, 0.86; length of chiroptagium/length of plagiopatagium, 1.47; greatest width of wing/length of wing, 0.36; aspect ratio, 9.71 (Vaughan,



FIG. 1. Photograph of *Nyctinomops macrotis*. Photograph courtesy of R. W. Barbour.



FIG. 2. Dorsal, ventral, and lateral view of cranium and lateral view of mandible of *Nyctinomops macrotis* (Texas Tech University 9181, female, from Espy Tank, 0.5 mi SE Madera Canyon Campground, Davis Mts., Jeff Davis Co., Texas). Greatest length of skull is 24.1 mm.

1966, 1970). Based on wing morphology, a flight speed in excess of 40 kph has been calculated for this species (Findley et al., 1972).

There is some variation in color of pelage between juveniles and adults of this species in that juvenile pelage is darker than that of the latter. There is no evidence of sexual dimorphism in color of pelage of *N. macrotis*. An adult female with white blotches has been reported (Easterla, 1973). The rectal temperature of an individual from Cuba was reported as 28.4°C (ambient temperature 27.4°; Silva Taboada, 1979).

The baculum of *N. macrotis* is distinctive among species of *Nyctinomops* (figured by Brown, 1967). "The general shape is that of a lumpy, laterally compressed cylinder. In dorsal aspect, there is a slight constriction about one-third the distance from the base. . . . In lateral aspect, there is a slight tendency for the distal end to tilt dorsad" (Brown, 1967:651). The base may be beveled dorsally, ventrally, or it may be symmetrically tapered. Average (and range) of measurements (in mm) for bacula of three specimens from Sinaloa, México, are as follows: greatest length, 0.62 (0.60–0.67); greatest breadth at base, 0.11 (0.10–0.12).

Cuticular structure of the hair of this species (figured by Miles, 1965) is dentate coronal in all body regions. Scales on the hairs of this and many other molossids, when viewed microscopically, resemble a series of paper cups stacked one inside the next, but with strongly serrated margins.

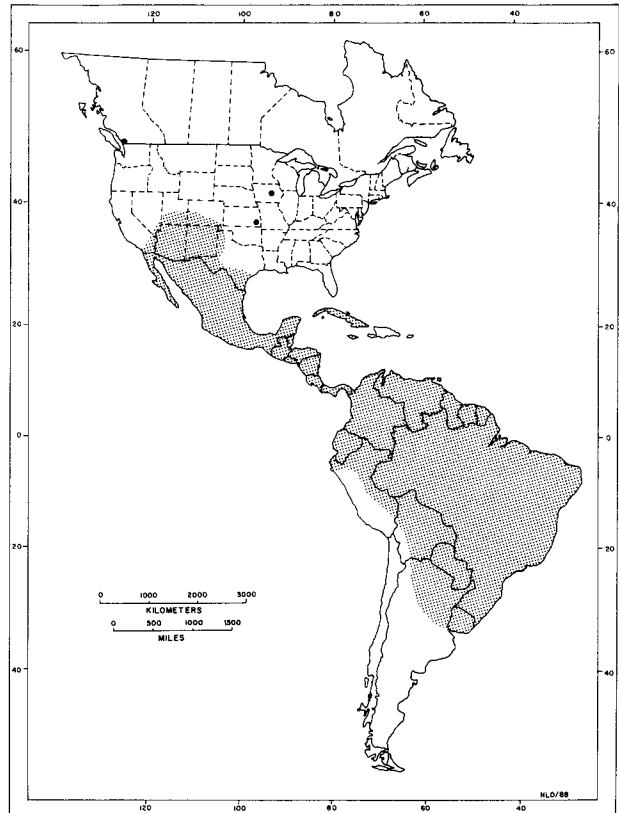


FIG. 3. Geographic distribution of *Nyctinomops macrotis* in North and South America (after Graham and Barkley, 1984; Hall, 1981; Koopman, 1982).

ONTOGENY AND REPRODUCTION. *Nyctinomops macrotis* forms maternity colonies (Barbour and Davis, 1969), and segregation of sexes occurs throughout the summer when the young are being raised (Schmidly, 1977). Of a total of 411 *N. macrotis* captured at Big Bend National Park, only one adult male was taken (Easterla, 1973). Of 56 bats netted in southeastern Arizona, 49 were adult females and only seven were adult males (Barbour and Davis, 1969); 47 *N. macrotis* captured in northern New Mexico included mostly adult females, with some juveniles of both sexes.

Females of this species bear one young in late spring or early summer in the Northern Hemisphere. A pregnant female was captured in late June in New Mexico; lactating females have been taken in July, August, and September, and young on the wing have been collected in August and September (Constantine, 1961; Findley et al., 1975). Eight of 10 females obtained in May in the Big Bend region of Texas contained one fetus (Borell and Bryant, 1942); 36 pregnant females captured in Big Bend National Park from 10 June to 21 July apparently contained single fetuses (Easterla, 1973). Lactating females were observed at Big Bend National Park from 27 June to 30 August; postlactating females were noted on 30 August and 9 September, and flying juveniles were recorded on 8 and 27 August. Nonreproductive females were reported from the months of June, July, and September (Easterla, 1973).

Fetuses examined in early May in Texas measured from 12 to 14 mm in crown-rump length and a female captured in late May in Arizona had a fetus measuring 23 mm (Barbour and Davis, 1969). Eight females collected between 8 and 10 June in Durango, México, contained fetuses measuring from 22 to 25 mm (Gardner, 1965), whereas one taken on 1 June in Chihuahua, México (Bradley and Mauer, 1965), carried a fetus measuring 2.5 mm. In Cuba, a pregnant female taken on 20 May carried a fetus 17 mm in crown-rump length; three collected on 29 June had fetuses ranging from 25 to 27 mm in length that weighed from 4.0 to 4.3 g (Silva Taboada, 1979). Two lactating females were obtained as early as 13 June and eight more were collected on 11 July in Cuba; a postlactating individual was recorded from there on 17 September (Silva Taboada, 1979). A nonpregnant female was taken in Perú in August (Graham, 1987). A male obtained on 17 May in Jalisco, México, had abdominal

testes (Núñez Garduño et al., 1981), whereas one taken on 9 January in Tamaulipas, México, had testes that measured 5 mm in length (Schmidly and Hendricks, 1984).

The deciduous dental formula for this species is $i\ 2/2$, $c\ 1/1$, $p\ 1/1$, total 16. The deciduous upper incisors and canines are about the same size and shape, sharp, and curved posteriorly; the upper premolars are flattened laterally and lanceolate in shape. Lower incisors are bifid, the first with a faint groove on the internal lobe, the second with noticeable groove that makes it appear almost trifid. The lower canine is sharp and recurved, having both anterior and posterior cusps; lower premolar flat (Silva Taboada, 1979).

ECOLOGY. *Nyctinomops macrotis* apparently is mostly an inhabitant of rugged, rocky country, at least in the southwestern United States and México. It is evidently a seasonal migrant throughout much of its range. In the Chisos Mountains, Texas, a colony of these bats occupied a horizontal crevice about 6 m long and 15 cm wide on the side of a cliff a little more than 12 m above a talus slope (Barbour and Davis, 1969). A colony of about 150 individuals occupied a rocky crevice in the Big Bend of Texas at least from early May until mid-October; a large deposit of guano was found at the base of the cliff beneath the crevice (Borell and Bryant, 1942). Colonies of *N. macrotis* were found in a crevice in the roof of a large sandstone rock shelter and beneath slabs of lava on a cliff in New Mexico (Findley et al., 1975). These bats also will roost in buildings, caves, and occasionally tree holes (Sanborn, 1951; Schmidly, 1977; Silva Taboada, 1979). In Cuba, they roost singly or in small groups (Silva Taboada, 1979).

In Chihuahua, in a canyon across the Rio Grande from Big Bend National Park, Easterla (1972) found a suspected nursery colony of big free-tailed bats in a vertical crevice of the canyon wall about 14 m above the canyon floor. Guano on a ledge below the roost indicated that the colony had been used for several years. "The colony was behind a large rounded flake of rock that had partially broken away from the canyon wall. The crevice was about 12 ft long and varied from 1 to 7 inches in width" (Easterla, 1972: 468).

Nyctinomops macrotis was recorded in four plant associations (River Floodplain-Arroyo, Shrub Desert, Woodland, Moist Chisos Woodland) in Big Bend National Park, Texas. However, most animals were netted in lowlands (550 to 1,220 m in elevation) of the River Floodplain-Arroyo association (Easterla, 1973). On the Río Cuchujaqui in southern Sonora, México, *N. macrotis* was taken in mist nets set over the river in an area surrounded by mixed-tropical deciduous forest and thorn forest; *Pteronotus parnellii*, *Artibeus hirsutus*, *Sturnira lilium*, *Myotis yumanensis*, *Lasiurus borealis* [= *blossevillii*], *Tadarida brasiliensis*, and *Nyctinomops femorosaccus* were taken at the same locality (Baker and Christianson, 1966). In Jalisco, big free-tailed bats were netted over a stream in an ecotonal area between tropical woodland and oak forest along with *Glossophaga soricina*, *Sturnira lilium*, *Artibeus jamaicensis*, *A. lituratus*, and *Molossus ater* (Sánchez Hernández, 1978).

This species has been captured in evergreen forest at about 2,440 m in elevation in New Mexico (Jones, 1965). Although it occasionally wanders into the highlands, *N. macrotis* seems to range primarily below 1,800 m in elevation in the southwestern United States (Easterla, 1973; Findley et al., 1975).

Nyctinomops macrotis occurs in the Patagonian subregion, Amazon Basin, northern coast and islands, and Pacific coast of Colombia and Ecuador in South America (Koopman, 1982). Details of the habitats of *N. macrotis* in South America are not well known. A male from Bolivia was netted over a pool bordered by thorn forest (Ibáñez and Ochoa G., 1989).

Apparently, more animals (total of 411) of this species have been captured in Big Bend National Park, Texas, than at any other place. During a 5-year study of 18 species of bats in this area, *N. macrotis* was the fifth most abundant species overall and it also ranked fifth in frequency of occurrence at capture sites. However, populations of big free-tailed bats fluctuated considerably in numbers from year to year (Easterla, 1973).

Nyctinomops macrotis feeds almost entirely on large moths (Lepidoptera), but crickets (Gryllidae), grasshoppers (Tettigoniidae), flying ants (Formicidae), stinkbugs (Pentatomidae), froghoppers (Cercopidae), and leafhoppers (Cicadellidae) are taken occasionally (Easterla, 1973; Easterla and Whitaker, 1972). The stomach of an individual from Venezuela contained remains of Coleoptera, Hemiptera, and unidentifiable insects (Ochoa G. et al., 1988). One stomach

examined from Arizona contained remains only of macrolepidoptera (Ross, 1967). Fecal material from four individuals listed by Freeman (1981) also contained only remains of moths.

Ectoparasites reported from *N. macrotis* (Whitaker and Easterla, 1975) include macronyssid mites (*Chiroptonyssus* sp., *C. robustipes*, and *Steatonyssus occidentalis*), myobiid mites (*Eudusabekia* sp.), chiggers (*Tecomatlana texana*), ticks (*Ornithodoros stageri*), and fleas (*Hormopsylla trux*, *Myodopsylla gentilis*). In Cuba (Silva Taboada, 1979), a nematode, *Anoplostrongylus paradoxus*, has been recorded from *N. macrotis* as have macronyssid mites (*Chiroptonyssus venesolanus*) and myobiid mites (*Ewingana doreyae*).

Silva Taboada (1979) recorded the cranium of a *N. macrotis* from the cast pellet of an owl. Otherwise, we know of no reports of predation on bats of this species.

BEHAVIOR. *Nyctinomops macrotis* apparently uses a combination of spatial familiarity and acoustic and visual cues to locate roosts. Return to roosting sites involves considerable ritualized behavior once bats have reached the vicinity of a roost, which often includes a general reconnaissance of the site and several landing trials before entry (Vaughan, 1959). When approaching their roosting places in crevices in cliffs, *N. macrotis* frequently makes steep dives with the wings partly folded (Vaughan, 1970). Some of these dives end with bats turning abruptly upward and away from the cliff; when individuals alight at the end of a dive the wings are spread and bats curve sharply upward and seem to fly into the mouth of the crevice. *N. macrotis* does not leave day roosting sites until after dark (Borell and Bryant, 1942).

Nyctinomops macrotis exhibits powerful, rapid flight (Vaughan, 1970). Little or no drop was apparent as animals were observed emerging from a roost on a perpendicular cliff; a captive big free-tailed bat was able to take wing from a flat surface (Findley et al., 1975). Powerful flight and apparent wandering behavior by young after they are weaned may explain, at least in part, the records of *N. macrotis* hundreds of kilometers beyond what seems to be the normal geographic range of the species (Barbour and Davis, 1969; Easterla, 1973).

Nyctinomops macrotis is easy to handle and fairly docile (Barbour and Davis, 1969). However, some investigators have found that temperament of individuals varied considerably, and that most of these bats, when captured, readily bite and vocalize loudly (Easterla, 1973).

GENETICS. The diploid number of the karyotype of this species is 48 and the fundamental number is 58. Autosomal pairs of chromosomes include one large metacentric, three medium-sized submetacentrics, one medium-sized subtelocentric, one small subtelocentric, and 17 acrocentrics. The X chromosome is a medium-sized submetacentric; the Y is a small acrocentric (Warner et al., 1974).

REMARKS. Big free-tailed bat is the accepted vernacular name for this species (Jones et al., 1986). The generic name *Nyctinomops* is compounded from Greek words and literally means "resembling a night feeder." The species name is from the Greek *macros* and *otos* for "long ear." In some of the earlier literature, this monotypic species was referred to under the name *Tadarida molossa*. We follow Freeman (1981) in regarding this bat, along with the American species *N. aurispinosus*, *N. femorosaccus*, and *N. laticaudatus*, as representing a distinct genus, *Nyctinomops*; some recent authors (for example, Koopman, 1982, and Jones et al., 1988), however, retained *Nyctinomops* as a subgenus of *Tadarida*.

We are grateful to N. L. Olson, who photographed the skull and prepared the map, and to S. Burgeson, who typed the manuscript. Several of our colleagues at Texas Tech University, particularly J. Arroyo-Cabrales, were helpful in locating literature pertinent to this account.

LITERATURE CITED

- ALBUJA V., L. 1983. Murciélagos del Ecuador. Escuela Politécnica Nacional, Quito, Ecuador, xii + 285 pp. (dated 1982, actually published in 1983 according to author).
- ALLEN, H. 1893. A monograph of the bats of North America. Bulletin of the United States National Museum, 43:ix + 1-198, 38 pls.

- ALLEN, J. A. 1894. Descriptions of ten new North American mammals, and remarks on others. *Bulletin of the American Museum of Natural History*, 6:317-332.
- . 1900. List of bats collected by Mr. W. H. Smith in the Santa Marta region of Colombia, with descriptions of new species. *Bulletin of the American Museum of Natural History*, 13:87-94.
- . 1914. New South American bats and a new octodont. *Bulletin of the American Museum of Natural History*, 33:381-389, pl. 38.
- BAKER, R. J., AND L. CHRISTIANSON. 1966. Notes on bats from Sonora, Mexico. *The Southwestern Naturalist*, 11:310-311.
- BARBOUR, R. W., AND W. H. DAVIS. 1969. *Bats of America*. University Press Kentucky, Lexington, 286 pp.
- BORELL, A., AND M. D. BRYANT. 1942. Mammals of the Big Bend area of Texas. *University of California Publications in Zoology*, 48:1-62.
- BRADLEY, W. G., AND R. A. MAUER. 1965. A collection of bats from Chihuahua, Mexico. *The Southwestern Naturalist*, 10:74-75.
- BROWN, R. E. 1967. Bacula of some New World molossid bats. *Mammalia*, 31:645-667.
- CARTER, D. C., AND P. G. DOLAN. 1978. Catalogue of type specimens of Neotropical bats in selected European museums. *Special Publications, The Museum, Texas Tech University*, 15:1-136.
- CONSTANTINE, D. 1961. Spotted bat and big free-tailed bat in northern New Mexico. *The Southwestern Naturalist*, 6:92-97.
- DOBSON, G. E. 1876. A monograph of the group Molossi. *Proceedings of the Zoological Society of London*, pp. 701-735.
- . 1878. Catalogue of the Chiroptera in the collection of the British Museum. *British Museum, London*, xlii + 567 pp., 30 pls.
- EASTERLA, D. A. 1972. A diurnal colony of big freetail bats, *Tadarida macrotis* (Gray), in Chihuahua, Mexico. *The American Midland Naturalist*, 88:468-470.
- . 1973. Ecology of the 18 species of Chiroptera at Big Bend National Park, Texas. *Northwest Missouri State University Studies*, 34:1-165.
- EASTERLA, D. A., AND J. O. WHITAKER. 1972. Food habits of some bats from Big Bend National Park, Texas. *Journal of Mammalogy*, 53:887-890.
- FENTON, M. B., AND G. P. BELL. 1981. Recognition of species of insectivorous bats by their ecolocation calls. *Journal of Mammalogy*, 62:233-243.
- FINDLEY, J. S., A. H. HARRIS, D. E. WILSON, AND C. JONES. 1975. *Mammals of New Mexico*. University of New Mexico Press, Albuquerque, xxii + 360 pp.
- FINDLEY, J. S., E. H. STUDIER, AND D. E. WILSON. 1972. Morphologic properties of bat wings. *Journal of Mammalogy*, 53:429-444.
- FREEMAN, P. W. 1981. A multivariate study of the family Molossidae (Mammalia, Chiroptera): morphology, ecology, evolution. *Fieldiana Zoology, new series*, 7:vii + 1-173.
- GARDNER, A. L. 1965. New bat records from the Mexican state of Durango. *Proceedings of the Western Foundation of Vertebrate Zoology*, 1:99-106.
- GRAHAM, G. L. 1987. Seasonality of reproduction in Peruvian bats. *Fieldiana Zoology, new series*, 39:173-186.
- GRAHAM, G. L., AND L. J. BARKLEY. 1984. Noteworthy records of bats from Peru. *Journal of Mammalogy*, 65:709-711.
- GRAY, J. E. 1839. Descriptions of some mammals discovered in Cuba by W. S. MacLeay. *Annals and Magazine of Natural History*, 4:1-7.
- GRIFFITHS, T. A., AND D. KLINGENER. 1988. On the distribution of Greater Antillean bats. *Biotropica*, 20:240-251.
- HALL, E. R. 1981. *The mammals of North America*. Second ed. John Wiley and Sons, New York, 1:xv + 1-600 + 90.
- HOFFMEISTER, D. F. 1986. *Mammals of Arizona*. University of Arizona Press and Arizona Game and Fish Department [Tucson], xix + 602 pp.
- IBÁÑEZ, C., AND J. OCHOA G. 1989. New records of bats from Bolivia. *Journal of Mammalogy*, 70:216-219.
- JONES, C. 1965. Ecological distribution and activity periods of bats of the Mogollon Mountains area of New Mexico and adjacent Arizona. *Tulane Studies in Zoology*, 12:93-100.
- JONES, J. K., JR., J. ARROYO-CABRALES, AND R. D. OWEN. 1988. Revised checklist of bats (Chiroptera) of Mexico and Central America. *Occasional Papers, The Museum, Texas Tech University*, 120:1-34.
- JONES, J. K., JR., D. C. CARTER, H. H. GENOWAYS, R. S. HOFFMANN, D. W. RICE, AND C. JONES. 1986. Revised checklist of North American mammals north of Mexico, 1986. *Occasional Papers, The Museum, Texas Tech University*, 107:1-22.
- KOOPMAN, K. F. 1982. Biogeography of the bats of South America. Pp. 273-302, in *Mammalian biology in South America* (M. A. Mares and H. H. Genoways, eds.). *Special Publication Series, Pymatuning Laboratory of Ecology, University of Pittsburgh*, 6:xii + 1-539.
- KOOPMAN, K. F., AND R. RUIBAL. 1955. Cave-fossil vertebrates from Camaguey, Cuba. *Brevoria, Museum of Comparative Zoology*, 46:1-8.
- KUMIRAI, A., AND J. K. JONES, JR. 1990. *Nyctinomops femorosaccus*. *Mammalian Species*, 349:1-5.
- MILES, W. B. 1965. Studies of the cuticular structure of the hairs of Kansas bats. *Search, University of Kansas*, 5:48-50.
- MILLER, G. S., JR. 1902. Twenty new American bats. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 54:389-412.
- NÚÑEZ GARDUÑO, A., C. B. CHÁVEZ T., AND C. SÁNCHEZ H. 1981. Mamíferos silvestres de la region de El Tuito, Jalisco, México. *Anales del Instituto de Biología, Universidad Nacional Autónoma de México*, 51:647-667.
- OCHOA G., J., H. CASTELLANOUS, AND C. IBÁÑEZ. 1988. Records of bats and rodents from Venezuela. *Mammalia*, 52:175-180.
- ROSS, A. 1967. Ecological aspects of the food habits of insectivorous bats. *Proceedings of the Western Foundation of Vertebrate Zoology*, 1:205-264, frontispiece.
- SANBORN, C. C. 1951. Mammals from Marcapata, southeastern Peru. *Publicaciones del Museo de Historia Natural "Javier Prado," Lima*, 6:1-26.
- SÁNCHEZ HERNÁNDEZ, C. 1978. Registro de murciélagos para el estado de Jalisco, México. *Anales del Instituto de Biología, Universidad Nacional Autónoma de México*, 49:249-255.
- SCHMIDLY, D. J. 1977. The mammals of Trans-Pecos Texas including Big Bend National Park and Guadalupe National Park. *Texas A&M University Press, College Station*, xiii + 225 pp.
- SCHMIDLY, D. J., AND F. S. HENDRICKS. 1984. Mammals of the San Carlos Mountains of Tamaulipas, Mexico. Pp. 15-69, in *Contributions in mammalogy in honor of Robert L. Packard* (R. E. Martin and B. R. Chapman, eds.). *Special Publications, The Museum, Texas Tech University*, 22:1-234.
- SILVA TABOADA, G. 1979. Los murciélagos de Cuba. *Editorial Academia, Academia de Ciencias de Cuba, Habana*, xiii + 423 pp., 15 pls.
- SIMMONS, J. A., ET AL. 1978. Echolocation by free-tailed bats (*Tadarida*). *Journal of Comparative Physiology*, 125A:291-299.
- VAUGHAN, T. A. 1959. Functional morphology of three bats: *Eumops*, *Myotis*, *Macrotus*. *University of Kansas Publications, Museum of Natural History*, 12:1-153.
- . 1966. Morphology and flight characteristics of molossid bats. *Journal of Mammalogy*, 47:249-260.
- . 1970. Flight patterns and aerodynamics. Pp. 195-216, in *Biology of bats* (W. A. Wimsatt, ed.). *Academic Press, New York*, 1:1-477.
- WAGNER, J. A. 1843. Diagnosen neuer Arten Brasilischer Handfluger. *Archiv für Naturgeschichte*, 9:365-368.
- WARD, H. L. 1891. Descriptions of three new species of Mexican bats. *The American Naturalist*, 25:743-753.
- WARNER, J. W., J. L. PATTON, A. L. GARDNER, AND R. J. BAKER. 1974. Karyotypic analyses of twenty-one species of molossid bats (Molossidae: Chiroptera). *Canadian Journal of Genetics and Cytology*, 16:165-176.
- WHITAKER, J. O., JR., AND D. A. EASTERLA. 1975. Ectoparasites of bats from Big Bend National Park, Texas. *The Southwestern Naturalist*, 20:241-254.

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