MAMMALIAN SPECIES No. 691, pp. 1–5, 3 figs.

Molossus sinaloae.

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Published 5 July 2002 by the American Society of Mammalogists

Molossus sinaloae J. A. Allen, 1906

Allen's Mastiff Bat

Molossus sinaloae J. A. Allen, 1906:236. Type locality "Escuinapa, Sinaloa," Mexico.

Molossus trinitatus Goodwin, 1959:1. Type locality "Belmont, Port of Spain, Trinidad, British West Indies."

CONTEXT AND CONTENT. Order Chiroptera, suborder Microchiroptera, family Molossidae. The genus *Molossus* contains 5 species: *M. ater*, *M. bondae*, *M. molossus*, *M. pretiosus*, and *M. sinaloae* (Jennings et al. 2000; Koopman 1993, 1994), but this genus probably contains additional species (e.g., Dolan 1989; Simmons and Voss 1998). Two subspecies of *M. sinaloae* are recognized (Hall 1981; Jones et al. 1988; Koopman 1994; Simmons and Voss 1998):

M. s. sinaloae J. A. Allen, 1906:236, see above.
M. s. trinitatus Goodwin, 1959:1, see above.

DIAGNOSIS. Except for size, skulls of different species of *Molossus* are difficult to distinguish (Dolan 1989; Freeman 1981). Keys to species of *Molossus* are presented elsewhere (Hall 1981; Jennings et al. 2000; Lopez-Gonzalez 1998). *M. sinaloae* (Fig. 1) is much larger than *M. bondae* and *M. molossus*, slightly smaller than *M. pretiosus*, and similar in size to *M. ater* (Dolan 1989; Freeman 1981; Goodwin 1959). Skull of *M. sinaloae* (Fig. 2) is narrower than that of *M. ater*. *M. ater* has a stouter, thick-chested physique, a short (ca. 2.0–2.5 mm) and black, unicolored pelage, rather than a long, bicolored one. *M. ater* also has a well-developed sagittal crest, particularly in males, and a short, square muzzle, as opposed to the more tapered nose of *M. sinaloae*. Finally, incisors of *M. ater* are spatulate, rather than pincerlike as in *M. sinaloae* (Dolan 1989).

GENERAL CHARACTERS. *Molossus sinaloae* is a blackish, medium-sized bat. Pelage on dorsum is a dull, dark brown, and grayish white from base to two-thirds of its length. Ventrum is brown (Goodwin 1959; Goodwin and Greenhall 1961).

Significant sexual dimorphism occurs in 15 of 16 external and cranial characters; only breadth of braincase does not differ between sexes. Average and range of external measurements (in mm) of 1 male and 2 females from Mexico, 7 males and 16 females from Honduras, and 11 males and 13 females from Costa Rica were: total length, Mexico: 141, 130 (128–131); Honduras: 120 (115–124), 116 (109–120); Costa Rica: 128 (121–135), 123 (117–128); length of tail, Mexico: 53, 48 (46–49); Honduras: 46 (44–46), 43 (41–45); Costa Rica: 47 (42–51), 43 (40–46); length of ear, Mexico: 17, 16 (16–16); Honduras: 15 (15–15), 15 (15–15); Costa Rica: 16 (15–16), 15 (14–15); length of forearm, Mexico: 51.5, 49.5 (49.4–49.6); Honduras: 47.1 (46.0–47.9), 47.1 (45.4–48.4); Costa Rica: 49.3 (47.6–51.1), 47.8 (46.7–49.0); length of metacarpal III, Mexico: 54.3, 51.3 (50.8–51.8); Honduras: 48.6 (46.7–50.6), 48.7 (46.7–50.6); Costa Rica: 51.1 (49.6–52.8), 50.1 (48.8–51.0); length of metacarpal IV, Mexico: 52.8, 50.1 (49.9–50.3); Honduras: 47.1 (45.4–49.0), 47.0 (44.3–49.0); Costa Rica: 49.0 (47.3–50.8), 48.2 (47.0–49.3). Average and range of cranial measurements (in mm) of 1 male and 2 females from Mexico, 5 males and 16 females from Honduras, and 11 males and 12 females from Costa Rica were: greatest length of skull, Mexico: 22.3, 21.6 (21.6–21.6); Honduras: 20.9 (20.5–21.8), 19.8 (19.2–20.8); Costa Rica: 21.8 (21.0–22.6), 20.3 (19.9–20.8); condylobasal length, Mexico: 20.2, 19.3 (19.3–19.3); Honduras: 18.6 (18.4–18.8), 17.7 (17.3–18.4); Costa Rica: 19.5 (18.8–20.2), 18.3 (17.8–18.7); breadth of braincase, Mexico: 10.1, 10.0 (9.9–10.1); Honduras: 9.9 (9.7–10.5), 9.6 (9.3–10.2); Costa Rica: 10.0 (9.8–10.3), 9.7 (9.5–10.1); length of maxillary toothrow, Mexico: 8.1, 7.9 (7.9–7.9); Honduras: 7.2 (7.2–7.3), 7.0 (6.8–7.3); Costa Rica: 7.6 (7.4–7.9), 7.3 (7.1–7.4); breadth across M3–M3, Mexico: 9.7, 9.3 (9.1–9.4); Honduras: 8.9 (8.6–9.1), 8.5 (8.2–9.0); Costa Rica: 9.1 (8.9–9.4), 8.7 (8.4–8.9); breadth across canines, Mexico: 5.7, 5.4 (5.3–5.4); Honduras: 5.3 (5.1–5.4), 5.0 (4.8–5.2); Costa Rica: 5.5 (5.3–5.7), 5.1 (5.0–5.2—Dolan 1989); Masses of a subadult male and an immature male were 19.3 and 16.0 g, respectively (Goodwin 1959; Goodwin and Greenhall 1961). Three fat specimens from Guerrero, Mexico, had masses of 25–33 g (Lukens and Davis 1957), average mass of 5 individuals from Nicaragua was 23.8 g (Lawlor 1973), and average and range of masses of 6 males and 6 females from French Guiana were 27.2 (26.0–29.8) and 23.1 g (18.0–28.8), respectively (Simmons and Voss 1998).

Significant geographic variation is present in Allen's mastiff bat. Populations from northwestern Mexico appear to be larger for all characters when compared to nearest geographic neighbors, as though populations in that region are isolated (Dolan 1989). In Yucatán, Mexico, average measurements (in mm) for 7 males and 3 females, respectively, were: total length, 125, 121; length of forearm, 46.0, 45.6; greatest length of skull, 19.4, 18.8; length of maxillary toothrow, 7.3, 7.1; zygomatic breadth, 12.2, 11.7; interorbital breadth, 4.0, 4.0; mastoidal breadth, 11.8, 11.2; palatal breadth at molars, 8.8, 8.5 (Birney et al. 1974). In Nicaragua, average measurements (in mm) of 4 males and 10 females, respectively, were: length of forearm, 47.6, 47.5; greatest length of skull, 21.2, 20.2; condylobasal length, 18.6, 17.8; zygomatic breadth, 12.3, 11.8; breadth of braincase, 9.8, 9.7; length of maxillary toothrow, 7.7, 7.3; breadth across upper canines, 5.4, 5.1 (Jones et al. 1971). In Colombia, forearms of 2 males were 47.2 and 42.8 mm. Measurements (in mm) of 2 females from Colombia were: length of forearm, 48.4, 48.4; greatest length of skull, 20.0, 19.4; condyloincisive length, 18.4, 18.1; palatal length, 5.8, 5.9; postpalatal length, 8.0, 8.1; length of maxillary toothrow, 7.5, 7.3; length of mandible, 14.3, 14.2 (Marinkelle and Cadena 1972). In French Guiana, average and range of measurements (in mm) of 6 males and 6 females, respectively, were: total length, 136 (129–143), 128 (124–130); length of tail, 53 (45–62), 49 (43–58); length of foot, 13.4 (12.5–14.0), 11.3 (10.0–13.0); length of ear, 15 (13–15), 14 (12–15); length of forearm, 48.5 (47.2–50.0), 49.0 (48.2–49.7); length of tibia, 17.3 (16.8–18.1), 17.0 (16.7–17.2); greatest length of skull, 21.0 (20.7–21.4), 20.1 (20.0–20.2); condyloincisive length, 19.7 (19.3–20.1), 19.0 (18.8–19.1); postorbital breadth, 4.0 (3.9–4.1),

FIG. 1. A female *M. s. sinaloae* from San Juan del Sur, Departamento Rivas, Nicaragua. Photograph by Keith Geluso.

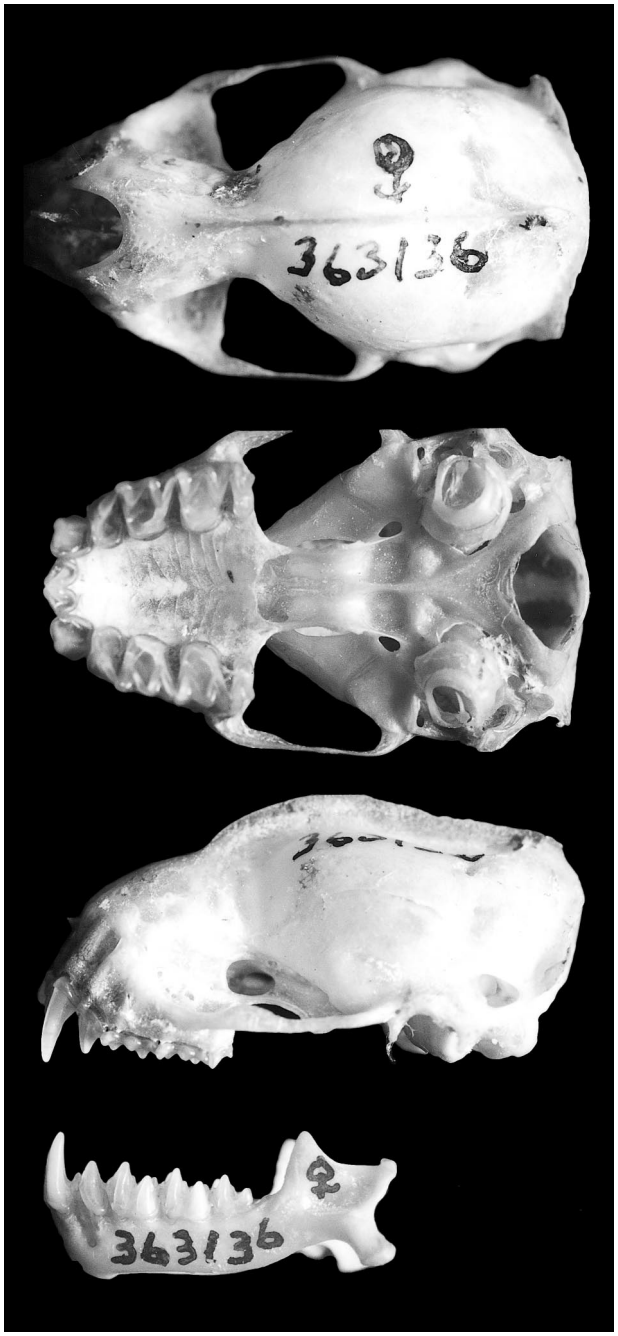

FIG. 2. Dorsal, ventral, and lateral views of cranium and lateral view of mandible of a *Molossus sinaloae* from Progreso, Chiriquí, Panama (female, United States National Museum of Natural History 363136). Greatest length of cranium is 20.3 mm. Photographs by T. L. Best.

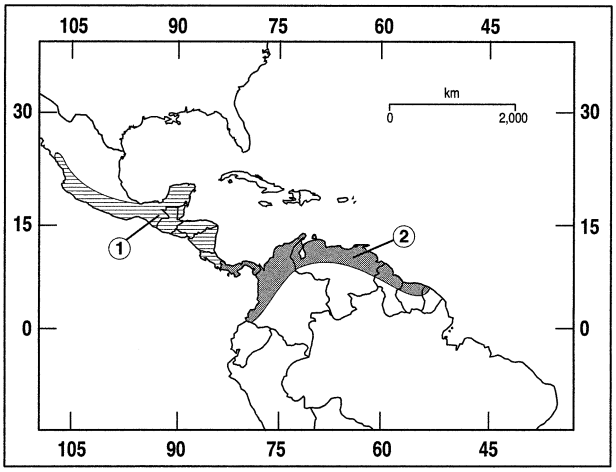

FIG. 3. Distribution of *Molossus sinaloae* in North and South America (Dolan 1989; Eisenberg 1989; Hall 1981; Jones et al. 1988; Koopman 1982, 1993): 1, *M. s. sinaloae*; 2, *M. s. trinitatus*.

4.0 (4.0–4.0); breadth of braincase, 9.9 (9.7–10.1), 9.7 (9.6–9.9); mastoidal breadth, 12.3 (12.2–12.4), 11.7 (11.5–11.8); zygomatic breadth, 12.7 (12.2–12.9), 12.1 (12.0–12.2); length of maxillary toothrow, 7.6 (7.4–7.8), 7.5 (7.4–7.6); breadth across molars, 9.1 (8.8–9.4), 8.9 (8.8–9.0—Simmons and Voss 1998).

Skull is relatively long and slender, with a narrow braincase and a long narrow rostrum. Sagittal and occipital crests are low and weakly developed. Molariform tooth rows are nearly parallel, but slightly divergent posteriorly. Basisphenoid pits are large and deep, posterior border of bony palate does not have a median projection, and anterior upper premolar is relatively large (Goodwin and Greenhall 1961).

Anterior border of interpterygoid fossa extends forward 0.5 mm beyond a line through posterior border of last upper molars. Fossa is narrow anteriorly and broad posteriorly. In 2 females, fossa was 1.8 by 1.8 mm and 1.7 by 1.5 mm and was divided by a 0.6-mm-long septum (Marinkelle and Cadena 1972).

The 2 subspecies are similar, especially with regards to their long, bicolored pelage. *M. s. trinitatus* has a larger skull, longer rostrum, narrower and higher braincase, and larger molariform teeth than *M. s. sinaloae*. In *M. s. trinitatus*, anterior border of interpterygoid fossa does not reach to a line across posterior border of posterior upper molars, whereas in *M. s. sinaloae* anterior border of interpterygoid fossa does extend past this line (Goodwin 1959; Goodwin and Greenhall 1964).

DISTRIBUTION. Allen's mastiff bat is distributed from southern Sinaloa, Mexico, to the Yucatán Peninsula, south through the Isthmus of Panama, and across northern South America to Trinidad, Surinam, and Guyana (Fig. 3; Dolan 1989; Eisenberg 1989; Handley 1966; Koopman 1982, 1993, 1994; Marinkelle and Cadena 1972). *M. sinaloae* occurs at elevations of 750 m in western Mexico (Watkins et al. 1972), 60 m in Guatemala (Jones 1966), 2,400 m in Colombia (Marinkelle and Cadena 1972), and below 1,160 m in northern Venezuela (Eisenberg 1989). No fossils are known.

FORM AND FUNCTION. Pelage is long, soft, lax, and reaches a length of 6.5 mm on shoulders. Fur extends from base to one-third the length of the interfemoral membrane (Goodwin and Greenhall 1961). *M. sinaloae* has a well-defined basal white band on dorsal hairs. In fresh pelage, dorsum is dull, dark brown; worn hairs impart a slight, reddish tinge to fur, but development of orangish-red color is never as pronounced as in *M. ater* (Dolan 1989).

Average surface area of Peyer's patches (organized lymphoid tissue) is 61.3 mm^2. Average surface area of caudalmost patch is 0.17 mm^2 and of cranialmost patch is 0.08 mm^2 (Forman 1974).

On the dorsum of females greasy, odoriferous marks apparently are produced through contact with the gular gland of males. About the time of parturition, gular glands of males were largest and produced the most secretory material; this also was when most marks were observed on females and when lacerations on males were most frequent. Size and secretory activity of gular gland varies through the year, with a high proportion of males with large, copiously secreting glands in May–August and a lower proportion in September–January. Secretions from the gular gland are highly distinctive: greasy or oily in appearance, viscous, and with a characteristic pungent odor. Skin and hair around a copiously secreting gland are matted and greasily moist or wet in appearance. A slight pressure on edges of gland usually will produce a drop of the gland's contents (Bowles et al. 1990; Heideman et al. 1990).

Dimensions and aerodynamic characteristics of 5 individuals from Nicaragua were: mass, 23.8 g; wing span, 32.8 cm; area of wing, 133.3 cm^2; area of wing excluding uropatagium, 123.78 cm^2; area of uropatagium, 9.6 cm^2; percentage of area of wing comprised by uropatagium, 7.2; wing loading, 0.179; aspect ratio, 8.06 (Lawlor 1973). In Yucatán, aerodynamic characteristics were also assessed;

males are significantly larger than females in length of forearm and mass. Average measurements for males and females, respectively, were: length of forearm, 46.8, 46.2 mm; mass, 25.5, 21.8 g; aspect ratio (wing span^2/surface area of wings), 8.10, 8.38; wing loading (mass/surface area of wings plus uropatagium), 0.27, 0.23 (Bowles et al. 1990).

Average measurements (in mm) of glans penis of 4 specimens were: length, 3.0; greatest width, 1.4; length of tip, 0.7; width of tip, 0.5 (Ryan 1991). Baculum of *M. s. sinaloae* is an irregularly shaped rod, which is slightly constricted medially and is among the smallest of molossid bats. In 1 specimen, base was expanded in lateral view, and in another specimen, distal end was enlarged. Baculum of 1 specimen from Yucatán had an upward bend, which is characteristic of *M. ater*. For 3 specimens from Mexico, length of baculum was 0.16–0.19 mm and breadth at base was 0.07–0.08 mm. The baculum of *M. s. trinitatus* is similar in its dorsal and lateral views. Base is pointed, midsection is cylindrical, and swollen distal end is round. Although similar, baculum of this subspecies is slightly longer than that of *M. s. sinaloae*. Base of baculum of 1 specimen of *M. s. trinitatus* was more pointed than that of any other molossid examined. Length of baculum of 1 specimen from Trinidad was 0.25 mm and breadth at base was 0.07 mm (Brown 1967).

ONTOGENY AND REPRODUCTION. Reproduction is synchronous and seasonal (Birney et al. 1974). In Michoacán, Mexico, scrotal testes were present in February (Sanchez Hernandez et al. 1985); in Yucatán, testes of 4 males averaged 6.2 mm long (range, 4–8 mm) in March and April (Birney et al. 1974); in Honduras, testes of 1 male were 6 mm long in July (Dolan and Carter 1979); and in Nicaragua, testes of an adult were 6 mm long in June, testes of 4 males were 5, 5, 6, and 7 mm long in July, and 1 had testes that were 3 mm long in August (Jones et al. 1971).

Females become reproductively active during their 1st year. No females of *M. sinaloae* have been found simultaneously pregnant and lactating (Dolan 1989). In Mexico, a female had a fetus that was 15 mm in length on 12 July (Ingles 1958). In Jalisco, Mexico, no reproductive activity occurred in females during February, September, and October (Watkins et al. 1972). In Yucatán, Allen's mastiff bat has a single annual birth period. Of 40 adult females examined September–January, none had fetuses detectable by palpation, and none were lactating. Pregnant females were present March–May (Birney et al. 1974; Bowles 1972; Heideman et al. 1990; Jones et al. 1973). In June, females gave birth to 1 young synchronously (Heideman et al. 1990). Lactating females were present June–August, and reproductively inactive females were present every month. Only 1 of 20 pregnant females had twins (Bowles et al. 1990). In Yucatán, lactation lasts 6–8 weeks (Bowles et al. 1990; Heideman et al. 1990).

In Honduras, 12 of 25 females examined 21–24 July were lactating, 2 were postlactating, 12 carried fetuses (14–29 mm in crown–rump length), and 2 were reproductively inactive (Dolan and Carter 1979). In Nicaragua, a colony containing only females and young, many of which were nearly full grown, was present in a house in late June. Some females were lactating and 2 were pregnant on 23 June (crown–rump length of fetuses was 12 and 14 mm). Another colony consisted of adult males, lactating females, and young. On 16 February, an adult male, a pregnant female (crown–rump length of fetus was 14 mm), and a hairless juvenile were observed in a small colony in an attic of a large house (Jones et al. 1971). In Costa Rica, occurrence of pregnant females and juveniles suggests some reproductive activity throughout the year, but most pregnancies are in the late dry season and early wet (La Val and Fitch 1977).

ECOLOGY. Allen's mastiff bat is a forest dweller (Dolan 1989) and is broadly tolerant of dry deciduous forests and premontane moist tropical forests (Eisenberg 1989; Handley 1976). Throughout its range, Allen's mastiff bat often roosts in houses and other man-made structures (Armstrong 1969; Birney et al. 1974; Dolan and Carter 1979; Goodwin 1959; Goodwin and Greenhall 1961; Handley 1966, 1976; Ingles 1958; Jones 1966; Jones et al. 1973; Test 1934).

In Mexico, *M. sinaloae* is associated with grazed and xerophilic thornforests, cultivated agave fields (Birney et al. 1974), and tree-lined streams (Watkins et al. 1972). Also in Mexico, Allen's mastiff bat has been observed under fronds of coconut palms (Alvarez 1968; de la Torre 1955; Goodwin 1959); 1 individual was under fronds ca. 0.6 m off the ground (Lukens and Davis 1957). In Guerrero, Mexico, only palms that had a large cluster of fronds harbored roosting bats. Along with *M. sinaloae*, these palms harbored roosting *Lasiurus ega* (Lukens and Davis 1957). In Yucatán, *M. sinaloae* roosted in gaps beneath ornamental roof tiles of a house; roosts were 2.5–15 m high and were shallow (<0.15 m) to moderately deep (0.5–1.0 m—Heideman et al. 1990). Also in Yucatán, *M. sinaloae* flew over swimming pools, man-made ponds, and a water-filled cenote (Birney et al. 1974).

In Nicaragua, a colony of *M. sinaloae* roosted in cracks in a stone wall and between rafters and the corrugated metal roof of a building (Jones et al. 1971). In Venezuela, *M. sinaloae* flew over streams, in evergreen forests, in forest openings, and over pastures (Handley 1976). In French Guiana, Allen's mastiff bat was captured in mist nets suspended 17–23 m over a narrow dirt road in lowland rainforest (Simmons and Voss 1998). *Molossus* rarely roosts in caves (Freeman 1981), but *M. sinaloae* has been found in caves in Colombia (Marinkelle and Cadena 1972).

Allen's mastiff bat is insectivorous (Forman 1974; Goodwin and Greenhall 1961; Iñiguez Davalos 1993; Lawlor 1973) and selects soft-bodied to hard-bodied flying insects (Dolan 1989). Six individuals had an average of 1,523 moth scales/g of fecal material; coleopteran parts and seeds also were present in fecal material (Freeman 1979, 1981). In Yucatán, stomachs of 10 adult males contained Lepidoptera (78.5% of volume), Coleoptera (Carabidae, 9.0%), Hemiptera (probably Lygaeidae, 8.0%), Diptera (1.0%), Coleoptera (Scarabidae, 1.0%), and unidentified insects (1.0%—Bowles et al. 1990).

In Yucatán, colonies contained more adult females than males (Bowles et al. 1990). Size of 1 colony ranged from 20–106 individuals between years. The difference may have been caused by vegetation blocking access to roosts in some years, causing a decline in number of bats (Heideman et al. 1990). Sixty-nine of 112 banded individuals were recaptured at least once; 2 females and 2 males were captured regularly at their respective roosts (Bowles et al. 1990). Several bats were recaptured ≥2 years after marking (Heideman et al. 1990). A female captured in 1977 was recaptured at different roosts in 1980 and 1983 (Bowles et al. 1990). Some bats left the roost for several nights (Heideman et al. 1990).

In Yucatán, Allen's mastiff bat was the most frequent of 6 species of molossid (Bowles et al. 1990), although it was less common than *M. ater* (Jones et al. 1973). *M. sinaloae* was observed over a swimming pool, along with *M. ater* and *Nyctinomops laticaudatus* (Bowles 1972; Jones et al. 1973). Rarely, >1 species of molossid used the same cavity in a tile roost site, although *M. ater*, *M. sinaloae*, and *Eumops bonariensis* at times used different tiles of the same roof segment (Bowles et al. 1990). In Nicaragua, Allen's mastiff bat occurred in the same attic as *Glossophaga soricina* (Jones et al. 1971). In Honduras, where dry savannah and mesic environments occurred in proximity, *M. sinaloae* and *M. ater* occurred sympatrically. *M. sinaloae* also occurs with *M. molossus* and *M. bondae* in Middle America (Dolan 1989).

Specimens from Trinidad were negative for rabies (Goodwin and Greenhall 1961). In Colombia, none was positive for the protozoan *Schizotrypanum* (Marinkelle 1982). None of 13 individuals from Panama had fleas (Tipton and Méndez 1966). Lifespan is unknown, but 1 individual lived in the wild for ≥6 years (Heideman et al. 1990).

BEHAVIOR. In Yucatán, *M. sinaloae* has a 2-h activity peak after sunset. There is a slightly lower activity peak before sunrise (Bowles et al. 1990).

In Yucatán, a male (on 23 July) was observed sniffing or searching the dorsum of a female, after which he climbed atop her dorsum and pressed closely against her in a manner that must have forced the gular gland into contact with her interscapular region. The female's 4-week-old young was roosting within a few centimeters of the pair. If the male's gular gland was secreting copiously (as was true for >90% of males at that time), his actions would have resulted in smearing of fluid onto the female. In July, a female entered a roost containing a secreting male and then left with a dorsal mark. On 6 other occasions, freshly marked females were captured exiting a roost within 20 min of departure of a secreting male. Marks are oily and strong-smelling spots that covered ≤4 cm^2 of fur on the marked bat, usually on the dorsum. Marked females that were recaptured 30 min after release always retained a

mark; however, for those recaptured after a longer period, the mark was either dried or no longer apparent. Of 134 individuals captured, all but 2 were females, and none were juveniles or neonates. Marked females were more common June–August than September–January (Heideman et al. 1990).

Injuries in *M. sinaloae* are uncommon. Most injuries are broken phalanges and torn wing membranes and occur equally in both sexes. Fewer than 1% of all observed animals had lacerations; more males had deep lacerations (2–5 mm in length) than females, and almost all of these occurred in June and July. In males, lacerations were present most often on the head (Heideman et al. 1990).

In Yucatán, 3 types of roost associations occur; resident solitary males, multiple-male groups, and groups of females with occasional or frequent visits by resident males. Three of 5 resident solitary males and members of multiple-male groups never visited groups of females. The other 2 resident solitary males were frequent visitors to the 4 groups of females. Occasionally, nonresident males would visit the 4 groups of females (Heideman et al. 1990).

GENETICS. Diploid number of chromosomes is 48, and the fundamental number of chromosomal arms is 58. Autosomal complement of *M. sinaloae* includes 1 large pair of metacentrics, 3 pair of medium-sized submetacentrics, 1 pair of medium-sized subtelocentrics, 1 pair of small subtelocentrics, and 17 pair of acrocentrics. Two of the acrocentric pairs sometimes have short 2nd arms. Secondary constrictions are present in 1 of the larger pairs of acrocentric chromosomes. Sex chromosomes consist of a medium-sized submetacentric X and a small acrocentric Y (Warner et al. 1974).

Molossus sinaloae is the most distinctive Central American *Molossus* examined, with species-specific isozymes at the esterase-2, α-glutamate-dehydrogenase, and malate-dehydrogenase loci. *M. sinaloae* has a distinctive esterase-2–108 allele that also is present in Jamaican populations of what may be *M. molossus* (Dolan 1989).

REMARKS. *Molossus* is from the Greek *molossos,* referring to the molossus or mastiff hound (Jaeger 1955). The specific epithet *sinaloae* refers to the state in Mexico where the type specimen was obtained. Additional common names are Trinidadian free-tailed bat (Husson 1978), Sinaloa mastiff bat, and moloso de Sinaloa (Goodwin 1942; Villa-R. 1967).

We thank L. L. Thornton, A. M. Krista, and other personnel in the Interlibrary Loan Department at Auburn University R. B. Draughon Library for assistance in obtaining articles from other institutions, Keith Geluso for providing Fig. 1, W. B. Robinson for helping in the preparation of Fig. 2, T. E. Rodriguez for preparing Fig. 3, and J. B. Armstrong, M. K. Causey, P. D. Heideman, C. López-González, and S. J. Presley for critically evaluating an early draft of the manuscript. This is journal article 15-985992 of the Alabama Agricultural Experiment Station.

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Associate editors of this account were ELAINE ANDERSON, VIRGINIA HAYSSEN, and SERGE LARIVIÈRE. Editor was VIRGINIA HAYSSEN.

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