

Condylura cristata. By Karen E. Petersen and Terry L. Yates

Published 15 April 1980 by The American Society of Mammalogists

Condylura Illiger, 1811

Condylura Illiger, 1811:125. Type species *Sorex cristatus* Linnaeus by original description.

CONTEXT AND CONTENT. Order Insectivora, Family Talpidae, Subfamily Condylurinae. The genus *Condylura* has one living and two fossil species.

Condylura cristata (Linnaeus, 1758)

Star-nosed Mole

(*Sorex*) *cristatus* Linnaeus, 1758:53. Type locality Pennsylvania (fixed by Jackson, 1915:87, as eastern Pennsylvania).

Talpa longicaudata Erxleben, 1777:118. Type locality North America.

Talpa caudata Zimmermann, 1777:497. Type locality North America.

Talpa radiata Shaw, 1800:523. New name for *Sorex cristatus* Linnaeus.

Sorex radiatus Shaw, 1800:531. Type locality Canada.

Condylura cristata Desmarest, 1819:230. First use of name combination.

Condylura longicaudata Desmarest, 1819:232. New name for *Talpa longicaudata* Erxleben. Type locality North America.

Condylura macroura Harlan, 1825:39. Type locality New Jersey.

Astromycter prasinatus Harris, 1825a:400. Type locality Maine.

Condylura prasinata Harris, 1825b:582. New name for *Astromycter prasinatus* Harris. Type locality Maine.

CONTEXT AND CONTENT. See generic summary above. Two subspecies are currently recognized (Yates, 1978):

C. c. parva (Paradiso, 1959:103). Type locality Virginia, Patrick Co., 5 mi. NW Stuart.

C. c. cristata (Desmarest, 1819:230), see above (*nigra* Smith is synonym).

DIAGNOSIS. Anterior nares directed obliquely upward; nose having ring of 22 fleshy appendages (Fig. 1); tail approximately as long as body, constricted at base, scaled, annulated; skull with high narrow braincase (Fig. 2); mastoids weak; rostrum long and narrow with distinct supero-medial crest in adults; premaxillae much extended beyond nasals anteriorly; first upper incisors large, curved and directed anteriorly; second upper incisors minute, third large and caniniform; first lower incisors moderate in size, flat, and directed anteriorly; second and third lower incisors much smaller than first and directed anteriorly; upper canine short and slender; lower premolars small, laterally compressed, successively increasing in size posteriorly; upper molars W-shaped in transverse section, with an anterior, basal shelf having an indistinctly tricuspidate edge; lower molars M-shaped in transverse section, laterally compressed; interior shelf narrow, tricuspidate. Dentition: i 3/3, c 1/1, p 4/4, m 3/3, total 44.

GENERAL CHARACTERS. *Condylura cristata* is the only North American talpid, other than *Neurotrichus gibbsii*, which fails to show significant differences in size between males and females. In general, specimens are largest in the northern parts of the species range, gradually decrease in size to the south, and reach a minimum size in western Virginia, eastern Tennessee, and western North Carolina.

Measurements in millimeters for *Condylura cristata* (N = 7) from eastern Nova Scotia (Yates, 1978) are as follows: total length, 194.8 (177.0 to 206.0); length of tail, 74.3 (70.0 to 78.0); greatest length of skull, 34.5 (34.1 to 35.2); basilar length, 28.2 (27.7 to 29.2); mastoid breadth, 13.4 (12.9 to 13.8); interorbital breadth, 7.2 (7.1 to 7.3); length of maxillary toothrow, 11.3 (10.9 to 11.8); length of palate, 14.8 (14.2 to 15.2); breadth across second molars, 7.6 (7.4 to 8.0); breadth across canines, 3.4 (3.2 to

3.6); depth of skull, 10.3 (9.9 to 10.8); and breadth of mesopterygoid fossa, 3.5 (3.3 to 3.6).

Measurements for *C. cristata* (N = 22) from western Pennsylvania (Yates, 1978) are as follows: total length, 180.0 (161.0 to 191.0); length of tail, 69.0 (61.0 to 76.0); greatest length of skull, 33.0 (32.1 to 34.3); basilar length, 27.1 (26.4 to 28.1); mastoid breadth, 13.1 (12.7 to 13.6); interorbital breadth, 6.9 (6.6 to 7.2); length of maxillary toothrow, 10.6 (10.0 to 11.0); length of palate, 13.7 (13.0 to 14.4); breadth across second molars, 7.3 (6.6 to 7.7); breadth across canines, 3.1 (2.9 to 3.3); depth of skull, 9.7 (9.0 to 10.4); and breadth of mesopterygoid fossa, 3.3 (3.0 to 3.7).

Hall and Kelson (1959) listed the following range in measurements for external and cranial characters for the species: total length 183 to 211; length of tail 65 to 83.5; hind foot length 26 to 30; and greatest length of skull 33.9 to 35.2.

Compared with *Condylura cristata cristata* to the north, *C. c. parva* has a shorter, shallower, narrower skull. All cranial measurements except interorbital breadth, breadth across the second molars, breadth across canines, and breadth of the mesopterygoid fossa average less. *Condylura cristata parva* is distinguished most easily from *C. c. cristata* by the following characters: greatest length of skull seldom greater than 34.0 mm in *C. c. parva*, seldom less in *C. c. cristata*; length of palate seldom greater than 14.4 mm in *C. c. parva*, seldom less in *C. c. cristata*; depth of skull seldom greater than 10.0 mm in *C. c. parva*, seldom less in *C. c. cristata*.

DISTRIBUTION. *Condylura cristata* occurs throughout much of the northeastern United States and eastern Canada (Fig. 3). In the northern part of its range, it is found from extreme eastern Manitoba and Minnesota to as far northeast as Labrador and Nova Scotia. The species ranges southeastward through much of Wisconsin, northern Indiana and Ohio, along the Atlantic coast as far south as southeastern Georgia, and in the Appalachian Mountains to eastern Tennessee and western North Carolina.

FOSSIL RECORD. Hutchison (1968) reviewed the fossil record of moles in North America. The first star-nosed mole fossils were found at the New Paris sinkholes near Bedford, Penn-

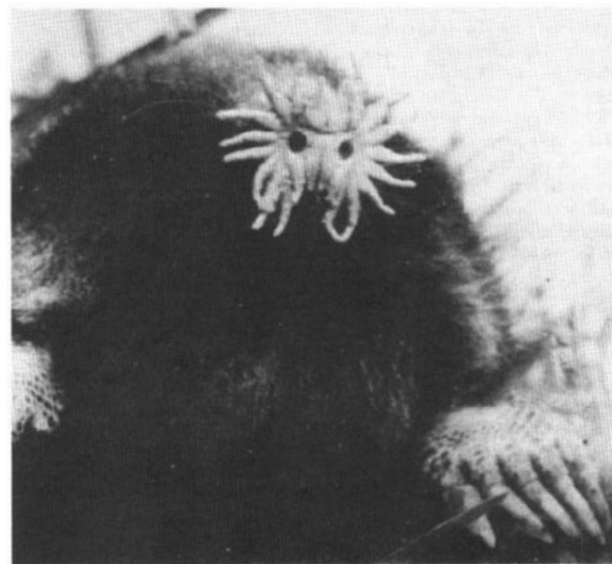


FIGURE 1. Anterior view of face and fleshy appendages on nose of *Condylura cristata*.

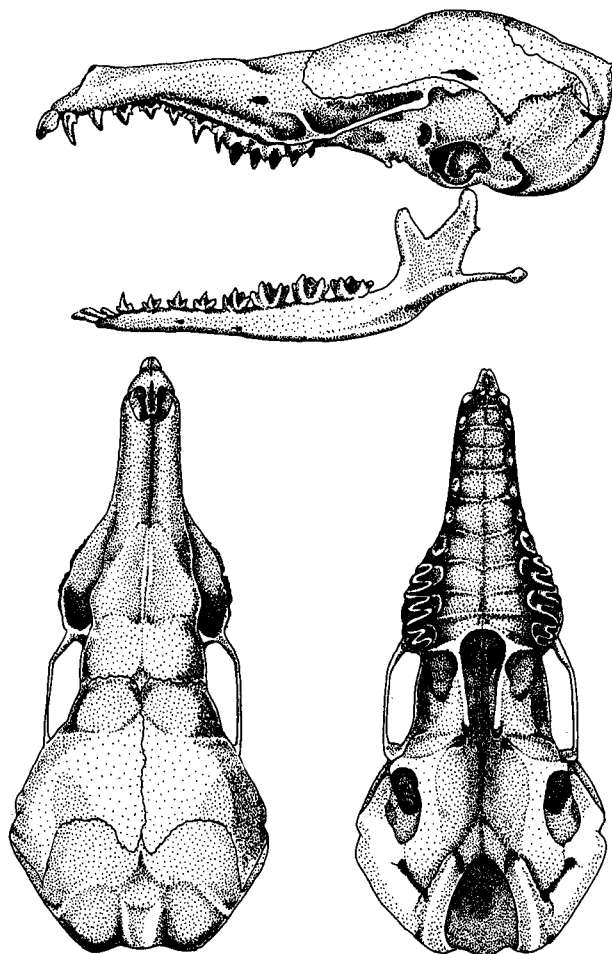


FIGURE 2. Dorsal, ventral and lateral views of skull of *Condylura cristata cristata*. Scale is 10 mm. Drawing by Patricia E. Hadley.

sylvania (Guilday et al., 1964). These fossils were of late Pleistocene origin (11,000 years B.P.). Other fossils of star-nosed moles have been found from Virginia, West Virginia, Maryland, Tennessee, and Missouri (Parmalee et al., 1969) and date back to as early as 700,000 years B.P. (Guilday, 1979).

Abundant fossils of *Condylura* dating from the middle and late Pliocene (4 million years B.P.) have been found in Poland (Skoczen, 1976). Two species of *Condylura* were described on the basis of these fossils: *C. kowalski* and *C. izabellae* (Skoczen, 1976). Skoczen (1976) hypothesized that *Condylura* became extinct in the Old World as a result of competition with species of the subfamily Desmaninae (large, aquatic, muskrat-sized moles with no adaptations for digging). The first known record of *Condylura* in North America was from the mid-Pleistocene (Guilday, 1979). Yates (1978) suggested that *Condylura* evolved in the Old World and dispersed to North America prior to this time while the other North American moles were derived from an earlier, separate invasion, probably during the early Miocene.

FORM AND FUNCTION. The anatomy and development of the nasal rays in the star-nosed mole were first described by Ayers (1884). Van Vleck (1965) gave a more recent and accurate anatomical description of the nasal rays. The rays contain highly sensitive tactile organs, called Eimer organs (Ayers, 1884). The Eimer organs, found also in *Talpa* (Eimer, 1871), function as mechanoreceptors similar to Pacinian corpuscles (Van Vleck, 1965). The mole's visual acuity is poor and allows it to distinguish only light intensity (Goodwin, 1935; Walls, 1963). Even *Condylura*'s olfactory and auditory systems are considered weak (Goodwin, 1935). The star-nosed mole, however, has a remarkably large external ear in comparison with other moles. Probably hearing is more important for this mole than for other, more fossorial moles (Hamilton, 1931).

Eadie (1954) discussed changes in pelage color resulting from

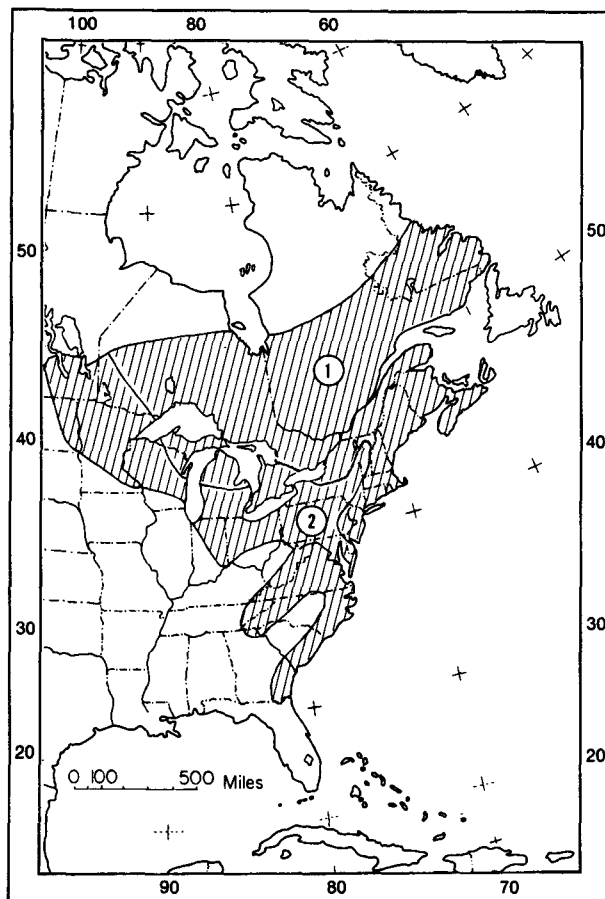


FIGURE 3. Geographic distribution of subspecies of *Condylura cristata*; 1, *C. c. cristata*; 2, *C. c. parva*.

skin gland activity. He noted that glandular areas in the dorsal head region, chin, wrists, and perineal region are most active during the breeding season. The glandular secretions resemble the ceruminous wax of the human ear and often produce a golden stain on the pelage (Eadie, 1954). Eadie (1948a, 1948b) also described the male reproductive anatomy and formation of copulatory plugs in *C. cristata*. He noted that the reproductive tract and associated glands may constitute almost 14% of the total body weight in a breeding male. The cauda epididymis has a sperm reservoir and shows some evidence of secretory activity. The glans of the penis is covered with rings of prominent epidermal spines and there is no os penis (Eadie, 1948a). A large paired prostate gland is present, which secretes corpora amylacea (Eadie, 1948a, 1948b). The prominent Cowper's gland secretes a substance which coagulates the corpora amylacea to form the copulatory plug (Eadie, 1948b). The accessory glands of *Parascalops* and *Condylura* are considered homologous (Eadie, 1948a). In female *Condylura* the uterine cornua open directly into a median uterovaginal canal, thus the copulatory plug may assure retention of the seminal mass and thereby assure mating success (Eadie, 1948b).

Pearson (1947) gave the oxygen consumption rate for an adult star-nosed mole (60 g) as 4.2–4.5 cc/g/h. Wiegert (1961) reported an oxygen consumption rate for one juvenile (20.7 g) as 1.84 cc/g/h, averaged over a 24 hour period; and 2.37 cc/g/h for a second juvenile (22.6 g) measured for one hour. He thought that the differences between his results and Pearson's (1947) might be due to lower activity of his moles or possibly a decrease in basic net rate of metabolism if the juvenile *Condylura* had only partially functional homeothermy.

ONTOGENY AND REPRODUCTION. Litters have been recorded from late March to early August with the greatest number of pregnancies occurring in April or May (Christian, 1951; Davis and Peek, 1970; Eadie and Hamilton, 1956). Females are assumed to have one litter per year (Eadie and Hamilton, 1956). Male *C. cristata* are apparently reproductively active from Jan-

uary through June (Eadie and Hamilton, 1956; Hamilton, 1931). Number of young per litter averages about five, ranging from three to seven (Davis and Peek, 1970; Eadie and Hamilton, 1956). Both males and females breed in their first year of life (Eadie and Hamilton, 1956).

Newborn young have no hair, but within 10 days the dorsum is finely covered, while hair on the belly is shorter and lighter in texture (Eadie and Hamilton, 1956; Hamilton, 1931; Simpson, 1923). The newborn young have mystacial vibrissae 3 to 6 mm long on the nasal papillae (Eadie and Hamilton, 1956; Hamilton, 1931; Simpson, 1923). Their feet are also well developed, and the nasal processes are formed but still enclosed in a thin translucent membrane (Eadie and Hamilton, 1956; Hamilton, 1931; Simpson, 1923). Ayers (1884) had mistakenly reported that the nasal rays formed after birth.

Older nestlings are covered with fine, loosely appressed black hair (Eadie and Hamilton, 1956; Hamilton, 1931). Young weighing approximately 20 g are active in the nest, while young weighing over 30 g are probably ready to be weaned and lead independent lives (Eadie and Hamilton, 1956).

ECOLOGY. Hamilton (1931) noted that the star-nosed mole is diurnal as well as nocturnal. Wiegert (1961) reported that a star-nosed mole was most active between 2300 and 0900 h, as indicated by increased rates of oxygen consumption. Star-nosed moles have been seen in the winter on or just under snow, or even swimming under the ice (Merriam, 1884; Tenny, 1871; Wood, 1922). The star-nosed mole is an excellent swimmer and is much less fossorial than other moles (Hamilton, 1931).

Condylura cristata is generally described as a gregarious, perhaps colonial, species of mole (Hamilton, 1931). There are numerous records of multiple captures, often of a male and a female in non-reproductive condition, indicating perhaps a tendency for companionship or extended courtship prior to mating (Hamilton, 1931).

Burrows of star-nosed moles are typically constructed in or near marshy areas or streams (Hamilton, 1931; Rust, 1966; Simpson, 1923). Burrows range in height from 3 to 6 cm, and in depth below the surface from 3 to 60 cm (Rust, 1966). Burrows are most common and elaborate around rocks, fallen logs, and tree roots, and often open underwater when near streams or ponds (Hamilton, 1931; Rust, 1966). There is some evidence to suggest that these moles spend more time in the water in the winter than they do in other seasons (Hamilton, 1931).

Schmidt (1931) described burrow excavation by a star-nosed mole, which is much like the burrowing technique of *Scalopus aquaticus* (Hisaw, 1923). The star-nosed mole uses lateral thrusts of its forefeet to dig, while the forefeet and shoulders are used to move the loose dirt out of the burrow (Schmidt, 1931). The star-nosed mole is an active swimmer, using lateral thrusts of its forefeet to move through the water (Hamilton, 1931; Schmidt, 1931).

Nest sites for the young of *Condylura* seem to be chosen with care to be above any high water flooding, by placement in some natural elevation (Bishop, 1902; Davis and Peek, 1970; Kennard, 1929; Hamilton, 1931; Simpson, 1923). Hamilton (1931) stated that the nest is typically composed of dead leaves, straw, and dead grasses, which are not shredded. Nests of dead grasses were reported by Bishop (1902), Davis and Peek (1970) and Simpson (1923). Wiegert (1961) described a nest made of dead leaves from the following trees: cottonwood (*Populus* sp.), hawthorne (*Crataegus* sp.), willow (*Salix* sp.) and a red oak (*Quercus* sp.). Nests for the young are considerably larger than the nest for a single adult, and are slightly more elaborate (Hamilton, 1931).

In Hamilton's (1931) study of food habits in *C. cristata*, he found that they fed almost entirely on aquatic annelids and aquatic insects (nearly two-thirds of the total diet). Schmidt (1931) found that *C. cristata* ate white grubs and earthworms while Rust's (1966) analysis of stomach contents showed *C. cristata* ate 84% *Lumbricus* spp. (earthworms). The differences in the analyses are probably a result of where the star-nosed moles were located; Hamilton's moles were collected near large bodies of water, while Schmidt's and Rust's moles were collected in areas which had only small ponds as sources of aquatic food.

Enlargement of the tail in *Condylura* occurs in both sexes, and is due to deposition of fat during the winter and early spring months (Hamilton, 1931). Eadie and Hamilton (1956) noted that the great majority of males collected just before and during the height of the breeding season had swollen tails. They also found many males after the breeding season which had thin tails, and postulated that when swollen with fatty tissue, the tails of male

C. cristata may act as a temporary reservoir for energy useful in the breeding season.

Hamilton (1931) mentions some of the parasites common to the star-nosed mole. Most ectoparasites collected by Yates et al. (1979) showed little host specificity for moles. They stated that most ectoparasites were probably acquired secondarily by the moles from rodents and insectivores which used their burrow systems. Yates et al. (1979) reported finding the mite, *Androlaelaps fahrenheitsi*, on *C. cristata*. Hamilton (1931) had previously reported finding *Androlaelaps* sp. on the star-nosed mole. Several species of Siphonaptera are also commonly found on the star-nosed mole: *Ctenophthalmus wenmanni*, *Ctenophthalmus pseudagyrtes*, and *Ceratophyllus wickhami* (Hamilton, 1931). Endoparasites are frequently found in *C. cristata*. Nematodes are often abundant, ascarids may be common in the stomach, walls of the intestine, or just under the integument, and cestodes are also occasionally found (Hamilton, 1931).

Choate (1971) and Hamilton (1931) noted that a variety of avian predators, including red-tailed hawks, great horned owls, screech owls, long-eared owls and barn owls, prey upon *Condylura*. Krull (1969) reported a *Tamias striatus* feeding upon a star-nosed mole, and Hamilton (1931) noted that a skunk had eaten a star-nosed mole. Hamilton (1931) also suspected that large fish could easily be using these moles as food.

GENETICS. *Condylura cristata* has a diploid number of 34 and a fundamental number of 64 (Meylan, 1968; Yates and Schmidly, 1975). Yates (1978) noted that *Condylura* has little genetic similarity with other North American moles ($S = .16$ to $.23$). Average heterozygosity for *C. cristata* was reported by Yates (1978) to be 0.0.

REMARKS. True (1896) stated that the name *Condylura* came from the inaccurate drawing of the animal by De La Faille, in which the tail was shown as constricted at intervals, like a string of beads. Illiger (1811) then included in his description of the species the expression "*cauda mediocris nodosa*," which translates as "tail with swollen middle ridges." Thus *Condylura* is derived from two Greek roots (*condyl*, -*ura*) which mean "knob by tail." *Crista* is a Latin root meaning "tuft" or "crest" in reference to the "star" nose of the animal.

This paper was made possible in part by grants from the Theodore Roosevelt Memorial Fund of the American Museum of Natural History and the National Geographic Society. We thank Jim Bandoli, Dave Hafner, Dwight Moore and Dave Reduker for critically reviewing the manuscript.

LITERATURE CITED

- Ayers, H. 1884. On the structure and development of the nasal rays in *Condylura cristata*. Biol. Centralblatt, 4:356-360.
- Bishop, W. L. 1902. A nest of the star-nosed mole. Trans. Nova Scotia Inst. Sci., 10:349.
- Choate, J. R. 1971. Notes on geographic distribution and habitats of mammals eaten by owls in southern New England. Trans. Kansas Acad. Sci., 74:212-216.
- Christian, J. J. 1951. The mammals of the Mazinaw Lake region of Ontario; their reproduction and population dynamics. Ann. Carnegie Mus., 31:339-386.
- Davis, D. E., and F. Peek. 1970. Litter size of the star-nosed mole (*Condylura cristata*). J. Mamm., 51:156.
- Desmarest, A. G. 1819. Note: Sur le genre *Condylura* d'Illiger. Journal de Physique, de Chimie, d'Histoire Naturelle, Avec des Planches en Taille-Douce. Par M. H.-M. Ducrotay de Blainville, Paris, 89:224-233.
- Eadie, W. R. 1948a. The male accessory reproductive glands of *Condylura* with notes on a unique prostatic secretion. Anat. Rec., 101:59-79.
- 1948b. Corpora amyacea in the prostatic secretion and experiments on the formation of a copulatory plug in some insectivores. Anat. Rec., 102:259-272.
- 1954. Skin gland activity and pelage descriptions in moles. J. Mamm., 35:186-196.
- Eadie, W. R., and W. J. Hamilton. 1956. Notes on reproduction in the star-nosed mole. J. Mamm., 37:223-231.
- Eimer, T. 1871. Die Schnauze des Maulwarfes als Tastwerkzeug. Arch. Mikr. Anat., 7:181-191.
- Erleben, J. C. P. 1777. Untitled. Systemae Regnum Animale, 118 pp. (Not seen.)
- Goodwin, G. G. 1935. The mammals of Connecticut. Bull. State Geol. Nat. Hist. Surv., 35:29-31.

- Guilday, J. E. 1979. The star-nosed mole/a Polish connection. *Carnegie Mag.*, 53(1):18-25.
- Guilday, J. E., P. S. Martin, and A. D. McCrady. 1964. New Paris No. 4: A Pleistocene cave deposit in Bedford County, Pennsylvania. *Bull. Natl. Speleo. Soc.*, 26:121-194.
- Hall, E. R., and K. R. Kelson. 1959. The Mammals of North America. Ronald Press, New York, 1:xxx + 1-546 + 79.
- Hamilton, W. J., Jr. 1931. Habits of the star-nosed mole, *Condylura cristata*. *J. Mamm.*, 12:345-355.
- Harlan, R. 1825. Fauna Americana: Being a description of the Mammaliferous Animals of North America. A. Finely, Philadelphia, 318 pp.
- Harris, T. W. 1825a. Non-descript Animal. *Amer. Jour. Sci.*, 9:399-400. (From Machias, ME, "Star" [newspaper].)
- Harris, T. W. 1825b. Description of a non-descript species of the genus *Condylura*. *Boston Jour. Philos. Arts*, 2:580-583.
- Hisaw, F. L. 1923. Observations on the burrowing habits of moles (*Scalopus aquaticus machrinoides*). *J. Mamm.*, 4:79-88.
- Hutchison, J. H. 1968. Fossil Talpidae (Insectivora, Mammalia) from the later Tertiary of Oregon. *Bull. Mus. Nat. Hist., Univ. Oregon*, 11:1-117.
- Illiger, C. 1811. *Prodomus systematics mammalium et avium*. C. Salfeld, Berolini, xviii + 301 pp. (Not seen.)
- Jackson, H. H. T. 1915. A review of the American moles. *N. Amer. Fauna*, 38:1-100.
- Kennard, F. H. 1929. A star-nosed mole's nest at Newton Center, Massachusetts. *J. Mamm.*, 10:77.
- Krull, J. N. 1969. Observation of *Tamias striatus* feeding upon *Condylura cristata*. *Trans. Illinois State Acad. Sci.*, 62:221.
- Linnaeus, C. 1758. *Systema Naturae*. ed. 10. vol. 1, *Regnum animale*, 824 pp.
- Merriam, C. H. 1884. The Vertebrates of the Adirondack Region, Northeastern New York. *Trans. Linnaean Society New York*, 2:48-55.
- Meylan, A. 1968. Formules chromosomiques de quelques petits mammifères nord-américains. *Rev. Suisse Zool.*, 75:691-696.
- Paradiso, J. L. 1959. A new star-nosed mole (*Condylura*) from the southeastern United States. *Proc. Biol. Soc. Washington*, 72:103-108.
- Parmalee, P. W., R. D. Oesch, and J. E. Guilday. 1969. Pleistocene and Recent vertebrate faunas from Crankshaft Cave, Missouri. *Illinois State Museum Reports of Investigations*, 14:1-37.
- Pearson, O. P. 1947. The rate of metabolism of some small mammals. *Ecology*, 28:127-145.
- Rust, C. C. 1966. Notes on the star-nosed mole (*Condylura cristata*). *J. Mamm.*, 47:538.
- Schmidt, F. J. W. 1931. Mammals of western Clark County. *J. Mamm.*, 12:99-117.
- Shaw, G. 1800. *Gen. Zool., Mammalia*, 1(1):523-531. G. Kearsey, London.
- Simpson, S. E. 1923. The nest and young of the star-nosed mole (*Condylura cristata*). *J. Mamm.*, 4:167-170.
- Skoczen, S. 1976. Condylurini, Dopson, 1883 (Insectivora, Mammalia) in the Pliocene of Poland. *Acta Zool. Cracovien-sia*, 21:291-319.
- Tenny, S. 1871. On the appearance of the star-nosed mole on the snow at Niles, Michigan. *Amer. Nat.*, 5:314.
- True, F. W. 1896. A revision of the American moles. *Proc. U.S. Natl. Mus.*, 19:1-111.
- Van Vleck, D. B. 1965. The anatomy of the nasal rays on *Condylura cristata*. *J. Mamm.*, 46:248-253.
- Walls, G. L. 1963. The Vertebrate Eye and its Adaptive Radiation. Hafner Publ. Co., New York, 785 pp.
- Wiegert, R. G. 1961. Nest construction and oxygen consumption of *Condylura*. *J. Mamm.*, 42:528-529.
- Wood, N. A. 1922. The mammals of Washtenaw County, Michigan. *Occas. Papers Mus. Zool. Univ. Michigan*, 123:1-23.
- Yates, T. L. 1978. The systematics and evolution of North American moles (Insectivora: Talpidae). Ph.D. Dissertation, Texas Tech University, 304 pp.
- Yates, T. L., D. B. Pence, and G. K. Launchbaugh. 1979. Ectoparasites from seven species of North American moles (Insectivora: Talpidae). *J. Med. Entomol.*, 16:166-168.
- Yates, T. L., and D. J. Schmidly. 1975. Karyotype of the eastern mole (*Scalopus aquaticus*), with comments on the karyology of the family Talpidae. *J. Mamm.*, 56:902-905.
- Zimmermann, E. A. W. 1777. Specimen zoological geographicae. L. Batavorum, T. Haak et socios, xxiv + 685 pp. (Not seen.)
- Primary editors for this account were DANIEL F. WILLIAMS and SYDNEY ANDERSON.
- K. E. PETERSEN AND T. L. YATES, DEPT. OF BIOLOGY AND THE MUSEUM OF SOUTHWESTERN BIOLOGY, UNIVERSITY OF NEW MEXICO, ALBUQUERQUE, NEW MEXICO 87131.