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Phyllostomidae

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## SEASONAL DISTRIBUTION OF NORTHWESTERN POPULATIONS OF THE LONG-NOSED BATS, *LEPTONYCTERIS SANBORNI* FAMILY PHYLLOSTOMIDAE

E. LENDELL COCKRUM\*

### RESUMEN

Los registros de frecuencia estacional y geográfica del murciélago *Leptonycteris sanborni* sugieren que las hembras adultas preñadas ocupan la región norte de su distribución a fines de abril y principios de mayo, congregándose en colonias de maternidad a elevaciones más bajas dentro de zonas con cactus *Cereus* y *Lemaireocereus*. Los machos adultos, y aparentemente algunas hembras no preñadas, permanecen en localidades más al sur hasta mediados o finales de junio. Las colonias de maternidad se dispersan a mediados o finales de julio y al menos algunos jóvenes y hembras adultas se desplazan a lugares de mayor elevación donde el néctar de los agaves se encuentra disponible. En esta etapa muchos jóvenes y hembras han abandonado las colonias de maternidad y los individuos de ambos sexos que antes estuvieron en áreas más sureñas migran hacia el área norte. Estos desplazamientos resultan en una distribución más amplia y pueden deberse a la combinación de una población más grande que requiere más alimento y la reducción de alimento disponible (néctar y frutos maduros de cactus columnares) en elevaciones menores. A finales de septiembre o principios de octubre todos los murciélagos, incluyendo jóvenes y adultos de ambos sexos, migran al sur. La importancia geográfica y estacional del néctar y fruta madura de los cactus columnares, del néctar de los agaves y de los insectos en la dieta de este murciélago requiere determinarse.

Palabras clave: distribución estacional, murciélagos de hocico largo, *Leptonycteris sanborni*, Phyllostomidae.

### ABSTRACT

An analysis of the rather limited currently available records of seasonal and geographical occurrence of long-nosed bats, *Leptonycteris sanborni* Hoffmeister, suggests that the gravid adult females enter the northern part of the range in late April and early May and congregate in traditional maternity roosts at lower elevations within the area of distribution of the saguaro (*Cereus*) and Organ Pipe Cacti (*Lemaireocereus*). Adult males, and apparently some non-gravid females, remain in more southern locations until mid- to late June. The maternity roosts largely disperse in mid- to late July and at least some of the adult females and young move to areas at higher elevations where agave nectar is available. By this time, many females and young have left the maternity roosts, and individuals of both sexes that have earlier been in more southern areas migrate into the area. These movements, resulting in an expanded range, may be the combined result of a larger population needing more food and a reduction of available suitable foods (nectar and ripe fruit of columnar cacti) at the lower elevations. By late September or early October all bats, adults, young, males, females, migrate south. The relative seasonal and geographic importance of the nectar and ripe fruit of columnar cacti, the nectar of agaves and of insects in the diet needs to be determined.

Key words: seasonal distribution, long-nosed bats, *Leptonycteris sanborni*, Phyllostomidae.

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## INTRODUCTION

There is little agreement as to the name which should be applied to this species. The papers of Davis and Carter (1962), Villa-R. (1966), Ramírez-Pulido and Álvarez (1972), Hall (1981) and Arita and Humphrey (1988), should be consulted for reviews and discussion of some of the nomenclature-systematics problems. A partial regional synonymy is presented in Appendix A.

Long-nosed bats of the Genus *Leptonycteris* occur from southwestern Arizona eastward to southwestern New Mexico and the Big Bend region of southwestern Texas southward through much of Mexico to El Salvador, in Central America—a range of about 3540 km in a NW-SE direction. They also occur on the islands of Aruba, Bonaire and Curacao in the Netherlands Antilles and at a few coastal localities on the adjoining mainland of Colombia and Venezuela. The latter population is some 2250 km to the east of the southernmost Central American records. The northern portion of the range is more or less Y-shaped, with no populations having been reported from most of the Chihuahuan Desert. See Davis and Carter (1962), Villa-R. (1966:243-253), Jones and Carter (1976:15), and Hall (1981:132-4) for further description of this distribution.

### Records of Distribution

None of the early regional reports (Coues, 1867; Allen, 1895; Mearns, 1907; Bailey, 1932) nor any of the early checklists of North American Mammals (Elliot, 1907; Miller, 1912; Miller, 1923) list this genus from the states of Arizona, New Mexico, Sonora or Chihuahua.

The first record of *Leptonycteris* from Arizona appears to be of specimens taken at or near Colossal Cave in 1930 which are now in the United States Biological Survey collections. These were collected by Kenneth Hobbs and prepared by Dr. Walter P. Taylor, Senior Biologist, Bureau of Biological Survey, U.S. Department of Agriculture. The earliest published records are those of Campbell (1934:242) of specimens from the Huachuca and the Patagonia mountain regions in 1933. The first records for New Mexico are specimens taken in 1958 from two localities in the southwestern part of the state (Jones and Findley, 1963:174).

Miller and Kellogg (1955:72-3) list the northern-most records for the region as Carimechi, Chihuahua (Burt and Hooper, 1941:2), mountains of eastern Sonora (Burt, 1938:21), and southeastern Arizona (Campbell, 1934:231). Hall (1981:133-4) provided a distribution map but gave no indication of the seasonal aspects of its occurrence.

The seasonal nature of the occurrence of long-nosed bats in the United States was first suggested by me in a paper "The hognosed bat, *Choeronycteris mexicana*, in Arizona", presented at the 33rd annual meeting of the American Society of Mammalogists in 1954. I reported the seasonal nature of records in Arizona for both *Choeronycteris* and *Leptonycteris* and concluded that, since both were flower feeders, both species bats migrated into Mexico to find food during the winter months.

Hoffmeister (1986:64) reported the range of *Leptonycteris* in Arizona as "Sout-

hern Arizona in summer, from near Phoenix on the north and Agua Dulce Mountains on the west, southward. Not known in winter...."

The recent concern with the populations of *Leptonycteris* (Wilson, 1985; Shull, 1988), lead me to compile all records of occurrence that I could locate. I used data from specimens on deposit in museums, literature reports, data from banding records at the University of Arizona, and from field notes on observations by me and others (Appendix B). For each record I have tried to determine the year, month and day of the record. Also included is negative evidence—dates on which no *Leptonycteris* were recorded. The general localities are indicated in figure 1.

## DISCUSSION

### Daily Distribution

The records compiled in Appendix B often were not clear as to time of day that the observation was made. However, almost all observations from caves and mine tunnels were diurnal and most captures in mist nets were made at night.

Relatively few records have been obtained by using mist nets set over water. Apparently *Leptonycteris* rarely, if ever, takes free water (Beatty, 1955; Carpenter, 1969; Hayward and Cockrum, 1971; Howell, 1972). Thus, the probability of capturing *Leptonycteris* in mist nets at watering places is low. Several hundred nights of netting over water recorded in the banding records at the University of Arizona in areas and at times of probable *Leptonycteris* presence, produced few captures.

Nets set in "flyways" such as the narrow valley at Alamo Wash (Appendix B, locality 8c) on the Organ Pipe Cactus National Monument, the flyway near Bahia Kino (locality 23b) and the mist net set over a little pool of water in a narrow canyon (a flyway?) at Bahia San Carlos (locality 24) have been more effective in taking *Leptonycteris*. Even in flyways, captures probably do not give much more than an indication of presence. As reported by Hayward and Davis (1964:239): "*Leptonycteris* ... are agile fliers. They are difficult to capture in hand nets because of their relatively high speeds and because they can maneuver so quickly."

Most of the records involve bats taken from roosts during the daytime. As in other migratory bats, various kinds of roosts can be recognized, based on time of day, season of year, and age and sex of bats present.

### Types of Roosts

The following are some characteristics of the various roosts used by *Leptonycteris* in the northwestern part of their range.

#### *Night Roosts*

Two types of roosts warrant separate recognition. The roost near feeding site, usually in the open, occupied by only a few bats, and used for a brief period between feeding sessions is here termed Local Night Roost. Regional Night Roosts can be

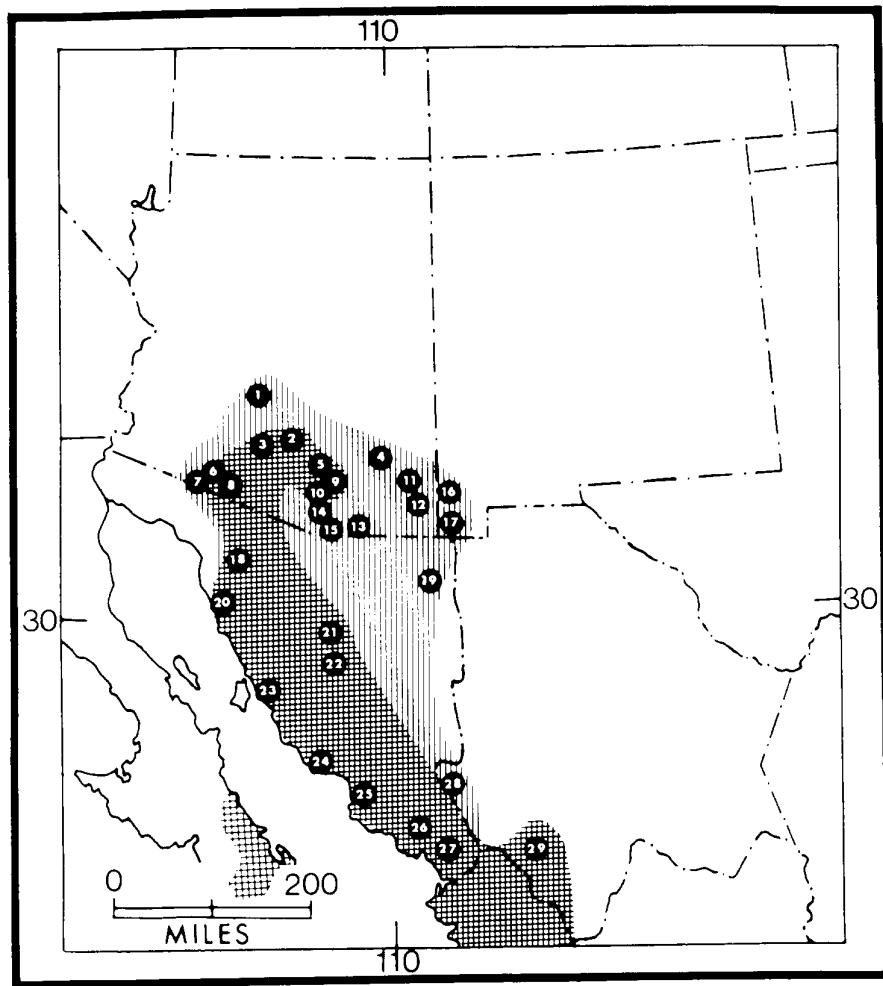


Fig. 1. Northwestern records of occurrence of long-nosed bats, *Leptonycteris saborni* Hoffmeister. The numbers correspond to the sites listed in appendix B. Seasonal shifts occur in the distribution, both latitudinally and altitudinally. During the winter (December-January) some individuals are found in southern Sonora and southern Chihuahua. During the spring, they occur at progressively more northern localities of the lower elevations of Sonora and by late spring and early summer gravid females, and females with young are found at maternity roosts at lower elevations in Arizona. These localities are all in the area covered by the darker pattern. During mid— and late summer as well as in the early fall, the maternity colonies disperse and other movements occur. During this period agave blossoms, especially at higher elevations in southeastern Arizona, become available as food. During this period adults and young of both sexes occur in the area covered by the lighter pattern as well as in the area of darker pattern.

applied to the roost that is usually in a more protected situation, often at some distance from at least some of the feeding sites, often containing several to many bats and used after an extended feeding period for a longer period. Some of the roosts used as Regional Night Roosts are probably in caves or tunnels that are also used as day roosts.

(1). *Local Night Roosts*. Few reports of local night roosts are available. Hayward and Cockrum (1971:116) reported for captives that: "Cycles of feeding occurred wherein groups of bats moved about actively, feeding for about five minutes, and then disappeared [to a roosting cluster in one corner of the cage] for 10 to 15 minutes." The general pattern of feeding in *Leptonycteris* kept in experimental enclosures has been described by Howell (1979:29-33). Flocks of bats feed for about five minutes, then rest hanging in a cluster group from some nearby object for about 20 minutes. This brief resting period is followed by another period of feeding. However Howell (1979:33) reported a longer period of active feeding — "an average 20 min foraging period." — Howell (op cit:29) reported that feeding flocks utilize a variety of situations such as on plants (ocotillos, columnar cacti, paloverde), or large rocks or cliff faces for local night roosts.

The study of kidney function in *Leptonycteris* by Carpenter (1969) estimated that a 22-gram bat, in the laboratory, consumed 20 ml of nectar-like food, of which the water content was 76% of its body mass (17 ml). After making allowances for losses in feces and to in-flight and resting evaporative losses, he calculated that the water excreted in urine was about 9.7 ml per 24 hour period. These bats have up to 4.5 ml in their stomach as they return to the day roost after feeding (Beatty, 1955; Carpenter, 1969) of which up to 30 percent is pollen (Beatty, 1955). Howell (1979:31) found an average mass gain after 5 minutes of feeding to be 1.4 g. Since the diet was primarily liquid, this is about 1.4 ml. More observations are needed but it appears probable that the time in the "Local Night Roost" involves gleaning nectar from the head and body and the elimination of part of the water content of the nectar by renal action. Perhaps the solid portion of the food (pollen, other) remains in the stomach for longer periods for later digestion and thus reduces progressively during the feeding period the capacity to consume in more nectar. Perhaps the longer time spent at the "Regional Night Roosts" involves the preliminary digestion and movement of accumulated solid foods from the stomach to the intestine.

(2). *Regional Night Roosts*. These have been more commonly recorded. Hoffmeister and Goodpaster (1954:55-6) described a night roost in a "ranch barn" (locality 13b). It consisted of  $\pm 100$  bats that Hoffmeister and Goodpaster judged to be a "nursery colony." "Of the 55 skins saved, all of those judged to be adult (24...) were females. Of the remaining 31, judged to be immature, 12 were males, 19 females." They reported that no bats were in the barn during the day but "An evening visit revealed" them. "The bats were prone to not leave the barn, for they did not fly in any mass movement... when we shot into the colony. One might suspect that this was a central meeting place within the feeding area for the colony... In any event, the barn did not provide a daytime roost." Howell (1979:33) reported that, "In the middle of the night the group retires to a shelter for a prolonged roosting period of 2-3 hours."

*Day Roosts*

All day roosts known in this part of the range of the species are situated in caves or tunnels. Most day roosts have only a single opening, thus insuring little or no air movement in the roost. In the places that have two or more entrances, the roosts are in a side pocket or branch that is, in effect, a single-entrance roost. Tuttle (1976:76-79) tabulated known dayroosts of phyllostomid bats by the physical nature of the roost in trees, culverts, etc. He reported that *Leptonycteris* had been reported only from roosts in caves and tunnels, with one exception of a roost in a building.

Few temperature and relative humidity readings in *Leptonycteris* roosts have been recorded. Those I found that of roosts in this area (Fig. 1) are listed in Table 1. *Leptonycteris* in warmer roosts usually hang in scattered groups in the warmest areas available. In cooler roosts they hang in dense clusters, usually near the entrance —perhaps to take advantage of the warmer external temperatures.

(1). *Maternity Roosts*. These are roosts that contain primarily adult females and young that appear to have been born there. Maternity roosts usually contain more individuals than do other types of roosts in the northern part of the range. They are found at elevations below 3500 feet, in or near extensive stands of columnar cacti and peniculate agaves. None are known in New Mexico and only two are well-documented in Arizona (localities 3a ?-3b, and 9b).

Colossal Cave (locality 9b), now unoccupied by *Leptonycteris*, is the only maternity roost that has been studied in detail (Beatty, 1955; Hayward and Cockrum, 1971). It is a large, complex limestone cave with many interconnecting chambers and draft-free side chambers. Gravid females formerly arrived at this roost as early as 2 May. The usual departure date was in the latter half of July. Scattered individuals were observed as late as 1 August. The maximum population has been estimated as 3000 adults and young (Beatty, 1955, and Appendix B).

Box Canyon Crevice (locality 9a), 10.5 miles NW of Colossal Cave, is used by a few females (200-300 maximum) as a maternity roost. The earliest seasonal record is 11 May, the latest 24 August.

Old Mammon Mine (locality 3a, 3b) is, in season, a maternity roost. At least 1000 females have been observed there (Hoffmeister, 1959:15). Additional observations are needed to document arrival and departure dates.

Whether some roosts such as Blue Bird Mine (locality 6), where gravid females were observed on 25 April (Sidner and Davis, 1988), and Copper Mountain Mine (locality 8e), where individuals were netted on 1 June, are actually maternity roosts has not been determined.

In Sonora, just to the southeast of the Organ Pipe Cactus National Monument, a mine tunnel at Tajitos (locality 18) is a maternity roost. Perhaps some of the other roosts listed in Appendix B may prove to be maternity roosts (e.g., La Aduana, locality 27b).

(2). *Male Summer Roosts*. Probably no well-developed male summer roosts occur in Arizona, New Mexico, or northern Sonora. Perhaps the roost in southern Sonora, 2 mi S Aduana (locality 27d), where 22 males and no females were taken on 18 May, is a summer male roost. Some transient roosts serve as temporary summer male roosts early in the summer. For example, on 29 June, when White-

lock (in Beatty:1955) reported examining 17 males (and no females), at Buckelew Cave (locality 12a), the site was serving as a male roost. This roost is included below as a transient roost.

(3). *Transient Roosts*. Transient roosts are sites that are seasonally occupied by bats for a relatively short period of time. Roosts at lower elevations and at more southerly locations appear to be occupied by a succession of different groups of bats. The physical nature of these sites is extremely varied. A few observations suggest that gravid females temporarily congregate in the warmest parts of the warmest low-elevation transient roosts available early in the year. The transient roosts at higher elevations that are used in the late summer are the most varied. The following are examples. Supporting details are summarized in Appendix B.

The mine tunnel at La Aduana (locality 27b) has two feet of water standing at the entrance and progressively shallower water extending into the tunnel about 150 feet. The end of the tunnel, over 200 feet from the entrance, also has standing water. On 29 March 1959 Commissaris (field notes) recorded that *Leptonycteris* roosted in scattered groups in the warmest, wettest portion of the mine. The 25 bats examined by him were all gravid females. Minas Armolillo (locality 27a), about two miles north of La Aduana, is quite similar. Both may well be used successively as transient roosts and as maternity roosts.

Cueva el Tigre (locality 22) is a volcanic cave about 450 feet to the deepest end. *Leptonycteris* use this cave between early April and late November. In April and May, populations up to 200 (one estimate of 6000) have been recorded. When examined for sex ratios, almost all have been pregnant females. In mid-May 1987, Yar Petryszyn (personal communication) estimated the population at 500 to 1000 pregnant, all very near-term. The estimates of 6000 on 26 May 1962 and 5000 on 21 June 1966 suggest a maternity roost. Unfortunately the sex ratios at these times were not recorded.

Buckelew Cave (locality 12a) is in the northeastern part of the range of the *Leptonycteris*. The roosting site in this multilevel limestone cave is in a fairly large, damp chamber approximately 200-300 feet from the entrance. The upper horizontal passage has small (3 feet high) constrictions that may restrict air flow to the lower chambers. My notes of 4 September 1958 read: "air gets bad down in cave-can't light matches." The population composition in this cave varies with time of year, being mainly males when first occupied. The bats typically arrive in mid-July. The earliest record is 29 June. On 14 July, 46 males and 3 females were examined of an estimated 1000 present; on 26 July, 46 adult males, 34 adult females, 34 juvenile males, 3 juvenile females, and 6 sub-adults were examined of an estimated 1500 present (Beatty, 1955:18). The latest record is 6 September.

Abandoned mine tunnels are frequently used as transient roosts at the higher elevations in August and September. The tunnels utilized are usually shallow and often have warm outside air flowing into them. The roost northwest of Patagonia (locality 15a) consisted of short tunnels, less than 100 feet in length, that were dry and airy (Hayward and Cockrum, 1971:82). The mine tunnel, 1 mi N Paradise (locality 12d) is about 300 feet deep and, near the end, has a vertical stope, open at the surface. The result is air circulation, with the air temperatures in the roost being greatly influenced by external temperatures. On 31 August a tightly clustered group



of about 200 were hanging in the back of this mine, of which 24 males and 25 females were examined (Larry Commissaris notes). The tunnel on a south-facing slope in Granite Pass, New Mexico (locality 16a) was short and warm (Table 1). Other tunnels in the same area were deeper and colder and had various vespertilionid bats but no *Leptonycteris*.

(4) *Winter Roosts*. Probably most, if not all, winter roosts are south of southern Sonora. There is some indication that the winter range includes maternity roosts (Humphrey and Bonaccorso, 1979:420), many transient roosts, and winter male roosts (for examples, the 10 males, 1 female, from Hda. Magdalena, Colima, in the Chicago Natural History Museum taken 18 March 1892; 25 males, no females from San Sebastián, Jalisco, taken March 20-21, 1897, in United States National Museum).

### Seasonal Distribution

Records in Appendix B indicate that this species is migratory, with most *Leptonycteris* being south of southern Sonora during the winter. During the spring, they make their way northward. Apparently adult gravid females move northward

TABLE 1  
TEMPERATURE AND RELATIVE HUMIDITY OF DAY  
ROOSTS

Roost	Elev.	Desc.	T °C	RH %	Ref.
La Aduana	1600 ft.	T I b	25.8	+100	2
Minas Armolillo (27a)	1500 ft.	T I b	27.3	74-84	3
Cueva el Tigre (22)	1400 ft.	C I b	27.3- 34.4	62-81	4
Colossal Cavè (9b)	3650 ft	C 2 b	22.2* 23.6 21.1- 22.8	dry 51-73	1 2 5
Bucklelew Cave (12a)	4800 ft	C I b	23.0	damp	2
mine, Paradise (12d)	5200 ft	T 2 a	22.9 23.0	dry	5 6
Granite Pass (16a)		T I a	22.6	damp	5

T = mine tunnel; C = natural cave; I = with only one entrance; 2 = with two or more entrances; a = roost near entrance; b = roost deep in warmest portion. Ref. = references: 1. Beatty (1955); 2. Hayward and Cockrum (1971); 3. Mitchell (1985); 4. Mitchell (1963); 5. Appendix B; 6. Cockrum and Ordway (1959). \* T and RH reported as higher in short, horizontal pocket at top of chimney where bats clustered.

more rapidly than do adult males. Gravid females arrive in southern Arizona at elevations below about 3500 feet in late April and early May and establish maternity roosts. These maternity roosts persist until after the young are capable of independent flight and feeding, generally sometime in mid- to late July. At this time most, if not all, females and their young move to other roosts that often are at higher elevations.

Details of the northward movement of males are not known. A male roost was reported from southern Sonora in mid-May. By late June or early July, before the maternity roosts disperse, some male roosts have been observed in southern Arizona, usually with small numbers and generally at higher elevations (up to elevations of 5500 ft) than maternity roosts.

During late July, August and September a diverse series of roosts, from high to low elevations, are occupied-often on a transient schedule. Hayward and Cockrum (1971:82) referred to this as pre-migratory wanderings, a term that I now think is not applicable. I doubt that these movements are "wanderings". However, most of the records for the northern margin of distribution of the species involve young of the year that, in some cases, are taken from non-typical situations.

*Leptonycteris* leave the northern part of the range in late September and early October. By mid-November they are absent from central Sonora and by late November have apparently vacated the southern part of Sonora and moved farther south.

Some details of the observations that lead to the above generalizations concerning seasonal distribution are:

1. Most *Leptonycteris* spend the winter months (November to March) somewhere south of southern Sonora. Only a few individuals have been seen as far north as Cueva el Tigre (locality 22) as late as early November (1 male, 1 Nov.; 5 of undetermined sex, 6 Nov.) Perhaps the lack of records in late November and December in southern Sonora and Chihuahua has been the result of too little field work. Adult males have been taken in January in southern Chihuahua (24 males at Carimechi, locality 28, on 4 January). In southern Sonora, fifty individuals (sex not determined) were observed on 27 January (Minas Armolillo, locality 27a) and 50 bats were again reported on 29 Feb.

2. Females start moving northward by late March. One gravid female was taken at Bahia San Carlos (locality 24) on 27 March, in south-central Sonora. Thousands were observed at La Aduana mine (locality 27b) on 29 March, southern Sonora, and all 25 examined were gravid females.

3. By April, populations are larger in southern Sonora and include both males and females (localities 27a, 27b). At Cueva el Tigre (locality 22) in north-central Sonora, 100 to 200 bats have been observed on several occasions. By late April gravid females are as far north as southwestern Arizona [Organ Pipe Cactus National Monument, (locality 8f) 23 April, gravid female; and Cabeza Prieta National Wildlife Refuge Blue Bird Mine (locality 6), 25 including gravid females, 25 April] and adult males are as far north as coastal northwestern Sonora (adult male, 25 April, Desemboque, locality 20).

4. By the end of the first week of May gravid females usually have congregated in maternity roosts such as Colossal Cave (locality 9b), Box Canyon Crevice (locality 9a), and Slate Mountain (locality 3a). By late May the roost at Colossal Cave

contained as many as 3000 bats. Some estimates of the size of the maternity roost at Slate Mountain were larger than those of Colossal Cave (see Appendix B).

During the same late May and early June period, maternity roosts have been seen at Tajitos (locality 18) and La Aduana (locality 27b), in Sonora.

5. In late May, in Arizona, a few records of single or small groups of adults, usually non-reproductive females, have been reported from transient roosts. The female from Helvetia (locality 10) taken on 28 May is an example. Similar records are known for June — 7 June, Manzanal Mine (locality 15d); and 24 June, Sabino Canyon (locality 5). Perhaps these are females that have lost their young.

6. In June and early July most of the *Leptonycteris* seen in Arizona are adult females and their recently born young residing in the maternity roosts. For example, Colossal Cave was occupied by adult females and their young until about the third week in July, at which time the young were volant. All of the *Leptonycteris* probably abandoned that maternity roost during a single night (Beatty, 1955, Hayward and Cockrum, 1971, and Appendix B), perhaps in part because of disturbances by the operation of the commercial cave. The maternity roosts at Old Mammon Mine (locality 3a,b) and Tajitos (locality 18) appear to be active until sometime in August.

7. By mid- to late June, some adult males make their appearance in transient roosts in southern Arizona. They are usually in roosts at higher elevations, e.g. males were taken from Buckelew Cave (locality 12a) on 14 June. During early July, in Arizona, there appears to be a major influx of adult males, adult females that have not borne young in the current year and some sub-adults of both sexes. These appear in the caves and mine tunnels at higher elevations in southeastern Arizona, areas lacking maternity roosts.

8. By mid-July some adult females and the young from the maternity roosts apparently begin to join the transient roosts. Roost size increase and the sex-age ratios shift (see records for Buckelew Cave, locality 12a and the mine, 1 mile N Paradise, locality 12d).

9. During late summer, smaller groups appear to move from between roost sites, probably influenced by the availability of food. A number of records from roosts in mines and caves and at hummingbird feeders in the Huachuca and Chiricahua mountains of Cochise County (localities 12e, 13e), and the Santa Rita Mountains in Pima County (locality 10b) are known.

10. Most marginal distribution records (Fig. 1) for the northern part of the range are from late summer, after the maternity roosts have dispersed, and most records are young of the year. The western-most record, Agua Dulce Pass (locality 7a) is a female taken on 29 July. An immature female from Phoenix (locality 1b) was discovered hanging on a screen door on 30 August. The record from Glendale (locality 1a) was another immature female. It was found dead in a yard on 16 September. At Gillespie Wash (locality 4a) a "young of the year" male was taken on 20 September (Sidner and Davis, 1988:494). The specimens from southwestern New Mexico (localities 16a, 16b, 17a, 17b, 17c) were taken between 17 July and 5 October (Findley et al., 1975:25-6).

11. By late September, most *Leptonycteris* appear to have left Arizona and New Mexico. Early October observations include a few at Granite Pass (locality 16a), at the hummingbird feeders at Portal (locality 12e), and just south of the Arizona

border at Tajitos, Sonora (locality 18).

### Causes of Seasonal Shifts

Seasonal changes in the availability of food is probably the major factor in determining the distribution of *Leptonycteris*. Gardner (1977:317) reported that *Leptonycteris sanborni* feed on fruit, nectar, pollen, and insects. Howell (1979:24) thought that "*Leptonycteris* are committed flower feeders. They exhibit an annual migration spatially and temporally co-evolved with a complex of flowers from Arizona to Central America."

The determination of the food intake of these bats in nature is difficult. The nectar that is taken into the elastic stomach is rapidly concentrated, with much of the water being eliminated as urine. An examination of the stomach of a *Leptonycteris* only a short time after it has fed does not give a clear indication of how much nectar was consumed. Examinations of intestinal tract contents and feces are unsuited for this purpose, as are examinations of preserved specimens. Pollen is ingested along with the nectar and by grooming of pollen from the fur of the snout and face.

Nectar and pollen apparently furnish much of the carbohydrate and protein needs of *Leptonycteris*. Beatty (1955) reported that the protein-rich cell contents of pollen grains are "digested out" in the intestinal tracts of *Leptonycteris* and Hayward and Cockrum (1971:106), suggested that since nectar is chiefly carbohydrates, pollen grains should provide a protein source for these bats. Howell (1972) carried out a series of studies that demonstrated the importance of pollen in a nectar diet. Beatty (1955) and Howell (1972) measured the volume of nectar and examined the other contents of a few stomachs taken immediately after the bats had finished feeding. Most examinations of digestive tracts for food contents have involved preserved specimens. Usually most of the contents are pollen grains.

Identification of the pollen from *Leptonycteris* reveal seasonal shifts in the type present (Beatty, 1955; Hayward and Cockrum, 1971; González and Álvarez, 1970; Howell, 1972, 1979; Hevly, 1979). Findings for southern Arizona are summarized in Table 2. The shift from saguaros to agaves in early June is obvious. The role of the nectar of other columnar cacti and, in more southern areas, various other plants, in the diet has been well documented (González and Álvarez, 1970; Howell, 1972; and Hevly, 1979).

Columnar cacti and agaves have somewhat different distributions and seasons of flowering (Kearney and Peebles, 1969; Hastings, Turner and Warren, 1972; Gentry, 1982). Saguaro in Arizona usually occur at elevations below 3500 feet and bloom the spring (mainly May and June). In Sonora, they occur southward to the southwestern part of the state and flower earlier. Organ pipe cacti occur in the lower portions of southwestern Arizona and low elevations in Sonora. Cardons are common in Sonora from just north of Desemboque southward. The latter two columnar cacti have a longer flowering period (mid-April to late July) than saguaros but produce fewer flowers at a given time.

The various species of paniculte *Agave* in Arizona and Sonora occur from low to high elevations (sea-level to 8000 ft) and generally bloom in the summer (mainly

TABLE 2  
TYPES OF POLLEN REPORTED FROM DIGESTIVE TRACT OF  
LEPTONYCTERIS TAKEN IN THE NORTHWESTERN PART  
OF THE RANGE

Date	Sample/ References	<i>Cereus</i>	<i>Agave</i>	Locality
15 May	2 F (1)	100%	0%	Colossal Cave
23 May	1 F (2)	99%	1%	Box Canyon
20 Jun	1 F (1)	98%	2%	Colossal Cave
20 Jun	1 F (1)	77%	23%	Colossal Cave
? Jun	7 (3)	50%	41%	Saguaro Nat. Mon.
2 Jul	1 F (1)	87%	13%	Colossal Cave
2 Jul	1 F (1)	0%	100%	Colossal Cave
14 Jul	8 M (1)	0%	100%	Buckelew Cave
18 Jul	2 F (1)	0%	100%	Colossal Cave
? Jul	4 ? (3)	0%	90%	Buckelew Cave*?
3 Aug	1 M (2)	0%	100%	Buckelew Cave
14 Aug	1 F (2)	0%	100%	1 mi N Paradise
? Aug	34 ? (3)	0%	92%	Buckelew Cave
? Aug	? (3)	0%	96%	"Arizona"
2 Sep	1 F (3)	0%	100%	Buckelew Cave

\* The shift from columnar cacti (*Cereus*) to agaves. The data reported by Howell includes small percentages (not shown) of insects and other materials. The references are: 1. Beatty (1955) and Hayward and Cockrum (1971:104). 2. Hayward and Cockrum (1971:104) and Hevly (1979). 3. Howell (1972). Pollen identifications reported in 1 were made by R. Y. Anderson, formerly with the Department of Botany, University of Arizona. The identifications reported in 2 were made by R. H. Hevly, Dept. of Geochronology, University of Arizona. Those reported in 3 were made by D. Howell.

June to August). Howell (1979:26-7) reported that in the Chiricahua Mountains of southeastern Arizona, *Agave palmeri* begins to bloom in late June or July, with some blooms still being present in September.

As discussed below, the seasonal expansion of range of *Leptonycteris* in Arizona is clearly correlated with the availability of saguaro blossoms at low elevations in April to June and agaves at low to high elevations from June to September.

The importance of fruit and insects in the diet of *Leptonycteris* remains to be determined. Howell (1972:tables 13-17) listed the "Pollen and other food materials taken from *Leptonycteris*... Expressed as per-cent of total gut contents." She reported on 219 individuals, grouped by month and locality into 53 samples, from most parts of the North American range of the genus. Most samples were from bats preserved in fluid in various museums. My calculations from her data reveal that 91.7% of the material was pollen (range 33-100%), 3.96% was insect material (range 0 to 11%), and 4.26% was "Misc." (range 0 to 60%). If one individual is ignored, then the ranges of pollen are 75-100%, and "misc" is 0-20%. One wonders if most of the "miscellaneous" was not plant fibers that would have been ingested with ripe fruit.

Dalquest (1953:28) reported that *Leptonycteris* taken in San Luis Potosi "...had their stomachs filled with thick, brilliant red fruit juice. This was almost certainly the juice of the fruit of the organ cactus..."

Beatty (1955:44) reported: "During July purple-red plant material and occasional small seeds were also found in the stomachs; these have been identified as the remains of the fruit of the Sahuaro (*Cereus gigantea*). At this time the feces, which previously had been pollen yellow, became dark red-brown." Hoffmeister (1959:15) reported on observations made in 1957: "Red splotches on the floor may have represented droppings left by *Leptonycteris*. There were small black seeds in these droppings, suggesting that the bats may have been feeding on the fruits, including the seeds, of cacti." Dr. Alfred L. Gardner (field notes) recorded that on 21 July 1960, at Bahia San Carlos, "the mouths of the bats showed evidence of Pitahaya cactus fruit which was very abundant in the area." He also observed *Leptonycteris* flying around the Pitahaya cactus plants.

Howell (1980:731-2), based on observations made in August at Organ Pipe Cactus National Monument, reported that "In spring, resident *Leptonycteris* feed on the numerous, mass flowering saguaros and from June to late summer, supplement organ pipe nectar with a substantial intake of organ pipe fruit. This frugivory is unusual for the species. I have examined over 2,000 samples of *Leptonycteris* guts or faces from all parts of their range (Howell, 1974) and have found fruit only in the bats from this localized area." The 1974 reference indicates that the sample size was 184, not 2000.

Just as in the case of fruit, the role of insects in the diet of this species must still be determined. Beatty (1955:45) found: "Insect remains... [made] up a small part of all digestive tract contents analyzed. Moth wing scales, fragments of the chitin shells of small scarab beetles and the abdominal segments of small bees were identified." Howell (1974:296) reported that an examination of the diet of 184 *Leptonycteris* revealed that, by volume, the food consisted of 25 per cent pollen, 75 per cent nectar and 0.5 [5.0 in another place on same page] per cent "rare insect bits (thrips, *Carpophilus* [=Coleoptera])." Analysis of data in Howell (1972), reported above, revealed that insect remains made up an average of 3.96%, by volume, of 219 individuals from localities throughout the range of the species.

The map (Fig. 1) indicates the seasonal shifts in the distribution of *Leptonycteris sanborni* in the northwestern part of its range. In northern Sonora and southern Arizona the darker, cross-hatched pattern in northern Sonora and southern Arizona is the area of late spring and early summer records—all gravid females, females and their young at maternity roosts.

Moderate to dense stands of columnar cacti, especially saguaros, occur in this region. As indicated above, most saguaro bloom between early May and early June. Ripe saguaro fruits are common in June and July. Organ Pipe cacti occur in the lower portions of southwestern Arizona and low elevations in Sonora. Cardons are common in Sonora from north of Desemboque southward. Cardons and Organ pipe cacti have a longer period of blossom production (mid-April to late July) and have scattered ripening of fruits (May to August) than is typical of saguaros. Various paniculate agaves occur in part of this region and begin an extended flowering season just as the season of saguaro blossoms ends.

From August to late September various transient roosts, of adult males as well as bats from dispersing maternity roosts, occur in the area indicated by the dark pattern.

The lighter, vertical-line pattern shows the distribution of records taken in transient roosts in the July to September period. The part of this area to the east of the darker pattern is almost all at higher elevations in areas where saguaros are rare or absent but agaves are available from late June through much of September. Areas to the north and west have both columnar cacti and agaves. It is evident that the mid-summer to early fall distribution, including the area covered by both the lighter and darker patterns, is an expansion of the late spring-early summer range and not the classical migration from place to place, nor any "pre-migratory wandering".

The expanded range may be, at least in part, the result of the late season arrival of adult males (and non-gravid females) from southern regions and the increased demands for food resulting from the feeding young of the year. I have found no estimates of total food resources potentially available to *Leptonycteris*. However, my personal impression is that during most years the total saguaro nectar available during May and June probably exceeds that available from agave blooms in the same area. Probably during this time the ripening fruit of the columnar cacti supplements the nectar from late-flowering columnar cacti and paniculate agaves. As agaves at higher elevations begin to bloom, the range of *Leptonycteris* expands altitudinally and geographically, the bats presumably moving upward and outward to the flowering agaves.

Although we do not yet have the answers to many critical questions, it appears that the major cause of seasonal shifts in the distribution of the long-nosed bats in the northwestern part of its range is the availability of food. Perhaps the food of choice is the nectar and pollen of various columnar cacti and paniculate agaves. Ripe fruits of the columnar cacti (both saguaros and organ pipe cacti) may well provide an important source of food after columnar cacti blooms become scarce and before agave blooms become common. The seasonal and geographic importance of nectar, fruit and insects in the diet of *Leptonycteris* remains to be determined.

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## APENDICES

### A. Regional Synonymy

The following synonymy is an attempt to list all papers that have referred to Long-nosed bats in this region.

- Leptonycteris nivalis sanborni* Hoffmeister, *Jour. Mamm.*, 38:456, 1957, type from mouth of Miller Canyon, Huachuca Mts., 10 mi SEE Fort Huachuca, Cochise Co., Arizona; Hoffmeister, *Southwestern Naturalist*, 4:15, 1959; Cockrum and Bradshaw, *American Museum Novitates* 2138:5, 1963;
- Leptonycteris sanborni*, Davis and Carter, *Proceedings Biological Society Washington*, 75:196, 1962; Loomis and Davis, *Jour. Mamm.*, 46:497, 1965; Constantine, *Jour. Mamm.*, 47:126, 1966; Baker and Cockrum, *Jour. Mamm.*, 47:329, 1966; Stull *et al.*, *Jour. Mamm.*, 47:542, 1966; Carpenter and Graham, *Comp. Biochem. Physiol.*, 22:709, 1967; Baker, *Southwestern Naturalist*, 12(4):427, 31 Dec 1967; Carpenter, *Physiological Zoology*, 42:299, 1969; Hayward and Cockrum, *Western New Mexico University Research in Science*, 1(2):75, 1971; Anderson, *Bulletin American Museum of Natural History*, 148:238, 1972; Cockrum, *Jour. Arizona Academy of Science*, 8:108, 1973; Howell, *Jour. Mamm.*, 55:298, 1974; Reidinger, *Jour. Wildlife Management*, 40:677, 1976; Jones and Carter, *Spec. Publ., Museum, Texas Tech U.*, 10:15, 1976; Howell, *Amer. Nat.*, 114:24, 1979; Howell, *Jour. Mamm.*, 61:730, 1980; Hoffmeister, *Mammals of Arizona*, Univ. Az. Press, 1986, p. 64; Anon., *Endangered Species Tech. Bull.*, 12(8); Sidner and Davis, *Southwestern Naturalist*, 33(4):493, 1988.
- Leptonycteris nivalis*, Burt, *Univ. Michigan Mus. Zool., Misc. Publ.*, 39:21, 1938; Burt and Hooper, *Occas. Pap. Mus. Zool., Univ. Mich.*, 430:2, 1941; Campbell, *Jour. Mamm.*, 15:242, 1934; Alcorn *et al.*, *Science*, 133:1594, 1961; McGregor *et al.*, *Ecology*, 43:261, 1962; Jones and Findley, *Southwestern Naturalist*, 8:174, 1963.
- Leptonycteris nivalis nivalis*, Miller and Kellogg, *Bulletin U. S. National Museum* 205:72, 1955; Cockrum and Ordway, *American Museum Novitates*, 1938:9, 1959; Cockrum, *Mammals of Arizona*, Univ. Az. Press, 1960, p. 34; Villa-R., *Anal. Inst. Biol., Univ. Nac. Mex.*, 244, 1966.
- Leptonycteris yerbabuena*, Villa-R. *Anal. Inst. Biol., Univ. Nac. Mex.*, 252, 1966 (1 from 400m O Aduana, Sonora); Hall, *Mammals of North America*, 1:133, 1981.

### B. Records of Occurrence

This appendix lists all of the records of occurrence of *Leptonycteris* that I have been able to find for the

northwestern portion of the range— southern Arizona, southwestern New Mexico, Sonora and Chihuahua. The records are of three types:

(S). Specimens examined by me (followed by citations to literature in which these specimens have been further reported);

(B). Records and notes associated with the files of banded bats produced by me and my students and housed in my office at the University of Arizona; and

(L). Literature and notes.

**Arizona: Maricopa County:**

1a. (S). Glendale, 1 immature f, 16 Sep 1963, UA. (Constantine, 1966:126; Hall, 1981:133; Hoffmeister, 1986:66 referred to Constantine report).

1b. (S). Phoenix, 1 immature f, 30 Aug 1963, UA. (Constantine, 1966:126; Hall, 1981:133; Hoffmeister, 1986:66).

**Arizona: Pinal County:**

2. (S). Drive-in Mine, Picacho Peak, 45 mi. N Tucson [ $\pm 200$  ft.], 1 f, 13 May 1960, UA. (Hoffmeister, 1986:66). =? Picacho Peak, mine tunnel, 1 m, 25 Aug 1955, UA. (B). = Picacho Peak, Drive-in [= mine tunnel, E end of S slope of Picacho Peak]. Visited at least 34 times between 16 Apr 1955 and 15 Oct 1960. *Leptonycteris* observed only three times, two above and 1 female banded 21 May 1960.

3a. (L). Old Mammon Mine, W base Slate Mountains, approx. 27 mi SW Casa Grande [ $\pm 1800$  ft.], unspecified date [20 Jul from field notes] 1957, "Some of the adult females were pregnant; others had associated young that were capable of flight. There were at least 300 *Leptonycteris* in one cluster"; 24 Jun 1958, "... there was an immense colony of between one and two thousand newborn and nursing *Leptonycteris* just inside the mine entrance... On this day, young 'Lepotos' were of two sizes, one almost entirely hairless and a larger size that was nearly fully haired", Hoffmeister 1959:15; = 27 mi SW Casa Grande, 6 (U), Hoffmeister, 1986:66.

3b. (L). 28 mi SW Casa Grande, 8 (U), "...maternity colonies are known in Arizona at two places in the Slate Mountains, 27 and 28 miles SW Casa Grande [mine shafts]. Hoffmeister, 1986:66.

3c. [= 3a and 3b?] 27-28 mi SW Casa Grande, 14 (U), Davis and Carter, 1962:197.

**Arizona: Graham County:**

4a. (S). Gillespie Wash, 0.25 mi N Highway 266 (Stockton Pass Road), 1 j m, 20 Sep 1986, UA; [=Gillespie Wash, 1321 m, in Stockton Pass, S end Graham (Pinaleno Mountains) [= Pinaleno Mountains on U. S. Dept. of Interior Geological Survey topographic sheet], Sidner and Davis, 1988: 494.

4b. (L). Muleshoe Preserve [=22 mi NW Willcox on Greenlee-Cochise county line,  $\pm 5000$  ft.], "small colony", date not given, Howell, 1988:9.

**Arizona: Pima County:**

5a. (L). Cave, 10 1/2 mi S Oracle [Control Road], 3 (UA), Hoffmeister, 1986:66. This must be an error of transcription. Material in UA from here is *Choeronycteris mexicana*.

5b. (B). Mist net, Sabino Canyon. Mist nets set at least 40 times between 21 Jul 1958 and 24 Aug 1962. *Leptonycteris* taken once: 24 Jun 1961, 1 female.

6. (L). Blue Bird Mine, 2 mi NW Growler Mine, just off OPCNM, 250 banded 18 Sep 1970 (OPCNM records), Cockrum, 1981:2; Cockrum and Petryszyn, 1986:8, 82; = Mine tunnel, Growler Mountains, Cabeza Prieta National Wildlife Refuge, "approximately 50... including many pregnant females," 25 Apr 1987, Sidner and Davis, 1988:494.

7a. (S). Agua Dulce Pass, Agua Dulce Mts., Cabeza Prieta Game Range [mist net], 1 female, 29 July 1968, UA. (Hoffmeister, 1986:66.)

7b. (S). Pozo Nuevo, Organ Pipe Cactus Nat. Mon. [mist net], 1 female, 29 Jul 1979, UA. (Cockrum and Petryszyn, 1986:8).

8a. (S). Alamo Wells, T12S-R4W, Organ Pipe Cactus Nat. Mon. [mist net], 2 females, 8-9 Jul 1979, UA. (Cockrum and Petryszyn, 1986:8).

8b. (L). Water trough, Alamo Canyon, 26 Jun 1977, netted (OPCNM records), Cockrum, 1981:2.

8c. (L). Scattered pools, Alamo Canyon, 29 May 1979, 1 netted; 9-10 July 1979, 16 (males, females, juveniles) netted, Cockrum, 1981:5.

8d. (S). 30 mi SE Ajo, 2 m, 1 f, 14 May 1953, LACM; = Tonoga, 30 mi SE Ajo, 8, LACM (see Constantine, 1961:405; Hoffmeister, 1986:66). =? Natural cave, 2 mi W Tonoga Well, E slope Ajo Mtns, "a group" including 1 female, 1 May 1943; none, 16 Mar 1946) Constantine, 1961:404; Hall, 1981:134.

8e. (L). Copper Mountain Mine, South entrance [Organ Pipe Cactus National Monument], 1 June 1977, 10 netted (OPCNM records), 27 Jul 1979, a day roost, Cockrum, 1981:2; Cockrum and Petryszyn, 1986:8, 83.

8f. (S). Bull Pasture Springs, Organ Pipe Cactus Nat. Mon. [mist net], 1 gravid f, 23 Apr 1982, UA. (Cockrum and Petryszyn, 1986:8).

8g. (S). Dripping Springs, Organ Pipe Cactus Nat. Mon. [mist net], 1 f, 28 July 1979, UA. (Cockrum and Petryszyn, 1986:8).

9a. (S). Box Canyon Crevice [ $\pm$  3500 ft.], Saguaro National Monument, 2 m 24 Aug 1960, UA. ( $\pm$  Box Canyon Crevasse, ...Hoffmeister, 1986:66); = Saguaro National Monument, Rockslide, N side Sentinel Butte, 5 f, 12 May 1967, UA. (Hoffmeister, 1986:66; see Sidner and Davis, 1988:494, for comments about this locality). (B). 5 Aug 1958, none; 15 Aug 1959, none; 11 May 1960, 1 f recovered of about 35 present; 24 Aug 1960, 2 subadults present; [= Saguaro Nat'l Mon., Rock slide on N side of Sentinel Butte] 12 May 1967, 189 f banded, 11 f recovered, 9 f retained, 2 young present. (L). = Saguaro National Monument, rock crevice near south boundary (2 m 5 f removed, June 1969, Howell, 1972:5; = Box Canyon Crevice (Saguaro National Monument), none, May and July, 1985; "about 50", 14 May 1986; 5, 24 July 1986; Sidner and Davis, 1988:494.

9a-9b. Box Canyon and Colossal Cave, June, 1966, 30 females taken "from a maternity colony", Carpenter and Graham, 1967:710.

9b. (S). Colossal Cave, 30 mi SE Tucson [= 23 mi E, 10 mi S Tucson, 3650 ft.], 1 female, 13 June, 1930, USBS; 2 juv males, 1 Aug 1953, UA; 1 male, 1 female, 3 June 1966, UA; entrance Colossal Cave, 1 mummy, 1953; near Colossal Cave, 30 mi SE Tucson, 1 female, 27 May 1930, USBS; (Hoffmeister 1986:66 listed Colossal Cave, 30 mi SE Tucson, 1 UA and 2, Ul.) (B). [Mr. T. J. Tichnor was Supervisor, Pima County Parks, in 1953, when I first visited the cave. He told me that in 1905, nine to ten (13 in Beatty, 1955:14) railroad carloads of guano were removed from the cave.] ? Jul 1953, observed 2 bats, probably *Leptonycteris*; 1 Aug 1953, 2 juv males taken; 2 May 1954, none; 3 May 1954, none; 6 May 1954, none; 8 May 1954, 8 females banded of est 10 present; 31 May 1954, 9 banded; 7 Jun 1954, 133 banded; 18 Jun 1954, 9 banded; 18 Jul 1954, 41 banded; 20 Jul 1954, 10 banded; 21 Jul 1954, 506 banded; 16 May 1955, 3 females recovered, 2 females retained of est 60 present; 18 May 1956, 33 females banded, 3 recovered, 1 ad male taken; 19 May 1956, 26 females banded, 4 females recovered; 26 May 1956, 42 females banded, 3 females recovered;  $\pm$  300 yg hanging from ceiling; 27 May 1956,  $\pm$  900 young hanging from ceiling; 28 May 1956,  $\pm$  1000 young hanging from ceiling; 23 Jun 1956, 2 yg males, 2 young females banded, 4 ad females recovered; 30 Jun 1956, 34 yg males 32 yg females, 1 ad female examined; 14 Feb 1957, none; 17 Mar 1957, none; 3 May 1958, none; 8 Jul 1958, 50 males, 52 females banded; 21 Apr 1959, none; 14 May 1959, 30-40, 1 young on ceiling; 23 Jul 1959, 8 recoveries; 28 Jul 1959, 1 male, 1 female banded — "several days since large numbers of bats have been seen;" 23 May 1960,  $\pm$  1000 present, 10 to Olin, 3 f with young, 4 gravid, 2 barren; 6 Jun 1960,  $\pm$  1000 present, many hundred young; 22 May 1964, 300 present; 23 May 1964, 200 present; 4 May 1966, none (no droppings on clean areas); 10 May 1966, none; 3 Jun 1966, 5 taken, R. Baker and J. T. Mascarello field notes; 27 Sep 1967, one T. Spalding and D. Barthels field notes. (L). = Colossal Cave, 30 mi SE Tucson, Cochise Country, [sic] 2 (USBS) Hoffmeister, 1957:457; 2 (Ul), Davis and Carter, 1962:197; 9 [or more] females removed for experiments, May-June, 1962, Huibregtse (1963); "all" [number not given but exceeded 16] experimental animals captured Colossal Cave, Carpenter, 1969:289; May and July, 1985, none seen, Sidner and Davis, 1988:494; 21 Sep 1988, T range from 21.1 to 22.8°C, humidity 51-73%, Lang Brod, report to Pima County Parks Commission.

9c. (L). Shallow Cave "near Colossal Cave." Verbal report, May, 1988, Bill Peachey.

10a. (S). 2 mi E Helvetia, 5200 ft., T 18S-R16E, sect 19., 1 female, 28 May 1976, UA.

10b. Summers past several years, feeding at hummingbird feeders, Madera Canyon Lodge, personal communication and photographs, Mrs Lyle Collister, in January 1989.

#### Arizona: Cochise Country:

11. (S). 1 mi W Ft. Bowie, T15S-R28 E, 1 female, 22 Sep 1976, UA (Roth and Cockrum, 1976:5).

12a. (S). Buckelew cave, sect. 24, T16S, R30E, about 4800 ft., 16 mi S, 0.3 mi W San Simon, also 7.7 mi N, 5.1 mi W Portal. = Buckelew Cave, 13 mi N Portal, 1 male, 28 Aug 1958, 1 male 27 Aug 1968, UA; [= Buckelew Cave, W end Blue Mtn., 17 mi S San Simon, Cockrum and Ordway, 1959:9; and Hall, 1981:133]; = W end Blue Mtn., 17 mi S San Simon, 3 males (one sub-adult), 11 Aug 1951, 2 males 6 Aug 1957, UA (Hoffmeister, 1986:66.); = Blue Mountain cave, 4800 ft., Baker and Cockrum, 1966:330; (B). 14 Jul 1954, 46 ad males, 3 ad females of est 1000+ present (Beatty, 1955:18); 26 Jul 1954, 46 adult males, 34 ad females, 3 juv males, 3 juv females, 6 subadults examined (Beatty, 1950:18); 16 Aug 1955, 3 males, 5 females banded of est 1500 present; 19 Aug 1955, 1 female banded; 28 Aug 1956, 1 male banded, 2 ad females, 1 juv male seen; 2 Sep 1958, 8 males, 51 females banded, 2 females recovered of est 5-600; 3 Sep 1958, 13 males, 31 females banded, 2 females recovered; 4 Sep 1958, 1 female banded of 10-12 present; 21 May 1963, one; 9 Aug 1965, 29 adult females removed, R. J. Baker notes; 15 Apr 1966, none; 30 Apr 1966, none; 26 July 1970, none, R.J. Baker notes.

(L). = "Buckelew Cave, blue mountain, 10.5 km south of San Simon by dirt road [sic] (47M 60F

removed, August 1968, Howell, 1972:5). Buckalew Cave, 2 males, 8 females, Aug 1963 (UM), Howell, 1972:8; =? 10 mi NW Paradise, 4 (W Gene Frum Collection), Hoffmeister, 1957:457; Hoffmeister, 1986:66 =? "Blue Mountain" not further specified, none, May and July, 1985, Sidner and Davis, 1988:494.

12b. (B). Frank Nolen mine, 2 mi ESE Buckelew Cave, 2 banded [in Buckelew] recovered by Dr. Arthur F. DiSalvo, MD, USPHS, 27 Sep 1967.

12c. (L). Whitetail Canyon, abandoned mine shaft, 1 September 1986, est 3000 present (per Al Morgan, Dr. Yar Petryszyn notes).

12d. (S). Mine tunnel, 1 mi. N Paradise, 5200 ft. [This shallow tunnel, just at the edge of the road, has a vertical stope near back that reaches the surface. As a result the tunnel is mostly in a twilight zone]. 3 females, 11 males, 14 Aug 1955, UA (Cockrum and Ordway, 1959:9; Hall, 1981:133; Hoffmeister, 1986:66.) (B). 14 Aug 1955, 16 m, 5 f banded, 2 males, 10 females taken of est 150 present; 19 Aug 1955, 6 m, 9 f banded of est 100; 3 Mar 1966, none; 18 Mch 1956, none; 31 Mch 1956, none; 29 Jul 1956, present; 11 Aug 1956, none (night observation); 11 Nov 1956, none; 27 Aug 1958, none; 22 Nov 1956, none; 7 Jan 1957, none; 4 Oct 1957, none; 5 Oct 1957, none; 2 Jan 1958, none; 3 Jan 1958, none; 1 Mar 1958, none; 2 Mar 1958, none; 3 Aug 1958,  $\pm 35$ , present, 22 examined, 8 males, 14 females, Commissaris notes, 7 August 1958, 20 present; 27 Aug 1958, none at night; 31 Aug 1958, 34 males, 16 females banded, of est. 200 in tight cluster; 2 Sep 1958, 1 male present; 3 Sep 1958, none; 10 Sep 1958, none; 13 Sep 1958, 6 present; 24 Sep 1958, none; 14 Oct 1958, none; 3 Nov 1958, none; 3 Dec 1958, none; 31 Jul 1959, none; 14 Aug 1959, 4 males, 5 females; 27 Nov 1959, none. (L). =? Paradise Mine, 2 M, 2 F removed, August 1968 (Howell, 1972:5); =? Mine tunnel near Paradise-Gayleville, 13, 5 Aug 1986 (Sidner and Davis, 1988:494).

12e. (L). Rancho-Aguila, the Spofford home, Portal, records of *Leptonycteris* using hummingbird feeders: 1971 Hummingbird feeders installed at Rancho-Aguila (Spofford, 1985:5). 1979. First noticed nectar feeding bats at the hummingbird feeders (Spofford, in 1982 letter). 1982. August-September, 1.5 to 2 gallons sugar water taken each night by bats, then about 1 gallon per night until they left in mid-October. Photographs taken nights of 7, 10, 20 and 24 September were of both *Choeronycteris* and *Leptonycteris*, but primarily of the latter species. 1979— "In late summer and early fall, our feeders are used by two species of Mexican nectar-eating bats. That is one reason why some of our neighbors take in their feeders at night." Spofford (1985:7) 1985. 8 August, "A few Leptos and Choeros have been showing up so our sugar supply is going down rapidly!" (in Spofford letter). 1988. Bats are still feeding at the hummingbird feeders. Some are present in June and July (at a time that the Spoffords are not in residence but have others keep the feeders filled) with most being present in August and September. Other people in the Portal area maintain hummingbird feeders. Some lower their feeders so that the bats cannot reach them but others let the feeders stay in place overnight. Often the feeders are empty the next morning. (Telephonic conversation, 28 December 1988, with Sally Spofford).

12f. (L). 2 mi S Portal, 7 (KU), Hoffmeister, 1986:66.

13a. (S). W boundary Ft. Huachuca Military Reserv., 1 male, 23 Aug 1933, CNHM (= Panama Mine, near Pyatt Ranch, Campbell, 1934:241) = Canelo Mine, 8 mi W Ft. Huachuca, 6 (1 adult male, 1 adult female, 4 young, taken sometime between 2 Aug and 27 Aug 1949, UI), Hoffmeister and Goodpaster, 1954:3 and 54; Hoffmeister, 1957:457; 3 8 mi W Ft. Huachuca, 1 (UI), Davis and Carter, 1962:197; = Fort Huachuca, Panama mine, near Pyatt Ranch [= Canelo Mine, see Hoffmeister and Goodpaster, 1957:39].

13b. Pyatt Cave, 5500 ft., Baker and Cockrum, 1966:330; = "Cave inside north gate Fort Huachuca" (4F removed, July 1967, Howell, 1972:6).

13c. (S). Hqtrs. Building, BLM San Pedro Riparian Study, T20S, R21E, 200 yds N hwy 82, probably sect 3, 1 mummified skeleton found, 11 June 1988, by Ronnie Sidner, UA.

13d. (L). Ranch barn, lower edge oak belt, Mouth of Miller Canyon, Huachuca Mts., below 5100 ft., 55 (24 ad females, 12 immature males, 19 immature females, UI), "In August, 1950, approximately 100 long-nosed bats occupied at night..." Hoffmeister and Goodpaster, 1954:54-55; Hoffmeister, 1957:457; = Miller Canyon, 10-15 SE Ft. Huachuca, 55 (UI), Davis and Carter, 1962:197. Hoffmeister (1986:66) reported as follows: 8 mi W Ft. Huachuca, Miller Canyon, 6 (UI); 10 mi SSE Ft. Huachuca, Miller Canyon, 51 (UI); 15 mi S Ft. Huachuca, Miller Canyon, 6 (UI). This listing appears to include materials listed in both 13a and 13d.

13e. (L). The Mile Hi, Ramsey Canyon Preserve, The Nature Conservancy. Nectar-feeding bats at hummingbird feeders. Date? "For several years" prior to 1982 (Spofford, in letter, 1982); 1978? first noticed "about ten years ago;" Warren and Howell (1988:1); "early and late summer [1985?];" Wilson (1985:18).

13f. (L). Star of Texas Mine, Coronado National Monument, Huachuca Mts., 1 male taken 14 Aug 1966 (Tor Hansen notes).

**Arizona: Santa Cruz County:**

14. (L). Cave of the Bells, 5440 ft. 29 Aug 1960, "many bats" — Anon?, Southwest Caver (vol 1, no. 8, Aug. 1960); 1 Sep 1965. "Approximately 200-250 bats seen in the room immediately after the entrance, hanging high on the ceiling" (Larry Marts notes); 6 Sep 1987, "cluster" just inside entrance seen by Joe White and Randy Gruss; 9 Sep 1987, 500, one recently dead saved as voucher, Dr. Yar Petryszyn notes; 10 September 1987, photograph taken by Bill Peachey; 12 Sep 1987, estimate no more than half those on 6 Sep, by Bill Peachey and Randy Gruss; 24 Sep 1987, 4 males examined of estimated 50 individuals present; 25 Sep 1987, 11 present, 3 (two subadults), all males, examined; Yar Petryszyn notes; 9 September 1988, Randy Gruss counted 170 *Leptonycteris* in evening flight; 10 September 1988, est 150 by Ronnie Sidner, Tom Valone and Russell Davis (in lit., Sidner); 17 September 1988, est. 25-30 by Randy Gruss.

15a. (S). 5 mi N, 2 mi W Patagonia, 4450 ft., 3, UA, [not found, 1988]; = Abandoned mine tunnel, 5 mi N, 2 mi W Patagonia, 5500 ft., present, 3 Jul 1954, Aug 1954 (Beatty, 1955:13-4).

15b. (L). Patagonia, several miles W in old tunnel directly over road, 1 (25 Aug 1933), Campbell, 1934:241.

15c. (L). 5 mi E Patagonia, 5 (UI), Davis and Carter, 1962:197; =? 5 mi E, 1/2 mi S Patagonia, 5 (UI), Hoffmeister, 1986:66; =? "a colony of approximately 200 *L. sanborni* remained in the Patagonia area," Howell and Roth, 1981:4; =? "in a very remote area on private property in the mountains near Patagonia... [contained] about 500 *L. sanborni*" sometime in the 10-25 July, 1985 period, Wilson, 1985:15; = bat cave, 5275 ft. elevation, 300 seen, 17 Sep 1988, Bill Peachey, personal communication.

15d. (B). Manzanal Mine, near White Oak Mine, Walker Canyon, 7 June 1959, 1 female banded.

**New Mexico: Hidalgo County:**

16a. (S). Mine tunnel, Granite Pass, 17 mi NNE Rodeo, 1 female, 5 Oct 1958, UA. (B). 4 Oct 1958, 1 female recovered, total 4 taken, tunnel short, warm, 22.6°C. (L). Granite Gap, Peloncillo Mts., 1 female, 5 Oct 1958 (MSB) Jones and Findley, 1963:174; = Mine tunnel, 17 mi NNE Rodeo, Baker and Cockrum, 1966:331; Hall, 1981:133; Findley et al. 1975:26.

16b. (L). T29S-R20W Sec. 17, 2 (MSB), Findley et al., 1975:26).

17a. (L). OK Bar, T31S-R19W, Sec. 24, 1 (MSB), Findley et al., 1975:26).

17b. (L). Clayton Canyon, T32S-R21W, Sec. 17, 1 (MSB), Findley et al, 1975:26; =? (L). Peloncillo Mts., Guadalupe Canyon, 1 male, 2 females, 11-12 August 1962, MSB, Jones and Findley, 1963:8, 12 (11, MSB, 1MHP), Findley et al, 1975:26.

17c. (L). Robertson Ranch, T33S-R21W Sec. 20, 3(MSB), Findley et al, 1975:26.

**Sonora?**

??, (L). "Mexico, Sonoran Desert, on the Gulf of California". Locality not further specified, "Tuttle [=Dr. Merlin Tuttle] found only a hundred bats where several thousand had been reported in the 1960's." Anon, 1938:4.

**Sonora:**

18. (S). Mine, 1 mi N Tajitos, 3 females, 5 Oct 1963, UA. (B). Mina de la Virgen and other mines in same hill, Tajitos, 28 June 1963, 5000 est., young range from very small to nearly flying stage; 30 Aug 1963, 10000 est.; 5 Sep 1963, none mentioned; 5 Oct. 1963, present; 5 Oct 1965, none. (L). Tajitos, 2500 ft., Baker and Cockrum, 1966:330; 2 females removed, July 1969, Howell, 1972:6.

19a. (S). Pilaes, 1 male, 30 June 1935, UM; Burt, 1938:21; 8 (UM), Hoffmeister, 1957:457.

19b. (S). Santa Maria Mine, near El Tigre, 5 females, 5 males, 5-6 Aug 1935, UM; = Below Santa Maria mine, near El Tigre, UM, Burt, 1938:21; [= Santa Maria Mine, El Tigre Mts., 3 (UM), Hoffmeister, 1957:457; Davis and Carter, 1962:197.

20. (S). 18 mi S Desemboque, 1 male, 25 Apr 1970, UA.

21. (L). Guiricoba (Donald R. Dickey collection [=MVZ]), collected by J. T. Wright between 1929 and 1934, Burt, 1938:21.

2. (S). [=Cueva el Tigre, 14.9 mi SSE Carbo, elev. 464 m,  $\pm$  1400 ft., see map NH 12-5, Estados Unidos Mexicanos 1:250,000 Series, Army Map Service, Corps of Engineers]; = Cueva del Tigre, 1500 ft., 14.9 mi, SSE Carbo, 3 females, 11 Apr 1959, UA; 1 male, 7 Nov 1959, UA, Cockrum and Bradshaw, 1963:5; 1 male, 27 Jun 1962, UA, = "Carbo, 1800 ft", Baker and Cockrum, 1966:330; 10 females, 15 May 1971, UA; 1 female, 3 June 1974, UA; =? 25 mi N Hermosillo, 1500 ft., Hall, 1981:134. (B). 12 Nov 1957, none; 17 Feb 1958, none; 11 Apr 1958, several hundred; 30 Nov 1958, 5 observed; 18 Apr 1959, 100 seen; 7 Aug 1959, ?; 6 Nov 1959, 5 seen; 5 Mar 1960, none; 8 Apr 1960, 200; 18 Jul 1960, 30; 2 Jul 1961, ?; 21 Jul 1961, ?; 30 Jan 1962, none; 3 Mar 1962, none; 24 Mar 1962, none; 25 Mar 1962, none; 21 Apr 1962, none; 26 May 1962, 6000; 30 Jan 1963, none; 15 Feb 1963, none; 15 Mar 1963, none; 30 Mar 1963, none; 11 Apr 1963, present; 26 Apr 1963, 100; 29 May 1963, 30 females; 1 July 1963, 16

males; 21 Sep 1963, ?; 3 Nov 1963, none; 21 Mar 1964, none; 21 Oct 1965, none; 21 June 1966, 5000; 13 Apr 1986,  $\pm 2000$  (Dr. Joel Brown notes); 13 Apr 1980,  $\pm 1000$ —all pregnant female (Dr. Yar Petryszyn notes). (L.) = 25 mi N Hermosillo, 1500 ft. 1 (TCWC), Davis and Carter, 1962:197; = "Cueva del tigre Carbo [sic];" 1 male, 5 females removed, May 1969, Howell, 1972:6; 25 Mar 1987, none, Yar Petryszyn field notes; 13 May 1986, 4 pg females examined of est 500—1000—"all appeared to be gravid females... in deepest chamber, Yar Petryszyn field notes; 6 Nov 1987, none, Yar Petryszyn field notes.

23a. (S). 2 mi N Chueca (18 mi NW Bahia Kino) [mist net], 2 females, 19 Sep 1974, UA.

23b. (L). Mist net in flyway,  $\pm 4$  mi N Bahia Kino, 5-6 taken, June 1984, Yar Petryszyn (*personal communication*).

24. (S). Mist nets, Bahia San Carlos, 1 female, 27 Mar 1959, UA, Cockrum and Bradshaw, 1963:5. (L). 7 May 1960, 1 male, (Dr. Alfred L. Gardner notes); 21-23 Jul 1960, 2 juv males, 1 adult female, 3 juv females (Dr. Alfred L. Gardner notes).

25. (S). 1 mi S, 7.6 mi E Vicam, 14 males, 17 females, 25 Aug 1963, UA.

26. (L). Tesia, 5, AMNH, Howell, 1972:8.

27a. (L). Minas Armolillo, 1500 ft., 5 mi NNW Alamos, 2 mi S Piedras Verdes. Estimates at following dates (1964): 27 Jan, 50; 29 Feb, 50; 16 Apr, 100; 31 May, 100; 16 Jun, present; 29 Jun, 1000, including many young; 20 Jul, present; 7 Aug, 100; 24 Aug, 10; 27 Nov, present; Mitchell, 1965:22-23.

27b. (S). Mine tunnel at La Aduana, 1600 ft., 5 mi W Alamos, 2 males, 8 females, 11 Apr 1958, UA; = mine tunnel, 1/2 mi N La Aduana, 1 female, 22 Apr 1960, UA; Cockrum and Bradshaw, 1963:5; = Minas Aduana, 5 mi W Alamos, 2 females, 25 Mar 1967, UA; = Aduana Mine, 1/2 mi W Minas Nuevas, 1 male, 1 female, 29 Aug 1983, UA; = 1/4 mi W Aduana, 1600 ft., 7 males, 42 females, 16 May 1948 (KU); 4, KU, Davis Carter, 1962:197. (N). 29 Mar 1959, thousands, roosting in scattered groups, 25 examined all gravid females, Commissaris notes; 29 July 1960, 1 subadult female in mine, Alfred L. Gardner notes. (L). 1 female (KU), Anderson, 1972:239; = 1 km SW La Aduana, 1600 ft., about 5 mi W Alamos (1 male, 1 female) Loomis and Davis, 1965:497; Hall, 1981:133; = Alamos, dry stream bed below Mina de Agua (3M 10F removed, April-June 1970, Howell, 1972:6).

27c. Mist nets, small arroyos near La Aduana, 31 Jul 1960, 1 male, 2 non-gravid females, Alfred L. Gardner notes.

27d. (L). Alamos, 1000 ft., Baker and Cockrum, 1966:330; 1 (females karyotype), Baker, 1967:427.

27e. (S). 2 mi S Aduana 2600 ft., 22 males, 18 May 1948, KU.

27f. (B). Mist net, Río Cuchahaque, 11.3 mi SSE Alamos, 5 taken 21 June 1966.

27g. (L). Chinobampo (Donald R. Dickey collection [=MVZ]), collected by J. T. Wright between 1929 and 1934, Burt, 1938:21.

#### Chihuahua:

28. (S). Cave in canyon near Carimechi, 24 males, 4 Jan 1935 (UM), Burt and Hooper, 1941:2; Río Mayo, Carimechi, 24 (UM), Hoffmeister, 1957:457; [=Carimechi, Río Mayo, 5 (UM), Davis and Carter, 1962:197; "taken in a cavern in a canyon near Carimechi in January... adul males." Anderson, 1972:239; Hall, 1981:133.

29. (S). Batopilas, 1 male, 1 June 1937, MVZ. = "was young enough to have retained its milk teeth," Anderson, 1972:239; Hall, 1981:133.

Abbreviations include: KU (University of Kansas, Lawrence), LACM (Los Angeles Country Museum), MSB (Museum of Southwestern Biology, University of New Mexico, Albuquerque), MV (Museum of Vertebrate Zoology, University of California, Berkeley), TCWC (Texas Cooperative Wildlife Collections, Texas A and M University, College Station), UA (University of Arizona, Tucson), UI (University of Illinois, Urbana), UM (University of Michigan, Ann Arbor), USNM (United States National Museum), USBS (United States Biological Survey).