Lasiurus Gray, 1831

Nycteris Borkhausen, 1797:66. Type species Vespertilio borealis Muller. Nycteris Borkhausen is a homonym of Nycteris Cuvier and Geoffroy St.-Hilaire.

Lasiurus Gray, 1831:38. Type species Vespertilio borealis Muller. Atalapha Peters, 1871:907, and other authors, not Atalapha Rafinesque, 1814.

Dasyurites Peters, 1871:912. Type species Lasiurus intermedius Allen.

**CONTEXT AND CONTENT.** Order Chiroptera, Suborder Microchiroptera, Family Vespertilionidae, Subfamily Vespertilioniinae, Tribe Lasiurini. The genus Lasiurus includes 11 extant species (Hall and Jones, 1961), and the following key should aid in their identification (Barbour and Davis, 1969; Hall and Jones, 1961).

1 Color reddish or grayish; two premolars on each side of upper jaw

2 Color yellowish; only one premolar on each side of upper jaw

3 (1) Occurring on mainland and coastal islands of North and South America; also on Galapagos, Bermuda, and Hawaiian islands; color reddish or grayish

4 Occurring on Antillean islands; color reddish

5 (2) Large size; total length more than 120 mm; forearm more than 49 mm; color grayish

6 Lasiurus cinereus Moderate size; total length less than 120 mm; forearm less than 49 mm; color reddish

7 (3) Upperparts brick red to rusty red, washed with white underparts; loral ridge present

8 Upperparts not brick red to rusty red; loral ridge not developed

5 (4) Not occurring on Galapagos

6 Lasiurus borealis Known only from Galapagos (east of 7.6 mm and thumb of 6.4 mm, also in L. borealis) ............ Lasiurus brachyotis

6 (5) Forearm more than 46.5 mm; dorsum bright rufous

7 Forearm less than 46.5 mm; dorsum not bright rufous

7 (6) Upperparts mahogany brown washed with white; forearm less than 43 mm

8 Lasiurus seminolus Upperparts deep chestnut; forearm more than 43 mm

9 Lasiurus castaneus

8 (7) Greatest length of skull greater than 13.9 mm; occurring on Jamaika

Lasiurus degelitus

9 (8) Length of upper tooth less than 4.5 mm; forearm less than 42 mm; occurring on Hispaniola and Bahamas

10 Lasiurus minor

10 (9) Length of upper tooth more than 4.5 mm; forearm greater than 42 mm; occurring on Cuba

Lasiurus pfefferi

10 (1) Total length more than 119 mm; length of upper tooth more than 6.0 mm; condylothere length more than 16.5 mm

Lasiurus intermedius

Total length less than 119 mm; length of upper tooth less than 6.0 mm; condylothere length less than 16.5 mm

Lasiurus ega

**Lasiurus borealis (Müller, 1776)**

Red Bat


Vespertilio latilis Schreber, 1781:62. Type locality North America.

Vespertilio melanos Schreber, 1776:204. Type locality unknown.

Vespertilio rubra Ord, 1815:291. Based on the red bat of Wilson, 1812:60.

Vespertilio tesselatus Rafinesque, 1818:445. Type locality unknown.

Vespertilio monachus Rafinesque, 1818:445. Type locality unknown.

Vespertilio rufus Warden, 1820:606. Based on the red bat of Wilson, 1812:60.

Vespertilio blossevilli Lesson and Garnot, 1826:95. Type locality Montevideo, Uruguay.

Vespertilio bornensis Lesson, 1826:156. Type locality Rio La Plata at Buenos Aires, Argentina.

Nycticeius varus Poepigk, 1835:451. Type locality Antuco, province of Bio-Bio, Chile.

Lasiurus funebris Fitzinger, 1840:46. Based on Nycticeius northoracensis Temminck, 1846. Type locality Tennessee.

Myotis quebecensis Yourou, 1890:65. Type from Anse-a-Wolfere, Quebec.

Atalapha frantzi Peters, 1871:908. Type locality Costa Rica.

Atalapha teletos Allen, 1891:5. Type locality unknown, probably California.

Lasiurus enderllii Lima, 1926:73. Type locality São Lourenço, Rio Grande do Sul, Brazil.

**CONTEXT AND CONTENT.** See generic account above. Five subspecies of Lasiurus borealis are recognized (Hall and Jones, 1961) as follows:

L. b. borealis Müller, 1776:20, see above (novoboracensis Erxleben, funebris Fitzinger, quebecensis Yourou, and presumably, lasiurus Schreber, blossevilli Palisot de Beauvois, rubra Ord, tesselatus Rafinesque, monachus Rafinesque, and rufus Warden are synonyms).

L. b. frantzi Peters, 1871:908, see above (ornatus Hall a synonym).

L. b. teletos Allen, 1891:10, see above.

L. b. blossevilli (Lesson and Garnot), 1826:95, see above (bornensis Lesson and enderllii Lima are synonyms).

L. b. varus (Poepigk), 1835:451, see above (sahnei Thomas a synonym).

**DIAGNOSIS.** Lasiurus borealis has a distinctive color; upperparts are brick red to rusty red washed with white (males are usually more brightly colored than females); underparts are slightly paler; anterior part of shoulder has buffy white patch. In hand, the tail, burled interfemoral membrane, and reddish color set this species apart from close relatives (also see key above); whereas flight, the tail extended straight behind the body is distinctive (Barbour and Davis, 1969; Hall, 1981; Miller, 1987).

The skull resembles that of L. cinereus but is smaller. It is short, broad, and has a high, rounded braincase. The surface of the rostrum is nearly in line with that of the braincase; width of the palatal emargination is greater than the depth; floor of braincase and palate are not parallel; diameter of each auditory bulla is approximately equal to the space between the bullae (Barbour and Davis, 1969; Hall and Jones, 1961; see Fig. 1).

**GENERAL CHARACTERS.** The red bat is a moderately sized lasiurine (7 to 13 g) with long pointed wings and heavily furred interfemoral membrane (Fig. 2). The ear is low, broad, and rounded, and the tragus is triangular. The ears when laid forward reach a little more than half way from angle of mouth to nostril.
The foot is small, less than one-half as long as tibia. The calcare is about twice as long as the foot.

Measurements (in mm) reported by Miller (1897) compare well with those noted by Hamilton and Whittaker (1979) and Jackson (1961), and are as follows (n = 10 males): total length, 108.9; length of tail, 52.7; length of tibia, 18.6; length of foot, 7.9; length of forearm, 46.0; length of thumb, 6.4; length of longest finger, 8.2; length of ear from notch, 10.5; width of ear, 9.8; length of tragus, 6.1. Williams and Findley (1979) found females of *L. b. tetliotis* to be 7.9% larger than males. Size-related measurements (X ± SE) for males (n = 30) and females (n = 30) in mm are, respectively, as follows: length of head and body, 35.2 ± 0.83 and 59.6 ± 0.75; length of forearm, 39.2 ± 0.254 and 41.14 ± 0.252; condylocanine length, 11.75 ± 0.042 and 12.23 ± 0.044; length of maxillary toothrow, 4.11 ± 0.015 and 4.31 ± 0.02.

The teeth are large and upper molars broad on the inner side; the lower molars are wide in their transverse diameter. The anterior upper premolar is minute, peglike, and displaced inward from the normal toothrow; occasionally this tooth is lacking. The dental formula is i 1/3, c 1/1, p 2/2, m 1/3, total 32 (Hall and Jones, 1961; Miller, 1897).

**DISTRIBUTION.** Red bats are found from southern Canada southward throughout the United States, Mexico, Central America, and into South America as far south as Argentina and Chile. In winter in the United States, they are found from the Ohio River Valley southward in the east and, in the west, along the coast from San Francisco south. They are common in the midwestern and east-central states, and can probably be found easily wherever there are trees in the prairie and Great Plains states. They have also been found on five Caribbean islands (Cuba, Jamaica, Hispaniola, Puerto Rico, and Bahamas), and wayward migrants have been found considerable distances from land (Baker and Genoways, 1978; Banfield, 1974; Barbour and Davis, 1969; Bogan and Williams, 1970; Cabrera, 1958; Dabbenb, 1902; Hall, 1961; Hall and Jones, 1961; Handley, 1966; Koopman, pers. comm.; Varona, 1974; Villa-R. and Villa-Cornejo, 1969). A map of the geographic range is presented in Figure 3.
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FOSSIL RECORD. Late Pleistocene specimens of this species have been found at: Vero, Indian River Co., Florida; Reddick, Marion Co., Florida; Bon Secours, Plioski Co., Missouri; Organ-Hedrick, Greenbrier Co., West Virginia; Natural Chimneys, Augusta Co., Virginia (Kurtén and Anderson, 1980; Martin, 1972).

FORM. The fur is dense and soft all over the body. The back has an average fur depth of 5.8 mm, while that of the uropatagium is 6.6 mm (Shump and Sump, 1980). The ears are naked inside and on the tips, with only the basal two-thirds of the outer portion being furred. The ears are positioned relatively low on the head and do not extend much above the dorsal fur line (Birney and Davis, 1966; Miller, 1897).

The aspect ratio (X = 7.55) and wing loading (X = 0.086) indicate that red bats fly relatively fast and are moderately maneuverable. In fact, L. borealis has the third highest aspect ratio and wing loading of 25 species of North American bats measured by Farney and Fitchart (1969).

Facial glands of L. borealis are comparatively more diverse and numerous than for nonfoliage-roosting species. Four distinct groups of glands are recognized: sudoriferous, sebaceous, paired submaxillary, and paired sublingual (Werner and Dalquest, 1952).

The baculum, as described by Hamilton (1949) is shaped somewhat like a slipper. The high base is slanted forward, appearing in dorsal view as a rounded spur directed over the shaft. The dorsal sides of the base are concave, joining with the shaft to form broad flanges. On the ventrum these flanges form the lateral borders of a deep concavity. The distal tip has a slight rise and is somewhat thickened and broader than the central shaft. The spermatozoa of L. borealis were described by Birtle (1960). The head has a concave base, and the apex is blunt and broadly rounded. Measurements (in mm) of the head are: length, 5.3 (5.0 to 5.7); width, 2.0 (1.9 to 2.5). The midpiece is not spired, and there is an evident swelling near the posterior end; its length is 11.2 (10.5 to 12.2) and the width is 0.8 (0.7 to 1.0). The tail is nearly uniform in width, with a length of 67.0 (64.0 to 70.0). Compared with spermatozoa of other vesperid bats (Forman, 1969), those of L. borealis have a unique bulge in the posterior region of the midpiece.

FUNCTION. Jones (1965) found that red bats became active outdoors when temperatures reached about 20°C. Davis and Lidicker (1956) and Lewis (1940) found them flying at ambient temperatures of 19°C and 13°C, respectively. This suggests that the ambient temperature initiating arousal is much higher than the temperature of hibernating cave bats, which would protect them from waking too frequently and wasting energy during winter.

This species seems capable of surviving even drastic temperature fluctuations. Individuals remain torpid in the laboratory below 20°C and decrease their heart rates to less than 16 beats/min at 5°C (Davis and Reite, 1967). They respond to subfreezing temperatures by increasing metabolism just enough to maintain body temperatures above the critical low limit of −5°C (Reite and Davis, 1966). Several other adaptations for surviving low temperatures include the short, rounded ears which minimize heat loss, the thick insulative pelt (insulation, °C kcal−1 h−1 m−2 averages 0.279, SE = 0.001), and a heavily furred uropatagium, adding about 13% insulation when wrapped over the pelts. This foliage-roosting bat is much better insulated than species of Myotis and Eptesicus which roost in caves and buildings (Shump and Shump, 1980).

Quay and Miller (1955) counted 17.63 ± 10° erythrocytes/mm³ of blood in a male taken in summer, and Dunway and Lewis (1965) reported an average 19.6 ± 10° in five individuals. These are relatively high values for mammals (four times that of humans) and may be an adaptation to the environmental stresses to which red bats are exposed.

ONT GENY AND REPRODUCTION. Lasiurus borealis breeds in August and September (Glass, 1966; Hamilton, 1943; Layne, 1958; Stuever, 1948); fertilization occurs in the spring. Copulation apparently is initiated in flight.

Jackson (1961) estimated that the gestation period is from 80 to 90 days. Mumford (1973) suggested that most young are born in mid-June in Indiana. Kurtz (1980) reported that red bats apparently gave birth in June; lactating females were found into early August in southern Lower Michigan. Pregnant females were found through 10 June in central Iowa, although lactating individuals were not captured until 20 June. The estimated median parturition date was 15 June and lactation lasted approximately 38 days (Kunz, 1971). Counts of embryos per female (n = 45) of L. b. borealis average 3.2 (Cockrum, 1955; Jennings, 1958; Layne, 1958), but the number of young born per litter ranges from one to five (Hamilton and Stalling, 1972; Mumford, 1973), with an average of 2.3 (Binney and Rising, 1968; Constantine, 1966; Jones et al., 1967; McClure, 1942). This discrepancy is probably due to intrauterine mortality and resorption or high mortality among the young. Measurements (mm) of three embryos that were probably near term were: total length, 44, 44, 41; tail length, 15, 12, 12; length of foot, 6, 6, 6 (Whitaker and Mumford, 1972). The sex ratio at birth is about equal, with a slight tendency toward more males (Jackson, 1961).

Very young bats cling to the fur of their mother with their teeth and thumb-claws as well as their hindfeet (Jackson, 1961). As they get older and larger each young clings the mother with its wings but hangs from a leaf or twig with one or both feet during the day (Johnson, 1932). The mother generally leaves the young at the roost when she forages for food in the evening. Times when females have been seen flying with young probably are instances where the mothers are moving their young to another roost (Barbour and Davis, 1969).

Little data on growth and development are available, but young are born completely hairless and with eyes closed, and weigh about 0.5 g each. By 3 or 4 weeks of age their eyes have opened, their fur is short but dense, and the weight of each is 4 to 5 g, or nearly half the weight of the mother (Jackson, 1961). Kurtz (1980) reported that the forearm size of four neonates varied from only 12.7 to 16.6 mm. The greatest forearm length of juveniles captured from 10 June to 14 July was 38.6 mm, which is less than that of most adults. Estimates are that the young are weaned in weeks 4 to 6, and that they can fly by sometime between week 3 and 6 (Barbour and Davis, 1969; Hamilton, 1943; Jackson, 1961). In Iowa, young were flying by 21 July (Kunz, 1971). Mumford (1973) and Whitaker and Mumford (1972) suggested that young probably become independent when 80 to 85 mm in total length.

ECOLOGY. Red bats are solitary, roosting mostly in trees or shrubs, sometimes near or even on the ground (Hall and Kelson, 1959). Roost sites in summer are often used by different individuals on different days (Constantine, 1966; Downes, 1964). Downes (1964) found that in captivity one bat will respond to sounds made by others and may be attracted by vocalizations to resting sites. He found five different bats in a 7-day period on the underside of a sunflower leaf in Illinois during August, although other suitable leaves in the row existed. He thought there was some kind of communication among the bats for the favored site. During the day, red bats commonly roost in edge habitats adjacent to streams, open fields, and in urban areas (Constantine,

1958, 1959, 1966; Kunz, 1973; Mumford, 1973). McClure (1942) studied use of tree species by bats in Lewis, Iowa. Constantine (1948) observed few bats in a town of Lewis County because there was sparse leaf density at the time of study. The red bats he found were in places distant from human population centers. Of 100 roost stations found, tree species were: Aesculus pavia, elder, 33; Zelkova carpinifolia, 24; and wild cherry, 3; Chinese elm, 2; mulberry, 1; willow, 1; hickory, 1; catalpa, 1; hawthorn, 1; sumac, 1; and black walnut, 1. Roosts generally provided dense shade and cover above and at least 1 m above ground except for family clusters, which often were 3 to 6.2 m high. There appeared to be no difference in preference among adults, but young occupied higher roosts after family groups broke up (Constantine, 1966). Mumford (1973) noted the average site size of 2.6 h and 2.3 m along the mouths of 13 m. Watkins and Shump (unpubl.) found preferred roost sites correlated well with reduced evaporative water loss.

Barbour and Davis (1969) described the flight pattern of red bats during foraging. Upon emergence, they went to a higher air, where they exhibited a slow, flapping, erratic flight. After 15 to 30 min, they descended and fed from treetop level to within a few feet of the ground. At this time they flew straight or in wide circles. The pattern was only broken to chase and capture insects not regularly found to be on foraging red bats (Davis, 1960). LaVal et al. (1977) found that both L. borealis and L. cinererus usually forage high above trees and pastures.

Kunz (1973) reported that red bats generally begin to forage 1 to 2 h after sunset, with some bats feeding throughout the night (see also Mumford, 1973). Jones (1965) found that red bats emerged just prior to L. cinererus, which appeared 1 h 40 min after sunset. In Missouri, Shump and Watkins (unpubl.) noted that red bats were first active just prior to hoary bats, but always later than other sympatric vespsilionids. The initial foraging period generally corresponds to the early period of nocturnal activity of insects reported for a number of groups, and the minor season appears to be correlated with increased activity of insects often noted several hours before sunrise (Kunz, 1973). Kunz (1973) indicated that red bats were similar to hoary bats in foraging on fewer taxa of insects than sympatric Myotis and Eptesicus. Ross (1967), however, suggested that L. borealis probably selects food according to the size of the insects and does not limit its choices to 1 or 2 groups. Whittaker (1972) found that of 128 stomachs analyzed in Indiana, 26.2% of the contents by volume was moths. Representative of Hemerobia, Coleoptera, Hymenoptera, Diptera, and Lepidoptera have been found in the stomachs of red bats (Mumford, 1973; Ross, 1967). They also feed on ground-dwelling crickets, flies, bugs, beetles, cicadas, grain moths, and wasps (Connor, 1943; McWhirter, 1943; Slessor, 1961; Lewis, 1940). We, Hamilton and Whitaker (1970), and Wilson (1965) have observed red bats around street lights in the city and flood lights on the sides of barns, presumably catching insects during these periods.

Records of movement patterns for individual red bats are sparse. Winterting sites are not well documented, but are probably in southern states; their numbers increase there from December to March. Although red bats have been seen at the mouths of caves in July, August, and September, they probably hibernate in trees in winter (Barbour and Davis, 1969; Davis and Lidicker, 1956; Mumford, 1973; Poole, 1932). Nevertheless, red bats sometimes enter and presumably become lost in caves in autumn (Mumford, 1973; Ross, 1967; Myers, 1960) found 100 or more in Missouri caves; they ranged from skeletons to well preserved specimens. They are most common in caves during August, but are rarely found there at other times of the year; the reason for their presence in August is not known (Barbour and Davis, 1969). Red bats arouse from hibernation on warm days to feed, often before dusk (Barbour and Davis, 1969; Davis and Lidicker, 1956; Whitaker and Mumford, 1972). LaVal and LaVal (1979) reported having seen red bats roosting at 7°C during winter.

Red bats are generally considered to be highly migratory. Although generally solitary, red bats seem to migrate in groups and forage in close association with one another in summer (LaVal and LaVal, 1979). Males and females seem to migrate at different times and to have different summer ranges (Grinnell, 1918; Williams and Findley, 1979). During summer, a preponderance of females has been reported in Missouri (Kuz, 1909), but females are even more common in Louisiana (LaVal and LaVal, 1979), central Iowa (Kuz, 1971), Indiana (Whitaker and Mumford, 1971), and southern Illinois (Layne, 1958); Baker and Ward (1976) noted that females are absent in winter from sodalacets in western Arkansas. Mumford (1973) reported that most bats leave Indiana by October and November and return between March and April, although some certainly remain all winter. LaVal and LaVal (1979) reported no set time of flights in Louisiana during the winter months. Data for California indicate that males and females winter together but may use different summer ranges (Williams and Findley, 1979).

Red bats have been found associating with other species only when foraging or drinking. They have been observed foraging with Eptesicus fuscus, Lasius varipes, Lasiogryllus noctivagans, Nycticeius humeralis, Pipistrellus subflavus, Myotis lucifugus, and M. kermisi (Barbour and Davis, 1969; Kunz, 1973). Opossums (Didelphis virginiana), domestic cats (Felis catus), sharp-shinned hawks (Accipiter striatus), American kestrels (Falco sparverius), merlins (Falco columbarius), great horned owls (Bubo virginianus), and roadrunners (Geococcyx californianus) are known to prey on red bats. In eastern North America blue jays (Cyanocitta cristata) are probably the most important predator, particularly of the young (Allan, 1947; Downing and Lehman, 1961; Drake, 1965; Huffaker, 1962; Hoffmann and Downes, 1964; John and Cole, 1967; Lowery, 1974; Mumford, 1973; Sperry, 1933; Streeker, 1924; Wilks and Laughlin, 1961).

Parasites reported from red bats include: mites—Steato myssus farmani, S. occidentalis, Acanthiphorus sp. (Ewing, 1933; Tipton and Boese, 1958; Whitaker, 1973; Whitaker and Wilson, 1974); flies—Eptesocapsa sp. (Jackson, 1961); bat bugs—Cimex pilosellus (Jackson, 1961); Lowery, 1974); hemiménta—Leothodi denium sp., Teenua sp., Luscinia siberica lasius, eleutherodactylus (Jackson, 1961; Lowery, 1974; Tromba, 1954); and protozoa—Distoma sp. (Jackson, 1961).

A relatively high incidence of rhabds has been noted for red bats. In Indiana, 7.2% of red bats examined between 1965 and 1968 (Whittaker et al., 1969) and 7.0% examined between 1968 and 1972 (Whittaker and Miller, 1974) were rhabd. The same investigators found higher incidences only in Lasius cinererus and Pipistrellus subflavus. Other higher incidences of rhabd red bats have been reported from various parts of the United States by Burns et al. (1956), Constantine (1967), Enright (1962), Irons et al. (1957), Richardson et al. (1966), Schneider et al. (1967), Schnurrenberger et al. (1968), Tirker et al. (1960), Trimarchi (1978), and Wiseman et al. (1962).

GENETICS. Lasius borealis has a karyotype of 2n = 28, FN = 48. It consists of seven pairs of large metacentric and sub-metacentric chromosomes, three pairs of medium metacentrics, and three pairs of small acrocentrics. The X chromosome is a medium submetacentric and the Y chromosome is a small acrocentric (Baker and Patton, 1967). Beckham (1979) presented G- and C-band data for L. borealis.

REMARKS. The generic name Lasius is derived from two Greek words meaning "lizard tail." The specific name borealis is from a Latin word meaning "northern."

Orr (1958) fed L. borealis mealworms supplemented with vitamins (Stuart Liquid Formula) at a level of one drop per bat on every other day. Bats did not learn to feed by themselves in less than 1 month. Red bats have been successfully maintained in captivity for several months (Gates, 1936, 1938; Orr, 1958).

In acclimating L. borealis to captivity, Nellis (1969) placed them directly on top of caviar in their cage mesh. Movement of mealworms induced the bats to bite and then subsequently consume prey. They later learned to fly down from the cage top and feed off the cage floor. Subsequently, they were maintained on mealworms and water with a multivitamin supplement. Other general information useful in raising bats is found in Russeweiler (1977).

K. Koopman graciously provided records necessary to approximate the range of L. borealis in South America.

LITERATURE CITED


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