PRESUMED INTOXICATION OF ELK WITH GROUND LICHEN *XANTHOPARMELIA CHLOROCHROA* IN RED RIM WILDLIFE HABITAT AREA SOUTHEASTERN WYOMING, FEBRUARY – MARCH 2004


Dead elk, Red Rim, WY 3 April 2004

Background: Recumbent adult elk were found on or shortly before 6 February 2004. New cases of the syndrome continued to be seen by wildlife managers until late March 2004. All were in the Red Rim wildlife habitat management area, a 40 - 50 square mile area southwest of the town of Rawlins, WY just east of the Sweetwater-Carbon county line (WGFD elk hunting area 108). Most affected animals were adult females; affected calves are underrepresented. This is a largely cow-calf herd, which is presumed to explain the paucity of affected bull elk. A herd of 400 healthy elk was seen feeding in the area in late January. Losses are assumed to have begun between 26 January and 6 February 2004. On 31 December 2003, a recumbent elk was found 0.5 mile south of the Ferris RR Crossing, 1 mile west of Rawlins, approximately 11 miles east of the Red Rim outbreak. This animal fits the case definition (below) and may be the first one affected in the outbreak. Estimate of total losses are 310 elk. Losses have now ceased. The affected herd has moved out of the Red Rim area. No other species, including resident cattle and pronghorn, were affected. Press releases on the investigation are posted on the Wyoming Game and Fish Department (WGFD) web site: http://gf.state.wy.us/

Case definition: Affected elk display progressive weakness and are generally found down, typically in sternal recumbency, and unable to rise. Elk are afebrile, with normal pulse and respiration. They display normal mentation. Affected elk do not survive, even if offered food and water. Animals are generally in fair-to-good nutritional condition. Findings at necropsy are minimal: some elk have muscle pallor, particularly of the thigh, corresponding to acute myopathy histologically. Many affected elk have moderately distended large bowels (small colon and rectum) that are filled with feces of normal consistency.

Discolored (red-brown) urine was found in the vicinity of many affected elk. The bladders of affected elk contained urine of normal color.

Attempted treatment: Four elk with typical clinical signs were collected in the field and transferred to the WSVL, where a WGFD veterinarian treated them for up to 17 days. Elk were treated with intravenous fluids, and injections of vitamin A, D, E and selenium. None responded. All were euthanized.

Disease investigation: A disease investigation was begun as soon as the large scale of the outbreak was recognized and was coordinated by Dr. Walt Cook of WGFD. Field data were collected by WGFD personnel, who conducted a feeding trial using ground lichen. Laboratory work was performed at the Wyoming State Veterinary Laboratory (WSVL), whose personnel did necropsies and collected samples in the field. WGFD personnel recorded dates on which individual affected elk was found, as well as sex, age and GPS locations. Data were entered on GIS maps, overlaid with geographic and vegetation data. These are currently being analyzed.

Based on laboratory diagnoses performed to date, the following potential causes are excluded:

- Salt poisoning
- Organophasphase/carbamate insecticide intoxication
- Nitrate poisoning
- Sulfate poisoning (rumen odor)
- Poisoning with following toxic metals: arsenic, barium, cadmium, cobalt, chromium, copper, iron, manganese, mercury, molybdenum, nickel, lead, selenium, thallium, vanadium, zinc.
- Selenium deficiency
- Chronic wasting disease
- Meningeal and carotid artery worm
- Tick paralysis
- Drilling surfactants
- Viral infection
- Bacterial infection
- Parasitism

The following diagnoses are tentatively excluded (rationale in parenthesis):

- Algal toxins (time of year, lack of liver lesions)
- Oxalate-concentrating plants, e.g. Halogeton (absence of renal lesions)
- H_2S intoxication (normal rumen pH, lack of lesions, incompatible signs)
- Sorghum intoxication (species, source, absence of cystitis)
- Locoweed intoxication (season, absence of lesions)
- Alkaloids intoxication (based on normal urine from one elk)
- Zinc phosphide intoxication (quantity needed would have been huge)
- Corticosteroids (lack of source)
- Gossypol (lack of source, age, no cardiac lesions)
- Halothane or succinylcholine intoxication (species, source, route)
- Snake venom (season, number involved)
- Aminoglycoside antibiotics intoxication (source)
- 2,4D herbicide intoxication (species, source)
- Coniine intoxication (urinalysis of 1 elk)
- Illicit drugs e.g. amphetamines, barbiturates (source)
- Bracken fern intoxication (species, source)
- Russian thistle intoxication (season, none found, no nitrate identified)

- Kochia intoxication (season, lack of lesions)
- Phenoxy herbicide intoxication (source, lack of lesions)
- Ethylene glycol intoxication (signs)
- Hypomagnesemia –grass tetany (season, signs, serum chemistry, no response to treatment)
- Hypocalcemia (serum chemistry, species, no response to treatment)
- Botulism (source, mouse bioassay).
- Sodium flouroacetate - compound 1080 intoxication (signs, normal pulse, progression of disease)
- Strychnine intoxication (lack of convulsions/seizures, progression of disease)
- Carbon disulfide intoxication (signs, lack of liver lesions)


Dr. Todd Cornish (WSVL) and Hank Edwards (WGFD) collected Xanthoparmelia, Red Rim, April 2004

Data indicating ground lichen intoxication

WGFD employees noted that elk in the Red Rim area were eating ground lichen. Digested ground lichen was present in the rumen contents of affected elk at necropsy. Three captive adult elk held at WFGD's Sybille facility were offered a diet of ground lichen between 15 – 25 March 2004. Two of three displayed clinical signs of weakness beginning 7 days after exposure, and were euthanized and examined post-mortem. The remaining elk ate little lichen, showed no clinical signs and was returned to a normal diet. Histological examination of tissues is ongoing. Additional experimental studies will be undertaken by personnel from the WGFD and the WSVL. A large volume of ground lichen was collected from the site where elk were affected and will be fed to animals to define the pathogenesis and toxicity of the lichen.

Ground lichen in the diets of elk, pronghorn and livestock

Lichens are composite, symbiotic organisms composed of members from as many as three kingdoms. The dominant partner is a fungus (kingdom Fungi), which cultivates partners that manufacture food by photosynthesis, either algae (kingdom Protista), or cyanobacteria (blue-green algae) (kingdom Monera). The ground lichen implicated in the current episode is *Xanthoparmelia chlorochroa* (Tuck.) Hale (Syn.: *Parmelia chlorochroa*) ("tumbleweed shield lichen"). Information on lichen as a food item used by elk is limited. Elk are reported to eat *Bryoria trichodes*, ssp. *Americana*, *Ramalina menziesii*, and *Usnea* sp. (*U. barbata* and *U. plicata*, cited, are misidentifications). Marcum, 1980, reported an average of 3% volume of lichens occurring in 33% of rumens sampled from a western Montana herd in Oct.-Nov., 1972. Most forage studies of elk do not list lichens; they are probably occasional winter forage, especially at times of stress. Schwartz and Mitchell, 1945, referring to Roosevelt elk (*C.e. rosevelti*) reported that lichens were "common on the trunks and limbs of trees" on the Olympic Peninsula and that "during winter, especially at higher elevations, they are important in the diet and are taken from as far up as the animals can reach. On the high ridges at this season, the elk apparently depend largely upon lichens and the browse from broken limbs of fir and hemlock." Reports of intoxication with *Xanthoparmelia* spp. are sparse. Poisoning of "laboratory animals" fed "an emulsion of usnic acid extracted from a lichen identified as *Parmelia molluscula* Ach is mentioned as two personal communications (OA Beath, Wyoming Agricultural Experiment Station 1960; WT Huffman, Salina Utah


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Experiment Station 1955) in Kingsbury's text *Poisonous Plants of the United States and Canada*. The remaining fraction, devoid of usnic acid, was not toxic. The lichen contains approximately 1.6% of usnic acid, which was extracted with carbon bisulfide. The species identification is incorrect as *Parmelia molluscula* does not occur in North America (TL Esslinger: *A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada*, version #8, posted 17 July 2002). Bulletin 324 of the Agricultural Experiment Station (Poisonous Plants and Livestock Poisoning; July 1953) has a brief section on intoxication produced by ground lichen identified as *Parmelia molluscula*. It stated that it was not a serious menace to livestock, and that it caused poisoning in winter when forage was scarce. The lichen was toxic year-round. Although the report states that "the nature of the poison and symptoms produced have been investigated quite thoroughly," Bulletin 324 is the only publication where the investigations are recorded. Signs consisted of "lack of coordination in movement of the hindlegs," with mild depression and inability to move either forelimbs or pelvic limbs in more severe cases. The authors stated that no lesions or characteristic pathology developed. Unlike sheep, cattle continued to eat and drink while recumbent. Subcutaneous injections with strychnine sulfate were stated to be beneficial for affected cattle, but not sheep. The authors concluded that the toxic principal affected either the spinal cord or cerebrum. A toxic dose was reported to be 1% of an animal's weight for 5 days, or a single dose of 3.6% of an animal's weight. There is no record of the *X. chlorochroa* occurring in elk. Other species in the Red Rim area, such as pronghorn, are reported to eat lichens including *X. chlorochroa*. A rumen sample of an antelope on winter range in southeastern Idaho contained 51% lichen (Bernt 1976). Domestic sheep grazed some of the same ranges and were thought to compete with antelope for the same lichens. Wildlife biologists with the Bureau of Land Management and the USDA Forest Service in Nevada and New Mexico used the presence of *X. chlorochroa* as an indicator of excellent antelope range for a number of years. They considered it "fair" forage in spring, and "poor" forage in summer (Suminski).

April 4, 2004

Useful texts, citations and links to lichen literature and lichen poisoning:

American Bryological and Lichenological Society: http://www.unomaha.edu/~abls/resources.html

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Esslinger TL: 2002, *A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada*, version #8, posted 17 July 2002 http://www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm

International Association of Lichenologists http://www.botany.hawaii.edu/cpsu/ial.htm

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