MAMMALIAN SPECIES No. 273, pp. 1–4, 4 figs.

Thomomys bulbivorus.

By B. J. Verts and Leslie N. Carraway

Published 27 February 1987 by The American Society of Mammalogists

Thomomys bulbivorus (Richardson)

Camas Pocket Gopher

Diplostoma bulbivorum Richardson, 1829:206. Type locality "Banks of the Columbia River, Oregon," probably Portland.

Thomomys bulbivorus, Brandt, 1855:188. First use of name combination.

CONTEXT AND CONTENT. Order Rodentia, Family Geomyidae, Genus *Thomomys* (Hall, 1981). Hall (1981) placed all Recent *Thomomys* in the subgenus *Thomomys*, but Thaeler (1980) placed *T. bulbivorus* with five other species in the subgenus *Megascapheus*, a taxon that Elliot (1903) erected for *T. bulbivorus* alone. No subspecies are recognized currently (Hall, 1981).

DIAGNOSIS. *Thomomys bulbivorus* (Fig. 1) is the largest member of the genus (Bailey, 1915); the hind foot usually exceeds 40 mm in males, 38 mm in females. Wight (1918) reported that the largest adult male taken was 328 mm in total length and weighed 495.5 g; only 1 (a 326-mm, 542.7-g male) of 147 that we examined exceeded either of those values. The dorsum is sooty brown and the ears and nose blackish; the venter is lead colored except for an irregular-shaped white patch on the throat (Bailey, 1915). The winter pelage is long and furry; the summer pelage short and coarse (Bailey, 1915). Incisors are highly procumbent (Hall, 1981). The presence of grooves on the exoccipital and pterygoids concave on their inner surfaces separate *T. bulbivorus* from all other members of the genus (Elliot, 1903; Thaeler, 1980).

GENERAL CHARACTERS. As all members of the genus, *T. bulbivorus* has small ears and eyes, short legs, powerfully built shoulders, slim hips, and a nearly naked tail. It is pentadactyl (the middle toe the longest) and plantigrade; the claws on the forefeet are longer than those on the hind feet. The fingers and palms are equipped with fringes of stiff bristles. Within the genus, the claws of the forefeet relative to body size are shortest in *T. bulbivorus* (Bailey, 1915). Upper and lower incisors protrude with the lips closing behind them. Fur-lined cheek pouches open lateral to the mouth; they are invaginated folds of skin that extend posteriorly to approximately the level of the shoulder. There are eight mammae, two pairs pectoral and two pairs inguinal.

The skull (Fig. 2) is heavy and angular with zygomata that spread posteriorly; a sphenoid fissure is present. The premaxillae terminate in truncated tips that extend posterior to margins of the wedge-shaped nasals (Bailey, 1915). The auditory bulla is small and narrow, but the meatus is broadly open. The angular process is narrowly connected to the dentary and the flange on the posteroventral edge of that bone is weak (Thaeler, 1980). As in other members of the subgenus *Megascapheus*, *T. bulbivorus* has an anteriorly inclined P4, the base of I1 is located between the bases of P4 and M1, a narrow anterior enamel plate on P4 is distinct from the lingual enamel plate, the incisive foramen is posterior to the infraorbital canal, and the enamel plate on the anterior edge of p4 is not recurved (Thaeler, 1980). The incisors are white tipped (from abrasion of the yellow surface enamel) and are relatively narrow. A groove (sulcus) on the median edge of each incisor, prominent in some *Thomomys* (for example, *T. mazama*), is obscure or completely obliterated in *T. bulbivorus* (Bailey, 1915). The dental formula is i 1/1, c 0/0, p 1/1, m 3/3, total 20.

Published measurements of *T. bulbivorus* are few; Bailey (1915) provided means of body measurements (in mm) for five adult males as follows: total length, 300; tail length, 90, hind foot, 42. For four adult females, the same measurements were: 271, 81, 39. Selected skull measurements (in mm) of a single adult male (USNM 57322) are (Bailey, 1915): basal length, 52; length of nasals, 19; zygomatic breadth, 36.5; mastoid breadth, 30.5; alveolar length of upper molar row, 10. Williams (1982) listed mean (±2 *SE*) and range (in parentheses) for the condylobasal length in seven adults as 54.6±1.29 (42.4 to 57.4).

DISTRIBUTION. *Thomomys bulbivorus* is restricted to the Willamette Valley, Oregon, and to drainages of tributaries (especially the Yamhill River) to the Willamette River system (Fig. 3).

The only fossil record is a Pleistocene specimen from Fort Rock, Oregon (McCornack, 1920) that, in view of the present distribution of *T. bulbivorus* and the intervening Cascade Mountains, seems open to question. We were unable to locate the specimen on which this record is based.

FORM AND FUNCTION. McChesney (1878) and Osborn (1894) described the muculature of the pouch of geomyids as consisting of a delicate sphincter-type constrictor that purses the opening; paired protractors that surround the pocket on each side are inserted on the premaxillary (Merriam, 1895), and pull the pocket forward toward the opening; and retractors that arise from inner and outer surfaces of the pocket and extend posteriorly and dorsally parallel to the latissimus dorsi. The retractor muscles form a band 7 to 10 cm long and about 2 cm wide and insert in the tendinous aponeurosis that covers the insertion of the latissimus dorsi on the neural spines of lumbar vertebrae.

Merriam (1895) used illustrations of *T. bulbivorus* to supplement descriptions of characters useful for distinguishing *Thomomys* from other genera and subgenera of Geomyidae. These include the two plates of enamel on M3 (as opposed to three in other genera of geomyids), and two plates of enamel on m1, m2, and m3 (as opposed to one in other genera). Merriam (1895) also provided several illustrations of sections of the skull of *T. bulbivorus*, but described only the relationship of the frontal, ethmoid, and presphenoid.

The phallus of *T. bulbivorus* possesses several features that are unique among the pocket gophers: mean length of the distal tract, 13.5 mm (range 11.3 to 14.5, $n = 7$); distal tract 3 to 4 times longer than wide; glans more than half the length of the distal tract; glans with converging sides in dorsoventral aspect; main portion of urethral processes exposed and partially united; erratic crevices between the collar and constriction instead of longitudinal grooves as in other geomyids; middorsal groove restricted ot the collar (Williams, 1982). Epidermal structures on the phallus possess single, proximally oriented projections of irregular size and distribution (Williams, 1982).

Burt (1960) reported that the baculum of a single *T. bulbivorus* was the smallest of any geomyid that he examined; the baculum measured (in mm): length, 8.5; height at base, 1.5; width at base, 1.8. Burt (1960) was unsure if the specimen that he examined was an adult. The same measurements for the baculum (Fig. 4) of

FIG. 1. Photograph of *Thomomys bulbivorus*. Note small eye and ear, naked tail, and highly procumbent incisors. Photograph from a slide by the late Kenneth L. Gordon.

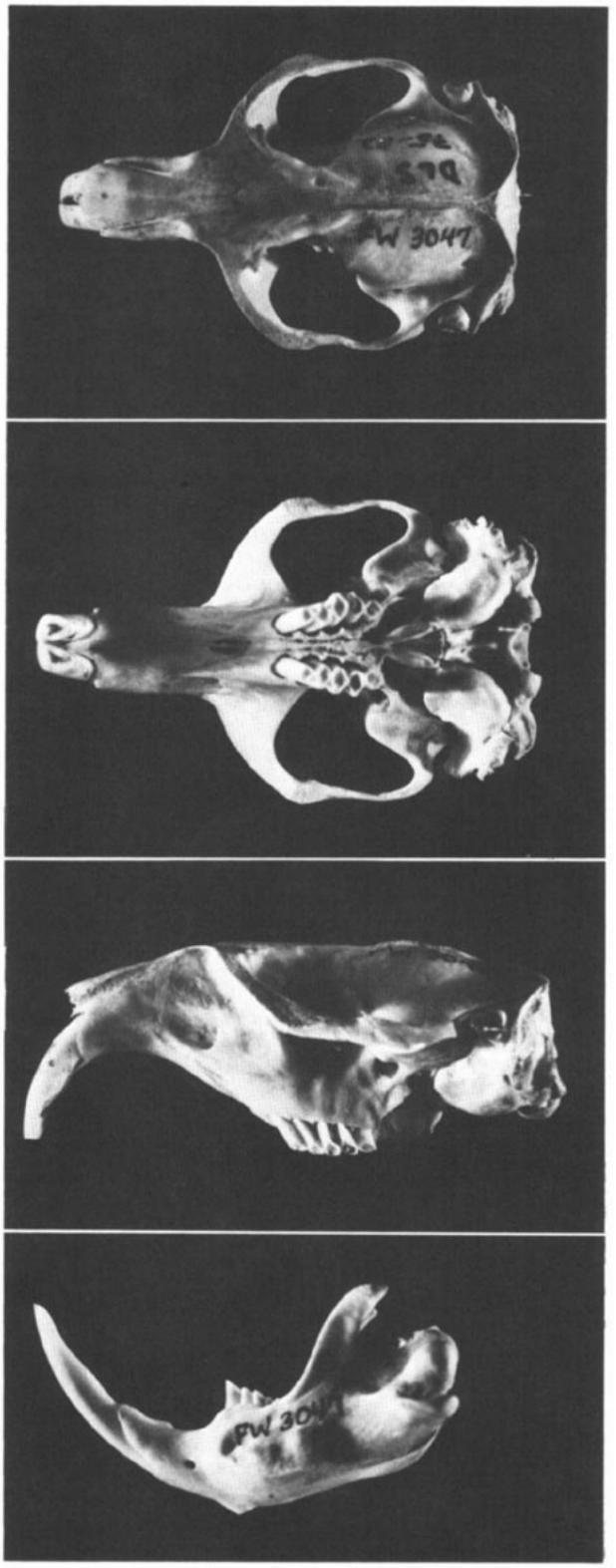

FIG. 2. Dorsal, ventral, and lateral views of the skull and lateral view of the mandible of adult male *Thomomys bulbivorus* (OSUFW 3047) from 3 mi S Junction City, Lane Co., Oregon. Occipitonasal length 51.7 mm.

the 542.7-g specimen that we examined were 10.51, 1.52, and 2.18. Means (±2 *SE*) and ranges (in parentheses) of length, height at base, and width at base (in mm) for five specimens (Williams, 1982) were 10.1±0.26 (9.6 to 10.3), 2.1±0.15 (1.9 to 2.3), and 2.2±0.26, (1.7 to 2.5), respectively.

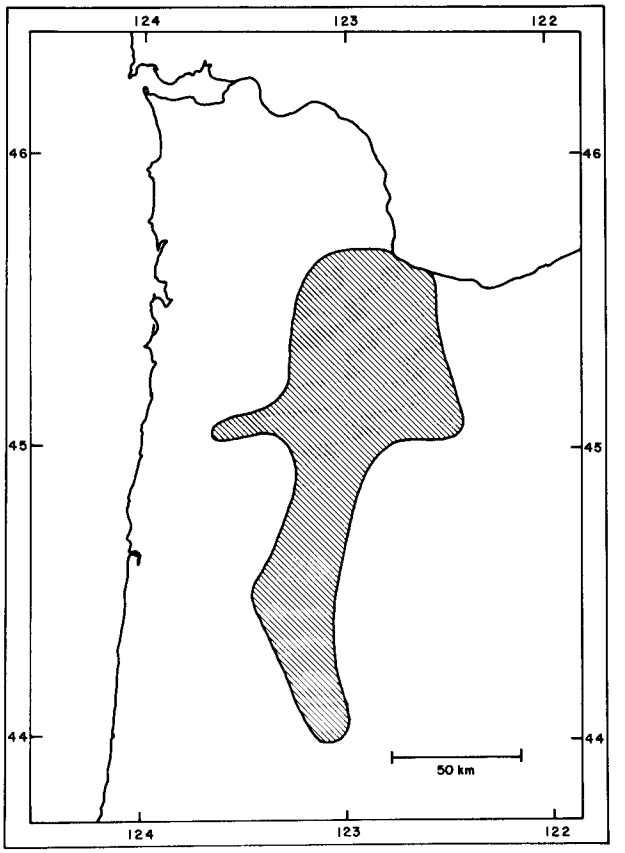

FIG. 3. Distribution of *Thomomys bulbivorus*; the species is endemic to Oregon. Map based largely on locality records provided by Bailey (1915) and Hall (1981).

Wight (1918:18) reported that camas pocket gophers occasionally secreted a "white milky fluid" that covered the eyes when fed, subjected to stress, or poisoned with strychnine.

ONTOGENY AND REPRODUCTION. The breeding season of *T. bulbivorus* reportedly extends from about the first of April to early June (Scheffer, 1930, 1938; Wight, 1918, 1922). However, Wight (1918:13) reported a female taken on 27 March as "evidently pregnant" and one taken on 29 June as having "foeti well developed." Later, he recorded a pregnant female caught on 22 July (Wight, 1922). However, Scheffer (1938) ascertained pregnancy in 0 of 5 taken on 15 February, 0 of 8 on 15 March, 2 of 9 on 12 April, and 3 of 10 (plus three postpartum females) on 5 May. The possibility of more than a single litter in a breeding season was discounted on circumstantial evidence (Scheffer, 1930).

Scheffer (1938:224) reported an average litter size of 4.2 ". . . determined mainly by actual count of embryos in pregant females . . . ." Presumably, the count was based on the five pregnant and three postpartum females taken in April and May. Wight (1918, 1922) suggested a range in litter size from four to nine, but listed embryo counts of eight, eight, and nine, a litter of five born in captivity, and five young in each of two excavated nests.

At birth, young weigh about 6.1 g, are about 50 mm long, and lack hair, teeth, and pockets (Wight, 1918). Growth is rapid; mass (in g) and length (in mm, in parentheses) at intervals during development are (Wight, 1918): 2 weeks, 23.0 (90); 3 weeks, 35.5 (108); 4 weeks, 53.6 (123.5); 5 weeks, 70.5 (153); 6 weeks, 86.0 (164); 8 weeks, 101.0 (no data); 10 weeks, 160.0 (no data); 17 weeks, 167.0 (no data). Young begin to develop hair by 2 weeks of age, crawl and eat solid food by 3 weeks, develop pockets by 4 weeks, open their eyes by 5 weeks, and are weaned by 6 weeks (Wight, 1918). Presumably, sexual maturity is attained by the breeding season following birth.

ECOLOGY. Except for that regarding selection of various foods, information about interactions of *T. bulbivorus* with its environment is largely anecdotal.

Throughout its range, *T. bulbivorus* occupies ". . . unwooded sections of both hill and low land about equally," where it builds complex systems of tunnels sometimes exceeding 240 m in total length (Wight, 1918:6). The burrow system consists of several main tunnels more or less parallel to the surface of the ground with inclined branches that extend to the surface. In 16 systems excavated, tunnels ranged in diameter from 51 to 127 mm and were from 0.08 to 0.91 m below the surface; tunnel systems on hillsides in drier soils tended to be deeper (Wight, 1918).

In the wild, *T. bulbivorus* cuts and stores roots of false dandelions (*Hypochaeris radicata*), vetch (*Vicia* sp.), roots of fruit and nut trees, root crops (for example, carrots, parsnips, potatoes), plantains (*Plantago* sp.), and roots of grasses (Poaceae). Many that we have handled smelled of wild onion (*Allium amplectens*) suggesting that it was eaten frequently. Bailey (1936) speculated that the scarcity of bulbs of the camas (*Camassia* sp.) in areas occupied by this pocket gopher was related to their feeding on them, but Wight (1918) did not believe that bulbs constituted much of the diet of the species. In 47 feeding trials in captivity, these pocket gophers selected false dandelion 39 times, other foods 5 times, and failed to select one food over the other in 3 trials (Wight, 1918).

Mammalian associates of *T. bulbivorus* include *Microtus canicaudus* that sometimes uses its tunnel systems (Maser and Storm, 1970); insectivores and other arvicoline rodents likely use the tunnels also. Other small mammals within the range of *T. bulbivorus* include *Sorex vagrans, Scapanus townsendii, Sylvilagus bachmani, S. floridanus, Tamias townsendii, Spermophilus beecheyi, Neotoma fuscipes, Peromyscus maniculatus, Microtus oregoni, M. townsendii, Zapus triotatus, Mustela frenata,* and *Mephitis mephitis* (Hall, 1981). Contrary to the statement that ranges of pocket gophers do not overlap in Oregon (Whitaker et al., 1985), specimens of both *T. bulbivorus* and *T. mazama oregonus* (=*T. douglasii oregonus*) are listed as having been taken at Forest Grove (Bailey, 1936; Hall, 1981), and ranges of the two species are depicted to overlap in the northern part of the Willamette Valley (Hall, 1981:Maps 301 and 303). Walker (1955:122) contended that, "Generally *oregonus* occurs along the sides of the valley above *bulbiverous* [sic] but systems of the two forms have been found within one hundred yards of each other." Whether these species are syntopic is, to our knowledge, unknown.

Maser and Brodie (1966) found remains of four *T. bulbivorus* in 621 regurgitated pellets of great-horned owls (*Bubo virginianus*), but none in 140 pellets from long-eared owls (*Asio otus*), 277 from barn owls (*Tyto alba*), and 115 from owls of unknown species. Likely other raptorial birds and carnivorous mammals prey on *T. bulbivorus* (Bailey, 1936), but seemingly additional information on the species as prey has not been published.

Ectoparasites of *T. bulbivorus* include the mites *Androlaelaps fahrenholzi* (Whitaker and Wilson, 1974; Whitaker et al., 1985), *A.* [*Haemolaelaps*] *geomys* (Strandtmann, 1949; Whitaker et al., 1985), and *Echinonyssus femuralis* (Whitaker et al., 1985) and the chewing louse *Geomydoecus oregonus* (Emerson et al., 1984; Whitaker et al., 1985). Hubbard (1943) reported that the flea *Dactylopsylla ignota franciscana* that infests nearby populations of *T. bottae* and *T. mazama* does not occur on *T. bulbivorus*; Whitaker et al. (1985) did not find the species on eight specimens they examined. Hubbard (1943) speculated that the absence was related to the tougher skin of the latter host species. Hubbard (1947) did not believe that pocket gophers in the Willamette and Tualatin valleys were infested with fleas of their own, but he reported finding "accidental occurrences" of *Monopsyllus ciliatus protinus, Calallagia charlotensis,* and *Corypsylla ornata* on *T. bulbivorus*, species of fleas that are more commonly associated with *Tamia, Peromyscus,* and *Scapanus*, respectively. Gardner and Jasmer (1983) named the nematode *Heligmosomoides thomomyos* and Gardner (1985) named the cestode *Hymenolepis tualatinensis* from specimens collected in the small intestine of *T. bulbivorus.* Gardner (1985) also established that *T. bulbivorus* served as host to the nematodes *Trichuris fossor* and *Ransomus rodentorum,* and the cestode *Hymenolepis horrida.*

Based on responses to a questionnaire, Wight (1918) estimated that 75% (more than 400,000 ha) of agricultural land in the Willamette Valley was "infested" by the species. He also indicated that damage to agricultural crops by the species was considerable and recommended its control. Crouch (1933) described techniques to reduce populations of geomyids in general through use of toxic baits, traps, fumigants, flooding, and shooting. He recommended

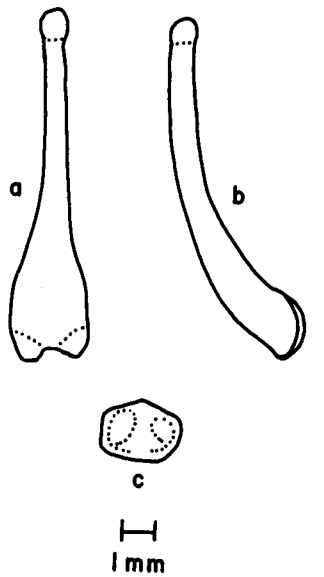

FIG. 4. Dorsal (a), right lateral (b), and proximal (c; dorsum upward) views of the baculum of *Thomomys bulbivorus* (OSUFW 7603) from 4½ mi S, 6½ mi W Albany, Linn Co., Oregon.

toxic baits placed in burrow systems as usually most effective and least costly, but claimed that the only effective bait for *T. bulbivorus* consisted of clover (presumably *Trifolium* sp.) leaves to which powdered strychnine alkaloid (0.625%) was applied. However, Sykes (1917) recommended strychnine on carrots, sweet potatoes, or parsnips for *T. bulbivorus.* Although Kuhn (1983) recommended toxic baits, he emphasized that strychnine was not available for mixing toxic baits, but that premixed baits containing strychnine alkaloid could be purchased. Victor or Macabee traps, suitable for most *Thomomys*, are too small to capture and kill *T. bulbivorus*; the "cinch" trap, available locally, is much more effective (Bailey, 1936; Kuhn, 1983).

BEHAVIOR. *Thomomys bulbivorus* is described as "morose and savage" (Bailey, 1936:250), and "one of the most vicious animals known for its size" (Wight, 1918:16). The fighting ability of pocket gophers is renowned, but they flee from opponents or potential predators when the opportunity arises (Wight, 1918). In captivity, they may become tame, yet remain intolerant of conspecifics. In the wild, individuals remain solitary by plugging interconnecting burrows except during the breeding season when males enter burrow systems of females for mating (Wight, 1918).

Activity is largely fossorial although occurrence of skeletal remains in regurgitated pellets of raptorial birds suggests some surface activity. Excavation of tunnels as a means of underground foraging is the most common activity (Wight, 1918). Because the forefeet and claws of *T. bulbivorus* are relatively weak and because many soils within its range become exceptionally hard when dry, most excavation of tunnels is by use of the procumbent incisors (Wight, 1918). Soil loosened by the teeth or claws is pushed out the entrance to one of the inclined lateral tunnels to form a characteristic fan-shaped mound. Lateral tunnels usually are plugged with soil well tamped in place. When soils are wet, large mounds with open burrows directly in the top are constructed. These "chimney mounds" are thought to be constructed to increase ventilation and promote drying of tunnels (Wight, 1918). Fumigants and toxic baits may be "walled off" by gophers plugging their tunnels (Kuhn, 1983; Wight, 1918).

Occasionally, camas pocket gophers forage on the surface a meter or two from the entrance to their burrows; food plants are cut and pulled into the burrows (Wight, 1918). Both roots and green leaves of plants may be eaten immediately or may be cut into pieces 5 to 7 cm long, placed in the pouches, and trasported to store piles. Foodstuffs are removed from the pouches by application of pressure in a sweeping motion with the forefeet to the sides of the cheek and face (Wight, 1918).

Most sounds made by the camas pocket gopher are produced with the teeth, either "chatter" or "grinding" sounds, but when males and females are put together they make "crooning" sounds

or "purrs" (Wight, 1918:17). Nestlings are reported to make twittering sounds (Wight, 1918).

GENETICS. Thaeler (1980) reported that *T. bulbivorus* has a diploid number of 76 but did not depict or describe the karyotype.

Bongardt et al. (1968), based on electrophoresis of serum proteins, reported that *T. bulbivorus* had two distinct transferrin bands that migrated faster than similar bands in *T. townsendii* and four subspecies of *T. umbrinus* (=*T. bottae*; Miller and Kellogg, 1955).

REMARKS. The etymology of the generic name *Thomomys* is the Greek *thomos* meaning "a heap" (likely in reference to mounds of soil produced in tunneling) and the Greek *mys* meaning "mouse"; the specific name *bulbivorus* is from the Latin *bulbus* meaning "a bulb" and from the Latin *voro* meaning "to devour" (Jaeger, 1955). The specific epithet likely was based on the erroneous presumption that *T. bulbivorus* was a bulb eater (Wight, 1918). The species also is known by the vernacular name "camas rat" (Bailey, 1915; Richardson, 1829).

We thank C. Maser and R. B. Forbes for commenting on an earlier draft of the manuscript. This is Technical Paper No. 7658, Oregon Agricultural Experiment Station.

LITERATURE CITED

BAILEY, V. 1915. Revision of the pocket gophers of the genus Thomomys. N. Amer. Fauna, 39:1–136.

———. 1936. The mammals and life zones of Oregon. N. Amer. Fauna, 55:1–416.

BONGARDT, H., V. B. RICHENS, AND W. E. HOWARD. 1968. Serum protein patterns in pocket gophers. J. Mamm., 49:544–547.

BRANDT, J. F. 1855. Beiträge sur nähern Kenntniss der Säugethiere Russland's. St. Pétersburg Acad. Sci. Mém., 9(pt. 2): 2–336. (not seen, cited in Hall [1981] and Royal Soc. Cat. Sci. Papers [1800–1863], 1:576, 1867)

BURT, W. H. 1960. Bacula of North American mammals. Misc. Publ. Mus. Zool., Univ. Michigan, 113:1–76 + 25 plates.

CROUCH, W. E. 1933. Pocket-gopher control. U.S. Dept. Agric. Farmers' Bull., 1709:1–20.

ELLIOT, D. G. 1903. A list of mammals obtained by Edmund Heller from the coast region of northern California and Oregon. Publ. Field Columbia Mus., Zool. Ser., 176(3):175–197.

EMERSON, K. C., C. MASER, AND J. O. WHITAKER, JR. 1984. Lice (Mallophaga and Anoplura) from mammals of Oregon. Northwest Sci., 58:153–161.

GARDNER, S. L. 1985. Helminth parasites of *Thomomys bulbivorus* (Richardson) (Rodentia:Geomyidae), with the description of a new species of *Hymenolepis* (Cestoda). Canadian J. Zool., 63:1463–1469.

GARDNER, S. L., AND D. P. JASMER. 1983. *Heligmosomoides thomomyos* sp. n. (Nematoda:Heligmosomidae) from pocket gophers, *Thomomys* spp. (Rodentia:Geomyidae), in Oregon and California. Proc. Helminthol. Soc. Washington, 50:278–284.

HALL, E. R. 1981. The mammals of North America. Second ed. John Wiley and Sons, New York, 1:1–600 + *90*.

HUBBARD, C. A. 1943. Our western giant pocket gopher fleas and their small relatives the Foxellas: a new subgenus—two new species: the allotype male of D. comis. Pacific Univ. Bull., 40(2):1–8.

———. 1947. Fleas of western North America. Their relation to the public health. Iowa State College Press, Ames, 533 pp.

JAEGER, E. C. 1955. A source-book of biological names and terms. Third ed. Charles C Thomas, Publisher, Springfield, Illinois, 323 pp.

KUHN, L. W. 1983. Controlling pocket gopher damage to lawns, gardens, and golf courses. Oregon State Univ. Ext. Circ., 1115, 4 unnumbered pp.

MASER, C., AND E. D. BRODIE, JR. 1966. A study of owl pellet contents from Linn, Benton, and Polk counties, Oregon. Murrelet, 47:9–14.

MASER, C., AND R. M. STORM. 1970. A key to the Microtinae of the Pacific Northwest (Oregon, Washington, Idaho). O.S.U. Book Stores, Inc., Corvallis, Oregon, 162 pp.

MCCHESNEY, C. E. 1878. Notes on the mammals of Fort Sisseton, Dakota. Bull. U. S. Geol. and Geogr. Survey Terr., 4(1):201–218.

MCCORNACK, E. C. 1920. Contributions to the Pleistocene history of Oregon. Univ. Oregon Leafl. Ser., Geol. Bull., 6(3)pt.2:15–23.

MERRIAM, C. H. 1895. Monographic revision of the pocket gophers of the family Geomyidae. N. Amer. Fauna, 8:1–259.

MILLER, G. S., JR., AND R. KELLOGG. 1955. List of North American Recent mammals. U.S. Nat. Mus. Bull., 205:1–954.

OSBORN, H. L. 1894. Notes on *Geomys bursarius*, the pocket-gopher. Science, 23:102–103. (not seen, cited in Merriam [1895] and Zool. Rec., 31[2]:16, 1894)

RICHARDSON, J. 1829. Fauna boreali-americana; or the zoology of the northern parts of British America: containing descriptions of the objects of natural history collected on the late northern land expeditions, under command of Captain Sir John Franklin. R. N. John Murray, London, 300 pp.

SCHEFFER, T. H. 1930. Determining the rate of replacement in a species. J. Mamm., 11:466–469.

———. 1938. Breeding records of Pacific Coast pocket gophers. J. Mamm., 19:220–224.

STRANDTMANN, R. W. 1949. The blood-sucking mites of the genus *Haemolaelaps* (Acarina:Laelaptidae) in the United States. J. Parasitol., 35:325–352.

SYKES, G. F. 1917. The control of the pocket gopher. Oregon Agric. College Ext. Bull., 200, 4 unnumbered pp.

THAELER, C. S., JR. 1980. Chromosome numbers and systematic relations in the genus *Thomomys* (Rodentia:Geomyidae). J. Mamm., 61:414–422.

WALKER, K. M. 1955. Distribution and taxonomy of the small pocket gophers of northwestern Oregon. Unpubl. Ph.D. dissert., Oregon State College, Corvallis, 200 pp.

WHITAKER, J. O., JR., AND N. WILSON. 1974. Host and distribution lists of mites (Acari), parasitic and phoretic, in the hair of wild mammals of North America, north of Mexico. Amer. Midland Nat., 91:1–67.

WHITAKER, J. O., JR., C. MASER, AND R. E. LEWIS. 1985. Ectoparasitic mites (excluding chiggers), fleas, and lice from pocket gophers, *Thomomys*, in Oregon. Northwest Sci., 59:33–39.

WIGHT, H. M. 1918. The life-history and control of the pocket gopher in the Willamette Valley. Oregon Agric. College Exp. Sta. Bull., 153:1–55.

———. 1922. The Willamette Valley gopher. Murrelet, 3(3): 6–8.

WILLIAMS, S. L. 1982. Phalli of Recent genera and species of the family Geomyidae (Mammalia:Rodentia). Bull. Carnegie Mus. Nat. Hist., 20:1–62.

Editor for this account was SYDNEY ANDERSON. Managing editor was CARLETON J. PHILLIPS.

B. J. VERTS AND L. N. CARRAWAY, DEPARTMENT OF FISHERIES AND WILDLIFE, OREGON STATE UNIVERSITY, CORVALLIS 97331.