AUTECOLOGY OF THE LONGNOSE BAT,
LEPTONYCTERIS NIVALIS (SAUSSURE)

by

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INTRODUCTION

In spite of a considerable interest in bats, as reflected by the numerous excellent studies published on chiropteran biology, little is known of the life histories of many species occuring in the United States. This is particularly true of the longnose bat, *Leptonycteris nivalis*. In the United States this phyllostomatid has been reported from only a few localities in Arizona and Texas, none more than 75 miles from the Mexican border. No previous studies have been devoted to the natural history of *Leptonycteris*, although portions of its anatomy have been described (Park and Hall, 1951; Park, 1954; Wille, 1954.), and its feeding habits are occasionally mentioned in the literature.

The reported establishment each summer of a colony of longnose bats in Colossal Cave (23 mi. E, 10 mi. S, Tucson), Pima County, Arizona, appeared to offer an excellent opportunity to secure data on the ecology of these bats. Aware of some of the difficulties involved, and of the inherent incompleteness of a study based on summer observations only, the writer began field work with the arrival of the colony at Colossal Cave in the first week of May, 1954. A permanent field camp was maintained until the colony migrated from the area on July 23-24, 1954. From time to time, one to three day field trips were made to other areas in southern Arizona where *Leptonycteris* had been reported.

ACKNOWLEDGMENTS

The writer is particularly indebted to Dr. E. Lendell Cockrum of the Department of Zoology, University of Arizona, who not only guided the study from beginning to end as Major Professor, but also gave unstintingly of his time and effort to advance this project in many other ways.

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METHODS

Most of the adult bats and many of the juveniles captured in the course of the study were taken in nets spread over entrances to caves or mines. Japanese "mist" nets of the type described by Dalquest (1954) /hard black silk with one inch mesh/ were used. It was found that a taut net permitted many bats to rebound and escape, while one hung loosely was more likely to enfold and detain them. When netting for purposes other than to determine exit or entrance preference at Colossal Cave, it was expedient to close off all but one exit with a dense cloth that would not ensnare bats, but would prevent them from passing in or out. This technique forced all of the bats to use only one exit, thus enabling one person to net and check.

When investigating the water requirements of the longnose bat, the silk nets often were set up over sources of open water near the colonies. When thus used, the net was erected perpendicular to the longest clear approach to the water, with the lower margin roughly two inches below the water surface.

Hand nets of the insect collecting type often were used to capture individual bats flying inside the caves. These hand nets were particularly effective in small passageways of caves and in mine tunnels.

Once captured, bats were placed in small retaining cages made of quarter inch hardware cloth. If cages of larger mesh were used, bats were able to slip a wing through the squares; the wing would then open, holding the bat fast. Under crowded conditions, this often resulted in fractured wing bones.

Bats held captive for more than several hours were transferred to larger cages permitting more freedom of movement.

Whenever possible, weights were determined within an hour of the time of capture. In the few cases where it was not feasable to determine weight until later, a significant loss of weight may have occurred; these instances are so noted in the tables.

Weight was measured by an Ohaus triple beam balance using a cardboard box to hold living specimens, and was recorded to the nearest tenth of a gram.

Linear measurements were recorded to the nearest millimeter, and for the most part were taken with a standard vernier caliper.

For stomach analyses bats were captured as they returned to Collossal Cave, immediately killed and their stomachs removed. Volumetric measurements were then made of the stomach contents of several bats by first tying off the cardiac and pyloric openings and then drawing the contents into a graduated syringe. Stomachs for subsequent content analysis were placed in 80% alcohol. R. Y. Anderson of the Department of Botany at the University of Arizona identified the pollen from these stomachs and from the large intestines of bats collected at Blue Mountain Cave, by the following method:

After agitation a drop of the material from the stomach was placed on a glass slide, stained with Safranin, and mounted in glycerine jelly under a cover slip. For the identification of the genera of plants represented, comparison was made of the pollen grains in the sample with those in prepared material of the collection of the Department of

Botany. To determine the percentage of each genus represented, over 200 grains were counted in each sample.

Ectoparasites were removed from the bats at the time of capture and placed in 80% alcohol. Identifications were made by R. L. Wenzel, Curator of Insects at the Chicago Natural History Museum, Chicago, Illinois.

A continuous record of temperature and humidity was secured with a Bristol Recorder which was installed on June 22, 1954, just outside the main entrance to Colossal Cave.

In the summer of 1954, 372 adult female and 332 juvenile *Leptonycteris* were banded at Colossal Cave. Size 0 bird bands were used as supplied by the United States Fish and Wildlife Service. In the first few bats banded, the band was applied to the leading edge of the wing and clamped shut behind the radius; when later recovered, bats so banded frequently exhibited badly infected wounds where the antebrachial membrane had been torn by the band. Therefore, in subsequent markings the band was applied from the dorsal surface of the wing and was closed just enough to encircle the radius without piercing or pinching the membranes.

Non-volant young bats were secured for banding by removing them from the rocks to which they clung in the Maternity Site, and transporting them down to the cave floor in a hardware mesh cage. After being measured, weighed and banded, the young were returned to the Maternity Site and were attached to the rocks as near as possible to the point of capture.

DESCRIPTION

The genus *Leptonycteris*, of which *L. nivalis* (Saussure) is the only recorded species, is a member of the family Phyllostomatidae (leaf-nosed bats). Martinez and Villa (1940) described a subspecies, *L. nivalis yerbabuenae*, from Guererro, Mexico, but as the type material was subsequently lost and some doubt exists as to the distinctness of *L. n. yerbabuenae*, all specimens are best referred to *L. nivalis nivalis* until topotypes of *L. n. yerbabuenae* are available for comparison. The following is a synopsis of the synonymy of the longnose bat.

Ishnoglossa nivalis Saussure, 1860. Revue et Magasin de Zoologie (2) XII:492.

Leptonycteris Lydekker, in Flower, W. H. and R. Lydekker, 1891. Mammals living and extinct. Adam and Charles Black, London. (*Ishnoglossa* Saussure, 1860, preoccupied by *Ishnoglossa* Kraatz 1856, a coleoptera.)

The longnose bat may be readily distinguished from other North American bats by its prominent triangular nose leaf, long fox-like muzzle and short interfemoral membrane with no vestige of a tail. Elongation of the rostrum has been accompanied by reduction in size of the teeth, especially the incisors, which are in pairs separated by median spaces, narrow above and fairly wide below. The dental formula of the adult is: $\frac{I2\ C1\ P2\ M2}{I2\ C1\ P3\ M2}$.

The pelage of the adult is short (approximately 5-7 mm. in the mid-dorsal area), straight, dense and sleek. The color ranged from Russet Brown (pg. 14, I 12) to New Cocoa (pg. 7, A 10). However, less than one per cent were Russet Brown; the other ca. 99 per cent ranged from Moose (pl. 8, C 10) to New Cocoa. The parenthetical color references are to Maerz and Paul (1930). No sexual dichromatism was evident in the specimens examined. The individual dorsal hairs are bicolored, the proximal half being a buffy cream and the distal half various shades of medium to dark brown. The hairs of the neck and shoulder areas tend to retain the shade of the proximal portion almost to the tips, giving a lighter, caped appearance to these regions; this is apparent in worn pelage. The underparts appear lighter for the same reason, and are lightly washed with buff in many adults. The ears are dusky and the flight membranes vary from dark chocolate to almost black.

The ears are moderately short, widely separate on the head, and roughly oblong, with a slight postero-lateral inclination of the distal third. A sparse growth of short hair is usually found on the antero-dorsal margin and inside surface of the pinna. The wings are short and broad, with comparatively heavy limb elements. The interfemoral membrane is reduced to a narrow strip about eight mm. long at the midline tapering to one mm. at the wrist; this deep indentation has much the symmetry of a Gothic arch. A sparse fringe of extremely short hairs is present on the posterior margin of the interfemoral membrane. The legs are long and the feet large, with five long digits each ending in a sharply curved claw. The narrow muzzle bears a prominent triangular flap of flesh, approximately four mm. wide and five mm. high, at the dorsal extremity.

Average and extreme measurements in millimeters, of a series of adults of both sexes taken in Arizona, are:

Feature	Mean	Extremes	No. of Specimens
Head and body length	88	78-90	49
Interfemoral membrane length	9	7-11	49
Hind foot length	13	13-15	49
Ear from notch	17	16-18	49
Height of tragus	7	6-7	49
Forearm length	53	45-57	83
Weights (grams)*	24.6	21.8-28.0	6

*Males only. For female weights see fig. 2.

A representative series of specimens of Leptonycteris nivalis from southern Arizona has been collected. Some were prepared as study skins with skulls, and others were preserved in alcohol. These are on permanent deposit in the museum of the Department of Zoology at the University of Arizona.

Three other Phyllostomatid bats occur in the United States. Common names given are as used by Burt (1952.). Superficially, these bats differ from Leptonycteris in the following characteristics:

Choeronycteris mexicana Tschudi, the hognose bat, has a short tail that extends halfway to the edge of the interfemoral membrane; the ears are smaller, barely projecting above the head; the lower incisors are absent; the zygoma is incomplete.

Macrotus californicus Baird, the leafnose bat, has a dark grey body, a short rostrum and large ears.

Mormoops megalophylla Peters, the leafchin bat, has prominent leaf-like folds of skin across the chin that extend from ear to ear; the face is very short, the forehead is high; the end of the tail is free on the upper side of the interfemoral membrane.

DISTRIBUTION

The geographic range of Leptonycteris nivalis extends from Guatemala and possibly Honduras (Goodwin, 1942:130.) northward through Mexico to the southern part of the United States (see map, fig. 3).

Locations from which the longnose bat has been collected, and present location of the specimens are as follows:

Arizona:

Colossal Cave, 10 mi. S, 23 Mi. E Tucson, Pima Co.; (UA)

W. boundary Ft. Huachuca Military Reservation; (Campbell, 1934:241.)

5 mi. N, 2 mi. W Patagonia, Santa Cruz Co.; (UA)

Tonoga, 30 mi. SE Ajo, Pima Co.; (LAM)

Redfield Canyon, Sect. 35, T 11S, R 19 E, Graham Co.; (UA)

Blue Mountain Cave, 17 mi. S San Simon, Cochise Co.; (UA)

Texas:

Mt. Emory, 7200 ft. Chisos Mountains, Brewster Co.; (Borell and Bryant, 1942:7.)

Sonora:

Pilares, near El Tigre; (Burt, 1938.)

1/4 mi. W Aduana 1600 ft.; (KU)

2 mi. S Aduana, 2600 ft.; (KU)

FIGURE 3

Geographic distribution of *Leptonycteris nivalis*.

<u>Chihuahua</u>:

Batopilas; (MVZ)

Carimechi; (Burt and Hooper, 1941-2.)

<u>Cohuila</u>:

12 mi. S, 2 mi. E Arteaga, 7500 ft.; (KU)

<u>Baja California</u>:

2 mi. W Santa Rosalia, 100 ft.; (MVZ)

1/4 mi. S Mulegé, 100 ft.; (MVZ)

San José del Commondú, 1000 ft.; (MVZ)

1 mi. E San Antonio; (MVZ)

4 mi. SE Buenavista; (MVZ)

Cerro del Elote; (MVZ)

<u>Nuevo León</u>:

Cerro Potosí, near Galena, 9000 ft.; (Koestner, 1941:10.)

<u>San Luis Potosí</u>:

Hacienda Capulín, 62 mi. SE Rio Verde, 3100 ft.; (Dalquest 1954-28.)

<u>Nayarit</u>:

2 mi. SE Jalcocotán, 300 ft.; (KU)

<u>Jalisco</u>:

5-11 mi. W Chapala, 5000 ft.; (KU)(UA)

8 mi. NE Ocotlán, 500 ft.; (KU)

Hacienda San Martin, 5000 ft., 18 mi. W Chapala; (KU)

<u>Guanajuato</u>:

Guanajuato; (Allen, 1938:105.)

<u>Colima</u>:

Hda. Magdalena; (CNHM)

Hidalgo:

6 km. NW Tasquillo, 5000 ft.; (KU)

Veracruz:

3 km. W Boca del Río, 25 ft.; (KU)

snowline, Mt. Orizaba; (type locality of L. n. nivalis)

Distrito Federal:

2.8 mi. NNW Milpa Alta, 8600 ft.; (KU) (IBM)

México:

Compartmento de Colorines; (IBM)

Michoacán:

Pátzcuaro; (CNHM) (Hall and Villa, 1949:441.)

12 mi. S Tzitzio, on Ruetamo Rd.; (Hall and Villa, 1949:441.)

Morelos:

600 M. SW Ruajintlan, 3500 ft.; (Davis and Russell, 1954:68.)

Oaxaca:

Cuicatlan, 2000 ft.; (KY) (IBM)

3 km. WNW Dominguillo, 730 M; (KU) (IBM)

Guererro:

Cueva de Juxtlahuaca; (IBM)

Yerba Buena; (type locality of L. n. yerbabuena)

Chiapas:

4 km. N Tuxlta Gutierrez, 760 M; (IBM)

Guatemala:

Dueñas; (Goodwin, 1942.)

Abbreviations used for museums in the above list follow:

(UA) Museum, Department of Zoology, University of Arizona, Tucson.

(KU) Museum of Natural History, University of Kansas, Lawrence.
(MVZ) Museum of Vertebrate Zoology, University of California, Berkeley.
(CNHM) Chicago Natural History Museum, Chicago, Illinois.
(IBM) Instituto de Biologia, Mexico D.F., Mexico.

Since adequate descriptions of the conditions throughout the extensive range of Leptonycteris are lacking, a general description of the habitat is not permissable at this time. However, in the northern part of its range, this bat is distributed in the upper Desert and Desert Grassland edge, and marginally into the lower edge of the Oak Woodland. Following are brief habitat descriptions of the three areas in which aggregations of longnose bats were observed in this study.

Colossal Cave, 10 mi. S, 22 mi. E Tucson, Pima Co., Arizona.

Colossal Cave, which contained the largest colony observed, is at an elevation of 3,650 feet, near the base of the southwestern slope of the Rincon Mountains. The vegetation type is Sahuaro (Cereus gigantea)-Palo verde (Cercidium microphyllum)- Ocotillo (Fouquieria splendens). Schott agave (Agave schotti) and Prickly pear (Opuntia engelmanni) predominate in the lower story. Thickets of Mesquite (Prosopis juliflora) are found in the several washes.

The nearest permanent sources of water are three small open tanks five feet in diameter, one within 100 feet of the cave entrance and the other two less than one quarter of a mile distant.

Fig. 1 gives the temperature determinations from the time of installation of the Bristol recording instrument near the cave entrance, until one week after the colony abandoned the site during the night of

July 23-24.

Blue Mountain Cave, 17 mi. S. San Simon, Cochise Co., Arizona.

Blue Mountain Cave is at the lower edge of the Oak Woodland, and is dominated by Mexican Blue Oak (Quercus oblongifolia). Both Schott agave and Palmer agave (Agave palmeri) are common on the rocky hill-sides, as is ocotillo. The cave entrance faces northwest, overlooking a broad valley where the major association is Creosote bush (Larrea tridentata) with Prickly pear and Palo verde, and with thick stands of Mesquite in the broad washes.

Water is available at all times in a pump-fed tank approximately 50 feet in diameter, located at the base of the hill containing the cave.

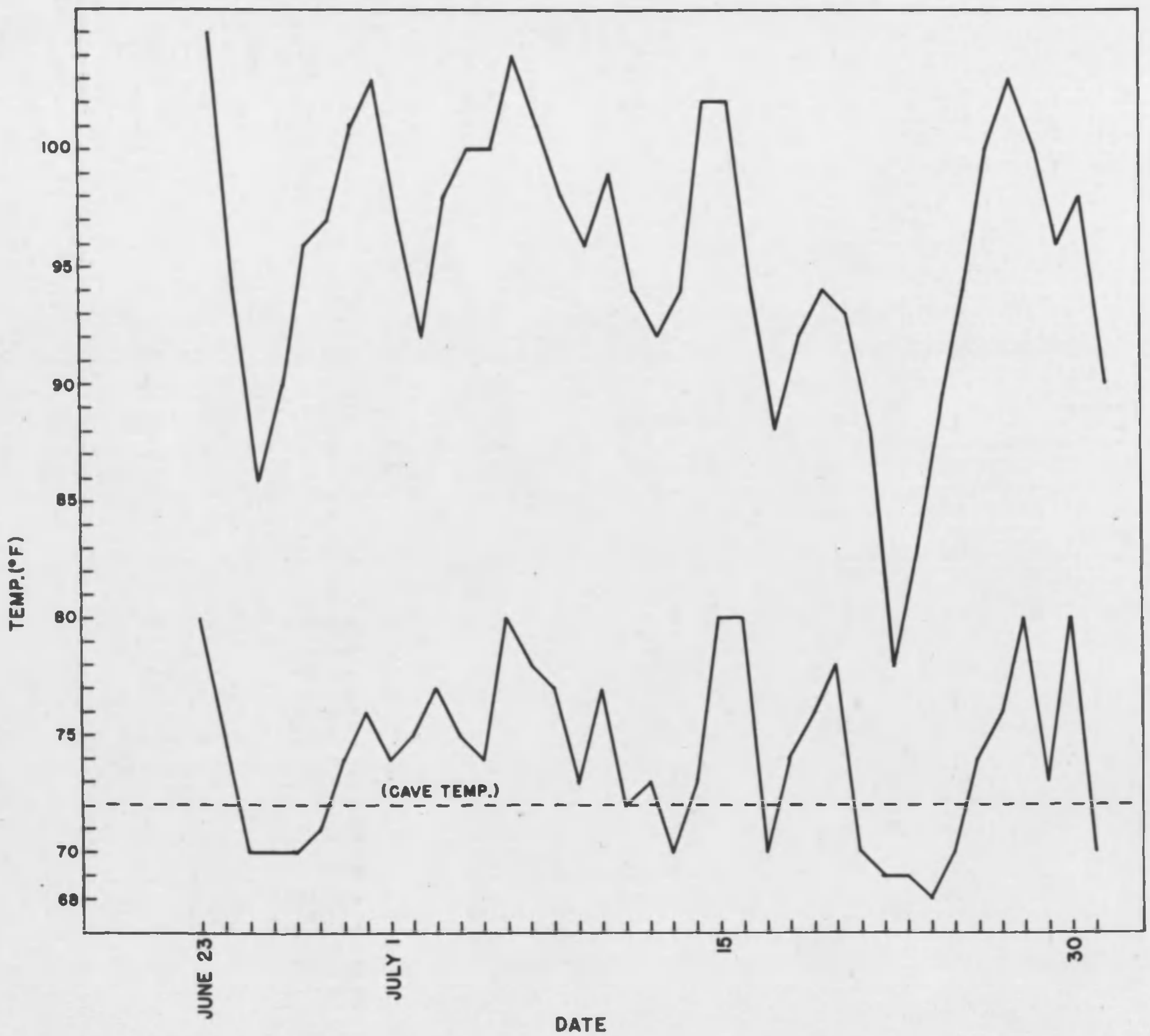
Abandoned mine tunnels, 5 mi. N, 2 mi. W patagonia, Santa Cruz Co., Arizona.

These tunnels are at an elevation of about 5,500 feet in the east face of the Santa Rita Mountains. The surrounding area has a wide range of vegetation types. In the valleys the dominants are Sycamore (Platanus racemosa) and Cottonwood (Populus fremonti), with a few scattered Walnut trees (Juglands rupestris). These riparians give way to sparse stands of Mesquite and Juniper (Juniperus deppeana) on the south and west facing slopes and are replaced by Blue oak, Arizona oak (Quercus arizonicus) and Juniper on the north and east facing slopes. Schott agave is conspicuous in the under story, while Manza-nita (Arctostaphylos pungens) appears on the north face of the ridges above the mining area.

Two tanks, constructed to collect run-off water for the cattle

FIGURE 1

Maximum and minimum temperatures at the entrance to Colossal Cave (June 23 - July 31, 1954).



TEMP.(°F)
100
95
90
85
80
75
70
68
(CAVE TEMP.)
JUNE 23
JULY 1
15
30
DATE

grazing in the area, were found within one half miles of the mine tunnels. One tank (40 feet in diameter) contained water on June 10, was dry when revisited on July 3, and had refilled by August. The second tank (60 feet in diameter) contained water on all three dates mentioned above.

ROOSTS

Colossal Cave has been water-cut in the limestone of Rincon Mountain. Of unknown extent and largely unexplored, the cave has been operated as a commercial venture since 1922. In 1933 it was purchased by Pima County, its present owner. Improvement of the cave was a construction project of the Civilian Conservation Corps from 1934 to 1937, when walks and guard-rails were installed for a commercial tour two miles in length, beginning and ending at the Main entrance.

Originally only two entrances existed, nearly 100 yards apart. The first, or Main Entrance, was a small aperture at the base of the nearly vertical south face of Colossal Hill. It was enlarged at the time of the C.C.C. project to an arch five feet wide and eight feet high. The second opening, known as the Bandit's Exit, is a narrow vertical fissure five feet long and 18 inches wide, flush with the gently sloping east face of the hill. In 1905 a tunnel five feet high and three feet wide was mined through 50 feet of the limestone rock to facilitate removal of guano from a cave chamber now known as the Bat Room. Thirteen carloads of guano were taken out before the project was abandoned a year later. The tunnel to the Bat Room is roughly halfway between the two original entrances.

Except for infrequent periods of extremely heavy rains, the cave has been dry, or inactive since many years before its discovery. A temperature approximately constant at 72° F persists throughout the year. However, the temperature in the blind "chimney" used as a maternity site by the longnose bats was much warmer and more variable, due to the metabolic heat of the many bats packed shoulder-to-shoulder in the narrow confines.

The Bat Room is a roughly circular, domed chamber about 40 feet in diameter and ten feet high at its center. From this room a number of tortuous passageways drop suddenly to levels from 20 to 40 feet lower before proceeding further back under the hill. Several of these passages connect with the commercial portion of the cave to the west, while others lead to the Bandit's Exit to the east.

The Maternity Site is a short, horizontal side pocket at the top of a 40 foot dead-end vertical shaft, or chimney. The shaft rises a few feet to one side of the flagstone-paved passage used by commercial tours, and is approximately three feet in diameter at its narrowest point; this is just below the site. The Maternity Site itself is seven feet long, six feet high and one to three feet wide. The walls and vault of this chamber are much pitted and seamed, offering an ideal surface to which bats may cling.

Blue Mountain Cave, like Colossal, has been water-cut in the limestone. However, it differs greatly in that it is wet, and apparently still "active." The entrance is 300 feet above the valley floor and has two apertures leading into a small domed antechamber roughly 25 feet in diameter and 15 feet high. One aperature is an elliptical cleft (six feet by three feet) in the chamber ceiling, while the other (six feet in diameter) opens horizontally from the chamber floor to the slope face. From the antechamber a low tunnel, rarely of sufficient height to permit standing upright, extends about 100 feet horizontally to the head of a vertical shaft; here there is a drop to a level 30 feet lower. From here the passage falls off at an average angle of 45 degrees for another hundred feet before terminating in the large chamber where the Leptonycteris were found. This chamber is roughly "L" shaped, one branch extending nearly 50 feet and the other 100 feet. The ceiling is extremely irregular, varying from 20 to 50 feet from the cave floor. When investigated in July, the cave was dank and the air of the lower chamber was unpleasant due to the high humidity and heavy, sickly sweet odor of the bats.

The abandoned mines NNW of Patagonia were excavated by hand during the First World War. All investigated were barely high enough to permit passage of a man with head and shoulders stooped, were on one level, and with one exception were straight, horizontal tunnels less than 100 feet deep. In two mines from which Leptonycteris were taken, some daylight penetrated to the end of the shaft. The floors of others were found to be flooded in places by springs.

Associated with Leptonycteris nivalis in its roosts were five other kinds of bats. In the following sections all mention of them has been omitted as there was no evidence of biotic interrelationships. These bats are:

Choeronycteris mexicana Tschudi: Possibly less than one per cent of the bats in Colossal Cave colony were found to be of this species. The few taken in the nets were all females, and they were either pregnant or lactating.

Macrotus californicus Baird: Only five were taken throughout the period of observation, four on May 6, and one on July 18. One specimen (adult male) in the Kansas Museum of Natural History is dated August 2, 1941. No other mention of this species from Colossal Cave was found in the literature. While apparently no colony has been established, occasional *Macrotus* do enter the cave.

Corynorhinus rafinesquei Miller: A large colony of these bats evidently occupied some area of the cave, since they made up the largest portion of every night's catch. However, the daytime roost was never located. *Corynorhinus* preceeded the longnose bats by at least one month and remained at the cave at least a month longer.

Myotis velifer (Allen): On May 2 a night roost comprising over 150 individuals was observed on the vault of the Bat Room. During the day this colony disappeared somewhere into the interior of the cave, but roosted nightly at this same location throughout the summer. Many were taken in the nets set at the entrances, and nearly 100 were banded.

Myotis thysanodes Miller: A small colony of 50-100 adults and young shared the lower chamber of Blue Mountain Cave with the "bachelor" colony of *Leptonycteris nivalis*.

POPULATIONS

No reliable data are available concerning the sex ratio in a breeding population of *Leptonycteris nivalis*. At the time and in the area of this study, separation of the sexes into "maternity" and "bachelor" colonies occurred.

Colossal Cave and the Patagonia mines contained only adult females and their young.

Blue Mountain Cave presented a widely varying population makeup. Seventeen Leptonycteris collected on June 29, 1954, by L. Whitelock (corresp.) were all males. On July 14, 1954, 49 specimens were collected from a population of over one thousand; of these 49, 46 were adult males and three were adult females. No juveniles were seen. Miscroscopic examination of these females failed to reveal embryos or turgidity of the uteri, and none were lactating. On July 26 the cave was revisited and 92 longnose bats were taken in one evening by means of nets over the exits. Positive identification was made of 46 adult males, 34 adult females, three juvenile males and three juvenile females. The remaining six were judged to be subadults, on the evidence of the unfused condition of the epiphyses of their forearms and the dark sooty color and fine texture of their pelage. If this age determination is correct, these subadults must have been born during the winter, since none were found in the Colossal Cave population that underwent parturition during June and July. It is interesting to note in this connection that two female Leptonycteris taken by Dalquest (specimens in U. Kansas Mus. Nat. Hist.) on September 28, 1947, in Veracruz, contained embryos of 20 mm. and 24 mm. length respectively. Judging by measurements of embryos from females taken in southern Arizona, parturition of these two embryos normally would have occurred within one month.

On August 25, 1952, D. G. Constantine (corresp.) checked Blue Mountain Cave and estimated that a population of at least 2000 Leptonycteris were present. On September 6, 1952, during Whitelock's earlier trip to the cave, he collected 32 specimens, as follows: 11

adult males, 10 adult females, 8 immature males and 3 immature females.

On the two collecting dates when young and adults of both sexes were represented in the Blue Mountain Colony--i.e., when it had ceased to be primarily a "bachelor" colony--the sex ratios were:

July 26, 1954 - 58% males, 42% females.

September 6, 1952 - 56% males, 44% females.

Since these ratios are within one per cent of those computed from the examination of 332 juveniles in Colossal Cave during the summer of 1954, (Table 2), they may approximate the ratio in a normal breeding colony of the longnose bat.

REPRODUCTION AND DEVELOPMENT

One embryo was found in each of the 13 gravid females that were autopsied in the present study. The only reference to number of embryos in this species was found on the museum tags attached to two Leptonycteris taken by Dalquest in Veracruz on September 28, 1947. As previously mentioned, each contained a single embryo, one 20 mm. and the other 24 mm. in length. There are several plausible explanations to account for the finding of embryos of the same size in Arizona during the summer and in Veracruz during the winter. More than one litter per year may be produced by the species. Or, within the species there may be two or more populations breeding at different times of the year, and thus reproductively isolated from each other. At present, extensive banding of females, either gravid or carrying young, throughout the range of this bat would seem to offer the best means of determining which, if either, of the above suppositions is correct.

TABLE 2

Sex ratios of juvenile Leptonycteris nivalis from Colossal Cave.

Date of capture	Sample size	Males	%	Females	%
June 7	119	73	61	46	39
June 18	32	20	62	12	38
June 21	128	66	52	62	48
July 18	28	16	57	12	43
July 20	20	13	65	7	35
totals	327	188		139	
averages			58%		42%

In the summer of 1954 a number of adult females were examined by autopsy for embryos. Females were collected at random on May 3, May 5 and May 15. After May 15 only females which appeared pregnant were autopsied. On May 3 all twenty females examined were gravid. On May 5, fourteen females were examined; eleven were gravid and three were lactating. On May 15, of seven females only one was gravid; the remaining six were lactating. Although females were examined between May 15 and the departure of the colony in late July, only one other pregnancy was discovered (May 23).

Fig. 2 shows the fluctuations of average body weight of the adult females taken through the summer.

The foregoing evidence suggests that parturition in the Colossal Cave colony, in the summer of 1954, occurred during the first two or three weeks of May. Since observations had not been made previous to this year, it is impossible to say what chronological fluctuation there might be from year to year. Climatic factors may directly or indirectly influence the reproductive cycle, as found by Pearson, Koford and Pearson (1952:319.) in the vespertilionid bat Corynorhinus.

Only eleven embryos and one new born young were collected in the course of this study. The embryos were taken between May 2 and May 15, 1954. The juvenile was found hanging from the ceiling of the Bat Room on May 23. The moist umbilicus still attached to it indicates that this bat was just a few hours old. Table 3 gives the weight, length of forearm, and length of the hind foot of each individual. These measurements call attention to the advanced state of pregnancy of the females at the time of their arrival at Colossal Cave.

FIGURE 2

Means and extremes of the weights of four collections of adult female *Leptonycteris nivalis* from Colossal Cave.

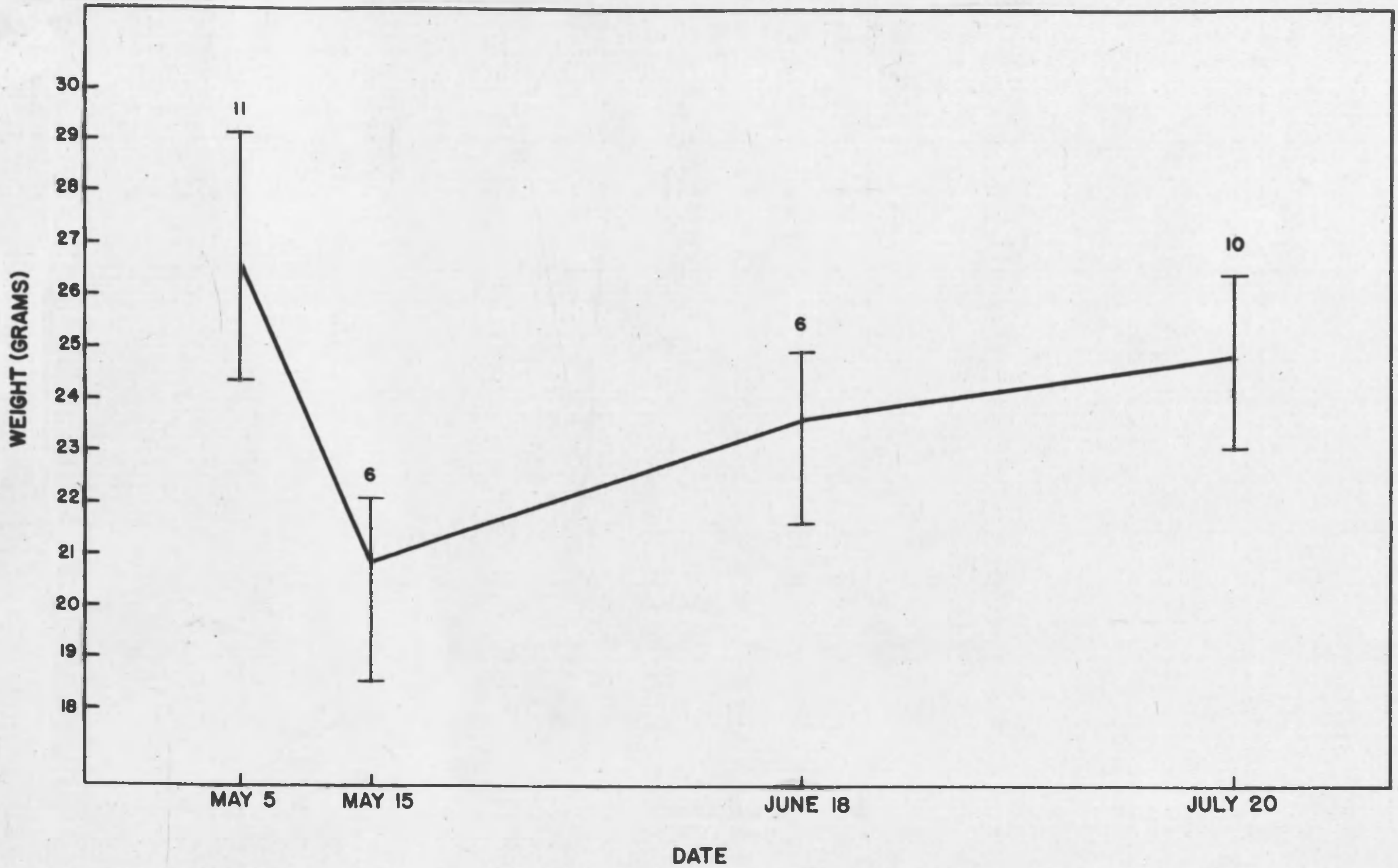

WEIGHT (GRAMS)
30
29
28
27
26
25
24
23
22
21
20
19
18
11
6
6
10
MAY 5
MAY 15
JUNE 18
JULY 20
DATE

TABLE 3

Measurements of embryos of Leptonycteris nivalis from southern Arizona.

Date	Forearm (mms.)	Hind foot (mms.)	Weight (gms.)
May 2	18	13	4.5
"	13	12	*
May 3	18	13	4.1
"	16	12	3.3
May 5	19	13	4.4
May 15	19	13	4.5
"	20	13	4.6
"	17	12	4.1
"	14	10	2.3
"	13	10	2.1
"	18	13	4.2
May 23	27	13	6.2**

* not recorded

**newborn (pg. 20)

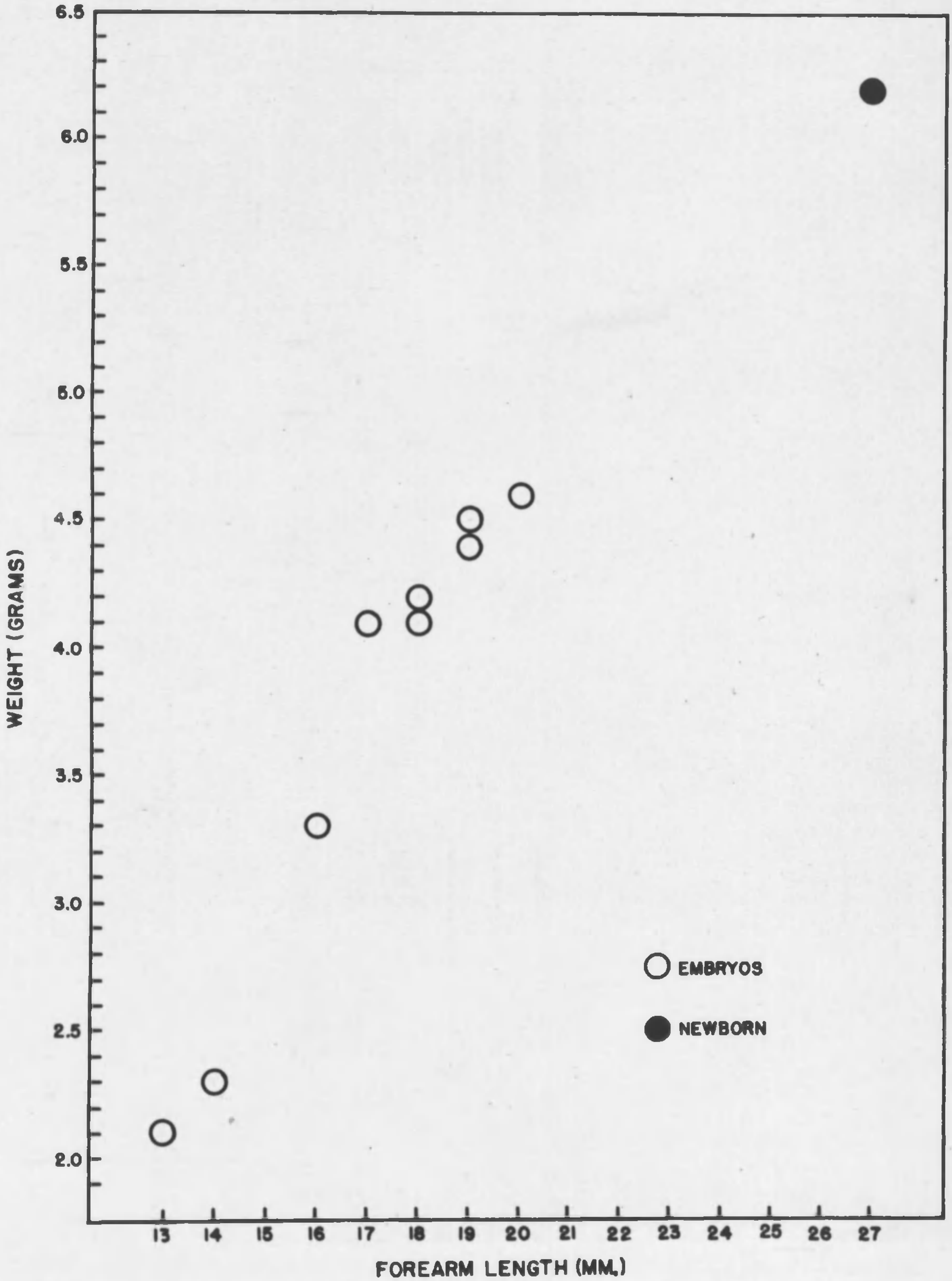
In fig. 4 weight in grams is plotted against length of forearm in mms. for the eleven embryos and one newborn bat. A fairly constant relationship between these measurements is evident in the approximately straight-line nature of the plots. The weight coordinate of the newborn bat falls slightly below the line as might be expected, as it lacked the foetal membranes in which the embryo were still enclosed when weighed.

An examination of table 3 shows that there is little variation in the length of the hind feet of these individuals. Thus it is clear that no correlation such as that of forearm length with weight exists for the length of hind foot. However, there is a possibility that some such relationship might be found in earlier embryonic stages, before the colony was found in southern Arizona. The hind foot reaches a length of 13 mm., the length found in many adults, while the forearm measures but 18 mm., or 34% of the adult average of 53 mm. The significance of this rapid development of the foot (to an essentially mature condition at birth) is apparent. From the first night following parturition, the young bat is constrained to suspend and support its entire weight by means of its feet, from the rocky surface in the roost where the mother has left it while she forages for food. The fact that no females bearing young were captured while entering or leaving Colossal Cave during the entire period of this study, strongly suggests that the young are never carried on these feeding flights.

The hallux also reaches essentially mature adult size *in utero*. Apparently the well developed, strong hallux and hind foot of the newborn bat aid greatly in clinging to the mother while hanging in the

FIGURE 4

Graph showing the relationship between weight and forearm length in developing embryos of *Leptonycteris nivalis*.


6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
WEIGHT (GRAMS)
13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
FORAREARM LENGTH (MM.)
EMBRYOS
NEWBORN

in the maternity colony and during her flights within the roost.

By birth much of the milk dentition has already errupted. This milk dentition is admirably specialized for clinging to the dense fur of the mother. The canines and premolars are slender, minute spicules with abruptly recurved tips. The incisors are lower crowned and chisel-shaped, with I2 being bifurcate from the gumline. This arrangement of the incisors permits firm attachment to the nipple. So strong is this attachment that it was necessary to insert a probe between the upper and lower cheek teeth and pry the jaws apart in order to separate a juvenile from the mother.

The skin of a newborn Leptonycteris is light slate grey, and devoid of hair. The flight membranes are relatively thick and vascular. By the time the forearm reaches 30 mm. in length, a sparse growth of short silvery hair covers the body, with the exception of the head. Individuals with a forearm measurement of 35-40 mm. were in full juvenile pelage. The juvenal fur is short, dull, sooty grey and less dense than that of the adult.

To secure data on growth in Leptonycteris nivalis, juveniles were periodically weighed and their forearms measured. Before the young were able to fly, they were collected from the night roosts where the females hung them before leaving the cave. To forestall possible abandonment by the mothers, care was taken to return each bat to approximately the same spot on the cave cailing from which it had been taken. Incidence of repeated recoveries of banded and measured individuals was unfortunately low. (Figs. 5 and 6). However, a fairly comprehensive picture of growth rates was produced by averaging a number of individuals at intervals throughout the study. These measurements have been graphically illustrated in figs. 7 (weights) and 8 (forearm lengths). Figs. 5 and 6 present the weights and forearm lengths respectively, of those juveniles first measured on June 7 and retaken at later dates. Since no significant morpholigical differences were evident between the juvenile males and females, they are not differentiated in the graphs. On examination of these graphs, it is patent that more frequent samplings are needed during the first four or five weeks following parturition; it is during this period that growth is most rapid.

On the night of June 25 the first juveniles were seen flying; they were making short flights in the corridors of the cave near the maternity site. By July 2 many were able to fly quite adeptly, and by July 15 some were caught as they were leaving or entering the cave. Pollen grains were observed on the muzzles of several attempting to enter. The young bats evidenced a distinct preference for the main entrance, comparatively few being taken in the net over the entrances to the Bat Room, less than a hundred yards distant. The adults showed no such preference. After the first week in July, very few females were seen carrying young; even within the maternity site the juveniles were found attached to the rock walls and ceiling by their hind feet, in the manner of adults.

No information was secured as to how a female identified her young after a separation, nor was it conclusively demonstrated that she would accept only her own. During the summer, 42 females and their attached young were banded, with consecutively numbered bands being applied to each pair. Only one of these females was recovered; she was without

FIGURE 5

Increase in the weight of juvenile _Leptonycteris_ _nivalis_ from Colossal Cave, based on the recovery of banded individuals.

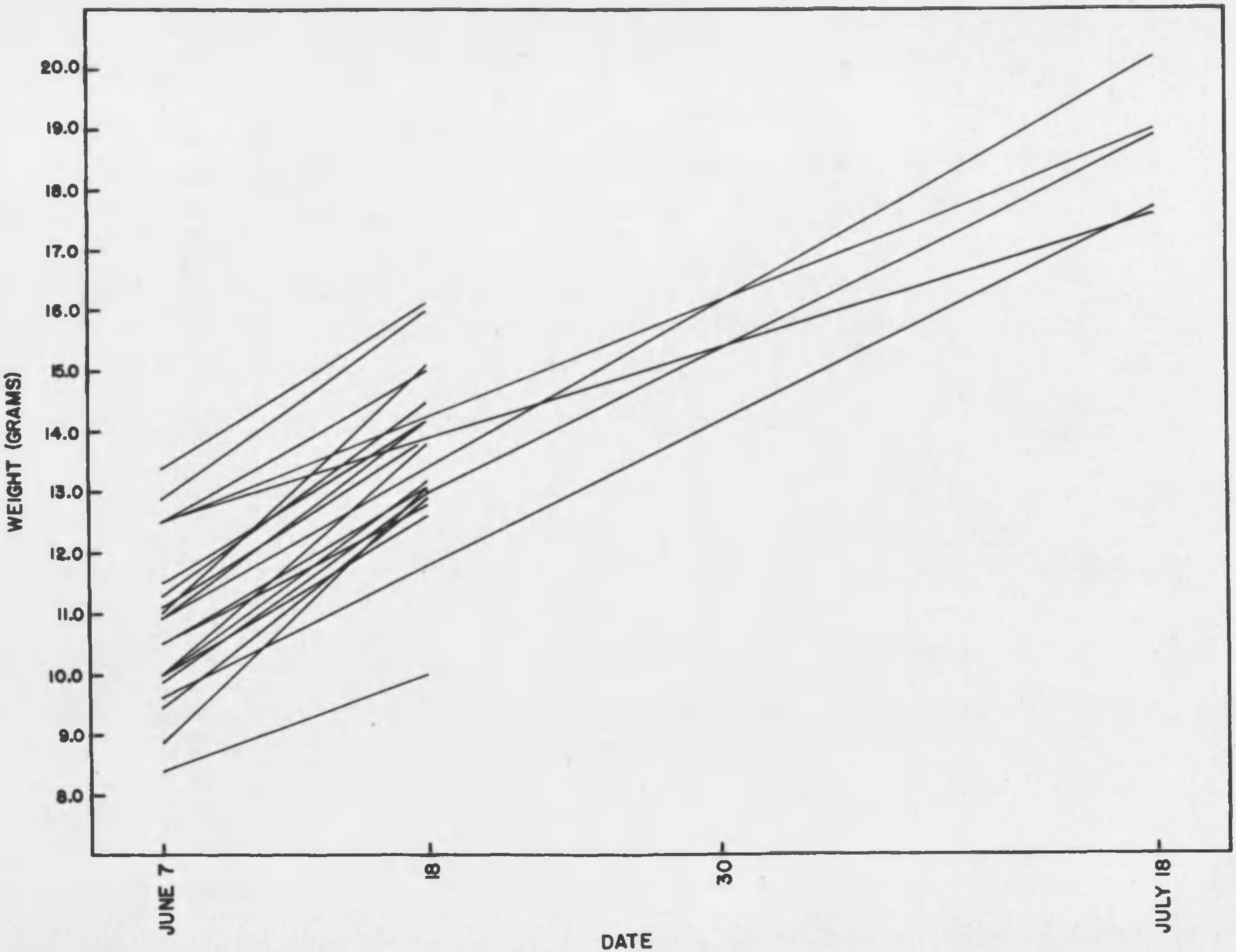
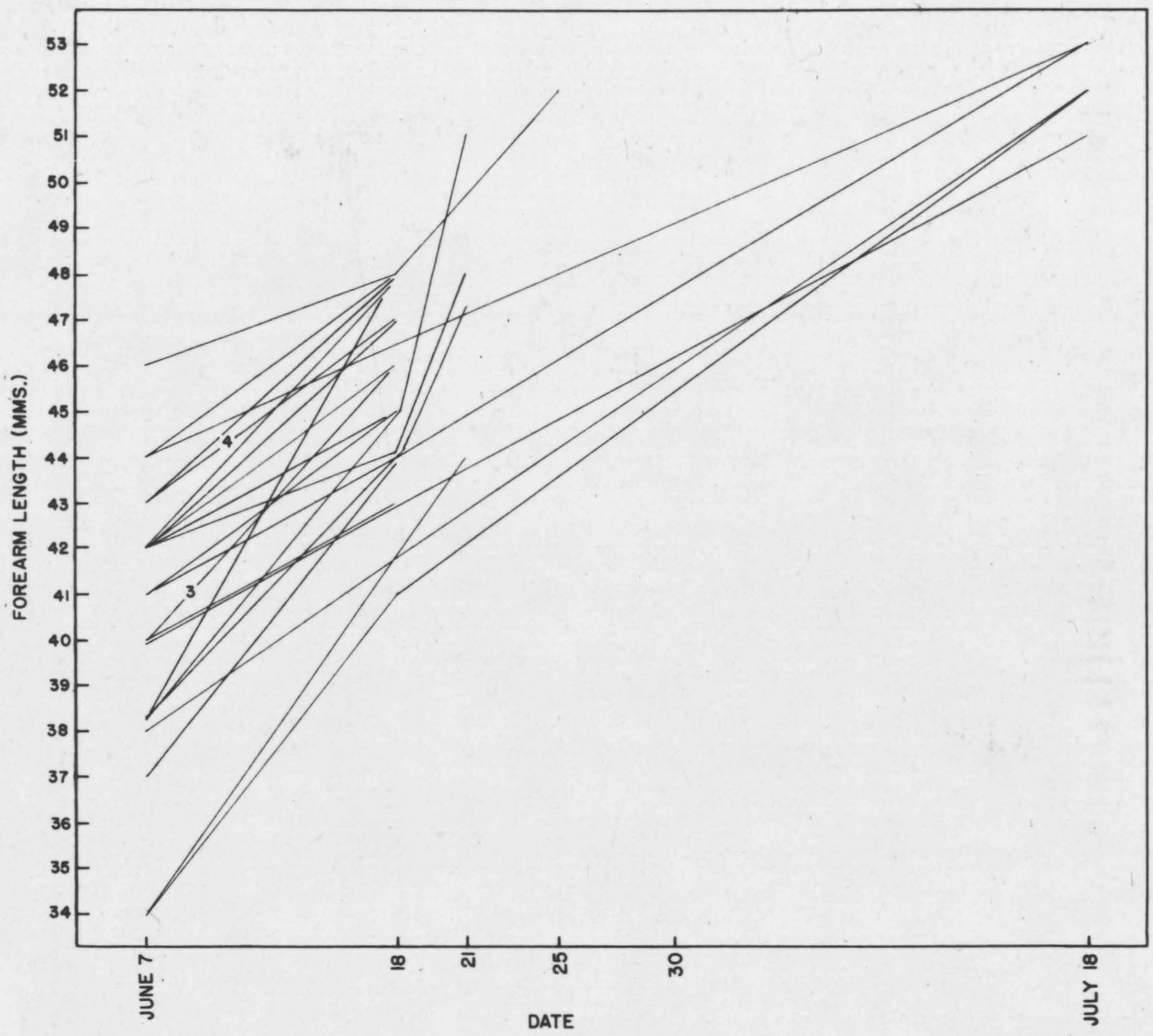

20.0
19.0
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
WEIGHT (GRAMS)
JUNE 7
18
30
JULY 18
DATE

FIGURE 6

Increase in the length of forearm of juvenile *Leptonycteris nivalis* from Colossal Cave, based on the recovery of banded individuals.



FOREARM LENGTH (MMS.)
53
52
51
50
49
48
47
46
45
44
43
42
41
40
39
38
37
36
35
34
4
3
JUNE 7
18
21
25
30
JULY 18
DATE

FIGURE 7

Histograms showing distribution of weights of juvenile *Leptonycteris nivalis* from Colossal Cave.

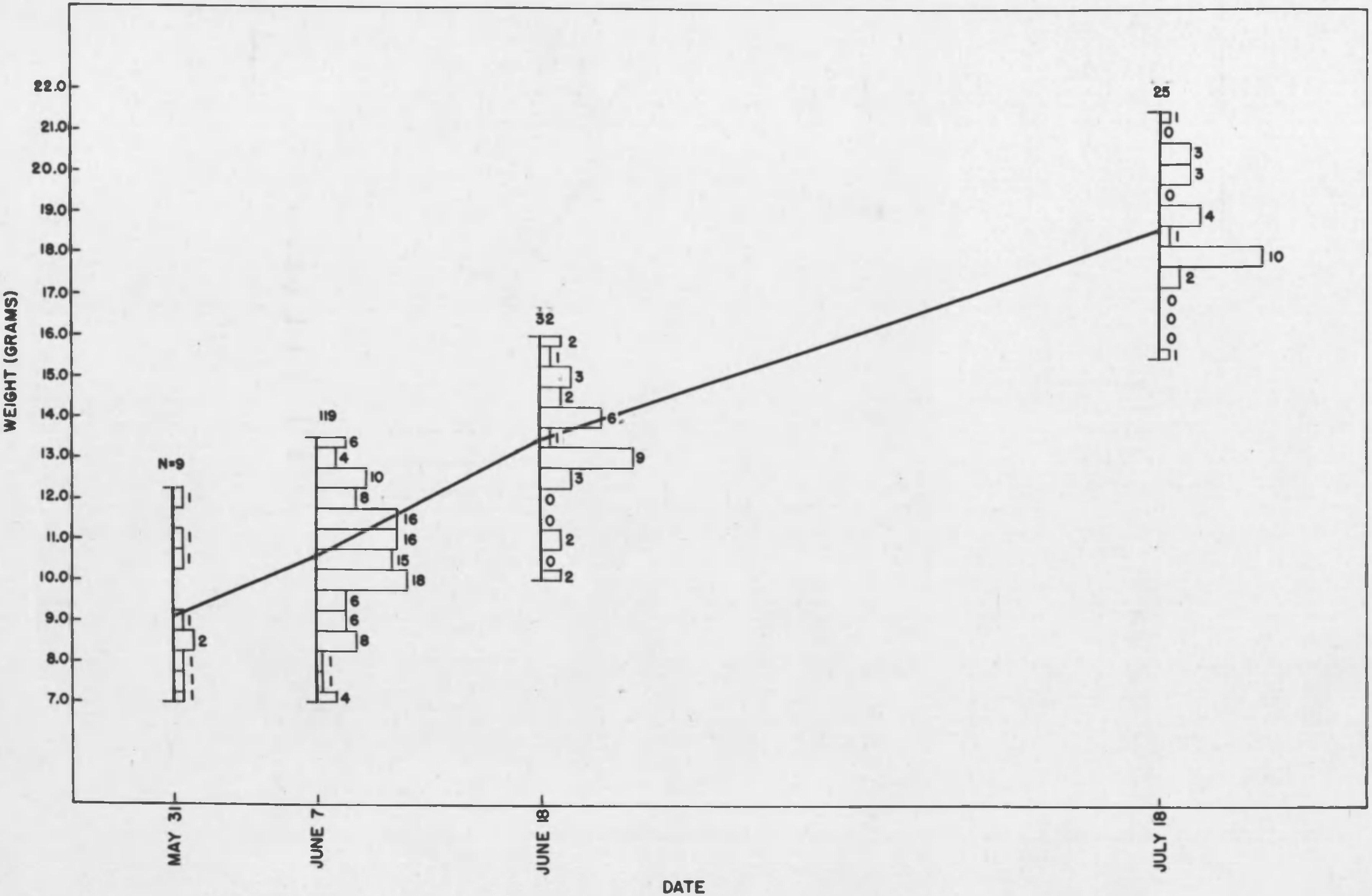
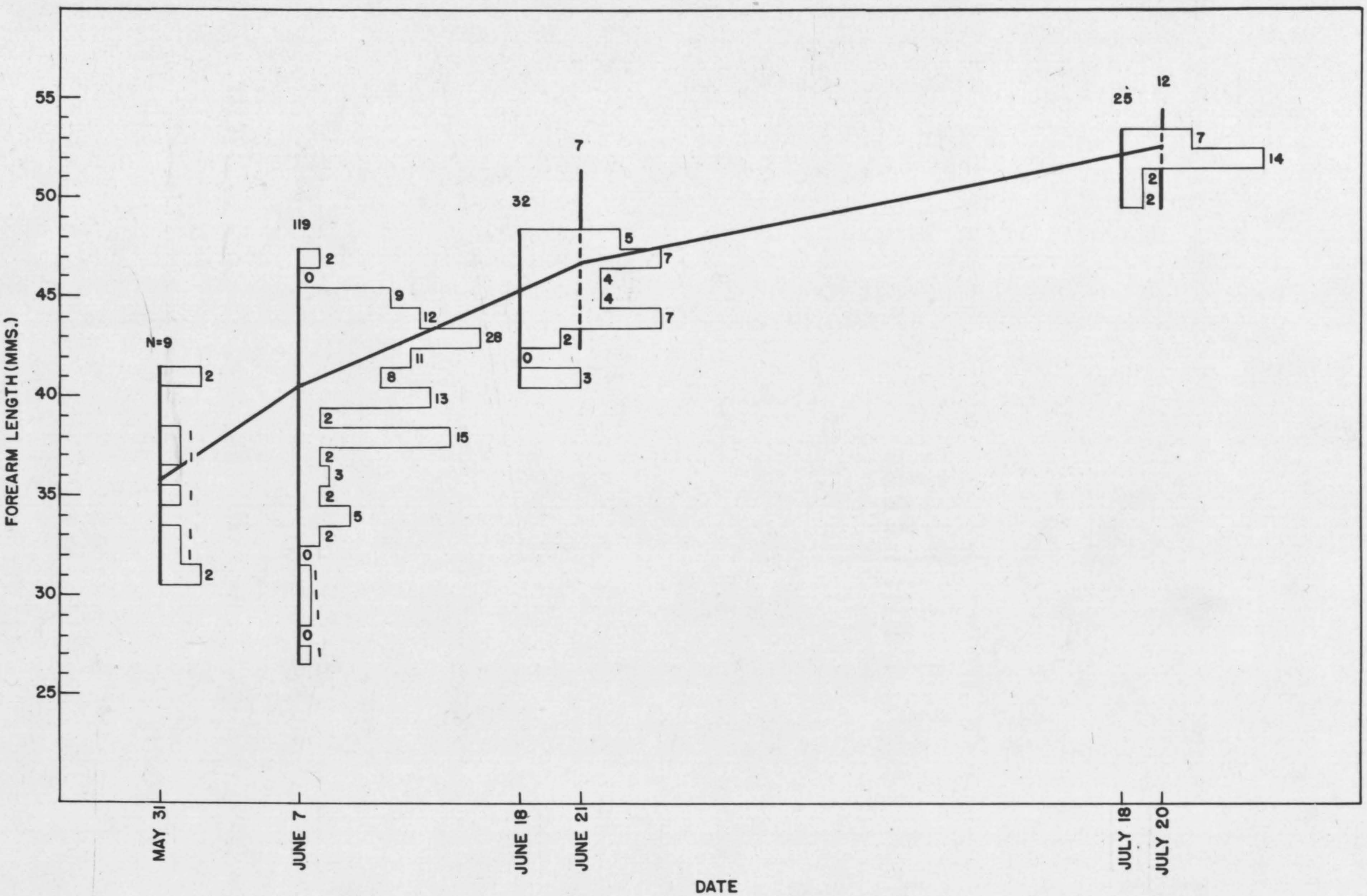

WEIGHT (GRAMS)
22.0
21.0
20.0
19.0
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
N=9
119
32
25
MAY 31
JUNE 7
JUNE 18
JULY 18
DATE

FIGURE 8

Histograms showing distribution of lengths of forearms of juvenile *Leptonycteris nivalis* from Colossal Cave.



FOREARM LENGTH (MMS.)
25
30
35
40
45
50
55
N=9
119
32
7
25
12
DATE
MAY 31
JUNE 7
JUNE 18
JUNE 21
JULY 18
JULY 20

young. Four of the juveniles were taken again, none in association with adult females. However, observations made on the behavior of adult females returning to clusters of young offer indirect evidence that only a certain juvenile is acceptable. On June 7, at 9:00 p.m., an estimated three to four hundred very young Leptonycteris were hanging singly and in groups from the ceiling of the Bat Room. About fifty adults were also present, but fled immediately to the dark recesses of the cave on the approach of a light. From one group of 150 to 200 young 120 individuals were removed and banded. These operations took several hours and as time passed, the adults circled progressively closer to where banding was being carried on in the light of a Coleman lantern. As the young were being replaced on the ceiling, some adults flitted or hovered over the cluster, only inches from the replacer's face. After the banding was completed and the lamp had been withdrawn a few feet from under the group, the adults immediately began landing, hanging head down by their feet among the young. Each female would then move about in the cluster, one leg placed stiffly ahead of the other, the entire body swinging as might a man's who was "handwalking" a parallel overhead ladder. Suddenly one would wrap her forearms about a juvenile in front of her, draw it to her breast, then release her hold on the ceiling and fly away. This apparent search for, and identification of, a particular young bat was noted many times. Other young might attempt to attach, but they were given no notice other than a fending off motion of the forearms.

BEHAVIOR AND ACTIVITY

When in captivity, many kinds of bats evidence antagonism toward individuals of other species, and toward members of their kind. This antagonistic behavior may be of a passive nature such as mere avoidance, or it may take the form of aggressive attack. No such antagonism on the part of Leptonycteris was witnessed in this study, either in free or captive individuals. Apparently docile by nature, the longnose bat rarely attempted to bite when handled, even when being relieved of the tightly clinging young. Both sexes readily became accustomed to being held in the hand during feeding.

When taking flight from the normal roosting position (i.e., hanging head down and attached to the cave walls or ceiling by the claws of the hind feet), the longnose bat does not merely release its hold, fall free and then level off in flight. Rather, it gives several strong wing beats while still attached to the rock surface, bringing the body into a nearly horizontal position; only then is the hold released. This method of taking flight without any loss of altitude may possibly be of some advantage to the bat, permitting it to roost in crevasses with little vertical clearance. Once airborne, Leptonycteris is a rapid, direct flyer, exhibiting none of the erratic, butterfly-like movements characteristic of many other species. The strong wing-beats of even a few individuals flying in a confined area give off a distinctive roar; once familiar with this sound, an investigator is frequently able to predict the presence of Leptonycteris in a cave before specimens are seen.

The frequency with which they avoided the fine silk collecting nets, or detected and flew through small rents in the nets, gives evidence of Leptonycteris' acute sense of obstacle location. However, on two occasions adults leaving Bat Room tunnel were seen to collide with a single strand of telephone wire stretched perpendicular to the entrance, twenty feet out from it and twelve feet about the ground.

Evidence concerning the reaction of Leptonycteris to artificial light is conflicting. Generally, the faintest ray from a flashlight caused all longnose bats to quickly disappear to the dark recesses of the cave or mine. However, in Mid-July the officials in charge of Colossal Cave wired a 200 watt bulb to shine directly into the Maternity Site, in an effort to dislodge the colony and thus eliminate the disagreeable odor. Although this bulb burned for at least five hours each day for a week, the colony remained. By the time of this disturbance, most if not all of the young were able to fly quite adeptly, and thus would have been able to accompany the adults to one of the many other similar sites found in that part of the cave. The only noticeable effect was to cause the colony to remain in a state of agitation through the part of the day when sound and movement were normally at a minimum. A few individual bats were usually to be seen flying in the cave passageways during this time; since the sight of these bats alarmed many visitors far more than the odor, the light was removed after a week's trial.

On several occasions, varying thicknesses of red cellophane were placed over a flashlight before entering the Bat Room, in hopes that Leptonycteris was less sensitive to red light. There was no significant difference in the rapidity with which the bats retreated to other parts of the cave. The presence of the observer was not a factor in the retreat, since one had only to extinguish the light to be immediately surrounded by the distinctive roar of the longnose bats in flight.

Early in the study at Colossal Cave, it became apparent that, unlike many cave bats, most individuals in the colony of Leptonycteris did not leave the cave in a massed evening flight. Rather, just before full darkness, longnose bats began leaving the caves as singles or in small groups of two to six. For the first half hour or so these departures were spaced five to ten minutes apart. Then after full darkness fell, the tempo increased, and a rhythmic nature became apparent. Larger groups estimated to include four to six individuals would leave only a few seconds apart until roughly 50 to 75 bats had left. Then the tempo of departure would slacken, and for several minutes only an occasional single bat or none at all would leave the cave. After several minutes, groups would again begin to depart with great rapidity. Observations within the cave gave at least a partial explanation of this rhythmicity of departure. Beginning about an hour before dark the bats in the Maternity Site became restless, with much crawling about on the rock surfaces being evident. Single bats would leave the site, fly about the cavern close by for a few seconds, then return and alight at the site again. Gradually more began leaving and fewer returning, until possibly five to fifteen bats were circling or clinging to the rock walls in the immediate area below the Maternity Site pocket. Then, as a group, they would quickly depart down the passageway toward the exits. Observations made in the Bat Room and in the vestibule just inside the Main entrance at about the same time in the evening (but on different days, of course) revealed groups estimated to contain 50 to 75 bats circling restlessly. These large aggregations apparently formed the peaks of the rhythmic departures that were observed from outside the exits of the cave.

Although most of the colony left the cave within the first two hours of darkness, lone Leptonycteris continued to be taken in the nets over the entrance throughout the night, both leaving and entering. Those ensnared entering would average about one every half hour. Little other activity was noted about the cave portals, until about a half hour before the first noticeable light of dawn, when there was a sharp increase in the number of bats attempting to enter. Groups of six to ten would appear simultaneously, swoop rapidly down at the entrance from a ten to twenty foot height, and execute a remarkably acute flaring reversal of direction when seeemingly about to touch the net. After two or three such passes, the group would disappear in the direction of one of the other entrances. However, with the arrival of full dawn light about half an hour before sunrise, caution seemed disregarded and many bats would rush headlong into the nets in an apparent effort to break through. On one occasion, all three entrances were kept obstructed until well after sunrise. Just before sunrise, after several increasingly frantic efforts to gain entrance, the bats were seen to disappear over the crest of the ridge to the north of the cave. The directness of this flight seems to indicate an awareness of the presence of an acceptable daytime roost to the north. Their reluctance to make use of it is accountable; their young, not yet able to fly, were still in Colossal Cave.

Due to the habit of Leptonycteris leaving the cave in small groups, and to the difficulty of carrying out observations at three exits, an erroneous idea of the size of the colony was first conceived. It was not until the discovery of the Maternity Site on June 20, that the entire population was seen together. Then it was realized that the colony comprised at least two thousand adults, and not merely three to five hundred as previously supposed. Well concealed at the top of a narrow, curved "chimney" at least forty feet above the cave floor, the Maternity Site was not found until the guides of the commercial tours complained of an increasingly strong, disagreeable odor in one corridor in the developed part of the cave. A few hours climbing and searching then revealed the colony. It is extremely unfortunate that this site was not found when the longnose bats first arrived, for parturition could undoubtedly have been observed, banding simplified, and many other pertinent data on the young more easily secured.

The only data on migration supplied by this study concerns times of arrival at, and departure from, Colossal Cave. J. Tichnor reports entering the Bat Room around noon on April 27 and finding no bats present. When this part of the cave was next entered at 4:00 p.m. on May 2, 50 to 75 large bats were milling about. One was shot and identified as Leptonycteris nivalis. As the rest quickly scattered to the small recesses and passageways leading off from the room, it was impossible to collect more at that time. On May 3 at 7:05 p.m., well over 100 were seen in the Bat Room on entering. It would appear that the colony arrived during the week of April 28 to May 3; whether the arrival was completed on one day or spread over several was not determined.

On July 22, the colony showed great restlessness, and the guides reported seeing many individuals flying in the cave corridors during the day. On the following day, July 23, groups of bats were seen flying about just inside the cave entrances. Some time during the night of July 23-24 the colony moved from Colossal Cave. When the Maternity Site was checked the following morning, only one juvenile remained, that was apparently too sluggish to fly. This young male was heavily parasitized by batflies (18 removed).

Fig. 1 presents a graph of the maximum and minimum temperatures for part of June and all of July, as recorded just outside the Main entrance to Colossal Cave. The maximum, occuring as it does shortly after the middle of the day, could have little effect on the bats roosting in the cave. Due to the great extent of the cave the temperature within remains approximately constant at 72° F. The minimum is usually reached between 2 a.m. and 4 a.m., when most of the long-nose bats are outside the cave. It is possibly significant that the exodus, and the restlessness preceeding it, coincided with a three day period of unusually low minimum temperatures. It is also of interest that on these three consecutive nights the minimum temperatures were significantly below the constant temperature within the cave. However, little can be suggested concerning the relation of environmental temperature to migration on the basis of but one season's determinations.

FOOD AND WATER

At irregular intervals during the summer of 1954 nets were erected and maintained throughout the night over the three sources of available water nearest to Colossal Cave. The tank at the foot of Blue Mountain Cave was netted on July 26. The tanks in the Patagonia mining area were netted on June 9 and 10, and on July 3. Although many bats were taken in the nets, no Leptonycteris were captured.

Stomachs removed from longnose bats caught entering the caves during the night were often found to be greatly distended by a clear liquid, sweet to the human sense of taste. Captive Leptonycteris were held for as long as ten days without water, fruits being available. Throughout this time water was offered periodically, but no interest was shown in it.

On the basis of the foregoing evidence, it is suggested that in southern Arizona Leptonycteris nivalis does not drink water, but rather obtains the required moisture from plant sources, primarily nectar. That this supposition may be warranted in other parts of the range is strongly suggested by the assertions found in the literature that Leptonycteris nivalis is a "nectar-eating bat" (Duegas, 1906; Taylor and Davis, 1947:14; Park and Hall, 1951:65; Wille, 1954:315). However, the premise that nectar is the only, or even principle, food source is not supported by the findings of this study. There has been little agreement concerning the foods of the longnose bat. Koestner (1941:10), on finding a large colony in a cave at an elevation of 11,500 feet in Nuevo Leon, supposed that "the absence of night flying insects probably compels them to feed at lower altitudes..." Sanborn (1954) also suggests insectivorous habits. Palmer (1954:60) notes that "like the long-tongued bat (*Choeronycteris mexicana*) it is adapted for flower feeding". Duegas (*loc. cit.*), Taylor and Davis (*loc. cit.*), and Wille (*loc. cit.*), among others have suggested that nectar is the principle food. Park and Hall (*loc. cit.*) made a study of the comparative morphology of the digestive tracts of several bats. Although they classified *Leptonycteris* as a nectar-eating bat, they state: "It is suggested that a liquid diet in bats is correlated with a type of stomach in which the two openings (cardiac and pyloric) are close together. It is to be noted, however, that the openings are relatively far apart in *Leptonycteris* which is thought to be a nectar-eating bat."

In the summer of 1954, four series of stomach samples were collected at Colossal Cave. These were secured from bats captured as they attempted to re-enter the cave. When captured, a bat was immediately killed and its stomach was removed. After a gross examination some of the stomachs were placed in 80% alcohol for later content analysis; others were utilized immediately for volumetric determinations of the contents.

The stomachs of bats returning to the cave showed a great variation in the degree of distension. In some cases distension was so great as to give the illusion of advanced pregnancy. On one occasion early in the study a series of adults judged to be near term were selected from the night's catch and housed in cages, with the hope of witnessing parturition. The following morning all sign of "pregnancy" had disappeared. Autopsy disclosed that the liquid content of the stomach had been absorbed. Some solid material, however, remained in the intestine.

Volumetric determinations were obtained by first tying off the cardiac and pyloric ends of the stomach, then withdrawing the contents, both liquid and solid, in a graduated syringe. The volumes of the contents of ten stomachs ranged from less than 0.1 c.c. to 4.5 c.c.

Gross examinations revealed that the walls of the stomachs that were greatly distended, were extremely thin and were transparent. In fact, newsprint could be read through an unruptured stomach; that is, through the two stomach walls and the enclosed liquid. Such stomachs retain their transparent nature even after being preserved in alcohol for several months. This condition is in contrast to that found by Park and Hall (op. cit.:67) for Leptonycteris in their study of the comparative morphology of the digestive tracts of certain bats. They found: "In these animals (the nectar-eating bats) the stomach is small, thick-walled, and externally moderately rugose...." Stomachs removed from bats that were captured in the daytime, when the stomachs were without fluid, and preserved in 80% alcohol did appear small and thick-walled on later examination; however little, if any, external rugosity was evident.

The solid material made up a varying percentage of the stomach contents, depending upon the amount of liquid present. In the stomachs showing the greatest distension, 10 to 30 per cent of the contents were solid materials. The stomachs preserved for later content analysis revealed that most of the solid materials were pollen. A summary of the results of the qualitative and quantitative analyses of the contents of these stomachs is given in table 4.

The presence of pollen in the digestive tracts of Leptonycteris may be accounted for in two ways; either it has purposely been consumed directly from the anther of the flower, or has been ingested as a contaminant in the nectar secured from the base of the corolla. The long muzzle and extensile tongue of this bat are well suited for seeking food deep in the base of a flower, but would be of little conceivable advantage in feeding from the projecting anthers. A coating of pollen, frequently extending to the neck, was observed on the heads of many bats returning to Colossal Cave. Therefore, it is suggested that a mixture of nectar and pollen which has sifted down to the base of the corolla is ingested by Leptonycteris, and that pollen is not consumed directly from the anthers.

The presence of pollen from Agave and Cereus on the heads and necks of many Leptonycteris suggests that this bat is an effective agent in the pollenation of these two plant genera. Sanforn (1940: 113) states that "...a few tropical plants appear to depend [for pollenation] in part or perhaps in some cases chiefly on certain kinds of bats which visit the flowers by night in search of nectar or pollen." The Austrian botanist O. Porsch (1932) has made a special study of such "bat flowers" and has summarized what is known of this relationship. According to Porsch, cross-fertilization by small, nectar-loving bats has been observed in half a dozen genera of tropical plants, and is suspected in some two dozen other genera.

TABLE 4

Qualitative and quantitative analyses of pollen from disgestive tracts of Leptonycteris nivalis collected in southern Arizona.

Sample no.	Date collected	% Cereus	% Agave	Location
1 (stomach)	May 15	100	0	Colossal Cave
2 "	"	100	0	" "
3 "	June 20	23	77	" "
4 "	"	2	98	" "
5 "	July 2	13	87	" "
6 "	"	0	100	" "
8-15 (rectum)	July 14	0	100	Blue Mt. Cave
16 (stomach)	July 18	0	100	Colossal Cave
17 "	"	0	100	" "

Cell contents were present within, or extruding from the exine of pollen grains in seven of nine stomachs analyzed; in the remaining two stomachs no cell contents were found. No pollen cell contents were present in materials removed from the recta of eight bats captured in the daytime, when their stomachs had emptied. The foregoing observations suggest that the cell contents of pollen grains are extracted from the exine during the passage through the digestive tract of the bat. That the preservative was not responsible for this dissolution is shown by the fact that the cell contents remained intact in pollen grains removed from the facial hair of Leptonycteris and immersed in the same preservative.

The replacement of Cereus by Agave (Table 4) in the pollen content of the stomachs may be explained by reference to the times of flowering of these plants. Kearney and Peebles (1951) state that in Arizona, Cereus gigantea flowers during May and June, while Agave schotti flowers from June to July. The digestive tract contents of eight Leptonycteris taken at Blue Mountain cave on July 14 were also analyzed, and were found to consist entirely of Agave pollen.

During July purple-red plant material and occasional small seeds were also found in the stomachs; these have been identified as the remains of the fruit of the Sahuaro (Cereus gigantea). At this time the feces, which previously had been pollen yellow, became dark red-brown. Dalquest (loc. cit.) states that specimens taken in open rooms at Hacienda Capulin, San Luis Potosi, Mexico, "had their stomachs filled with thick, brilliant-red fruit juice. This was almost certainly the juice of the fruit of the organ cactus...".

Insect remains were found to make up a small part of all digestive tract contents analyzed. Moth wing scales, fragments of the chitin shells of small scarab beetles and abdominal segments of small bees were identified. The size of some of these fragments would seem to preclude their having been accidentally ingested with pollen or nectar. However, the dentition and chewing musculature of the longnose bats are poorly adapted for mastication of insects. Pending further investigation, the question as to whether *Leptonycteris* is to any large degree insectivorous remains open.

A variety of foods were offered to longnose bats held in captivity for periods of 24 hours to ten days. Most acceptable were fruits such as bananas, grapes and plums; later in the summer when the prickly pear (*Opuntia engelmanni*) bore fruit the "pears" were accepted, if the outer membrane was first ruptured.

PARASITES

Two species of batflies were found to be ectoparasites on *Leptonycteris nivalis* from southern Arizona. These are *Trichobius sphaeronotus* Jobling and *Nycterophilia coxata* Ferris, both of the Family Streblidae. *T. sphaeronotus* is the only genus of batfly previously recorded from the longnose bat. Two to six batflies per bat were common, and as many as ten were occasionally found on one individual. No adverse effects were noticeable, even in the more heavily infested bats.

SUMMARY AND CONCLUSIONS

The longnose bat, Leptonycteris nivalis (Saussure) was studied in southern Arizona in the summer of 1954. Most observations were made at Colossal Cave in Pima County, where several thousand adult females established a maternity colony during the week of April 23 - May 3. This colony left the cave in the night of July 23. Minimum temperatures significantly below the constant temperature maintained inside the cave were recorded outside the cave entrance on the three days preceeding the departure of the bats.

Geographic distribution was determined on the basis of collection localities compiled from the literature. In the northern part of its range, Leptonycteris is distributed in the upper Desert and Desert Grassland edge, and marginally into the lower edge of the Oak Woodland.

During the study, 372 adult females and 332 juveniles of both sexes were captured and marked by banding. Series of adults and juveniles were periodically measured and their weights and forearm lengths recorded. No sexual dichromatism or dimorphism was evident in the bats examined.

The young are volant at nine to eleven weeks of age. In leaving and entering the cave, the juveniles showed a preference for a particular exit; no preference was evinced by the adults.

Most of the bats in a Leptonycteris colony leave the cave singly or in groups of from two to six, during the first two hours of darkness. However, individuals pass in or out during the entire night, and many bats are present in the roost at all times. The tempo of return increases sharply about one-half hour before dawn.

No Leptonycteris were taken in nets erected over open water near the colony sites. On the basis of this and other evidence, it is suggested that, in southern Arizona, the longnose bat does not drink water, but obtains the required moisture from plant sources - i.e., nectar. Stomachs of this species of bat are capable of great distention. The volumes of contents ranged from 0.1 c.c. to 4.5 c.c. Solid material in the stomachs consisted of pollen from Cereus and Agave, and insect remains. It is likely that the pollen was ingested as a contaminant in the nectar, and not eaten directly from the anthers. The cell contents are extracted from the exine as the pollen grains pass through the digestive tract. The progressive replacement of Cereus pollen by Agave pollen in the contents of digestive tracts is correlated with the times of flowering of these plant genera. During July, juice and seeds of Cereus fruit were also found in stomachs.

Females from Colossal Cave were autopsied throughout the study. The results indicate that parturition occurred during the first two or three weeks of May, and that each female gives birth to one young. Because embryos apparently near term have been found in southern Mexico in September, it is suggested that either the species is polyestrous, or reproductively isolated populations exist. The mean sex ratio of collections of juveniles from Colossal Cave was 58% males to 42% females. This ratio is within one per cent of that recorded for collections of adults and juveniles in Blue Mountain Cave, Cochise County, Arizona, in late July. Earlier in the summer a ratio of 93% males to 7% females was observed in this cave; no juveniles were then present, and the few females were neither pregnant nor lactating.

The hind foot and hallux develop rapidly *in utero*, and are almost mature size at birth. A constant relationship between rates of increase of weight and of forearm length during embryonic development is evident. No significant difference in rate of growth of males and females was noted. Much of the milk dentition is irrupted at birth, and is specialized for clinging to the fur of the adult.

It was not demonstrated conclusively that the females will accept only their own young; however, a process of selection, apparently involving identification, was observed.

Two species of batflies of the family Streblidae were found to parasitize *Leptonycteris* in southern Arizona.

Bats associated with *Leptonycteris* in its roosts were *Choeronycteris mexicana* Tschudi, *Corynorhinus rafinesquei* Miller, *Myotis velifer* (Allen), and *Myotis thysanodes* Miller.

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