

Myotis septentrionalis. By M. Carolina Caceres and Robert M. R. Barclay

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***Myotis septentrionalis* (Trouessart, 1897)**

Northern Long-eared Bat

Vespertilio gryphus var. *septentrionalis* Trouessart, 1897:131. Type locality "Halifax, Nova Scotia."

Myotis keenii septentrionalis Miller and Allen, 1928:105.

Myotis septentrionalis van Zyll de Jong, 1979:993. First use of current name combination.

CONTEXT AND CONTENT. Order Chiroptera, suborder Microchiroptera, family Vespertilionidae, subfamily Vespertilioninae, genus *Myotis*, subgenus *Myotis* (Findley, 1972). This species was presented as a subspecies of *M. keenii* in Mammalian Species No. 121 (Fitch and Shump, 1979). *M. keenii* and *M. septentrionalis* occupy nonoverlapping ranges. Thus, any reference to *M. keenii* (Keen's myotis or Keen's bat) occurring outside of the Pacific Northwest of North America refers to *M. septentrionalis*. No subspecies are recognized.

DIAGNOSIS. *Myotis septentrionalis* (Fig. 1) can be distinguished from *M. lucifugus* by its longer ears and tragus and relatively longer tail. *M. septentrionalis* is similar in color to *M. lucifugus*, but *M. lucifugus* has a glossier pelage. Unlike *M. lucifugus*, the maxillary tooththrow of *M. septentrionalis* exceeds width across molars. *M. septentrionalis* also has a least interorbital width/length of maxillary tooththrow ratio <0.7 , whereas that of *M. lucifugus* is >0.7 (van Zyll de Jong, 1985). *M. septentrionalis* can be distinguished from *M. evotis* by its darker pelage and paler membranes, which give *M. septentrionalis* an overall brown look. *M. keenii* usually possesses dark shoulder spots and a sparse scattering of hair along free end of uropatagium, characteristics that are not present in *M. septentrionalis*. Skull of *M. keenii* is distinguished from that of *M. septentrionalis* by a width of canine at cingulum of <0.76 mm. Both *M. keenii* and *M. evotis* tend to have longer ears and a narrower skull (van Zyll de Jong, 1979).

GENERAL CHARACTERISTICS. Head and body length <50 mm, with total length up to 95 mm. Hind foot is generally $<60\%$ length of tibia. Pelage and membranes are light brown; membranes usually concolor with pelage. Ears are long and usually extend past the nose when pushed forward. Third, fourth, and fifth metacarpals are of about equal length. Skull is narrow with a relatively long rostrum. Females are generally larger and heavier than males (Caire et al., 1979; Williams and Findley, 1979).



FIG. 1. *Myotis septentrionalis* at a roost hole. Photograph by M. B. Fenton.

Body mass is 5–8 g. Mean (van Zyll de Jong, 1985) and range Glass and Ward, 1959; Turner, 1974) of some external and skull measurements (in mm) are as follows (Fig. 2): length of forearm, 36.4 (34–38); length of ear, 16.4 (14–19); total length, 86.2 (77–95); length of tail, 37.7 (35–42); length of hind foot, 9.4 (8–10); greatest length of skull, 14.8 (14.6–15.6); mastoid breadth, 7.8 (7.4–7.9); length of maxillary tooththrow, 5.8 (5.4–6.0); least interorbital width, 3.7 (3.4–3.8); and zygomatic breadth, 8.2–9.7. Other mean cranial measurements (in mm) include cranial depth, 5.0



FIG. 2. Dorsal, ventral, and lateral view of the skull and lateral view of the mandible of a male *Myotis septentrionalis* (Provincial Museum of Alberta, Z79.116.1, from Cadomin, Alberta). Greatest length of skull 15.3 mm. Photographs by G. Newlands.

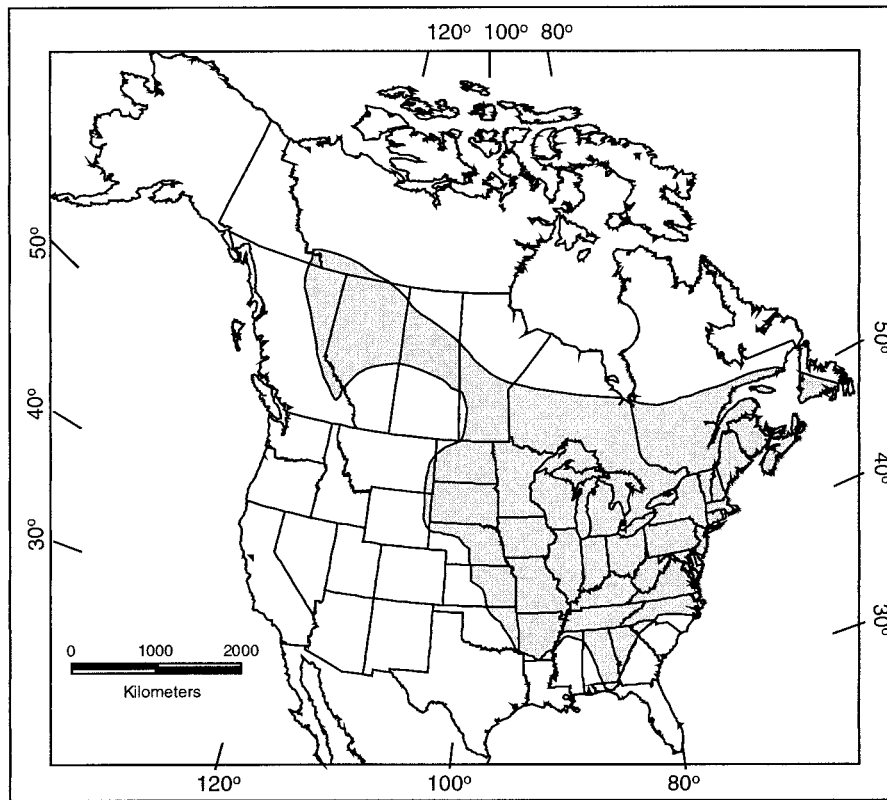


FIG. 3. Geographic distribution of *Myotis septentrionalis* in North America. (Adapted from Hall, 1981; van Zyll de Jong, 1985.)

(range, 4.7–5.5); maxillary width at M3, 5.6 (range, 5.0–5.9); orbital width at the lacriminal foramina, 4.49 (*SD*, 0.181); rostral width immediately posterior to canines, 3.57 (*SD*, 0.134); palatal width at P2, 3.66 (*SD*, 0.130); width of upper incisors, 2.65 (*SD*, 0.096); length of P4/M3 series, 4.00 (*SD*, 0.111); length of M2, 1.22 (*SD*, 0.056); width of M2, 1.59 (*SD*, 0.086); and basal width of the upper canine at the cingulum, 0.81 (*SD*, 0.038—van Zyll de Jong, 1979, 1985). Dental formula is $i\ 2/3$, $c\ 1/1$, $p\ 3/3$, $m\ 3/3$, total 38.

DISTRIBUTION. *Myotis septentrionalis* is widely distributed in eastern United States and Canada (Fig. 3). It is commonly encountered, especially during swarming and hibernation, in Canadian Maritimes, Quebec, Ontario, and New England states. However, it also ranges as far south as Florida and west into Alberta, British Columbia, Montana, and Wyoming. It is uncommon at western extremes of its range. Few captures of this species occur in treeless prairie regions of Canada and United States. Fossil forms of *Myotis septentrionalis* occur in six different Pleistocene cave deposits in Pennsylvania, Virginia, West Virginia, and Tennessee (Kurtén and Anderson, 1980).

FORM AND FUNCTION. Seasonal increases in mass for male and female *M. septentrionalis* are 45% and 41%, respectively, between August and October, presumably due to an increase in fat stores prior to hibernation (Caire et al., 1979). At the end of hibernation, bats had lost this extra mass.

Myotis septentrionalis tends to have a longer tail and larger wing area than aerial hawking *Myotis* species of similar size. These structural adaptations are associated with gleaning, a foraging strategy whereby bats capture prey items moving on foliage (Faure et al., 1993). They also allow *M. septentrionalis* to be more maneuverable during slow flight. This is beneficial for bats flying in cluttered areas (Norberg and Rayner, 1987).

ONTOGENY AND REPRODUCTION. In Indiana and Ontario, male and female *M. septentrionalis* begin visiting hibernacula and copulating from late July until September or early October (Fenton, 1969; Whitaker and Rissler, 1992a). A male *M. septentrionalis* mounts a female from behind and occasionally grasps the female's neck with his teeth (Caire et al., 1979). Females

probably store sperm over winter and fertilize a single egg in the spring.

Parturition in *M. septentrionalis* may occur between mid-May and mid-June in southeastern portions of its range but may occur as late as mid-July in more northern portions (Caire et al., 1979; Cope and Humphrey, 1972; Easterla, 1968; Hamilton and Whitaker, 1979). In Missouri, lactating females were caught in mid-June (Caire et al., 1979). However, pregnant females were collected in late June and July in British Columbia, New York state, and Iowa (Clark et al., 1987; Hamilton and Whitaker, 1979; van Zyll de Jong et al., 1980). A female *M. septentrionalis* with a nonvolant offspring was observed 12 June in Ohio (Brandon, 1961), and another female with a nonvolant young was observed in late June in Missouri (Caire et al., 1979). Subadults were captured in early August in Missouri and Ohio but soon after were indistinguishable from adults (Caire et al., 1979; Mills, 1971). In Iowa and New Hampshire, subadults were captured as early as July (Clark et al., 1987; Sasse and Pekins, 1996).

ECOLOGY. During winter, *M. septentrionalis* is found at hibernacula, which are commonly caves or abandoned mines (Caire et al., 1979; Griffin, 1940; Hitchcock, 1965; Whitaker and Rissler, 1992a, 1992b). Hibernation is preceded by "swarming," or flights through the hibernacula, which occurs in August and September in Ontario. *M. septentrionalis* was the second most common species captured swarming at Renfrew Mine in Ontario but made up <10% of all individuals caught (Fenton, 1969). Length of hibernation varies with latitude and corresponding environmental factors. Hibernation may begin from September to early November and last until March, April, or May (Caire et al., 1979; Fenton, 1969; Nagorsen and Brigham, 1993; Whitaker and Rissler, 1992a, 1992b).

Myotis septentrionalis will return to the same hibernaculum although not always in sequential seasons. Individuals generally hibernate with large numbers of bats of other species, particularly *M. lucifugus*, *Eptesicus fuscus*, and *Pipistrellus subflavus*, but *M. septentrionalis* usually forms a small proportion of the total hibernating population (Caire et al., 1979; Griffin, 1940; Hitchcock, 1949; Mills, 1971). One of the largest hibernating populations was about 300 *M. septentrionalis* hibernating with about 1,000 *M. lu-*

cifugus in an abandoned mine in Quebec (Thomas, 1993). A large number of bats caught when trapping at an abandoned mine entrance in mid-March were *M. septentrionalis* (Whitaker and Rissler, 1992b). This species may be easily overlooked in a hibernaculum because it prefers to cluster in deep crevices, which are hard to sample (Glass and Ward, 1959; Griffin, 1940; Raesly and Gates, 1986; Whitaker and Rissler, 1992a). *M. septentrionalis* may move between hibernacula throughout winter (Griffin, 1940; Whitaker and Rissler, 1992b), which may affect population estimates.

During summer, *M. septentrionalis* occupies a variety of day and night roosts. It favors tree roosts, although individuals have been found in human-made structures (Barbour and Davis, 1969; Foster and Kurta, 1999; Kunz, 1973; Sasse and Pekins, 1996; van Zyll de Jong, 1985). Sexes roost separately, and reproductive females form small maternity colonies of <60 individuals. Maternity groups roost in trees, under shingles, and in buildings (Brandon, 1961; Clark et al., 1987; Foster and Kurta, 1999; Mumford and Cope, 1964; Nagorsen and Brigham, 1993; Sasse and Pekins, 1996).

During the day, female *M. septentrionalis* in New Hampshire prefer to roost in tall, large-diameter hardwood trees in early stages of decay (Sasse and Pekins, 1996). *M. septentrionalis* in British Columbia also roosted in tall, early decay trees or in live trees with less canopy closure than randomly available trees (Caceres, 1998). Female *M. septentrionalis* in Michigan roosted in crevices, in hollows, or under bark of live and dead deciduous trees. Females roosted in larger-diameter tree species (maples, *Acer*, and green ash, *Fraxinus pennsylvanica*) present in the stand, but characteristics of occupied and unoccupied trees were not significantly different (Foster and Kurta, 1999). Individual bats frequently switch roost trees, and roost trees tend to be clustered together (Caceres, 1998; Foster and Kurta, 1999; Sasse and Pekins, 1996). Majority of roost trees in Michigan were in a 20-ha site with females traveling an average of 191 m (SE, 22 m) between roosts. Roost switching occurred about every 2 days (Foster and Kurta, 1999). In New Hampshire, roost trees were grouped an average of 602 m (SE, 66.6 m) from foraging areas (Sasse and Pekins, 1996).

Adult males and nonreproductive females roost singly or in small (<10) groups in or on buildings, caves, or trees (Nagorsen and Brigham, 1993; Nagorsen and Nash, 1984; Turner, 1974). Occasionally, *M. septentrionalis* will use caves as temporary night roosts between foraging bouts (Barbour and Davis, 1969). Distance traveled between summer habitat and hibernacula may be up to 56 km (Nagorsen and Brigham, 1993).

Myotis septentrionalis feeds on Lepidoptera, Coleoptera, Neuroptera, Diptera, Hemiptera, Homoptera, and Hymenoptera (Caceres, 1998; Griffith and Gates, 1985; LaVal and LaVal, 1980; Whitaker, 1972). Diet varies with geographic location or season and among individuals (Caceres, 1998; Whitaker, 1972). *M. septentrionalis* may be an opportunistic forager and is probably limited only by the size of insect it can obtain (Kunz, 1973).

Longevity record for *M. septentrionalis*, based on bats banded in the wild, is 18.5 years (Hall et al., 1957). Anecdotal observations of predation on *Myotis* bats have not included *M. septentrionalis*. *M. septentrionalis* hosts chiggers (Trombiculidae: *Euschoengastia pipistrelli*, *Leptotrombidium myotis*), other mites (Acarina: *Acanthopthirus*, *Macronyssus crosbyi*, *Spinturax americanus*, *Olabi-docarpus whitakeri*), batbugs (Cimicidae: *Cimex adjunctus*—Jones and Genoways, 1967; Whitaker, 1973), and internal helminths (*Hymenolepis christensoni*, *Vampirolepis roundabushi*, *Prosthodendrium volaticum*, *Plagiorchis vespertilionis*—Blankespoor and Szymusiek, 1974; Nickel and Hansen, 1967). Rabies virus (CVS 27) and eastern equine encephalomyelitis have been detected in a few northern long-eared bats (Burnett, 1989; Main, 1979).

BEHAVIOR. *Myotis septentrionalis* feeds on flying insects, but also gleans prey from substrates (Faure et al., 1993). Gleaning bats use passive listening as well as echolocation to locate insects resting on leaves, tree trunks, or against buildings. Gleaning allows a broader diet, including insects that may be able to detect echolocation calls of aerial hawking bats (Faure et al., 1993).

Northern long-eared bats forage under the forest canopy, at small ponds or streams, along paths and roads, or at the forest edge (Caire et al., 1979; Fenton et al., 1983; van Zyll de Jong et al., 1980). In Iowa, an initial foraging peak occurred during the first 2 h after sunset, corresponding to a sunset peak in insect activity. *M.*

septentrionalis also foraged during a presunrise peak of insect activity (Kunz, 1973).

Myotis septentrionalis uses frequency modulated (FM) echolocation calls of a higher frequency (126–60 kHz), shorter duration (1.01 ms), broader bandwidth, and lower intensity (78 dB) than other *Myotis* species, which only aerial hawk (Faure et al., 1993). Calls exhibit a sharp FM sweep, which is almost linear over time (Fenton et al., 1983; Miller and Treat, 1993). High-frequency, low-intensity *M. septentrionalis* calls may be relatively inaudible to prey such as some moths and lacewings (Faure et al., 1993).

GENETICS. Karyotype of *M. septentrionalis* is $2n = 44$ with $FN = 50$ (Baker and Patton, 1967). Of the 21 pairs of autosomal chromosomes, 4 are metacentric or submetacentric and 17 are acrocentric. Both sex chromosomes are submetacentric.

CONSERVATION STATUS. Although *M. septentrionalis* is common in eastern portions of its range, it is rarely captured at western extremes. In Canada, *M. septentrionalis* is on the “blue list” in British Columbia and Alberta (Alberta Wildlife Management Division, 1996; Cannings et al., 1999). It is not considered at risk in the United States.

REMARKS. *Myotis septentrionalis* originally was considered a subspecies of *M. keenii* (Fitch and Shump, 1979) until van Zyll de Jong (1979) proposed division of *M. keenii* into two distinct species. Manning (1993) suggested that *M. keenii* and *M. septentrionalis* are sister species, whereas van Zyll de Jong and Nagorsen (1994) argued that *M. evotis* and *M. septentrionalis* are sister species, based on external and cranial characteristics.

Myotis is derived from the Greek for “mouse eared.” *Septentrionalis* comes from the Latin for “northern” (Nagorsen and Brigham, 1993). Other common names for this species are northern bat (Foster and Kurta, 1999) and northern myotis (Jones et al., 1997).

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