

the ranch's progress or decline in overall range condition if photographed plots are permanently marked and estimated each 5 or 10 years.

This photographic method aids in the management of

the range on a short-term basis (i.e., determine the proper stocking rate or the proper grazing cycle length), and can provide a reliable visual record of the manager's ability to improve it.

Senecio: A Dangerous Plant for Man and Beast

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The genus *Senecio* includes 1,000 to 3,000 species distributed throughout the world. *Senecio* and other species that contain pyrrolizidine alkaloids (PA) [i.e., hounds tongue (*Cynoglossum officinale*), fiddleneck (*Amsinckia intermedia*), and species of *Crotalaria*, *Borago*, *Heliotropium* and *Echium*] are perhaps the most important group of poisonous plants worldwide. They are toxic to livestock when grazed or ingested in hay or contaminated grains. They are also toxic to humans when ingested as contaminants in cereals, from PA contaminated milk products (PA's ingested by lactating animals are excreted in the milk), and when made into herbal teas. Tansy ragwort (*Senecio jacobaea*) is often confused with tansy (*Tanacetum vulgare*), which has been used in herbal medicines (Cheeke and Shull 1985). Comfrey (*Symphytum officinale*), which has been reputed as having medicinal properties, also contains PA.

In the western US, only 7 *Senecio* species are reported to be toxic (Kingsbury 1964), but many other species probably contain PA. The greatest economic loss is from cattle poisoning. Horses are also highly susceptible to PA, but sheep and goats are more resistant and may be an effective biological control for some *Senecio* species.

Three *Senecio* species cause the majority of cattle losses in the western US. Tansy ragwort was introduced from Europe and occurs in the coastal Pacific Northwest and in the Northeast. The plant is a weedy winter annual or biennial that germinates in the fall, over-winters as a rosette, and forms a tall flowering stalk in the spring and summer. It grows on moist well-drained soils in pastures, forests, and wastelands.

Threadleaf or woolly groundsel (*S. douglasii* var. *longilobus*) grows principally in the Southwest. It is a low-growing, perennial, evergreen shrub and is most abundant on loamy to clay soils. Its leaves and stems are covered with a white woolly pubescence. It is an increaser species that becomes abundant on abused and degraded rangeland.

Riddell's groundsel (*S. riddellii*) occurs in the Mid- and Southwest. It is a suffrutescent half-shrub that dies back to the crown each fall and thrives on sandy soil. It is similar in appearance to threadleaf groundsel except that its leaves and stems are bright green. It was implicated as causing "walking horse" disease early in this century and has systematically been eradicated in many areas of the Midwest (Barkley 1978).

Toxicology

Estimates of toxicity of *Senecio* species are commonly based on the amount of plant required to cause symptoms or death. These estimates are not reliable or realistic because toxicity depends on the PA concentration in the plant, the specific PA present, the form of PA, and the rate at which the plant is ingested.

There are many different PAs. The majority are toxic and primarily affect the liver. Tansy ragwort contains 8 PAs, threadleaf groundsel contains 4, and Riddell's groundsel contains only 1. Each PA exists in the plant as a nontoxic free-base or a N-oxide. They become toxic when the free-base is converted into highly reactive alkylating pyrroles by liver microsomal enzymes. The N-oxide must first be converted to the free-base, presumably in the gut, before conversion to the pyrrole. Initially the free-base form was considered potentially more toxic (Johnson et al. 1985b), but recent evidence suggests that the N-oxide can be equally toxic (Molyneux et al. 1989). Thus, the total PA content of a species is currently the best estimate of its toxicity.

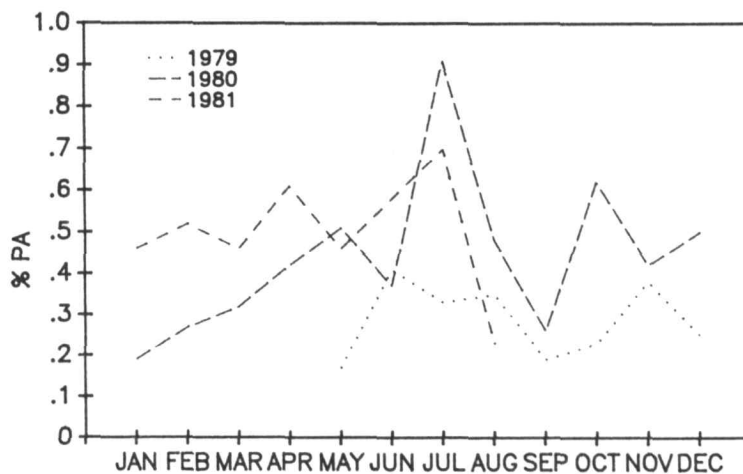
The reactive pyrrole crosslinks with DNA and prevents liver cells from reproducing. As the cells senesce and die, they are not replaced. Increasing numbers of liver cells are damaged with each successive toxic dose of PA, resulting in a cirrhosis-like liver condition with blocked bile ducts and veins. These changes lead to eventual liver failure and death of the animal. The disease is progressive and symptoms may not become apparent for 3 weeks up to 18 months after ingestion of the plant. Thus, a large proportion of deaths and illnesses may go undiagnosed.

Editor's Note: 1 pound (lb) equals 454 grams (g)
1 kilogram (kg) equals 2.2 pounds

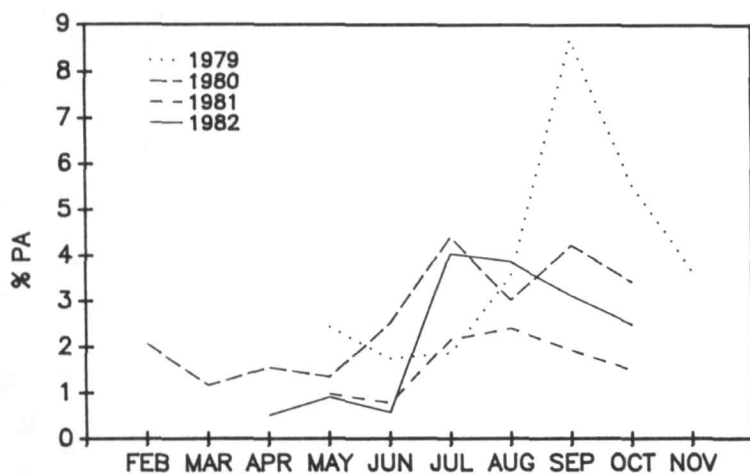
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a. TANSY RAGWORT



b. THREADLEAF GROUNDSEL



c. RIDDELL'S GROUNDSEL

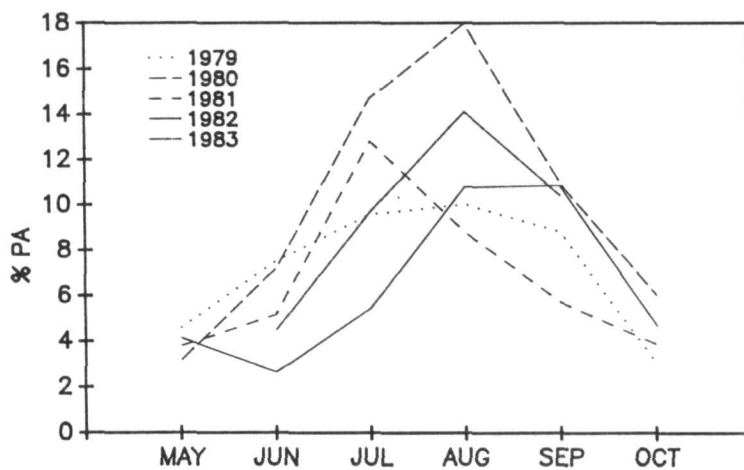


Fig. 1. Pyrrolizidine alkaloid content of leaves of three *Senecio* species: (a) tansy ragwort collected at Roseburg, OR; (b) threadleaf groundsel collected at Sonita, AZ; (c) Riddell's groundsel collected at Woodward, OK.

The acute or chronic nature of the disease depends on how much plant and PA are consumed and how rapidly they are ingested. There appears to be a threshold of tolerance by the liver, or pre-absorbance influences in the gut, that must be exceeded before PA become dangerous (Johnson and Molyneux 1984). Animals can eat small amounts of *Senecio* over periods of time without any adverse effects. Above the threshold level, *Senecio* ingested for 15 to 20 days may lethally damage the liver. In time, or due to stress, the liver may fail to function properly, and the animal eventually dies. Acute poisoning is rare because of the low palatability of *Senecio* species. However, if animals are forced to eat large quantities of PA-containing plants in a short time, necrosis in the liver and severe hemorrhage causes death within 1 to 2 days (Kingsbury 1964).

Younger animals are more susceptible to PA because of increased cellular activity and higher levels of PA metabolizing enzymes in the liver (Johnson et al. 1985a). Clinical signs include a rough, unkept appearance; diarrhea; prolapsed rectum; bloated appearance; lassitude and dullness; neurological disturbances, such as "head pressing" against solid objects; and restless pacing (Cheeke and Shull 1985).

PA content varies among species, within seasons, and between years (Fig. 1). The level of PA in Riddell's groundsel is extremely high. The peak PA concentration in leaves exceeded 10% of dry weight in 5 consecutive years of sampling (Molyneux and Johnson 1984). The extreme PA content in Riddell's groundsel at Woodward, OK, in 1980 (Fig. 1-c) occurred in a hot, dry year. Alkaloid levels rarely exceed 7% in other species specifically cultivated for their alkaloids. Drought stress can increase PA content of *Senecio* (Briske and Camp 1982).

Of the three species studied, PA in tansy ragwort are most toxic, requiring only 2.3 mg PA/kg body weight/day for a lethal dose (Johnson 1979). The larger number of PA and their differing toxicity probably account for its higher toxicity compared to the other 2 species. The flowers are most toxic, followed by leaves, then roots. The stems are relatively nontoxic (Swick et al. 1979). However, the average PA content in the tansy ragwort plant is lowest of the three species studied (0.31% of dry matter). Thus, the amount of fresh plant material required for a lethal dose is greater than the other species (Table 1). The toxicity of threadleaf groundsel is intermediate (Johnson and Molyneux 1984). PA of Riddell's groundsel are least toxic (Johnson et al. 1985a). However, Riddell's groundsel had the highest average concentration in the plant (6.4%). At the extreme concentration of 18% PA, only 111 g/day of fresh plant material for 20 days would be required to kill a 220 kg calf (Table 1).

Management

PA content of tansy ragwort can be high during any month due to its flexible biannual growth form. There is no safe grazing period. The maximum hazard from threadleaf groundsel is from mid-summer through fall

Table 1. Toxicity of *Senecio* species fed to 220 kg calves for 20 days.

Species	PA		Lethal amount of plant	
	lethal dose	level in plant	Dry	Fresh ⁴
	mg/kg body wt	%	-----g/day-----	
Tansy ragwort	2.3 ¹	.31	161	806
Threadleaf groundsel	10-13 ²	2.19	118	594
Riddell's groundsel	15-20 ³	6.40	63	312
Riddell's groundsel High PA	15-20 ³	18.0	22	111

¹Johnson 1979

²Johnson and Molyneux 1984

³Johnson et al. 1985a

⁴Based on dry matter content of 20%.

when plants are flowering. PA content of Riddell's groundsel is lowest when it starts growth in the spring and increases as the plant matures. Maximum hazard is in mid-summer during the bud and flower stage.

These *Senecio* species are not very palatable to livestock. However, if they are present on range or pastures, cattle should be watched closely to see if they are grazing *Senecio*, and removed if they begin to select them. When PA content is high, only a small amount of plant material needs to be consumed over 15 to 20 days to be lethal to young cattle.

Sheep are more resistant to PA toxicity and many selectively graze *Senecio*. Thus, they can be used to reduce *Senecio* availability for cattle (Sharrow and Mosher 1982). Other biological agents such as the cinnabar moth and the ragwort flea beetle are effective in controlling tansy ragwort when they can be established in colonies of sufficient strength. Herbicides such as 2,4-D applied in the spring or dicamba applied in early summer are also effective controls. Threadleaf groundsel can be controlled with 2,4-D plus picloram (0.8 + 0.3 kg a.e./ha) applied in the autumn when plants are actively growing, and metsulfuron at rates as low as 18 g ai/ha is also promising (Sharrow et al. 1988).

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Goats Make "Cents" out of the Scourge of Leafy Spurge

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These days, ranchers all over Montana are searching for the answer to this question: **How do you deal with the scourge of leafy spurge?** Today, this noxious weed covers well over half a million acres of Montana rangeland. Thousands of dollars are literally poured into spurge control every year, yet leafy spurge continues to spread—and spread—and spread. As anyone who has it on their place can tell you, S.P.U.R.G.E. is just another way to spell **big** trouble.

The latex in spurge is a face irritant to cattle and they avoid it. In overgrazed areas, the cattle will eat everything in sight—with the exception of the spurge and any plant growing directly within the spurge patch. Grazing leafy spurge with cattle—or even horses—actually helps the spurge, by removing its competition.

Spurge (a Eurasian plant probably brought to Montana in hay from North Dakota) is not only here to stay, it's here to take over!

Leafy spurge is well suited to its conquest of Montana. It's a hardy plant and none of its natural enemies are native to anywhere in the whole United States. It spreads like a wild fire by means of its extensive and powerful root system, which is covered with small pink buds that sprout into new plants. Most plants will die if you keep their top growth cut back so that they can't photosynthesize. Not leafy spurge! Spurge has the ability to store phenomenal amounts of glucose in its roots and can survive for years on the nutrients stored there alone. A tiny piece of root only half an inch long and a tenth of an inch thick can still grow into a whole new plant.

Leafy spurge also reproduces at run-away rates by seed. A single stalk can produce as many as 140 seeds. They are exploded from their pods up to fifteen feet from

the parent plant and can survive in the soil undamaged for eight years.

One method for leafy spurge control is applying chemical herbicides. The chemical most effective on spurge is Tordon. Minimum control requires half a pound of Tordon mix an acre. That would cost at *least* twenty dollars per acre. For good control it is necessary to use twice that, which costs about 40-45 dollars an acre. If the spurge is sprayed every year it probably won't spread, but if given even half a chance, it will come back as strong as ever. Also, leafy spurge prefers riparian areas where it is dangerous to humans and animals alike to introduce chemicals. In addition, the amount of herbicide necessary to damage a spurge plant can injure grasses, trees and other desirable plants as well. So even though chemicals will control spurge and stop it from spreading, they cost a great deal, and the land that was spurge infested cannot always be reclaimed for grazing.

Another control possibility is severe cultivation. This is not a very feasible option for Montana's ranges, because they are in most cases difficult to plow and leafy spurge's roots are so hardy.

The idea of control with insects (which may soon become a very real possibility) is only in its relatively early stages. It will probably be a number of years before a workable insect spurge control program is available. Until then, we can't afford to bury our heads in the sand. Something must be done—and now.

One possibility is the goat. Goats love leafy spurge. It's true that there isn't a very ready market for goat cheese in Montana; however, there are more goats around than just dairy goats. One that fits the need nicely is the Angora.

Angoras are raised for mohair, a strong type of hair that makes a versatile, shiny yarn. It has many of the qualities of wool, but is less irritating to the skin. It is used for