

Elver H. Voth

Department of Biology
George Fox College
Newberg, Oregon 97132

Chris Maser

USDI Bureau of Land Management
Forestry Sciences Laboratory
3200 Jefferson Way
Corvallis, Oregon 97331

and

Murray L. Johnson

Puget Sound Museum of Natural History
University of Puget Sound
Tacoma, Washington 98416

Food Habits of *Arborimus albipes*, the White-footed Vole, in Oregon¹

Abstract

Stomach contents and fecal pellets were collected from 21 snap-trapped individuals of *Arborimus albipes*, the white-footed vole. Animals were trapped on the ground surface within a few kilometers of the Oregon Coast. Habitat was the Riparian Alder/Small Stream, *Alnus rubra*/*Rubus spectabilis* (red alder/salmon berry) union. Fifty-seven percent of the voles' diet came from four hardwood tree species, predominantly *Alnus rubra* and *Salix lasiandra* (red willow), 15 percent from eight shrub species, mainly *Berberis nervosa* (long-leaved Oregon grape) and *Rubus parviflorus* (thimble berry), 23 percent from 15 forbs, primarily *Trifolium repens* (white clover) and *Senecio sylvaticus* (wood grandisel), and small amounts from pteridophytes and grasses. The spatial niche of this vole extends at least from the ground surface into the tree canopy. The diet consists entirely of leaves; no evidence was found of the use of seeds, fruits, fungi, or animal matter. Therefore, the white-footed vole is one of the smallest mammalian browsers known.

Introduction

Nothing has been previously known about the food habits of white-footed voles. Our objectives, therefore, were to identify ingested plant species and to estimate their percentage composition of the voles' diet. The white-footed vole, considered to be one of the rarest microtine rodents north of Mexico, occurs in western Oregon and northwestern California (Maser and Johnson 1967, Johnson and Maser 1982).

Methods and Materials

Stomach contents and fecal pellets were taken from the colon of 21 snap-trapped white-footed voles caught between 1971 and 1973. The stomach contents and fecal pellets were preserved in 70 percent ethanol in glass vials. Trapping sites extended from Bandon, Coos County, to Cascade Head, Tillamook County, approximately 220 km

¹A contribution of the Oregon Coast Ecological Survey, Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, Washington 98416.

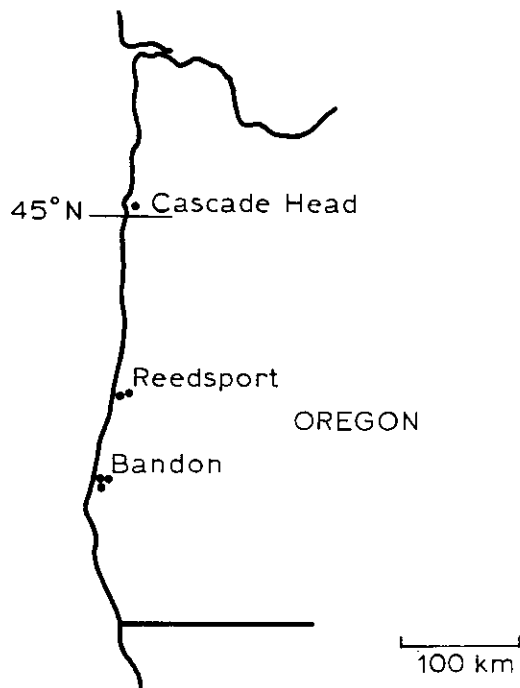


Figure 1. Collecting locations of *Arborimus albipes* represented in samples.

along the Oregon Coast ($43^{\circ}\text{N } 124^{\circ}\text{W}$ to $45^{\circ}\text{N } 124^{\circ}\text{W}$) within a few kilometers of the ocean (Fig. 1). Elevations ranged from near sea level to 300 m. Habitat was the Riparian Alder/Small Stream (Maser and Franklin 1974), *Alnus rubra*/*Rubus spectabilis* (red alder/salmon berry) union.

The voles were caught in February, March, June, July, August, and November. Six random extracts (a total of 36) were removed from the vials for each month of collection. From each of these, approximately 1 mm^3 of stomach or fecal contents was spread on a $25 \times 75 \text{ mm}$ glass slide, mixed with six drops of glycerol and six drops of chloral hydrate solution, teased, and covered with a $20 \times 42 \text{ mm}$ glass coverslip. The smear was examined microscopically at $\times 100$ through a wide-field ocular that provided a 2 mm field diameter. Five sweeps of observation were made across a smear with two stops per sweep, for 10 fields per slide. Fragments of ingested material to be identified had to measure at least 0.1 mm in at least one dimension; smaller particles were ignored. Identification of vascular plant species followed a reference collection of black and white photographs of adaxial and abaxial leaf epidermis for more than 50 species likely to be encountered.

Fragment counts were entered on one tally sheet per slide. A sample was defined as that part of the 1 mm^3 pellet or stomach contents appearing in 10 fields examined, or one complete tally sheet. The counts were then tabulated, added, and converted directly into percentage of intake by species. Assumptions about digestive equivalence of leaf epidermis among plant species have been previously challenged (Voth and Black 1973), but since moisture content data were not available for several species encountered, each percentage was allowed to stand as expressed.

Results

Plants identified as intake are given in Table 1. Fragment counts and percentage of fragments for each vascular plant species are shown in Table 2. Thirty plants from 23 families were identified to species in the sample; the species included 2 pteridophytes, 6 trees (2 conifers and 4 hardwoods), 8 shrubs, and 14 forbs. One unidentified grass and 1 unidentified forb (Liliaceae) were also included.

TABLE 1. Vascular plant species found in the diet of *Aborimus albipes*.

Family	Scientific name*	Common name**	Habitat	
			Aquatic	Semi-aquatic Riparian
Equisetaceae	<i>Equisetum telmateia</i>	Giant horsetail		"
Polypodiaceae	<i>Pteridium aquilinum</i>	Western brake fern		"
Pinaceae	<i>Tsuga heterophylla</i>	Western hemlock		"
	<i>Pseudotsuga menziesii</i>	Douglas-fir		"
Gramineae	Unidentified			
Araceae	<i>Lysichiton americanum</i>	Yellow skunk cabbage	"	
Liliaceae	Lilium or unidentified			
Salicaceae	<i>Salix lasiandra</i>	Red willow		"
Betulaceae	<i>Alnus rubra</i>	Red alder		"
Urticaceae	<i>Urtica dioica</i>	Northwest nettle		"
Portulacaceae	<i>Montia sibirica</i>	Western spring beauty		"
Caryophyllaceae	<i>Arenaria macrophylla</i>	Long-leaved sandwort		"
Berberidaceae	<i>Berberis aquifolium</i>	Oregon grape		"
	<i>Berberis nervosa</i>	Long-leaved Oregon grape		"
Saxifragaceae	<i>Chrysosplenium glechomaeifolium</i>	Western golden saxifrage	"	
Rosaceae	<i>Fragaria vesca</i>	Western wood strawberry		"
	<i>Rubus parviflorus</i>	Thimble berry		"
	<i>Prunus emarginata</i>	Bitter cherry		"
	<i>Holodiscus discolor</i>	Ocean-spray		"
Leguminosae	<i>Trifolium repens</i>	White clover		"
	<i>Lotus crassifolius</i>	Thicket lotus		"
Aceraceae	<i>Acer circinatum</i>	Vine maple		"
Violaceae	<i>Viola glabella</i>	Smooth woodland violet		"
Umbelliferae	<i>Oenanthe sarmentosa</i>	Water parsley	"	
Ericaceae	<i>Gaultheria shallon</i>	Salal		"
	<i>Vaccinium ovatum</i>	Shot huckleberry		"
	<i>Vaccinium parvifolium</i>	Red huckleberry		"
Hydrophyllaceae	<i>Nemophila parviflora</i>	Small-flowered nemophila		"
Scrophulariaceae	<i>Digitalis purpurea</i>	Foxglove		"
Caprifoliaceae	<i>Linnaea borealis</i>	American twinflower		"
	<i>Sambucus cerulea</i>	Blue elderberry		"
Compositae	<i>Senecio sylvaticus</i>	Wood groundsel		"

*/Hitchcock 1955

**/Peck 1961

We think 99 percent of all countable fragments (by our definition) were identified and tallied. The remaining "unidentified" species are not shown in a separate category and have been disregarded.

The 18 most abundant species in the diet, including everything that represents at least 1 percent intake, are given in Table 3. Nearly 41 percent of the diet was supplied by one species of hardwood tree, red alder, the dominant tree in the habitat. About 50 percent of the diet was supplied by red alder and red willow (*Salix lasiandra*). Hardwood trees accounted for more than 57 percent of the voles' diet, whereas forbs accounted for more than 23 percent and shrubs for more than 15 percent of the diet. The 18 species most abundant in the diet supplied about 95 percent of the intake. The

TABLE 2. Vascular plant species composition of the diet of *Arborimus albipes*. Systematic according to Hitchcock et al. (1955).

Month	Feb.		Mar.		Jun.		Jul.		Aug.		Nov.		Total	
Count & percent of total	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Pteridophytes														
1. <i>Equisetum telmateia</i>	1	1											1	0.1
2. <i>Pteridium aquilinum</i>							12	10					12	1.7
Spermatophytes														
trees														
conifers, softwoods														
3. <i>Tsuga heterophylla</i>			4	4					10	7			14	2.0
4. <i>Pseudotsuga menziesii</i>							1	1					1	0.1
anthophytes, hardwoods														
5. <i>Salix lasioandra</i>			11	12			32	26	22	14	1	1	66	9.5
6. <i>Alnus rubra</i>	28	25	16	17	46	49	54	44	64	42	75	65	283	40.9
7. <i>Prunus emarginata</i>	19	17							9	6			28	4.1
8. <i>Sambucus cerulea</i>	3	3							5	3	11	10	19	2.8
shrubs														
9. <i>Berberis aquifolium</i>			5	5									5	0.7
10. <i>Berberis nervosa</i>	36	32			16	17							52	7.5
11. <i>Rubus parviflorus</i>	1	1	3	3							16	14	20	2.9
12. <i>Holodiscus discolor</i>			1	1					2	1	6	5	9	1.3
13. <i>Acer circinatum</i>									1	1			1	0.1
14. <i>Gaultheria shallon</i>							5	4					5	0.7
15. <i>Vaccinium ovatum</i>			5	5									5	0.7
16. <i>Vaccinium parvifolium</i>	1	1							7	5			8	1.2
herbs														
grasses														
17. Unidentified			1	1									1	0.1
forbs														
18. <i>Lysichitum americanum</i>			1	1									1	0.1
19. <i>Urtica dioica</i>			4	4					3	2			7	1.0
20. <i>Montia sibirica</i>									1	1			1	0.1
21. <i>Arenaria macrophylla</i>							2	2					2	0.3
22. <i>Chrysosplenium glechomaeifolium</i>							3	2					3	0.4
23. <i>Fragaria vesca</i>	2	2	6	6	5	6							13	1.9
24. <i>Trifolium repens</i>	10	9	5	5	23	24			2	1			40	5.8
25. <i>Lotus crassifolius</i>	3	3			1	1	1	1			3	3	8	1.2
26. <i>Viola glabella</i>									1	1			1	0.1
27. <i>Oenanthe sarmentosa</i>									16	11			16	2.3
28. <i>Nemophila parviflora</i>	1	1											1	0.1
29. <i>Digitalis purpurea</i>			5	5			1	1			1	1	7	1.0
30. <i>Linnaea borealis</i>			22	23			1	1					23	3.3
31. <i>Senecio sylvaticus</i>	5	4	6	6	3	3	12	10	9	6	2	2	37	5.4
32. Unidentified	2	2											2	0.3
TOTAL FRAGMENT COUNT														
	112		95		94		124		152		115		692	
TOTAL PERCENT														
		101		98		100		102		101		101		99.7

692 fragments = 19.2/sample = 1.92/field
360 fields

remaining 14 species comprised less than 1 percent each and a total of only 4 percent of the intake.

The percentage composition of the voles' diet by life forms of the plants, through as much of the calendar year as could be represented, is shown in Figure 2.

Evidence indicates that this small herbivore occupies a spatial niche extending from ground level into the tree canopy, and that its diet consists entirely of leaves from vascular plants. A leaf lamina is chewed into fragments, seldom larger than 0.3 mm in the longest dimension. No seeds, fruits, fungi, or animal parts were found as dietary intake. Some undigested hair shafts and louse instar exoskeletons from groom-

TABLE 3, Rank order of vascular plant species contributing 1 percent or more of the diet of *Arborimus albipes*.

	%
<i>Alnus rubra</i>	40.9
<i>Salix lasiandra</i>	9.5
<i>Berberis nervosa</i>	7.5
<i>Trifolium repens</i>	5.8
<i>Senecio sylvaticus</i>	5.4
<i>Prunus emarginata</i>	4.1
<i>Linnaea borealis</i>	3.3
<i>Rubus parviflorus</i>	2.9
<i>Sambucus cerulea</i>	2.8
<i>Oenanthe sarmentosa</i>	2.3
<i>Tsuga heterophylla</i>	2.0
<i>Fragaria vesca</i>	1.9
<i>Pteridium aquilinum</i>	1.7
<i>Holodiscus discolor</i>	1.3
<i>Vaccinium parvifolium</i>	1.2
<i>Lotus crassifolius</i>	1.2
<i>Urtica dioica</i>	1.0
<i>Digitalis purpurea</i>	1.0
	95.8

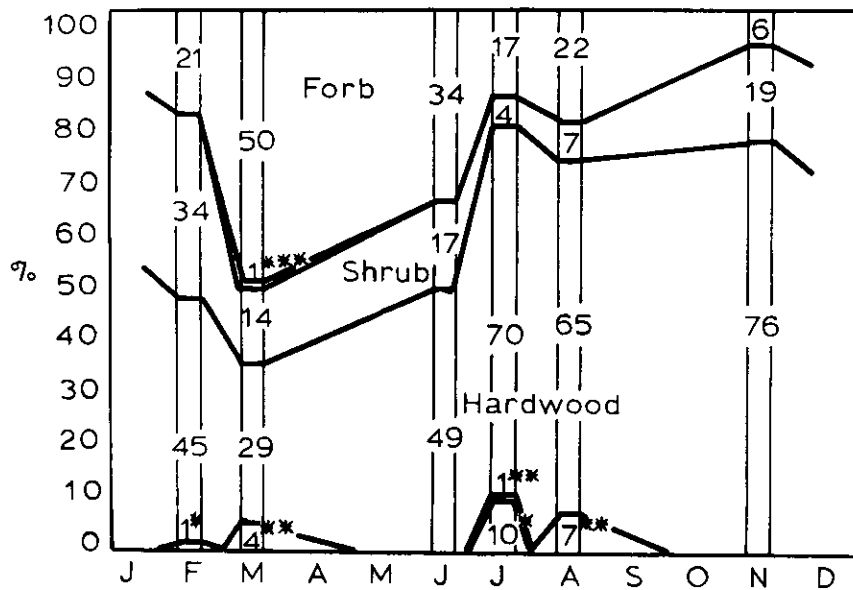


Figure 2. Percentage composition of the diet of *Arborimus albipes* through an annual cycle.
 * = Pteridophyte
 ** = Softwood
 *** = Grass

ing were found, however, as were moss gametophytes and pollen grains. The white-footed vole is therefore a browser.

Discussion

Vegetation on the maritime side of the Oregon Coast Range Mountains has been characterized as depauperate in species (Peck 1961, p. 11). Trees dominate, yet few tree species occur. Away from streams and sand dunes of the immediate coast, the climax conifer forest dominants are *Tsuga heterophylla* (western hemlock) and, sometimes

considered subdominant, *Pseudotsuga menziesii* (Douglas-fir). Maritime rain forest precipitation (> 175 cm/year) and the dissection of the landform ensure the development of stream habitats. Hardwoods have long dominated streamsides; first is red alder. Logging of the commercially valuable softwoods has increased hardwood secondary succession, and much land formerly in conifer forest is now covered by red alder. Long history of edge effect has fostered niche proliferation for small mammals in the streamside habitats, despite the paucity of plant species.

Maser and Franklin (1974, p. 29) identified eight habitat types in typical maritime Coast Ranges; the white-footed vole is restricted to type 1—Riparian Alder/Small Stream. Dominant plants of this habitat include the hardwood trees *Alnus rubra* and *Salix lasiandra*; the shrubs *Rubus spectabilis*, *Rubus parviflorus* (thimble berry), and *Acer circinatum* (vine maple); and the forbs *Urtica dioica* (Northwest nettle), *Oxalis oregana* (Oregon oxalis), and *Linnea borealis* (American twinflower). All have a much larger distribution than the vole.

Maser and Johnson (1967) reviewed the known information about the white-footed vole. Johnson (1973) characterized the genus *Arborimus* (tree voles) as scansorial, arboreal, and the genus *Phenacomys* (heather voles) as cursorial, terrestrial. The tree-climbing ability of the white-footed vole appears to be substantiated by our finding its dependence to be on alder and willow during vernal and pre-abscission seasons. That it can be seen and trapped at ground level, and that it ingests low forbs and grasses, indicate, however, that it certainly is not restricted to the tree canopy.

On logged or burned land, a white-footed vole may be found several hundred meters from a streamside (Maser and Hooven 1969). It also can be found far from water in less disturbed situations (late E. Hooven and M. Lais, pers. comm.). Our results indicate that it depends on riparian or forest rather than on aquatic or semi-aquatic vegetation.

We therefore have found that the habits of *Arborimus albipes* may closely parallel those of *Arborimus longicaudus* (red tree vole). The two voles have a very similar distribution. The spatial niche of *A. longicaudus* extends from ground level into the conifer canopy (Walker 1964, p. 842); the niche of *A. albipes* extends from ground level into the hardwood canopy. Both voles are obligate browsers. This similarity provides significant support for the demonstrated close relationship of the white-footed vole and the red tree vole (Johnson and Maser 1982).

Red tree voles and white-footed voles may be among the smallest browsing arboreal mammals known, close to the minimum size for mammalian herbivores. The wet climate and moderate temperature extremes that contribute to a long growing season and little winterkill, along with limited competition for browse by other mammals in the tree canopy, obviously influence the occurrence of these voles along the coast of Oregon and northwestern California.

Acknowledgments

Gratitude is expressed to S. Duke and C. Thomas, students at George Fox College, who helped with counting.

Literature Cited

Hitchcock, C. L., A. Cronquist, M. Ownbey, and J. W. Thompson. 1955-64. *Vascular Plants of the Pacific Northwest*. Univ. Washington Press, Seattle, 5 vols.

- Johnson, M. L. 1973. Characters of the heather vole, *Phenacomys*, and the red tree vole, *Arborimus*. *J. Mammal.* 54:239-244.
- , and C. Maser. 1982. Generic relationships of *Phenacomys albipes*. *Northw. Sci.* 56(1):17-19.
- Maser, C., and J. F. Franklin. 1974. Checklist of Vertebrate Animals of the Castade Head Experimental Forest. Pac. Northwest For. and Range Exp. Stn., Portland (USDA For. Serv. Resour. Bull. PNW-51).
- , and E. F. Hooven. 1969. A new locality record of *Phenacomys albipes*. *Murrelet* 50:22.
- , and M. L. Johnson. 1967. Notes on the white-footed vole (*Phenacomys albipes*). *Murrelet* 48: 24-27.
- Peck, M. E. 1961. A Manual of the Higher Plants of Oregon, 2nd ed. Binfords and Mort, Portland.
- Voth, E. H., and H. C. Black. 1973. A histologic technique for determining feeding habits of small herbivores. *J. Wildl. Manag.* 37:223-231.
- Walker, E. P., F. Warnick, S. E. Hamlet, K. I. Lange, M. A. Davis, H. E. Vible, and P. F. Wright. 1964. *Mammals of the World*. Johns Hopkins Univ. Press, Baltimore, 3 vols.

Received February 24, 1981

Accepted for publication April 10, 1981