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Author(s): Thomas P. O'Farrell

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curved needle. After perfusion with penicillin G, the second incision was closed. The base of the plug was slipped into the first incision and sutured to the lumbodorsal fascia with 5-0 Mersilene (Ethicon). After perfusion around the plug with penicillin G, the skin was sutured around the narrow neck of the plug and the incision was dusted with antibiotic powder.

The bat could be lifted by the plug with no apparent discomfort and no distortion of the skin or damage to the electrodes. Scratching or chewing did not dislodge the plug, although the skin sutures were occasionally scratched loose. With daily cleansing of the skin around the plug and application of antibiotic ointment, the plug remained in place for 3 weeks without infection or necrosis of the surrounding tissue.

A shielded cable with a male plug (Fig. 1, E) was used to connect the bat to the recording equipment. If the bat moved beyond the length of the cable, the male plug pulled free and prevented damage to the electrodes or injury to the bat. With some modification, this type of implantable plug with female connectors could support a transmitting device that could be plugged on and off at any time allowing chronic implant of electrodes without permanent attachment of a cumbersome transmitting device.—J. SCOTT ALTENBACH, *Department of Zoology, Colorado State University, Ft. Collins, Colorado 80521. Accepted 1 March 1972.*

ECOLOGICAL DISTRIBUTION OF SAGEBRUSH VOLES, *LAGURUS CURTATUS*, IN SOUTH-CENTRAL WASHINGTON

The sagebrush vole (*Lagurus curtatus pauperrimus*) is a small rodent that occurs in the most xeric habitats occupied by members of the subfamily Microtinae in Washington State. The species presents an interesting problem regarding its ecological distribution in Washington because the holotype was collected in Walla Walla County in 1860 (Cooper, 1868), but no specimens have been reported there or in bordering counties since that time. James and Booth (1954) reported information on the distribution of *Lagurus* but they did not record specimens for Columbia, Franklin, or Benton counties, which border Walla Walla County. They speculated that *Lagurus* might occur in Benton County, but trapping was not conducted because the prime habitat was located within the U. S. Atomic Energy Commission's Hanford Reservation.

Intensive small mammal trapping conducted on the Hanford Reservation since 1966 has confirmed the presence of *Lagurus curtatus* in Benton County, Washington. Locations on the Reservation that have been sampled for small mammals and the distribution of captures are shown in Fig. 1. Table 1 summarizes the elevational distribution of the sagebrush vole along with a brief description of the habitats. The numbers of captures in Fig. 1 and Table 1 should be interpreted only as indices to relative abundance since the trapping effort was not uniform for all sites. The summary includes trapping information from Kritzman (1970).

More *Lagurus* were trapped on the Hanford Reservation between 1000 and 2000 feet, and above 3000 feet than at any other elevations. The greatest numbers were taken at 3500 feet, which is the summit of Rattlesnake Mountain. Only four voles were taken at elevations below 1000 feet: three were captured at 800 feet in pitfall traps set for ground-dwelling beetles and one was trapped at 640 feet (the only vole captured during three years and 28,000 trap-nights of effort at that elevation). These data support the observations of Johnson *et al.* (1948) that the sagebrush vole occurs mainly between 1000 and 2800 feet in Washington.

The dominant vegetation above 1000 feet is *Artemisia-Agropyron* association (Daubenmire, 1970). The physiognomy of this association is generally similar throughout the elevational gradient, but the plants are shorter and more widely spaced on the stony soils of exposed ridges and at the highest elevation. Sagebrush is absent where fires have

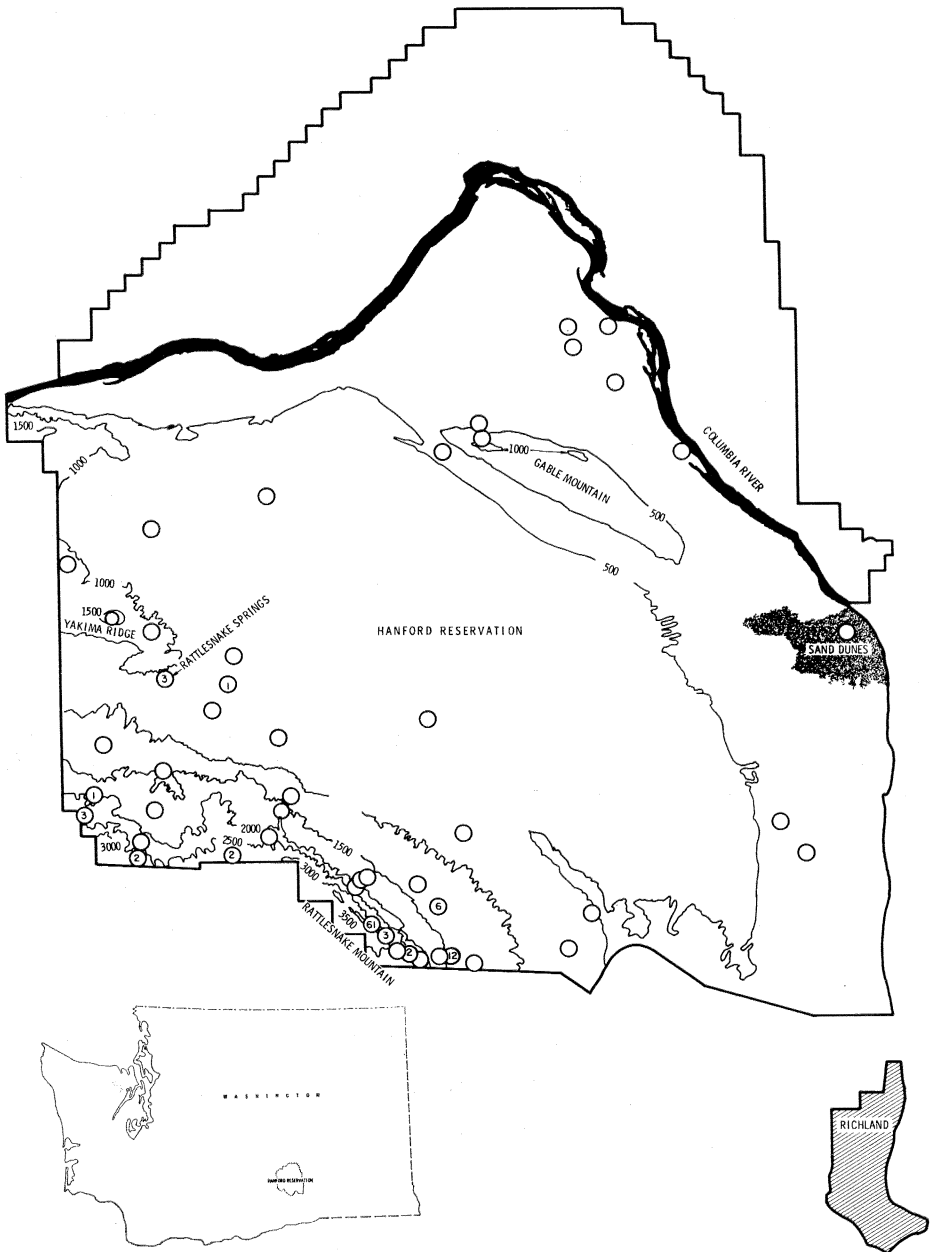


FIG. 1.—Small-mammal trapping sites (open circles) on the U. S. Atomic Energy Commission's Hanford Reservation, Benton County, Washington. Numbers in circles indicate the number of *Lagurus curtatus* trapped at that site. The town of Richland is shown as a geographic reference point. Contour intervals are 500 feet.

TABLE 1.—*Elevational distribution of Lagurus curtatus trapped in Benton County, Washington, 1966–1971.*

Vegetation type and elevation (feet)	Number trapped	Soil types and climatic conditions
<i>Artemisia-Agropyron</i>		
≥3000	64	Silt-loams; climate cooler and more moist with increasing elevation.
2000–2999	9	
1000–1999	19	
<i>Artemisia-Poa</i>		
<1000	4	Sandy or sandy-loams; mean annual temperature 53.1°; precipitation averaged 6.25 inches for 58 years of records.
Total captures	96	

occurred in past years. Two examples of sites where *Lagurus* were taken are shown in Fig. 2. The soils are silt-loams, usually with a meter or more of soil over basalt (Hajek, 1966). At intermediate and higher elevations *Lagurus curtatus* coexists with *Peromyscus maniculatus*, *Perognathus parvus*, and *Spermophilus townsendii*.

In eastern Washington, Rickard (1960) captured *Lagurus* in the *Artemisia-Agropyron* association but not in the *Agropyron spicatum-Poa secunda* association. He suggested that the distribution of *Lagurus* might be restricted to the occurrence of *Artemisia tridentata*. On the Hanford Reservation, *Lagurus* was trapped occasionally on old burn sites dominated by *Agropyron spicatum*.

Below 1000 feet, where the soils are sandy-loams (Hajek, *op. cit.*), the *Artemisia-Poa* association is the most common vegetation type. Average temperatures at this elevation are more extreme than on the higher slopes (Rickard, 1971), and precipitation can be half that of higher elevations. The average annual precipitation measured at 720 feet is 15.5 centimeters. Cheatgrass, *Bromus tectorum*, and other introduced annual weeds replace *Poa* on many sites and provide food for *Perognathus parvus*, which is the most abundant mammal.

Hall (1928) reported that most known specimens of *Lagurus* had been taken in scattered sagebrush having a uniform height of about 2½ feet where the lower branches are near the ground. No *Lagurus* had been taken in areas where the sagebrush had a markedly different growth form. Hall mentioned *Lagurus curtatus pauperrimus* as the only exception to this observation and cited Bailey (1900) and Cooper (1868), who reported its habitat as high prairie or shortgrass plains. Hall considered sagebrush an important food item for *Lagurus*, which would partly explain its affinity for stands of *Artemisia* where the leaves, twigs, and bark would be closer to the surface of the ground. Moore (1943) collected *Lagurus curtatus pauperrimus* in eastern Oregon where *Artemisia tridentata* and *A. nova* formed the predominant cover.

Although the greatest trapping effort on the Hanford Reservation between 1966–1971 was sustained in the *Artemisia-Poa* association, only four *Lagurus* were taken. I suggest that the distribution of *Lagurus curtatus* is related to the occurrence of *Artemisia tridentata* when the sagebrush grows in association with large bunchgrasses such as *Agropyron*

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FIG. 2.—Photographs of two trapping sites at different elevations where *Lagurus curtatus* were captured. The reference staff is marked in decimeters. Note that these sites have *Artemisia tridentata* and *Agropyron spicatum*.



spicatum; the latter being an indicator of more mesic conditions than occur at lower elevations where *Poa secunda* is the dominant perennial grass. Moore (1943) listed *Poa secunda*, *Collinsia parviflora*, *Sitanion hystrix*, and other grasses and forbs as important food items. He found little evidence indicating that sagebrush was fed upon.

The occurrence of *Lagurus curtatus* in Benton County, Washington, does not explain the enigma of why sagebrush voles have not been captured in the area surrounding the type locality in adjacent Walla Walla County. Perhaps *Lagurus* will be trapped in the higher elevations of the Rattlesnake and Horse Heaven hills where they extend into Walla Walla County. However, the Columbia River, which has been an effective barrier to the free movements of other small mammals (Dalquest, 1948), breaks the continuity of these ridges at Wallula Gap. Modern agricultural practices have greatly reduced the *Lagurus* habitat in Walla Walla County since 1860 and few relict populations may persist.

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THOMAS P. O'FARRELL, *Terrestrial Ecology Section, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, Washington 99352. Accepted 7 January 1972.*