

THE SYSTEMATICS OF THE BAT GENUS MOLOSSUS  
(CHIROPTERA:MOLOSSIDAE) IN MEXICO

by

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## ABSTRACT

Five species of the Mastiff bat genus Molossus are recognized as occurring in the Republic of Mexico. These are assigned to three species-groups. The status of Molossus macdougalli Goodwin is questioned, Molossus pygmaeus Miller is reported from Mexico for the first time and a new subspecies of Molossus aztecas is described from Chiapas. Geographic and individual variation, including sexual dimorphism, was found to be great and apparently more significant than indicated by many of the earlier investigators. Comments are made regarding the probable status of some Central and South American species of this genus. This study is based on an examination of 164 specimens from various localities in Mexico and 129 specimens of supplementary material from Central and South America. None of the Antillean forms are included in this study.

Frontispiece.--The red mastiff bat, Molossus ater nigricans  
(approx. 1 3/4 natural size).



## INTRODUCTION

Members of the genus Molossus are small to medium-sized, robust, free-tailed bats. They are assigned to the family Molossidae and are commonly known as Mastiff bats, a name which also includes the closely related genera Eumops and Promops. They are restricted to the New World tropics and sub-temperate regions of South, Central and North America. In Mexico, they are known to occur as far north as Guemes (northeast of Ciudad Victoria), Tamaulipas in the east (Alvarez, 1963), and Alisos (north of Badri-guato), Sinaloa, in the west. They are not known from the central plateau north of Amecameca, Mexico. Their elevational range extends from sea level, along both the Atlantic (Caribbean) and the Pacific coasts, to over 8,000 feet on the central plateau and southern mountains. Ecologically they are associated with forests and woodlands consisting, at least in part, of tropical or semi-tropical elements. The more diagnostic constituents of such habitats in the more northern latitudes or higher elevations are usually the fig trees (Ficus spp.) or cypress (Cupressus spp.). These habitats vary from purely riparian situations in arid or semi-arid thorn forests, mesquite grasslands, oak woodlands and savannas to

extensive tropical deciduous and tropical evergreen forests. Within this geographic, elevational, and ecological range, there are five species of Molossus; two are apparently restricted in distribution and the others are rather widespread although not necessarily common.

The Mastiff bats of this genus have been known to science since Daubenton described a specimen from Martinique, (one of the Windward Islands, Lesser Antilles), under the name "mulot-volant" in the Memoires of the Royal Academy of Science, Paris, for the year 1759 (Volume published in 1765). The same animal appears as "antre chauve-souris" in Buffon's Natural History, Volume 10, pages 84-87, plate 19, figure 1. In 1766, there appeared a description of another bat, Vespertilio molossus Pallas. Pallas supposed that his bat was the same as the one figured by Buffon, but additional data published by Pallas proves that it represents a member of the genus Tadarida. Kerr, in 1792, also applied the name Vespertilio molossus major to the "antre chauve-souris" depicted on Buffon's plate 19. Subsequently, other names were applied to this bat on the same plate. Geoffroy, in 1805, proposed the generic name Molossus for the bats to which this specific name had been previously applied. Miller (1913) further restricted the name Molossus to those bats Geoffroy knew at first hand and from which he derived his technical

characters. This restriction separated the genera Eumops and Promops from Molossus. Miller (1913) was the first to elucidate this confusion regarding the history of the generic name Molossus.

The first Molossus described from Mexico was Molossus aztecas Saussure (1860). Later two more species were named: Molossus nigricans Miller (1902), now known as Molossus ater nigricans Miller, and Molossus sinaloae Allen (1906). The fourth Mexican species was named by Goodwin (1956) as Molossus pretiosus macdougalli. Later (1964) Goodwin elevated it to species rank and it is now known as Molossus macdougalli Goodwin. As a result of this study, a fifth species is recognized from Mexico, Molossus pygmaeus Miller and a subspecies of Molossus aztecas is described as new.

I have studied the known Mexican species of the genus Molossus and have arrived at a general concept of their affinities. I have also examined specimens of Central and South American species in an attempt to understand possible relationships between them and Mexican forms. Since Hershkovitz (1949) tentatively synonymized M. aztecas Saussure and all other related small species under the name Molossus major Kerr, pending a revision of the genus, I have devoted considerable time examining the relationship between M. aztecas and M. "major" of

South America. Most attention has been given to the amount of variation within and between the Mexican species. Unfortunately, very few of the total number of specimens collected from Mexico, and none of the Antillean representatives, have been examined. Most of the Mexican material examined is from western and southern Mexico. A great deal of attention has been given to the technique involved in evaluating population relationships and individual variation within each of the five species. This investigation is considered a basic evaluation of the systematics of Mexican species of Molossus and essentially a precursor to a more extensive study of the whole genus.



## MATERIAL AND METHODS

### Material

The number of specimens examined totals 357. Of these, 164 are from Mexico and include 9 fluid preserved, 5 skeletons, 2 skull only and 145 conventional study skins and skulls. All of the specimens are in institutional collections as listed below and as indicated by the appropriate symbols in the lists of specimens examined under Species Accounts and in Appendix A.

AMNH American Museum of Natural History  
CNHM Chicago Natural History Museum  
KU University of Kansas, Museum of Natural History  
LACM Los Angeles County Museum  
UA University of Arizona  
USNM United States National Museum

### Measurements

Measurements of total length (13), tail vertebrae (14), hind foot (15) and ear (16) are those recorded by the collector. Measurements of forearm, metacarpals, phalanges, and skull dimensions were taken using parallel-jawed, dial calipers graduated in twentieths of a millimeter (0.05 mm). The taking of certain measurements was aided by the use of low magnification in a dissecting

microscope. The numbers in parentheses correspond to the same measurements listed in Tables 1-15. All wing measurements were taken from prepared dry material. Wing and cranial dimensions in addition to the four body measurements are as follows:

Length of forearm (17). The distance from the wrist, including skin, to the elbow, including the olecranon process and skin.

Length of metacarpals. Metacarpals III (18), IV (20) and V (22) were measured. The longest distance from the wrist, including skin, to the metacarpal-phalangeal joint, as discerned through the skin.

Length of phalanges. The first phalanx of the third (19) and fourth (21) digits were measured. Longest distance from the metacarpal-phalanx joint to the distal end of the first phalanx.

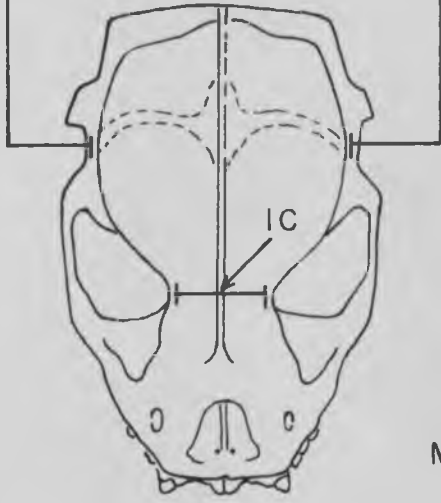
Greatest length of skull (01). The greatest length obtainable in the midline of the skull from the tips of the incisors to the most posterior bulge of the supraoccipital.

Condylbasal length (02). The distance, in the midline of the skull, from the premaxillary bone just above the incisors to a line connecting the posteriormost margins of the condyles.

Figure 1.--Dorsal, ventral, front and lateral aspects of the cranium of Molossus to illustrate cranial dimensions.

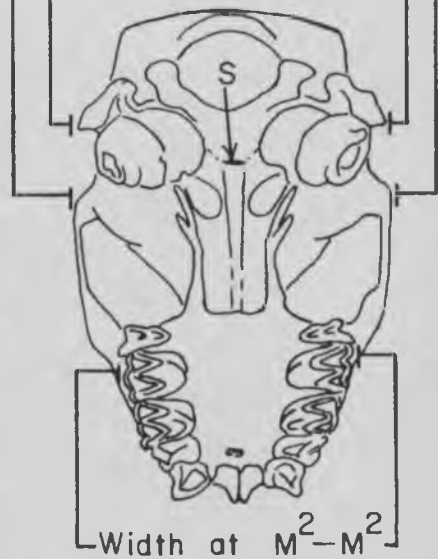
IC is interorbital constriction. S is the visible suture between the basioccipital and basisphenoid bones, indicative of subadult animals. See text for explanation of dimensions.

Breadth of brain case

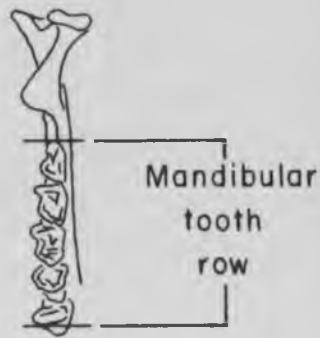
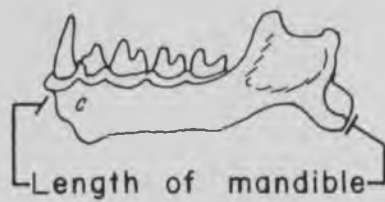
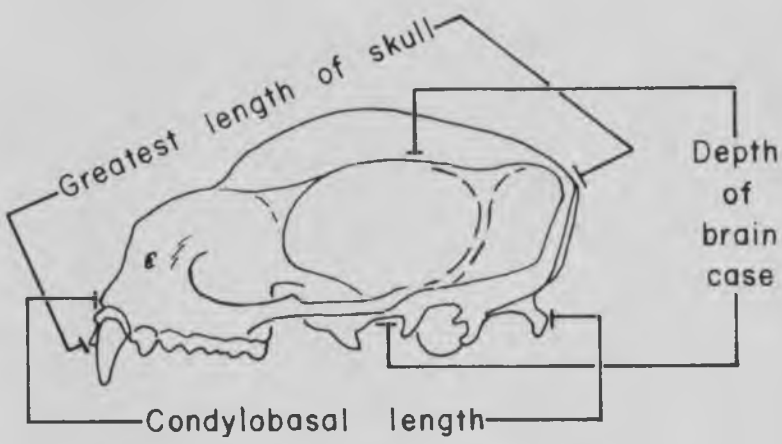
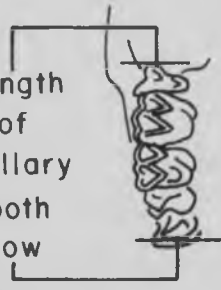


Zygomatic breadth

Mastoid breadth



Length of Maxillary tooth row



Interorbital constriction (03). The least distance across the skull between the orbits.

Zygomatic breadth (04). The greatest spread of the zygomatic arches, measured on the squamosal bones at a right angle to the long axis of the skull.

Mastoid breadth (05). The greatest breadth of the mastoid processes measured at a right angle to the long axis of the skull.

Breadth of brain case (06). The greatest breadth of the brain case above the zygomatic arches and mastoid processes.

Depth of brain case (07). The least depth of brain case measured from the glenoid fossa to the top of the skull on one side of the sagittal crest. This measurement proved to be very satisfactory. The extreme development of the sagittal crest and the common loss of the otic capsules do not allow consistent measurements using the standard technique involving a glass slide. The calipers are held at a right angle to the long axis (vertical to the skull) with the ventral surface of the glenoid fossa held against and parallel to one jaw of the calipers. The jaws of the calipers are then brought together until the uppermost comes in contact with the top of the cranium where it will allow the least measurement without compressing the skull.

Breadth at  $M_2-M_2$  (08). The greatest breadth across the crowns of the second upper molars.

Breadth of canines (09). The least breadth of the upper canines immediately inferior to and against the cingulum.

Maxillary tooth row (10). The distance from the anterior face of the upper canine, inferior and against the cingulum, to the posteriormost portion of the last upper molar.

Length of mandible (11). The greatest length of a single ramus from the base of the lower incisors to the posteriormost projection of the angular process.

Mandibular tooth row (12). The distance from the anterior face of the lower canine, superior and against the cingulum, to the posteriormost portion of the last lower molar.

Measurements of the wing are from the right side of the animal. If the right forearm was broken or otherwise unmeasurable, the left forearm was measured and all measurements of metacarpals and phalanges are also from the left side of that individual. Length of the maxillary tooth row is of the left side unless unmeasurable, then the measurement is of the right side. Length of mandible and mandibular tooth row is of the right side.

Measurements of the thumb are omitted because of

their extreme unreliability due to variation in position on dry specimens. Certain cranial measurements have been omitted because of the great individual variation. For example, palatal and post-palatal measurements are omitted because of the extreme variation of the posterior margin of the palate. Other measurements have been included because of their common use in published accounts of members of this genus, but I feel that their diagnostic value, in many cases, is questionable. Such a measurement is total length of skull. In adults, this unstable measurement is influenced by the state of incisor wear, age and sex. This measurement can be expected to increase steadily during the individual's life due to the growth of bone in the supraoccipital region and continued development of the sagittal and lambdoidal crest. This measurement tends to reflect secondary sex influence on skull proportion and this may be its only true value. Loose or lost incisors make this measurement valueless, and, in my opinion, the superior border of the foramen magnum should not be used as a reference point because the slope of the supraoccipital changes with age. In some individuals the extreme development of the lambdoidal crests makes this measurement even more difficult and unreliable if not impossible. Another measurement which is highly unreliable for close comparison of data is the length of mandible. When employing the dermestid method for cleaning skulls,

the rather thin bone along the posterior margin of the angular process is often eaten by the beetles, thereby altering the measurement.

All specimens have been separated according to sex in the analyses. Males are significantly larger than females and often display extreme development of both sagittal and lambdoidal crests. All measurements were transferred to I B M cards and the data analyzed by means of an I B M computer.



## AGE CLASSES

Each specimen examined was assigned to one of three age classes. The age classes are designated as juvenile, subadult and adult. Specimens are classed as juvenile if the epiphyseal cartilage of the digital elements of the wing are not completely ossified. This is usually readily visible through the skin in the prepared specimen. This lack of ossification coincides with the unossified sutures between the presphenoid and basisphenoid, and between the basisphenoid and basioccipital bones of the skull. Specimens are designated subadult if the epiphyseal cartilage of the wing elements appears ossified but the suture between the basisphenoid and basioccipital bones is still open or incompletely ossified in the midline of the skull (see Fig. 1). Such individuals show little or no tooth wear. Adults are those which have no prominent unossified sutures in the skull. I realize that animals classed as subadult are often physiologically and sexually mature but in order to minimize variation of cranial measurements due to initial skull growth, these individuals have not been considered in the analyses, with the following exceptions: subadults have been included if only a few or no adults were immediately available for

comparison; or if measurements of subadults appeared not to affect population analysis. No juveniles have been included in the analyses.

## CHARACTERISTICS OF THE GENUS

### Morphology

The short upper incisors, 1 - 1 lower incisors, smooth upper lip and minute, subterete tragus serve to distinguish Molossus from other molossid genera. The short, broad, rounded skull is also characteristic of the genus. Adults, and particularly adult males, have greatly developed, knife-like sagittal and lambdoidal crests. The basisphenoid pits are distinct. The upper incisors are short and very broad. Although shorter and broader than incisors in other members of the family, statements to the effect that the length or width along the cingulum is equal to, or greater than, the height of the shaft (Miller, 1907; Hall and Kelson, 1959) are true only if the shaft is defined as that part of the incisor projecting beyond the cingulum. The species of Molossus having the longest and narrowest incisors are M. sinaloae and M. trinitatus. The dental formula for the genus is: I 1/1, C 1/1, PM 1/2, M 3/3 x 2 = 26.

The external form is heavy and robust. The ears are short, low and rounded, and both arise from the same point on the forehead. The antitragus is large, lobate and constricted at the base. The wings are long and narrow. There are patches of fur on the forearm, between

the fourth and fifth metacarpals and on the propatagium near the elbow. The thumb is short and strong. The tail projects well beyond the broad uropatagium. The toes bear tactile bristles. Other tactile bristles are located on the rump at the base of the uropatagium, on the face and upper throat. An elevated ridge, with stiff hair, extends down over the forehead to the nares. There is a patch of unusual bristly hairs with spoon-shaped tips on the upper lip under the nostrils. Adult males have a large gland on the lower throat which is assumed to be most active during the breeding season. This gland is rudimentary on females. These bats have a characteristic strong, musty odor.

#### Pelages and Molt

There are two basic types of fur found in Molossus. One is short, coarse and generally stiff. It is represented by M. ater and its allies M. macdougalli and M. pretiosus, the latter apparently confined to South America. The other type is long, fine and lax. It is characteristic of M. sinaloae, M. aztecas and M. pygmaeus of Mexico, M. trinitatus, M. major and its allies in South America. The fur of M. bondae is apparently intermediate between these types. Specimens from Panama have short, coarse, stiff fur while specimens from Honduras have longer, finer fur. There is much variation within

each basic type. This variation may be related to the variation in color which appears closely correlated with the habitats in which these bats occur. In M. bondae the short, coarser and stiffer hair type appears to be associated with very dark brown or black fur characteristic of animals found in humid lowland forests such as those of Panama.

Coupled with wide variation in color and texture of hair is the relative degree of bicoloration and widespread dichromatism. Mainland species of Molossus which do not appear to be dichromatic are sinaloae, major, pygmaeus and Mexican Plateau representatives of aztecas. Dichromatic species are ater, macdougalli, pretiosus, bondae, coibensis and lowland forms of aztecas. In general, the color phases are of two types: the black or sooty-brown is the most common and buffy-red or chestnut is more unusual. There is a rarer third color phase noted in M. ater, a light buffy or reddish yellow which may be nothing more than a pigment variation of the lighter of the two more common phases.

Contrary to statements in much of the literature, I find that all of the species examined have dorsal bicolored fur with the exception of certain individuals of M. pretiosus and M. bondae. While it is not always readily apparent with the naked eye, this bicoloration

can be seen with little difficulty with a dissecting microscope using low magnification. One can wonder why unicolored fur is said to be characteristic of certain dichromatic species when it is obvious that animals in the lighter color phase have bicolored fur. The basal portion of the individual hair varies from a rich buff or creamy yellow to white. In general, the darker the hair the whiter the basal portion. Also, the darker the hair the shorter the light basal portion. M. sinaloae, M. trinitatus (Goodwin, 1959), Mexican Plateau forms of M. aztecas and some long-haired South American populations of M. major are exceptions since the basal coloration is always white or whitish although, terminally, the hair is usually light brown. Individuals of those species which characteristically have short, coarse, stiff fur have a very short lighter basal hair color. Specimens in the darker color phase of M. ater and M. pretiosus have very short, white basal color. Some individuals may have only scattered hairs showing the white basal color, the other hairs being unicolor. This is in addition to the sometimes common, scattered, all-white hair. These two species, in general, have the darkest color pattern of all species of Molossus with the exception of Panamanian representatives of M. bondae mentioned previously.

The stages of molt affect the fur color. Specimens of Molossus undergoing molt show that all the fur

is usually replaced at the same time. The molt may progress more rapidly on some parts of the body than on others; but the molt appears to be initiated uniformly over the body at the same time. A few specimens show an earlier initiation of molt in the pigmented streaks close to the flight membranes. The dark tips of the new hair coming in make specimens appear darker than normal. Specimens in the darker color phase of M. ater from arid areas on the Pacific Coast of Mexico indicate that there may be some color fading between molts. Most black-phase individuals from these areas have a faint ruddy wash on the fur, but the new fur coming in does not show this lighter overtone. It seems probable that this overtone is the result of wear and color modification in response to air. Although individuals have been observed flying about as early as 3 PM on hot sunny afternoons, I am assuming that color fading caused by the sun is negligible in this normally nocturnal bat. The material showing the light overtone is relatively fresh and I do not believe that fading has had time to occur. Some molting individuals in the light color phase show a new pelage of black fur. This indicates that the presence of one color phase in any one individual is not necessarily constant.

Miller (1902), in his original description of M. [ater] nigricans, makes reference to "a crescentic area of broccoli brown about 10 mm in width" on the

shoulders of the type specimen. Felton (1957) states that the spot referred to by Miller is absent on his specimens from El Salvador. I find that this "spot" is an artifact of the specimen preparation technique. The fur between the shoulders is thinner and longer than the remaining body fur. This crescent-shaped spot is visible on well-stuffed specimens and is the lighter basal hair color showing through the longer, thinner fur in that area.



## VARIATION

### Non-geographic Variation

In Molossus, sexual dimorphism is the most significant factor to consider when evaluating variation within populations. The t-test was used to determine significance of difference between samples of males and females. Most skin and skull measurements of males are significantly larger ( $P < .05$ ) than corresponding measurements of females. The t-test and probability values for M. ater nigricans, M. sinaloae, M. aztecas aztecas and M. aztecas lambi are given in Table 1. The difference between sexes of the following measurements of M. ater nigricans is not significant at the 5 per cent level: interorbital breadth; depth of brain case; total length; length of hind foot; length of ear; length of metacarpal V. M. sinaloae differs from M. ater nigricans in that measurements of depth of brain case are significantly different between sexes and length of tail, length of forearm, length of phalanx III, length of metacarpal IV and phalanx IV are not significantly different. Although the probability values for M. sinaloae indicate that body measurements tend to be similar between the sexes, the inclusion of both subadults and adults in the samples may have influenced the results. In general, the

Table 1.--Tests (t-Test) for Difference between Sexes of Adult Molossus ater nigricans (I) from Colima; Subadult and Adult Molossus sinaloae (II) from Colima and Jalisco; Adult Molossus aztecas aztecas (III) from Sinaloa, Jalisco, Colima and Oaxaca; Adult Molossus aztecas lambi (IV) from Chiapas, Mexico

	<u>t</u> I	P	<u>t</u> II	P	T III	P	<u>t</u> IV	P
01	9.62	<.01	6.66	<.01	3.76	<.01	11.97	<.01
02	8.43	<.01	7.24	<.01	3.94	<.01	9.08	<.01
03	0.17	<.20	1.67	<.20	1.15	<.30	2.20	<.05
04	3.59	<.01	3.57	<.01	2.03	<.10	14.66	<.01
05	9.57	<.01	4.64	<.01	1.72	<.20	7.74	<.01
06	4.71	<.01	2.69	<.02	4.12	<.01	5.58	<.01
07	1.94	<.10	3.63	<.01	2.22	<.10	3.21	<.01
08	8.73	<.01	3.80	<.01	2.57	<.05	3.14	<.01
09	9.09	<.01	2.96	<.02	4.37	<.01	8.01	<.01
10	7.22	<.01	6.08	<.01	3.12	<.01	3.57	<.01
11	6.36	<.01	2.23	<.05	3.35	<.01	6.05	<.01
12	2.68	<.02	5.14	<.01	5.43	<.01	4.75	<.01
13	2.06	<.10	0.94	<.40	2.17	<.05	3.57	<.01
14	2.33	<.05	1.90	<.10	1.14	<.30	2.80	<.02
15	0.97	<.40	0.42	<.70	0.45	<.70	0.23	<.90
16	1.40	<.20	0.65	<.60	0.14	<.90	1.08	<.30
17	2.77	<.02	0.04	<.90	2.12	<.10	4.24	<.01
18	3.28	<.01	2.56	<.05	1.15	<.30	0.69	<.50
19	3.20	<.01	0.77	<.50	1.66	<.20	1.73	<.20
20	4.15	<.01	1.68	<.20	2.31	<.05	1.98	<.10
21	2.79	<.01	0.95	<.40	0.76	<.50	0.84	<.50
22	1.55	<.20	0.31	<.80	0.55	<.70	0.42	<.70

\* See pages 5 to 8 for explanation of measurements.

probability values for significance of difference between sexes of both M. aztecas aztecas and M. aztecas lambi are similar. The few measurements which are not significant at the 5 per cent level in M. aztecas aztecas and which are significantly different in M. aztecas lambi may be a result of the heterogeneous sample of aztecas which is comprised of individuals from Sinaloa to Oaxaca, Mexico. Measurements of a single sample of individuals from such widely separated localities are secondarily influenced by geographic variation. In some instances, sample size was not large enough to indicate adequately a consistent difference in size between males and females. However, it is readily apparent that males are significantly larger than females, and for that reason, males and females are herein considered separately.

The coefficients of variation (V) are given in Tables 2, 3 and 4. The low values for V indicate that the samples are relatively pure, which is to be expected when samples are of one sex, from the same general locality and habitat, and contain only adult individuals. The V values for the samples of M. aztecas aztecas are higher in general than V values for corresponding measurements of other species samples. This is understandable because the samples of M. aztecas aztecas contain individuals from different Mexican states and include air-line distances totalling over 550 miles between extreme

Table 2.--Coefficients of Variation (V) for 22 Linear Measurements of Adult Molossus ater nigricans from Colima and the Pacific Coast of Southern Oaxaca and Chiapas, Mexico

*	Colima		Oaxaca and Chiapas	
	Males (N=12) (V)	Females (N=16) (V)	Males (N=8) (V)	Females (N=20) (V)
01	1.99	1.20	1.77	1.53
02	1.67	1.15	1.87	1.46
03	1.40	2.82	3.45	2.52
04	1.58	1.40	2.67	1.66
05	1.42	1.77	2.74	1.57
06	1.45	1.70	1.61	2.81
07	3.64	2.00	2.93	2.19
08	1.21	1.42	3.28	1.71
09	1.96	1.73	1.87	2.11
10	1.37	1.38	2.66	1.82
11	2.14	1.74	1.93	1.84
12	1.81	1.27	3.02	2.03
13	2.95	3.88	3.70	2.46
14	4.54	5.78	11.26	4.61
15	13.13	9.49	7.00	8.39
16	5.94	11.47	7.86	4.56
17	2.15	1.50	3.14	2.46
18	2.62	1.52	2.39	1.80
19	2.68	2.55	3.32	2.81
20	2.34	1.12	1.55	2.12
21	2.98	2.09	3.07	3.12
22	3.24	1.66	4.48	2.88

\* See pages 5 to 8 for explanation of measurements.

Table 3.--Coefficients of Variation (V) for 22 Linear Measurements of Subadult and Adult Molossus sinaloae from Jalisco and Colima, Mexico

*	Males (N=6)	Females (N=7)
	(V)	(V)
01	1.67	0.97
02	1.05	1.00
03	2.04	2.30
04	2.34	1.34
05	2.57	1.05
06	1.42	2.04
07	0.70	1.22
08	1.84	1.33
09	2.76	1.96
10	1.54	0.85
11	2.75	1.68
12	1.33	0.69
13	6.53	6.10
14	3.42	4.18
15	4.19	9.29
16	7.71	3.43
17	1.77	1.27
18	1.43	0.89
19	1.47	1.52
20	1.38	0.84
21	2.11	1.85
22	2.29	2.14

\* See pages 5 to 8 for explanation of measurements.

Table 4.--Coefficients of Variation (V) for 22 Linear Measurements of Adult Molossus aztecas aztecas from Sinaloa, Jalisco, Colima, and Oaxaca, and Adult Molossus aztecas lambi from Chiapas, Mexico

*	<u>M. a. aztecas</u>		<u>M. a. lambi</u>	
	Males (N=7) (V)	Females (N=6) (V)	Males (N=5) (V)	Females (N=11) (V)
01	2.94	1.46	0.58	1.37
02	1.98	1.63	0.66	1.48
03	3.51	2.88	4.61	1.91
04	1.74	2.13	1.87	1.76
05	2.49	2.42	1.17	1.74
06	1.00	0.84	0.63	0.73
07	3.32	2.62	1.86	2.68
08	2.79	2.09	2.90	1.94
09	2.25	3.67	1.68	2.83
10	2.15	1.19	2.40	2.28
11	2.97	2.01	1.99	1.97
12	2.00	1.61	1.57	2.22
13	4.89	5.45	5.70	3.36
14	11.06	8.70	5.31	5.94
15	5.22	18.38	8.84	5.37
16	7.56	4.03	3.15	4.33
17	2.92	3.34	1.72	1.25
18	2.32	3.36	1.49	1.94
19	3.49	4.63	1.67	3.18
20	2.63	3.86	1.52	1.62
21	6.22	5.49	1.73	3.26
22	2.63	4.65	1.86	2.72

\* See pages 5 to 8 for explanation of measurements.

localities. It is interesting to note that, with few exceptions, the conventional body measurements (total length, tail, hind foot and ear) have the larger V values. This indicates that either these proportions are highly variable or that the collector was not careful and consistent when taking these measurements. I believe that both of these alternatives are true. You would expect measurement variation when the size, shape and condition of the animal, when being measured, are considered. Also, the number of specimens awaiting preparation, the field facilities and conditions (humidity, number of insect pests, etc.) all tend to influence the accuracy of these measurements. I do not intend to belittle the usefulness of such measurements, but their relative accuracy should be considered in the light of these variable conditions.

Heavy, well-developed sagittal and lambdoidal crests are generally characteristic of males. Skulls of old adult females with worn dentition do not show the extreme crest development of adult males. In lateral view, the dorsal margin of the rostrum varies with age and sagittal crest development. As the crest becomes larger, it extends forward on the rostrum, tending to flatten the dorsal rostral plane and steepen the angle of the rostrum.

#### Geographic variation

Geographic variation is great between individual

populations of Molossus. Size variation is expressed in response to changes in elevation and latitude. Individuals from higher elevations or more northern latitudes are larger than individuals from lower elevations or more southern latitudes. Evidence indicates that habitat types may affect individual size. Animals from heavily forested areas tend to be larger than animals from open habitats such as coastal savannas, although such habitat types may be very close geographically to each other. Color variation, in general, appears to follow changes in elevation, latitude, and humidity. Populations from higher elevations or more northern latitudes are usually lighter in color. Also populations from more humid areas tend to have a "richer" color tone. These color differences found in populations from different elevations, latitudes and levels of seasonal humidity appear to be interrelated and complex. In Chiapas, populations from dense, humid forests are darker than populations from the dryer open vegetation of the Pacific Coastal Plain. This same darker coloration is seen in coastal populations to the north in Colima but the color tone is not as rich or intense as that of populations from the more humid areas farther south.

Certain characters which are variable within a given population also show variation in frequency of occurrence between populations. Such a "qualitative"



character is the shape and development of the lingual cingulum on the first two upper molars (see Table 5). When comparing this character, three categories were used. First, those in which the cingulum has a sharp occlusal ridge (S) on the lingual side. Second, those in which the cingulum ridge is rounded on one molar and yet sharp on the other or with both rounded and sharp areas on each molar (R-S). Finally, those in which the cingulum ridge is rounded on both molars (R). Any one of the conditions is symmetrical; that is, the condition on one tooth row also appears on the other. There is no occlusion of cingula, therefore tooth wear does not affect this character except in extremely old individuals. Other such variable characters are: the relative depth of basisphe-noid pits; the posterior palatine margin, either indented, straight or with a medial posterior projection; the posterior margin of the upper premolars which vary from indented to straight. There are other randomly-occurring cranial variations such as relative size of the first lower premolar; occipital depth of cranium; variable size and position of the infraorbital foramen. Individual variation is great and local populations often display particular combinations of these variable characters. This consistency of characters within a single population sometimes permits recognition of individuals as being

Table 5.--Variation in Development of the Lingual Cingulum of M1 and M2 in Molossus ater nigricans between Four Mexican Localities--Sharp Occlusal Ridge (S); Sharp Occlusal Ridge Poorly Developed with Part of Cingulum Rounded (R-S); Occlusal Ridge Rounded (R)--Values Expressed as Per Centage of Occurrence in Samples Examined

Locality	S	R-S	R
Colima	70.0	20.0	10.0
West Coast of Chiapas and southeastern Oaxaca	38.0	5.0	57.0
ca. 12 miles east of Ortiz Rubio on Villa Flores Road, Chiapas	6.7	20.0	73.3
ca. 8 kilometers southward from Solosuchiapa, Chiapas	--	18.0	82.0

from that particular population. Nothing is known of the full extent of variation nor the relative stability of these traits or combinations of traits in any single population.

Any combination of the discussed variable "qualitative" characters may be present in any one species. However, the basic cranial configuration appears to be species specific. With the exception of the few species specific body, cranial or size characteristics, the basic cranial proportions and configuration are the best "tools" for species identification. The great range of body, cranial and color variation, the pronounced size differences between sexes and relative frequency and consistency of variable traits within any particular population, have all contributed to the confusion and disagreement regarding the taxonomy within this genus. Many of the species were poorly diagnosed when originally described. One of the more common species, M. ater, was called M. rufus until very recently (Goodwin, 1960), an example of an inadequate original diagnosis and subsequent confusion by earlier workers. In addition, much of the confusion regarding the taxonomy of this genus, even today, is the result of a paucity of comparative material. Because of the little-known disparity in size between sexes, specimens of one sex have been compared with specimens of the opposite sex belonging to different species. Also, specimens belonging

to the same species but from widely separated localities have been compared without regard to the sometimes great clinal variation in size.

Little is known about the ecology of this genus. The majority of specimens have been collected from human habitations utilized by the bats as day roosts or when, by chance, these bats flew into rooms at night. A collecting method which is still practical, is to shoot them during the last light of early evening when they begin their nocturnal activities. More recently, mist-nets have proven effective as collecting tools. All in all, these collecting methods have revealed little information concerning natural day roosts, population structure, daily and seasonal activity patterns and the relative abundance of these bats. Many collectors fail to note the reproductive condition of animals captured.

These bats are fast, strong fliers and can often be observed feeding at great heights above the ground. One would not expect a bat population which has these flight capabilities to show strong local tendencies toward endemism. Molossus species are widely distributed, even occurring on the Island of Cuba. It is my opinion, at this time, that these strong robust bats could easily withstand the forces of storms and hurricanes which could have been the dispersal mechanisms initiating their population of the Antillean Islands. Now a question is posed.

What controls the localized island and mainland populations? Obviously, geographic barriers such as rivers, mountains and narrow expanse of sea should not be expected to limit such widely distributed and strong-flying bats. If other genera and species of bats find these geographic barriers essentially non-restrictive, then it is my opinion that these same barriers should offer little dispersal resistance to bats of the genus Molossus. It does appear that tropical and semitropical ecological requirements restrict their distribution but this is not critical throughout much of their range. I believe that the high degree of variation observed between different populations of the same species is the result of a basically sedentary behavioral pattern. In Colima I have observed that M. ater nigricans can usually be found in the same habitats and often in the same tree hole throughout the year. Dalquest (1953:68) also reported that in San Luis Potosi, individuals of M. [ater] nigricans utilized their day roost as a night roost. These observations tend to confirm my hypothesis that these bats are, in fact, sedentary and tend to localize nocturnal activity to the vicinity of their day roost and to remain in the same general area throughout the year. Mist-netting on the Pacific Coastal Plain of Chiapas indicates that nocturnal activity may become concentrated around permanent water

supplies during the dryer months of the year, usually April and May. Although the populations sampled from this region show a high degree of homogeneity, I still think that little or no gene flow results from this short seasonal intermingling of populations due to water scarcity. However, normal population pressure may account for the similarity of populations in this continuous habitat. Judging from reproductive data, the breeding season is completed before these populations are drawn together. In this area, most females give birth to young from April through August with a peak in early June.

Without any doubt, bats of this genus represent a wide-ranging, poorly understood assemblage of species which present fascinating taxonomic, life history and biogeographical problems.

## SPECIES GROUPS

The criteria for separating the genus Molossus into species groups are based on body size, fur color and texture, and size, shape and configuration of the skull. These species groups do not necessarily follow those outlined by Miller (1913). The questionable status of some of these species is discussed in the species accounts.

### Ater-group

Includes the largest members of the genus. All have broad, massive skulls with well-developed sagittal crests in both sexes; a wide septum between sphenoidal pits; short, stiff fur on dorsum (Central American forms of M. bondae excepted); basal lighter portion of hair short to lacking; dichromatism is evident. This group includes: Molossus ater Geoffroy; Molossus pretiosus Miller; Molossus macdougalli Goodwin; Molossus bondae Allen.

### Sinaloae-group

Includes medium to large-sized members of the genus. Characterized by a massive skull with a high, long narrow brain case; well-developed sagittal crests in both sexes; a very narrow septum between sphenoidal pits; long, fine,

lax fur; basal fur color very light to white, including one-half or more of the hair length; not dichromatic; tactile bristles on rump very long and fine. This group includes Molossus sinaloae Allen and Molossus trinitatus Goodwin.

#### Major-group

Small to medium-sized members of the genus. Skull variable, usually shorter and narrower than in M. bondae; sagittal crest usually well developed in males only; sphenoidal pits widely separated to narrow (not as wide as in ater-group); fur long to short with lighter basal portion readily visible; some members dichromatic. Mainland species of this group include: Molossus aztecas Saussure; Molossus burnesi Thomas; Molossus coibensis Allen; Molossus major (Kerr); Molossus pygmaeus Miller.

#### Key

The following is a key to the Mexican species of Molossus.

1. Length of forearm more than 42 mm
2. Fur short, stiff and velvety; tactile bristles on rump short and stiff; separation between sphenoidal pits wide
3. Known only from vicinity of Tehuantepec,  
Oaxaca Molossus macdougalli.



3°. Widely distributed in Mexico

Molossus ater nigricans.

2°. Fur long, fine and lax; tactile bristles on rump long, fine and often inconspicuous; separation between sphenoidal pits narrow

Molossus sinaloae.

1°. Length of forearm less than 42 mm

4. Color brownish; fur fine, lax and distinctly bicolored

5. Distribution north of the Isthmus of Tehuantepec; short, wide skull; subposterior margin of infraorbital foramen expanded laterally and continuous with zygomatic arch

Molossus aztecas aztecas.

5°. Distribution south of Isthmus of Tehuantepec; slender skull with low, narrow rostrum; subposterior margin of infraorbital foramen not as above; known from southern Chiapas

Molossus pygmaeus.

4°. Fur fine and lax; two color phases; dark color phase blackish; skull as in Molossus a. aztecas; known from southwestern Chiapas and Pacific coastal plain of the Sierra Madre del Sur de Chiapas

Molossus aztecas lambi.

SPECIES ACCOUNTS

Genus Molossus E. Geoffroy St.-Hilaire

Vespertilio Schreber, Saugeth., 1, 1774:171 (part; not Linnaeus, 1758).

Molossus Geoffroy, Ann. Mus. Hist. Nat., Paris, 6, 1805:151.

Dysopes Illeger, Prodromus Systematis mammalium et avium, 1811:76.

Molossus ater nigricans Miller

1805 Molossus ater Geoffroy, Ann. Mus. Hist. Nat., Paris, 6:156.

1902 Molossus nigricans Miller, Proc. Acad. Nat. Sci. Philadelphia, 54:395.

1955 Molossus sinaloae de la Torre, Fieldiana:Zool., Chicago Nat. Hist. Mus., 37:701 (not Allen, 1906).

1955 M[olossus]. r[ufus]. nigricans de la Torre, Fieldiana:Zool., Chicago Nat. Hist. Mus., 37:701.

1962 Molossus ater nigricans Jones, Alvarez and Lee, Univ. Kansas Publ., Mus. Nat. Hist., 14(12):155.

Type

Adult male (skin and skull), USNM 90941 (Biological Survey Collection). Collected by E. W. Nelson

and E. A. Goldman at Acaponeta, Nayarit, 2 August 1897.

#### Range

Sinaloa and Tamaulipas, south through Mexico and Central America to Costa Rica.

#### Characters

Largest species in the genus, with broad, massive skull; high sagittal crests; short, stiff, velvety fur; two color phases. See Tables 6 to 10 for measurements.

#### Color

Dark phase: varies between Blackish Brown, Sooty Brown and Bone Brown to Light Seal Brown and Van Dyke Brown. Light phase: varies from Argus Brown and Russet to Sudan Brown and Ochraceous Tawny, the latter apparently uncommon. Underparts lighter.

#### Distribution

M. ater nigricans is common and widely distributed in Mexico. The following localities are indicated in Figure 2. The sequence followed extends from north to southeast in eastern Mexico and south to northwest in western Mexico. Tamaulipas: (Alvarez, 1963:47, unless otherwise noted) 3 mi. NE Guemes; Rancho Santa Rosa, 25 km. N, 13 km. W Cd. Victoria, 260 m.; 2 mi. S Cd. Victoria (Davis, 1951:219); Rancho Pano Ayuctle, 6 mi. N Gomez

Table 6.--Skin and Skull Measurements in Millimeters of Adult Molossus ater nigricans from Ca. 8 Kilometers Southward from Solosuchiapa, Chiapas, Mexico

*	Males (N=2)	mean	Females (range)	N
01	24.15-23.85	22.71	(23.15-22.20)	9
02	21.00-20.85	20.01	(20.40-19.70)	9
03	4.85- 4.75	4.61	( 4.80- 4.55)	9
04	15.10-14.95	13.93	(14.35-13.70)	9
05	14.60-14.40	13.59	(13.80-13.40)	9
06	11.35-10.15	11.08	(11.30-10.75)	9
07	7.30- 7.00	7.05	( 7.30- 6.35)	9
08	10.35-10.25	9.08	(10.15- 9.35)	9
09	6.20- 6.10	5.69	( 5.90- 5.45)	9
10	8.35- 7.95	8.24	( 8.40- 8.10)	9
11	17.45-17.25	16.47	(16.65-16.30)	9
12	9.50- 9.30	9.08	( 9.20- 8.95)	9
13	145.0-139.00	132.33	(135.0-130.0)	9
14	54.00-52.00	51.89	(54.00-50.00)	9
15	14.00-12.00	12.89	(14.00-11.00)	9
16	13.00-12.00	15.89	(18.00-12.00)	9
17	52.30-49.85	51.61	(52.70-50.50)	9
18	54.55-52.20	52.96	(53.85-52.20)	9
19	25.75-23.75	23.64	(24.50-22.55)	9
20	52.85-50.65	51.22	(52.50-50.10)	9
21	22.75-21.10	20.51	(21.70-19.40)	9
22	33.90-32.75	33.20	(33.90-31.95)	9

\* See pages 5 to 8 for explanation of measurements.

Table 7.--Skin and Skull Measurements in Millimeters of  
 Adult Molossus ater nigricans from La Soledad,  
 Municipio Las Margaritas, Chiapas, Mexico

*	Males (N=2)	Female
01	22.05- 23.50	21.85
02	19.35- 20.45	18.95
03	4.35- 4.70	4.30
04	14.00- 14.30	13.40
05	13.50- 13.95	13.00
06	11.10- 11.40	11.25
07	7.00- 7.05	6.80
08	9.80- 9.85	9.45
09	5.85- 5.90	5.50
10	8.10- 8.50	7.85
11	15.90- 16.95	15.50
12	9.00- 9.35	8.85
13	123.00-126.00	123.00
14	46.00- 47.00	42.00
15	11.00- 11.00	11.00
16	17.00- 18.00	17.00
17	49.50- 52.55	50.15
18	50.75- -----	51.20
19	21.85- 24.30	22.50
20	48.55- 51.70	49.55
21	19.65- 21.05	19.75
22	31.00- 33.80	31.55

\* See pages 5 to 8 for explanation of measurements.

Table 8.--Skin and Skull Measurements of Adult Molossus ater nigricans in Millimeters from 12 Miles E. Ortiz Rubio on Villa Flores Rd., Chiapas, Mexico

*	Males			Females		
	mean	(range)	N	mean	(range)	N
01	23.98	(24.30-23.80)	3	22.26	(23.15-21.65)	12
02	20.57	(20.75-20.25)	3	19.38	(20.00-18.65)	12
03	4.77	(4.90-4.65)	3	4.58	(4.85-4.20)	12
04	14.50	(14.75-14.10)	3	13.60	(14.30-13.25)	12
05	14.40	(14.80-14.15)	3	13.38	(13.95-13.00)	12
06	11.33	(11.45-11.20)	3	10.86	(11.20-10.60)	12
07	7.17	(7.45-7.05)	3	7.01	(7.25-6.60)	12
08	10.02	(10.20-9.75)	3	9.63	(10.00-9.40)	12
09	6.20	(6.45-6.05)	3	5.64	(5.95-5.35)	12
10	8.42	(8.50-8.25)	3	8.03	(8.40-7.80)	12
11	16.67	(16.85-16.55)	3	15.76	(16.35-15.00)	12
12	9.55	(9.60-9.55)	3	8.91	(9.25-8.55)	12
13	130.67	(132.0-128.0)	3	129.08	(134.0-125.0)	12
14	48.00	(50.00-46.00)	3	48.67	(52.00-46.00)	12
15	11.33	(12.00-11.00)	3	11.17	(12.00-10.00)	12
16	18.67	(19.00-18.00)	3	18.33	(19.00-17.00)	12
17	50.43	(50.85-49.75)	3	49.52	(50.55-46.50)	12
18	51.95	(52.65-51.40)	3	51.00	(53.25-48.60)	12
19	24.10	(24.60-23.60)	3	23.38	(24.70-22.05)	12
20	49.98	(50.55-49.40)	3	49.35	(51.55-47.30)	12
21	20.73	(20.95-20.30)	3	20.12	(20.85-19.25)	12
22	32.45	(33.70-31.25)	3	32.41	(33.55-30.85)	12

\* See pages 5 to 8 for explanation of measurements.

Table 9.--Skin and Skull Measurements in Millimeters of  
 Adult Molossus ater nigricans from the Pacific  
 Coastal Plain of Southeastern Oaxaca and Chiapas,  
 Mexico

*	Males			Females		
	mean	(range)	N	mean	(range)	N
01	23.60	(23.65-22.55)	7	22.00	(22.50-21.30)	19
02	19.93	(20.45-19.50)	8	19.18	(19.60-18.55)	19
03	4.69	(4.90-4.45)	8	4.47	(4.65-4.30)	20
04	14.37	(14.90-13.95)	6	13.71	(14.20-13.30)	18
05	14.23	(14.80-13.80)	7	13.32	(13.70-12.95)	20
06	11.11	(11.25-10.75)	8	10.78	(11.15-10.35)	20
07	7.08	(7.40-6.80)	8	6.94	(7.20-6.70)	20
08	9.64	(10.15-9.10)	8	9.44	(9.80-9.20)	20
09	5.91	(6.05-5.80)	7	5.43	(5.70-5.25)	20
10	8.11	(8.45-7.75)	7	7.89	(8.15-7.65)	19
11	16.35	(16.90-16.00)	8	15.65	(16.05-14.85)	18
12	9.14	(9.40-8.50)	8	8.75	(9.05-8.45)	20
13	132.87	(139.0-127.0)	8	129.30	(136.0-125.0)	20
14	46.12	(53.00-39.00)	8	47.30	(51.00-44.00)	20
15	10.62	(12.00-10.00)	8	10.30	(12.00-9.00)	20
16	18.00	(21.00-17.00)	8	17.25	(18.00-16.00)	20
17	49.26	(51.10-46.35)	8	48.73	(51.25-45.70)	20
18	50.65	(52.25-48.75)	8	50.10	(51.80-48.40)	20
19	22.68	(23.90-22.10)	8	22.56	(24.05-21.80)	20
20	49.33	(50.50-48.40)	8	48.15	(50.10-46.35)	20
21	19.37	(20.30-18.70)	8	19.45	(20.65-18.15)	20
22	31.81	(34.55-30.20)	8	31.44	(33.15-29.65)	20

\* See pages 5 to 8 for explanation of measurements.

Table 10.--Skin and Skull Measurements in Millimeters of  
Adult Molossus ater nigricans from Colima,  
Mexico

*	Males			Females		
	mean	(range)	N	mean	(range)	N
01	24.13	(24.75-23.35)	12	22.76	(23.25-22.40)	16
02	20.97	(21.45-20.50)	12	20.02	(20.50-19.50)	16
03	4.70	(4.80-4.55)	12	4.59	(4.80-4.35)	15
04	14.73	(15.20-14.45)	12	14.05	(14.50-13.70)	16
05	14.34	(14.60-13.95)	11	13.50	(14.05-13.10)	16
06	11.19	(11.50-11.00)	12	10.87	(11.35-10.65)	16
07	7.20	(7.85-6.90)	12	7.05	(7.35-6.80)	16
08	10.36	(10.60-10.15)	13	9.92	(10.15-9.65)	16
09	6.16	(6.35-5.95)	13	5.78	(6.00-5.60)	16
10	8.54	(8.70-8.30)	13	8.23	(8.50-8.05)	16
11	17.02	(17.60-16.40)	12	16.24	(16.75-15.65)	15
12	9.52	(9.80-9.25)	12	9.06	(9.20-8.85)	16
13	134.31	(140.0-130.0)	13	130.73	(138.0-120.0)	15
14	50.54	(54.00-45.00)	13	48.27	(52.00-43.00)	15
15	13.69	(18.00-11.00)	13	13.13	(15.00-10.00)	15
16	18.69	(20.00-16.00)	13	17.80	(19.00-12.00)	15
17	51.94	(54.20-50.15)	11	50.94	(52.00-49.25)	16
18	53.22	(55.80-51.10)	13	51.84	(52.80-49.90)	15
19	23.97	(25.30-22.60)	12	23.21	(24.10-21.90)	15
20	51.50	(54.00-49.65)	12	50.09	(50.80-49.20)	16
21	20.51	(21.45-19.30)	13	19.97	(20.70-19.20)	16
22	32.76	(34.50-30.30)	13	32.30	(35.50-31.45)	16

\* See pages 5 to 8 for explanation of measurements.



Farias, 300 ft.; Rancho Pano Ayuctle, 25 mi. N El Mante  
 and 3 km. W Pan American Hwy., 2200 ft.; 8 km. W, 10 km.  
 N El Encino, 400 ft.; Alta Mira (Miller, 1902:396). San  
 Luis Potosi: (Dalquest, 1953:67) El Salto; Rio Moctezuma  
 at Tamazunchale. Veracruz: (Hall and Dalquest, 1963:  
 255, unless otherwise noted) Ozuluama, 500 ft.; La Mar,  
 20 ft.; Tuxpan; 12 $\frac{1}{2}$ mi. N Tihuatlan, 300 ft.; Puente  
 Nacional, 500 ft.; 4 km. W Paso de San Juan, 250 ft.; Rio  
 Atoyac, 8 km. NW Potrero; 4 km. WNW Fortin, 3200 ft.; 6  
 mi. E Cordoba (Booth, 1957:10); Potrero Viejo, 1700 ft.;  
 3 km. SE Orizaba; Tuxpango (the last five localities in-  
 dicated by single large circle in Fig. 2); Cosamaloapan,  
 150 ft.; San Andres Tuxtla; Catemaco; Jesus Carranza, 25  
 ft. Yucatan: (Hatt and Villa, 1950:232, unless otherwise  
 noted) Opechen; Calcehtok; Chichen Itza (Miller, 1913:88);  
 Yaxcash (not found, Miller, 1913:88). Chiapas: ca. 8 km.  
 Southward from Solosuchiapa; La Soledad; Huehuetan (Miller,  
 1902:396); 11 km. NW Escuintla, 100 ft.; 20 km. SE  
 Pijijiapan; 15 mi. ESE Tonala; 9 mi. SE Tonala; Finca  
 Ocuilapa, 8 mi. SE Tonala (= 10 km. SE Tonala); Tonila  
 (Miller, 1902:396, = Tonala?); 12 mi. E Ortiz Rubio on  
 Villa Flores Rd.; 15 mi. SW Las Cruces (KU coll.); 2 km.  
 NW Tenochitlan. Oaxaca: Las Minas, 5 mi. E Tapanatepec;  
 Tehuantepec (Miller, 1902:396); 1 mi. SE Tequixistlan  
 (KU coll.); Chacalapa, 2500 ft. (KU coll.); Puerto Angel

Figure 2.--Map showing the known Mexican distribution of Molossus ater nigricans as indicated by locality records.



(KU coll.); Llano Grande (Miller, 1902:396). Guerrero: 2 mi. NW Acapulco, 50 ft. (KU coll.); 15 mi. NW Acapulco (de la Torre, 1955:701, reported as M. sinaloae); 5 mi ESE Tecpan, 50 ft. (KU coll.). Puebla: 2 mi. SE Izucar de Matamoras (KU coll.). Morelos: Hda. Cocoyotla (Davis and Russell, 1954:70). Colima: Colima (Miller, 1902:396); 3 km. S Pueblo Nuevo (LACM coll.); Pueblo Nuevo (LACM coll.); La Sidra, near Agua Zarca; 5 km. NE Pueblo Juarez; Cuatecomatan; Las Juntas, 5 km. SE Pueblo Juarez; Tlapeixtes, near Manzanillo; 1 km. N Tlapeixtes; 2 km. N Tlapeixtes. Jalisco: Los Masos (not found, Allen, 1906:260); Teuchitlan (Miller, 1902:396). Durango: Santa Ana (Jones, 1964:752). Nayarit: 5 mi. N San Blas; Acaponeta (Miller, 1902:395). Sinaloa: (Jones, Alvarez and Lee, 1962:155, unless otherwise noted) 5 mi. NE Concordia on Mex. Hwy 40 (UA coll.); 1 mi. SE Camino Real, 400 ft.;  $\frac{1}{2}$  mi. E Piaxtla; 32 mi. SSE Culiacan; 1 mi. S Pericos.

#### Remarks

M. ater nigricans is the most common member of this genus in Mexico. Locality records indicate that it is widespread in the lower, tropical and semi-tropical habitats. In the northern parts of its range this bat appears to be restricted to tropical deciduous riparian forests associated with permanent water. Farther south, the habitat restrictions appear to be non-existent with

the obvious exception of habitats at elevations over 6000 feet. Day roosts include a wide variety of situations: hollow trees and tree holes well above the ground; rock crevasses in cliffs and shallow caves (Dalquest, 1953:68; Jones, Alvarez and Lee, 1962:155); under palm fronds; human habitations in attics and under roof tiles (Miller, 1902:395).

Geographic variation is pronounced in this species. Variation in size, color pattern, and development and frequency of qualitative cranial characters is apparent between populations, close geographically but from different habitats (see Table 5 and Figs. 3 and 4). This geographic variation plus pronounced sexual dimorphism has resulted in much confusion regarding the taxonomic status of individual populations.

Goodwin (1956:3-4) originally described M. macdougalli as a subspecies of M. pretiosus. He assigned this specimen, a young adult female collected near Tehuantepec, Oaxaca, to M. pretiosus on the basis of size and close comparison with M. pretiosus from La Guaira, Venezuela, although he stated that M. pretiosus had not been recorded north of the Isthmus of Panama. In addition, he compared his type with an immature female M. [ater] nigricans from Acaponeta, Nayarit. On the basis of his findings he indicated that this specimen was smaller than

Figure 3.--A graphic comparison of four cranial measurements of samples from six populations of Molossus ater nigricans from Mexico.

Vertical line indicates the range; horizontal line the mean; box on each side of the mean 95 per cent confidence limits of the mean. Horizontal lines with dot indicate one individual. Confidence limits of the mean are not graphed for samples of four or less. Males and females are graphed separately. Localities are: A, ca. 8 km. southward from Solosuchiapa, Chiapas; B, La Soledad, Chiapas; C, 12 mi. E Ortiz Rubio on Villa Flores Rd., Chiapas; D, southeastern Oaxaca and Pacific Coastal Plain of Chiapas; E, 15 mi. WNW Acapulco, Guerrero; F, Colima.

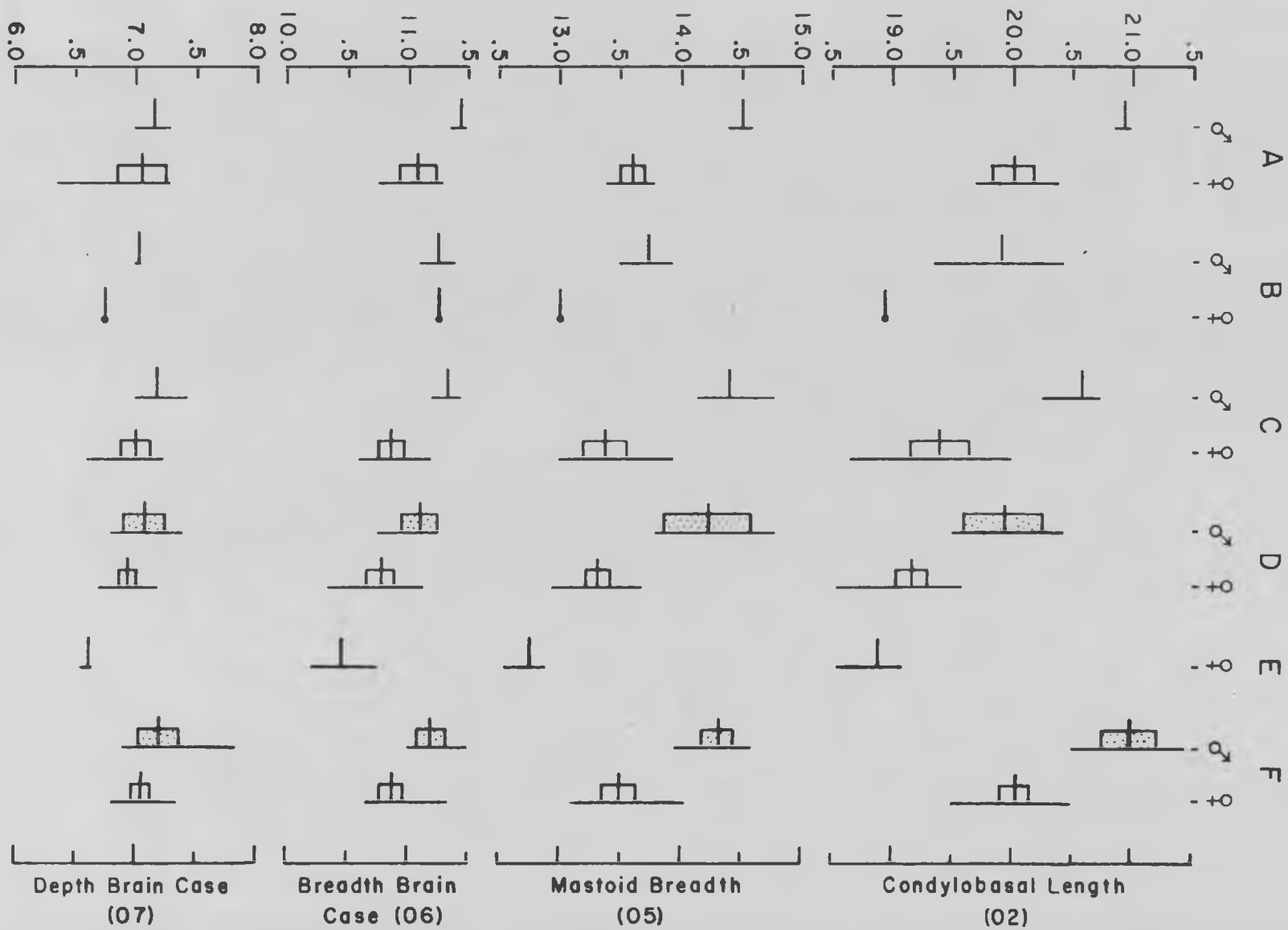
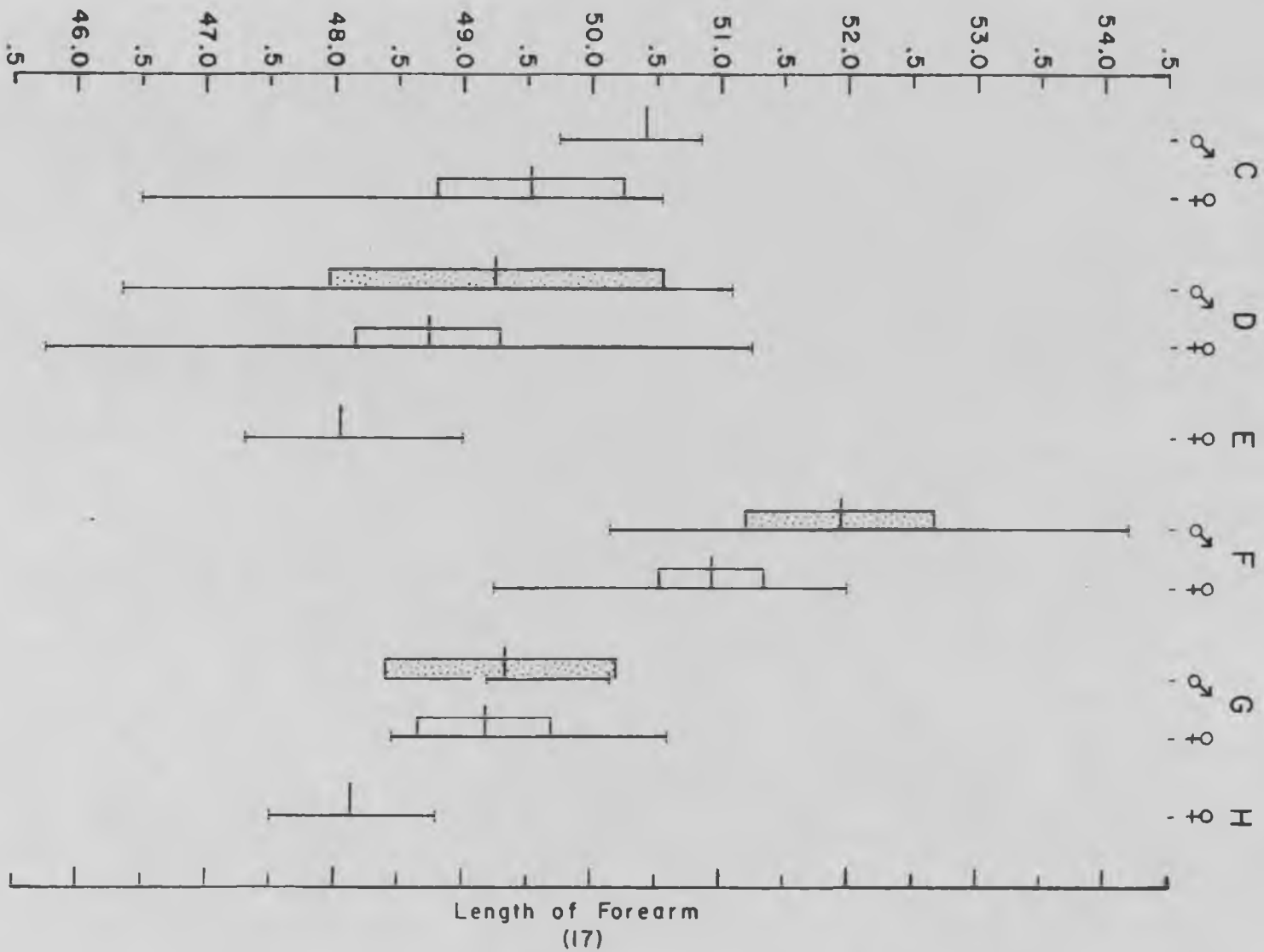


Figure 4.--A graphic comparison of length of forearm measurements between samples of three populations of Molossus ater nigricans (C, D, E and F) and samples of two populations of Molossus sinaloae (G and H).

Vertical line indicates the range; horizontal line the mean; box on each side of the mean 95 per cent confidence limits of the mean. Confidence limits for the mean are not graphed for samples of four or less. Males and females are graphed separately. Localities are: C, 12 mi. E Ortiz Rubio on Villa Flores Rd., Chiapas; D, southeastern Oaxaca and Pacific Coastal Plain of Chiapas; E, 15 mi. WNW Acapulco, Guerrero; F, Colima; G, Jalisco and Colima, Mexico; H, Rio Grande, Nicaragua.





M. [ater] nigricans although "in external measurements it could come within the extreme range of individual variation for Molossus nigricans Miller." He also stated that "Molossus pretiosus macdougalli is much larger and needs no comparison with Molossus sinaloae J. A. Allen." Earlier, de la Torre (1955:701) reported nine females (in alcohol) from 15 mi. NW Acapulco, Guerrero as M. sinaloae and included forearm measurements. In this article de la Torre stated: "M. sinaloae, however, is a medium size species and is distinct from the larger M. rufus [now known as M. ater] of which nigricans Miller is the northern race. M. r. nigricans and M. r. rufus differ only in average size, while M. sinaloae can always be separated from M. rufus on absolute characters." This is assuming, of course, that de la Torre's statements were in regard to the specimens he had collected and was, at that time, reporting as M. sinaloae. Later, Goodwin (1959:1-3) described a new species from Trinidad as M. trinitatus. In this description he repeated de la Torre's last statement regarding M. sinaloae and M. rufus. This statement, "M. sinaloae can always be separated from M. rufus on absolute characters," has now appeared twice without any explanation or definition of these "absolute characters." It appears that mammalogists were beginning to question the status of M. trinitatus as a possible

consequence of the large forearm measurements presented by de la Torre for "M. sinaloae." This prompted Goodwin (1964:20) to examine these specimens reported by de la Torre, and he came to the conclusion that they do not represent M. sinaloae, but are referable to M. macdougalli which he then elevated to full species rank. In this same publication, Goodwin compared these specimens with M. sinaloae and M. trinitatus. Through the courtesy of the personnel at the Chicago Natural History Museum, I have examined six (two intact alcoholics and four with skulls removed) of the nine female specimens reported as M. sinaloae by de la Torre and as M. macdougalli by Goodwin. After closely comparing these specimens with adult females of M. ater nigricans from western Mexico, I have come to the conclusion that they represent only geographic variants of the wide-spread M. ater nigricans and do not closely resemble M. sinaloae. With the exception of depth of brain case and mastoid breadth which are less than in representatives of M. ater nigricans examined, I find that they fall within the size range of M. ater nigricans from the Pacific Coastal Plain of Chiapas. The extent of variability shown by the female specimens of M. ater nigricans from Chiapas includes that shown by the specimens from Guerrero. Figures 3 and 4 are Dice-Leraas graphs of selected measurements of these

specimens from Guerrero and Chiapas in addition to those of other populations. I feel certain that my sample from the Pacific Coast of Chiapas is pure because of the low coefficient of variation values indicated in Table 9 (if the sample were mixed, then I would expect much higher V values). This still leaves the question of the type of M. macdougalli. I am reluctant to say that M. macdougalli is a synonym of M. ater without having the opportunity to examine the type. However, at this time, it does appear that such is the case; a possibility also suggested by Goodwin in the original description (1956:4). I suspect that future work may show that populations of M. ater from coastal areas of Guerrero and Oaxaca are distinct from the subspecies nigricans. If this is so, the name macdougalli will then be applicable. Because I have not examined the type of M. macdougalli, I choose to include it herein as a full species. Another problem is the specimens reported by Lukens and Davis (1957:13) as M. sinaloae from El Papayo, Guerrero. These also may prove not to be M. sinaloae, a possibility mentioned by Davis (personal communication).

As a result of examining representatives of M. ater from Mexico, the possibility that populations from certain areas may be subspecifically distinct from the nominal subspecies nigricans appears a certainty. However, I have

not chosen to name any as such because we know very little about the overall variation within this species and nothing about the stability of the various population identities.

#### Specimens Examined

States are arranged in alphabetical order and localities shown by the symbols in Figure 2 are covered from north to south in each state. Chiapas: ca. 8 km. southward from Solosuchiapa (UA, 11); La Soledad (UA, 3); 12 mi. E Ortiz Rubio on Villa Flores Rd. (UA, 15); 10 km. SE Tonala (LACM, 11); Finca Ocuilapa, 8 mi. SE Tonala (LACM, 2; UA, 12); 9 mi. SE Tonala (LACM, 1); ca. 15 mi. ESE Tonala (LACM, 1); 20 km. SE Pijijiapan (LACM, 4); 11 km. northwest from Escuintla (UA, 2). Colima: 3 km. S Pueblo Nuevo (UA, 1); 5 km. NE Pueblo Juarez (UA, 1); La Sidra, near Agua Zarca (UA, 1); Pueblo Juarez (UA, 1); Las Juntas, approx. 5 km. SE Pueblo Juarez (UA, 5); Cuatecomatan (UA, 3); 2 km. N Tlapeixtes (UA, 8); 1 km. N Tlapeixtes (UA, 6); Tlapeixtes, near Manzanillo (UA, 4). Oaxaca: Las Minas, 5 mi. E of Tapanatepec (UA, 2). Sinaloa: ca. 5 mi. NE Concordia on Mex. Hwy 40 (UA, 1).

#### Molossus macdougalli Goodwin

1956 Molossus pretiosus macdougalli Goodwin, Amer. Mus.

Novit., 1757:3.

1964 Molossus macdougalli Goodwin, Amer. Mus. Novit.,  
2195:20.

#### Type

Adult female (skin and skull, prepared from fluid preserved specimen), AMNH 145150. Collected by Thomas MacDougall at San Blas, 3 kilometers southeast of Tehuantepec, Oaxaca, 5 September, 1946.

#### Range

Known only from the type locality.

#### Characters

(After Goodwin, 1956:4) "A medium-sized, uniformly colored, blackish free-tailed bat of the Molossus rufus group. It has soft, velvety pelage, a small, sharply pointed tragus, broad, thick antitragus, square across the top...."

"Skull short and massive, with relatively low weak sagittal and lambdoidal crests, similar in size to that of M. pretiosus but with a somewhat larger brain case."

#### Distribution

Type locality. Plotted as an "Δ" in Figure 5 with M. sinaloae.

#### Remarks

See Remarks under M. ater nigricans.

## Specimens Examined

None.

Molossus sinaloae J. A. Allen

1906 Molossus sinaloae J. A. Allen, Bull. Amer. Mus. Nat. Hist., 22:236.

1935 Molossus rufus sinaloae G. M. Allen, Jour. Mamm., 16(3):228.

1957 Molossus sinaloae Lukens and Davis, Jour. Mamm., 38(1):13 (perhaps not M. sinaloae, see Remarks under M. a. nigricans).

## Type

Adult female (skin and skull), AMNH 24524. Collected by J. H. Batty at Escuinapa, Sinaloa, 15 February, 1904.

## Range

Sinaloa, Mexico, south through Central America to western Panama (Goodwin, 1946:341).

## Characters

A medium to large-sized, free-tailed bat with a long narrow skull; high sagittal crest; upper incisors slender, longest for the genus; very narrow separation between sphenoidal pits; pelage long, fine and lax; light basal color extending more than half of fur length;

tactile hairs on rump fine and long (some exceed 17 mm); not dichromatic. See Tables 11 and 12 for measurements.

#### Color

The pelage is very obviously bicolored. The terminal portion varies from Fuscous and Clove Brown to Auburn and Snuff Brown. The basal portion varies from Light Buff to white.

#### Distribution and Specimens Examined

States are arranged alphabetically, localities from north to south, see Figure 3. Colima: Las Juntas, 5 km. SE Pueblo Juarez (UA, 5); Tlapeixtes, near Manzanillo (UA, 1). Guerrero: El Papayo, 25 ft. (Lukens and Davis, 1957:13, see Remarks under M. a. nigricans).

Jalisco: Juntas del Salitre, 6 km. N Soyatlan del Oro (UA, 6); Rio del Aguacate, ca. 4 km. E Soyatlan del Oro (UA, 1); 5 km. S Soyatlan del Oro (UA, 1). Sinaloa: Escuinapa (type locality, J. A. Allen, 1906:236).

Yucatan: Calcehtok (Hatt and Villa, 1950:232); Yaxcash (not found, Miller, 1913:89).

#### Additional Specimens Examined

Nicaragua: Sixicial Creek, Souix Plantation, 125 mi. up Rio Grande (AMNH, 4).



Table 11.--Skin and Skull Measurements in Millimeters of  
Adult and Subadult Molossus sinaloae from  
Jalisco and Colima, Mexico

*	Males			Females		
	mean	(range)	N	mean	(range)	N
01	22.67	(23.15-22.35)	6	21.62	(22.00-21.35)	8
02	19.73	(20.00-19.45)	6	18.96	(19.25-18.65)	8
03	4.10	(4.20-3.95)	6	4.02	(4.15-3.85)	8
04	12.92	(13.30-12.60)	6	12.47	(12.75-12.25)	8
05	12.45	(12.90-12.15)	6	11.88	(12.10-11.70)	8
06	10.12	(10.30-9.90)	6	9.86	(10.10-9.50)	8
07	7.06	(7.15-7.00)	6	6.92	(7.05-6.80)	8
08	9.37	(9.60-9.15)	6	9.14	(9.30-9.00)	8
09	5.47	(5.65-5.30)	6	5.27	(5.45-5.10)	8
10	8.31	(8.50-8.15)	6	7.99	(8.10-7.90)	8
11	15.69	(16.10-15.10)	5	15.25	(15.60-14.90)	7
12	9.12	(9.30-8.95)	6	8.84	(8.90-8.75)	7
13	130.00	(135.0-113.0)	6	127.00	(143.0-120.0)	8
14	51.50	(54.00-50.00)	6	49.50	(52.00-45.00)	8
15	12.33	(13.00-12.00)	6	12.12	(13.00-10.00)	8
16	15.17	(17.00-14.00)	6	15.57	(16.00-15.00)	7
17	49.32	(50.15-47.75)	6	49.18	(50.60-48.45)	8
18	52.10	(53.00-51.40)	6	51.27	(52.00-50.40)	8
19	22.70	(23.30-22.35)	6	22.56	(22.90-21.85)	8
20	50.02	(51.05-49.05)	6	49.53	(50.20-48.90)	8
21	19.73	(20.25-19.25)	6	19.93	(20.70-19.50)	8
22	32.25	(33.20-31.20)	6	32.37	(33.65-31.25)	8

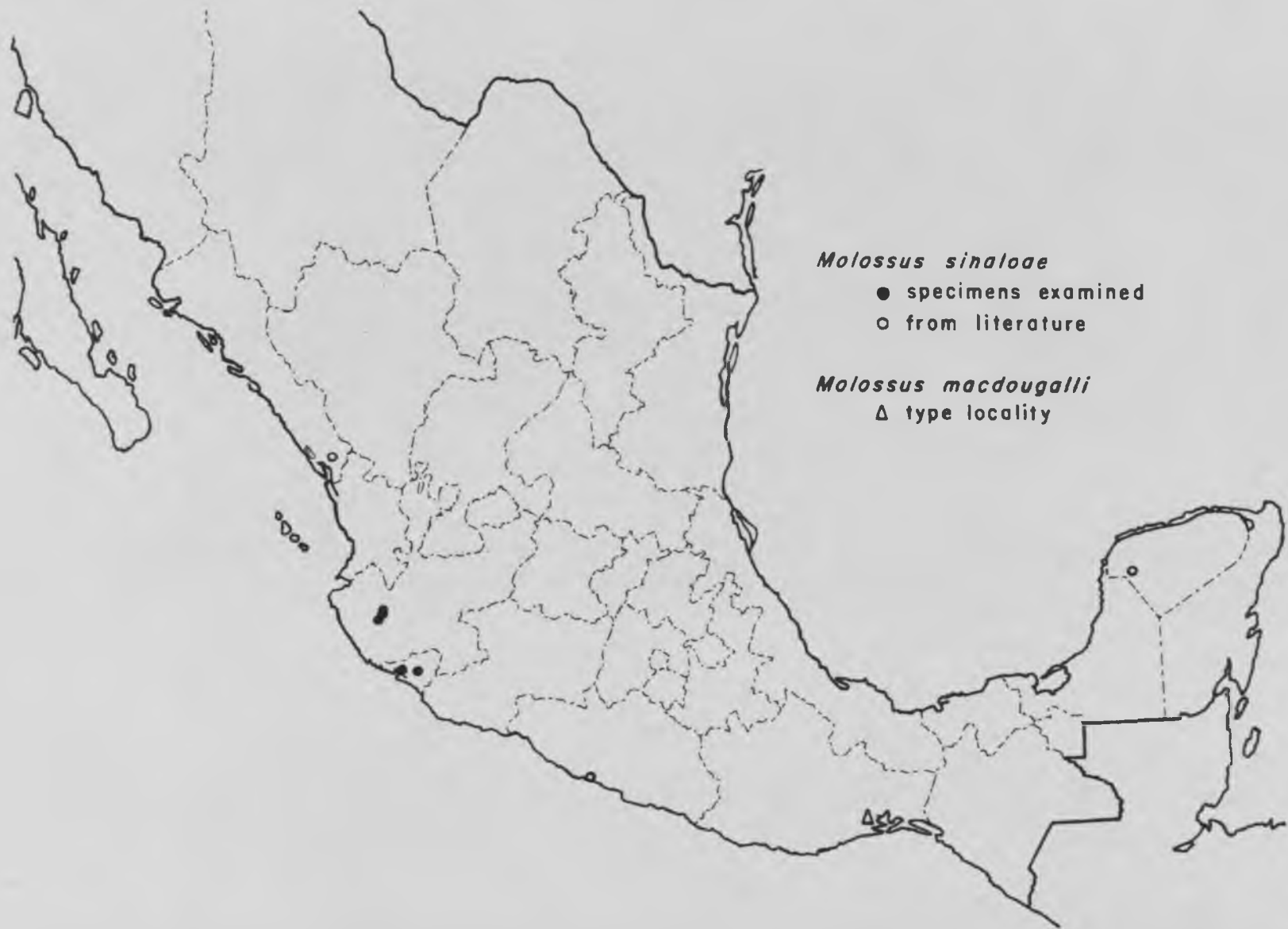
\* See pages 5 to 8 for explanation of measurements.

Table 12.--Skin and Skull Measurements in Millimeters of Adult Female Molossus sinaloae from Nicaragua and Adult Male Molossus trinitatus from Venezuela (AMNH 142617) and British Guiana (AMNH 42198)

*	<u>Molossus sinaloae</u> AMNH Numbers:			<u>Molossus trinitatus</u> AMNH Numbers:	
	41190	41193	41194	142617	42198
01	19.70	20.00	20.25	22.70	22.11
02	17.00	17.55	17.70	19.50	19.15
03	3.65	3.75	3.95	4.15	3.95
04	11.15	11.40	11.60	12.95	12.85
05	11.00	10.90	11.25	12.55	12.85
06	9.25	9.25	9.75	9.95	10.05
07	6.40	6.50	6.55	7.15	7.10
08	8.15	8.00	8.15	9.25	9.10
09	4.70	4.75	4.65	5.55	5.40
10	7.10	7.50	7.45	8.10	8.05
11	13.35	13.95	13.90	15.85	15.20
12	7.75	8.05	8.15	9.10	8.90
17	47.50	48.80	48.10	-----	-----

\* See pages 5 to 8 for explanation of measurements.

Figure 5.--Map showing the known Mexican distribution of Molossus sinaloae and Molossus macdougalli as indicated by locality records.



## Remarks

This species is apparently uncommon throughout its range. Statements by de la Torre (1955:701) regarding the ease of separating M. sinaloae from the generally larger M. ater are true although his specific application was faulty (see Remarks under M. a. nigricans). Material at hand indicates that M. sinaloae is not always smaller than M. ater nigricans, as was previously supposed. However, it can always be separated from M. ater nigricans on the basis of the narrower, higher brain case; very narrow bony septum separating sphenoidal pits; long, slender incisors; long, fine, lax, strongly bicolored fur; long, very fine tactile hairs on rump. This same material indicates that the type, "an old female with worn teeth" (J. A. Allen, 1906:236) is smaller than female specimens from Jalisco and Colima. This has undoubtedly created some confusion regarding the true status of M. trinitatus Goodwin. Male specimens of M. sinaloae are as large as M. trinitatus according to measurements given by Goodwin (1964:20 and Table 1). Although supposedly confined to Trinidad, I have examined two specimens from northern South America labeled M. pretiosus (both skull only) and I am reassigning them to M. trinitatus. One specimen, AMNH 142617, an adult male, is from the vicinity of Caripito, Venezuela, relatively close to Trinidad. The other, AMNH 42198, an adult male, is from Kartabo, British

Guiana. Both were collected by William Beebe; the former has no date, the latter on 13 August 1919. These two skulls, which are almost identical and which I assume represent M. trinitatus, essentially differ from males of M. sinaloae (from Jalisco and Colima) only in the dorsal outline of the rostrum. These two skulls have a "hump" on the rostrum as opposed to a flat, sloping rostrum characteristic of the Mexican specimens. Goodwin (1964: Table 1) gives measurements of four females of M. sinaloae from Nicaragua. I have also examined these specimens (AMNH 41190-94, No. 41191 a juvenile, the others adult) and find them considerably smaller than females from Jalisco and Colima. I think that this difference in size may prove to be clinal in nature. Also these specimens show a decided "hump" on the rostrum, like that of M. trinitatus, which is lacking in Mexican representatives at hand. Since M. sinaloae is not known south of the Isthmus of Panama and does apparently show a variation in size between Mexican and Nicaraguan forms that may be clinal, it seems advisable to continue recognizing M. trinitatus as a full species. M. trinitatus is as large as Mexican M. sinaloae but they are separated geographically by a smaller form of the latter. It is still possible that future work will show M. trinitatus to be no more than a well-marked South American race of M. sinaloae. Figure 4 is a Dice-Leraas graph of forearm

measurements of M. sinaloae from Mexico and Nicaragua, and Table 12 gives cranial measurements of the two M. trinitatus from northern South America.

A female collected at Juntas del Salitre, Jalisco, 28 April 1964 contained a single embryo which measured (crown-rump) 8.5 mm. The round, flat wing bud and the blunt leg bud show no digital development.

Molossus aztecas aztecas Saussure

1860 M[olossus]. aztecas Saussure, Rev, Mag, Zool., Paris, ser. 2, 12:285.

1905 Molossus rufus obscurus Elliot, Field Columbian Mus. Publ. 105, Zool. Ser., 11:495.

1949 [Molossus] [major] aztecas Hershkovitz, Proc. U. S. Nat. Mus., 99(3246):454.

Type

Collected (?) by Henri de Saussure at Amecameca, Mexico, 8200 ft., at the base of Popocatepetl.

Range

Northern Sinaloa and west-central San Luis Potosi, south to the Isthmus of Tehuantepec, Oaxaca, Mexico.

Characters

A small-sized, robust, free-tailed bat with a relatively short, broad skull; short, deep rostrum; broad braincase; palate broadly domed; posterior margin of

palate straight or with median posterior projection; sphenoidal pits deep; "medium" separation between sphenoidal pits (wider than in M. sinaloae and narrower than in M. ater); infraorbital foramen opening forward and situated high above maxillary tooth row; sub-posterior border of infraorbital foramen expanded laterally and this expansion continuous with maxillary portion of zygomatic arch; molariform teeth wide; hypocone well developed for genus; high sagittal crest in males only; forearm not exceeding 39 millimeters in males and 38 millimeters in females; fur relatively long, fine and lax; clearly bicolored, not dichromatic. See measurements in Table 13.

#### Color

The pelage is bicolored. Terminally, the hair varies from Sepia in Sinaloa, between Bister and Cinnamon-Brown in Jalisco, Snuff Brown in coastal Colima to between Prout's Brown and Mummy Brown in Oaxaca. With the exception of the lighter Coliman specimens, the fur color progressively becomes darker from north to south. The color pattern of the venter is lighter than that of the dorsum. The lighter basal hair color varies from Light Buff to white. In M. aztecas aztecas there is a characteristic smoky-white wash over the fur which is most pronounced ventrally.



### Distribution and Specimens Examined

States arranged in alphabetical order and localities given from north to south, see Figure 4. Colima: Tlapeixtes, 4 km. ENE Manzanillo (AMNH, 2); Jalisco: Pena Colorada, Rio de Talpa, ca. 10 km. N Talpa de Allende (UA, 2); Rancho de los Ocotes, ca. 6 km. N Talpa de Allende (UA, 1); Rio de Talpa, Talpa de Allende (UA, 6); Los Masos (not found, AMNH, 2). Mexico: Amecameca, (Saussure, 1860:285). Oaxaca: 5 mi. N Juchatengo, ca. 4000 ft. (UA, 2); 3 mi. S Nejapa (KU, 1); Tehuantepec (AMNH, 1). San Luis Potosi: Rio Verde (Dalquest, 1953:69). Sinaloa: Alisos (=Aliso) ca. 50 km. NNE (by Rd.) from Badiraguato (UA, 1).

### Remarks

M. aztecas aztecas appears to be uncommon to rare throughout its range. It is locally common in semi-tropical, sub-temperate and temperate habitats on the Mexican Plateau and southern mountains north of the Isthmus of Tehuantepec. All specimens from the vicinity of Talpa de Allende, Jalisco, were obtained by shooting as they emerged from day roosts in rock crevasses or flew along the Rio de Talpa in early evening. Mist nets failed to capture specimens in this region. Dalquest (1953:69), in San Luis Potosi, observed that this species utilized large cypress trees as day roosts. The single specimen

Table 13.--Skin and Skull Measurements in Millimeters of  
 Adult Molossus aztecus aztecus from Sinaloa,  
 Jalisco, Colima and Oaxaca, Mexico

*	Males			Females		
	mean	(range)	N	mean	(range)	N
01	18.18	(19.10-17.70)	5	17.07	(17.35-16.75)	4
02	15.52	(16.10-15.15)	8	14.94	(15.20-14.60)	5
03	3.94	( 4.15- 3.75)	8	3.87	( 4.00- 3.75)	7
04	11.24	(11.65-11.10)	8	10.77	(11.10-10.55)	7
05	10.52	(10.90-10.25)	8	10.30	(10.55- 9.85)	6
06	9.14	( 9.35- 9.05)	8	8.94	( 9.00- 8.85)	4
07	6.08	( 6.35- 5.90)	6	5.87	( 6.15- 5.75)	6
08	7.85	( 8.30- 7.65)	8	7.61	( 7.75- 7.30)	7
09	4.56	( 4.70- 4.35)	8	4.28	( 4.50- 4.10)	6
10	6.39	( 6.60- 6.25)	8	6.21	( 6.30- 6.10)	6
11	12.66	(13.30-12.10)	8	12.14	(12.45-11.80)	7
12	7.01	( 7.30- 6.85)	8	6.68	( 6.85- 6.55)	7
13	102.50	(110.0-97.00)	6	96.29	(102.0-89.00)	7
14	36.50	(42.00-30.00)	6	34.29	(40.00-31.00)	7
15	10.50	(11.00-10.00)	6	10.14	(13.00- 8.00)	7
16	13.67	(15.00-12.00)	6	13.60	(14.00-13.00)	5
17	37.48	(38.80-36.00)	6	36.19	(37.85-34.35)	6
18	39.56	(41.20-38.30)	7	38.87	(40.60-37.15)	7
19	17.91	(18.70-16.90)	7	17.32	(18.50-16.30)	8
20	38.39	(40.30-37.40)	7	36.99	(38.85-35.45)	8
21	15.14	(16.75-14.15)	7	14.82	(15.90-13.85)	8
22	24.89	(26.15-24.30)	7	24.64	(26.35-23.00)	8

\* See pages 5 to 8 for explanation of measurements.

from Sinaloa was caught in a mist net stretched across a small pool in a narrow rocky arroyo. The general habitat in this area is a mixture of mesquite and oak grassland. The riparian association includes wild figs, cypress and the introduced mango (Mangifera indica). This specimen from Sinaloa is the most northern known of the genus Molossus and represents a northwestward extension of the known distribution of M. aztecas from the vicinity of Talpa de Allende, Jalisco, an airline distance exceeding 400 miles. All populations north of the Isthmus of Tehuantepec, Oaxaca, have long forearms, are not dichromatic and show a marked affinity for sub-temperate and temperate habitats. The two specimens from Tlapeixtes, Colima, are exceptions in that they are from a tropical habitat at low elevation and have a much brighter color pattern.

Two females collected at Pena Colorada, ca. 10 km. N of Talpa de Allende, Jalisco, 11 June, 1964, were each carrying a single embryo. Crown-rump measurements of the embryos are 24.6 mm and 17.6 mm respectively.

Molossus aztecas lambi, new subspecies<sup>1</sup>

Holotype

An adult male, skin with skull, Los Angeles County

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1. Named in honor of a friend, the late Chester C. Lamb, a veteran Field Collector and Naturalist who was very well acquainted with the Mexican state of Chiapas.

Museum No. 27001 (UA 9525). Collected by A. L. Gardner (original No. 5139) from 11 km. northwest from Escuintla, Chiapas, Mexico, ca. 100 feet elevation, 18 November 1962. Measurements in millimeters of the holotype followed by measurements in parenthesis of an adult female, LACM No. 27002 (UA 9519), collected by A. L. Gardner (original No. 5053) from the type locality, 15 November 1962: Total length, 98 (92); tail, 36 (33); hind foot, 9 (8); ear from notch, 15 (14); tragus, 5 (4); forearm, 36.50 (35.15); weight, 17 gr. (15 gr.); metacarpal III, 37.75 (36.70); phalanx III, 16.45 (15.70); metacarpal IV, 36.20 (35.25); phalanx IV, 13.95 (13.30); metacarpal V, 24.00 (23.20); greatest length of skull, 18.25 (17.20); condylobasal length, 15.40 (15.00); interorbital constriction, 4.00 (3.90); zygomatic breadth, 11.10 (10.85); mastoid breadth, 11.20 (10.65); breadth of brain case, 9.10 (9.00); depth of brain case, 6.25 (6.10); breadth across  $M_2^2 - M_2^2$ , 7.40 (7.50); breadth across canines, 4.50 (4.10); maxillary tooth row, 6.20 (6.10); length of mandible, 12.50 (12.20); mandibular tooth row, 6.85 (6.60). Both the holotype and the associated female are in the dark color phase.

#### Paratypes

Eleven additional specimens from the type locality are designated paratypes. The males (UA Nos.) are: 9517 ad.; 9520 juv.; 9522 ad.; 9524 ad.; 9527 ad.; 9528 subad.;

9529 juv. The females (UA Nos.) are: 9518 ad.; 9523 subad.; 9526 subad.; 9530 ad. All specimens except UA 9526 are in the dark color phase; UA 9526 is in the light color phase.

#### Range

Known from southwestern Chiapas and the Pacific slope of the Sierra Madre del Sur de Chiapas, Mexico.

#### Specimens examined

Specimens have been examined from the following localities in Chiapas: 13 mi. SW Las Cruces (KU, 2); 15 mi. SW Las Cruces (KU, 1); 12 mi. E. Ortiz Rubio on Villa Flores Rd. (UA, 1); 20 km. SE Pijijiapan (LACM, 4; UA, 1); 11 mi. NW Escuintla, ca. 100 ft. (LACM, 2; UA, 11). The first two localities are in southwestern Chiapas, north of the Sierra Madre del Sur de Chiapas and the last two localities are at lower elevations on the Pacific Coastal Plain of Chiapas. Localities are indicated on Figure 7. I have not examined the specimen reported by Murie (1935: 20) and I question the identification of material reported from El Salvador by Felton (1957:13), see Remarks under M. pygmaeus.

#### Diagnosis

Size small for species; two color phases present, dark phase blackish, approaching Fuscous and the light

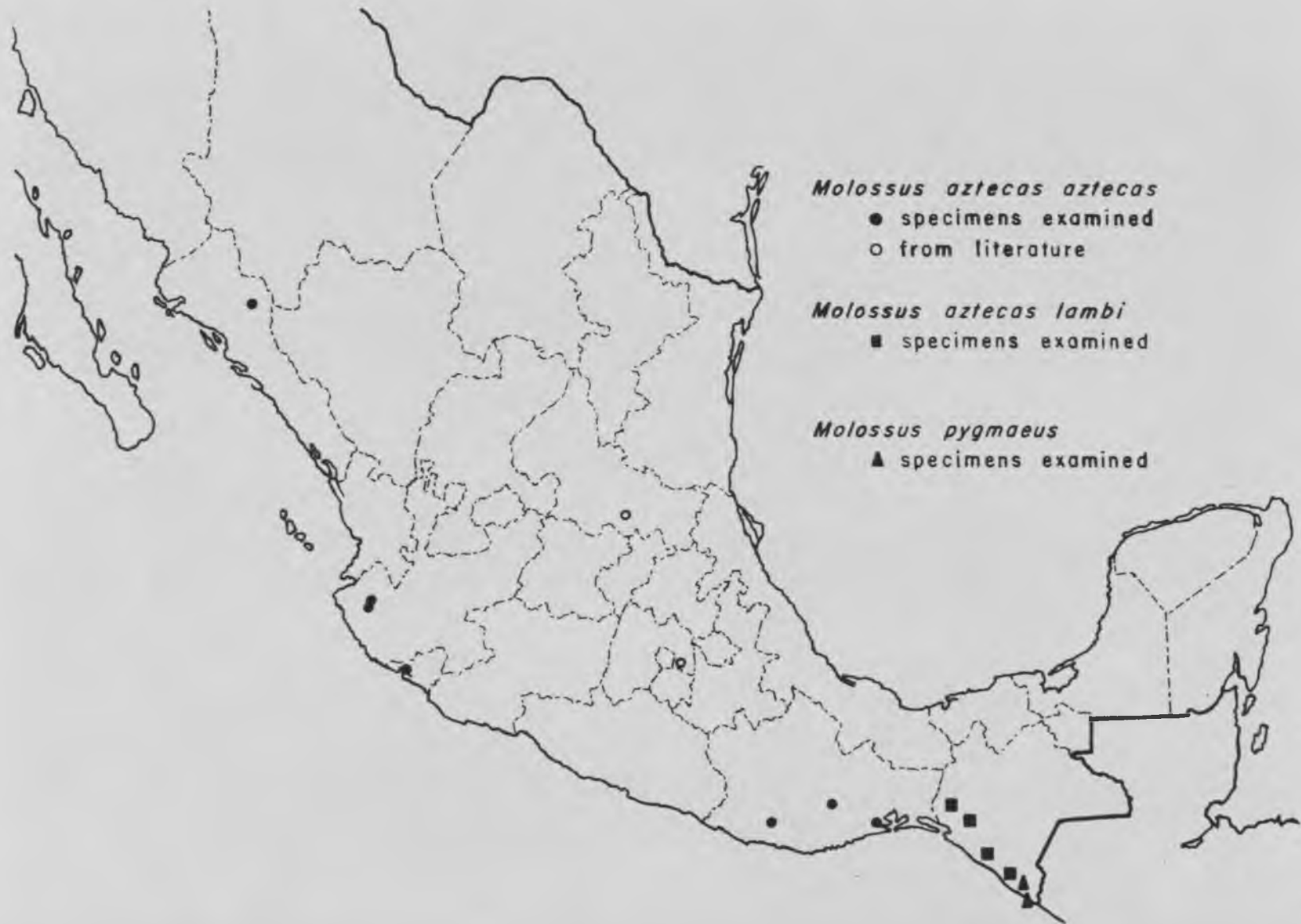
Figure 6.--The southern Aztec mastiff bat, Molossus aztecas lambi (approx. 1 7/8 natural size).

This bat, an adult female (UA 10835) from ca. 12 mi. E Ortiz Rubio on Villa Flores Rd., Chiapas, Mexico, collected 26 June 1964, is undergoing extensive molt. Note the absence of long fur between shoulders.



Figure 7.--Map showing the known Mexican distribution of Molossus aztecas aztecas, Molossus aztecas lambi and Molossus pygmaeus as indicated by locality records.





phase approaching Sudan Brown; light basal portion of bi-colored fur short; flight membranes and ears black.

#### Comparison

This bat differs from the Mexican Plateau form, M. aztecas aztecas, in generally smaller size (see measurements in Table 14); darker color; two color phases and lack of smoky-white wash over fur, especially ventrally. In these respects it compares favorably with M. coibensis J. A. Allen of Panama, a much smaller bat. In basic cranial proportion and configuration, M. aztecas lambi is very similar to the much smaller M. coibensis. Future work may reveal that M. aztecas lambi represents a northern intermediate between M. aztecas aztecas and M. coibensis. M. aztecas lambi was compared with three specimens of a small Molossus from Puerto Madero and four specimens from Huehuetan, Chiapas. Huehuetan is on the railroad about 18 miles airline to the southeast from the type locality of M. aztecas lambi and Puerto Madero is about 20 miles airline farther south on the Pacific Coast of southern Chiapas. The four specimens from Huehuetan (a female adult, CNHM 44254; a male adult, USNM 77661; two adult females, USNM 77662 and 77663) and the three specimens from Puerto Madero (a subadult male, KU 68780; a juvenile female and an adult female KU 68781 and 68782 respectively) all compare favorably with a northern South American form

Table 14.--Skin and Skull Measurements in Millimeters of  
 Adult Molossus aztecus lambi from Chiapas,  
 Mexico

*	Males			Females		
	mean	(range)	N	mean	(range)	N
01	18.25	(18.40-18.10)	5	17.01	(17.30-16.60)	9
02	15.44	(15.55-15.35)	5	14.57	(15.00-14.35)	9
03	4.03	( 4.30- 3.80)	5	3.89	( 4.00- 3.80)	9
04	11.95	(13.35-10.85)	5	10.52	(10.85-10.30)	9
05	11.04	(11.20-10.85)	5	10.38	(10.65-10.15)	9
06	9.12	( 9.20- 9.05)	5	8.94	( 9.05- 8.85)	9
07	6.14	( 6.25- 5.95)	5	5.90	( 6.10- 5.60)	9
08	7.64	( 7.95- 7.40)	5	7.36	( 7.55- 7.10)	9
09	4.52	( 4.60- 4.40)	5	4.09	( 4.25- 3.95)	9
10	6.25	( 6.50- 6.10)	5	5.99	( 6.25- 5.85)	9
11	12.46	(12.75-12.10)	5	11.72	(12.20-11.40)	9
12	6.91	( 7.10- 6.85)	5	6.58	( 6.90- 6.45)	9
13	101.80	(111.0-96.00)	5	94.00	(98.00-87.00)	9
14	36.20	(39.00-34.00)	5	33.11	(37.00-30.00)	9
15	8.00	( 9.00- 7.00)	5	8.22	( 9.00- 8.00)	9
16	14.20	(15.00-14.00)	5	13.89	(15.00-13.00)	9
17	36.12	(36.65-35.15)	5	35.01	(35.60-34.10)	9
18	37.57	(38.05-36.70)	5	36.82	(38.00-35.90)	9
19	16.53	(16.95-16.20)	5	16.13	(16.90-15.35)	9
20	36.11	(36.80-35.40)	5	35.53	(36.55-34.85)	9
21	13.98	(14.40-13.80)	5	13.81	(14.45-13.05)	9
22	23.76	(24.05-23.00)	5	23.38	(24.40-22.65)	9

\* See pages 5 to 8 for explanation of measurements.

closely resembling the description of Molossus pygmaeus Miller and to which, at this time reserving a re-examination of their identity, I tentatively assign them. They differ markedly from M. aztecas lambi in fur quality and color pattern: longer and thinner than in lambi but approaching the lighter color of the more northern highland populations of aztecas; longer forearm; smaller, narrower skull; narrower, lower rostrum; infraorbital foramen situated lower, close to maxillary tooth row; sub-posterior border of infraorbital foramen not expanded and expansion not continuous with maxillary portion of zygomatic arch; palate narrow and not broadly domed; separation between sphenoidal pits narrower. See Figure 8 for a comparison of length of forearm and interorbital constriction.

#### Remarks

All specimens of M. aztecas lambi, except those from SW Las Cruces, were collected by me in mist nets placed across pools or over streams at road crossings. Late one afternoon, in camp at the type locality, my attention was drawn to a pair of Yellow-naped parrots which was creating a disturbance outside a hole high in a tall fig tree. While watching the parrots, I noticed several bats fly out of the hole and swoop down over the hill toward the river. One of the bats, which proved to

be M. aztecas lambi, became enmeshed in a mist net already in place at the edge of a deep pool of water in a gravel pit left by bridge construction workers. This is the only information I have regarding day roosts. Of the five females collected at 20 mi. SW Pijijiapan between 13 March and 27 March 1961, three were pregnant, each with a single embryo (crown-rump measurement of one, 11 mm) and two contained no embryos. Another female collected 12 mi. E Ortiz Rubio on Villa Flores Rd. 26 June 1964, contained one embryo measuring 14.1 mm crown-rump. Males collected at the type locality, 11 mi. NW Escuintla, between 13 and 18 November 1962, showed some sign of sexual activity. Three males had enlarged testes measuring 2 mm x 5 mm, 3 mm x 5 mm and 4 mm x 6 mm respectively. Three additional males had testes not enlarged.

Two of the 22 specimens at hand show the light color phase. Two others show a partial mixing of the color phases. Both apparently in the lighter phase are molting and the new fur is dark.

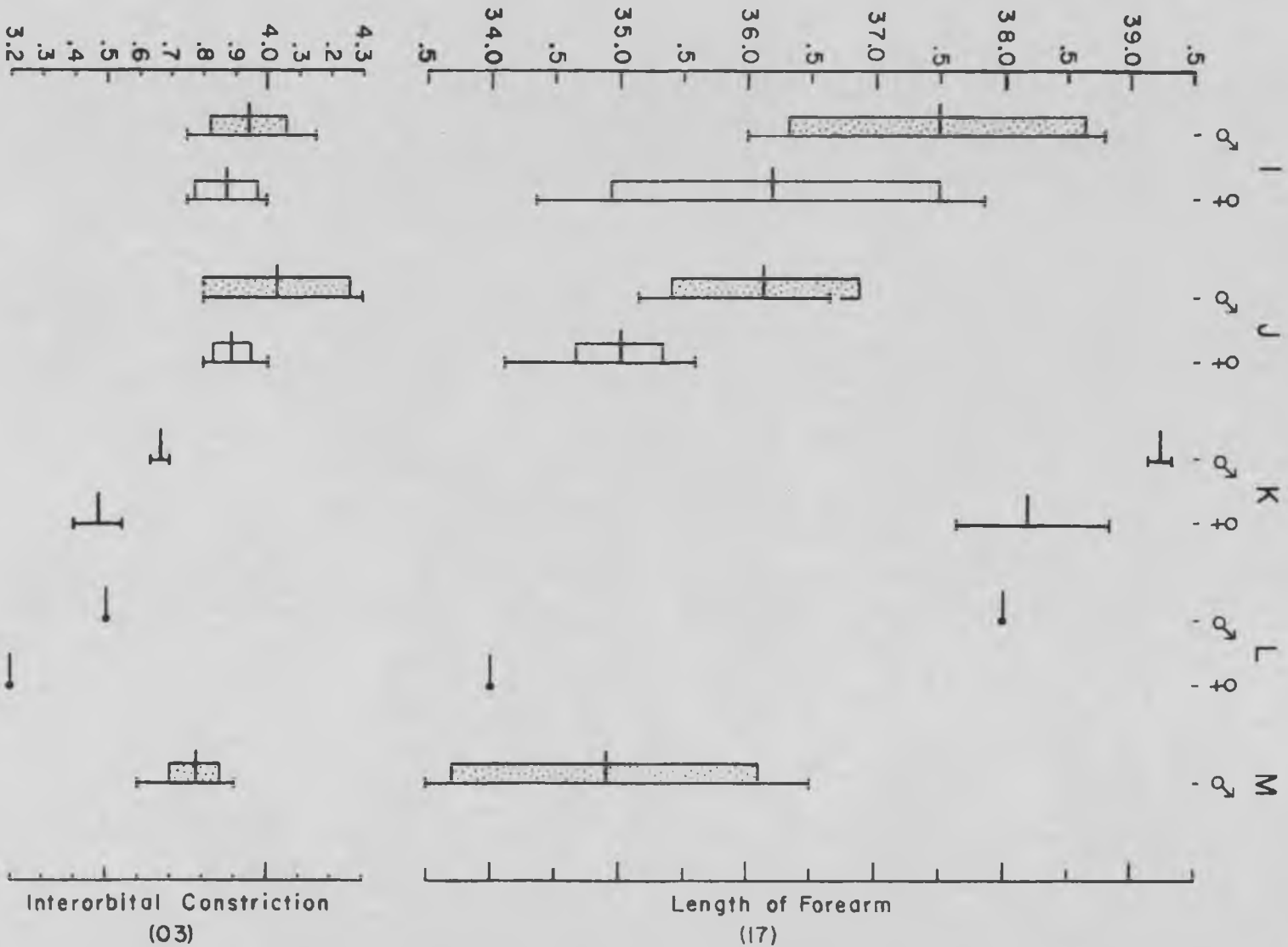
Molossus pygmaeus Miller

1900 Molossus pygmaeus Miller, Proc. Biol. Soc. Washington, 13:162.

1916 Molossus daulensis J. A. Allen, Bull. Amer. Mus. Nat. Hist., 35:530.

Figure 8.-- A graphic comparison of length of forearm and interorbital constriction between Molossus aztecas aztecas (I); Molossus aztecas lambi (J); Molossus pygmaeus (K); measurements given by Felton (1957) for male Molossus "major aztecas" and female Molossus "trepidorrhynchus colibensis" (L); Molossus colibensis (M).

Vertical line indicates range; horizontal line the mean; box on each side of the mean 95 per cent confidence limits of the mean. Horizontal lines with dot indicate one individual. Confidence limits of the mean are not graphed for samples of four or less. Males and females are graphed separately. Localities are: I, Sinaloa, Jalisco, Colima and Oaxaca, Mexico; J, Chiapas, Mexico; K, Chiapas, Mexico; San Salvador, El Salvador (Felton, 1957); M, Panama.



1949 Molossus major Hershkovitz, Proc. U. S. Nat. Mus.,  
99:454.

1957 Molossus major daulensis Cabrera, Rev. Mus. Arg.  
Ciencias Nat., 9(1):131.

#### Type

Adult female (in alcohol) USNM 102104: Collected  
near Willemstad, Curacao, West Indies, 16 January 1900.

#### Range

Southernmost corner of Chiapas, Mexico. Possibly  
ranges through Central America to South America. Known  
from two geographic areas in South America: northern  
Colombia and Venezuela including Curacao Island; north-  
western Peru and southwestern Ecuador.

#### Characters

A small free-tailed bat with long, lax, bicolored  
fur; relatively long forearm; small narrow skull; low  
narrow rostrum; narrowly domed palate; first two molars  
"squarish" in outline due to narrow protocone; hypocone  
small, poorly developed. Measurements given in Table 15.

#### Color

Specimens from Chiapas, Mexico are between Mummy  
Brown and Clove Brown with a lighter wash over the fur,  
especially ventrally.



### Distribution and Specimens Examined

Chiapas: Huehuetan (CNHM, 1; USNM, 3); 1 mi. SE Puerto Madero (KU, 3), see Figure 4. Additional specimens examined: Venezuela: Ciudad Bolivar (1, AMNH No. 16105); Maripa (1, AMNH No. 17016). Ecuador: Portovelo, Prov. del Oro (3, AMNH Nos. 47208, 47211-12); Daule (2, AMNH Nos. 36254-55); Rio Pindo, Prov. del Oro (1, AMNH No. 47215).

### Remarks

The four specimens examined from Huehuetan, Chiapas, are probably among those mentioned by Miller (1913:91) as M. aztecas.

Through examination of material borrowed from the American Museum of Natural History, I have arrived at the general, although tentative, conclusion that there are three small species of Molossus (four including M. colibensis) occurring in South America. These are as follows: Molossus major (Kerr) a small form from northern South America and the Lesser Antilles, and a larger form occurring south and east of the Andes to Uruguay, both typified by a large, long skull with a broad brain case and long rostrum; Molossus pygmaeus Miller, a small form from northern Colombia and Venezuela including Curacao Island and a slightly larger form from northwestern Peru and southwestern Ecuador, both characterized by a small, narrow skull with a narrow brain case and low slender

Table 15.--Skin and Skull Measurements in Millimeters of Subadult and Adult Molossus pygmaeus from Huehuetan and Puerto Madero, Chiapas, Mexico

*	Males			Females		
	mean	(range)	N	mean	(range)	N
01	17.90	-----	1	16.63	(16.50-16.75)	2
02	15.60	-----	1	14.63	(14.50-14.75)	2
03	3.68	( 3.65- 3.70)	2	3.48	( 3.45- 3.50)	4
04	10.58	(10.50-10.65)	2	10.17	( 9.95-10.30)	3
05	10.65	-----	1	9.70	( 9.55- 9.85)	2
06	8.85	-----	1	8.57	( 8.45- 8.65)	3
07	6.00	-----	1	5.73	( 5.55- 5.85)	3
08	7.28	( 7.25- 7.30)	2	7.08	( 6.90- 7.25)	4
09	4.43	( 4.35- 4.50)	2	4.04	( 3.85- 4.20)	4
10	6.23	( 6.15- 6.30)	2	6.06	( 6.00- 6.15)	4
11	12.13	(12.10-12.15)	2	11.55	(11.40-11.80)	4
12	6.85	( 6.75- 6.95)	2	6.66	( 6.65- 6.70)	4
13	100.50	(98.00-103.0)	2	100.00	(98.00-102.0)	3
14	35.50	(33.00-38.00)	2	38.33	(37.00-39.00)	3
15	10.00	-----	1	10.00	-----	1
16	13.00	-----	1	12.00	-----	1
17	39.25	(39.15-39.35)	2	38.21	(37.65-38.80)	4

\* See pages 5 to 8 for explanation of measurements.

rostrum; Molossus burnesi Thomas, apparently uncommon across northern South America from Brazil to Colombia, typified by a short broad skull, a broad, inflated brain case and short, broad rostrum; Molossus coibensis J. A. Allen, seemingly restricted to Panama and perhaps Costa Rica. The northern form of M. major is referred to by Cabrera (1957:131) as M. major major (Kerr) and the southern form as M. major crassicaudatus Geoffroy. In my opinion, it appears that M. pygmaeus populations from northern Colombia, Venezuela and Curacao Island should be called M. pygmaeus pygmaeus Miller: and the Ecuador-Peru population M. pygmaeus daulensis J. A. Allen. The specimens referred to as M. burnesi are very similar to M. coibensis cranially, although larger in size. At this time, it appears possible that M. burnesi may not be specifically distinct from M. coibensis. The same possibility regarding the relationship between M. aztecas and M. coibensis was previously mentioned (see Remarks under M. a. lambi). Although I have not seen the specimens referred to by Felton (1957:13-14) as M. major aztecas and M. trepidorhynchus coibensis, they appear to be males and females of the same species. The latter is called M. coibensis by Burt and Stirton (1961:41). The disparity in size between the two sexes is comparable to that observed within M. aztecas. The large forearm and the

extremely small interorbital constriction measurements given by Felton (1957:13-14) do not agree with those of M. aztecas, but do agree with measurements of M. pygmaeus from Chiapas, Mexico, (see Fig. 8). Since I have not examined any of the Antillean Molossus, I do not know the extent of similarity between M. tropidorhynchus of Cuba and the specimens from El Salvador.

## SUMMARY

This study of the Mexican bats of the genus Molossus is based on a total of 164 specimens representing numerous localities from Sinaloa to Chiapas. Material borrowed from various museums was supplemented by 129 specimens collected by me in Chiapas, Colima, Jalisco, Nayarit and Sinaloa. In order to reach a better understanding of the taxonomic status of certain Mexican species it became necessary to examine material representative of related forms in Central and South America; this entailed a study of 193 additional specimens.

A critical examination of specimens, particularly with reference to cranial morphology, body size, color and quality of fur, and personal observations of the habits and behavior of these bats in the field, have clarified the status of four of the forms under consideration and resulted in the description of a new subspecies, Molossus aztecas lambi.

Mexican specimens examined have been assigned to Molossus ater nigricans Miller, Molossus sinaloae J. A. Allen, Molossus aztecas Saussure and Molossus pygmaeus Miller. The referral of seven of them to Molossus pygmaeus is tentative, subject to further examination and comparison with additional material from Central and South America.

The status of Molossus macdougalli Goodwin as a full species is questioned. Tentative conclusions regarding the taxonomic status of the four species of small bats in this genus in Central and South America are expressed. The Antillean species are not included within the scope of this study.

The species considered have been assigned to three species groups, each based on size, pelage quality and basic cranial configuration and characteristics. These species groups are: the ater-group, containing larger members of the genus, all with short stiff pelage and broad, robust skulls; the sinaloae-group, containing medium to large-sized species with long lax fur and long narrow skulls; the major-group containing all of the small-sized species of Molossus.

Variation is great within all species examined. Sexual dimorphism is usually extreme and warrants considerable attention when studying members of this genus. Individual variation in color pattern and cranial features is pronounced. Dichromatism is common. Geographic variation is evident, even between populations separated by only a few miles. Interpopulation variation appears to be related to latitude, elevation, climate and habitat. The basic cranial pattern and configuration, together with pelage characteristics and relative size, are the best tools for species identification. Tonal differences in

color and minor variations in size are evident within each species.

The extent of variation evident within species of this genus can be explained, in part, by their apparent sedentary behavior. This restrictive behavioral pattern can be expected to minimize gene flow between even adjacent local populations. These behavioral isolating mechanisms, often resulting in localized and sometimes identifiable populations within species, have brought about the current state of confusion regarding the taxonomy of this genus. Other contributing causes of confusion are the lack of comparable material from little-known critical areas and the failure to consider the full extent of both geographic and sexual variation by previous investigators.

## APPENDIX A

### Additional Specimens Examined

Molossus ater ater (AMNH, 3). Colombia: Cucuta, north of Santander, (1). British Guiana: Demerara, East Bank (1). Ecuador: Boca R. Curary (1). Molossus pretiosus (AMNH, 26). Venezuela: La Guaira (3); Suapure (10); Ciudad Bolivar (12); Caicara (1). Molossus bondae (AMNH, 13). Ecuador: Prov. del Oro, Rio Pindo (2); Honduras: Los Encuentros, La Paz (1); El Manteado, La Paz (1). Nicaragua: San Francisco, San Juan River (1). Panama: Chagres River (6); La Chorrera (2). Venezuela: (1). Molossus major (AMNH, 114). Argentina: Yuto, Jujuy (1). Brazil: Calama (1). British Guiana: Dadanawa, Rupununi Savanna (1); Georgetown (2); Kartabo (8). Colombia: Amazonas Leticia (2); north of Santander, Cucuta (2); Santander, San Gil (2); Florencia, Caqueta (1); Villavicencio, Meta (1). Peru: Mouth Cenipa River (4); Iquitos (1). Trinidad: Bolivia (1). Venezuela: Auyan-tepui (14); Caracas (1); Ciudad Bolivar (14); El Dorado, Rio Cuyuni (1); Maripa (19); Monagua, Cuiribanas de Caicara (1); Rio Tocuyo (11); Santa Elena (5); Suapure (1). Molossus burnesi (AMNH, 11) Venezuela: Caripito (vicinity) (2); Ciudad Bolivar (1); Cuchirano (1); Maripa (7).



Molossus coibensis (AMNH, 10). Panama: Coiba Island (3); Chagres River (1); Corozal, Canal Zone (1); La Chorrera (3); Panama City (1); Santiago (1). Molossus spp (pygmaeus?) (CNHM, 3). El Salvador: San Salvador, (all alcoholics with skulls intact).

LITERATURE CITED

Allen, Glover M.

1935. Bats from the Panama region. Jour. Mamm.,  
16(3):226-228.

Allen, J. A.

1904. New bats from tropical America with note on  
species of Otopterus. Bull. Amer. Mus. Nat. Hist.,  
20:227-237.

---

1906. Mammals from the states of Sinaloa and  
Jalisco, Mexico, collected by J. H. Batty during  
1904 and 1905. Bull. Amer. Mus. Nat. Hist., 22:191-  
262.

---

1916. List of mammals collected for the American  
Museum in Ecuador by William B. Richardson, 1912-  
1913. Bull. Amer. Mus. Nat. Hist., 35:113-125.

---

1916. New mammals collected on the Roosevelt  
Brazilian expedition. Bull. Amer. Mus. Nat. Hist.,  
35:523-530.

Alvarez, Ticul

1963. The recent mammals of Tamaulipas, Mexico.  
Univ. Kansas Publ., Mus. Nat. Hist., 14:365-473.

Booth, E. S.

1957. Mammals collected in Mexico from 1951 to  
1956 by the Walla Walla College Museum of Natural  
History. Walla Walla College Publs., Dept. Biol.  
Sci. and Biol. Station, 20:1-19.

Burt, W. H. and R. A. Stirton

1961. Mammals of El Salvador. Misc. Publs. Mus.  
Zool., Univ. Michigan, 117:1-69.

Cabrera, A.

1957. Catalogo de los mamiferos de America del Sur.  
Rev. Mus. Arg. Ciencias Nat. "Bernardino Rivadavia",  
9(1):1-307.

Dalquest, W. W.

1953. Mammals of the Mexican state of San Luis Potosi. Louisiana State Univ. Studies, Biol. Ser., 1:1-229.

Davis, W. B.

1951. Bat, Molossus nigricans, eaten by the rat snake, Elaphe laeta. Jour. Mamm. 32:219.

Davis, W. B. and R. J. Russell, Jr.

1952. Bats of the Mexican state of Morelos. Jour. Mamm., 33:234-239.

---

1954. Mammals of the Mexican state of Morelos. Jour. Mamm., 35:63-80.

de la Torre, L.

1955. Bats from Guerrero, Jalisco and Oaxaca, Mexico. Fieldiana: Zool., Chicago Nat. Hist. Mus., 37:695-701.

Elliot, D. G.

1905. A check list of mammals of the North American Continent, the West Indies and the neighboring seas. Field Columb. Mus., Publ. 105, Zool. Ser., 6:1-761.

Felton, H.

1957. Fledermause (Mammalia, Chiroptera) aus El Salvador. Teil 5. Senckenbergiana Biologica, 38:1-22.

Goodwin, G. G.

1946. Mammals of Costa Rica. Bull. Amer. Mus. Nat. Hist., 87:271-473.

---

1956. A preliminary report on the mammals collected by Thomas MacDougall in southeastern Oaxaca, Mexico. Amer. Mus. Novit., 1757:1-15.

---

1942. Mammals of Honduras. Bull. Amer. Mus. Nat. Hist., 79:107-195.

---

1959. Descriptions of some new mammals. Amer. Mus. Novit., 1967:1-8.

- 
1960. The status of Vespertilio auripendulus Shaw, 1800 and Molossus ater Geoffroy, 1805. Amer. Mus. Novit., 1994:1-6.
- Goodwin, G. G. and A. M. Greenhall  
1961. A review of the bats of Trinidad and Tobago. Bull. Amer. Mus. Nat. Hist., 122:191-301.
- 
1964. New records of bats from Trinidad and comments on the status of Molossus trinitatus Goodwin. Amer. Mus. Novit., 2195:1-23.
- Hall, E. R. and W. W. Dalquest  
1963. The mammals of Veracruz. Univ. Kansas Publ., Mus. Nat. Hist., 14:167-362.
- Hall, E. R. and K. R. Kelson  
1959. The mammals of North America. Ronald Press Co., Vol. 1.
- Hatt, R. T., and B. Villa R.  
1950. Observaciones sobre algunos mamiferos de Yucatan y Quintana Roo. Anal. Inst. Biol., 21:215-240.
- HersHKovitz, P.  
1949. Mammals of northern Colombia, preliminary report no. 5: Bats (Chiroptera). Proc. U. S. Nat. Mus., 99:429-454.
- Jones, J. K., Jr.  
1964. Additional records of mammals from Durango, Mexico. Trans. Kansas Acad. Sci., 66(4):750-753.
- Jones, J. K., Jr., T. Alvarez, and M. R. Lee  
1962. Noteworthy mammals from Sinaloa, Mexico. Univ. Kansas Publ., Mus. Nat. Hist., 14:145-159.
- Lukens, Paul W., Jr., and W. B. Davis  
1957. Bats of the Mexican state of Guerrero. Jour. Mamm., 38:1-14.
- Miller, G. S., Jr.  
1900. A second collection of bats from the Island of Curacao. Proc. Biol. Soc. Wash., 13:159-162.
- 
1902. Twenty new American bats. Proc. Acad. Nat. Sci. Philadelphia, pp. 389-412.

---

1913. Notes on the bats of the genus Molossus. Proc.  
U. S. Nat. Mus., 46:85-92.

Murie, A.

1935. Mammals from Guatemala and British Honduras.  
Misc. Publ. Mus. Zool., Univ. Michigan, 26:1-30.

Saussure, H.

1860. Note sur quelques mammiferes du Mexique. Revue  
et Magasin de Zoologie pure et appliquee. Paris,  
12:281-293.