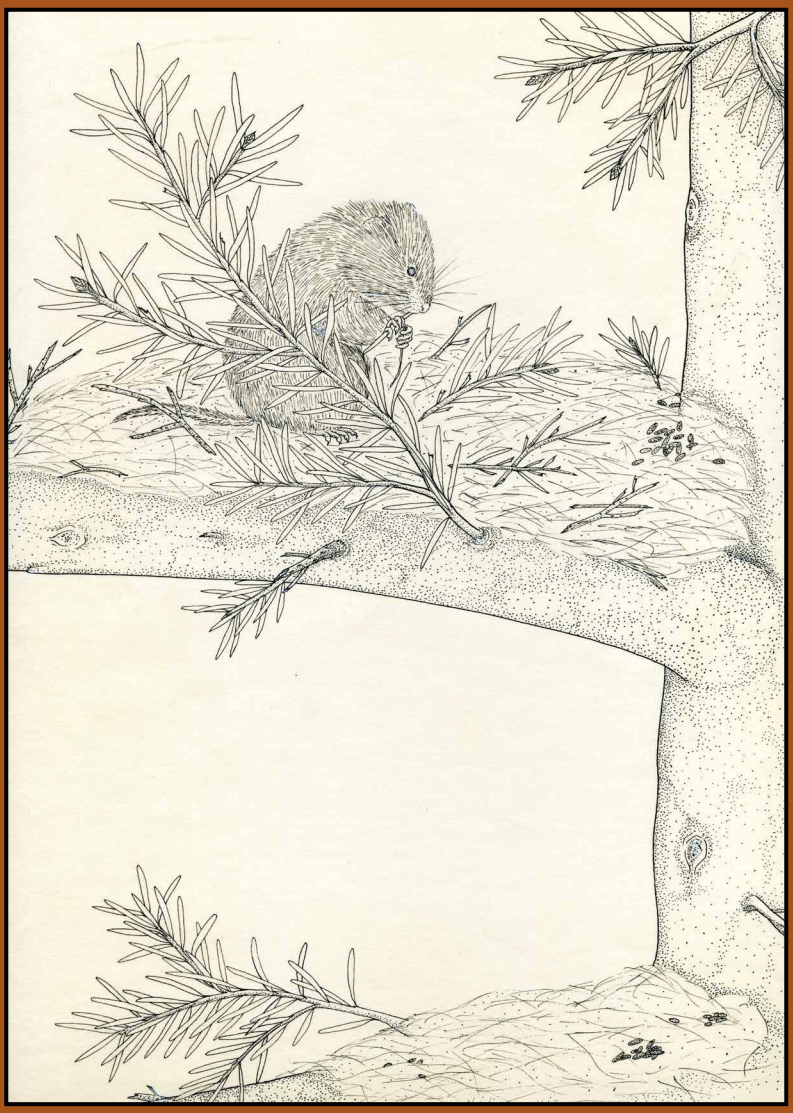
Field Guide to Red Tree Vole Nests



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Cover art: Adult red tree vole on a nest, drawn by Carol Clothier

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Surveys for red tree vole (*Arborimus longicaudus*) nests require tree climbing because the species is a highly specialized arboreal rodent that lives in the tree canopy of coniferous forests in western Oregon and northwestern California. Tree voles are associated with old coniferous forests (≥80 years old) that are structurally complex, but are often found in young forests (<80 years old), especially in unthinned young forests adjacent to old forest. Throughout much of their range, tree voles primarily forage and nest in Douglas-fir (*Pseudotsuga menziesii*) and occasionally in grand fir (*Abies grandis*). The exception is in the Sitka spruce (*Picea sitchensis*) zone along coast of Oregon, where tree voles primarily nest in and feed on Sitka spruce and western hemlock (*Tsuga heterophylla*). This photographic nest guide is intended to aid identification and classification of tree vole sign with minimal impact on nests. The primary users of this guide will be tree climbers who search for distinctive tree vole nest material that indicates presence. The tree vole survey protocol (http://www.blm.gov/or/plans/surveyandmanage/ files/sp-RedTreeVole-v3-0-2012-11.pdf) is the primary document for surveys of tree vole nests on lands managed by the USDA Forest

Service and USDI Bureau of Land Management.

The tree vole survey protocol classifies tree vole nests as “active” if there are green cuttings, resin ducts, or fecal pellets present, or “inactive” if the nest material is old. In this guide, we will use the biological terms occupied, likely occupied, or recently occupied to define “active” tree vole nests and old vole nest to define “inactive” nests. Climbers should be aware that wasps, hornets, and other stinging insects are likely to be encountered during tree vole surveys.

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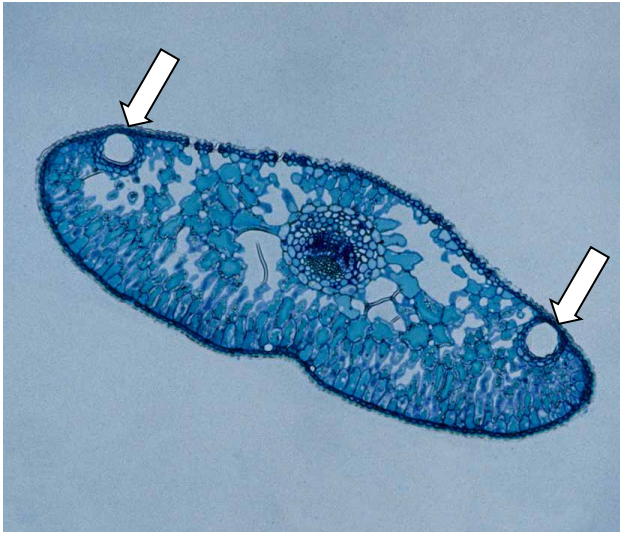
Tree voles harvest conifer branch-tips at night and store these cuttings on top of or inside their nests as their food source. This photo shows a Douglas-fir branch after a tree vole harvested the tip (arrow). The result is a chisel-cut at a 45° angle from the top of the stem to the bottom. Discovering a harvested branch tip may suggest tree vole presence, but provides no evidence of nesting, because tree voles often collect cuttings from adjacent trees that have interconnecting branch pathways with the nest tree. Furthermore, other arboreal rodent species such as the dusky-footed woodrat (*Neotoma fuscipes*), bushy-tailed woodrat (*N. cinerea*), northern flying squirrel (*Glaucomys sabrinus*), Douglas' squirrel (*Tamiasciurus douglasii*), and western gray squirrel (*Sciurus griseus*) also harvest live conifer branches and incorporate these cuttings into their nests. *Eric Forsman photo.*


15 cm
TV
TV
WR
TV

Throughout their range, tree voles feed primarily on Douglas-fir, but occasionally some will feed on grand fir. Tree voles that feed on Douglas-fir will harvest branch tips that average 14 cm in length (range = 1–35 cm) and store these cuttings on the top or inside of the nest. This photo compares 3 tree vole (TV) cuttings to the larger woodrat (WR) cutting. Compared to tree vole cuttings, woodrat cuttings are typically longer, thicker, and have more axillary branchlets emerging from the main stem. *Eric Forsman photo.*


2 cm



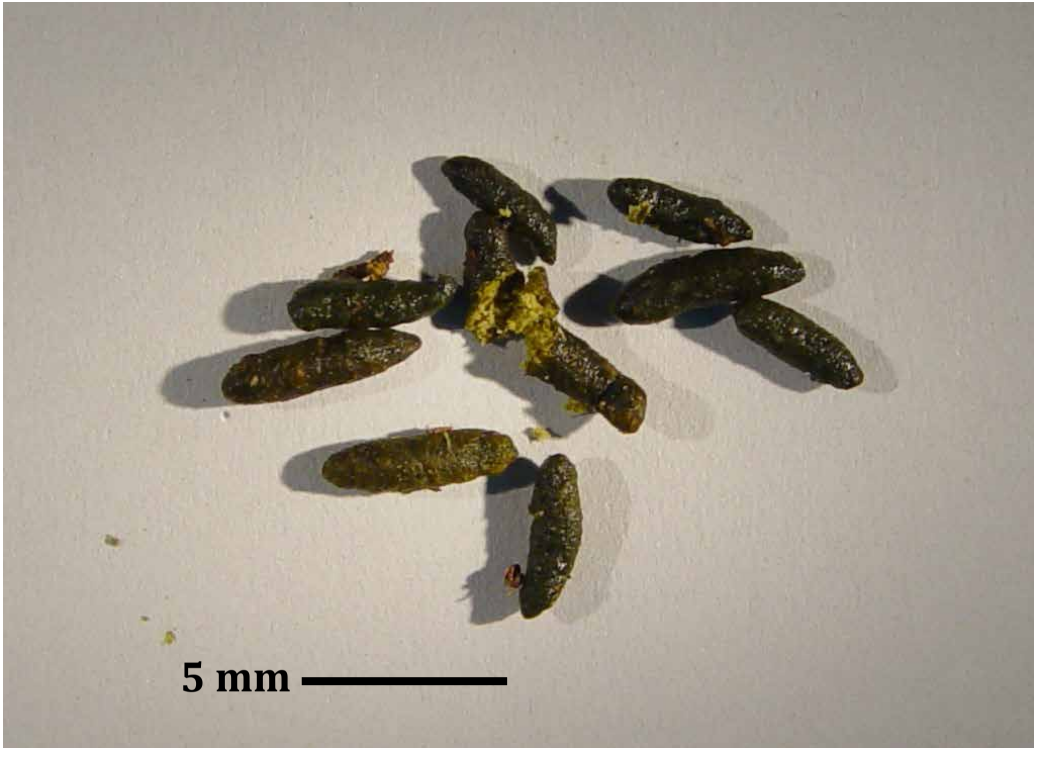
The left-hand photo is a cross-section of a Douglas-fir needle that illustrates the location of the 2 lateral resin ducts (arrows). Douglas-fir resin ducts are tubules along the outer edge of the entire length of the needle. They are the conifer's defense against herbivores, as they contain terpenes and other unpalatable chemicals. Tree voles mechanically remove the 2 resin ducts in each needle by chewing along the outer edges of the needle. Resin ducts are definitive evidence of tree vole presence because no other species remove resin ducts from needles and incorporate the ducts into their nests. *Oregon State University photo*.

Douglas-fir resin ducts are linear or slightly curved, and very thin (right-hand photo). Under magnification, tooth marks that appear as jagged edges on resin ducts can be easily seen. After removing the resin ducts, tree voles consume the remaining needle tissue. Most resin ducts have a reddish-brown enlarged tip at one end where the resin duct joins the petiole at the base of the needle, and a tapered tip at the other end. Another nest material similar in appearance to resin ducts is filamentous lichen. Under magnification, filamentous lichen appear smooth and do not have a petiole. *Jim Swingle photo*.

10

Resin ducts are used as nest material, and a definitive sign that a tree vole used the nest. The survey protocol classifies tree vole nests as “active” if resin ducts are bright green (likely occupied or very recently occupied vole nest) or over time fade to a pale green (recently occupied vole nest). Old resin ducts are reddish-brown, and result in classifying the nest as “inactive” (old vole nest).

Debarked twigs that are ≤6 cm long with chisel-cuts at both ends found in a nest are further evidence of tree vole presence. Tree voles remove bark and eat the tender bark, or remove the bark to eat the cambium layer below. Debarked twigs persist longer than other tree vole sign such as resin ducts, fecal pellets, and cuttings, which rapidly decompose to a soil-like material. *Eric Forsman photo*.


5 mm

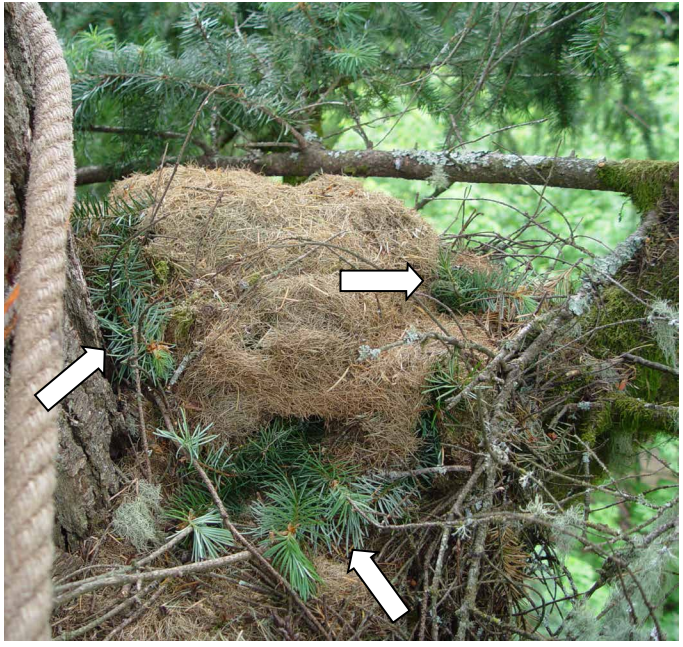
Tree vole fecal pellets are small and oval-shaped (5 mm x 1.0–1.5 mm), and are another distinctive sign of the species' presence. With the aid of magnification, the fibrous and bright-green interior compared to the dark-green exterior can be seen in dissected tree vole pellets. Tree vole fecal pellets can be used to estimate the activity status of a tree vole nest. An occupied or recently occupied nest will have moist or dried dark-green fecal pellets, and the nest should be characterized as active. Brown to black fecal pellets identify an old vole nest (i.e., inactive). White-footed voles (*Arborimus albipes*) are the only other arboreal rodent that has nests with green fecal pellets that are nearly identical to tree vole fecal pellets. Therefore, other evidence must be used to determine which species used the nest. Seasonally, white-footed voles use arboreal nests in conifers if the branches are interconnected with red alder (*Alnus rubra*) or California hazel (*Corylus cornuta*) trees. Fecal pellets from other arboreal rodents are usually black, round, and larger than tree vole pellets. Deer mouse (*Peromyscus maniculatus*) fecal pellets are the exception, as they are oval-shaped, but differ from tree vole pellets because they are smaller, black, and usually have one end that tapers to a point. *Jim Swingle photo*.

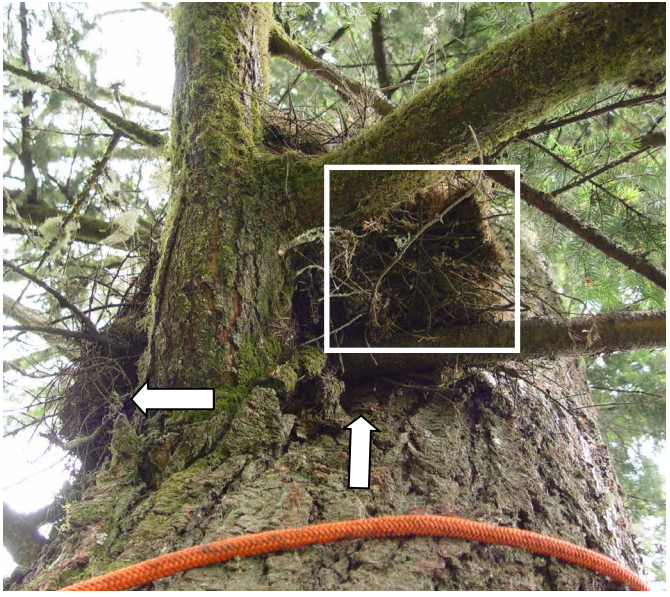

15 cm

Many tree vole nests are built on broken tree tops, forked trunks, epicormic branches, or closely spaced limb-whorls. This nest contains fresh tree vole nest material and is possibly under construction, because there is no covering for the nest chamber. The cup depression is a good example of how an inner chamber of a tree vole nest would look without a roof. The depression was made by a tree vole spinning in circles and compacting the resin ducts with the front feet, causing the cup-shaped depression in the resin ducts. *Jim Swingle photo*.


15 cm

This nest was occupied by a male tree vole. If the tree vole was not observed, the nest would still be classified as active based on the green resin ducts and fresh Douglas-fir cuttings. The nest could not be seen from any point on the ground, even though the nest was quite low (8 m). Male tree vole nests are typically smaller than female nests, especially if the female is raising young. This nest was built in a crotch of a broken top with 2 leaders. Fresh resin ducts were found on the outside of the nest. There was a single entry that was plugged with cuttings on the top of the nest against the bigger more vertical leader. On the opposite side, there was an escape tunnel at the bottom of the nest at the junction of the crotch and smaller leader. Escape tunnels are located on the bottom of tree vole nests and often are placed between gaps in the bole or branches. *Jim Swingle photo.*





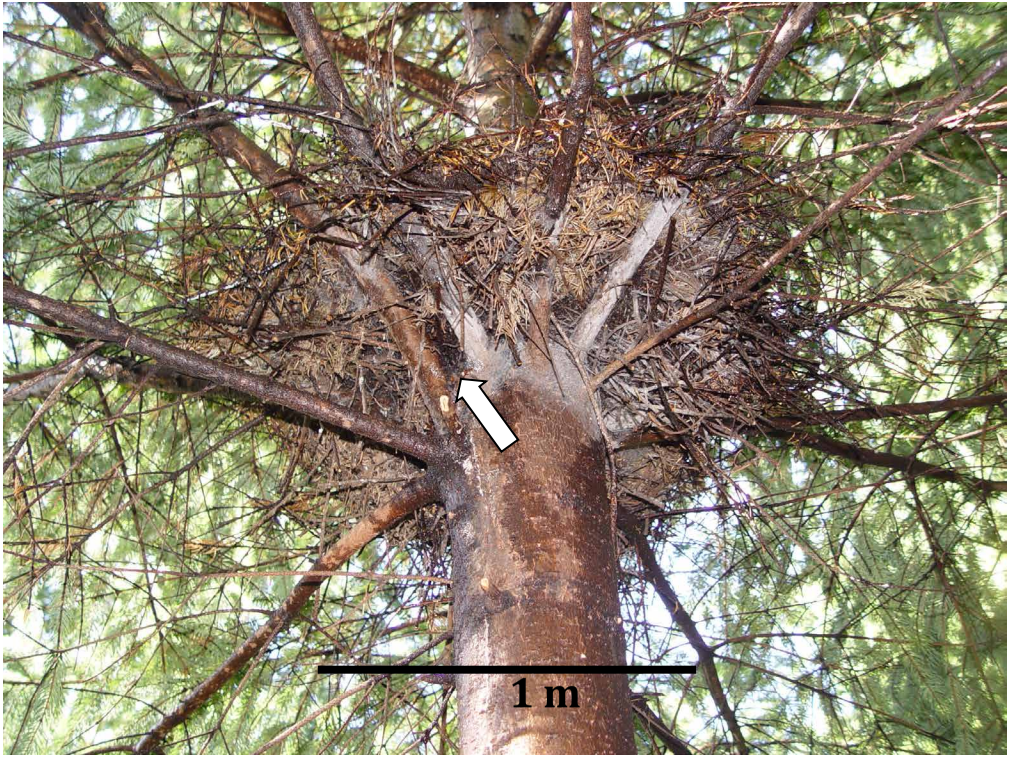
This is the same tree vole nest from 2 different vantage points. It was monitored with continuous video for 15 weeks to document the behavior of a female tree vole. The female at this nest produced 3 litters of young while the nest was monitored. Compared to male nests, female tree vole nests are usually easier to see from the ground because of their larger size, especially nests of females that are raising young.

This nest would be classified as active based on fresh Douglas-fir cuttings at 3 entrances (arrows) shown on top photo. The bottom photo shows 2 escape tunnels exiting the bottom of the nest at the branch junctions (arrows). There may have been more escape tunnels that were hidden from view. Often tree vole sign can be seen at the bottom of a nest. Infrequently, clumps of nest material (box) can be found on the ground, which may be a result of the material calving off or the nest being torn apart by a predator. *Eric Forsman top photo, Jim Swingle bottom photo.*

This is likely an occupied tree vole nest, given the presence of bright-green resin ducts, dark-green fecal pellets (arrows) that are moist, and fresh Douglas-fir cuttings. Above the fecal pellets is a side entrance tunnel that was built against the tree bole. Many tree vole tunnels are located against the bole of the tree on dense branch whorls that provide firm foundations for the nests. The sticks (>30 cm long) against the bole are thicker than tree vole cuttings or twigs and suggest that the tree vole built its nest in an abandoned squirrel nest. These sticks created an ideal substructure on which the tree vole built its nest, as the sticks were tightly woven together and secured firmly to the bole and branch whorls. *Mike McDonald photo.*

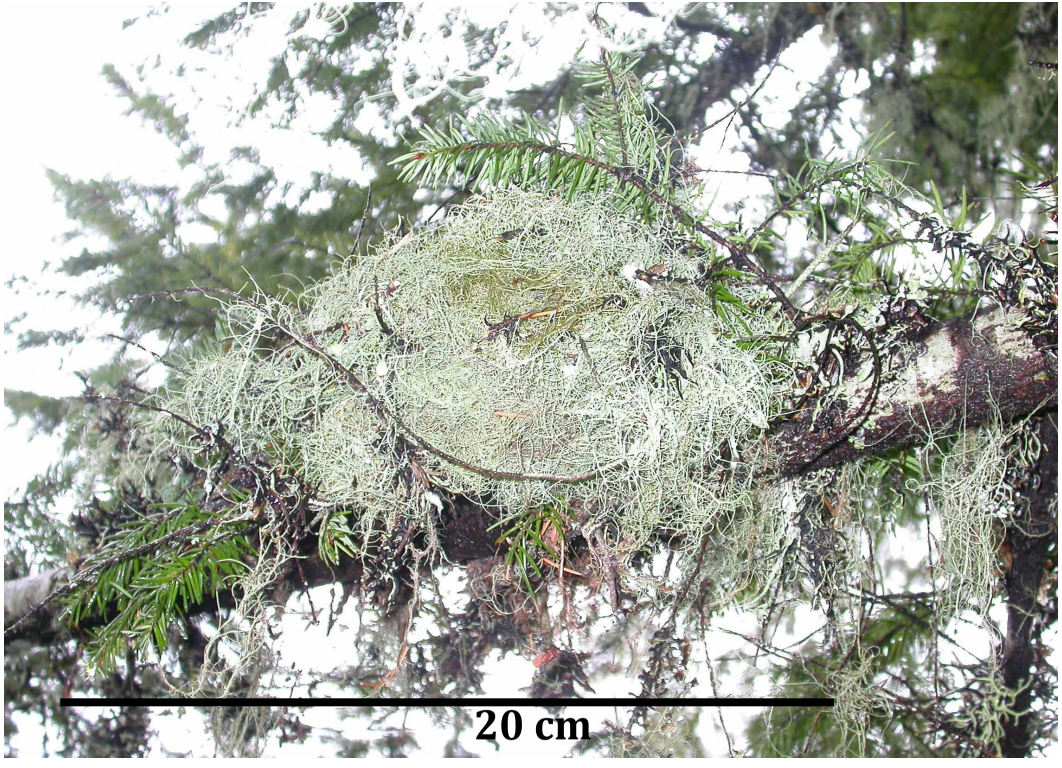
This tree vole nest would be classified as active, based on the green Douglas-fir cutting, bright-green resin ducts, and dark-green fecal pellets that are intermixed with brown and black pellets. This was probably a feeding platform rather than a nest because of the lack of additional nest material. The lichens in the top left of the photo (box) were approximately the same diameter as the resin ducts (bottom center of photo). Lichen filaments are kinked and twisted compared to the linear or slightly curved resin ducts. *Nicholas Sobb photo*.

Northern flying squirrel nests often consist of fresh moss with a chamber about the size of a grapefruit (approximately 10 cm in diameter) built on a base of sticks. From the ground, this appeared to be a northern flying squirrel nest, but a juvenile tree vole was found on top of nest. The pelage on the back and head of the juvenile was transitioning from gray to the adult red, indicating that the juvenile was at the age when it would disperse from the maternal nest. *Mike McDonald photo*.


1 m

This is an example of why trees should be climbed to determine if a tree vole used a nest. From the ground this nest looked to be an old woodrat nest, but close inspection revealed that the nest also contained tree vole sign. The woodrat nest was constructed of sticks, moss, and lichens, and built on branch whorls that completely circled the bole of a secondary leader that was growing from the broken top. Most woodrat nests contain a variety of vegetation, including deciduous leaves and conifer cuttings, but woodrat conifer cuttings are typically longer and thicker than those found in squirrel or tree vole nests. A distinctive characteristic of an occupied woodrat nest is a strong urine odor.

Tree vole sign at this nest consisted of brown fecal pellets, brown resin ducts, and debarked twigs on the inside of the nest. An escape tunnel (arrow) lined with resin ducts exited at the base of 2 branches. This would be classified as an old vole nest. *Nick Hatch photo*.


20 cm

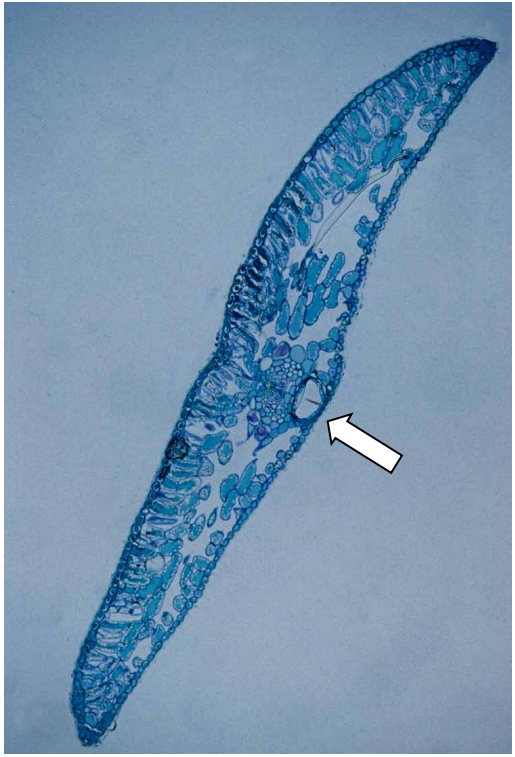
This is an example of an unusual tree vole nest. Inside this squirrel nest, constructed of lichen, was a small tree vole nest constructed of resin ducts, with a few cuttings that could be seen when the lichen was carefully opened. We recommend that climbers carefully open nests that do not have tree vole sign or for which activity status cannot be determined by examination of the exterior. Interiors of most nests can be searched for tree vole sign without damaging the integrity of the nest. *Jim Swingle photo.*

We suspect that tree cavities are an ideal place for tree vole nests. Cavities have sturdy foundations for nests and provide protection from storms and predators. Many types of cavities are used by tree voles, including broken tops, boles, and limbs. Searching for a nest in a cavity of a live tree is often difficult because entrances are typically small and the cavity can extend beyond the reach of the tree climber. *Eric Forsman photo.*

Occasionally tree voles will nest in tree species other than Douglas-fir. This nest is in a bigleaf maple (*Acer macrophyllum*) cavity that had branch pathways interconnecting with Douglas-firs, from which the tree vole collected cuttings. Cavity nests are rarely seen from the ground, but can often be seen while climbing adjacent trees. Therefore, when conducting surveys climbers should search for nests in adjacent trees in addition to the tree they are climbing. *Jim Swingle photo.*

Tree voles and other arboreal rodents often nest in dwarf mistletoe (*Arceuthobium* spp.) brooms in Douglas-fir and western hemlock because these structures are ideal foundations for nests. *Nicholas Sobb photo.*

Occasionally, grand fir cuttings may be found in tree vole nests. Grand fir resin ducts are similar to Douglas-fir but much shorter (approximately 1.0 cm vs. 2.0 cm, respectively). *Eric Forsman photo.*



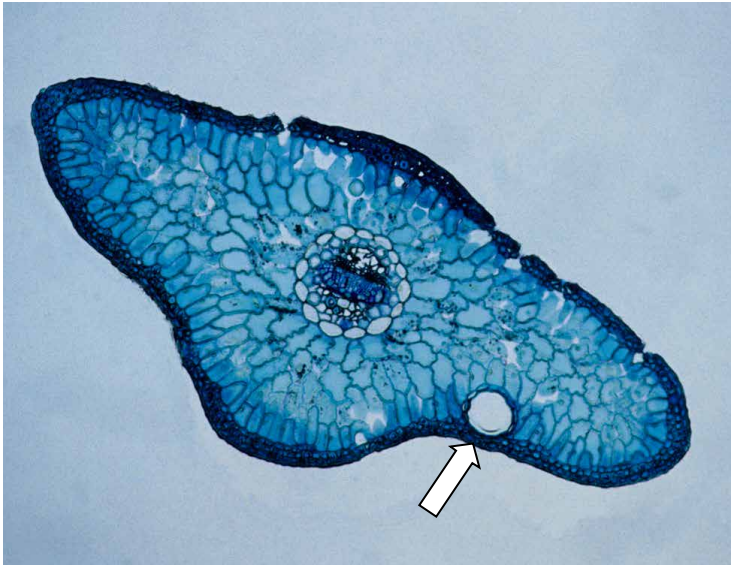

1.5 cm

In this section, we discuss tree voles in the coastal forests of Oregon in the Sitka spruce zone, where tree voles feed on western hemlock or Sitka spruce. The left-hand photo shows the single resin duct in the center of a western hemlock needle (arrow). Instead of chewing along the edge of the needle to mechanically remove the resin ducts as in Douglas-fir and grand fir, tree voles eat western hemlock needles by chewing along the length of one side of the needle and consuming this material before flipping the needle over and repeating the process and discarding the centrally located resin duct. Hemlock resin ducts have a distinctive double-serrated pattern where the incisors of the tree vole removed the palatable tissue of the needle. *Oregon State University photo.*

The right-hand photo shows western hemlock resin ducts with a complete needle in the middle for comparison. Western hemlock resin ducts are curved, and like Douglas-fir ducts, one end has the petiole that attaches to the twig stem. With the aid of magnification, western hemlock resin ducts have 2 sides that are serrated where a tree vole nipped off and consumed the outer portions of the needle. *Jim Swingle photo.*

The nest was likely occupied by a tree vole because the top of the nest was completely covered with western hemlock cuttings that were quite fresh. From the ground it was impossible to determine if these were the tips of hemlock branches or cuttings. *Eric Forsman photo.*

Here is a tree vole nest built in a dwarf mistletoe broom in a western hemlock. Short, 2- to 5-cm western hemlock cuttings lay on top of the nest, but a few additional cuttings can be seen on the side of the nest. Searching for tree vole sign in dwarf mistletoe brooms in western hemlock is difficult because the brooms are very dense, with numerous branches closely spaced and twisted around each other. *Eric Forsman photo.*




DF
SS

The left-hand photo shows a cross section of a Sitka spruce needle with a single resin duct in the lower portion of the needle on the right (arrow). The distribution of resin in Sitka spruce needles is unique in that it does not occur continuously like resin ducts in Douglas-fir, western hemlock, and grand fir. Instead, resin may occur in sacs that are irregularly or linearly distributed, or resin sacs may not be present at all in Sitka spruce needles. The resin sacs are found primarily in the basal half of the needle. Nests of tree voles feeding on Sitka spruce may contain only fecal pellets, debarked twigs, and Sitka spruce cuttings. *Oregon State University photo*.

The right-hand photo compares 2 Sitka spruce (SS) resin ducts (above) on top and 2 Douglas-fir (DF) resin ducts (below). The Sitka spruce resin ducts were collected in a Sonoma tree vole (*A. pomo*) nest in California. Compared to Douglas-fir resin ducts, Sitka spruce resin ducts are shorter (2.0 cm vs. 1.5 cm, respectively) and more serrated. We suspect that the Sonoma tree vole removed a series of linear resin sacs, resulting in what appears to be a single, long spruce resin duct. *Jim Swingle photo*.

In this section, we describe nests of other arboreal mammals that may be mistaken for tree vole nests. In fact, when abandoned these nests are often used by tree voles.

This photo illustrates the top portion of a northern flying squirrel nest. These nests are usually constructed of moss, with a grapefruit-sized chamber on top of a bed of sticks. Flying squirrels will incorporate stripped bark into their nests, but not as often or to the extent that Douglas' squirrels do. An entrance is located at the base of the moss in this photo, but usually flying squirrel nests do not have such an obvious entrance leading to the nest chamber. *Jim Swingle photo.*

This was an occupied white-footed vole nest, with red alder cuttings that had chisel-cut basal tips. The nest also contained fecal pellets that were very similar to red tree vole pellets, but no resin ducts or debarked twigs were found. Because white-footed voles feed on non-conifer vegetation, their nests do not contain resin ducts, debarked twigs, or conifer cuttings. White-footed vole nests often contain deciduous leaves, but the species primarily eats forbs and ferns. *Eric Forsman photo.*

Western gray squirrel nests are very different from tree vole nests because they are constructed of large sticks that are loosely woven, and typically contain deciduous leaves. Distinctive characteristics of gray squirrel nests can easily be seen from the ground with the aid of binoculars. We have found tree vole sign inside gray squirrel nests that appeared to be constructed only of sticks and deciduous leaves when viewed from the ground. However, if the nest is in a deciduous tree that does not have interconnecting branches with conifers from which tree voles can obtain cuttings, it is unlikely to be occupied by a tree vole. *Eric Forsman photos.*