A NATURAL HISTORY STUDY OF THE FUNNEL-EARED BAT, NATALUS STRAMINEUS

by

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ABSTRACT

A natural history study was made on the funnel-eared bat, Natalus stramineus, in southern Sonora, Mexico. Topics discussed were taxonomy, ecology, day-shelters, night activities, population dynamics and reproduction.

Findings show N. stramineus are nonmigratory and limited in distribution to a humid tropical environment. Further, findings indicate this species have a reproductive cycle characterized by a gestation period of seven months. A gestation period this long has not been shown among families of bats.

FRONTISPIECE. A Natalus stramineus in the striking red color phase.

(Photograph by Bruce J. Hayward)

INTRODUCTION

The funnel-eared bat, Natalus stramineus, is a member of the monogeneric family, Natalidae. Members of the family are restricted, geographically, to the tropical and subtropical parts of the New World, from northern Brazil northward to southern Sonora, Mexico. Representatives of the family occur on many of the islands in the Caribbean Sea (see Figure 1). As compared to most other kinds of North American Chiroptera, little has been published concerning the bats of this family and the few observations that have been published pertain primarily to gross morphology as related to taxonomy and to geographic distribution of the various species.

This study, conducted on a population near the northern geographic limits of the family, is concerned primarily with the behavior and biological adaptations of the species Natalus stramineus. Some of these adaptations appear to be unique among bats.

Figure 1. Distribution for the bat family Natalidae.


Range of Natalidae
To Minas Gerais, Brazil

TAXONOMY

Bats of the family Natalidae are small and delicately formed, and have distinctly funnel-shaped ears, noticeably elongated legs, and clawed thumbs. All lack adhesive discs either on the thumb or on the sole of the foot. All adult males possess a unique bell-shaped natalid organ that is inconspicuous externally but which covers the entire frontal region of the head. There it is connected by a few strands of fascia to the skin and the underlying muscles. The function of this natalid organ is unknown, but it is thought glandular and /or sensory (Dalquest, 1950).

Phylogentically the family appears to be closely related to the Furipteridae and the Thyropteridae. These three families appear to be phylogenetically intermediate between the family Phyllostomatidae and the family Vespertilionidae. Further, all three families have much the same geographic distribution, each contains only a single genus, and all appear externally similar. Diagnostic differences include the degenerate thumbs in the Furipteridae and the suction discs on the thumbs and sole of the hind feet in Thyropteridae. The relationships of these families are obscure. The Natalidae appear to be more highly specialized than the others in that they possess fused vertebrae

and a more highly developed sternum, but simultaneously appear to be more primitive in the structure of the teeth and thumbs (Miller, 1907).

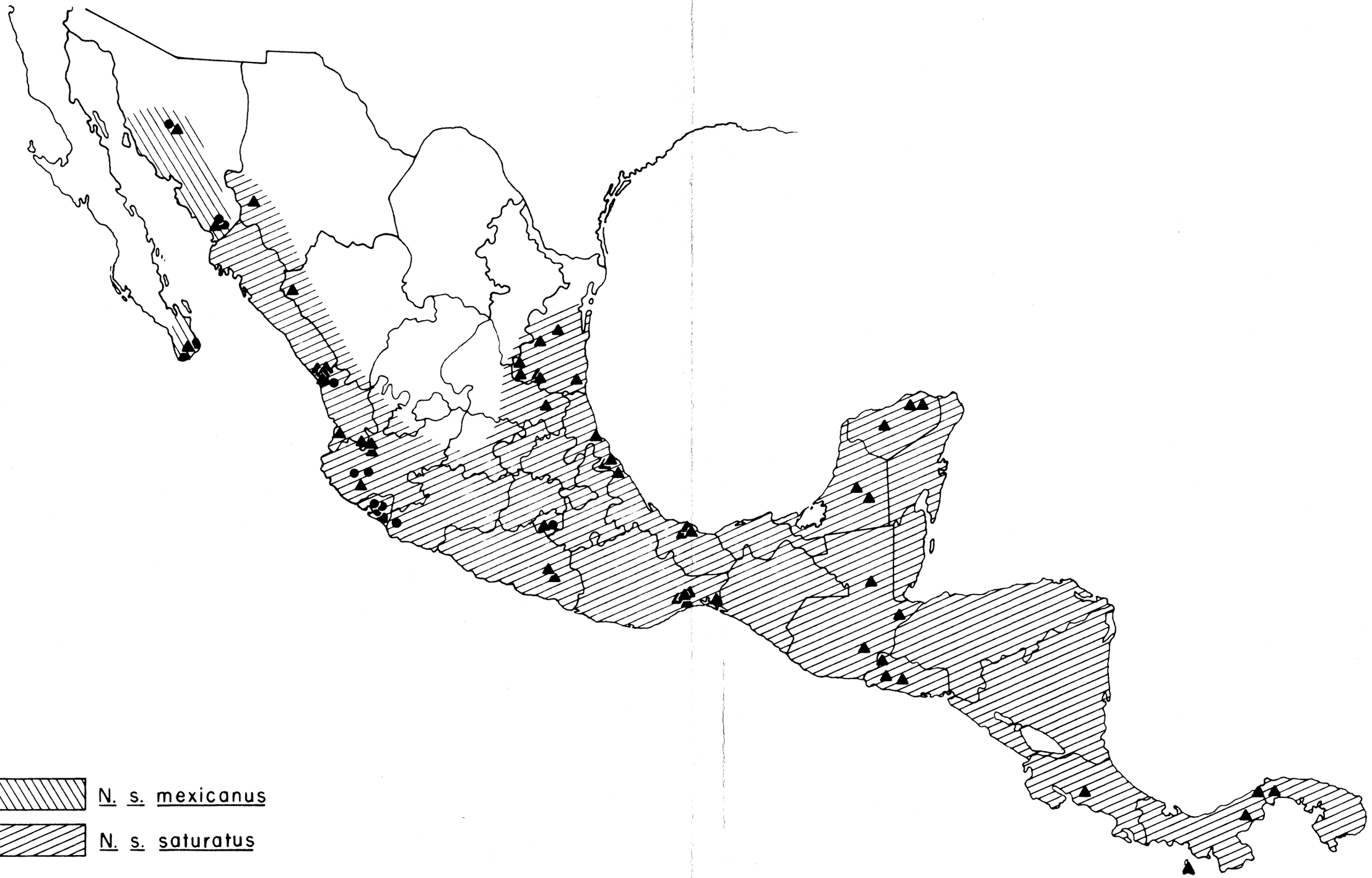
As currently understood, the single genus within the family Natalidae, Natalus, is divisible into three subgenera: Chilonatalus, Nyctiellus, and Natalus. The subgenus Chilonatalus, isolated to the West Indies, includes four species as follows: Natalus (Chilonatalus) brevimanus, only on Old Providence Island, Caribbean Sea; Natalus (Chilonatalus) macer, confined to Cuba; Natalus (Chilonatalus) micropus, only on Jamaica; and Natalus (Chilonatalus) tumidifrons, restricted to Watling Island, Bahamas. The subgenus Nyctiellus contains but a single species, Natalus (Nyctiellus) lepidus which is restricted to the islands of Cuba and the Bahama Islands. The subgenus Natalus includes three species: Natalus (Natalus) major, found in the Dominican Republic and Haiti, as well as on the islands of Jamaica and Cuba; Natalus (Natalus) tumidirostris, on Trinidad, Curacao, and in Venezuela; and Natalus (Natalus) stramineus which occurs from northern Brazil northward to southern Sonora, Mexico. It is the last species of the complex, stramineus, that is of primary concern in the present study.

Goodwin (1959) has recently studied Natalus stramineus and has divided it into four geographic races as follows: Natalus stramineus stramineus, type locality unknown, but probably Antigua, British West Indies, occurring on the islands of the Lesser Antilles; Natalus stramineus natalensis, type locality Natal, Rio Grande de Norte, Brazil, restricted to eastern Brazil from Natal to Lagoa Santa, Minas Gerais; Natalus stramineus saturatus, type locality three km. east of San Andreas Tuxtla, Veracruz, Mexico, ranging from Tamaulipas on the east coast to Nayarit on the west coast of Mexico south to the Canal Zone in Panama; and Natalus stramineus mexicanus, type locality Santa Anita, Baja California, Mexico, and known from Baja California and Sonora, Mexico.

Morphological features used by Goodwin in separating the species into geographic races include size, especially the length of the forearm and cranial measurements, and color. In general, there appears to be a cline of characters, ranging from smaller, lighter populations in the northern part of the range to larger, darker populations in the south.

As shown in Figure 2 two subspecies of Natalus stramineus occur on continental North America. Localities on which this distribution map is based are as follows. Specimens from localities designated by an asterisk are found in the University of Arizona collection.

Figure 2. Distribution for subspecies of Natalus stramineus found in Mexico and Central America.



N. s. mexicanus

N. s. saturatus

▲ Literature reports

● University of Arizona collection

Natualus stramineus mexicanus Miller

BAJA CALIFORNIA: Las Cuevas (6F, May 24, Cockrum, 1955); Santa Anita (2, Miller, 1902); San Jose del Cabo (3, Miller, 1902).

SONORA: La Aduana, 5 mi. W Alamos (2F, May 15, Cockrum, 1955); *La Aduana, 5 mi. W Alamos (1M, Nov. 5, 1956; 2M, 6F, Dec. 20, 1957; 2F, April 9, 1958; 2F, March 29, 1959; 1F, April 22, 1960; 18M, 26F, Jan. 27, 1964); *Minas Armolillo, 5 mi. NNW Alamos, 2 mi. S Piedras Verdes (4M, 4F, Nov. 2, 1963; 1M, 4F, June 16, 1964; 5F, June 29, 1964; 12M, 4F, Aug. 24, 1964; 3M, Aug. 27, 1964); Cueva El Tigre, 14.9 mi. SSE Carbo (1M, Dec. 20, 1957; 1M, Feb. 16, 1958; 1, April 11, 1958; 1F, Nov. 6, 1959, Cockrum and Bradshaw, 1963); Tesia (1M, 3?, Goodwin, 1959); 13 mi. SW Ures (2M, Dec. 28, 1951, Broadbooks, 1961).

Natalus stramineus saturatus Dalquest and Hall

CAMPECHE: Apazote (=Apozote?) (1, Miller, 1902); La Tuxpena (2, Dalquest and Hall, 1946).

CHIHUAHUA: Mojarachic (=Maguarichic?) (1, Knobloch, 1942).

COLIMA: *Rancho Tavernillas, 35 km. NW Puebla Juarez (4M, 1F, April 5, 1962); *Tecoman (2M, Sept. 12, 1959); *Cueva de la Fabrica, 4 mi. S Coquimatlan (13M, 7F, Oct. date?, 1961); *Rancho Nuevo (1F, July 12, 1964).

DURANGO: Chacalor (25, Miller, 1902).

GUERRERO: 4 mi. N Colotlipa (2, Lukens and Davis, 1957); Acahuizotla (5, Lukens and Davis, 1957).

JALISCO: *Mina del Baladero, 3 km. NW Talpa de allende (1F, Jan. 19, 1964); Ameca (17, Miller, 1902); Itzatlan (=Etzatlan?) (1, Miller, 1902); 5 mi. S, 1 mi. E El Arado (1, Hall and Kelson, 1949); *Cueva de las Garrochas, Soyatlandel Ore (8F, Dec. 23, 1963); (Mina Hedionda, 30 km. W Rancho de los Ocoles (2M, 2F, March 17, 1964).

MICHOACAN: *Laqunita (5M, Feb. 17, 1962).

MORELOS: Tequesquitengo (1M, 3F, Goodwin, 1959); *Tetecalita (1F, Aug. 27, 1961).

NAYARIT: Amatlan de Canas (9M, Goodwin, 1959); 6 mi. SSE Las Varas (1, Hall and Kelson, 1949); *Huajicori 1F, May 29, 1963; 1M, 3F, Nov. 5, 1963).

OAXACA: Basilano (=Bisilana?) (1M, Goodwin, 1959); El Salado (3M, Goodwin, 1959); Guingola (=Guiengola?) (3M, 2F, Dec. 22, 1950, Goodwin, 1959); San Antonio (2M, 3F, Dec. 15, 1953, Goodwin, 1959); Tapanatepec (1M, Goodwin, 1959); Tehuantepec (1F, May 23, 1957, Goodwin, 1959).

SAN LUIS POTOSI: Rancho Nacimiento del Rio Coy, 16 mi. S Valles (150 caught, Constantine, 1958).

TAMAULIPAS: Sierra de Tamaulipas, 14 mi. W, 3 mi. S Piedra (2, June 12, 1953, Anderson, 1956); Cuevo el Pachon, 5 mi. N Antiguo Morelos (22, July 2, 1951, Martin, M. and P.S., 1954); Cueva de la Esperanza 6 km. SW Rancho Santa Rosa (20, Alvarez, 1963); 6.5 mi. N, 13 mi. W Jimenez (14, Alvarez, 1963); 3 mi. S, 16 mi. W Piedra (7, Alvarez, 1963); 3 mi. S, 14 mi. W Piedra (2, Alvarez, 1963); 20 mi. N, 3 km. W El Mante (20, Alvarez, 1963); Ejido Ojo de Agia (20, Alvarez, 1963); 8 km. NE Antihuo Morelos (1, Alvarez, 1963).

VERACRUZ: 3 km. E San Andreas Tuxtla (88, Dalquest and Hall, 1949); San Andreas Tuxtla (1, Dalquest and Hall, 1949); Jalapa (73, Ward, 1904); Mirador (2, Miller, 1902); Tilapa (1, Sumichrast, 1882); 14 km. NW Tuxpan (10, Hall and Dalquest, 1963); 13 km. WNW Potrero (10, Hall and Dalquest, 1963); 4 km. WNW Fortin, (1, Hall and Dalquest, 1963);

YUCATAN: Balaan Canche Cave, Chichen (9, Pearse, 1938); Hoctun Cave, Hoctun (1M, July 7, 1936, Pearse, 1938); Muruztun Cave, Tiziman (1M, Aug. 12, 1936, Pearse, 1938).

COSTA RICA: Anguilla (3, Goodwin, 1946).

EL SALVADOR: Dept. Santa Ana: Laguna de Guija and Finca El Narne (1953, Felten, 1957); Dept. La Libertad: Cueva Hedionda and Hacienda San Diego (1953, Felten, 1957); Dept. Morazan: Hacienda Santa Rosa and Mineral Los Encuentros (1954, Felten, 1957).

GUATEMALA: 2 mi. S Flores, Peten (8, Goodwin, 1955); El Progresso (6, Goodwin, 1959); Morelos (reported, Miller, 1907).

PANAMA: Coiba Island (1, June 1, 1900 or 1901, Allen, J.A., 1904); Fort San Lorenzo (14F, April 7, 1953, Bloedel, 1955); Chibibrillo Cave, 10 mi. N Pedro Miguel (1, Hall and Jackson, 1953); Penonome (5, Allen, G.M., 1935).

As indicated by Goodwin (op. cit.), Natalus stramineus mexicanus differs from Natalus stramineus saturatus in that it is smaller in size and is generally lighter in color. Table 1, a tabulation of measurements recorded in the literature and measurements taken during this study, shows that a cline is visible when comparing cranial measurements with N. s. saturatus averaging larger. In comparing hair coloration a marked separation of races is not as clearly evident. Several authors (Felten, 1957; Lukens and Davis, 1957; and Alvarez, 1963) have observed that hair coloration in populations which corresponded to Natalus stramineus saturatus in measurements more closely resembled N. s. mexicanus. The population near Alamos also shows an intergradation of colors, but more closely corresponds to Natalus stramineus mexicanus in measurements. It might be pointed out that marked fading of hair color is observed when comparing the same animal in the field with its skin in the museum.

TABLE 1. Cranial measurements for samples of Natalus stramineus from various localities in their range. The top figure for each measurement is the mean in millimeters. The figures in parenthesis are extremes. Standard deviations are given for the measurements from the present study. Abbreviations are: GLS, greatest length of skull; ZB, zygomatic breadth; BBC, breadth of brain case; LIC, least interorbital constriction; Max B, maxillary breadth at third molar; M, male; F, female.

Locality	N	GLS	ZB	BBC	LIC	Max B	Reference
Near Alamos, Sonora, Mexico	M 40	15.53±.60 (15.2-15.9)	7.89±.47 (7.6-8.2)	7.80±.34 (7.6-8.0)	3.04±.26 (2.9-3.2)	5.25±.29 (5.1-5.4)	Present Study
" "	F 40	15.40±.97 (14.9-16.1)	7.81±.48 (7.6-8.0)	7.70±.34 (7.5-7.9)	3.06±.19 (3.0-3.2)	5.19±.32 (5.0-5.4)	"
Tesia, Sonora, Mexico	M 1	16.0	7.8	7.8	3.2	5.3	Goodwin, 1959
Santa Anita Baja Calif., Mexico	F 7	15.9 (15.3-16.1)	7.9 (7.7-8.0)	7.5 (7.3-7.7)	3.25 (3.0-3.4)	5.3 (5.1-5.6)	Goodwin, 1959
Amatlan, Nayarit, Mexico	M 9	16.0 (15.6-16.2)	7.8 (7.5-8.1)	7.8 (7.3-7.8)	3.3 (3.2-3.4)	5.3 (5.0-5.4)	Goodwin, 1959
3 Km. E San Andreas Tuxtla, Veracruz, Mexico	F10	16.2 (16.0-16.6)	8.3 (8.1-8.4)	7.7 (7.6-7.9)	3.2 (3.1-3.3)	5.3 (5.1-5.3)	Dalquest and Hall 1949
El Salvador	M10	16.2 (15.9-16.4)	8.3 (8.0-8.7)	7.9 (7.8-8.0)	3.3 (3.1-3.4)	5.5 (5.4-5.6)	Felten, 1957
" "	F 4	16.2 (16.0-16.2)	8.2 (8.0-8.4)	7.9 (7.8-8.0)	3.4 (3.3-3.4)	5.4 (5.3-5.5)	" "

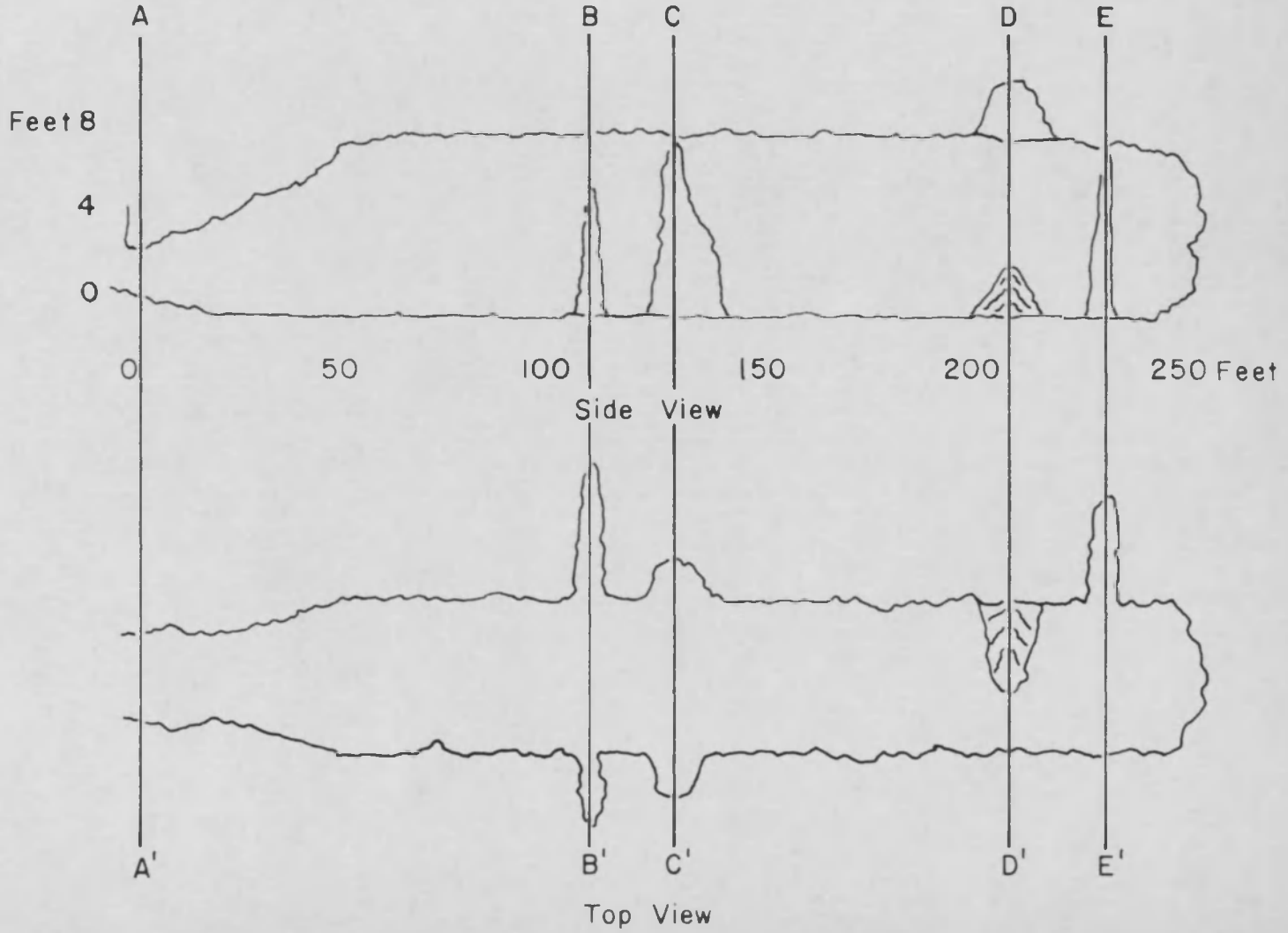
DESCRIPTION OF STUDY AREA

The present study, conducted during 1964, is concerned primarily with the ecology, behavior, and population dynamics of the Natalus stramineus mexicanus in the region of Alamos, Sonora, Mexico; more specifically the population of Minas Armolillo, an abandoned mine 5 mi. NNW Alamos and 2 mi. S. Peidras Verdes.

Southern Sonora is well-known as an area where extensive silver mining has occurred. The height of mining activities in the Alamos area was during the 1800's. All mining operations in the Alamos area ceased in the 1920's. During the period of activity many test tunnels were sunk around Alamos and the hills are literally filled with short tunnels, many of which have since collapsed.

Minas Armolillo was one of these test tunnels and, as Figure 3 shows, it is a horizontal shaft entering the mountain for only 250 feet. The floor, walls, and ceiling are relatively smooth except for the short man-made side tunnels and at the 200 ft. point a portion of the ceiling has fallen creating a small cone and a rock pile on the floor under it. Through the years the mine's approach has filled until one must crawl to gain entrance, though one can stand after the initial 50 feet.

Figure 3. A horizontal outline map of Minas Armolillo, 5 mi. NNW Alamos, 2 mi. S Piedras Verdes, Sonora, Mexico.



Vertical exaggeration 5 X

In the following sections of this thesis a review of pertinent literature of each specific topic is followed by original observations made between January, 1964, and February, 1965, at Minas Armolillo and in the surrounding area.

ECOLOGY

Literature

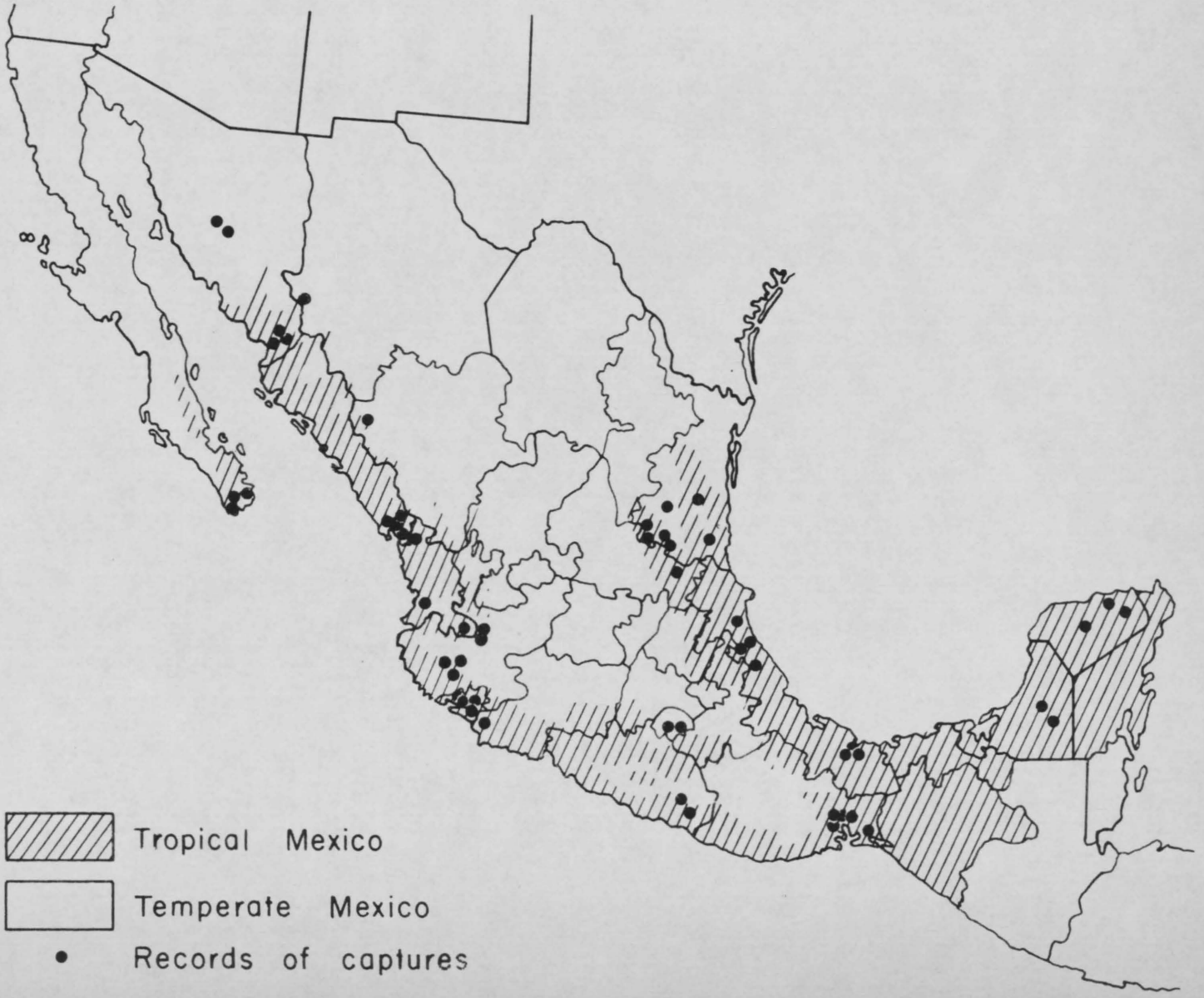
Figure 4 correlates the reported capture data of Natalus stramineus taken in Mexico with Leopold's tropical-temperate climatic divisions of Mexico (1959). With few exceptions distribution occurs only in a low tropical environment. Only Felten (1957) has reported ecological data for N. stramineus. In El Salvador, he always found them within the low dry tropical zone, but the collecting areas differed climatically; those localities in the coastal area were characterized by moist, hot lowland forests. The other collecting locality although in the very dry eastern part of the country receives water from the Rio Grande de San Miguel.

Natalus stramineus has been reported between sea level in a sea cave under Fort San Lorenzo, Panama (Bloedel, 1955) and 5,500 feet at Cerro Ameca, 5 mi. NNW Ameca, Jalisco, Mexico (Cockrum, 1955). The majority of captures have been below 3,000 feet.

Present Study

Minas Armolillo, elevation 1,500 feet, is in the Short-tree Forest, a heterogeneous deciduous forest with a strong infusion of tropical elements. Periods of growth alternate with periods of dormancy

Figure 4. Comparison of tropical-temperate Mexico with capture data for Natalus stramineus.


Tropical Mexico
Temperate Mexico
Records of captures

corresponding to the wet and dry seasons (Gentry, 1942). After the rains commence in late June, the barren trees almost immediately leaf and undergrowth becomes virtually impenetrable. The summer rains continue until late September or early October with little rainfall until the following June. Figure 5, a photograph taken on January 26, 1965, shows the typical habitat at Minas Armolillo during the dry season. In spite of the long dry season in southern Sonora there are permanent streams and water is available from many of the inactive water-filled mines.

Normally the Short-tree Forest receives about 30 inches of rain yearly, most during the summer. Rainfall in the Minas Armolillo area in 1964 was atypical. In Alamos, 3.7 inches were recorded from the first of January to February 17 and between June 24 and October 17, 15.45 inches fell. No other measurable amount was recorded.

Figure 5. Winter habitat at Minas Armolillo, 5 mi. NNW Alamos, 2 mi. S Piedras Verdes, Sonora, Mexico.

DAY-SHELTERS

Literature

Even though natural caves and mine tunnels are reported as the day-shelters used by Natalus stramineus very little descriptive information is available other than that they prefer a dark, damp area of the shelter (Goodwin, 1946; Lukens and Davis, 1957; Felten, 1957; Broadbooks, 1961; Hall and Dalquest, 1963; and Cockrum and Bradshaw, 1963).

Goodwin (1934) reports the only exception to the dark, damp condition of day-shelters: a collection of bats from Progresso, Guatemala, was taken from under an overhanging rock which the collector said "could hardly be called a cave." The degree of illumination and relative humidity were not given.

From Dr. G. G. Goodwin it is learned that T. MacDougall found 5 Natalus stramineus occupying hollow trees as day-shelters from San Antonio, Oaxaca, Mexico. Three were in a hollow guirisina (Cordia elaeagniodes) on December 15, 1953, and two were in a hollow zompante on January 22, 1954; thus these bats may also use hollow trees as day-shelters.

In their day-shelters bats of this species have always been reported as hanging from the roof or sides of the cave or tunnel as individuals or in a loose association (Felten, 1957; and Hall and

Dalquest, 1963). Felten (1957) and Goodwin (1946) considered the capture of N. stramineus as difficult since these bats fly at the slightest disturbance; but Hall and Dalquest (1963) in a capture from Veracruz state that individuals were usually plucked from the wall as they twisted about, watching the light, although on most occasions a few took flight when an observer approached. When those too high to be reached by hand were shot, the others hanging nearby rarely took flight at the sound of the gun.

Other bats found occupying the same day-shelter with Natalus stramineus are Desmodus rotundus, Glossophaga soricina, Mormoops megalophylla, Chilonycterus rubiginosa, Pteronotus davyi, Carollia perspicillata, and Artibeus hirsutus (Ward, 1904; Lukens and Davis, 1957; Constantine, 1958; Alvarez, 1963; and Hall and Dalquest, 1963). The only described relationship of this species with other bats in its day-shelter was an unusual association between a male Carollia perspicillata and a female stramineus reported by Hall and Dalquest (1963). The stramineus was a single found in a cave occupied by a colony of C. perspicillata and was hanging with the one male Carollia separate from the others. When disturbed enough to cause them to fly, they flew simultaneously and then hung up together.

Present Study

As previously stated, Minas Armolillo is a short mine tunnel some 250 feet long (Figure 3). Air temperature and relative humidity were measured in Minas Armolillo with a Bendix Hygrothermograph (Friez Inst. Div., Bendix Aviation Corp., Baltimore, Md.) on February 29, April 16, and June 16, 1964. These measurements were taken at a point 200 feet from the entrance. On all three dates the air temperature remained a constant 81°F. for the 24 hour periods. The relative humidity on February 29 remained a constant 84 per cent except at night when it was between 81 and 84 per cent due to turbulence with the bats flight activity. On April 16 the relative humidity remained at the 82 per cent level, but on June 16 the humidity had dropped to a constant 74 per cent. Whether this drop in humidity is normal during the year, coinciding with the dry season, or whether it dropped during 1964 when the rainfall was some 12 inches below normal, is unknown. However, with the drop in humidity a noticeable reduction in the population of N. stramineus was observed.

When removed from Minas Armolillo natalids demonstrated very low tolerance to desiccation. At 10:00 A.M. on February 29, 1964, the relative humidity at the mine's entrance was 65 per cent compared to 84 per cent at the 200 foot point in the mine. Most of the bats removed from the mine at this time expired within an hour even though sheltered from the sun. Novick (1964) found he could keep bats of this

species alive in the laboratory only by placing their cage under a dripping faucet. This low desiccation tolerance has made laboratory experimentation on the species virtually impossible.

Adult natalids were never observed in Minas Armolillo before reaching the 125 foot point (Figure 3). From this point to the end of the mine they were found hanging from the walls and ceiling with two to three inches between individuals. Adults were hanging at least five feet from the floor. No observable change in humidity or temperature in this area of the mine to points closer to the entrance was noticed, but less illumination was found in the last 125 feet and other bats using Minas Armolillo as a day-shelter almost always occupied the initial 125 feet.

Table 2 gives estimated populations of bats using Minas Armolillo as a day-shelter during 1964. Three species, Leptonycteris nivalis, Glossophaga soricina, and Natalus stramineus were found occupying the mine during each visit, but their populations varied with the season. L. nivalis and G. soricina reached their maximum in numbers in the summer months with the 1,000 nivalis on June 29, the population containing many young. Natalus stramineus had a small population during the summer months and reached its maximum of approximately 1,000 from November to May. Macrotus waterhousii was the only other species found in the mine during most of the year. This species maintains a small population during the fall, increases in

TABLE 2. Monthly population estimates of bats found in Minas Armolillo, 5 mi. NNW Alamos, 2 mi. S Piedras Verdes, Sonora, Mexico. The male and female columns are numbers of each sex found in a random sample of 50 adult Natalus stramineus taken on each date. Question marks indicate presence but no estimate of numbers was made.

Date	*Leptonycteris nivalis*	*Glossophaga soricina*	*Macrotus waterhousii*	*Chilonycteris parnelli*	*Myotis velifer*	*Pteronotus davyi*	*Natalus stramineus*	Males	Females
Jan. 27, 1964	50	100	100	?	0	0	1,000	22	28
Feb. 29, 1964	50	100	100	20	0	0	1,000	23	27
April 16, 1964	100	300	500	20	0	0	1,000	25	25
May 31, 1964	100	?	50	20	0	20	300	28	22
June 16, 1964	?	?	0	0	0	0	300	20	30
June 29, 1964	1,000	200	0	0	0	0	200	24	26
July 20, 1964	?	?	0	0	0	0	200	28	22
Aug. 7, 1964	100	200	10	0	200	0	200	24	26
Aug. 24, 1964	10	50	10	0	200	0	500	20	30
Nov. 27, 1964	?	50	10	10	0	0	1,000	24	26

numbers in the spring, and is absent in summer. The other species, Chilonycteris parnelli, Myotis velifer and Pteronotus davyi occupied the mine only briefly during the year. Myotis velifer was found in the mine only during August and testicles of males were scrotal on these dates. Though other bats were always found in the mine on each visit, no gregariousness was demonstrated by Natalus, which preferred to stay in the area where few other species were found.

Each time that we visited Minas Armolillo during the day our first passing through the mine found the natalids quite timid. Even when a light was directly shone on one, it would twist and appear irritated for several seconds before releasing from the wall or ceiling, dropping a few inches and taking flight. This timidity was lost quite rapidly and on our following passes through the tunnel it was impossible to get within 10 feet of a Natalus before it would take flight. Once a bat was in flight its capture with hand net was difficult even though the mine is quite narrow. Members of this species are excellent fliers and even when capture appears inevitable they manage to elude the net.

NOCTURNAL ACTIVITIES

Literature

Very little has been reported on the night activities of this species. In an abandoned mine near Ures, Sonora, a N. stramineus was observed leaving at deep dusk, about 6 P. M., then flying back into the mine. No individuals were taken leaving the mine, but two were caught trying to enter the mine, one at 7:00 P. M. and another at 9:00 P. M. (Broadbooks, 1961). Martin and Martin (1954) caught 22 N. stramineus, within an hour's time after dusk, trying to enter a cave in Tamaulipas; the cave had a pool, one of the few sources of water in the region. Constantine (1958) captured 150 N. stramineus in a bat trap as they were leaving a cave in San Luis Potosi. The trap was left erected from 5:30 P. M. to 11:30 P. M. and the natalids captured between 9:00 and 11:30.

Felten (1957) gives the only observation of N. stramineus using a night roost. Two were observed in a water pipe under a railroad bank at night, but were never observed there during the day.

Hall and Dalquest (1963) recorded finding one individual of this species in a cave at night where, reportedly, it had retired after the evening hunt with its stomach crammed with insect remains.

Present Study

On four different occasions in 1964 (January 27, February 29, April 16, and August 24) the evening flight was observed at Minas Armolillo and in each case the same pattern was followed. Well after dusk, 10 to 15 minutes prior to total darkness, the natalids began their flight. Characteristically, one bat left the mine, circled and re-entered, then in a minute's time the flight began, lasting for approximately 10 minutes. On January 27 I entered the mine just following the flight and only one Natalus remained out of the estimated 1,000 population.

Upon leaving the mine the bats circled and darted in and around the trees and surrounding cacti rather than immediately leaving the vicinity of the mine. Undoubtedly they were feeding on the insects available close by.

No bats were observed reentering the mine prior to two hours after the initial flight, but after this time their activity increased with movement in and out and continued for the remainder of the night. All the natalids returned to the mine shortly after the sky began to lighten with dawn.

On February 29, 1964, I entered the mine at early dusk to observe activity prior to the evening flight. Virtually all the natalids were quite active with many leaving upon my entrance. Rather than starting their foraging at this time some reentered, but many hung in

the trees and cacti nearby until the night darkened.

Each time Minas Armolillo was visited the swimming pool at Las Delicias in Alamos was mist-netted for bats. Although several Natalus were observed dipping for water at night, especially during the dry season, few were captured. Even when two nets were set the bats still avoided collision with the nets, showing their agility of flight by sharply dropping at almost a 45 degree angle then ascending in as sharp an angle. On the few occasions when they did hit the net, they almost immediately flew off without becoming entangled. It was always completely dark before any Natalus were observed over the pool.

POPULATION DYNAMICS

Literature

Four estimates have been made of populations of N. stramineus in their day-shelters. Goodwin (1946) found only 3 individuals in a cave at Anguilla, Costa Rica, but the date of capture was not given. Alvarez (1963) reported 400 individuals of this species from Cueva La Esperanza, near Rancho Santa Rosa, Tamaulipas, Mexico, and Bloedel (1955) reported what he thought to be a large maternity colony in Panama on April 7, 1953, as no males were captured and all 15 females examined were gravid. Hall and Dalquest (1963) found the N. stramineus population at a cave near San Andreas Tuxtla, Veracruz, to vary greatly from day to day, reaching a low point of two bats on January 2, 1948, and a high of about 300 on January 10, 1949.

Present Study

On each date which Minas Armolillo was visited in 1964 estimates were made of the Natalus population. Table 2 shows the mine maintained a population of around 1,000 from November through April, but in May a marked reduction occurred and only 200 individuals occupied the mine throughout the summer. These population fluctuations were not daily occurrences as the mine was visited on subsequent days during each trip to the area.

On February 29, 1964, one hundred adult N. stramineus (56 males, 44 females) were banded and released at Minas Armolillo. Normally a band is placed on a bat's forearm, but since these bats are so small the band was placed on the upper arm for fear the forearm banding would interfere with flying. Banded individuals did not seem to be hindered and no scar tissue developed where the band was placed.

After the initial banding date, an estimated 20 banded bats were observed each time the mine was visited. All the banded ones present on a given date were not recaptured because of difficulties in capturing and fear of injury to the bat. In six instances banded bats were killed during capture.

On April 18, 1964, 7 males and 4 females were recovered from those originally banded; June 16, 4 males and 6 females; July 20, 3 males; August 7, 1 male; August 24, 3 males, 2 females; January 26, 1965, 7 males, 6 females; and February 26, 1965, 2 males, 2 females. In all, 35 of the original 100 were recovered sometime during the year's study, 25 were found once, 7 twice and 3 were recovered three times. On January 26, 1965, 13 recoveries were made, with 6 of these recovered for the first time since the banding date of February 29, 1964.

On August 27, 1964, a banded bat was killed, for no apparent reason, by a Mexican guide who had led another University of Arizona student to Minas Armolillo. Just how many died in this manner is unknown but it was observed that the mine had been entered by others

after each of our visits.

Located 5 miles west of Alamos and approximately 2 miles south of Minas Armolillo are La Aduana and Yeger Mines, less than one-half mile apart and, typical of inactive mines in the area, partially filled with water. La Aduana Mine is a day roost of natalids throughout the year, but Yeger Mine, which appears to be quite similar, is used only in the summer months by this species. Yeger Mine is the day roost of a small colony of vampire bats, Desmodus rotundus, and Natalus may avoid using the mine for a permanent colony because of them. However, in other areas, the two species have been taken from the same cave (Alvarez, 1963; and Hall and Dalquest, 1963).

La Aduana and Yeger Mines were visited by me each date that Minas Armolillo was visited. From April to July, during the dry season, I found natalids in Yeger Mine, but they were not present on other dates, and during the same period the population at La Aduana Mine increased. Though all the banded N. stramineus were never observed at Minas Armolillo on any one date, no banded individuals were observed in La Aduana or Yeger Mines except during the summer when the population at Minas Armolillo dropped. As previously stated the decrease in population at Minas Armolillo coincided with a decrease in relative humidity. On June 29 banded individuals were observed in both La Aduana and Yeger Mines and on July 19 only in La Aduana.

REPRODUCTION

Literature

Very little has been published about reproduction in the Natalidae. Only two references are made to the male cycle: one reports small testes in January (Hall and Dalquest, 1963) and the other gives testicular measurements from December being 2 mm. long and 1 mm. wide (Broadbooks, 1961). Data concerning the female cycle are equally scanty. Felten (1957) found pregnant females on January 4, but Hall and Dalquest (1963) reported that females taken in early January were non-pregnant. Cockrum (1955 and 1963) reported gravid females taken in March, April, May and June. Bloedel (1955) also reported gravid females taken in April.

Present Study, Male

Members of the family Natalidae have very small testes. During the height of the breeding season, December and January, the largest testes I measured were only 2.4 mm. long and 1.5 mm. wide.

During the breeding season the testes are not scrotal, but lie slightly lateral and anterior to the penis on the pubic crest. During the inactive period they lie one to two mm. lateral to this position. Table 3 lists testicular measurements from Natalus taken during the winter

TABLE 3. Comparisons of testes size and quantity of sperm present from winter samples of Natalus stramineus. Measurements are in millimeters: length by width.

Locality	N	Date	Measurements	Quantity of sperm present	Source
Cueva de La Fabrica 4 mi. S Coquimatlan, Colima, Mexico	1	Oct. ?, 1961	1.7 x 0.8	?	Alcoholic
Minas Armolillo	1	Nov. 27, 1964	2.0 x 1.0	many	Present study
Ures, Sonora	1	Dec. 28, 1951	2.0 x 1.0	?	Broadbooks, 1961
Minas Armolillo	1	Jan. 27, 1964	2.4 x 1.5	many	Present study
Minas Armolillo	1	April 18, 1964	2.1 x 1.3	many	Present study
La Aduana Mine 5 mi. W Alamos, Son., Mexico	1	May 4, 1957	1.6 x 1.0	?	Alcoholic
Minas Armolillo	1	June 16, 1964	1.0 x 0.7	none	Present study

and spring months. From June to October the testes are so small that identification is extremely difficult, even with a dissection microscope, and measurements practically impossible. In October they begin increasing in size and the epididymides become clearly visible. Unfortunately testicular smears were not made during the fall months (August, September and October) so degree of spermatogenesis for these months is unknown. From October through January there is a marked increase in testes size and in the quantity of sperm present. The largest observed were measured on January 27. After this date the size of the testes and quantity of sperm present decreased. By June 16 no sperm were found and the epididymides were not visible.

Present Study, Female

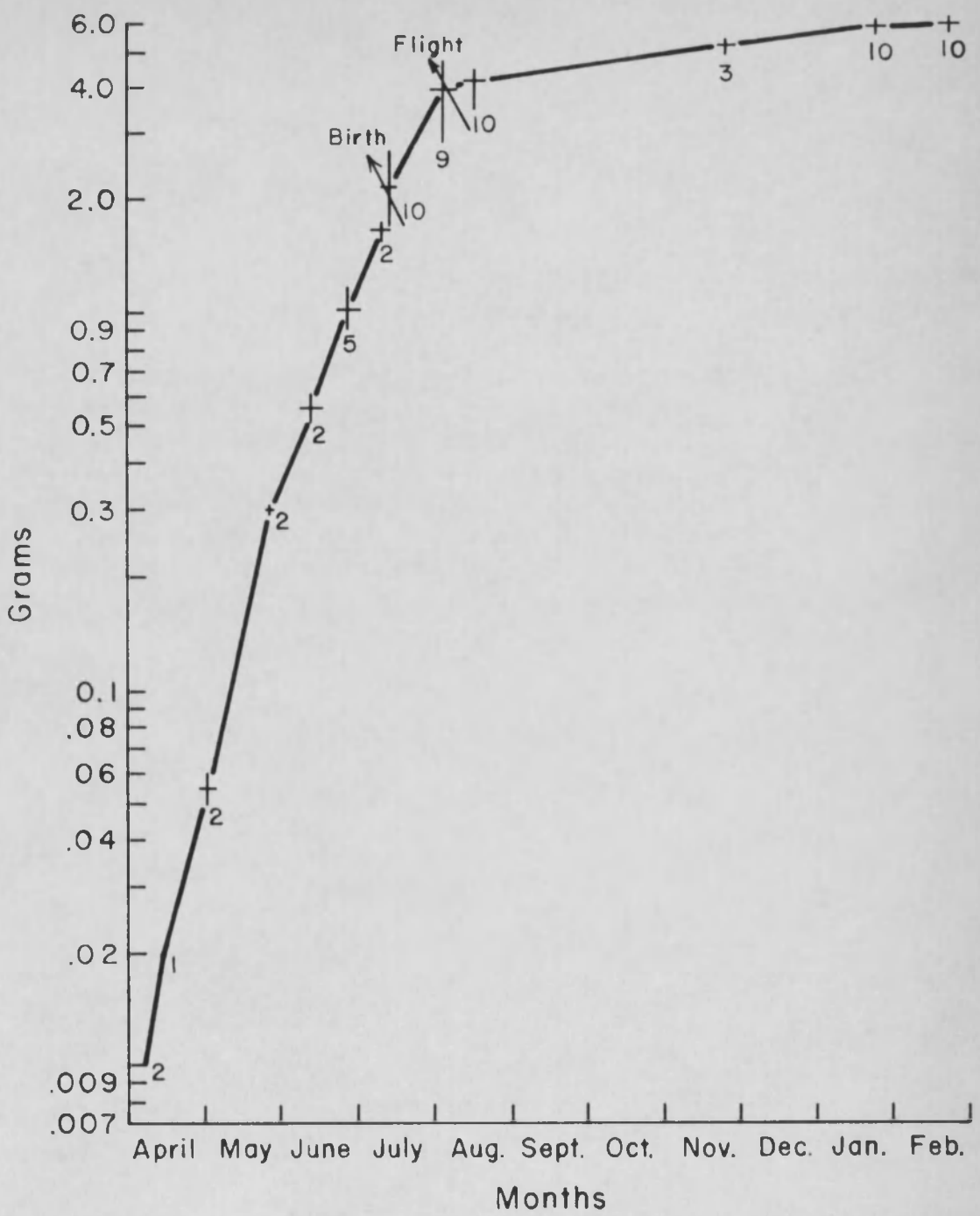
In the onset of this study, it was thought that the Natalidae had a long gestation period. With the males at the height of spermatogenesis in December and January and embryos only reported from January through early June, it was postulated that June was the month of parturition. After collecting reproductive tracts and embryo data throughout 1964 it was found that these bats are monestrus mammals and that they have the longest gestation period reported for any family of bats. Implantation occurs in December or early January and parturition is in late July or early August; a gestation period of some seven months.

With spermatogenesis at its height in December and January it was assumed that fertilization and implantation also took place during these months. Five reproductive tracts taken from adult females on November 27, 1964, were sectioned and none proved to be pregnant. Unfortunately no reproductive tracts were taken in December or early January but examination of reproductive tracts of ten females taken January 27, 1964, showed that all were pregnant; the developing embryo was easily visible in the left horn of the uterus. Each time pregnant females were examined during this study only one embryo per female was found and it was always in the left horn of the uterus.

Present Study, Embryonic

In utero development from implantation through early April is quite slow. Reproductive tracts examined on February 29 showed little embryonic growth. From April, 1964, through February, 1965, embryos and young were collected, weighed, and measured to determine pre- and post-natal development. Weights were taken in grams with a Torsion Balance (Style RX-1, The Torsion Balance Co., Clifton, New Jersey) and forearm measurements were taken in millimeters with calipers. The weights given in Figure 6 are of embryos taken from freshly killed females, with the exception of the early May and early June samples. These two samples are from alcoholic specimens in the University of Arizona collection. Pre- and post-natal forearm

Figure 6. Monthly pre-natal and post-natal development of Natalus stramineus, grams. The embryos and young were collected in 1964 and 1965. Females were pregnant in January, but weighable embryos were not found until April. Parturition is in late July or early August and adult size is reached by late February. The figure under each sample is the sample number. Horizontal lines are means and vertical lines are extremes.


6.0
4.0
2.0
0.9
0.7
0.5
0.3
0.1
.08
06
.04
.02
.009
.007
Grams
Flight
Birth
April
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
Feb.
Months

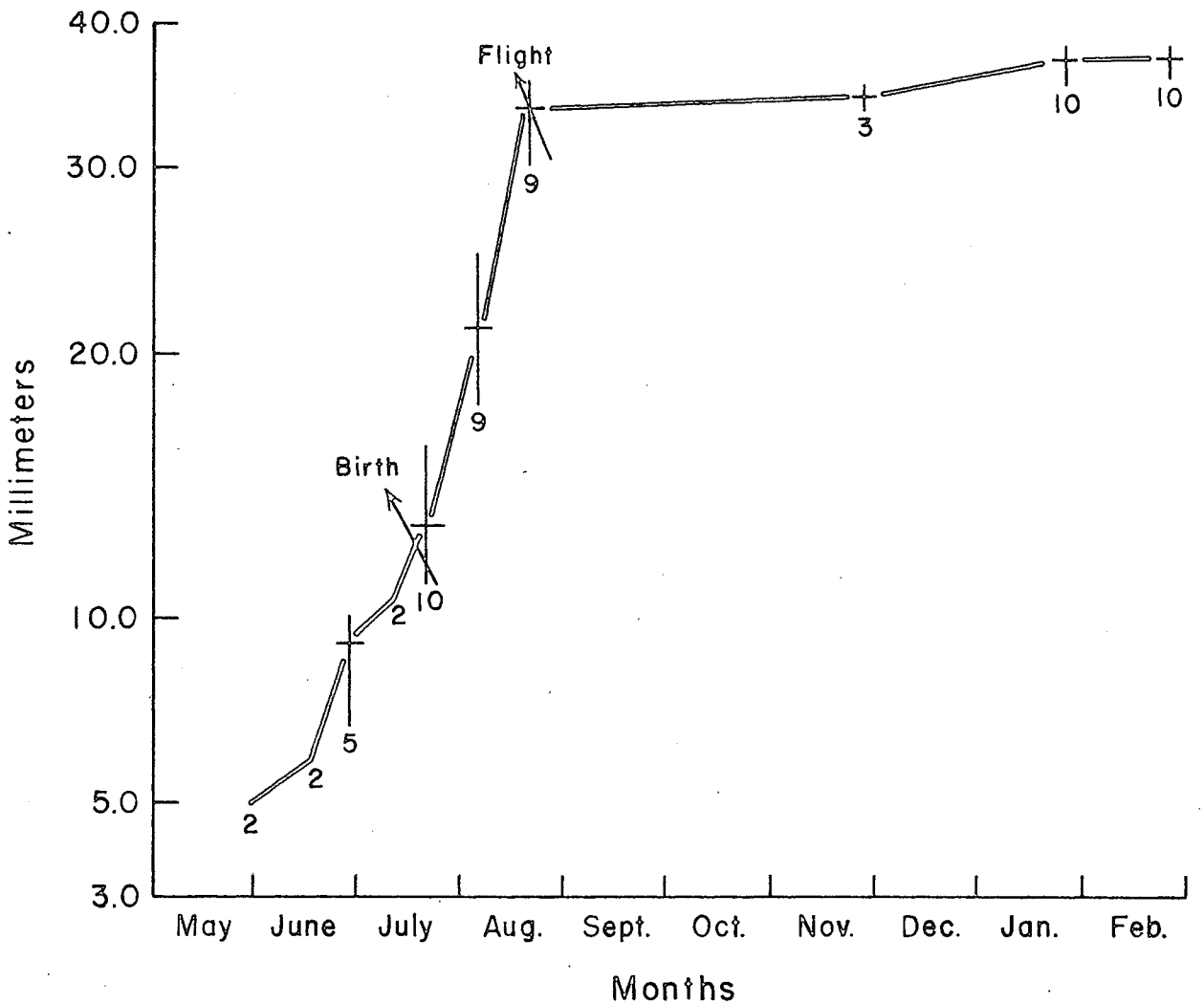
measurements, for those embryos and young weighed, are given in Figure 7. Measureable forearms were not found until the May 31 collection.

By April 8 both anterior and posterior limb buds were well-formed. Each of two embryos taken on this date weighed 0.01 gms. This slow development continued during the next month. One embryo on April 16 weighed 0.02 gms. and two on May 4 averaged 0.055 gms. By May 31 the weight had reached 0.3 gms. and limb and wing membranes were well-formed. Forearm measurements on this date were 5.0 mm. This rapid development continued until parturition.

On June 16 the average weight of two embryos was 0.55 gms. and in the next thirteen days the weight almost doubled, with five embryos taken June 29 averaging 0.99 (extreme weights, 0.9-1.15) gms. Forearm development was equally fast: from 6.0 mm. on June 16 to an average 8.2 (extremes, 7.0-10.0) mm. on June 29.

Gravid females on July 12 flew with difficulty about the mine and tired rapidly. Though no newly born were found, the embryos were quite large, two averaging 1.625 gms. This represents nearly 25 per cent of the adult female's weight when compared with the average weight of 40 females taken on February 29, 1964. The 40 females, weighed between 10:00 A.M. and noon on that date, averaged 6.1 (5.7-6.6) gms.

Figure 7. Monthly pre-natal and post-natal development of Natalus stramineus, forearm measurement in millimeters. Females were pregnant in January but forearms were not measureable until May. Explanations are given for numbers and symbols under Figure 6.


40.0
30.0
20.0
10.0
5.0
3.0
Millimeters
Flight
Birth
2
2
5
2
10
9
9
3
10
10
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
Feb.
Months

Present Study, Post-natal

Shortly after noon on July 20 a cluster of some 50 hairless young was found in Minas Armolillo. It was situated on the wall 60 feet from the entrance and 3 feet above the floor. This is an area in the mine where adults were never found, as adults always occupied the last 125 feet of the mine (see Figure 3). Why a position away from the adults was used for the maternity cluster is unknown, but until the young were able to fly for themselves they were always found at the same location. Development of young in an aggregation separate from the adults has never been shown in bats. Other bats, Myotis velifer, Tadarida, and Leptonycteris, are known to deposit their young collectively prior to the evening's flight, but upon return from foraging remove them from the group. The female and young then remain together until the next forage. When the cluster of young observed was approached, 3 or 4 adult females, which were nursing their young, took flight carrying the young with them. The female only carries her young if disturbed while nursing, as the young weigh over half the weight of the adult. Average weights for 10 young was 2.1 (1.7-2.6) gms. Approximately 50 per cent of the females had given birth on July 20. Two embryos taken averaged 1.425 gms. and when comparing these embryos weights to newly born weights it appears the weight at birth is between 1.45-1.75 gms. Further, when comparing the forearm length for the newly born (mean 13.0, extremes

11.0-16.0 mm.) to that of the embryos (both 11.0 mm.) the embryos are almost as fully developed as the young.

On August 7 nine more young were removed from the cluster. It then contained lightly haired animals with eyes opened as well as blind, naked, individuals. Though the haired young were much advanced they still could not fly. Weights and measurements of nine haired young showed an almost doubling in size from the July sample. The mean weight was 3.9 (2.8-4.4) gms. and mean forearm 22.1 (18-25) mm. Only one gravid female was captured and this was probably an overdue as the embryo weighed 2.6 gms., almost a gram more than the average weight of the newly born examined on July 20.

By August 24 the more advanced, haired young could fly actively in the mine and were hanging separately from the maternity cluster. Most of these advanced young were still nursing, but a few had insect remains in their digestive tracts. All the haired young were uniform in their juvenal pelage: the hair Deep Mouse Gray to Darkish Mouse Gray on the tips and near Smoke Gray basally (color nomenclature after Ridgway, 1912). These bats had increased in size, but not in weight over those measured on August 7. The mean forearm length was 34.3 (34-35) mm., an increase of 11.2 mm. over that of the sample taken on August 7, but the mean weight was 4.15 gms., an increase of only 0.25 gms. This slight increase in weight is probably indicative of the end of the nursing period. No gravid females were

found on this date.

By November 27, the young were subadult in size, with the average weight being 5.1 (4.9-5.3) gms. and the forearm mean length being 34.3 (34-35) mm. Their pelage was more Pale Smoke Gray basally and near Drab at the tips. This lighter pelage was not produced by a molt of the juvenal pelage, but rather the fur had grown longer and become lighter.

On January 25, 1965, the reproductive tracts of 10 young were examined: 4 males and 6 females. None of the females was pregnant and none of the males was undergoing spermatogenesis, thus it appears that the young are not sexually mature in their first year. Growth had continued, but much more slowly than in the first month after birth. Weights averaged 5.8 (5.6-6.0) gms. and the forearms averaged 36.9 (36-38) mm. in length. The pelage remained Drab on the hair tips, but was slightly lighter at the base, a more Light Grayish Olive. On this date 15 subadults were banded in order to follow their development in later months.

On February 26, 1965, the terminal sample was taken from the subadults. By now full adult proportions had been reached and it was difficult to distinguish adult and subadult, though the pelage of the young was still Drab on the tips and Light Grayish Olive at the base. Fortunately most of the young banded on January 25 were still present and a sample was taken. Comparisons were made of the weights

and forearm measurements of 10 subadults taken on this date with 40 adults weighed and measured on February 29, 1964. The subadults weighed 5.9 (5.7-6.2) gms. and forearms averaged 36.9 (35-38) mm. The adults weighed 6.1 (5.7-6.6) gms. and the mean of their forearms was 37.3 (36-39) mm. Within this six to seven month period following birth, the young were near full development.

DISCUSSION

Allen (1939) thought that the three closely related families--Thyropteridae, Furipteridae and Natalidae-- were isolated in South America during parts of the Tertiary and only recently have moved into southern North America. If these families were isolated for such a length of time, certain distinguishing external characters, the elongated legs and increased body membranes, are understandable. Since the bats of all three families are rather small in volume, averaging less than 10.0 gms., elongated legs, with a larger interfemoral membrane, and increased wing-membranes would insure sufficient heat loss in the humid tropics. However, when natalids invaded northern Mexico with its more arid environment, the large surface area and the associated desiccation became a handicap. In such a habitat a decrease in total surface area, and especially wing-membrane areas, would result in less moisture loss and a greater chance for survival. Thus Goodwin's findings (1959) that the northern population of Natalus stramineus has evolved to a smaller race, N. s. mexicanus, is quite logical. This study was conducted on the northern race and many of the observed activities are possibly unique to this subspecies.

With the large surface area for such a small animal, the natalids are definitely controlled in their range and choice of shelters by relative humidity. Those taken in more tropical Mexico were using mines, caves, and hollow trees as day-shelters. The mines and caves were always damp. Hollow trees are used only in the more tropical areas where the relative humidity is constantly high, but in southern Sonora the daily and seasonal fluctuations in precipitation and relative humidity are so great that such habitats probably are not used as day-shelters. In Minas Armolillo, where the present study was conducted, the relative humidity remains high throughout most of the year, but drops somewhat in the summer. This corresponds to fluctuations in the observed population size: about 1,000 during most of the year but only about 200 during the summer.

Bloedel (1955) thought the population he found in Panama in April was a maternity colony as no males were captured and all 15 females examined were gravid. If segregation of the sexes did occur during gestation and parturition, this might account for the low summer population at Minas Armolillo. However, as shown in Table 2, no segregation of sexes was found at any time during the study. After interpreting humidity and banding data it is thought that a humidity drop gave rise to a local migration by most of the population from the mine. The population decreased from 1,000 to 200 from April to June and a drop in humidity in the mine from 82 to 74 per cent

occurred during the same period. Further, bats banded at Minas Armolillo began appearing in mines where they were never observed before--mines which have a permanent high humidity, due to water being present throughout the year. The population at Minas Armolillo did not return to its maximum 1,000 until well after the rainy season was under way. It is not understood what gave rise to the daily fluctuation in the population of Natalus that Hall and Dalquest (1963) found in Veracruz; this was not true for the population in Minas Armolillo.

In their day-shelter, bats of this genus are found hanging separately from the walls and ceiling and remaining isolated from other bats in the same shelter. The association of a female Natalus with a male Carollia perspicillata reported by Hall and Dalquest (1963) is probably atypical behavior. Seldom were any other species of bats found occupying the same area in Minas Armolillo where natalids were taken.

Members of this species are inactive in their day-shelter until dusk, then they become quite active in the mine but do not leave for the evening's foraging until near total darkness. Probably this late flight time is a means of protection, as those with red pelage would be easily identifiable by predators if it were earlier. It is not understood why Constantine (1958) did not catch any Natalus in his bat trap until 9:00 P. M. unless the activity at the cave entrance disrupted the bats

enough to cause a later flight than normal. Findings at Minas Armolillo indicate a late flight time but never this late after dusk. As darkness nears, all the adults leave the day-shelter in unison and forage close by. Rather than flying high above the trees they dart in and around the trees and cacti. Possibly their agility of flight gives them a source of food which is not available to larger bats that need more room to effectively navigate. This low flying, among the trees, also gives added protection from predators.

Although no night roosts were observed in southern Sonora they have been reported by Felten (1957). On February 29, 1964, when Minas Armolillo was entered prior to dusk, many natalids left the mine and hung in the trees and cacti near-by rather than reentering the mine or beginning their nightly foraging. This activity and the failure of all to return to the mine until dawn seems to imply night roosts are also used in southern Sonora.

From the banding data it appears that these bats do not undergo any mass migration and that they do demonstrate some homing tendencies. Since many comparable day-shelters are found in the area it is probable that individuals may use an alternate roost after foraging if it is closer. This could account for the many recoveries for the first time several months after banding.

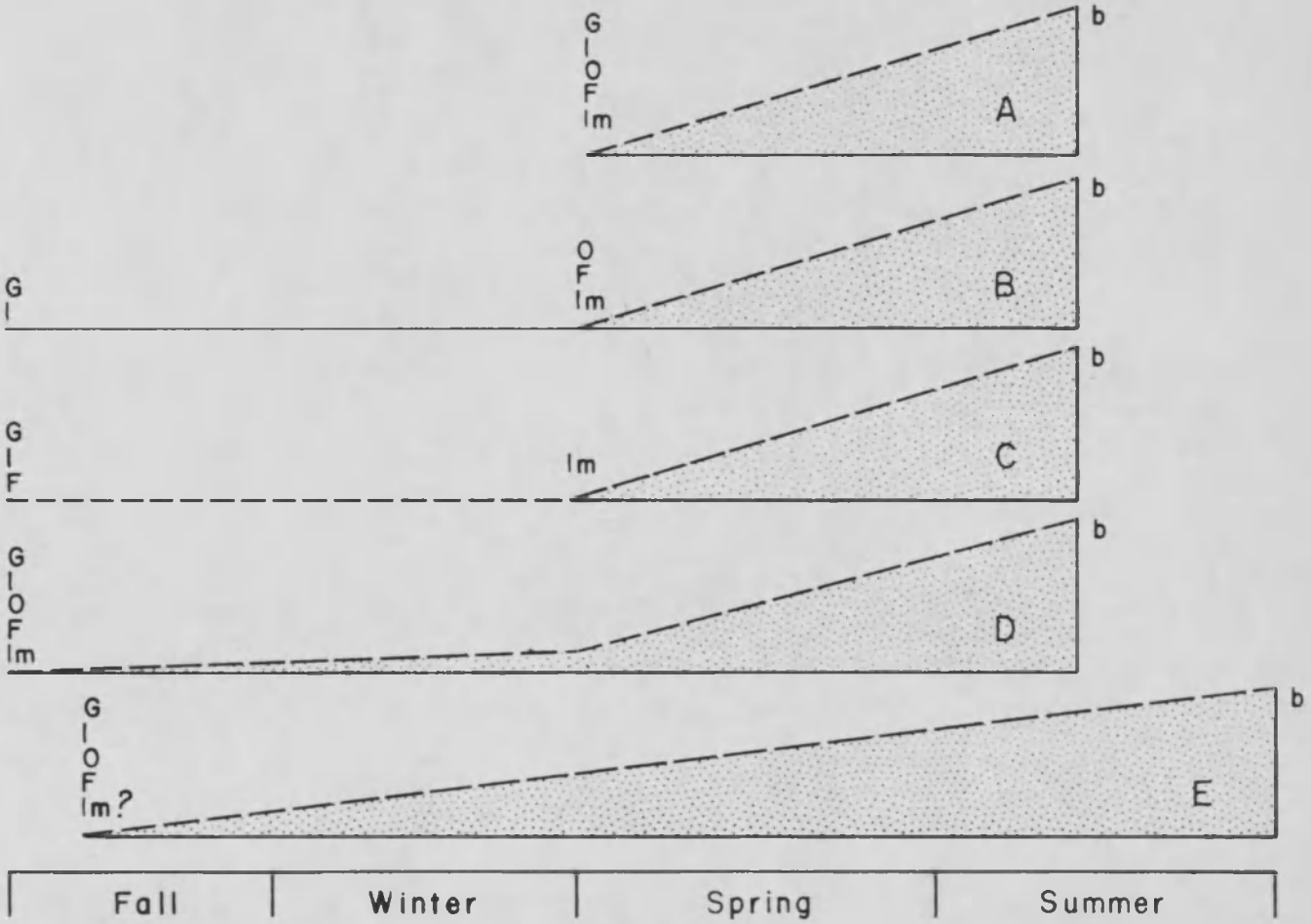
For an organism to fill a niche successfully it must be able to reproduce, and for successful reproduction certain ecological

requirements must be met; the temperature range must be one which is conducive to reproduction and a food supply must be available. The food supply is critical in two respects. It must be sufficient to allow the female to adequately provide food for the developing embryo, and there must be an adequate food supply for the young to develop to the point of survival. If these requirements are not met an animal can not successfully inhabit an area, unless the organism itself adapts. Most animals have adapted their reproductive cycle to their environment. Shown in Figure 8 are five examples of mammalian adaptation of reproductive cycles to environment. The graphs are highly diagrammatic and do not give exact dates of events discussed.

Graph A (Figure 8) represents the reproductive cycle of the members of the family Molossidae and many members of the family Phyllostomatidae. These families show a pattern fairly typical of most placental mammals, in that spermatogenesis and ovulation both occur in early spring, a short time before implantation. Rapid development follows with birth in early summer. The young then develop quite rapidly and can survive a dry or cold season.

Typical Vespertilionidae bats, Graph B (Figure 8) have become adapted for a temperate environment, wherein no food is available during winter months and survival depends on storage of energy, in the form of fat. The metabolic drain of gametogenesis just leaving hibernation in the spring, at which time stored fat has been exhausted, is

Figure 8. A diagrammatic representation of reproductive cycles in five families of mammals. Graph "A" is pattern followed in Molossidae and many Phyllostomatidae. Graph "B" is typical Vespertilionidae development. Graph "C" is followed in Mustelidae. Graph "D" is shown in Macrotus waterhousii and perhaps other members of Phyllostomatidae. Graph "E" is the pattern in Natalidae. Period of growth is indicated by the broken lines. Abbreviations are: I, insemination; G, gametogenesis; O, ovulation; F, fertilization; Im, implantation; b, birth.


G
I
O
F
Im
A
b
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Im
B
b
G
I
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Im
D
b
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I
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F
Im?
E
b
Fall
Winter
Spring
Summer

avoided by having the process of spermatogenesis and oögenesis occurring in late summer or fall of the year, just before the animal enters hibernation. The spermatozoa may survive the winter months in epididymides or within the female accessary ducts, thus insemination may occur in fall, winter, or spring when the female leaves hibernation. Ovulation, fertilization and implantation then occur in the spring after hibernation is over and food is again available. As in the case of Molossidae, growth is rapid and birth occurs in early summer.

Not as yet known among families of bats, but known among carnivores, e.g. Mustelidae, is still another mechanism of placing the metabolic drain of gametogenesis in a different season (Graph C, (Figure 8). This process termed delayed implantation is similar to the pattern seen in Vespertilionidae (Graph B), but differs in that actual ovulation and fertilization occur near the time of gametogenesis. The resulting zygote does not implant at that time, but remains in a relatively inactive state for several weeks. Upon implantation the embryonic growth is rapid and birth is in the spring.

Bradshaw (1962) discovered in Macrotus waterhousii a modification that appears intermediate between types B and C outlined above. In this phyllostomatid (Graph D, Figure 8) implantation is in the fall of the year, but the rate of embryological development is extremely slow throughout the winter months when minimal supplies of food are available to this non-hibernating bat. In spring when food is again available,

development proceeds at a rapid rate.

The pattern shown by Natalidae (Graph E, Figure 8) appears to differ from any of the above mentioned patterns. Here the pattern of metabolic drain of the developing embryo is not concentrated into a period of three months or less, but is spread over a seven month period. Such a pattern could have developed only under environmental conditions where there were very little seasonal differences evident in food supply or temperature. Further, this type of reproduction gives support to those paleontologist who feel this family was restricted to the tropics during the early Tertiary. With the Pliocene reconnection of North and South America, the natalid bats expanded their range northward. They reached their limits of the northward expansion when they encountered an environment that had a fluctuant temperature and food supply. In all probability the Natalidae, unless they undergo a major modification in their reproductive cycle, may never invade the temperate region of the New World.

Extremely little is known about the reproductive cycles of the Thyropteridae and Furipteridae. Without any real data to support my view, I will predict that the reproductive cycles in these two families of bats will be similar to that found in the Natalidae.

SUMMARY

A natural history study was made on Natalus stramineus in the Alamos, Sonora, Mexico, area in 1964 and early 1965. The study was concentrated on the population at Minas Armolillo, an abandoned mine shaft 5 mi. NNW Alamos and 2 mi. S Piedras Verdes where a maximum population of 1,000 was found.

From measurements taken on 40 males and 40 females from the Alamos area it was learned that this population is a member of the subspecies N. s. mexicanus as opposed to N. s. saturatus which is found throughout most of Mexico and Central America.

From relative humidity and banding data it was found this bat does not have a mass migration but do have some local migration in search of a more favorable day-shelter. Members of this species require a day-shelter which maintains a constantly high relative humidity and a drop in relative humidity will produce a drop in the population. Also shown with the banding study, natalids demonstrate some homing tendencies.

At the onset of the study, it was postulated that the Natalidae have a long gestation period when the literature reported pregnant females from January through June. After collecting reproductive tracts, embryos, and young throughout 1964 and early 1965 it was found

that they have the longest gestation period reported for bats. Fertilization and implantation occur in late December or early January and parturition is in late July or early August; a gestation period of some seven months. The young mature quite rapidly, are able to forage in a month's time and reach adult proportions by six months.

This study shows that in the habitat requirements of high relative humidity in environment and in the type of reproductive cycle indicated, the Natalidae are well adapted for an insectivorous diet, in a relatively uniform environment, a climate such as found in the tropics of the New World.

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