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Abstract

During the past 20 years (1982–2001) we have studied the biology, occurrence and distribution of LeConte's (Brazilian) free-tailed bat, *Tadarida brasiliensis cynocephala*, in Arkansas. Colonies and individuals were reported from manmade structures only. Four new county records have been documented since 1988, extending the range from the central part of the state to Arkansas's northern-most tier of counties. Numerous nuisance maternity colonies were investigated during exclusion activities and one, year-round colony provided the majority of reproductive data. A total of 152 free-tailed bats was submitted to the Arkansas Department of Health Rabies Laboratory (1982–2001); most during February through April, a period that corresponded to annual mating activity. Pregnant bats had single embryos only in the right uterine horn and parturition occurred in mid-June. Seven specimens tested positive for rabies.

Introduction

The Brazilian free-tailed bat (*Tadarida brasiliensis cynocephala*) is one of the most abundant and conspicuous bats in North America and one of the most widely distributed mammal species in the Western Hemisphere (Wilson and Ruff, 1999). Long narrow wings, ears that almost meet at the mid-line and project forward over the face, deep vertical grooves on the upper lip, exceptionally long toe hairs and a tail that extends conspicuously beyond the tail membrane (uropatagium) facilitate easy identification of Arkansas's only member of the family Molossidae (Fig. 1) (Sealander and Heidt, 1990). In 1956, Sealander listed the occurrence of the species in the state as hypothetical. The first published report of Brazilian free-tailed bats in southern and central regions of Arkansas did not appear until 1964 (Sealander and Price), which is surprising considering this bat is associated with human dwellings and other manmade structures. However, until the potential for bats to serve as a vector for rabies had been demonstrated, there was little reason for the public to submit bats to health department officials. An additional factor may have been the virtual absence of biologists in the state with interests in bats to whom specimens could be sent and positively identified. Rabies in bats was not reported in the United States until 1953 and in Arkansas not until 1961 (Heidt et al., 1987).

The majority of documented occurrences of *Tadarida* are primarily the result of specimens submitted to the Arkansas Department of Health Rabies Laboratory (ADHRL) and investigations of nuisance colonies associated with buildings (Heidt et al., 1987; Saugey et al., 1983, 1988a). The capture of this species using mist-nets has been reported at only one location and that was in a park within an urban setting (Saugey et al., 1988b). Colonies associated with roosts in tree cavities in Arkansas are unknown although hollows of large trees probably served this species prior to arrival of Europeans and the associated large-scale clearing of forests (Kiser, 2000). In Arkansas, this species has been documented from buildings (primarily) and bridges, but it has not been reported from caves or mines (McAllister et al., 1995; Heath et al., 1986; Dunivan et al., 1982; Saugey et al., 1978; McDaniel and Gardner, 1977).

In the 13 years since the original publication of the distribution and status of this species (Saugey et al., 1988a), we had expected specimens to be submitted to the ADHRL from all major cities, particularly those adjacent to major

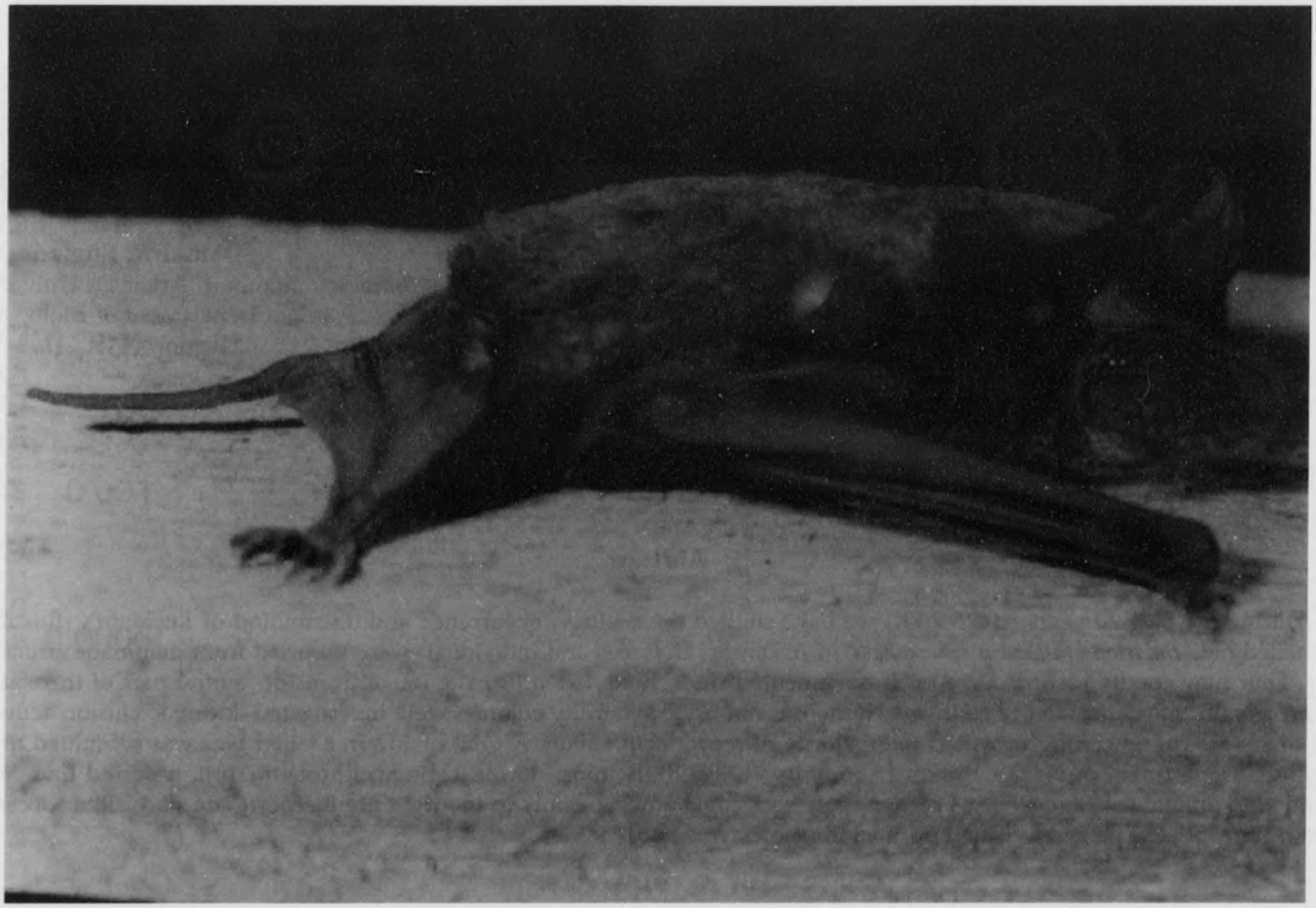

Fig. 1. Adult Brazilian free-tailed bat.

waterways, but this has not been the case. One would have thought public awareness of bats as potential vectors of rabies would have increased the incidence of reporting colonies of bats to public health officials and resulted in additional locality records.

Through the years, bats have been wing-banded using metal bands issued by the U.S. Fish and Wildlife Service and split-ring plastic bands purchased from A.C. Hughes Company. Bats recaptured from colonies in buildings are few because most were banded at the time of exclusion and have dispersed. A few individuals banded at a bridge in Ouachita County and at a house and bridge in Pike County have been recaptured but these colonies have been infrequently checked due to long travel distances. The purposes of this study were to determine the present distribution of *T. b. cynocephala* in Arkansas and summarize natural history and behavior observations.

Materials and Methods

Identification of specimens submitted to the ADHRL were made two or three times annually. Due to various stages of deterioration of submitted specimens and damage that occurred to skulls when tested for rabies, none were deposited in museum collections and should be considered "sight records." Investigations of nuisance colonies occurred when building owners requested assistance through extermination companies who passed information along to one of us or to the Arkansas Game and Fish Commission. The nuisance colony at Daisy and the observations at Self Creek bridge (both in Pike County) were made in conjunction with studies on the southeastern bat (*Myotis austroriparius*).

Bats were captured by hand and in traps when excluded from buildings using methods described by Greenhall (1982). Measurements of mass, length of body and length of left forearm (LFA) were taken to the nearest 0.1 g, 1 mm, and 0.1 mm respectively. Young-of-the-year bats were determined using a combination of closure of phalangeal

epiphyses, overall size and color of fur. The position of the embryo in the uterus and rump-crown length also were recorded.

Results

Distribution.--*Tadarida* previously had been reported from 14 counties in an area encompassing the southern two-thirds of the state (Saugey et al., 1988a). We report four new county records as a result of submissions to the ADHRL (Boone, Baxter, Pike) and investigations of nuisance colonies of bats (Pike, Yell) (Fig. 2). Typically, little information accompanied bats submitted to the ADHRL with regard to conditions under which they were obtained. On 14 September 1990, a rabid male (ADHRL 297) was submitted from the city of Harrison, Boone County. Six juvenile females (ADHRL 67-72) were submitted from Mountain Home, Baxter County, on 8 July 1998. The fact these bats were juveniles and estimated to have been submitted within 30 days of their births clearly indicated the presence of an established maternity colony. A female (ADHRL 407) was submitted from Glenwood, Pike County, on 10 November 1999. An additional observation in Pike County occurred on 15 June 2001 when a maternity colony with about 45 bats was discovered in the attic of a home 5 kilometers (km) west of Daisy, Pike County. Pregnant *Tadarida* were observed roosting in a mixed colony with the big brown bat (*Eptesicus fuscus)* that had already given birth. In Alabama, Henry et al. (2000) also reported that parturition occurred slightly earlier in *Eptesicus* than in *Tadarida*. Four pregnant *Tadarida* had an average mass of 15.9 g (15–16.5) and LFA of 43 mm (41.8–44.9). A total of 6 bats, including one adult male, was banded and released. Four days later, one of the *Tadarida* banded at Daisy was accompanied by a number of non-

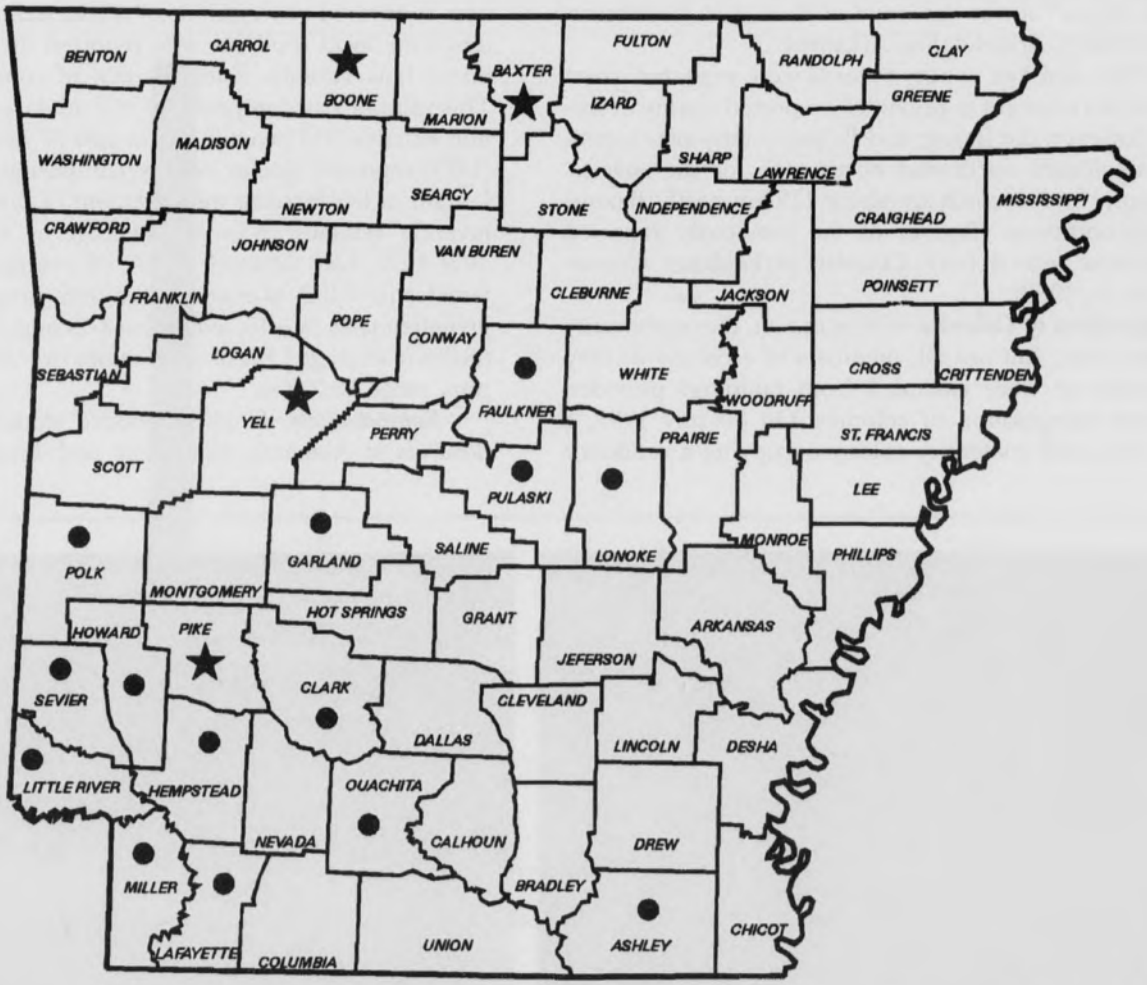

Fig. 2. Distribution of the Brazilian free-tailed bat in Arkansas. Solid circles are previously published county records. Stars represent new county records.

banded individuals day-roosting in a narrow space beneath a metal platform on the State Highway 70 bridge at Self Creek (Pike County). Self Creek bridge spans a portion of the U.S. Army Corps of Engineers' Lake Greeson Project and is home to a large (400-500) maternity colony of the southeastern bat. Individual *Tadarida* also were observed roosting in clusters of southeastern bats that occupied expansion joints in portions of the bridge located over water.

During late August 2001, male and female *Tadarida* were observed day-roosting with *Eptesicus* in an old classroom building at Plainview-Rover School in Plainview, Yell County. The colony roosted on the brick surface of an old chimney and in adjacent locations of the attic. Bats exited the structure through narrow spaces between wooden blocks placed between rafters at the roof's edge. *Tadarida* and *Eptesicus* in mixed colonies have been reported previously (Kiser, 2000; Henry et al.; 2000, Saugey et al., 1988a). Two males were collected for preparation as museum specimens for deposit in the mammal collection at Henderson State University, Arkadelphia, Arkansas.

The Pike and Yell county records were expected given their locations adjacent to previously reported county occurrences. However, the Baxter and Boone county sites constituted a significant northward occurrence for the species. Interestingly, both records are about 139 km north (Baxter) and north-northwest (Boone) of the previously reported northern-most record from Conway in Faulkner County (Saugey et al., 1983).

Composition of Colonies.--On occasion, the opportunity to capture some, but not all, members of a colony as they exited roosts or were excluded from buildings provided insight into composition of colonies. On 30 July 1993, a sample of a small maternity colony occupying a residence yielded 58 adult females, 41 juvenile females, 44 juvenile males, but no adult males. The colony was located in a brick home and used a small opening about 2.5 centimeters (cm) square to access the structure where they lived in a wall-space, not in the attic. A larger sample of 641 animals was collected and released from a maternity colony located in Hot Springs (Garland County) on 17 July 1999. The colony, which contained more than 2,000 animals, was in the attic and walls of a large, three-story wooden house originally constructed in 1913. The building, now owned by a church, had been covered with metal siding in recent years, but gaps between the siding and the original surface allowed easy access for bats. The colony primarily occupied the air space (chase) adjacent to both sides of the fireplace chimney that extended from the basement through the attic. Bats frequently were observed to roost directly on the chimney's brick surface, but would access the air space between the attic and upper floor when disturbed. The accumulation of crystallized guano along the attic ridgeline and support timbers confirmed observations of maintenance personnel and long-time local residents who reported the house had harbored bats virtually since its date of completion (Fig. 3). This sample was composed of 207 adult females, 184 juvenile females, 213 juvenile males and 37 adult males. LaVal (1973) reported similar colony compositions in Louisiana. Length of left forearm measurement of these bats revealed juvenile females (n = 10, average = 41.8 mm, range 40.9–42.8) had attained 98.1% of average LFA of adult females (n = 130, average = 42.6 mm, range 40–44.7), and juvenile males (n = 10, average = 41.5 mm, range 38.9–42.1) 98.3% of average LFA of adult males (n = 23, average = 42.2 mm, range 39.2–44).

Reproduction.--Unlike extended studies of colonies of *Tadarida* in Alabama, Louisiana, and Texas (Henry et al.,

Fig. 3. Free-tailed bat colony roosting in an attic (left) and accumulation of guano (feces) on rafters.

2000; LaVal, 1973; Spenrath and LaVal, 1974), conducting long-term studies of individual colonies of this species has proven problematic because owners and occupants of buildings are intolerant of their presence and want them immediately removed due to accumulation of guano and the excessively musky odor associated with colonies. However, we were able to engage in a protracted study (March 1983 – January 1984) of a large maternity colony located in an old dormitory building on the campus of Central Baptist College, Conway, Faulkner County (Saugey et al., 1983, 1988a). The roost structure was scheduled for demolition in early spring 1984 and the owners decided against exclusion. The dormitory was occupied by a small number of students who were, for the most part, absent on weekends and holidays. As a result, on winter days when students were absent, the building was heated to just above freezing to prevent rupture of water pipes and restroom facilities. The two-story building was constructed of double brick walls with a space in-between. The attic had a high ceiling, was large, and situated over an auditorium. The roost was shared with a colony of *Eptesicus.* The following observations and reproductive data are from the Conway location, unless otherwise noted, with information from other maternity colonies summarized and synthesized chronologically by month, regardless of year, to provide a partial picture of the biology of Brazilian free-tailed bats in Arkansas.

Examination of Fig. 4 indicates there are two periods in *Tadarida's* annual cycle when activity occurred at elevated levels and bats were submitted (submission event) to the ADHRL. We have defined a "submission event" as one or more specimens of *Tadarida* submitted to the ADHRL from the same locality on the same date. The majority of these submission events were represented by single specimens, but on occasion have included as many as 32 individuals. Interestingly, the major activity period occurred February through April when most vespertilionid bats are still deep in

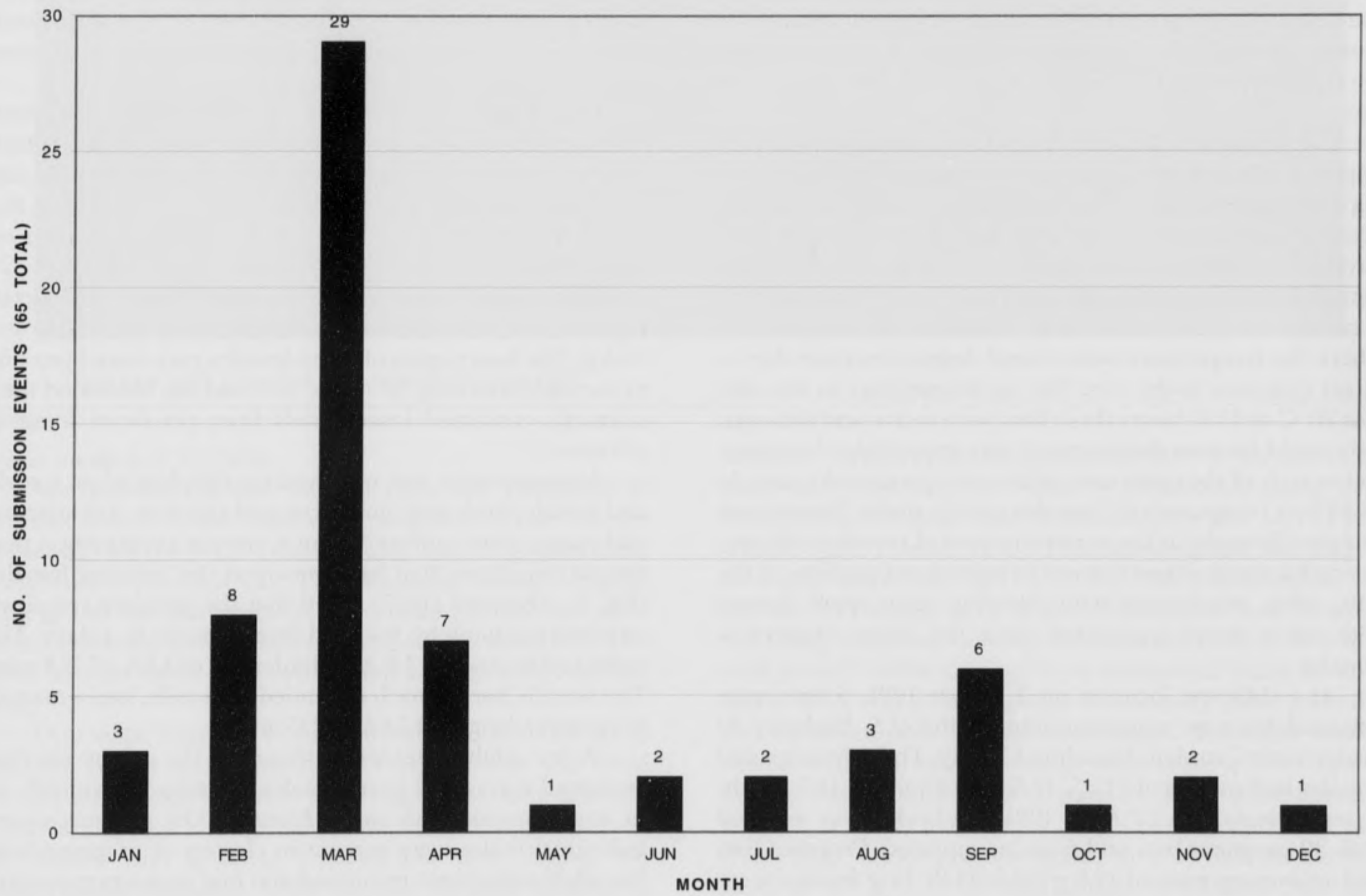

Fig. 4. Submissions of free-tailed bats to the Arkansas Department of Health Rabies Laboratory show two peaks. The February through April submissions probably are associated with breeding activity. The peak in September may result from increased activity as bats prepare for hibernation.

hibernation and inactive or have just begun to leave hibernacula for summer habitats. Although we did not observe copulation, this peak period was presumed to have corresponded with increased activity associated with mating (Sherman, 1937; LaVal, 1973; Henry et al., 2000). As discussed by Krutzsch (2000), this period of early spring activity is the monoestrous breeding season for temperate-dwelling molossids with male libido and female oestrous occurring concurrently. The male reproductive cycle is characterized by late winter-early spring recrudescence, spermatogenesis, and androgenesis. Oestrous females are inseminated during this period with fertilization following immediately and birth occurring during early summer. Sperm storage in interfemoral caudae epididymides, typical of temperate vespertilionids, does not occur.

Because most of the buildings colonized by *Tadarida* are human abodes, the incidence of submissions to the ADHRL are tied directly to periods when human/bat interactions are most likely to occur. We found the lower rate of submission events during the parturition period and when young were learning to fly, interesting. One might logically assume the number of human/bat interactions would be higher because the colony would have doubled in size, but this was not the case.

On 5 March 1983, we initiated our study at Central Baptist College where many *Eptesicus* were observed roosting along rafters with a few males of *Tadarida* interspersed. Female *Tadarida* were virtually absent from the open attic having moved through a small opening into an airspace between two brick walls. The area of congregation was near a corner along the south and west sides of the building where the temperature was several degrees warmer due to direct exposure to the sun. The air temperature in the attic was 20°C at 1330 hours (hrs). Bats were active and although they could be seen their capture was impossible. An extensive search of the open area of the attic produced a sample of 30 bats composed of 7 females and 23 males. Subsequent samples throughout the maternity period revealed the tendency for single males to roost in more open portions of the attic, often side-by-side with *Eptesicus*, or in small clusters with other males segregated from the larger clusters of females.

At a different location on 2 March 1991, 5 bats were collected from an expansion joint in the U.S. Highway 79 bridge near Camden, Ouachita County. Three females and 2 males had masses of 11.25, 12.5, and 13 g, and 11.5 and 16 g, respectively. On 27 April 1991, the bridge was revisited with 39 pregnant bats and 5 males captured. Pregnant bats had an average mass of 12.6 g (10.8–13.8). Five females were sacrificed and single fetuses removed. All fetuses were implanted in the right uterine horn. Rump-crown length averaged 14.4 mm (13–15.8), length of LFA averaged 5.4 mm (4.4–6.5), and mass averaged 0.4 g (0.3–0.5). Sex of fetuses was not determined. Average body measurements of sacrificed adult bats were total length 100 mm; length of tail 34 mm; length of foot 10 mm; length of ear 19 mm; length of tragus 4.5 mm; and length of LFA 41 mm. Mass of males averaged 11.4 g (10.8–12.8). On 4 May 2000, at the same location, mass of 6 pregnant bats averaged 12.8 g (12.0–13.3) and a single male 11.3 g, and on 11 May 1991, mass of 8 pregnant bats averaged 14.9 g (14.3–15.5) and 5 males averaged 12.9 g (12.5–13.5).

At the Conway site, on 4 June 1983, there were 1500-2000 *Tadarida* (primarily females) distributed among several large clusters scattered about the attic on the south and west walls. Numerous individuals also continued to occupy the airspace between brick walls. A thorough examination of these clusters and the attic in general did not reveal any neonates. Several small clusters of *Eptesicus* with neonates contained one to several pregnant *Tadarida*. Thirty-six pregnant *Tadarida* had an average mass of 16.1 g (15.0–19.0). Temperature and relative humidity in the attic were 35.5°C and 48%, respectively. Unlike observations by LaVal (1973) in Louisiana, and mentioned elsewhere in this document, we did not observe clusters of *Tadarida* hanging from open areas in the attic at the Conway site.

On 10 June, the majority of females were pregnant. Clusters of females previously described were intact, although more bats appeared to have moved into the airspace between brick walls. Females were more active on this day and attempted to retreat when a light was shown on them. Many females were visually examined with 28 weighed. Average mass was 17.1 g (15.0-19.0). Three lactating bats were examined and had masses of 12.5, 12.8, and 13.5 g. The heavy mass of some females may have been due to our early morning (0730 hrs) visit and the likelihood their stomachs contained insect foods from pre-dawn foraging activities.

Neonates were first observed on this date when a male and female, both with umbilicus and placenta still attached and moist, were removed from a crevice containing a portion of the cluster that had contained the lactating females (Fig. 5). Sherman (1937) noted that the placenta remained attached to young by the cord from 8 hours to 2 days. The male had a mass of 3.0 g and a length of LFA of 17.8 mm. The female, her stomach distended with milk, had a mass of 3.5 g and a length of LFA of 17.7 mm.

A few adult males were present in the colony site, but remained segregated from females, roosting individually or in small groups with male *Eptesicus*. On rare occasions, individual males were present in clusters of pregnant bats. Six adult males were examined and had an average mass of 13.9 g (13.0–14.8). Although exact ratios were not determined, females greatly outnumbered males. LaVal (1973) found females to outnumber males on all occasions

Fig. 5. Neonate with placenta and umbilicus attached.

by as much as a 5:1 ratio.

We returned the next day (11 June) and examined 10 females from a cluster. Nine were pregnant with an average mass of 15.4 g (14.5–17.3), considerably less (1.7 g) than those weighed the previous day. The remaining female weighed 11.8 g, and was not pregnant nor lactating. Only one additional newborn with umbilicus attached was observed. The male neonate had a mass of 3.0 g and a length of LFA of 17.7 mm.

One week later, on 18 June, we arrived at 0845 hrs to find the colony active and noisy. Pregnant bats and those having already given birth were segregated into different clusters, although a few pregnant individuals were observed in clusters with lactating females and their young. We observed an estimated 1,000 juvenile *Tadarida* ranging in age from several days to those recently born evidenced by the presence of attached umbilicae and placentae that were still moist and pliable. A majority of newborns appeared to be only hours old. About 50% of females had given birth by this date. LaVal (1973) reported about 50% of females in his study had given birth by 4 June. In Oklahoma, young were born during the latter part of June and the first part of July (Glass, 1958; Twente, 1956). Thirteen pregnant bats had an average mass of 16.3 g (14.5–17.5). Fifty-two juveniles (27 females – 25 males) were weighed, examined, and released. All young had been nursing, their stomachs distended with milk clearly visible through their abdominal walls. In both sexes, there was a small group of distinctly older juveniles that had been born several days earlier. The older female newborns (n = 3) had an average mass of 6.6 g (6.0–7.0) and average length of LFA of 23.9 mm (23–24.4), while younger females (n = 24) averaged 4.29 g (3.5–5.3) and 19.6 mm (18.4–21.5). Older juvenile males (n = 3) had an average mass of 6.9 g (6.5–7.3) and length of LFA of 24.9 mm (24.3–25.8). Younger juvenile males (n = 22) averaged 4.2 g (3.5–4.5) and 19.4 mm.

During our visit on 26 June, most adults and all juveniles were in the airspace or deep within crevices where

ceiling beams entered brick walls. Clusters were not observed and areas on brick walls where clusters had occurred were devoid of bats. Whether this action was in response to our weekly visits or a deliberate attempt to take advantage of the cooler temperatures and breeze within the airspace was not known. LaVal (1973) observed similar behavior and indicated the site chosen for the nursery colony by *Tadarida* was especially favorable because it was immediately adjacent to the only opening of a concealed inter-roof space into which females and young could retreat if danger threatened or temperatures were cool. We have observed *Tadarida* selecting similar roost locations within three different colony sites. Interestingly, *Eptesicus* continued to roost in the vaulted area of the attic and in maternity clusters as previously described. Parturition was about 95% complete based on the large number of young seen in recessed areas and in the airspace, and the paucity of observable pregnant bats. Only one 15.0 g pregnant bat was observed in a small group of lactating females. Collection of juveniles was virtually impossible due to the small size of the opening into the air space, large enough to accommodate a human head and one hand holding a light. Hundreds of juveniles were observed with four collected from the surface of mortar between rows of bricks. Masses and lengths of LFA were as follows: males – 4.5 g/22.2 mm, 5.25 g/24.3 mm, 5.5 g/24.2 mm; female – 4.0 g/19.6 mm. The period of parturition for this colony was 10 – 28 June with the majority of young born on or near 18 June.

On 3 July 1983, many adult females were again clustered along the south and west walls. Numerous females were examined with none pregnant. A sample of 20 lactating bats was examined and had an average mass of 14.0 g (13.0–15.3). Mammary tissue was greatly enlarged and copious quantities of milk were easily expressed from elongated teats. The skin area around teats was completely devoid of fur due to nursing activity. Juveniles were not seen in the attic proper, but were observed in previously described inaccessible areas. Juveniles appeared agile and scurried and scampered about the brick surface, retreating farther from the opening when a light was introduced into the airspace. Juveniles were not captured. Observable mortality among juveniles in the open attic area was deemed negligible considering the size of the colony. The carcasses of only 5 individuals were seen atop fresh piles of guano that lay beneath clustering sites along the south and west walls. Juveniles dislodged at these locations would have fallen about 1 meter (m) and could have climbed the wall or been retrieved by their mothers. However, mortality of juveniles within the air space was probably much higher due to the 10 m drop from the attic to ground level. Juveniles falling from this height probably would have died on impact, been difficult to retrieve, and exposed to a variety of insect predators. Three adult male *Tadarida* removed from a cluster of *Eptesicus* had masses of 12.8, 13.3, and 13.5 g.

A colony located in a residence in Little Rock (Pulaski County) was examined on 6 July 1989. Fourteen lactating bats were captured. Three females apparently were entering post-lactation as fur re-growth around teats had begun and the quantity of milk expressed from mammary glands was far less than from other females. These bats had an average mass of 14.0 g (13.0–15.0). Interestingly, exactly 2 years later (6 July 1991), a maternity colony in a home in Hot Springs was examined. Ten adult females and one adult male were captured. All females were lactating and had an average mass of 13.4 g (11.5–14.8). The male had a mass of 12.3 g. *Tadarida* shared this roost with a maternity colony of the evening bat, *Nycticeius humeralis.*

On 13 July 1987, a building in Hot Springs that contained nursery colonies of *Tadarida* and *Eptesicus* was examined. The open area of the attic was unused by either species with both colonies located behind facia boards along the warmer, southern edge of the structure. Both species used the same access point and were seen simultaneously exiting the roost. Of 25 females captured, 24 were lactating. These lactating females had an average mass of 12.0 g (11.0–13.5).

A maternity colony sharing its roost with *Eptesicus* was reported from Hot Springs on 4 August 1989. Both species occupied a small space between a brick veneer wall and concrete blocks in a school building. Fifty-four *Tadarida* were captured as they exited the building to forage. Juveniles were easily distinguished from brown colored adults by their gray fur and generally smaller size and mass. Nine juvenile males had an average mass of 10.6 g (9.3–11.3) and an average length of LFA of 42.7 mm (41.5–43.5), 101% of the adult male average length of LFA, but within the normal range for adult males. Juvenile females (n = 10) had an average mass of 10.3 g (8.8–11.8) and an average length of LFA of 42.2 mm (41–43.8), 99% that of adult females. Post-lactating females (n = 12) had an average mass of 13.3 g (12.0–14.8), while lactating females (n = 15) averaged slightly less at 13.1 g (12.0–14.3). Eight adult males had an average mass of 12.0 g (11.5–13.3).

On 30 August 1987, an additional mixed maternity site for *Tadarida* and *Eptesicus* was discovered in Hot Springs that provided for interesting observations of behavior. A hopper style bat trap (Greenhall, 1982) was erected at the primary roost exit with a bag attached to the bottom to retain captured bats. The trap was erected several hours before sunset and all other known exits previously used by the colony had been thoroughly sealed. After the evening exodus had begun and bats became entrapped in the bag, small "swarms" composed of 10-15 bats would descend on the colony site at 30-45 minute intervals. Members of these swarms repeatedly flew to, landed upon, and crawled about the surface of the bag in apparent response to distress calls from bats within. Observations of similar behavior by red

bats (*Lasiurus borealis*) have been reported by Baker and Ward (1967) and Saugey et al. (1988b, 1989).

An additional observation seemed to indicate the possibility that members of these colonies used multiple roosts. As swarms of bats descended on the building, they attempted to enter the structure by way of previously used, but now sealed, access points. The arrival of bats from other locations attempting to enter this roost structure suggested that small, scattered colonies in the area may have been subunits of larger, freely intermingled populations of *Tadarida* and *Eptesicus*, and that use of multiple roosts a common occurrence. We have documented the use of multiple roosts by *Nycticeius* in the Hot Springs area when bats banded at one location were recovered at later dates from three different homes within the city by Hot Springs Animal Control personnel.

The Conway location was revisited on 5 November 1983. The bats were quiet, exhibited little activity, were cool to the touch, and appeared to be in torpor. Temperature in the attic was 22.2°C with a relative humidity of 52%. Females were clustered on walls in the same locations as when pregnant and lactating in the summer. A sample of 47 females was examined that probably contained a mix of adults and young-of-the-year. Average mass was 17.3 g (14.0–19.8). A single male was found roosting within clusters of females. All other males were found roosting with male *Eptesicus* scattered along ceiling joists throughout the attic. Six males were fat and had an average mass of 16.6 g (14.5–18.5).

On 4 December, the colony was quiet and inactive. The temperature was 16.9°C and the relative humidity was 64%. Females continued to cluster along the south and west walls and in the airspace. Twenty-four females were examined and weighed. Average mass was 14.3 g (13.0–16.0), 3.0 g lighter than the November group. Males exhibited a similarly reduced average mass of 13.9 g (13.0–16.3), 2.7 g lighter than November. Possible causes for such a reduction in average masses may have included a greater percentage of young-of-the-year bats in the December sample, and the extremely cool temperatures from mid-November to early December coupled with a reduced level of building heat. Lowered roost temperatures probably would have required additional energy expenditure by bats. Because bats were not wing-banded, individual loss of mass was impossible to determine.

The last observation at Conway occurred on 5 January 1984. The outside air temperature was –3°C, and, although the temperature in the attic was not recorded, it was well below freezing as evidenced by the accumulation of ice on the interior attic walls. All major sources of heat in the building had been reduced during the holiday break with only small, gas, space-heaters in bathrooms. Examination of a tightly packed cluster of *Tadarida* on the west wall revealed all but one of the 102 individuals frozen. A thorough search of the entire attic produced 20 live *Tadarida* in the air-space between walls. Eight bats, three females and five males, were weighed. Females had masses of 12.8, 14.3, and 14.3 g. Males had masses of 12.3, 13.0, 13.5, with two at 14.0 g each. *Eptesicus* was not observed anywhere in the attic. The building was demolished in summer 1984.

Rabies.--During the study period, a total of 152 specimens of *Tadarida* was submitted to the ADHRL from Arkansas and nearby Texarkana, Texas. This total includes those specimens reported in 1988a (Saugey et al.). Ninety-five females and 57 males have been examined and of these, seven bats (4 males, 3 females) tested positive for rabies and represent 4.6% of submissions. Arkansas counties with rabid specimens included Boone, Clark, Garland (2), and Pulaski (2). The months in which these specimens were submitted were March, April (2), and September (3). The Texarkana, Texas, specimen was a female submitted in June.

Conclusions

All of the colonies of *Tadarida* that occurred in buildings during this study have been excluded, except for the Conway site that was destroyed. The members of this colony were reported to have spread throughout the city of Conway in search of suitable roost locations. One of us (DAS) received many calls during the week following demolition requesting information on what could be done to remove bats roosting directly on exterior surfaces of buildings in full view, in ventilation louvers, and in various types of out-buildings – areas not routinely used by this species during our study. Clearly, suitable alternative roost locations are not always known or readily available to some or all members of a colony, exposing them to additional predation pressures and destruction by humans. And as expected, the original solution to infestation problems proposed by virtually all property owners was unanimous – extermination.

Kiser (2000) observed that continued loss of established roosts through renovation of buildings, bat-proofing, and razing of old buildings (habitat loss), does not bode well for populations of Brazilian free-tailed bats. Bellwood (1992) stated the nature of this species to congregate in large numbers where they may become a nuisance and the relatively few locations in which they occur offer special problems in conservation. Both of these statements are applicable to populations of Brazilian free-tailed bats in Arkansas. *Tadarida* appears to be abundant where older or poorly maintained buildings are readily available, but exclusion, enhanced maintenance, and construction of new buildings using improved methods and materials also are gradually reducing the number of structures available as summer maternity sites and suitable over-wintering quarters.

Fortunately, it is unlikely this species will soon be extirpated from larger metropolitan areas because it is very adaptable and has the ability to exist as large numbers of scattered, small population units as opposed to large populations in few locations. This adaptability may provide the time necessary to educate the public of the beneficial aspects of bats in metropolitan areas, and conduct research to provide suitable roost opportunities in selected areas where human/bat interactions can be reduced.

The distribution of *Tadarida* will undoubtedly change as new location records are discovered through investigations of infestations and monitoring of specimens submitted to the ADHRL. Additional records may also be derived through the use of mist-nets that seem more productive when deployed adjacent to or within urban areas. Close communication with local pest control companies may also afford biologists opportunities to discover new locations and assist in the proper timing of exclusion activities to the benefit of the colony. The investigations of building and bridge infestations offer the greatest opportunities for more complete, long-term studies of *Tadarida* natural history, behavior, and colony dynamics. In all situations, we recommend bats be wing-banded to help facilitate understanding of inter- and intra-colony movements, roost fidelity, and possible migration.

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