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Parascalops breweri.

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Parascalops True, 1894

Parascalops True, 1894:2. Type species *Scalops breweri* Bachman, 1842, by original designation.

CONTEXT AND CONTENT. Order Insectivora, Family Talpidae, Subfamily Scalopinae. The genus *Parascalops* includes one species, *Parascalops breweri*, as treated below.

Parascalops breweri (Bachman, 1842)

Hairy-tailed Mole, Brewer's Mole

Scalops breweri Bachman, 1842:32. Type locality "Martha's Vineyard." Hall and Kelson (1959) and others believed this in error, placing the locality more generally in eastern North America.

Parascalops breweri, True, 1895:101, first use of present name combination.

CONTEXT AND CONTENT. Context as given above. The species is monotypic.

DIAGNOSIS. The following diagnosis applies to both genus and species: size medium; tail short, less than one-fourth of total length, fleshy, slightly constricted at base, annulated, densely covered with long coarse hairs; snout shorter than in *Scalopus* or *Scapanus*, extending about 9 mm beyond the incisors, the anterior half with a superior longitudinal median groove; nostrils lateral and crescentic, with concavities upward; palms of the forefeet as broad as long, toes not webbed; auditory bullae incomplete; first and second upper molars with a trilobed basal shelf (see figure 1), corresponding part of third molar bilobed (modified from True, 1896; Jackson, 1915; Hall and Kelson, 1959). Illustrations of tail, feet, and snout are in Jackson (1915).

GENERAL CHARACTERS. External characteristics primarily reflect the fossorial habits of *Parascalops* and for adults include: body fusiform; head depressed, triangular; nose a conical snout; eyes minute, covered by fur; external ears (pinnae) absent; auricular orifice oblong, about 3.5 mm long; legs short; feet large, fleshy, sparsely haired above, naked below; soles of hind feet each with two tubercles and a distinct heel pad; claws of forefeet broad, flat, and heavy and those of hind feet relatively short and slender; fur dense, soft, and silky; hairs nearly equal in length; color fuscous-black, chaetura black, or chaetura drab; ventral surfaces slightly paler and more gray; tail, feet, and base of snout dark brown, changing with age to mixed white and brown and to pure white in old adults. The skull is flat, depressed postorbitally, slightly constricted interorbitally, with a moderately broad braincase; zygomatic arch moderately heavy; pterygoid process small; auditory meatus absent; rostrum narrow, premaxillae extending beyond nasals and forming a truncate notch anterior to nasals; first upper incisor with distinct external accessory cusp. The above characters are taken from detailed descriptions in True (1896) and Jackson (1915).

Eadie (1939) reported sexual dimorphism, males being slightly larger than females. Mean external measurements (mm) and weights (in grams) for 41 adult males and 19 nonreproductive adult females from New Hampshire are, respectively: total length, 155, 147; length of tail vertebrae, 29, 28; length of hind foot, 20, 19; weight, 54.5, 47.5. Means and extremes for external measurements and weights of 22 adult males and 12 nonreproductive adult females from New York (Conner, 1960) are, respectively: total length, 164.8 (155.0 to 173.0), 158.6 (151.0 to 166.0); length of tail vertebrae, 31.3 (29.0 to 33.0), 30.1 (26.0 to 33.0); length of hind foot, 18.5 (18.0 to 19.5), 17.8 (16.0 to 19.0); weight, 51.5 (45.5 to 62.8), 45.4 (41.0 to 49.9). Mean and extreme (where available) cranial measurements (mm) for six adult males and four adult females from North Carolina (True, 1896) are, respectively: total length, 32.4 (31.0 to 33.7), 31.5 (31.1 to 32.0); basilar length, 27.0 (26.0 to 28.1), 26.2 (26.0 to 26.5); length of palate from inside of first incisor, 12.8 (12.4 to 13.5), 12.5; mastoid breadth, 14.8 (14.1 to 15.2), 14.4 (14.0 to 14.7); zygomatic breadth, 12.2 (12.0 to 12.5), 11.9 (11.8 to 12.0); length of upper toothrow, 13.6 (13.0 to 14.1), 13.2 (13.0 to 13.5); coronoid process of mandible to angle, 10.1 (9.9 to 10.5), 9.5 (9.0 to 9.8). Additional data on measurements are available in True (1896) and Jackson (1915).

DISTRIBUTION. *Parascalops* ranges in the northeastern United States and southeastern Canada from southern Ontario, across southern Quebec, and possibly extending into New Brunswick (R. L. Peterson, 1966), south to central Ohio and Connecticut, and, following the Appalachian Mountains, to western North Carolina (figure 2). Records from New Brunswick (Jackson, 1915) and Mount Desert Island, Maine (Manville, 1942) are based upon hearsay. Elevational records include the following: New York, 182 to 915 m (Conner, 1960); Virginia, 915 to 1675 m (Handley and Patton, 1947); West Virginia, 182 to 808 m (McKeever, 1951); North Carolina, 915 m (Jackson, 1915).

FOSSIL RECORD. Specimens from Pleistocene deposits of Frankstown Cave, Blair Co., Pennsylvania, have been described (O. A. Peterson, 1926). This locality is within the present distribution of the species.

FORM AND FUNCTION. Hairs of *Parascalops* considered to have a tactile function include: vibrissae on the snout; a pair of stiff hairs on each side of the dorsal surface of the head

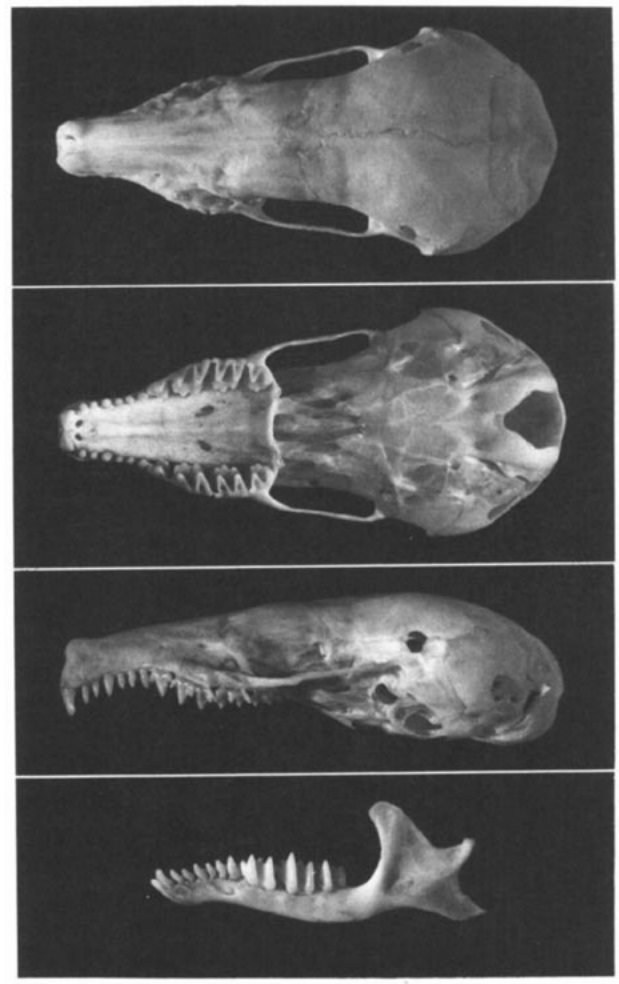

FIGURE 1. Dorsal, ventral, and lateral views of skull and mandible of a female *Parascalops breweri* in the author's collection.

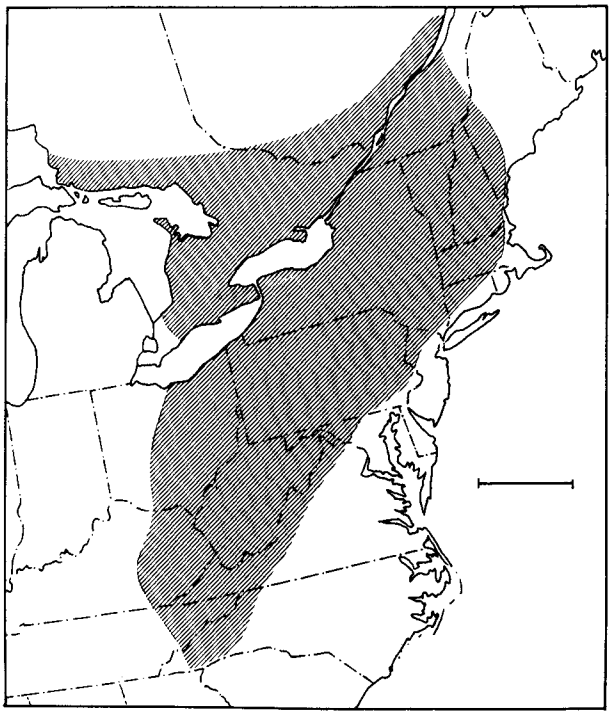

FIGURE 2. Geographic distribution of *Parascalops breweri* in eastern North America. Scale at right equals 150 miles (240 kilometers).

about 10 mm behind the eyes and extending 7 to 8 mm above the pelage; a dense fringe of carpal vibrissae that curve ventrally on the lateral and posterior edges of the palms of the forefeet (Eadie, 1939). Enlarged and numerous sudoriferous glands are located on the dorsal surface of the head, at the base of the snout, and on chin, throat, abdomen, and wrist. The glands are most active during breeding and produce a yellowish secretion on the skin and fur, imparting a characteristic odor to males and to a lesser extent to females. The glands lie in the deepest layer of the corium at the base of hair follicles and open individually on the skin; cells lining the coiled tubular glands are cuboidal to columnar in shape and have large nuclei. Normal sebaceous glands are associated with each hair follicle in these areas, but sweat glands are small and relatively few in number (Eadie, 1939, 1954). A pair of perineal glands are located between the skin and underlying body muscles on either side of the genital papilla in both males and females (Eadie, 1947, 1954). Eight mammae are lateropectoral 2-2, lateroabdominal 1-1, inguinal 1-1. The vertebral column contains 7 cervical vertebrae; 13 thoracic; 6 lumbar; 6 sacral, the last with a short broad transverse process; 13 caudal, the last rudimentary. Eight intervertebral ossicles are located from between the last two thoracic vertebrae to between the last lumbar and first sacral vertebrae (True, 1896).

Campbell (1939) described the shoulder anatomy of *Parascalops* and figured the manubrium, clavicle, scapula, and humerus. The sternum consists of six segments and is broadly keeled, especially anteriorly, and anterior to the ribs has a broad dorsal surface with a median crest. The manubrium is as long as the other segments combined and has the facets for the first pair of ribs at the beginning of its posterior third. The scapula has a suprascapular foramen through the base of the acromion, which is degenerate, and the clavicle is as long as broad. Skeletal measurements for two specimens (right side where applicable, in mm) are as follows: sternal length, 14.0, 16.5; sternal width, 3.7, 3.9; clavicular length, 3.7, 4.5; scapular length, 22.0, 23.4; scapular width, 4.6, 5.1; humeral length, 11.0, 12.5; humeral width, 3.5, 4.0. The shoulder girdle of *Parascalops*, as in other moles, is located in the neck region rather than near the anterior thorax due primarily to the lengthening of the manubrium. The humerus has the same axis as a generalized quadruped, but the distal end, instead of the proximal end, points forward and upward. This has resulted in the hand being turned so that the thumb side is down and the palm faces outward or backward. The *os falciforme* is short and broad at the base, reaching the proximal end of the first metacarpal. Terminal phalanges of the forefeet are irregularly bifid. The pelvis is narrow and reduced. The pelvic cartilages of nestling moles are fused for .3 to .5 mm, enclosing the alimentary and urogenital canals; in adults the pubic bones are separate, about .5 mm apart under the acetabulum and becoming widely divergent posteriorly (Eadie, 1945). The ilia are completely fused to the sacral vertebrae forming two small foramina per side; the ischia are not joined to the sacral vertebrae by osseous bridges in contrast to their condition in *Scalopus* and *Scapanus* (Jackson, 1915).

The dental formula is i 3/3, c 1/1, p 4/4, m 3/3, total 44. Three of 50 adult specimens examined had an extra tooth and one specimen had two extra teeth (Eadie, 1939, 1944). The additional teeth are unicuspid incisors or premolars in either jaw and may obtain normal size. The milk teeth are small and penetrate the gums (unlike *Scalopus* and *Condylura* in which the gums are not cut), but are probably nonfunctional. In juvenile moles (eight to 10 weeks), the milk teeth were still in place next to the erupting permanent teeth, supported only by the gum membrane. Eadie (1944) discussed the histology of dental development in *P. breweri*. Campbell (1939) described and illustrated shoulder musculature. Eadie (1947) described the male reproductive system and accessory glands and illustrations appeared in Kaudern (1907) and Eadie (1947). Testes are abdominal, lying on either side near the base of the bladder in post-breeding animals, and moving into an extension of the abdominal cavity prior to breeding. There is no scrotum. The *caput epididymis* is normal, but the *cauda epididymis* is a large sack-like structure, lies posterior to and distinct from the testes, and probably functions in sperm storage. The prostate gland is large, compact, and pear-shaped, lies ventral to the bladder, and consists of two parts closely bound together. The stalk of the prostate attaches ventrally to the membranous urethra near the base of the bladder; ducts from each part of the gland penetrating the urethral canal independently. Cowper's glands are well developed, paired, oval bodies located on either side of the union of the crura of the penis; their ducts enter the dorsal wall of the membranous urethra slightly anterior to the mouths of the *vasa deferentia* and prostate ducts. The glans penis is smooth, without spines or rugosities. The adult eye is less than 1 mm in diameter; all structural parts are present although modified. The lens consists of polyhedral cells with distinct nuclei, but lacks lens fibers, which are present in the embryo. The ocular aperture is relatively large, almost 1 mm in diameter, and circular in shape when fully open (Eadie, 1939).

ONTOGENY AND REPRODUCTION. Eadie (1939) discussed reproduction in this species. Mating occurs in late March and early April in New Hampshire. Testes attain maximal size (12 by 7 mm) in March, decrease sharply in mid-May, and reach resting size (3 by 2 mm) in October. The prostate gland enlarges and may reach a length of 25 mm during the breeding season (in contrast to *Condylura*, in which the gland remains diminutive). Cowper's glands also increase in size in early spring (up to 8 by 4 mm). The vaginal orifice opens prior to mating. The skin covering of the orifice reappears in late summer and completely closes it by September. Mating has not been observed, but females have been collected with copulatory plugs, formed by coagulation of the prostatic fluid by a secretion of the Cowper's glands (Eadie, 1948).

Females produce one litter per year and become reproductive at 10 months. The usual litter size is four or five (Eadie, 1939; Conner, 1960), but a female with eight embryos was reported from Pennsylvania (Richmond and Roslund, 1949). Estimated gestation time is four to six weeks. Average body length and weight of four nestling moles found dead in New Hampshire were 70.7 mm and 10.2 g, respectively (Eadie, 1939). The skin of the nestlings was whitish and wrinkled. The young moles were naked except for short vibrissae on the snout and facial hairs near the eyes and on the lips. The eyes were about 0.5 mm in diameter and appeared as black spots under the skin. The ears were slit-like openings about 1 mm in length. Forelimbs resembled those of the adult, but the claws were short, soft, and blunt. Teeth were not discernible. Young moles remain in the nest for about one month, by which time they are eating solid food. Eadie (1939) reported the weights of moles that had recently abandoned the nest; the smallest of four females weighed 13 g less than the average adult female and the corresponding difference for the smallest of five males was 18 g. The postnatal pelage is slightly grayer and much shorter than that of adults in summer.

Eadie (1939) described the molting process of *Parascalops* in New Hampshire. The spring molt began as early as 29 March and was completed by middle or late May. Moles collected after 1 June were all in new pelage. The autumn molt began in early September and usually was completed by mid-October. Two adult females collected on 8 and 12 September were in advanced stages of molt. Most immature moles began molt in late August and were in new pelage by the end of October. Molt usually starts on the breast and then on the dorsal lumbar region anterior to the base of the tail. Molt proceeds from the breast caudad and laterad to cover the abdomen and connect to the dorsal area, where the change is spreading to the head. The ventral molt is usually completed before the dorsal and the new pelage ordinarily appears in solid patches distinct from the old fur.

Moles caught in early spring were placed in four age classes based upon tooth wear by Eadie (1939), as follows: first year (25 specimens), tooth cusps worn to one-fourth their height and molar ridges leveled to one-half their height; second year (19), tooth cusps worn to one-third their height and molar ridges about two-thirds their length; third year (eight), tooth cusps were from one-third to one-fourth their length and molar ridges completely leveled; fourth year (three), tooth cusps of most teeth completely worn away, teeth level with the gums, and the molars correspondingly worn.

ECOLOGY AND BEHAVIOR. *Parascalops* is primarily fossorial and is not restricted to any one vegetational type or successional stage. Habitats include the following: secondary hardwood forests; white pine and hemlock; white oak; hemlock and black birch; beech; spruce and hardwood forests; open fields; old pasture land with a thin cover of young trees and shrubs; cultivated fields; roadsides (Eadie, 1939; Handley and Patton, 1947; McKeever, 1951). This mole is most abundant in sandy loam soils with good surface cover and sufficient moisture (Eadie, 1939). The degree of rockiness is unimportant, but soils with high moisture or clay contents are avoided (Eadie, 1939; Olive, 1950). Eadie (1939) described the tunnel systems of the hairy-tailed mole. Tunnels which allow free passage of moles measure 37 to 45 by 25 to 32 mm in horizontal and vertical diameters, respectively. Surface tunnels are extensive, irregular branching networks with main routes characterized by large size and smooth, well packed walls. Smaller, less well-defined tunnels are formed during foraging. Main tunnels often follow surface features such as stone walls. Occasional enlargements measuring about 80 mm in diameter are found in tunnels from 100 to 200 mm in depth and may serve as resting places. Surface ridges may sometimes be formed, but are difficult to see except in hard packed soils with little surface cover. The ridges are not as pronounced as those of *Scalopus*. Tunnels have occasional openings, but artificial breaks are repaired when first encountered. Tunnels may remain in use for up to eight years (Wright, 1945). Deep tunnels are relatively few in number and are tortuous and intricate, occurring at depths between 250 and 450 mm. *Parascalops* is active throughout the year, but is usually restricted to the deep tunnels when the soil freezes in winter. In fall, deep tunnels are enlarged and extended resulting in the appearance of numerous mole hills, which are smaller than those of *Condylura* and *Scalopus* and average 150 mm in diameter by 75 mm in height. A winter nest was located 410 mm below the surface, was ovoid in shape, measured 200 by 150 mm, and was composed of well packed leaves and grass. Moles of both sexes winter separately in areas approximately 15 to 24 m in diameter. Surface tunnel activity resumes in spring and females remain near the winter range. Males leave their winter quarters in search of mates and several may appear in a female's range during breeding. After mating, females are again solitary and construct nests. The nest chamber of one female was spherical, about 160 mm in diameter, its top was 250 mm below the surface in sandy loam soil with a cover of dead leaves and humus. The nest lay snugly in the chamber and was composed of concentric layers of coarsely shredded dead leaves.

Males freely associate during spring and by late summer males, females, and young all utilize the same tunnel systems. No evidence of agonistic behavior has been reported. Tunnels and nests are kept free of fecal matter, which is deposited outside of tunnel openings in piles of two to 12 scats. Scats are cylindrical, taper to abrupt points at both ends, and average 10 by 2.5 mm in size. *Parascalops* is active throughout the day and night, but appears to be most active during the day (Eadie, 1939; Hamilton, 1939). Moles may forage above ground at night. *Parascalops* is awkward when above ground because of its specialized forelimbs and can move about 4.6 m in 30 seconds (Eadie, 1939). Foote (1941) reported a swimming hairy-tailed mole whose movements were the same as in burrowing, each pair of legs moving in unison. Eadie (1939) found average population densities of three moles per hectare (maximum of 27 per ha) in New Hampshire. In years of unusually high densities, 25 to 30 animals per hectare (10 to 12 per acre) have been reported in New York (Hamilton, 1939). Small rodents and insectivores utilize the tunnel systems of *Parascalops* throughout its range. For example, the following were taken with *Parascalops* in New Hampshire (in decreasing order of abundance): *Blarina brevicauda*, *Microtus pennsylvanicus*, *Peromyscus leucopus*, *Sorex cinereus*, *Microtus pinetorum*, *Synaptomys cooperi*, *Condylura cristata*, *Zapus hudsonius* (Eadie, 1939). Although *Parascalops* and *Condylura* are often captured in the same areas, I have only one record of occurrence at the same spot with *Scalopus* (Terry L. Yates, personal communication).

Eadie (1939) examined the stomach contents of 100 hairy-tailed moles from New Hampshire. Food items reported, by percent volume (percent frequency in parentheses), were earthworms 34 (84), insect larvae and pupae 29 (96), adult insects 18 (86), millipedes and centipedes 2 (32), snails and slugs 1 (3), sowbugs 1 (4), sand and rootlets 2 (100), and detritus 14 (100). The most frequently occurring insect larvae were Coleoptera: Elateridae (38% frequency), Cantharidae (22), Scarabaeidae (19), Curculionidae (16), Carabidae (15), and Tenebrionidae (9); Diptera: Tipulidae (36), Mycetophilidae (16), Leptidae (7), and Asilidae (4); and Lepidoptera (5). Beetles were the most common adult insects. Ants (57% frequency) were eaten in greatest numbers in early spring and late autumn and may be an important food item when other foods are scarce. Hamilton (1941) examined 29 *Parascalops* stomachs from New York. Earthworms, ants, beetle larvae, centipedes, and small rootlets were the principal stomach contents. Jameson (1943) reported four dipterous larvae from the stomach of an adult male from Ontario. Brooks (1923) found evidence that *Parascalops* in West Virginia destroyed nests of ground-nesting wasps, *Vespa* sp., and removed the larvae and pupae. Brooks (1908) maintained captive hairy-tailed moles on small birds' eggs and meat. The moles starved when only vegetable matter was offered. One 50-g animal consumed 66 g of earthworms and insect larvae in 24 hours. Fay (1954) kept three *Parascalops* in captivity on a diet of earthworms. The moles weighed 41, 49, and 45 g and ate an average of 158.9, 132.4, and 116.0 per day, respectively.

A few cases of predation on *P. breweri* have been recorded. Hamilton *et al.* (1937) found remains of this mole in one of 131 scats of the red fox, *Vulpes vulpes*, in Massachusetts and Eadie (1939) found one in a red fox scat in New Hampshire. Sperry (1933) reported one *Parascalops* in the stomach of an opossum, *Didelphis virginiana*, in North Carolina. Specimens have been taken by cats and dogs (Hamilton, 1939; Gordon and Bailey, 1963). Fisher (1893) found *Parascalops* remains in the stomach of a gray owl, *Scotiaptex cinerea* (= *Strix nebulosa*), from Maine. Richmond and Roslund (1949) reported that 31 (1.2%) of 2484 small mammals removed from barn owl pellets in Pennsylvania were *Parascalops*. An adult hairy-tailed mole was taken from the stomach of a bullfrog, *Rana catesbeiana*, in New York (Heller, 1927). Saylor (1938) reported *Parascalops* in three stomachs of the copperhead snake, *Agkistrodon contortrix mokasen*, in Virginia and West Virginia. The short-tailed shrew is a possible predator on unprotected nestling moles (Eadie, 1939).

Eadie (1939) studied the endoparasites in a series of about 100 *P. breweri*. Acanthocephalid worms, *Moniliformis* sp. (possibly *M. clarki*), were frequently found in the intestine. The ileum of a male collected in spring contained 10 of these worms. No tapeworms were found. Roundworms, found only in the stomach, were present in 15% of the specimens. Fleas and mites are the most numerous ectoparasites, occurring in greatest abundance in the spring and summer. Eadie (1939) collected up to 24 fleas and 15 to 20 mites per mole. The following mites have been recorded: *Haemogamasus liponyssoides* (Keegan, 1951), *Hirstionyssus blarinae* (Herrin, 1970), and *Labidophorus talpae* (Fain and Whitaker, 1973). Jameson (1950) found *Hirstionyssus* sp. distinct from *H. blarinae*. Six species of fleas have been recorded: *Ctenophthalmus pseudagyrtes* (Eadie, 1939; Jameson, 1950; Conner, 1960; Holland and Benton, 1968). *Doratopsylla blarinae* (Conner, 1960), *Histrichopsylla tahavuana* (Conner, 1960; Holland and Benton, 1968), *Megabothris acerbus* (Holland and Benton, 1968), *Peromyscopsylla hesperomys* (Conner, 1960), and *Nearctopsylla hygini* (Eadie, 1939). Eadie (1939) found the louse, *Euhaematopinus abnormis*, and Jameson (1950) found the beetle, *Leptinus americanus*, on some specimens.

Eadie (1939) and Rudge (1966) give trapping methods for moles, and Henning (1952) and Rudge (1966) describe techniques for maintaining moles in captivity. *Parascalops* is probably economically neutral due to its local distribution, doing some damage to lawns, gardens, and golf courses, however consuming large numbers of injurious insects (Eadie, 1939; McKeever, 1951).

GENETICS. The karyotype of two male *Parascalops* was reported by Gropp (1969). The diploid number is 34 and consists of nine pairs of metacentric, seven pairs of acrocentric or subacrocentric chromosomes, a metacentric X, and a minute Y chromosome. The fundamental number is 62 (Yates and Schmidly, 1975). The karyotype resembles that of *Talpa europaea europaea* in having the same diploid number, nearly identical sex chromosomes, and a pair of metacentric chromosomes with a secondary constriction in each of the short arms. The two species differ by a shift from metacentrics (*Talpa*) to acrocentrics or subacrocentrics (*Parascalops*). Pericentric inversions and translocations have probably both been important in producing this karyotypic variation (Gropp, 1969; Yates and Schmidly, 1975).

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