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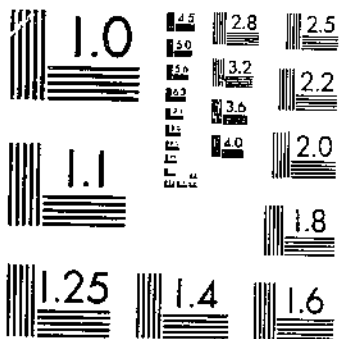
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HABITS AND ECONOMIC STATUS OF THE POCKET GOPHERS

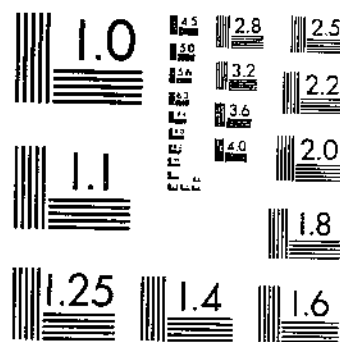
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NATIONAL BUREAU OF STANDARDS 1963 A



UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

HABITS AND ECONOMIC STATUS OF THE
POCKET GOPHERS

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CONTENTS

	Page		Page
Introduction.....	1	Description and habits—Continued	
Geographic distribution and classification...	2	Breeding habits.....	12
Species and subspecies of pocket gophers		Food of pocket gophers.....	16
of the genera Thomomys, Geomys, and		Natural enemies.....	17
Cratogeomys, with general ranges in		Damage to agricultural crops.....	18
the United States.....	4	Alfalfa and the clovers.....	18
Description and habits.....	6	Natural-grass meadows.....	19
Appearance.....	6	Root crops.....	19
Size.....	6	Horticultural crops.....	20
General habits.....	7	Irrigated lands and crops.....	21
Disposition.....	8	Pasture and range.....	21
Senses.....	8	Measures of control recommended.....	22
Sounds.....	9	Statutory provisions.....	22
Fossorial habits.....	9	Summary.....	23
Active seasons.....	11	Bibliography.....	24

INTRODUCTION

The extent to which pocket gophers affect the interests of agriculture is becoming more apparent each year. Scarcely any group of native rodents is more widely distributed in the United States, and certainly none has shown more readiness to adapt itself to the changed conditions introduced into its habitat by the farmer. The growing of such crops as alfalfa and clover has made conditions of life easy for the pocket gopher, since these plants furnish an abundant food supply in their roots and are usually maintained on the same ground for a period of years. The extensive reclaiming of desert lands also has furnished new food supplies and harbor for these rodents and has assisted their local wanderings. These changes as well as the destruction of hosts of its natural enemies by man, have favored the pocket gopher's rapid increase in many agricultural sections until now it is one of the most destructive mammal pests of the country. Nothing short of vigilance on the part of every land-

owner and cooperation with his neighbor will rid an affected community of the pocket gopher. It would be impossible, even if desirable, to exterminate the animal, for it tenants a wilderness of waste lands throughout its range, whether they be scantily covered with sagebrush or forested with snow-laden spruce. But this does not mean that its ravages need be tolerated, for these are fairly easily controlled in settled districts. Many a farmer has found that if he keeps careful watch of his acres, it requires no more than a few hours or perhaps a day or two a year to keep the pocket gopher under control.

Accounts of pocket gophers in the literature of agricultural experiment stations and in the farm press are not lacking. The chief publications by the Department of Agriculture on the subject thus far have been technical revisions of the groups (1, 21),² brief economic circulars (19), and incidental discussions of pocket-gopher control in bulletins dealing also with other agricultural pests (20). It remains, therefore, to bring together the results of extensive investigations in recent years of the habits of the pocket gopher and to combine them in a single publication for making readily available to naturalists and other lovers of wild life and to control operators the essential facts in the life history of this rodent.

Perhaps the term "gopher" may be as well applied to certain other burrowing animals as to the rodent that most commonly goes by that name. The word has a significance derived from the honey-combing of the earth by burrows. In the pine barrens of the southeastern part of the United States the true pocket gopher is known as "salamander," while a big land tortoise with burrowing habits masquerades under the rodent's real name. Commonly throughout the central West certain species of ground squirrels are called gophers, striped gophers, or gray gophers. Locally, too, in some districts both East and West, moles are called gophers. In this bulletin only the true pocket gopher, an animal easily distinguished by well-marked characters, is to be dealt with.

GEOGRAPHIC DISTRIBUTION AND CLASSIFICATION

The pocket-gopher family (Geomyidae) is found in North America and Central America only. Over this continent it has a wide distribution and a remarkable range in altitude. (Fig. 1.) Within its geographical limits some one of the many species may be found in almost any situation from sea level to the rugged mountain slopes above timber line. The animal is as much at home in an alpine park or on the sun-scorched desert as in the lush clover fields where it is looked upon with such disfavor.

Within the borders of the United States, the range of the pocket gopher includes all the States west of the lower Mississippi River, the Wabash River, and Lake Michigan, and also three States of the southeastern coastal region, Alabama, Georgia, and Florida. Strangely enough, no connection between these two areas has been traced either eastward or westward through Mississippi. A large

² Italic numbers in parentheses refer to the Bibliography, p. 24.

district including the contiguous parts of Kansas, Missouri, Oklahoma, and Arkansas has no pocket gophers in its fauna.

The wide distribution of pocket gophers, with the consequent isolation of groups, has given rise to the many species and subspecies recognized by the naturalist. Of the eight genera of North Ameri-

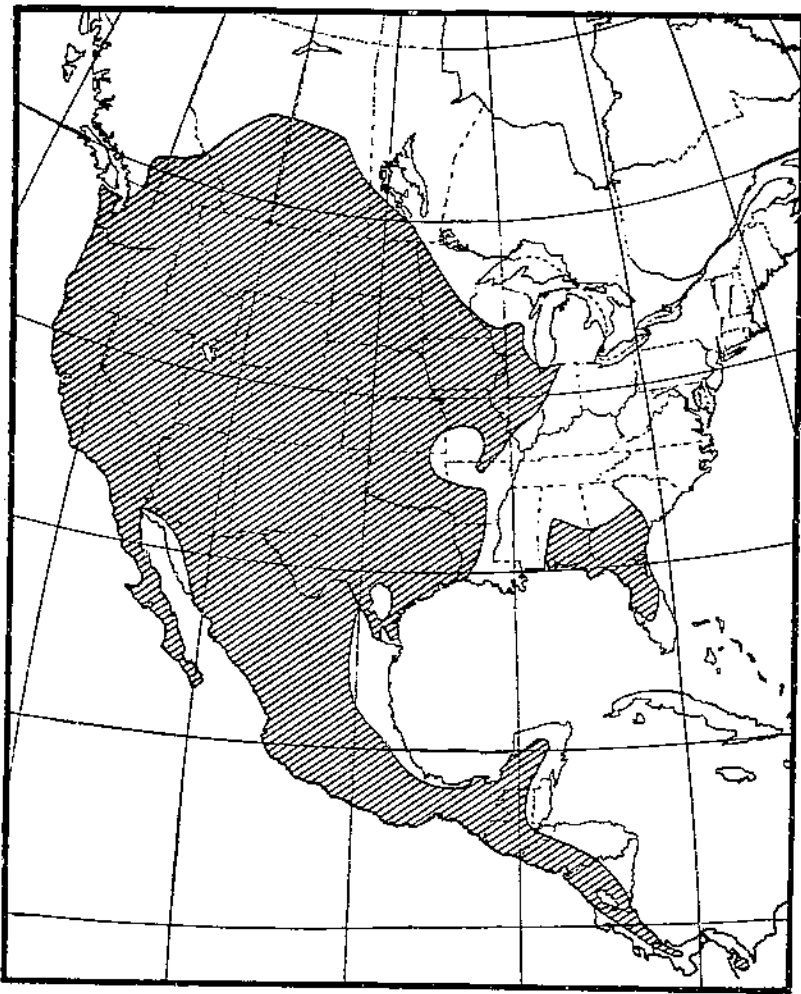


FIGURE 1.—Distribution of pocket gophers shown by shaded portions of the map

can pocket gophers, three are found within the United States—*Geomys*, *Thomomys*, and *Cratogeomys*. The species and subspecies of each, with their ranges, are as follows:²

² For preparing the systematic list and statement of ranges of the species and subspecies of pocket gophers of the United States here presented the writer is indebted to Vernon Bailey, field naturalist of the Division of Biological Investigations of the Bureau of Biological Survey, long a close student of the classification, distribution, and habits of the pocket gophers.

SPECIES AND SUBSPECIES OF POCKET GOPHERS OF THE GENERA THOMOMYS, GEOMYS, AND CRATOGEOMYS, WITH GENERAL RANGES IN THE UNITED STATES

THOMOMYS, WITH PLAIN, UNGROOVED UPPER INCISORS

<i>Thomomys bulbivorus</i>	Willamette Valley, Oreg.
<i>townsendii townsendii</i>	Southwestern Idaho and eastern Oregon.
<i>townsendii nevadensis</i>	Northwestern Nevada and southern Oregon.
<i>bottae bottae</i>	Coast region of California from Sonoma County to San Diego.
<i>bottae laticeps</i>	Coast strip from Humboldt Bay to southwestern Oregon.
<i>bottae leucodon</i>	San Francisco Bay and low country, both sides of Sacramento Valley, Calif., to Rogue River Valley, Oreg.
<i>bottae navus</i>	Sacramento Valley, Calif.
<i>bottae mewa</i>	Foothills west of San Joaquin Valley, Calif.
<i>bottae minor</i>	Coast strip south of Humboldt Bay, Calif.
<i>bottae diaboli</i>	Mount Diablo Range, Calif.
<i>bottae angularis</i>	Valley country west of San Joaquin Valley, Calif.
<i>bottae pascalis</i>	East side and south end of San Joaquin Valley, Calif.
<i>bottae pallescens</i>	Los Angeles region, Calif., from San Bernardino to Alhambra.
<i>bottae infrapallidus</i>	Carriso plains, west of Bakersfield, Calif.
<i>bottae nigricans</i>	Southwestern California back of coast region.
<i>bottae pueriae</i>	San Felipe Valley, southern California.
<i>bottae altivallis</i>	Top of San Bernardino Mountains, Calif.
<i>alpinus alpinus</i>	Mount Whitney region, Calif.
<i>alpinus awahnee</i>	Middle west slope of Sierra Nevada, Calif.
<i>neglectus</i>	San Gabriel Mountains, Calif.
<i>jacinteus</i>	San Jacinto Mountains, Calif.
<i>perpallidus perpallidus</i>	Imperial Valley, west of Salton Sea, Calif.
<i>perpallidus albatrus</i>	Eastern part of Imperial Valley and west side of Colorado River, Calif.
<i>perpallidus chrysonotus</i>	Lower Gila and Colorado Valleys, Arizona, and Sonora.
<i>perpallidus perpes</i>	Deserts of eastern California.
<i>perpallidus mohavensis</i>	Mohave River Valley, Calif.
<i>perpallidus amargosae</i>	Amargosa River Valley east of Death Valley, Calif.
<i>perpallidus canus</i>	Desert valleys of western Nevada and Honey Lake Valley, Calif.
<i>perpallidus aureus</i>	Rio Grande and Colorado Valleys in New Mexico, Arizona, Colorado, Utah, and Nevada.
<i>perpallidus apache</i>	Valleys in northern New Mexico and Arizona and southern Colorado.
<i>cabazonae</i>	Valley between San Jacinto and San Bernardino Peaks, Calif.
<i>operarius</i>	Owens Lake Valley, Calif.
<i>melanotis</i>	White Mountains, Calif.
<i>cervinus</i>	Gila Valley about Phoenix, Ariz.
<i>latirostris</i>	Tanners Crossing, Little Colorado River, Ariz.
<i>fulvus fulvus</i>	Plateau country of Arizona and New Mexico.
<i>fulvus pervagus</i>	Valleys in northern New Mexico and southern Colorado.
<i>fulvus desertorum</i>	Desert valleys in northwestern Arizona.
<i>fulvus intermedius</i>	Mountains of southeastern Arizona and southwestern New Mexico.
<i>fulvus texensis</i>	Davis Mountains, Tex.

<i>Thomomys fulvus toltecus</i>	Valleys of southwestern New Mexico, southeastern Arizona, and northern Mexico.
<i>mearnsi</i>	Animas Valley, N. Mex.
<i>bleyi</i>	Sierra Blanca, Tex., and Tularosa Valley, N. Mex.
<i>lachuquilla</i>	Rio Grande Valley of western Texas, southeastern New Mexico, and western Chihuahua.
<i>perditus</i>	Eastern Mexico and into middle western Texas.
<i>talpoides talpoides</i>	Prairies of northwestern Montana, and of southern Saskatchewan and Alberta.
<i>talpoides rufescens</i>	Prairies of North Dakota, South Dakota, and southern Manitoba.
<i>talpoides clusius</i>	Plains of southern Wyoming and northern Colorado.
<i>talpoides bullatus</i>	Sage plains of western Dakotas and eastern Montana and Wyoming.
<i>talpoides nebulosus</i>	Black Hills, S. Dak., and Bear Lodge Mountains, Wyo.
<i>talpoides caryi</i>	Bighorn Mountains, Wyo.
<i>talpoides pryori</i>	Pryor Mountains, Mont.
<i>talpoides agrestis</i>	San Luis Valley, Colo.
<i>columbianus</i>	Columbia Valley of Washington and Oregon.
<i>ocius</i>	Sage plains of southwestern Wyoming and adjoining parts of Colorado and Utah.
<i>idahoensis</i>	Snake River Valley in eastern Idaho.
<i>pygmaeus</i>	Plateau country of southeastern Idaho and western Wyoming.
<i>fossor</i>	Mountains of Colorado, Utah, southern Wyoming, and northern New Mexico and Arizona.
<i>bridgeri</i>	Cold meadows of western Wyoming and eastern Idaho.
<i>uinta</i>	Mountains in western Wyoming, northern Utah, and southern Idaho.
<i>quadratus quadratus</i>	Sage plains of eastern Oregon, northeastern California, and southwestern Idaho.
<i>quadratus fisheri</i>	Desert valleys of northeastern California, northern Nevada, and western Utah.
<i>douglasii douglasii</i>	North of Portland, Oreg., on both sides of the Columbia River.
<i>douglasii oregonus</i>	Northern end of Willamette Valley, Oreg.
<i>douglasii yelmensis</i>	Valleys south of Puget Sound, Wash.
<i>douglasii lacomensis</i>	Pierce County, Wash.
<i>douglasii melanops</i>	Olympic Mountains, Wash.
<i>douglasii shawi</i>	Upper slopes of Mount Rainier, Wash., and Cascade Range to the east.
<i>douglasii limosus</i>	South slope of Mount Adams, Wash.
<i>douglasii niger</i>	Coast of middle western Oregon.
<i>douglasii hesperus</i>	Coast of northwestern Oregon.
<i>monticola monticola</i>	Sierra Nevada, Calif.
<i>monticola mazama</i>	Cascade and Siskiyou Mountains in Oregon and Trinity Mountains in California.
<i>monticola pinetorum</i>	Yolla Bolly and Scott Mountains, Calif.
<i>monticola nasicus</i>	East base of Cascades, in Oregon.
<i>monticola helleri</i>	Near mouth of Rogue River, Oreg.
<i>fuscus fuscus</i>	Rocky Mountain region from central Idaho to central British Columbia and from eastern Washington to western Montana.
<i>fuscus saturatus</i>	Coeur d'Alene Mountains in Idaho and Montana.
<i>fuscus loringi</i>	East base of mountains in Alberta.
<i>fuscus myops</i>	Vicinity of Conconully, Okanogan Valley, Wash.

GEOMYS, WITH DEEPLY DOUBLE-GROOVED UPPER INCISORS

<i>Geomys bursarius bursarius</i>	Red River and Mississippi Valleys from northern Minnesota and North Dakota to Missouri and from eastern Kansas to northwestern Wisconsin.
<i>bursarius lutescens</i>	Plains and prairies from South Dakota to northern Texas.
<i>breviceps breviceps</i>	Louisiana, Arkansas, and eastern Texas.
<i>breviceps sagittalis</i>	Gulf coast of Texas near Galveston Bay.
<i>breviceps altwateri</i>	Coast of Texas between Matagorda and Nueces Bay.
<i>breviceps llanensis</i>	Stream valleys in northern Texas.
<i>texensis</i>	Mason County, central Texas.
<i>arenarius</i>	Monahans and El Paso, Tex., Las Cruces and Deming, N. Mex.
<i>personatus personatus</i>	Padre Island and lower Rio Grande Valley, Tex.
<i>personatus fallax</i>	Nueces Bay and lower Nueces River, Tex.
<i>tuza tuza</i>	Pine barrens of Georgia.
<i>tuza mobilensis</i>	Southern Alabama and northwestern Florida.
<i>floridanus floridanus</i>	St. Augustine region, Fla.
<i>floridanus austrinus</i>	Western part of the Florida peninsula.
<i>colonus</i>	Southeastern Florida.
<i>cumberlandius</i>	Cumberland Island, coast of Georgia.

CRATOGEOMYS, WITH SHALLOW SINGLE-GROOVED UPPER INCISORS

<i>Cratogeomys castanops castanops</i> ---	Eastern Colorado and New Mexico, western Oklahoma and Texas, into Mexico.
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In addition to the various species and subspecies of pocket gophers above listed, there are approximately 13 forms of *Thomomys* and 23 forms of five other genera—*Platygeomys*, *Orthogeomys*, *Heterogeomys*, *Macrogeomys*, and *Zygogeomys*—the ranges of which do not reach the United States but are limited to Mexico and the Central American countries, including Panama.

DESCRIPTION AND HABITS

APPEARANCE

The true pocket gopher is a stockily built rodent of chiefly subterranean habits. It has capacious cheek pockets wholly outside the mouth and lined with soft hair or fur of a lighter shade than that covering the body. The body hair, while not true fur, is soft to the touch, glossy, and not readily soiled by contact with damp earth. The incisor, or front, teeth are long and prominent and practically outside the mouth cavity. Adapted for digging, the animal is the more heavily built forward. It has strong shoulders, arms, and hands that are equipped with long, sharp claws. (Pl. 1, A.) The hind legs and feet do not show these special adaptations for burrowing. The tail is short and scantily haired, serving undoubtedly as a sensitive feeling organ. The ears are inconspicuous and the eyes small and beadlike.

SIZE

The pocket gophers in general are much larger than the mouse group of rodents, and most species are considerably larger than the moles. There is the usual individual variation in respect to

adult proportions, but more marked is the difference in size of the two sexes. The males are larger and somewhat broader in the shoulders than the females and longer in the proportionate extension of the body back of the hind legs. This difference in size, as determined by relative weights, is fairly constant in the different species. The males are usually from a fourth to a third heavier than the females; in the *Thomomys bottae* group the difference is greater. (Pl. 1, B.) Table 1 gives the average weight for five species of the genus *Thomomys* and three species of the genus *Geomys*—two groups comprising by far the greater number of the pocket gophers.

TABLE 1.—Comparative sizes (by weight) of sexes in the pocket gopher of five species of *Thomomys* and three species of *Geomys*

Species	Locality collected	Period collected	Males weighed	Females weighed	Average weight of males	Average weight of females	Largest male	Largest female
			No.	No.	Ozs.	Ozs.	Ozs.	Ozs.
<i>Thomomys bulbivorus</i>	Corvallis, Oreg.....	Mar. 15-May 5.....	38	22	13.16	10.40	17.37	11.87
<i>douglasii yelmensis</i>	Roy, Wash.....	Mar. 7-Apr. 6.....	30	30	4.42	3.48	5.62	4.24
<i>fulvus fulvus</i>	Flagstaff, Ariz.....	Apr. 12-July 10.....	9	14	4.40	3.64	5.62	4.75
<i>bottae bottae</i>	El Monte, Calif.....	December-January.....	23	62	9.50	5.00	11.00	6.62
<i>perpallidus albatius</i>	El Centro, Calif.....	Jan. 15-16.....	13	32	6.82	3.40	8.80	6.70
<i>Geomys bursarius</i>	Manhattan, Kans.....	Jan. 25-Mar. 3.....	14	36	13.50	10.10	17.37	13.50
<i>bursarius lutesceus</i>	Sun City, Kans.....	Mar. 7-17.....	11	39	8.20	6.25	10.50	7.25
<i>floridanus floridanus</i>	Lyna, Fla.....	February.....	3	4	6.58	5.43		

GENERAL HABITS

The pocket gopher is one of the few burrowing animals that have adopted a life of subterranean seclusion. In this respect it is akin to the mole. Most fossorial rodents, as the prairie dogs (*Cynomys*), the ground squirrels (*Citellus*), and the woodchucks (*Marmota*), seek their food above ground in the daylight hours, incidentally making the acquaintance of the rest of creation. Others, like the clumsy mountain beaver (*Aplodontia*) and the dainty little kangaroo rats (*Dipodomys*), come forth at night to get in touch with their broader physical environment and find their living. The pocket gopher, on the other hand, has retreated farther from the stress of competition and the menace of foes aboveground to find food and shelter in dark labyrinths of its own construction. In general, it does not leave the seclusion of this subterranean niche, except for the brief periods when it is engaged in heaping on the surface the loads of earth it has pushed from its excavations. Even then it appears wary and apprehensive, shoving the earth about and backing into the burrow again with quick, nervous movements. Much of this work is accomplished under cover of darkness, but sometimes on cloudy days and regularly in the hours of evening twilight and early morning, the pocket gopher may be found busily disposing of the freshly dug earth in hummocky dumps about the exit of an open burrow. The animal then is as expeditious as possible in the performance of its task and exposes no more of its body than is needful.

At times, however, chiefly when disturbed by agricultural operations but also under natural conditions and surroundings, the pocket gopher moves about on errands aboveground—sometimes to seek more accessible forage, sometimes to gather nesting materials, and sometimes perhaps to satisfy the restless urge of the mating and migratory instincts. From the toll of pocket gophers taken by owls and the accidental death of others in situations aboveground at night, it may be assumed that their nocturnal excursions are more common than their diurnal. Only occasionally will those who are most familiar with the habits of these little animals find one aboveground in the daytime, except under the changed conditions imposed by agriculture.

DISPOSITION

Living more or less to itself for the greater part of the year does not tend to develop a social disposition in the individual pocket gopher. It would be difficult to determine precisely just what the attitude of each may be toward its fellow in the life of a group so secluded from human observation. That this is little more than one of indifferent toleration may be inferred from the fact that the door of each occupied burrow or burrow system, in a locality where pocket-gopher infestation is heavy enough to make intersection of tunnels inevitable, is usually plugged off by tightly packed earth from the premises of a neighbor. Observations of the life habits of pocket gophers over a period of many years do not indicate that these rodents are in any degree colonial or even gregarious, except in a restricted sense during periods of mating and rearing the young.

The writer has found it practically impossible to keep pocket gophers when taken alive and uninjured and placed together, even by twos, in cages. When thus associated they fight furiously, usually to the death of one or the other.

SENSES

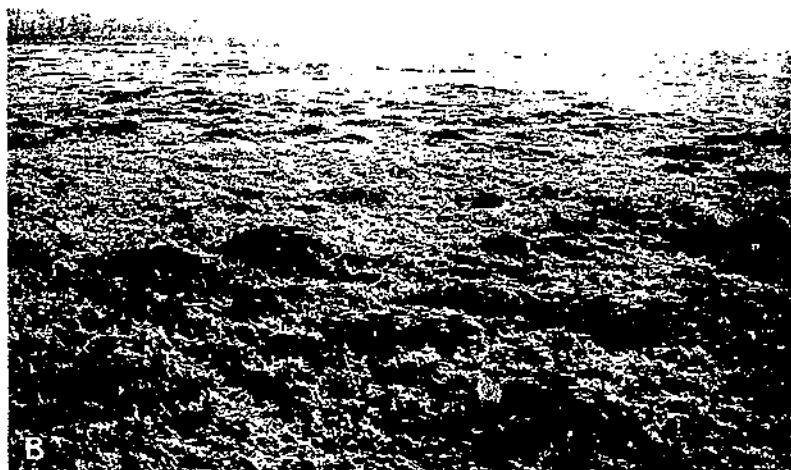
As with other burrowing mammals that rarely leave their subterranean homes, the pocket gopher has little use for eyes. The degeneration of these organs has not proceeded so far, however, as in moles, whose vestigial eye slits are sealed in one genus (*Scalopus*) and in another (*Scapanus*) permit only an extremely small eye to be exposed to the light. Both field observation and experiment show that the pocket gopher is not at all keen sighted and that its range of vision is very limited. On the other hand, as might be expected, a study of the animal's sensory reactions to stimuli shows that its organs of touch and of smell are exceptionally well developed. The short, stubby tail, nearly devoid of hair, is particularly sensitive to touch.

Careful discrimination in the selection of its food from a quantity of vegetation placed before it attests the pocket gopher's keen sense of smell. Observations in the mating season also point to the conclusion that this sense is useful to the animal in locating its kind. It probably also enables it to detect the presence of certain enemies that invade its burrows, particularly the weasel.



A, Head and front feet of Mississippi Valley pocket gopher (*Geomys bursarius*); B, male (left) and female (right) of California pocket gopher (*Thomomys bottae*) from El Monte, Calif.

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A, Pocket-gopher mounds and mole ridges in a field recently plowed and rolled (Torrance, Calif.);
B, Mounds of pocket gophers (*Citellus burbanus*) in an alfalfa field in central Kansas

SOUNDS

In the haunts of pocket gophers, no calls to their kind, no notes of strife, and no noises of any nature are heard to indicate the presence of the animals. If there are any sounds of domestic felicity or infelicity, they are so subdued that they are lost in the galleries under the listener's feet. In captivity, however, the pocket gopher is not entirely mute. A grinding chatter of teeth and peculiar, aspirated sounds accompany the struggle for supremacy in combat; squeals of anger may be distinguished when the animal is annoyed, and vocal expression of pain when it is bitten by an antagonist or caught in a trap. Certain domestic sounds also have been noted by investigators (27).

FOSSORIAL HABITS

BURROWS

The burrows of pocket gophers and of moles differ from those of most other fossorial mammals in one important respect—their extent. The excavations of most burrowing mammals are comparatively short, deep enough usually to be secure, and they constitute the animal's living quarters only. Pocket-gopher and mole runways, however, communicate with extensive ramifications of subterranean feeding runs or hunting paths. Except where a pioneer has recently established itself in new territory, it is difficult to determine the limits of a pocket gopher's system of runways. One prairie dog or one spermophile digs a burrow very much like that of any other, but, as noted above, these animals are constructing homes, not extending passageways in search of food. Heading nowhere in particular, a pocket gopher may in the course of a year explore the length and breadth of a field of many acres. Again, if food is plentiful, it may limit its operations to a few square rods.

In attempting to explore and map out a burrow system (fig. 2), one will distinguish the open runways that are continuous from those that are partly or wholly packed with refuse or with earth from newer excavations. Some of these packed galleries, which can be traced by differences in the color of the soil in uncultivated lands, appear to be age-old in construction. In this habit of filling the older galleries with material carried from the newer, pocket gophers differ from all American moles. Mole burrows are open continuously throughout and form a network of highways used by all the moles that contribute to their construction or find their way into them. The mole has no more persistent habit than that of keeping these runways always open. It is not at all uncommon, therefore, to trap from a dozen to 20 or more moles at the same spot; while in the case of the pocket gopher usually no more than 1 adult is taken from what is apparently a single burrow.

This difference in the burrowing habits of two animals that live under such similar conditions is directly related to a difference in the character of their food. The mole is a little beast of prey, catching its food alive, not only as it extends its hunting galleries but as it retraces the passageways time after time in search of worms and insect larvæ that also are on the move. The pocket gopher, being a root

eater, may exhaust the food possibilities of a burrow extension at the time it is dug, and, having no more use for the gallery, is likely to fill it up again.

Unlike the hunting paths of the mole, the feeding runs of the pocket gopher are never so close to the surface as to ridge up the sod or the soil crust. (Pl. 2, A.) They usually range at depths somewhat less than a foot but are sometimes much deeper, especially in sandy soils penetrated by succulent roots. The size of the burrow openings depends, of course, upon the size of the individuals that construct them. The diameter of those of some of the smaller

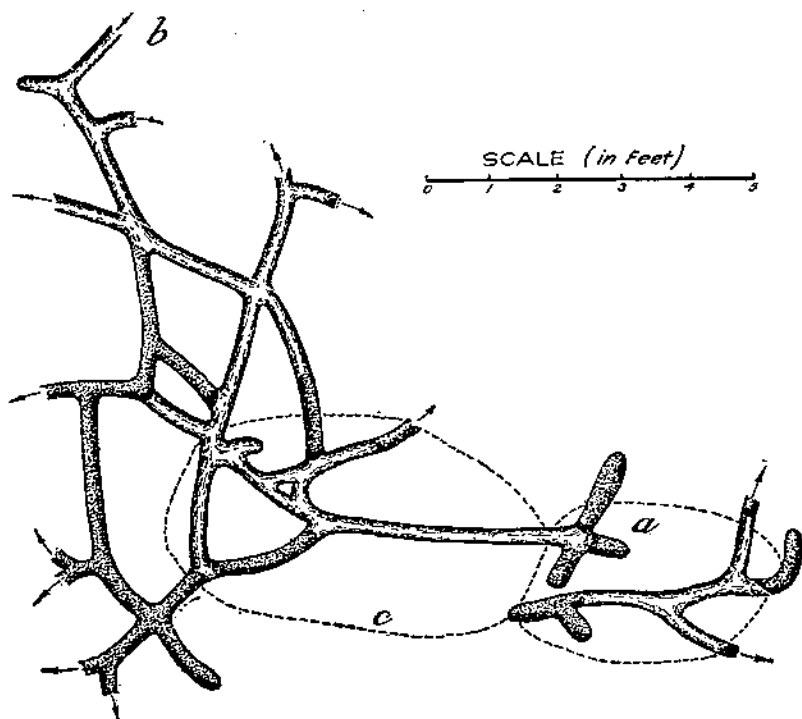


FIGURE 2.—Part of a deeper runway system of *Geomys bursarius* excavated at Manhattan, Kans.; packed portions of burrow are shaded: a, Blind laterals filled with earth and refuse, 18 to 20 inches below surface; b, continuation of deep runway, 3 feet below surface; c, outlines of composite surface mounds

desert or high-altitude species is no more than $1\frac{1}{2}$ inches, while in the case of burrows of the large Mississippi Valley pocket gopher (*Geomys bursarius*) or the Camas pocket gopher (*Thomomys bulbivorus*), the common species inhabiting the Willamette Valley, Oreg., one can sometimes thrust the hand and arm back into the tunnel as far as he can reach. (Pl. 4, A.)

Many of the branching burrows end blindly where the animal ceased digging. Others are blocked by refuse or earth tightly packed into the opening. Still others connect with pockets excavated for food storage or descend to the chambers containing the nests. At irregular intervals the feeding runs connect with short laterals that terminate at the earth heaps on the surface of the ground.

MOUNDS

In general, the pocket gopher brings to the surface only freshly excavated earth. Unused or spoiled food supplies, old nesting material, and pellets of excrement are sealed up in old galleries or in special pockets constructed for the purpose. Through the short laterals from the feeding runs the animal pushes the loose earth to the surface in quick, nervous movements that betray an anxiety to keep out of sight as much as possible. The loads of soil thus thrust out accumulate in front, to the right, and to the left of the burrow opening, forming ordinarily low, flat mounds somewhat semicircular or fan-shaped in outline. (Pls. 2 and 4.) As the heap grows, some of the loads may be pushed to the rear of the line of exit, thus leaving the opening within the base of the mound but near one edge. Finally when the pocket gopher has stopped using that particular dumping ground, temporarily at least, he plugs the opening snugly from beneath, leaving concentric rings of earth on the completed mound to mark the point of this last outthrust. (Pl. 3, A.) In time the lateral may also be packed entirely back to the main runway.

As originally constructed, pocket-gopher mounds are more or less in lines corresponding to the direction taken by the burrow. In time, however, many deviating cross runs and the reopening of old workings alter the appearance of things. Not infrequently a composite mound is formed of earth pushed out from many openings until the accumulation may cover several square feet and contain more than a wagonload. (Pl. 3, B.)

In contrast with the pocket-gopher mounds described, the mole-hills of the Pacific-coast country have a more rounded, dome-shaped appearance and may be distinguished by a structural detail that indicates plainly that they were built up, volcano fashion, by successive upheavals beneath and through the center of the pile. In the freshly constructed molehill, too, the earth appears in the form of compacted plugs, while in the pocket-gopher mound it is fine and scattered.

ACTIVE SEASONS

Pocket gophers store food at harvest time and do not hibernate. They seem to be more or less busy at any season of the year when the ground is not frozen too hard or sun baked too deeply for mining operations. They continue to work whether the soil is so wet that it has to be carried out of the burrows in balls, or so dry that it runs like the sand of an hourglass. Not uncommonly their mounds of fresh earth are seen thrown up from under the snow of midwinter. Beneath this covering, too, they pack the dirt in snow tunnels, which, melting later, leave the soil filling in ridges resembling sections of a heavy cable. (Pl. 4, B.) During periods of particularly inclement weather in winter the pocket gopher can keep up its quest of food, if necessary, by disposing also of the excavated earth in the older workings.

Though the pocket gopher is active at all times of year, its work of burrowing is usually carried on more vigorously in the fall, when summer droughts are broken and soil conditions make digging easy. At that season also the little animals are busy storing food, and the young, then well grown, are establishing themselves in quarters of

their own. In the spring, again, after the frost has left the ground or when vegetation starts, their activity is renewed for a time. But when the drier period of midsummer comes on, extension of the burrows, especially at shallower depths, receives less attention.

BREEDING HABITS

As might be expected of mammals living a life of comparative security in underground burrows, the pocket gopher in a wild or natural environment is not a prolific breeder. Its rate of reproduction is somewhat higher, though, than that of the mole, a comparison that is correlated with the fact that, in its various activities, the pocket gopher is more exposed to predatory attacks than the mole and is more relished as food by predators. There are no data from which the longevity in either group can be ascertained.

In middle and northern latitudes the young of the pocket gopher are brought forth in the spring, throughout a period that is more prolonged than in the case of most other small rodents or of the mole. This fact appears to be correlated with the secluded life habits of the animal, which necessarily reduce the chances for the meeting of the sexes. It has been observed too that a considerable percentage of the females go through the spring season without mating, particularly where the animals are of scattered occurrence.

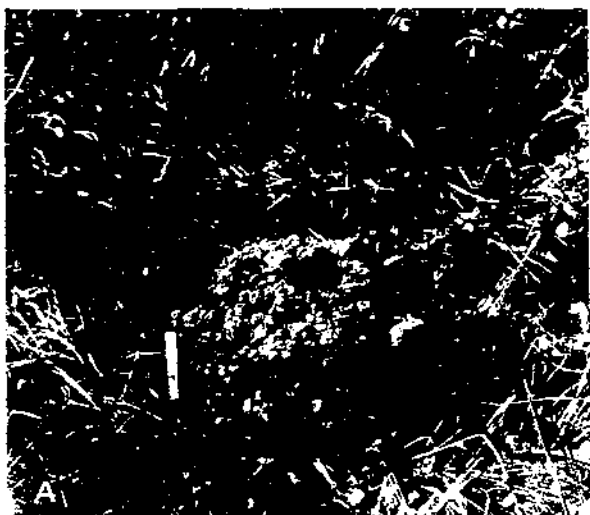
Field observations in the Pacific-coast country show that the meeting of the sexes is ordinarily within the burrow labyrinths, instead of aboveground. The male may wander abroad more or less in search of the habitations of the female, but data are lacking on which to base such a conclusion. It is certain, however, that there is unusual activity within the burrows during the mating season. At this time the writer setting his traps by twos, one facing each way at the break into a burrow, occasionally caught from one to three pairs of pocket gophers within the hour following sunset. Also, all other places at which females had been taken in the afternoon or evening were visited during the night and the breaks stopped with earth. In these evening observations no pocket gophers were seen abroad.

On the basis of the interval noted in several species between the earliest observed cases of pregnancy and the first ensuing records of the birth of young, it is concluded that the period of gestation is approximately four weeks. No records of the breeding of pocket gophers in captivity are available. The young are brought forth and sheltered in nests of fine, dry grasses or shredded stubble—materials that certainly are procured entirely aboveground. These nests are almost globular in form and have no permanent opening into the interior, where the young are kept dry and warm. They serve likewise to shelter the adults at all seasons of the year. (Pl. 5, A.)

The nesting chambers of the several species studied are from 7 to 10 inches in their interior dimensions and are completely filled with the materials just mentioned. They may be entered by two or more openings, connecting usually with the deeper underground passages. On low meadowlands, however, the nests of *Thomomys vul-*



A, Single mound of pocket zopher. The circular plug near one side is the last earth pushed out and indicates the position of the lateral. B, Composite mound, formed by accumulations of earth pushed out from a number of laterals terminating in close association.



A, Type of mound constructed by the Canvas pocket gopher (*Thomomys bulbivorus*) in low, wet meadows of the Willamette Valley, Oreg. B, pocket gopher "cables," or ridges of excavated earth deposited by the animals in tunnels under the snow.

bivorus are sometimes less than a foot beneath the surface. On better-drained slopes the same species nests at a depth of 2 or 3 feet. Nests of *Geomys bursarius*, in the Middle West, are from 1½ to 2½ feet beneath the surface of the ground. On the gravelly prairies of western Washington the feeding runs of *T. douglasii yelmensis*, as they approach the vicinity of the nest, descend almost vertically to depths of 2, 3, and even 5 feet. From the bottom of this nearly vertical shaft the burrow then takes a horizontal or sometimes an up-grade course of several feet to the nest chamber. In excavating four burrow systems of this species, the writer found the nests at depths of 26, 29, 34, and 36 inches, respectively. The greatest depth reached by any one of the connecting passageways was 64 inches.

From investigations of the pocket gopher in captivity (27), it is learned that the young are born blind, hairless, and without cheek pockets or teeth. (Pl. 5, B.) The first two of these conditions have been noted also in the field. At the age of about 3 weeks the young begin to take an interest in the green food provided by the mother. A week or 10 days later they are well on the way toward overcoming their physical handicaps. When about a month and a half old they are weaned and soon after begin to shift for themselves. At this time they may be trapped in the parental burrows, but are often found in short, simple tunnels of their own construction. All are mature by the next breeding season.

Whether a female pocket gopher will produce two or more litters in a season depends upon locality and upon the food relations of the particular species. Painstaking investigations of the writer in the Middle West and in the Northwest lead to the conclusion that even the lengthened breeding season of the pocket gopher does not suffice generally for such a performance. By following carefully, week by week, the sexual development (seasonal) in both males and females early in the spring, by noting the first cases of pregnancy and the birth of the first young, by calculating the periods of gestation and lactation, and by observing again the rapid recession from breeding condition in both sexes, one is led to the conclusion that in the latitudes mentioned and in natural environment few pocket gophers may be expected to raise more than one litter a year. There is, however, considerable evidence that pocket gophers living in the changed environment brought about by irrigation and agriculture become more prolific. This physical reaction is understood to account for the rapid increase in numbers following the introduction of ditch and plow, especially in the valleys of the Southwest, where an abundant supply of green food thus provided sometimes the year round reacts upon the plastic nature of this race of mammals to prolong the breeding season and to facilitate the interbreeding of different family groups. Normally in this region seasonal sexual development is coincident with the beginning of the fall rains and is stimulated by the new growth of green vegetation. Breeding conditions obtain throughout the winter. Where green food grown under irrigation is to be had, with no dependence on rainfall, breeding is under way late in November, and in some localities may continue indefinitely.

Tables 2 and 3 present data concerning the breeding of one form of each of the two principal genera of pocket gophers in the United States (*Geomys bursarius* and *Thomomys douglasii yelmensis*). Climatic conditions of habitat include, in one case, the hot summers and rigorous winters of a mid-western State (Kansas) and, in the other, the lesser extremes of seasonal range on the Pacific coast. The number of young of *bursarius* ranged from 1 to 6, with an average of 4.2, and of *yelmensis* from 2 to 7, with an average of 5.

TABLE 2.—Breeding records of 131 females of *Geomys bursarius* taken at Manhattan, Kans., on 28 different dates in three successive springs

Date taken	Females examined	Embryos	Breeding condition or seasonal sexual development
First year:			
	<i>Number</i>	<i>Number</i>	
Feb. 27	4	None	No indications of pregnancy.
Mar. 15	2	4, 5	1 lot almost fully developed; other, a little less so.
Mar. 18	2	5, 5	1 lot embryos 25 millimeters long; others, slightly developed.
Do	2	None	1 showed marked development; other, medium.
Mar. 19	1	do	Marked development.
Mar. 25	2	3, 4	1 lot embryos nearly developed; other, fetal sacs 15 millimeters long.
Mar. 26	2	1, (0)	Single fetal sac 15 millimeters long; (0).
Apr. 1	2	3, 4	1 lot 7 millimeters long; other, 15 millimeters long.
Apr. 4	3	4, 4, 5	2 lots advanced development; other, fetal sacs 16 millimeters long.
Apr. 5	3	4, 4, 5	2 lots fetal sacs 25 millimeters long; other, 15.
Apr. 8	1	(0)	
Apr. 9	3	4, 4, 4	2 lots embryos in early stage of development; others, advanced.
Apr. 15	2	5, 5	Both lots fetal sacs 15 millimeters long.
Do	1	None	Marked development.
Apr. 22	2	4, 4	1 lot fetal sacs 7 millimeters long; other, 15.
Apr. 24	2	4, 3	1 lot in early stage of development; other, fetal sacs 20 millimeters long.
May 3	2	(0)	
Do	1	3	Fetal sacs 7 millimeters long.
Do	2	(0)	
Do	2	None	No indications of pregnancy or that young had been born.
May 13	2	2, 4	1 lot fetal sacs 7 millimeters long; other, 17 millimeters.
Do	1	(0)	
Do	7	None	No indications of pregnancy or that young had been born.
May 20	3	(0)	
Do	7	None	Do.
Second year:			
Jun. 31	1	4	Fetal sacs 15 millimeters long.
Do	1	None	No indications of pregnancy.
Feb. 6	1	5	Fetal sacs 7 millimeters in diameter.
Do	2	None	Marked development.
Do	1	do	No apparent development.
Feb. 7	1	5	Fetal sacs 15 millimeters long.
Do	2	None	Marked development.
Do	2	do	No apparent development.
Feb. 8	2	do	Do.
Do	1	do	Marked development.
Feb. 10	3	6, 6, 5	1 lot fetal sacs 7 millimeters long; second, 15; third, 20.
Do	4	None	Marked development.
Do	2	do	No apparent development.
Feb. 12	1	4	Fetal sacs 7 millimeters in diameter.
Do	2	None	Marked development.
Do	1	do	No apparent development.
Third year:			
Jan. 25	5	do	Marked development.
Do	9	do	No apparent development.
Feb. 11	6	do	Marked development.
Do	6	do	Medium development.
Do	6	4, 4	1 lot fetal sacs 7 millimeters in diameter; other, 5.
Mar. 3	5	None	No apparent development.
Do	3	5, 6, 4	First lot fetal sacs 7 millimeters in diameter; second, 8; third, 5.

1 Evidence that young had been born.

TABLE 3.—Breeding record of 222 females of *Thomomys douglasii yelmensis* taken on 20 different dates on Olympia prairies, Wash., in three successive springs

Date taken	Females examined	Embryos	Breeding condition or seasonal sexual development
First year:	<i>Number</i>	<i>Number</i>	
Feb. 11	2	None	No apparent development.
Feb. 20	5	do	Do.
Mar. 17	6	do	Do.
Do	1	do	Slight development.
Do	1	do	Marked development.
Do	1	6	Fetal sacs 7 millimeters in diameter.
Apr. 6	1	None	Marked development.
Do	4	do	No evidence of pregnancy.
Second year:			
Feb. 24	11	do	No apparent development.
Do	1	do	Slight development.
Do	1	do	Marked development.
Mar. 17	8	do	Slight to medium development.
Do	1	do	Marked development.
Apr. 11	2	do	No apparent development.
Do	5	do	Medium development.
Do	2	do	Marked development.
Do	1	7	Fetal sacs 7 millimeters in diameter.
May 5	8	None	Medium to strong development.
Do	6	6, 4, 5, 7, 6, 4	Fetal sacs in first three lots 7 millimeters in diameter; fourth, 13 long; fifth, 4 in diameter; sixth, sacs just discernible.
May 12	13	None	Not pregnant; some may have borne young; others certainly had not.
Do	2	7, 6	First lot fetal sacs 7 millimeters in diameter; second, 4.
May 26	13	None	Field note: Not pregnant; had borne young or had not mated.
Do	5	5, 4, 5, 4, 6	First lot fetal sacs 7 millimeters long; second, 12; third, 13; fourth, 18; fifth, just discernible.
Third year:			
Feb. 20	8	None	No apparent development.
Mar. 7	5	do	Do.
Do	5	do	Slight development.
Do	5	do	Medium development.
Mar. 21	3	do	Slight development.
Do	6	do	Medium development.
Do	3	do	Marked development.
Apr. 4	1	do	Medium development.
Do	0	do	Marked development.
Do	4	5, 5, 5	First lot fetal sacs 7 millimeters in diameter; second, 8; third and fourth, 13.
Apr. 19	2	None	Medium development.
Do	5	do	Marked development.
Do	4	4, 5, 5, 4	Two lots fetal sacs 7 millimeters in diameter; third, 8; fourth, 22 long.
May 1	3	None	Medium development.
Do	1	do	Marked development.
Do	0	5, 4, 7, 4, 5, 3	First lot fetal sacs 7 millimeters in diameter, second, 7; third, 10; fourth, 10; fifth, 5; sixth, 19 long.
Do	2	(1)	
May 17	2	None	Medium development.
Do	13	(2)	
Do	3	None	Marked development.
June 1	14	do	Uterus in normal out-of-season condition.
Do	2	4, 4	Fetal sacs 12 by 16 millimeters in each case.
June 15	8	None	Uterus in normal out-of-season condition.
Do	1	2	One fetus 23 millimeters long; other, smaller; both in right horn of uterus.
July 15	8	None	Uterus in normal out-of-season condition.

¹ Young born in each case; nest not found.

² Young born in each case but number could not be estimated.*

DISPERSAL OF YOUNG

As has been indicated (p. 13), the young pocket gophers are probably mature enough at six or seven weeks to care for themselves. They will sometimes be taken in the traps or appear outside the burrows at an earlier age if the mother has been killed by the trapping operations. Shallow retreats and tunnels of small diameter appearing in spring and summer are signs of the dispersal of the young, some to places near the parental burrows and others to unoc-

cupied territory at a considerable distance. Burrow studies appear to show also that dispersal is partly accomplished by the simple expedient of plugging off from the old home by a door of compacted earth and then extending the laterals.

FOOD OF POCKET GOPHERS

The natural food of pocket gophers consists of the fleshy roots and underground stems of various plants growing wild in its habitat. Where these abound in favorable spots, the pocket gophers become more or less colonized. In other localities, where vegetation that will serve for food is scant, the distribution of individuals or of families is much more scattering. In addition to roots and root-stocks, the succulent stems of grasses, legumes, and other edible vegetation contribute to the pocket gopher's subsistence, as do also the leaves of such plants as dandelion (*Taraxacum*) and cats-ear (*Hypochaeris*).

Stems and leaves of food plants are usually obtained by tunneling to the source of supply from beneath and drawing the vegetation down into the burrow, to be eaten or stored. Legumes growing in clumps, particularly, are thus attacked. At times also, chiefly at night, the pocket gopher ventures from its burrows and forages near by.

Whether found in its tunneling or obtained by foraging, the plant structures eaten by the pocket gopher are sectioned into convenient lengths to be carried through the burrows, usually in the animal's cheek pockets. The sections thus made are commonly an inch or two in length, sometimes shorter. Stores of roots, however, have been found in which dozens of the pieces ranged from 4 to 8 inches long. (Pl. 6, A.) These the animal must carry or drag to the storeroom without the aid of its pockets. The same is necessarily true of the large cultivated tubers that it often steals from the fields or bins of the farmer. Years of careful study in the field, however, as well as observations of captive animals, have established the fact that these cheek pockets are a structural adaptation for transporting food supplies only, and that pocket gophers do not carry out in these pockets the earth excavated in burrowing.

The underground chambers excavated for the purpose of storing food vary in size according to the supplies within reach and with the seasonal demands. Sometimes one will find in a pocket of the burrow only a handful of roots or a few fleshy leaves and bits of stems; in other places a peck or more. Indeed, when an overindustrious pocket gopher finds its way into a truck patch or into a pit stocked with potatoes or apples, it will sometimes carry away bushels of this food.

Except for the handful of fresh food that may usually be found in or near a pocket gopher's nest, the stores are commonly near the surface in chambers connecting with the feeding runs. This arrangement simplifies the transportation of supplies in the harvest season.

The pocket gopher follows instinct in storing, for when food supplies are abundant the animal will cache them away without stint of labor, though much of it may not be used and may subsequently spoil. In turning over clover sod in the spring the plow



B

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A, Excavation showing nest of the Yelva pocket gopher (*Thomomys douplasi yelmensis*) in western Washington; B, young of the Camas pocket gopher (*T. talbotensis*), Willamette Valley, Oreg.



A



B

U'3942 B2915

A, Root stores of the Mississippi Valley pocket gopher (*Cromys burkarius*); B, pocket gophers gnawed off the roots of this cherry tree and six others in a small orchard at Bueloia, Wash.

sometimes uncovers a great many such stores. It would appear, too, that the instinct to provide food for a period of possible scarcity is operative even when such a course does not seem necessary. In the Pacific Northwest, where the pocket gopher's harvest season may cover the entire year, the little animal appears to store as abundantly as it does in regions of severe winters, where the soil freezes to considerable depths.

A study of the pocket gopher's underground stores and of the evidences of its damage to certain vegetation indicates that it feeds on a wide range of plants. The bill of fare is in fact as varied as the plant life in the diverse sections of its habitat, including, as it does, the bitter as well as the sweet or palatable, judged by human taste. Roots, stems, and sometimes leaves of herbaceous vegetation, and also roots of various shrubs and trees, are found among the food supplies. (Pl. 6, B.) It is not the habit of the pocket gopher to bark or girdle trees above the surface of the ground; such work is usually done by mice or rabbits.

NATURAL ENEMIES

Since pocket gophers only occasionally leave their secluded runways, they have less to fear from predatory foes than have those of the rodent race that seek their living aboveground. They are not entirely safe from attack, it is true, for a few sharp-eyed and vigilant enemies habitually capture considerable numbers of them when they come to the exits of their burrows at twilight, or on dark, cloudy days, to push out loads of earth. Lacking too the protective advantage of the mole, pocket gophers are greatly relished by the carnivores, while the mole is seldom eaten even by the rapacious birds and mammals that occasionally capture it.

The pocket gopher's habit of showing itself aboveground mainly at twilight and dawn has the effect of including owls and house cats particularly among its enemies. The great horned owl (*Bubo virginianus*), the long-eared owl (*Asio wilsonianus*), and the barn owl (*Tyto alba pratincola*), species of wide distribution in the pocket gopher's range, render valuable service in keeping down the numbers of these destructive rodents. A single pair of owls, nesting on the farm, will destroy scores of pocket gophers in a brief season. During some periods these birds live on nothing else, as evidenced by the pellets of bones and fur, which, in common with most birds of prey, they invariably disgorge after a meal.³

Many house cats become addicted to the habit of hunting pocket gophers and will roam the fields day after day and lie in wait for the little animals to appear. Such cats should be encouraged in the habit and protected; but most cats that hunt away from the farm premises are a menace to bird life and as such should be destroyed.

The weasel (*Mustela*) is a relentless foe of the pocket gopher, being practically the only predatory mammal small enough to make its way through the burrows on the trail of its prey. In this commendable pursuit it sometimes blunders into traps set for pocket-

³ See FISHER, A. K. HAWKE AND OWLS OF THE UNITED STATES. U. S. Dept. Agr., Div. Ornithol. and Mammal., Bul. 3, 210 p., illus. 1893.

gopher control and becomes a sacrifice in a good cause. The burrows of the larger species of pocket gophers are entered occasionally also by the little striped skunk (*Spilogale*). Proof of this is furnished, as in the case of the weasel, by the taking of a skunk now and then in a steel trap placed in the pocket gopher's runway.

In the South and in the Middle West the king snake (*Lampropeltis getulus*) preys upon pocket gophers to some extent, and in certain sections is known as the "gopher snake." Not only is it able to enter the burrows when the pocket gopher has left them open temporarily, but it has been observed worming its way into fresh mounds. The service rendered the farmer, however, by rodent-eating snakes must be discounted by the fact that the reptiles require a meal but seldom.

Except perhaps in a few favored localities, natural forces can not be depended upon to keep in check the increase of the pocket gopher in agricultural sections. Increasing the acreage of certain crops produces the very conditions that are favorable to more rapid multiplication of the species, as does also thoughtless or wanton destruction of harmless owls, hawks, king snakes, and of certain small predatory mammals. The worst that can be said of some of the enemies of the pocket gopher is that the great horned owl, the weasel, and the skunk sometimes destroy domestic poultry; this damage could be prevented by proper measures of control and precaution in protecting the birds at night.

DAMAGE TO AGRICULTURAL CROPS

The original economic status of the pocket gopher changed with the coming of the pioneer farmers into its habitat. There was a time when the work of these little animals was of real benefit to the future interests of agriculture. For untold ages they had been mixing the soils on prairies and mountain slope; bringing up the subsoil to mellow; and covering up vegetation to molder and add humus to the clays and sand. But now that the virgin soil has been formed, these services of pocket gophers in agricultural areas can be dispensed with, as also can those of other burrowing mammals that have played their part in the preparation of soils, for their presence there simultaneously with crops is seriously detrimental to agricultural interests. As the pocket gopher is primarily a root eater, crops having fleshy roots, rootstocks, or tubers are likely to suffer most from its depredations. This distinction practically excludes the small grains, though in some situations shocked grain is injured when the pocket gopher works up among the sheaves from beneath.

ALFALFA AND THE CLOVERS

In districts of the Middle West where alfalfa is grown without irrigation, no other crop suffers so heavily from the destructive habits of the pocket gopher. The damage results not only from the roots being eaten and, to a lesser extent, the stems, but also from the fact that mounds of earth are thrown up that cover considerable areas of the growing crops and obstruct later the harvesting of the remainder. From 1,200 to 1,500 distinct earth heaps to the acre have actually been counted on fields of average infestation.

Conditions of life for the pocket gopher in an unirrigated field of alfalfa are easy, for the ground is not tilled for years at a time, at least not deep enough to interfere with the underground runways, and the roots of the plants are fleshy and penetrate deep into the soil. There they may be found in abundance at almost any depth at which the animals range, summer or winter. As a result of these favorable conditions pocket gophers increase greatly in numbers wherever alfalfa is extensively grown. In the river valleys of the Middle West large fields may be seen in which one might walk over the entire tract by stepping from one pocket-gopher mound to another. (Pl. 2, B.)

Fields of clover, alone or mixed with meadow grasses, suffer less than does alfalfa from the attacks of pocket gophers only because they are less permanent on the same ground. The usual practice of plowing them every two or three years and rotating the clover with other crops interferes with the pocket gophers' habit and drives the animals to new pastures.

Even a few pocket gophers in an alfalfa or clover field become an intolerable nuisance by obstructing the work of mowing the crop. The man who is running the machine must be constantly on the lookout for the mounds so that he may raise the cutter bar until the obstacle is passed. This entails much extra labor and a portion of the crop is lost by cutting too high. If the mound is not seen in time to be avoided it will clog the machine, and sections of the knives will be dulled and nicked by sand and gravel. In certain soils the horses drawing the mower stumble frequently as their feet break through into the pocket-gopher runways or into enlargements of these caused by the washing of heavy rains.

NATURAL-GRASS MEADOWS

Meadows of native grasses are sometimes so infested by pocket gophers that in places they have the appearance of being plowed. The animals apparently find suitable food scarcer there than in alfalfa and clover fields and are consequently obliged to dig more extensive runways in search of the roots of native plants. Such lands, being adapted to its permanent residence, must be cleared of the pocket gopher if they are to be profitably handled for the production of hay.

ROOT CROPS

Truck gardens and lands utilized in the growing of root crops are frequently subject to invasion by pocket gophers, although as a rule the animals do not gain a permanent foothold in such situations. The retreats from which they come are usually tracts of waste land or fields that remain uncultivated for a period of years, as fence rows, wood lots, public highways, pastures, meadows, and alfalfa fields. If no effort is made to destroy the animals they will often establish themselves for a time in some part of a cultivated field and do much damage. Here they eat the pieces of potato that are planted in spring and later feed upon newly forming roots and tubers in general, causing thereby the death of the plants. In the fall they harvest a share of the crop that is left and store it underground for winter use. Being overprovident by nature, they store

and leave to be wasted a great deal more than they can ever consume. Not content with what they may harvest on their own account, they too often find their way into the farmer's root cellar or pit and plunder at their leisure. Several bushels of potatoes, turnips, or other stored products are sometimes thus carried away by a single industrious pocket gopher.

HORTICULTURAL CROPS

The pocket gopher is a pest that can not be tolerated either in large commercial orchards or in the home garden. Its damage is greatest in newer orchards, because the younger trees are less able to survive attack on their root systems. Then, too, the ground having been cleared for planting, the roots of the fruit trees are sought by the pocket gophers as the only food available. Instances may be cited where young orchards have suffered the loss of almost every tree from such attacks. Because the pocket gopher works out of sight, the damage may be accomplished before the owner is aware that his trees are threatened. By testing the anchorage strength of such trees one will find that they yield readily to a pull. Nothing but stubs of the root system are left. (Pl. 6, B.)

An orchard, like an alfalfa field or a meadow of native grasses, may shelter the pocket gophers permanently, especially since the older practice of clean cultivation has generally given way to the growing of cover crops among the trees. This complicates the problem of pocket-gopher control, not only by providing more harbor and shelter for the animals and concealing their work, but also by furnishing them additional food.

What has been said of damage to orchard trees is also true of nursery stock in the field. The loss to the nurseryman may be even greater because of the closer spacing of the young trees and the great value of some of the grafted or budded stock.

In the citrus-fruit growing districts of the Southwest, injury to the younger orange trees is always imminent if there is any waste land near by from which invasion of pocket gophers may occur. Damage to the root systems is similar to that suffered by the deciduous fruits but is perhaps more keenly appreciated by the citrus-fruit rancher on account of the relatively high value of his lands and their products.

Ornamental palms introduced into the southern parts of the United States have found a new enemy in the pocket gopher, which not only feeds upon the roots but hollows out the base of the trunk or tunnels spirally upward through it and excavates nesting chambers in its soft interior. Such infestation is sometimes not discovered until serious injury to or death of the tree has resulted. (Pl. 7.)

Certain classes of bulbs, more recently grown commercially in some parts of the country, are relished by the pocket gopher and will be eaten in quantity or carried away and stored unless the grower is vigilant in protecting his crop. At times the bulb alone serves as food for the animal; sometimes the bulb is rejected when distasteful and the tender parts of the plant eaten. Gladioluses, bulbous irises, tulips, and freesias are particularly subject to the pocket gopher's attacks.



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A and B, Old leaf bases of palms removed to show the pocket gopher's method of tunneling spirally into the trunks, Palo Alto, Calif.



B31387 ©18053

A, Break in irrigation canal at Kennewick, Wash., originating in water flow through pocket-gopher burrows; B, a catch of the Carnus pocket gopher (*Thomomys talpiformis*) from the Willamette Valley, Oreg.

IRRIGATED LANDS AND CROPS

Pocket gophers present special problems in irrigated districts. Perhaps the chief of these relates to their habit of burrowing into and through the banks of ditches; another is concerned with their increasing abundance on reclaimed lands; and a third has to do with their permanent occupancy of only such situations as are not regularly flooded.

Certain other of the pocket gopher's activities have sometimes proved more disastrous to the farmer than its food habits. The animal's practice of covering up a considerable percentage of a growing crop with its mounds of earth and thereby obstructing harvesting has already been referred to. Even more destructive is its habit of burrowing into the banks of irrigation ditches—canals as well as smaller laterals. (Pl. 8, A.) Constant vigilance, day and night, is sometimes necessary on the part of the rancher, both to conserve the water that is likely to waste through pocket-gopher burrows and to prevent breaks in the ditch banks at points where they have been weakened by the animal's tunneling. Major breaks of this sort sometimes result in thousands of dollars' damage to crops and irrigation construction. Less expensive, but more common and annoying, are the breaks that allow the water to flow onto private roads or public highways, frequently rendering them boggy and impassable.

Balance in the animal world is maintained by conditions of food supply, environment, and inter rivalry. When the desert is reclaimed for agriculture, the food of the pocket gopher is abundant, shelter is more accessible, and the number of its natural enemies reduced. Consequently, there is always a steady, sometimes a rapid, increase in the numbers of these rodents following the introduction of irrigation practice. This adds one more complication to the pioneer rancher's problems.

Because of the periodic flooding of the land, certain crops grown under irrigation suffer less damage from pocket gophers than when raised under natural conditions. This is particularly true of alfalfa, one of the mainstays of irrigation farming. Not being able to remain in such cultivated tracts, pocket gophers maintain permanent residence on the waste lands and in ditch banks. From these situations they make their underground forays to the crops in the intervals between flooding and in the nonwatering season.

PASTURE AND RANGE

It is only in certain situations that pocket gophers are found on stock ranges in numbers sufficient to affect materially their value for grazing purposes. Where heavy infestation occurs in spots over such lands, it is generally an indication of the presence of other food plants than the forage grasses. The removal of such plants would, in some cases, benefit the range rather than detract from its grazing value. In the smaller, inclosed pastures, in which there is a mixture of clover and grasses, the pocket gopher sometimes becomes a nuisance by covering up parts of the grazing surface with its mounds of earth.

MEASURES OF CONTROL RECOMMENDED

In general, the control of the pocket gopher and its eradication in particular localities are not extremely difficult, but they require persistence and cooperative effort. Unlike the rat or the meadow mouse, the animal can not be rated as a prolific breeder; it does not spread by long migrations; it is open to attack at any time of year; it has its limitations as to habitat; and it is not by nature shrewd and suspicious of the wiles of man. Details of control methods have no place in the present discussion. It is sufficient to state that the methods tested and variously employed include fumigation of the burrows of the pocket gopher, trapping with specially designed traps (Pl. 8, B), shooting, and poisoning, all either individually on single premises or in general campaigns of community cooperation. Lack of wariness on the part of this rodent makes it possible to obtain satisfactory results with any practicable method of control. Use of acceptable baits treated with powdered strychnine gives quicker results than trapping over extensive areas.

Requests are sometimes made for a virus that will communicate a contagious disease to pocket gophers. No such virus is known to science, and no such disease has been recognized as affecting these animals. It has not yet been demonstrated that a virus can be employed successfully in the destruction of any rodent, much less an animal of such solitary life habits as the pocket gopher.

Detailed information on methods of control will be furnished by the Biological Survey on request, either direct to the applicant or through the bureau's local leaders of rodent control.

STATUTORY PROVISIONS

The sentiment that always looks to legislative enactment for the correction of evils has, at various times and in various States, crystallized into two types of pocket-gopher laws—(1) compulsory-extermination laws, and (2) bounty laws.

Compulsory-extermination laws have their merits as well as their weaknesses. They usually provide for the creation of a pest district on petition of a certain number of citizens. Or such districts may be formed by the initiative of the governing board in township or county. Under the provisions of the law the matter of destroying pocket gophers, or other rodent pests, is commonly left primarily to the landowner or lessee. If he fails to do his duty, as prescribed by the law, properly authorized persons may enter upon his lands and attend to the work of destroying the rodents, the costs being added to the owner's taxes.

A weakness of these laws lies in the difficulty of enforcing them without engendering neighborhood strife. One man may be able to think clearly in terms of the public good, while his neighbor may reason that pocket gophers, because of their burrowing habits, are, like weeds, practically fixtures of the soil, to be eradicated or allowed to thrive as the owner of the land pleases or his interests dictate.

The merits and demerits of the bounty system have been frequently discussed in the agricultural press and in Government publications,

but since many counties in several States are still paying bounties on these small rodents, some further discussion of the system as it relates to pocket gophers is warranted.

The bounty system is most objectionable in the case of a small rodent like the pocket gopher, which roams about so little that it is practically a resident of the farm on which it burrows. If there is any justification for placing a price on the scalp of a predatory animal, as the coyote or the cougar, that may take toll from one man's flock to-day and from his neighbor's, miles away, to-morrow, this is entirely wanting in the case of the pocket gopher. The principle of requiring the community at large to pay the expense of protecting the careless man's crops, while his thrifty neighbor looks after his own fields, is theoretically wrong. It imposes a double burden upon thrift. A pocket-gopher-infested district would profit much, however, by legal enactment requiring the proper officials to exterminate the pest on the public roadsides, on the railroad right of ways, and on any land set apart for public or community use. Such measures, thoroughly undertaken, would deprive the shiftless farmer in the community of his pet excuse for not cleaning up his own acres.

The cost of maintaining a bounty system is out of all proportion to the benefits gained. Experience with the system in many States has fully demonstrated that bounties on small mammals seldom, if ever, accomplish the desired end of ridding the communities of the pest. After the greater part of the animals of the territory have been trapped, it becomes unprofitable to take the rest for bounty, and considerable numbers are left to reproduce and to reoccupy the ground. Long before all the bounties have been claimed the heavy drain on the public treasury usually results in the repeal or modification of the law.

Finally, the opportunities for fraud in claiming bounties are even greater in the case of the pocket gopher than of the larger and better-known predatory animals. Many county officials to whom the scalps are presented for bounty perhaps have never seen a pocket gopher. At least they will not be able to distinguish its dried and shriveled scalp from that of some of the other small mammals. Half a dozen legal scalps may easily be faked from a single animal; and as for catching the animal in the particular county where bounty is claimed, fraud is too often practiced by passing the bundle of scalps from one dishonest trapper to another.

SUMMARY

The true pocket gopher is a small or medium sized rodent having external cheek pockets lined with fur. Though almost entirely subterranean in its habits and nocturnal in its rarer activities above-ground, it is not to be confused with other burrowing small animal pests frequently termed "gopher," including moles and such rodents as ground squirrels and prairie dogs.

The presence of pocket gophers on any premises is usually indicated by the heaps of fine earth it carries or pushes out from its underground workings. Sometimes the activity of the animal is concealed by its habit of carrying this excavated soil into old aban-

done parts of its burrows. There are no permanent external openings to the runways.

✓ The pocket gopher is more or less active at all times of the year, never hibernating. Its operations are characteristic and its earth mounds readily recognized. When digging is easy and fresh food readily obtained the rodent is tirelessly busy; when these conditions are not met the animal resorts as needs be to its cache of supplies.

In middle latitudes the pocket gopher has a definite and prolonged breeding season, in the spring and early summer. In this period some individuals may raise a second brood and some certainly on account of isolation fail to mate at all. Pocket gophers are not social in their habits and are not even noticeably gregarious. The breeding season is undoubtedly prolonged where food is abundant, particularly in warmer parts of the country, where the winters are springlike in character, and where cultivated crops follow one another under irrigation.

The pocket gopher subsists largely on roots and other edible underground plant structures, whether native to its habitat or introduced by agriculture. A certain quantity of plant foliage also is pulled or carried down into the burrows for food. The animal at times stores these products in generous quantity.

Agricultural practices, particularly irrigation, sometimes favor a rapid increase in numbers of the pocket gopher, until it becomes a serious crop pest where it was not formerly a subject of concern or comment. Considerable wastage of water, damage to lands, and costly breaks in irrigation structures are also directly chargeable to the pocket gopher.

Control of the pocket gopher, where troublesome, is accomplished chiefly by poisoning and trapping, the animal not showing any great degree of wariness when either method is employed. Traps are specially designed for the purpose and adapted to the burrowing habits of the rodent. Powdered strychnine on some form of root bait has proved generally effective in poisoning operations on large areas. Public bounties on the pocket gopher have always failed permanently to rid a locality of the pest.

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