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Horizontal and vertical diameter of burrows of five small mammal species in southeastern Idaho

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HORIZONTAL AND VERTICAL DIAMETER OF BURROWS OF FIVE SMALL MAMMAL SPECIES IN SOUTHEASTERN IDAHO

John W. Laundré

Abstract.—Burrow diameters of five small mammal species, Townsend’s ground squirrel (Spermophilus townsendii), Wyoming ground squirrel (S. elegans), Ord’s kangaroo rat (Dipodomys ordii), montane vole (Microtus montanus), and deer mouse (Peromyscus maniculatus), were examined. Burrow cross sections were noncircular for all species with horizontal diameters 1.2–1.6 times wider than vertical diameters. Montane vole and deer mouse burrows were the smallest diameter, burrows of Wyoming and Townsend’s ground squirrels were the largest, and kangaroo rat burrows were intermediate. Soil bulk density and texture significantly affected burrow diameters of montane voles and deer mice but not the other three species.

Fossorial and semifossorial mammals rely on their tunnels for a myriad of purposes, including storage of food, protection from predators, and shelter from the environment. Dimensions of burrows, depth, length, volume, and diameter can indicate function; ground squirrels use shallow burrows for summer retreats but rely on deeper ones for winter hibernation (Bartholomew and Hudson 1961, Alcorn 1940, Shaw 1924). Diameter, depth, and/or length can determine a burrow’s effectiveness in thwarting predators. The dimensions of a burrow also determine its impact on soil processes (Laundré and Reynolds, in preparation). Thus, data on burrow measurements would increase our knowledge of the life history of fossorial and semifossorial mammals. However, few data on burrow dimensions of small mammals currently exist.

Several researchers have excavated burrows of different small mammal species (Hawbecker 1940, Criddle 1943, Smith 1948, Panuska and Wade 1956, Miller 1957, Anderson and Allred 1964, Reynolds and Wakkinen 1987). Hawbecker (1940) excavated 15 burrows of the Santa Cruz kangaroo rat (Dipodomys venustus venustus) but did not measure any burrow dimensions. Several researchers excavated burrows but measured only depth (Criddle 1943, Panuska and Wade 1956, Anderson and Allred 1964). Smith (1948) measured depth and diameter of one plains pocket gopher (Geomys bursarius) burrow. Miller (1957) measured depth, length, volume, and diameter of 9 valley pocket gopher (Thomomys bottae navus) burrows. Reynolds and Wakkinen (1987) excavated and measured over 70 burrows of four common species in southeast Idaho. They measured maximum depth, volume, and length but did not record burrow diameter. Thus, data on the diameter of burrows of small mammal species are still limited.

To add to our data base on burrow dimensions, I report diameter measurements of burrows for five common burrowing mammals in southeast Idaho.

Study Area and Methods

Data were collected from two regions in southeastern Idaho: the Idaho National Engineering Laboratory Site (INEL), 65 km north of Pocatello, Bannock Co., Idaho, and near Soda Springs, Caribou Co., Idaho. The INEL is a U.S. Department of Energy National Environmental Research Park on the upper Snake River plain. The area is a cool sagebrush desert dominated by sagebrush (Artemisia spp.) and grasses. More complete descriptions of the INEL can be found in Harniss and West (1973) and Anderson and Holte (1981).

Study sites near Soda Springs were in three mountain valleys: site 1 was T33N, R43E, Sec. 25; site 2 was T8S, R42E, Sec. 23; and site 3 was T9S, R43E, Sec. 13. Vegetation at the sites varied from a sagebrush-grass mixture to plantings of alfalfa (Medicago sativa) and orchard grass (Dactylis glomerata).

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Table 1. Mean horizontal and vertical diameters, ± SE (n), for the five species studied. Results of analysis of variance comparisons (F and P) among species within the two diameter measurements are at the bottoms of the appropriate columns. Means with the same superscript within a column are statistically similar.

<table>
<thead>
<tr>
<th>Species</th>
<th>Horizontal diameter (cm)</th>
<th>Vertical diameter (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\bar{x}$ ± SE</td>
<td>n</td>
</tr>
<tr>
<td>Deer mice</td>
<td>6.1 ± 0.5$^{b}$</td>
<td>18</td>
</tr>
<tr>
<td>Kangaroo rats</td>
<td>7.6 ± 0.5$^{b}$</td>
<td>9</td>
</tr>
<tr>
<td>Townsend's ground squirrels</td>
<td>8.0 ± 0.4$^{c}$</td>
<td>10</td>
</tr>
<tr>
<td>Wyoming ground squirrels</td>
<td>7.8 ± 0.3$^{c}$</td>
<td>41</td>
</tr>
<tr>
<td>Montane voles</td>
<td>4.3 ± 0.3</td>
<td>42</td>
</tr>
<tr>
<td>F</td>
<td>22.3</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>&lt; .01</td>
<td></td>
</tr>
</tbody>
</table>

I measured burrow diameters of five semiofssorial rodent species: Townsend’s ground squirrel (*Spermophilus townsendii*), Wyoming ground squirrel (*S. elegans*), deer mouse (*Peromyscus maniculatus*), kangaroo rat (*Dipodomys ordii*), and montane vole (*Microtus montanus*). All Townsend’s ground squirrel, deer mouse, and kangaroo rat burrows were on the INEL. Burrows of montane voles were on the INEL and site 3 near Soda Springs. Burrows of Wyoming ground squirrels were on all three Soda Springs sites. I randomly selected burrows at each study site and determined species use of selected burrows by visual observations and/or snap trapping.

Burrows were injected with polyurethane foam (Felthauser and McInroy 1983), which forms a rigid, closed-cell cast. Soil covering burrow casts was removed with shovels and/or backhoes. The burrow systems were mapped (Reynolds and Wakkinen 1987) for use in another phase of this study (Laundré and Reynolds, in preparation). The foam casts were then removed and brought to the laboratory. For each burrow system, three locations along the burrow were randomly chosen, and horizontal and vertical diameters of these points were measured with a Vernier caliper. These measurements were averaged and used to represent the whole burrow system.

Average burrow diameters were compared among species with a single classification analysis of variance. For montane voles and Wyoming ground squirrels, burrows from different sites were excavated and measured. Before interspecific comparisons were made, diameter measurements between/among sites within a species were compared with either t-test (montane voles) or single classification ANOVA designs (Wyoming ground squirrels).

Bulk density and soil texture (percent sand, silt, and clay) were measured at most burrow sites. The core technique (Blake 1965) was used to measure bulk density, and the hydrometer technique (Day 1965) was used for soil texture. Burrow diameters were regressed on bulk density and soil texture in multiple regression analyses. Because the sum of the proportions of the three soil separates in any sample totaled 100%, I also calculated simple regression coefficients for each soil separate individually to determine which had the greatest effect on burrow diameter.

All statistical comparisons were calculated with either the Statistics with Finesse® (J. T. Bolding, Box 339, Fayetteville, Arkansas 72702), Biostatistics® (Linscott’s Directory, 40 Glen Dr., Mill Valley, California 94941), or Biostat® (Sigma Soft, 1430 Shalanwood Lane, Placentia, California 92670) computer packages.

**Results**

I excavated and measured 120 burrows (Table 1). Horizontal and vertical diameters did not differ among sample sites for either montane voles or Wyoming ground squirrels. The data were subsequently combined within species. For all species, the horizontal diameter was 1.2–1.6 times wider than the vertical measurement.

Horizontal and vertical diameters differed significantly among the five species (Table 1). Results of multiple range testing (Newman-Keuls) indicated montane voles had significantly smaller horizontal diameter burrows than the other four species. The two species of ground squirrels and kangaroo rats had the largest and most statistically similar diameter
burrows. However, horizontal burrow diameters of kangaroo rats were also statistically similar to those of deer mice.

Vertical diameters of montane vole burrows were statistically similar to deer mouse burrow diameters which, in turn, were indistinguishable from diameters of kangaroo rat burrows. As with horizontal diameters, kangaroo rat burrows also had statistically similar diameters to those of the two ground squirrel species.

Bulk density and soil texture (Table 2) varied among species. Multiple regressions of horizontal diameters with bulk density and soil texture were significant for deer mice and montane voles (Table 3). Vertical diameters of burrows regressed significantly only for montane voles. Horizontal and vertical diameters of montane vole burrows significantly regressed separately with bulk density and all soil separates. Bulk density and percent sand had negative effects, and percent silt and clay had positive effects on burrow diameters. Percent clay was the one soil component to regress significantly with horizontal diameters of deer mice burrows.

**DISCUSSION**

Burrows of the five species examined were not circular or oval in cross section. Rather, the floors of the burrows were flattened, likely by the repeated movement of the burrow occupant through the tunnel.

Burrow diameters corresponded to body size of the five species examined. Deer mice and montane voles were the two smallest species and had the smallest diameter burrows. Kangaroo rats have an intermediate body size, but their burrow diameters were statistically indistinguishable from either the smaller mice or the larger ground squirrel burrows.

As indicated by multiple regression analyses, burrow diameter for the larger species was not affected by bulk density and soil texture. Of the five species, kangaroo rats and ground squirrels are possibly the strongest
diggers and would least likely be influenced by soil properties. Montane voles are relatively weak diggers; and, thus, increased soil compaction would most likely limit the diameter of a burrow they constructed. The relationships between burrow diameters of montane voles and soil separates undoubtedly reflect complex combinations of soil properties related to soil texture that affect ease of digging and maintenance of burrow integrity.

ACKNOWLEDGMENTS

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LITERATURE CITED