CASE REVIEW APPROACH TO TOXICOLOGICAL PROBLEMS IN DOMESTIC ANIMALS

By

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INTRODUCTION.

The tradition of teaching toxicology in veterinary schools has typically been presentation of the toxic plant, its characteristics, the toxic principle and mode of action, the clinical syndrome produced and the ante or post mortem findings if any. The same format is adopted in most of the texts, often with little or no reference to differential diagnosis. In some schools, Toxicology is taught before the bulk of clinical studies are taught so that the time lag between initial learning and a full appreciation of plant poisonings as a part of the animal disease spectrum is often prolonged. In schools lacking clinical toxicologists on the clinical department faculty, there is often lack of reinforcement of the basic toxicological problem information base. This shortfall may contribute towards misdiagnosis of veterinary problems and a delay in students gaining a more complete understanding of these problems until late in their professional careers. In addition, the infrequent occurence of plant poisonings preclude the likelihood of students encountering these problems during training.

It is in the light of these inherent problems with learning toxicology that the need for a different approach to teaching toxicology is acknowledged. The availability of computer software for interactive tutorials enables presentation of material in a format that will encourage the student to learn plant poisoning as a possible etiology among others for any clinical problem encountered. The format of this case series was devised to provide for such interactive tutorials.

The headings, Anamnesis, History, Physical examination , Problem list, Differential diagnosis, Diagnostic Plan, Diagnostic findings, Tentative diagnosis, Laboratory findings and Definitive diagnosis, have been adopted for presentation of information pertaining to a plant poisoning case. After each stage, the student is prompted to use the information already given in a way that will eventually lead to a diagnosis. It is envisaged that the student will learn from the comparison between his or her deductions and answers given in the following stage and begin to appreciate plant poisoning as a possible cause for disease in livestock. The importance of differential diagnosis and diagnostic plan cannot be over emphasized. Finally, grouping of important findings from the history , physical examination , pathology and laboratory findings to arrive at a definitive diagnosis is an inherent component of each case presentation. Each case is concluded with general remarks including a summary of literature on the particular plant poisoning syndrome.

CASE 1

ANAMNESIS: 2 YEAR OLD MALE THOROUGHBRED CROSS: 600 KG BODY WEIGHT.

HISTORY:

There are three pleasure horses on this property in the Oklahoma panhandle. The animals graze in the backyard with little supplementation except during the winter when hay is fed. This year, supplies from the usual source were not sufficient and an additional source of alfalfa hay is being used. The horses are fed hay individually. This April morning, one horse was found sweating, pacing and rolling. It was able to walk only with difficulty. Soon afterwards the horse collapsed on its hindquarters, exhibited convulsions and now remains recumbent. Expert help is sought from a nearby equine practice.

PHYSICAL EXAMINATION FINDINGS:

The horse is in good body condition, although recumbent.There are slow paddling movements (convulsions). The pupils are dilated and the skin soaked with sweat. While being examined, the horse stops breathing and respiration cannot be revived with doxapram intravenously.

WHAT IS YOUR PROBLEM LIST?

PROBLEM LIST:

1. Colic.

2. Incoordination and weakness of the pelvic limbs.

3. Recumbency, convulsions, respiratory arrest and death.

These problems are considered related and therefore comprise a single neurologic disease.

WHAT ARE YOUR DIFFERENTIALS?

DIFFERENTIAL DIAGNOSIS:

1. Milkweed neurotoxicosis (*Asclepias* spp).
2. Cantharidin poisoning.
3. Monensin poisoning.
4. Colic due to other etiology.
5. Leukoencephalomalacia.
6. Encephalitis.

WHAT WOULD YOU DO TO RULE IN OR OUT EACH OF THESE DIFFERENTIALS?

DIAGNOSTIC PLAN:

1. Conduct a post mortem examination and submit samples for histopathology and toxicology.
2. Examine feed carefully and submit samples for toxicology.
3. Examine hay for blister beetles.

FIELD DIAGNOSTIC FINDINGS:

1. Post mortem examination reveals a carcass in good condition; the musculature appears normal in color and texture; the liver appears congested; there are petechial to ecchymotic hemorrhages in the epicardium and endocardium and froth in the airways. Samples of stomach contents, urine, liver, kidney, heart, lung and skeletal muscle are taken for toxicology and histopathology.
2. There is little possibility of monensin on the property as there are no cattle nor poultry and the feed manufacturer assures that the feed is not contaminated.

3. Examination of hay does not disclose the presence of blister beetles, which reduces the likelihood of cantharidin involvement. This batch of hay was first fed yesterday to the affected animal whose stall was at the end of the row. The remainder of the bale started yesterday is further closely examined, revealing another plant species different from alfalfa. These plants are herbaceous with linear leaves arranged in whorls. The tiny flowers are borne in flat -topped clusters and the petals are strongly reflexed with hooded lobes and protruding horns. Samples of this plant are taken for identification.

WHAT IS YOUR TENTATIVE DIAGNOSIS?

TENTATIVE DIAGNOSIS:

Milkweed neurotoxicosis (*Asclepias* sp).

WHAT LABORATORY FINDINGS WOULD HELP CONFIRM YOUR TENTATIVE DIAGNOSIS?

LABORATORY FINDINGS:

1. Histopathology report:

   Sections of heart showed epicardial and endocardial hemorrhages typical of agonal change. Other sections examined including liver, skeletal muscle, cardiac muscle, kidney, were normal.

2. Toxicology report:

   Stomach contents were analyzed for monensin and cantharidin and results were negative in both tests. The urine sample was negative for cantharidin by Gas Chromatography / Mass Spectroscopy.

   The plant specimens submitted for identification were identified as *Asclepias subverticillata* (Gray) Vail.

WHAT IS YOUR DEFINITIVE DIAGNOSIS?

DEFINITIVE DIAGNOSIS:

Asclepias subverticillata intoxication.

REMARKS:

The genus *Asclepias* (milkweed) includes about 150 species distributed throughout the tropics, subtropics and temperate regions of the world. Two distinct syndromes are caused by ingestion of milkweeds; cardiotoxicosis and neurotoxicosis. The broad-leafed milkweeds such as *A. latifolia* and *A. speciosa* tend to be cardiotoxic whilst some of the narrow -leaved species; such as *A. verticillata, A. fascicullaris and A. subverticillata;* are neurotoxic. Plants are toxic both fresh and when dry. Milkweeds are usually unpalatable when fresh and therefore are a greater hazard in hay, where they may comprise a large proportion of a bale especially as a contaminant in alfalfa hay.

The toxic principles responsible for the cardiotoxicity are glycosidic cardenolides whereas for the neurotoxicity the causal principle has not been identified.

Clinical signs appear shortly after ingestion, within 2 hours with neurotoxic milkweeds, and progress rapidly. The cardiotoxic syndrome may be more protracted, causing death in up to 2 days. The neurotoxic syndrome in horses is characterized by restlessness, incoordination, colic and weakness of the pelvic limbs. This is followed shortly by trembling, periodic falls, marked sweating and tetanic convulsions giving way to paddling and finally to death from respiratory failure. Post mortem findings are limited to those of agonal changes. The cardiotoxic effects are similar to those associated with other cardiotoxins and comprise depression, generalized weakness, dyspnea, diarrhea and abdominal pain. Death generally occurs without a struggle and necropsy findings reflect inflammation of the gastrointestinal tract.
Diagnosis is based on clinical signs, including severity and duration and evidence of ingestion of the plant material. Treatment is symptomatic for both syndromes but control by prevention of exposure is the most cost-effective means of reducing losses.

CASE 2

ANAMNESIS: BEEF HERD PROBLEM.

HISTORY:

This farmer in Western Oklahoma placed replacement heifers with a running bull, first-calf heifers in calf, and cull cows onto a recently acquired adjacent property. Stocking rates had been adjusted according to the carrying capacity of the native dryland pasture four months previously at the beginning of the winter season. During the first two weeks of April, there has been increasing concern over an apparent reproductive failure among the replacement heifers, abortions among the first calf heifers and unusual behavior among the cull cows. The herd has been certified brucellosis-free for the past two years and there have been no introductions into the herd.

First opinion was obtained from extension workers who recalled a similar problem among mares grazing the same pasture that forced the previous farmer out of business earlier. Plant poisoning is suspected and the second opinion of a veterinarian is sought.

PHYSICAL EXAMINATION FINDINGS:

General: Animals appear dull and depressed to varying degrees. The body condition is fair to poor.

Cull cows: There is loss of herding instinct in two cows which appear to gaze in space continuously. When forced to move, the cows walk with a high-stepping straddle-legged gait, extreme nervousness and appear to have difficulty in prehension. The cows are difficult to drive into and through the runway into the chute.

Heifers in calf: There is distension of the abdomen in two heifers, and three have retained placenta. On rectal palpation, the uterus is distended precluding palpation of the fetus. There is a corpus luteum on the right ovary in both heifers with abdominal distension. Rectal temperature is 38 to 38.1° C in affected animals.

Replacement heifers: Observed libido in the bull running with the heifers is low for the bull/cow ratio. One heifer is in standing heat.

WHAT ARE THE MAIN PROBLEMS?

PROBLEM LIST:

1. Abortion and retention of placenta, excessive fetal fluids.
2. Loss of libido in bull.
3. Disturbed gait and prehension, uncooperative behavior.
4. Poor body condition.

WHAT ARE YOUR DIFFERENTIALS?

DIFFERENTIAL DIAGNOSIS:

a) for abortion and reproduction failure:

1. *Gutierrezia sarothrae* poisoning.
2. *Astragalus / Oxytropis* locoweed poisoning.
3. *Iva angustifolia* poisoning.
4. *Pinus ponderosa* poisoning.
5. Epizootic bovine abortion (vector *Ornithodoros coriaceus*).
6. *Chlamydia psittaci.*

b) for neurological syndrome:

1. *Astragalus/Oxytropis* locoism.

c) both reproductive and neurological syndromes:

1. *Astragalus /Oxytropis* locoism.

HOW WOULD YOU RULE IN OR OUT EACH OF THESE DIFFERENTIALS?

DIAGNOSTIC PLAN:

1. Obtain blood samples from a representative number of affected animals for CBC and cellular morphology .

2. Obtain a sterile sample from retained placentas for histopathology and culture.

3. Survey the pasture for poisonous plants. Submit samples for identification.

4. Examine each animal's body carefully for presence of the soft shelled pajaroello tick (*Ornithodoros coriaceus)*.

FIELD DIAGNOSTIC FINDINGS:

Survey of the pasture reveals a perennial herb characterized by short stems with numerous basal leaves and pealike flowers borne on long stalks. Mature stems have pealike pods which are one and half centimeters long. The bloom of this herb is apparent across most of the pasture. Samples of this plant are obtained for laboratory identification.

None of the ticks found resemble the soft shelled pajaroello tick.

WHAT IS YOUR TENTATIVE DIAGNOSIS?

TENTATIVE DIAGNOSIS:

***Astragalus / Oxytropis* locoism**.

WHAT LABORATORY FINDINGS WOULD HELP CONFIRM YOUR TENTATIVE DIAGNOSIS?

LABORATORY FINDINGS:

1. **Toxicology report:**
   Plant identification: *Astragalus mollissimus* Torr.

2. **Hematology Report.**

   Leukocytes in all samples submitted show marked cytoplasmic vacuolation.

3. **Histopathology Report**:

   There is moderate to severe cytoplasmic foamy vacuolation in placental epithelial cells. No organisms are identifiable even on special staining.

WHAT IS YOUR DEFINITIVE DIAGNOSIS?

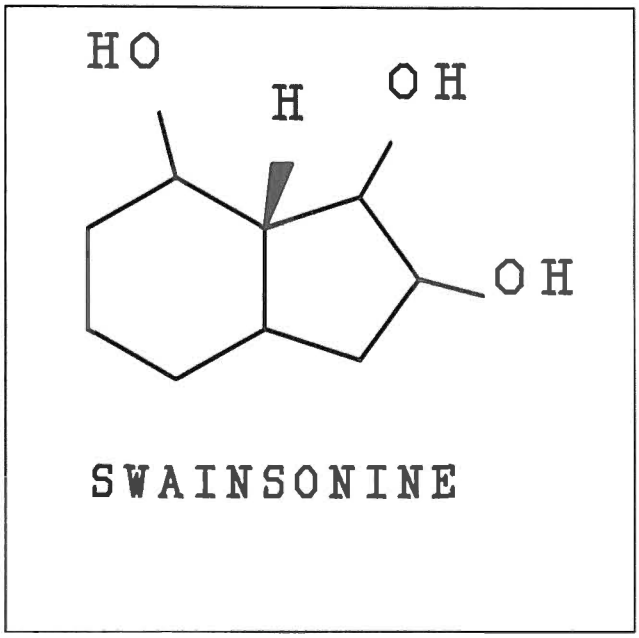
DEFINITIVE DIAGNOSIS:

Astragalus locoism. herd problem.

REMARKS:

Locoism is a disease syndrome characterized by bizarre nervous signs in both ruminant and non-ruminant animals following ingestion of large amounts of some species of the genus *Astragalus* including *A. mollisimus, A. lentiginosus, A. wootonii, A. thurberi, and A. northoxys* over a long period of time extending to several weeks. This syndrome is also caused by *Oxytropis* species notably *O. sericea, O. lambertii, O. soximontana* and in other areas of the world by *Swainsona* species including *S. canescens*. Grazing of both fresh plants and dry senescent stalks results in poisoning and/or possibly habituation to the plant. Introduced animals are more prone to eating the plants when other forage is dry and dormant during winter and early spring. In the presence of other palatable forage, animals have been reported to preferentially graze the young succulent pods but not other plant parts.

The toxic principle identified, first from the *Swainsona* species, is an indolizidine alkaloid, swainsonine. It has also been isolated from several molds, particularly *Rhizoctonia leguminicola* growing on red clover *and Metarhizium anisoliae* growing on culture. The chemical structure of swainsonine is given below.



Swainsonine is an avid inhibitor of alpha-mannosidase and results in an oligosaccharide storage disease similar to congenital mannosidosis. Clinical signs include loss of body condition and coat lustre; solitary grazing, uncoordinated gait and prehension, abortion, birth of small weak and deformed young, and an increased predisposition to right heart failure in calves raised at high altitudes. Signs are normally reversible in the less severely affected animals on withdrawal from exposure but may recur when stressed . Histopathologically the lesion is a multi-systemic neurovisceral cytoplasmic foamy vacuolation.

Control requires that animals be prevented from grazing the fresh plants or dry stalks by herding or removal from locoweed infested areas until other forage is available.

CASE 3

ANAMNESIS: 3 SHORTHORN CALVES: 4 MONTHS OF AGE; ANGORA GOAT; PAYNE COUNTY,OKLAHOMA.

HISTORY:

This nucleus herd is comprised of five cows with calves. The herd was grazed on a native grass pasture bordered by a wooded creek to the west from June through August. For the past two weeks the herd has been grazed on a woodland native grass pasture along with a pet Angora goat which was acquired two weeks ago. The goat was discovered dead on pasture this morning. A veterinarian is called out to investigate a disease in three of the calves which have been noticed to be reluctant to move when the herd was being rounded up for vaccination and deworming.

PHYSICAL EXAMINATION FINDINGS:

The calves are presented in poor body condition, depressed and reluctant to move. On forced movement, marked tremors develop around the muzzle and down the leg muscle groups and an obvious ataxia with stiffness of the joints is noticeable during locomotion. There is diminished tone in the jaw muscles and an acetone odor from the mouth is easily detectable. The body temperature is 39°C. Rigor mortis is still present in the carcass of the goat.

WHAT ARE THE MAIN PROBLEMS?

PROBLEM LIST:

1. Loss of body weight.
2. Weakness, ataxia, stiff joints and tremors on locomotion.
3. Acetone odor to the mouth.
4. Dead goat.

The problems associated with the calves may very well be part of a single syndrome. The cause of death in the goat is not apparent at this stage but you should be suspicious of an association.

WHAT ARE YOUR DIFFERENTIALS?

DIFFERENTIAL DIAGNOSIS:

1. White snakeroot (*Eupatorium rugosum*) plant poisoning.

2. Rayless Goldenrod (*Isocoma wrightii*) plant poisoning.

3. Lead poisoning.

4 Bitterweed / sneezeweed (Hymenoxys / Helenium) plant poisoning.

5. Cardiotoxic plant poisoning (Milkweed, Lily of the valley, etc.).

HOW WOULD YOU RULE IN OR OUT EACH OF THESE DIFFERENTIALS?

DIAGNOSTIC PLAN:

1. Conduct a post mortem examination of the goat and take samples for histopathology.

2. Take blood for serum chemistry.

3. Survey the pasture for toxic plants.

FIELD DIAGNOSTIC FINDINGS:

1. Post mortem examination of the goat reveals an enlarged mottled liver with rounded lobe edges. On cutting, edges bulge outward. A sample in formalin is collected for histopathology.

2. Survey of the pasture reveals, along the wooded creek, dense stands of a herbaceous perennial plant with opposite, simple leaves prominently 3-ribbed and with clusters of showy small white flowers. There is evidence of grazing disturbing the continuity of the stands dominating the understory. A representative sample of this plant is collected for identification.

WHAT IS YOUR TENTATIVE DIAGNOSIS?

TENTATIVE DIAGNOSIS:

White snakeroot (*Eupatorium rugosum*) poisoning; in both the goat and the calves.

Advise the farmer to prevent animals from grazing along the wooded creek, preferably place affected animals in the shade with feed and water and minimize handling. Administration of activated charcoal may be helpful.

WHAT LABORATORY FINDINGS WOULD HELP CONFIRM YOUR DIAGNOSIS?

LABORATORY FINDINGS:

1. Clinical Pathology report (calves):

AST (SGOT), U/L	537
GGT, U/L	246
CPK, U/L	630

Remarks: Elevated serum enzymes are suggestive of a generalized metabolic disorder affecting muscles and the liver. BSP retention time would confirm the extent of involvement of the liver.

2. **Toxicology report:** plant identified as *Eupatorium rugosum.*

3. **Histopathology report:** (goat) Section of liver shows centrilobular necrosis without any inflammatory cell infiltration suggestive of a toxicosis rather than an infectious process.

WHAT IS YOUR DEFINITIVE DIAGNOSIS?

DEFINITIVE DIAGNOSIS:

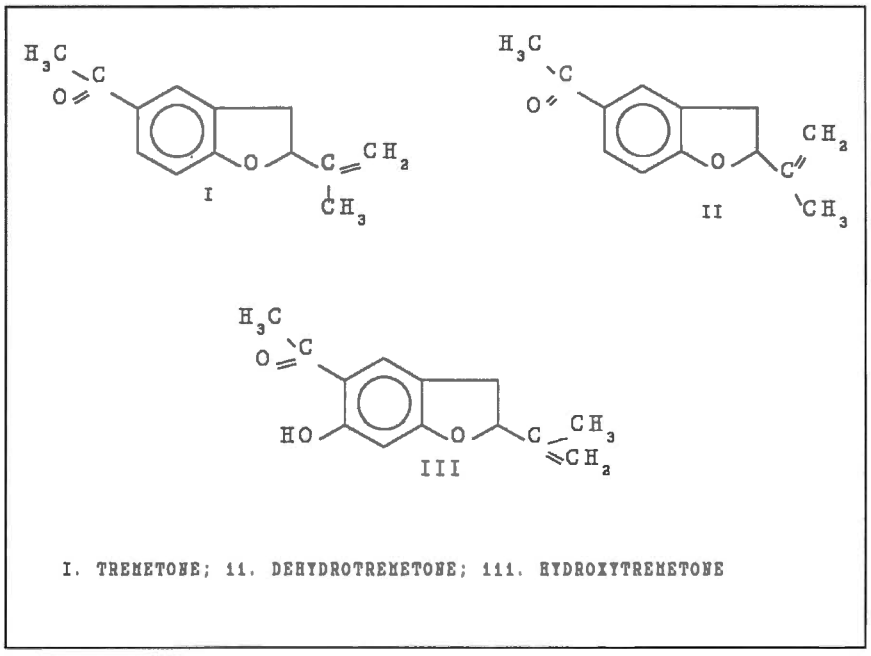
Eupatorium rugosum plant poisoning in both species.

REMARKS:

Eupatorium rugosum has an eastern US distribution and poisoning with this plant resembles toxicity due to a south western US plant *Isocoma wrightii.*

All warm blooded animal species including man are susceptible. Humans and nursing young become poisoned through relay toxicosis following ingestion of milk from animals grazing this plant since the toxin is excreted in milk. Ingestion of the toxin in milk over a long period produces 'milksickness' characterised by ketosis in humans. Clinical signs, invariably include weakness, ataxia, stiffness and trembling seizures in cattle, sheep and goats. Goats are sometimes found dead. Horses may show signs of cardiac insufficiency and the disease may require differentiation from monensin poisoning.

Green stems and leaves are highly palatable but contain high levels of tremetol, an alcoholic fraction of plant extract cosisting of three ketones, two steroids and a sesquiterpene hydrocarbon. Toxicity is attributable to the ketones with the structures shown below.



I. TREMETONE; 11. DEHYDROTREMETONE; 111. HYDROXYTREMETONE

Metabolic bioactivation of tremetol to a toxic principle, yet unidentified, is necessary and explains the delay to onset of signs. A cumulative inhibitory effect occurs on metabolic pathways including citrate synthetase of the Krebs's cycle. Inhibition of citrate synthetase yields lactic acidosis, ketosis and an initial hyperglycemia. Generally large amounts of plant material (5-10 percent of body weight) ingested over several days or smaller amounts over several weeks are required for intoxication to occur. The goat, however, especially the Angora goat, has been reported to be particularly sensitive; 0.5 percent body weight single dose producing death within 5 days.

Clinical pathology reveals elevated liver enzymes, AST, CPK, and LDH.
Post mortem findings in the goat typically include centrilobular hepatic necrosis. In the horse, myocardial degeneration and hydropericardium are characteristic findings. In cattle and sheep, gross pathology is generally unremarkable.

Recovery is possible. Animals should be denied access to the plant and provided nursing care with minimum handling. Activated charcoal may be useful in reducing further absorption and limiting enterohepatic recycling of the tremetol.

CASE 4

ANAMNESIS: 4 EWES 2½, YEARS OLD; OKLAHOMA PANHANDLE..

HISTORY:

This flock of ten ewes, two lambs and a ram, acquired at the recent spring sales, has only been on this Oklahoma panhandle open range for one week. Two of the ewes were observed sick two days ago. Both appeared to have poor appetite and were lethargic. The farmer then decided to treat the whole flock with ivermectin injection for gastrointestinal parasites and nasal bots. Today, in early May, one of the affected animals is dull and stands with an arched back grinding its teeth. There is a thin discharge from its nose and the animal is no longer grazing. The other ewe appears to be more severely affected. There is green staining of the muzzle and it is breathing with dificulty.

PHYSICAL EXAMINATION FINDINGS:

The affected ewes are presented in moderate body condition and both have nursing lambs. One ewe is anorectic, depressed and has rumenal stasis. The back is arched and the animal is constantly grinding its teeth. The nasal discharge is thin and green stained. The animal is reluctant to move and when forced to do so, it displays muscle tremors and becomes dyspneic. The second ewe appears more severely affected. This ewe is depressed and dyspneic and has green staining to the muzzle. It is now recumbent, bloated and occasionally undergoes paddling convulsions interspaced with regurgitation of ruminal contents through the nose, intensifying the greening of the muzzle.

WHAT ARE THE MAIN PROBLEMS?

PROBLEM LIST:

1. Depression, anorexia, ruminal stasis and tympany, abdominal pain.

2. Dyspnea, green staining of the muzzle, blood tinged serous nasal discharge, regurgitation of ruminal contents.

3. Muscle tremors.

4. Recumbency, convulsions.

The problems exhibited in both animals are considered to be related to the same syndrome with one ewe at a more severe stage than the other.

WHAT ARE YOUR DIFFERENTIALS?

DIFFERENTIAL DIAGNOSIS:

1. Bitterweed (*Hymenoxys spp)* plant poisoning.

2. Sneezeweed (*Helenium spp)* plant poisoning.

HOW WOULD YOU RULE IN OR OUT EACH OF THESE DIFFERENTIALS?

DIAGNOSTIC PLAN:

1. Survey the pasture for poisonous plants.

2. Necropsy the severely affected ewe.

FIELD DIAGNOSTIC FINDINGS:

1. Survey of the pasture reveals clusters of composite herbs, with multi-branched stems and deeply pinnatifid leaves. The yellow heads have trilobed ray and disk florets respectively. There is evidence of grazing among these clusters. A representative sample of these plants is collected for identification.

2. Necropsy reveals congestion and edema of the abomasal mucosa and consolidation of the cranial lung lobes.

WHAT IS YOUR TENTATIVE DIAGNOSIS?

TENTATIVE DIAGNOSIS:

Bitterweed (*Hymenoxys spp)* plant poisoning.

Sneezeweed *(Helenium spp.)* are not typically distributed through the Oklahoma

panhandle except perhaps *H. autumnale.*

WHAT LABORATORY FINDINGS WOULD HELP CONFIRM YOUR TENTATIVE DIAGNOSIS?

LABORATORY FINDINGS:

Toxicology report:

1.Plant identification: *Hymenoxys odorata* **DC**

WHAT IS YOUR DEFINITIVE DIAGNOSIS?

DEFINITIVE DIAGNOSIS:

Bitterweed (*Hymenoxys odorata)* plant poisoning.

REMARKS:

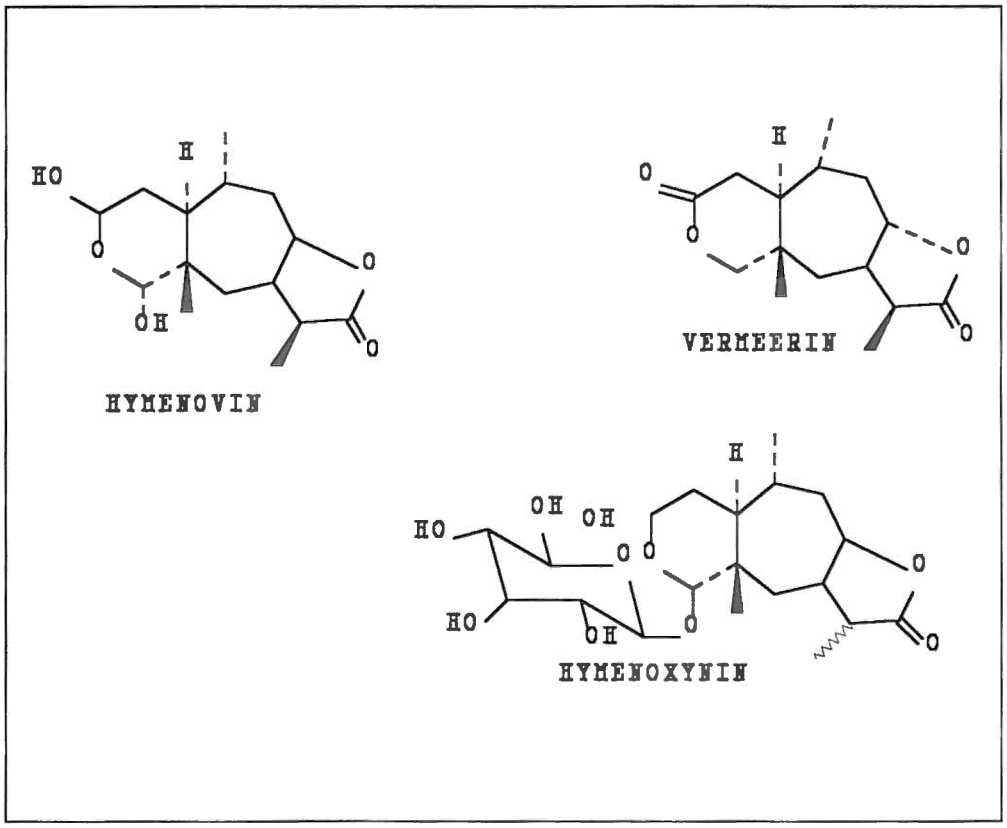
Bitterweed (*Hymenoxys spp)* and sneezeweed (*Helenium spp)* poisoning cause considerable losses in livestock due to fatalities in animals that develop clinical disease and loss in productivity in those that are chronically exposed to small quantities in their diet. Both genera are members of the sunflower family, (Asteraceae) and closely resemble each other in both phyllotaxy and chemical composition.

Toxic principles in these plants have been identified as sesquiterpene lactones and an aliphatic lactone. The mode of action is thought to involve inhibition of sulphydryl groups thereby inactivating various enzymes systems. Enzymes involved with carbohydrate metabolism and the glutathione oxidase system appear to be affected most. Toxicity can be prevented by pretreatment with L-cysteine but is irreversible once clinical signs appear. Antioxidants such as ethoxyquin have been found useful in preventing disease in experimental studies although prevention of access to these plants is the best management strategy for range conditions.

Clinical signs are varied and include excess salivation, regurgitation of ruminal contents through the nose, dyspnea, diarrhea, abdominal pain, bloat, stiff gait,

lethargy, anorexia, severe weakness, recumbency and in protracted cases death from starvation. The syndrome manifests itself as a combination of any of these signs in any one animal. Terminal convulsions have also been reported. Sheep and goats are more susceptible than cattle; the disease has not been experimentally reproduced in horses and donkeys although isolated cases have been reported. A similar syndrome is produced by *Geigeria aspera;* another member of the Compositae family in Southern Africa where Merino and Karakul breeds of sheep have been reported to be more susceptible than Dorpers, Persian and mixed breeds in decreasing order of susceptibility. This variation in breed susceptibility has been correlated with grazing habits and nutritional requirements: actively growing animals, ewes suckling young or pregnant, and heavy wool producers being at greater risk of developing disease.

The structures of some of the toxic sesquiterpene lactones identified from these plants are shown below.



CASE 5

ANAMNESIS: 7 MIXED BREED YEARLING STEERS. WEIGHT RANGE 215 - 235 KG. WESTERN OKLAHOMA, NEAR THE TEXAS BORDER.

HISTORY:

Seven out of sixty yearling steers are thought to be in unusually poor condition for the feed available. Four weeks previously (mid-July) the steers had been put out on a field which had been summer-fallowed last year and then grass-seeded early in the spring. Mineral salt supplement was available *ad. lib.* and piped drinking water was supplied from a bore hole on an adjacent property. The farmer has observed poor doing among the steers and a few have crusty muzzles unexpected of animals on a light stocking rate and short stay considering the carrying capacity of the pasture. The farmer is convinced that the mineral-salt supplement must be contaminated and has requested a second opinion to support his claim for compensation from the feed manufacturer. Previous batches of the same supplement, fed up till the end of June this year, had not given any problems.

PHYSICAL EXAMINATION FINDINGS:

You observe the animals from a distance and notice some animals lacking herding behavior. One steer appears to be periodically head pressing against the fence without any external stimuli; another appears to be grazing along the fence only. On closer examination, the animal exhibiting periodic head pressing has frothy saliva drooling from the mouth and is jaw champing. The other is apparently blind and has medial dorsal strabismus but a pupillary light reflex is present in both eyes. From the main group, five steers appear depressed, weak and emaciated, have rough hair coats and crusting and sloughing of the non-pigmented skin and the muzzle. The rectal temperature is 37.8° C in the most severely affected steer. Rectal examination reveals nothing remarkable about the abdominal viscera. The farmer is certain the rest of the steers have gained weight poorly over the last 4 weeks.

WHAT ARE THE MAIN PROBLEMS?

PROBLEM LIST:

1. Head pressing and blindness.

2. Emaciation.

3. Crusting and sloughing of non-pigmented skin and around the muzzle.

4. Poor weight gains.

WHAT ARE YOUR DIFFERENTIALS?

DIFFERENTIAL DIAGNOSIS:

a) neurological signs:
   - i. Lead.
   - ii. Polioencephalomalacia.
   - iii. *Kochia scoparia* plant poisoning.
   - iv. Pyrrolizidine alkaloidosis.

b) emaciation; poor weight gain:
   - i. Pyrrolizidine alkaloidosis.
   - ii. *Kochia scoparia* plant poisoning.
   - iii. Gastrointestinal parasitism.
   - iv. Chronic liver disease.

c) photosensitization:

   a) Primary photosensitization.
   - i. *Hypericum perforatum* plant poisoning.
   - ii. *Polygonum spp* plant poisoning.

   b) Secondary photosensitization.
   - i. *Kochia scoparia* plant poisoning.
   - ii. *Lantana camara* plant poisoning.
   - iii. *Agave lecheguilla* plant poisoning.
   - iv. *Tetradymia canescens* plant poisoning.
   - v. *Tribulus terrestrus* plant poisoning.

HOW WOULD YOU RULE IN OR OUT EACH OF THESE DIFFERENTIALS?

DIAGNOSTIC PLAN:

1. Blood for serum chemistry and hematology.

2. Feed samples (mineral supplement and water) for toxicology.

3. Survey of pasture for poisonous plants and contamination sources.

4. Feces for helminthology if the above is not diagnostic.

FIELD DIAGNOSTIC FINDINGS:

1. Survey of the pasture reveals the pasture to be dominated by a herb characterised by reddish mature stems otherwise green and multi-branched. The leaves are simple, alternate, linear and less prominent in mature plants. The flowers are green, inconspicuous and borne in axils of upper leaves. A representative sample of this herb is obtained for identification.

WHAT IS YOUR TENTATIVE DIAGNOSIS?

TENTATIVE DIAGNOSIS:

Kochia scoparia plant poisoning.

Animals should be moved from the sun, photosensitization lesions treated with ointments and further access to the plant prevented. In those showing neurological signs, vitamin B_1 (Thiamin) 10 mg/kg body weight intravenously every 3 hours should yield clinical response within 6 hours and complete remission of neurologic signs in 24 hours.

WHAT LABORATORY FINDINGS WOULD HELP CONFIRM YOUR TENTATIVE DIAGNOSIS?

LABORATORY FINDINGS:

Serum chemistry		Hematology	
GGT, (IU/L)	153.7	RBC (x 10^{12}/L)	6.5
LDH, (IU/L)	2338	Hb, (g/dl)	8.5
AST (SGOT), (IU/L)	334.4	PCV, (%)	25
Total bilirubin, (mg/dl)	2.8	WBC, (x 10^{9}/L)	7.8
		MORPHOLOGY	Not remarkable

Remarks: enzyme profile is suggestive of cellular necrosis involving at least the liver.

3. **Toxicology report**:

a). Feed sample is negative for lead.

b). The plant sample submitted is identified as *Kochia scoparia* (L.) Schrad.

Remarks: The signs described in affected animals are consistent with *Kochia scoparia* plant poisoning.

WHAT IS YOUR DEFINITIVE DIAGNOSIS?

DEFINITIVE DIAGNOSIS:

Kochia scoparia plant poisoning.

REMARKS:

Kochia scoparia, a member of the Goosefoot (Chenopodiaceae) family, is an annual herb found throughout the western United States where it is generally regarded as an undesirable weed. However, this plant is also highly nutritive with crude protein levels comparable to alfalfa and could be a prospective forage crop in arid and semi-arid

lands with alkaline soils. Disadvantages include not only lower digestibility and palatability when compared with alfalfa but also toxicosis of up to 30% morbidity and 5% mortality in clinically affected animals. Of those animals not showing clinical disease, poor weight gains may prove the plant to be uneconomical for the livestock producer.

Kochia scoparia toxicosis is characterized by any combination of 4 syndromes:

1. Polioencephalomalacia in cattle which is exacerbated by high sulphur levels in the diet and is responsive to thiamin therapy.

2. Mild to severe degenerative hepatopathy evidenced by elevated serum GGT and total bilirubin levels and secondary photosensitization lesions. Microscopically, sections of the liver may show a variety of pathological changes including foamy to granular degeneration of hepatocytes, hepatocyte necrosis and birefringent concretions in bile duct lumens.

3. Nephrosis due to soluble oxalate (sometimes up to 6% DM) which may be evidenced by an elevated blood urea nitrogen and proteinuria prior to death or a tubular nephrosis dominated by diffuse tubular dilatation, tubular cell degeneration and necrosis and mild to moderate interstitial fibrosis microscopically. Oxalate poisoning may be highest in late summer when oxalate accumulation is greatest in mature plants.

4. Nitrate poisoning can also occur since *Kochia scoparia* has been shown to accumulate nitrate especially in mature plants. Signs are typically acute in nature and include discoloration of mucus membranes, rapid respiration rates, severe incoordination, recumbency and death.

Toxic principles responsible for hepatopathy and polioencephalomalacia have not been identified. Horses, cattle and sheep are all susceptible to intoxication. *Kochia scoparia* may grow as an invader species on fallowed fields and form a dense cover if the soil is sufficiently alkaline to produce what could be a high carrying capacity for the field since it is palatable.

CASE 6

ANAMNESIS: 5 ANGUS YEARLING STEERS; SOUTHEASTERN OKLAHOMA.

HISTORY:

It is late August and you have been called out to investigate a problem of sudden collapse in a few animals from among a herd of eighty-four Angus yearling steers. The steers have been brought from the range hills where grazing has been scarce for some time and they have been introduced to 50% irrigated pasture and 50% grain feedlot in preparation for slaughter. To optimize use of the herbage by preventing a build up of high crude fibre, strip rotation with an electric fence is practiced. The last two afternoons, the steers have been allowed to graze the first strip by the edge of the pasture. Late this afternoon, as the steers were being moved from the pasture back into pens, a few steers showed reluctance to move and when forced to do so, two collapsed and died and three began to breath heavily.

PHYSICAL EXAMINATION FINDINGS:

Affected animals are in good body condition but appear distressed and exhibit periodic loud grunts audible from a distance. An unusual posture with head held down is apparent and mouth breathing is evident. Frothy saliva droops freely from the mouth. The respiratory rate is 55/minute.
Auscultation reveals marked expiratory dyspnea, moist rales and harsh respiratory sounds. Subcutaneous crepitus is present in the neck and ventral thoracic regions. Severe muscle weakness is evident. The animals stagger and sway when they are forced to move.

WHAT ARE THE MAIN PROBLEMS?

PROBLEM LIST:

1. Acute deaths following introduction to new pasture.
2. Expiratory dyspnea with mouth breathing and excess salivation.
3. Subcutaneous emphysema in neck and ventral thorax.
4. Polypnea.
5. Severe muscle weakness.

WHAT ARE YOUR DIFFERENTIALS?

DIFFERENTIAL DIAGNOSIS:

1. Perilla mint poisoning.
2. Sweet potato *(Fusarium solani)* poisoning.
3. Atypical acute Bovine Interstitial pneumonia (fog fever).
4. Visceral larvae migrans pneumonia *(Ascaris suis)*.
5. Lungworm infestation *(Dictyocaulus viviparus)*.

HOW WOULD YOU RULE IN OR OUT EACH OF THESE DIFFERENTIALS?

DIAGNOSTIC PLAN:

1. Conduct post mortem examination of the dead animals and take samples for histopathology and culture.
2. Survey the pasture for any poisonous plants.
3. Examine feed in the feedlot for any contamination (moldy sweet potatoes or moldy garden beans).
4. Take fecal samples from sick animals for helminthology.

FIELD DIAGNOSTIC FINDINGS:

1. Post mortem examination reveals heavy, hyper-inflated lungs filled with fluid and froth in the airways. The lungs appear lobulated and have a firm rubbery feel. Cut surfaces appear glandular and there is an aromatic odor to the carcass. The changes are uniform over both lungs. Lymph vessels are dilated and septae are filled with air and fibrin. The airways are free of any helminths grossly. Occasional round worms are encountered in the gastrointestinal tract contents.

2. Survey of the pasture reveals a dense stand of aromatic plants with square stems and small purplish blooms at the edges of the pasture along the first strip grazed and some evidence of the plant having been eaten. The irrigated pasture is mainly Bermuda grass and is otherwise virtually free of weeds. The pasture is heavily fertilized; hence afternoon grazing adopted. You obtain sufficient plant material for identification.

3. Feedlot feed is composed of crushed corn and cobs.

WHAT IS YOUR TENTATIVE DIAGNOSIS?

TENTATIVE DIAGNOSIS:

Perilla mint toxicosis.

WHAT LABORATORY FINDINGS WOULD HELP CONFIRM YOUR DIAGNOSIS?

LABORATORY FINDINGS:
Hematology report:

hemogram		leukogram	
RBC, (x 10^{12}/L)	8.5	WBC, (x 10^{9}/L)	6.8
Hb, (g/dl)	11.5	neutrophil, (%)	35
PCV, (%)	35.7	lymphocyte, (%)	55
morphology	normal	monocyte, (%)	3
parasites	none	eosinophil, (%)	7

Histopathology report:

light microscopy:
A section of the lung shows marked interstitial and intra-alveolar edema with rupture of septal walls. There is vascular congestion and diffuse interstitial neutrophilic infiltration.

electron microscopy:
This section is characterised by vesiculation, vacuolation, fragmentation of cytoplasm, and clumping of nuclear chromatin. Some areas show sloughing of endothelial cells of

alveolar capillaries and Type I pneumocytes. The interstitial and intra-alveolar spaces are filled with edema, proteinaceous material and fibrin. Progressive Type II pneumocyte hyperplasia is remarkable.

Morphological Diagnosis: Acute pulmonary emphysema and edema.

Toxicology report

The plant is identified as *Perilla frutescens.*
The clinical syndrome and histopathological findings correspond closely to perilla ketone toxicosis.

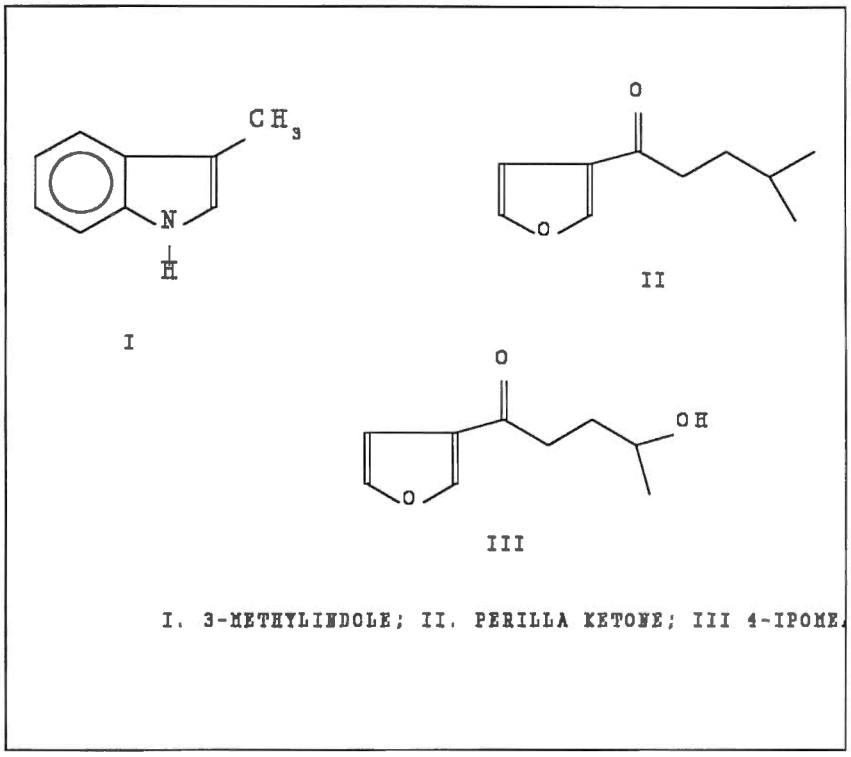
WHAT IS YOUR DEFINITIVE DIAGNOSIS?

DEFINITIVE DIAGNOSIS:

Perilla frutescens plant poisoning.

REMARKS:

Perilla mint is an escape plant often growing in semi-shaded areas and forming dense stands along fence rows, near springs and creeks. The toxic principle is a furan ketone, Perilla ketone, which closely resembles 4-ipomeanol, a phytoalexin produced by sweet potatoes when infested with the mold, *Fusarium solani.* Perilla ketone differs from 4-ipomeanol by having a methyl group in place of a hydroxyl group on Carbon 4 of the side chain. Both of these toxins produce a disease syndrome that cannot be distinguished from fog fever (Atypical Bovine Pulmonary emphysema and edema) caused by 3-methyl-indole which undergoes lethal synthesis in the lung following a change to lush pasture and an abrupt increase in L-tryptophan ingestion. Cytochrome P_{450} dependent microsomal enzymes in type I and II pneumocytes, secretory bronchial epithelium and capillary endothelial cells are responsible for the metabolic activation of Perilla ketone, 3-methyl-indole and 4-ipomeanols to pneumotoxic metabolites. The structures of all three pneumotoxins are given below for comparison.



I. 3-METHYLINDOLE; II. PERILLA KETONE; III 4-IPOME

Diagnosis is facilitated by examination of the feeding system, duration on the new pasture and time of the year. Fog fever typically occurs in autumn, 5-10 days following a change to better, often lush pasture after a period of negative energy balance. Perilla mint toxicosis is often encountered in the fall when cows are introduced to strange pastures or are forced to eat it in the absence of grasses. The flowering and seed stages are most toxic. Moldy sweet potato poisoning occurs in animals being fed sweet potatoes as part of their ration.

Histopathological examination does not distinguish between the causal etiologies. Lesions are limited to the respiratory tract in all cases and are characterized macroscopically by edematous, dark-red and heavier than normal lungs with a firm and rubbery consistency. On cut surface a protein rich, almost gelatinous fluid exudes from the lung and fills the airways. Emphysema and bullae formation are typical.

Microscopically, the lesions are characterized by a proteinaceous interstitial and intra-alveolar edema, interstitial neutrophil, eosinophil and macrophage infiltration , sloughing of Type I pneumocytes and hyperplasia of Type II pneumocytes. Treatment has not been rewarding and the incidence can only be reduced by management practices that prevent 3-methyl-indole production in the rumen or exposure to perilla mint and moldy sweet potatoes.

CASE 7

ANAMNESIS : 4 EWES; 2 YEARS OF AGE; AVERAGE WEIGHT 67 KG.

HISTORY:

A farmer in central Oklahoma has just discovered two ewes dead and another two sick thirty minutes after moving his flock to a new pasture in late June. The live ewes are restless, apprehensive and have difficulty in breathing. Afraid of further losses should the pasture have been contaminated by the sewage slurry obtained from New York City, the farmer has moved the ewes out and placed them onto an overgrazed pasture nearby. This was the first time this pasture has been grazed since the slurry was spread over the land and it was seeded with a fodder crop in time for the summer grazing. Professional advice is requested.

PHYSICAL EXAMINATION FINDINGS:

The veterinarian arrives on the property fifteen minutes after the ewes were found dead. The two dead ewes are still on the pasture under scrutiny. The rest of the flock appear settled in the adjacent pasture except for the two ewes that had been observed to be restless. One appears mild to moderately dyspneic; respiration rate is 22 per minute; mucous membranes are bright pink, body temperature is 39°C, salivation is slightly excessive and voiding of feces and urine is frequent. Generalized muscle tremors start to appear and the animal appears more distressed. The animal goes down gasping for breath and the veterinarian intervenes with a diagnostic treatment.

WHAT ARE THE MAIN PROBLEMS?

PROBLEM LIST:

1. Sudden death shortly after grazing fresh herbage.

2. Progression of signs from restlessness, dyspnea, frequent urination and defecation, muscle tremors to recumbency in a short time.

WHAT ARE YOUR DIFFERENTIALS?

DIFFERENTIAL DIAGNOSIS:

1. Prussic acid (cyanide) poisoning.
2. Nitrate / Nitrite ion poisoning.
3. Urea poisoning.
4. Organophosphate poisoning.
5. Carbamate poisoning.
6. Blackleg / Black disease / malignant edema disease/ anthrax.

HOW WOULD YOU RULE IN OR OUT EACH OF THESE DIFFERENTIALS?

DIAGNOSTIC PLAN:

1. Determine mucous membrane color to distinguish nitrate/nitrite poisoning (cyanotic) from cyanide poisoning (bright red) and administer the appropriate antidote (methylene blue for nitrate/nitrite and sodium thiosulfate (500 mg/kg for cyanide intoxication).
2. Determine presence or absence of fever to enable you to rule out infectious processes and rule in intoxications.
3. Obtain management history to rule out the possibility of insecticide and urea poisoning.
4. Conduct post mortem examination of the dead animals and collect samples of stomach contents, liver and muscle for laboratory confirmation.
5. Survey the pasture for poisonous plants and perform picrate and diphenylamine tests on fresh herbage and determine the rate of color change to estimate levels of cyanogenetic glycosides and nitrate respectively in the forage.

FIELD DIAGNOSTIC FINDINGS:

1. Clinical signs resolve within five minutes of intravenous administration of sodium thiosulfate in both affected ewes.

2. Mucous membranes are bright pink in color in affected animals and in dead animals.

3 . Blood is bright colored and is not clotted in dead animals and stomach contents have an almond odor.

4. The pasture is irrigated sorghum and fresh plants test positive on picrate test in 3 minutes.

WHAT IS YOUR DEFINITIVE DIAGNOSIS?

DEFINITIVE DIAGNOSIS:

Prussic acid poisoning:

The evidence is overwhelming for cyanide poisoning when a history of acute disease (with some deaths) shortly after introduction to a lush sorghum pasture is coupled with polypnea responsive to sodium thiosulfate, almond odor to the stomach contents and the forage rapidly testing positive on picrate test.

REMARKS:

Prussic acid (cyanide,hydrocyanic acid) is one of the most rapidly acting poisons known; capable of causing death within minutes of ingestion. The most important source to animals is plant material, where it occurs as cyanogenetic glycosides, and /or calcium cyanamide fertilizer. Highest glycoside levels are found in rapidly growing plants; with wilting, stunting, mechanical damage, nitrate fertilization when phosphorus is low and 2,4-D- induced growth increasing their toxic potential. Plants with high cyanogenetic potential include *Sorghum* spp, (sudan grass, Johnson grass); *Trifolium repens* (white clover); Prunus spp (cherry, apricot, peach); *Pyrus malus* (apple); *Zea mays* (maize) *Triglochin maritima* (arrow grass) and *Phaseolus lunatus* (lima bean). Ruminants are most susceptible to poisoning by cyanogenetic glycosides due to microbial hydrolysis in addition to plant enzymatic hydrolysis of the cyanogenetic

glycosides in the rumen whereas in monogastrics the specific glycosidase in the plant material is broken down by hydrochloric acid in the stomach.

Toxicity arises from the ability of cyanide to bind with the ferric ion state of iron in cytochrome oxidase thereby blocking the electron transport system and cellular respiration. Cytotoxic anoxia ensues. The respiratory system is stimulated via a direct action of cyanide on the carotid and aortic chemoreceptors and indirectly via cellular anoxia.

Clinical signs typically include, in progression: excitement, dyspnea (hyperpnea), muscle tremors, weakness, collapse, and finally clonic convulsions (asphyxial) just prior to death. As these signs closely resemble those due to nitrate / nitrite intoxication, it is important to distinguish one from the other because delay in administering the specific antidote for cyanide is fatal whilst it is not so critical for nitrate / nitrite intoxication. Differentiation is achieved based on the color of mucus membranes and management history. Nitrate / nitrite poisoning is encountered mainly in animals fed hay whilst cyanide poisoning involves fresh forage. The color of venous blood and mucus membranes soon after death are cherry red with cyanide poisoning and cyanotic with nitrate / nitrite poisoning. Stomach contents exude a bitter almond odor in cyanide intoxication.

Diagnosis is confirmed by a rapid response to antidotal therapy (within minutes), by a positive (within minutes) picrate test of forage and by a negative diphenylamine test result on the herbage. Laboratory confirmation can be obtained if rumen contents, liver and muscle are collected and frozen or preserved in mercuric chloride.

CASE 8

ANAMNESIS:

HEREFORD CROSS COW, 5 YEARS OLD; 300 KG BODY WEIGHT:
PONY, 17 YEARS OLD; 400 KG BODY WEIGHT. MALE.
EASTERN OKLAHOMA NEAR THE ARKANSAS BORDER.

HISTORY:

The only pony on the property has been allowed to graze for the past two years with a beef herd now comprising thirty cows, and fifteen weaners of various ages. A continuous grazing system has been in operation successfully for years but this year supplementary hay has been necessary due to the sparsity of rainfall drastically reducing the carrying capacity of the pasture this September.

The pony has been losing condition over the past two weeks despite a normal appetite and feed intake. During the past two days, it has developed an uncoordinated gait with a tendency to circle and in addition some generalized body tremors have been noticed. One cow has just been noticed passing red urine.

PHYSICAL EXAMINATION FINDINGS:

You find the pony depressed and in poor body condition with a considerable generalized loss in muscle mass even though appetite and feed intake are normal. Movement is uncoordinated and tremors are noticeable. Vital signs are: rectal temperature 38.1°C; mucous membranes pale, capillary refill time >2 seconds and pulse rate 30 / minute.

The cow is also depressed, in poor body condition (+1.5 score on a 1-5 scale) and the skin is slack and dry. Vital signs are: rectal temperature 41.6°C, respiratory rate 22 / minute, pulse rate 65 / minute. Rectal examination reveals fresh blood from the rectum and red coloured urine when the urinary bladder is massaged; the urinary bladder and the wall of the bladder feels thickened.

WHAT ARE THE MAIN PROBLEMS?

PROBLEM LIST:

Pony:
1. Loss in body condition and loss of weight.
2. Incoordination and body tremors.
4. Bradycardia and pale mucus membranes.

Cow:
1. Fever.
2. Loss in body condition.
3. Hemorrhages and ulceration of mucosae.
4. Red colored urine and thickened walls of urinary bladder.

WHAT ARE YOUR DIFFERENTIALS?

DIFFERENTIAL DIAGNOSIS:

Pony:
1. Bracken fern poisonng *(Pteridium aquilinum).*
2. Horsetail poisoning *(Equisetum arvense).*
3. Leukoencephalomalacia.
4. Amprolium toxicity.
5. Pyrrolizidine alkaloid toxicosis.
6. Perennial ryegrass poisoning.
7. Pyrethroid insecticide poisoning.

Cow:
1. Bracken fern poisoning *(Pteridium aquilinum).*
2. Sweet clover poisoning (dicoumarol).
3. Acute septicemia such as anthrax, blackleg, pasteurellosis, leptospirosis.
4. Blood parasitemia: babesiosis, anaplasmosis.
5. Trichloroethylene extracted soybean meal.

HOW WOULD YOU RULE IN OR OUT EACH OF THESE DIFFERENTIALS?

DIAGNOSTIC PLAN:

a) Pony:
1. Take blood for CBC, serum chemistry and toxicology.
2. Commence thiamine 5mg/kg every 3 hours i.m. for 2-4 days; initial dose to be given i.v.
3. Request information on any previous treatments, food additives or drugs not given in the history.

b) Cow:
1. Take blood for CBC, serum chemistry and a peripheral smear for blood parasites and morphology.
2. Obtain a urine sample for urinalysis (at the site).
3. Survey the pasture for toxic plants.
4. Examine hay for *Equisetum and Pteridium* spp.

FIELD DIAGNOSTIC FINDINGS:

1. Urinalysis using dipstick reveals ++++protein; the urine clears of the red color on standing.
2. A survey of the pasture reveals a fern growing on the edges of the creek running through the property but no *Equisetum* spp are found. You obtain a representative sample of the fern for identification.
3. No previous exposure to food additives and no treatments were given in the last six weeks.

WHAT IS YOUR TENTATIVE DIAGNOSIS?

TENTATIVE DIAGNOSIS:

Bracken fern poisoning.

WHAT LABORATORY FINDINGS WOULD HELP CONFIRM YOUR TENTATIVE DIAGNOSIS?

LABORATORY FINDINGS:

1. Pony.

hemogram		leukogram		serum chemistry	
RBC (x 10^{12}/L)	8.2	WBC (x 10^{9}/L)	7.5	ALP (U/L)	43
Hb (g/dl)	13.1	diff (%)		ALT (U/L)	17
PCV (%)	37	neutr segs	49	Lactate (mg%)	40
morphology	normal	neutr band	0.3	rbc transketolase	reduced
parasites	none	lymphocytes	42.5		
		eosinophil	7.5		
		basophil	0.7		

2. cow

a) hemogram		b) leukogram	
RBC, (x 10^{12}/L	4.7	WBC, (x 10^{9}/L)	1.02
Hb, (g/dl)	8	differential (%)	
PCV, (%)	23	Neutrophil segs.	15
Platelet, (/Ol	40 000	Neutrophil bands	0.0
Reticulocytes (%)	1.0	lymphocyte	70
morphology	slight anisocytosis	eosinophil	15
parasites	none	basophil	0.0

WHAT IS YOUR DEFINITIVE DIAGNOSIS:

DEFINITIVE DIAGNOSIS:

Bracken fern (*Pteridium aquilinum*) poisoning in both animals.

REMARKS:

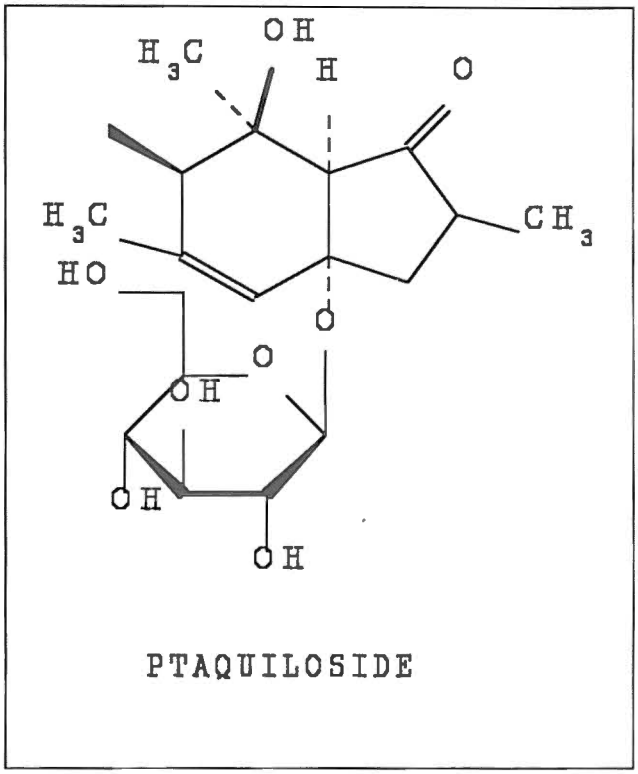
Bracken fern poisoning has sporadic incidence in many countries. The plant grows in semi-shaded or moist but well drained areas and often forms dense stands. Ingestion of large amounts over a sustained period of time is necessary to produce disease; hence the sporadic occurrence. Both leaves and rhizomes are toxic. There is variation in the concentration of toxic principles with season although toxicity is retained on drying. The type of toxic syndrome observed depends on the species, quantity consumed, time of year, duration of consumption and other management factors.

The raised serum levels of lactate and reduction of erythrocyte transketolase are supportive evidence of increased thiaminase activity in the donkey. Additional confirmation would be derived from marked recovery after a few doses of daily thiamine. The absence of horsetail from the pasture strongly suggest *Pteridium aquilinum* as the likely cause of the disease in the pony. Pyrrolizidine alkaloid toxicosis is eliminated by the absence of hepatic injury evidenced by the normal to near normal ALP and ALT levels in serum. Amprolium poisoning is eliminated by the lack of evidence of ingestion in the history and could have been confirmed by a negative Toxilab result.

In the cow, a diagnosis of brackern fern poisoning is supported by granulocytopenia, thrombocytopenia and slight anemia in conjunction with hematuria and mucosal hemorrhages. The leukogram rules out infectious processes and the peripheral blood smear rules out blood parasitism ; the poor condition of the animal and lack of evidence of ingestion of sweet clover rules out dicoumarol toxicity. The absence of soybean meal from the diet eliminates trichloroethylene extracted soybean meal toxicity from the differentials.

Prognosis for the pony is good with thiamine supplement and removal from exposure to the plant. Prognosis for the cow is poor since the platelet count is less than 50 000/µl.

Bracken fern contains several toxic principles of which only one, ptaquiloside, has been isolated, identified and characterized. It is a norsesquiterpene glucoside with the structure given below.



PTAQUILOSIDE

Administration of ptaquiloside has reproduced neoplasia of the urinary bladder and gastrointestinal tract in cattle and sheep respectively; tumors which have high incidence in areas heavily infested with bracken fern. Concomitant exposure to Bovine Papilloma Virus results in conversion of benign papillomas to neoplasia of the urinary bladder and intestines with accompanying secondary cystitis and pyelonephritis. Other toxic principles as yet unidentified appear to be responsible for pancytopeniaa and hematuria, respectively, in cattle and thiamine responsive encephalomalacia in horses.

The syndrome typically observed in cattle relates to a radiomimetic bone marrow suppressive action yielding marked granulocytopenia and thrombocytopenia and a mild non-regenerative anemia. Neoplasia of the urinary bladder or intestines are often incidental findings at necropsy. Secondary cystitis and pyelonephritis may complicate the condition and worsen the prognosis for the animal. Hemorrhages from mucosal surfaces due to thrombocytopenia with fever are often the hallmark for the attending veterinarian

In the equine, thiaminase activity is responsible for the neurological syndrome observed in an animal in poor body condition despite normal appetite. The condition is reversible with thiamine therapy.

CASE 9

ANAMNESIS: BEEF HERD PROBLEM. SOUTH WESTERN OKLAHOMA.

HISTORY:

It is late May and this herd has been on a continuous grazing system on woodland range conditions for the past ten days. Previously, the herd was maintained on Bermuda grass hay through the winter. The problem was first noticed yesterday evening when three yearling steers were found dead and nine others depressed and a few appeared to breathe with difficulty. This morning, one of the nine sick animals is recumbent.

PHYSICAL EXAMINATION FINDINGS:

The affected animals are depressed, anorectic and dyspneic. Body temperature is 37.2°C. Other signs include rumenal atony, constipation with mucous coated hard, dark feces or hemorrhagic diarrhea, straining, polyuria, polydipsia, and dehydration. The recumbent animal exhibits rapid and shallow breathing, and has edema of the brisket.

WHAT ARE THE PROBLEMS WITH THIS HERD?

PROBLEM LIST:

1. Subnormal temperature.
2. Constipation to hemorrhagic diarrhea.
3. Respiratory distress.
4. Brisket edema.
5. Polyuria/polydipsia.

WHAT ARE YOUR DIFFERENTIALS?

DIFFERENTIAL DIAGNOSIS:

1. Oak poisoning.

2. Mucosal disease (Bovine viral diarrhea complex).

3. Gastrointestinal parasitism.

4. *Amaranthus retroflexus* poisoning.

HOW WOULD YOU RULE IN OR OUT EACH OF THESE DIFFERENTIALS?

DIAGNOSTIC PLAN:

1. Survey the pasture for toxic plants.

2. Necropsy the most severely affected animal and obtain tissue samples depending on gross pathology.

3. Obtain blood samples from affected animals for hematology, serum chemistry and virus isolation.

4. Obtain fecal samples for helminthology.

FIELD FARM DIAGNOSTIC FINDINGS:

1. Survey of the range pasture reveals a sparse dry grass cover, a few scattered trees and stumps from which young shoots are beginning to grow. There is evidence of grazing from these stumps and shrubs which appear to be the same species as the young shoots. The leaves are opposite, simple, lobed and awned at the apices of the lobes. Older shrubs are bearing growing immature acorns on last year's wood. Specimens are collected for species identification.

2. Necropsy findings include subcutaneous edema of ventral parts of the body, ascites, hydrothorax and hydropericardium, abdominal visceral edema, blood and mucous clots in the abomasal fluid contents and desquamation of the mucosa of the abomasum, small and large intestines. The kidneys are swollen and embedded in edematous perirenal tissue and appear grayish-yellow with numerous scattered whitish foci throughout the cortices on cut surface. Samples are obtained from the kidney and gastrointestinal tract where gross pathology is most obvious and preserved in formalin for histopathology.

WHAT IS YOUR TENTATIVE DIAGNOSIS?

TENTATIVE DIAGNOSIS:

Oak poisoning (*Quercus spp)*

Treatment of affected animals is supportive but may not be useful in those severely affected. Prevention of intoxication of remaining animals may be accomplished by removing the animals from the pastures, thereby preventing further exposure, or supplementing the diet with good quality alfalfa hay and/or feed calcium hydroxide at 10% total ration. Calcium hydroxide will reduce absorption of toxic tannin or polyphenolics from the gastrointestinal tract. Recovered animals may show compensatory weight gain.

WHAT LABORATORY FINDINGS WOULD CONFIRM YOUR DIAGNOSIS?

LABORATORY FINDINGS:

Hematology report:

hemogram		**leukogram**		**serum chemistry**	
RBC (x 10^{12}/L)	4.67	WBC (x 10^{9}/L)	11.5	BUN (mg/dl)	99.3
Hb (g/dl)	7.18	diff (%)		Creatinine (mg/dl)	5.85
PCV (%)	23.4	neutr. segs	30.0	AST (U/L)	114
MCV (fl)	50.1	neutr. bands	0.2	LDH (U/L)	1071
RETIC (% RBC)	0.53	eosinophils	3.6		
		lymphocytes	66.2		

Remarks: elevated creatinine and blood urea nitrogen levels are suggestive of renal pathology. There is no indication of liver pathology.

Virology report:

negative for BVDV on virus isolation.

Toxicology report:

The plant is identified as *Quercus havardii* (shinnery oak). Shinnery oak has been reported to cause a syndrome characterized by enteritis, visceral edema, perirenal edema, and renal tubular nephrosis.

Histopathology report:

Sections of the kidney show marked necrosis of proximal convoluted tubules, interstitial edema, mononuclear cell infiltration,and fibrosis. Necrotic tubular cells contain yellowish-brown lipofuscinous granular pigment. Tubule lumens in both the cortex and medulla are filled with cellular and hyaline casts. There is fibrinoid degeneration of the walls of small arteries and thrombosis associated with degeneration and necrotic lesions in the mucosal epithelium.

Morphological diagnosis:

The renal lesions are suggestive of nephrosis due to oak poisoning. Differentials for these lesions include intoxication with *Amaranthus retroflexus;* babesiacidal drugs, imidocarb and amicarbalide;

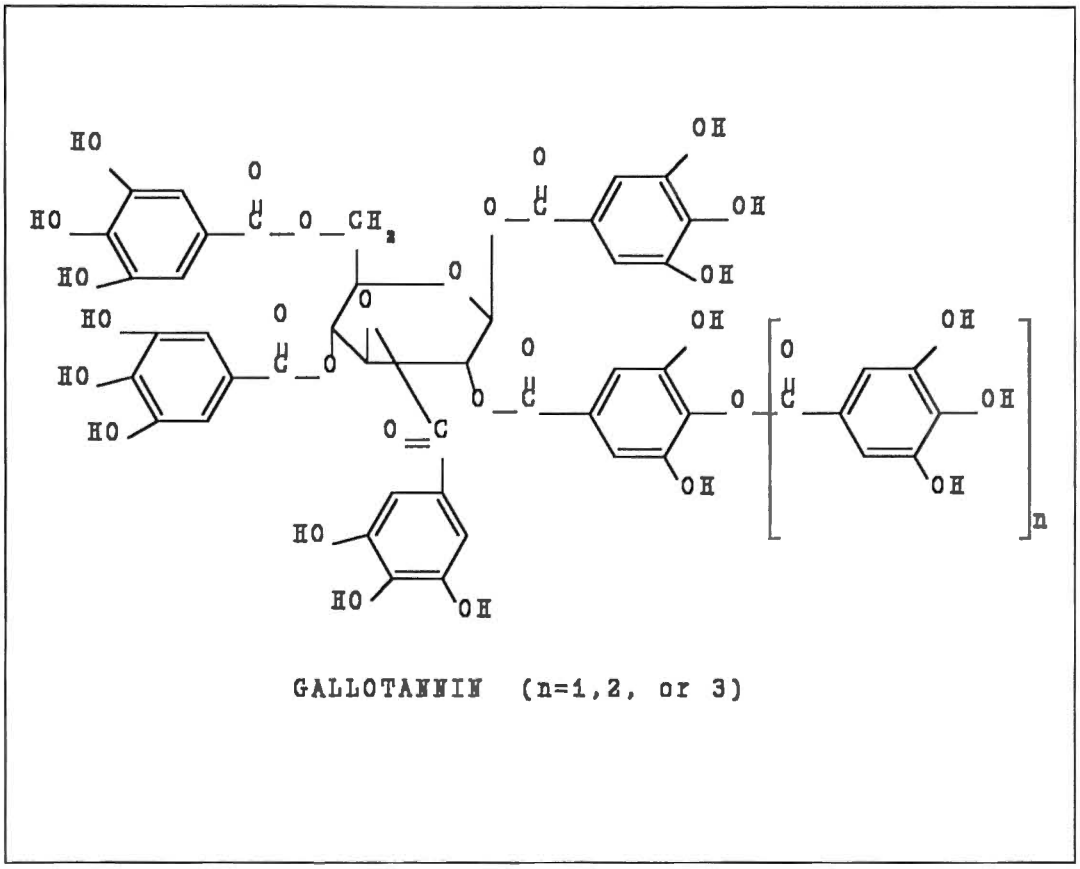
WHAT IS YOUR DEFINITIVE DIAGNOSIS?

DEFINITIVE DIAGNOSIS:

Oak *(Quercus havardii)* poisoning.

REMARKS:

Oak poisoning has been reported from many countries including South Africa, India, China, and the United States of America. Both black and white oak are considered toxic although intoxication reports have mainly implicated *Quercus havardii, Q. rubera, Q. incana, Q.agrifolia, Q. marilandica, Q. stellata, Q. mohriana* and *Q. gambelii.* The toxic principle is believed to be a gallotannin which is hydrolysed in the gastrointestinal tract to nephrotoxic polyphenolics. Gallotannins are present in high concentrations in young leaves, stems and green acorns; factors that explain seasonal occurrence of the disease. Tannins and polyphenolics are thought to exert their toxic effect through binding to proteins and other macromolecules thereby inhibiting cellular function. The general structure of tannin is given below.



GALLOTANNIN (n=1,2, or 3)

The clinical signs reflect a hemorrhagic gastroenteritis and interstitial nephrosis. Treatment is symptomatic for renal failure and lengthy. Mildly affected animals may be expected to recover and perform well through a compensatory mechanism. Prevention through good range management involving protein and calcium hydroxide supplementation is considered more economical than treatment.

Cattle, sheep, goats, rabbits and guinea pigs have been shown to be susceptible to the disease and cases have also been reported in horses and poultry. Young animals are more susceptible than older animals.

Differentials that can be confused with the disease include BVD and helminthiasis for the GIT signs and *Amaranthus retroflexus* plant poisoning and drug (imidocarb & amicabarlide) overdose for the renal signs. Evidence of ingestion of the plant is the quickest way of excluding these differentials although other tests can be done such as virus isolation for BVD. Analysis of the deworming program yields a good indication for ruling out helminthiasis.

CASE 10

ANAMNESIS: 6 ADULT HEREFORD X COWS; 5 WITH NURSING CALVES. WESTERN OKLAHOMA.

HISTORY:

it is mid-August and this farmer has had problems with calf losses to predators and recently adopted a maternity paddock program in which cows are brought from range pastures to a fenced paddock about three weeks before calving. The cows now described were the first to be confined in the maternity paddock. Shortly before they were paddocked, these cows were brought from the hills early in May to a valley pasture and kept there for forty-five days. The maternity paddock had mixed bermuda grass and native grass in good condition and had been examined for poisonous plants.

Calving was unremarkable except for one stillborn, cultures from which were negative for infectious causes. The cows were moved back to the valley pastures two weeks ago which was four weeks post calving. They have been discovered in poor condition and showing a variety of signs including diarrhea, straining, recumbency and depression. The farmer is worried that his maternity program has cost him more than just calves.

PHYSICAL EXAMINATION FINDINGS:

You find the cows in the same valley described in the history while the rest of the herd is scattered in the hills. A continuous grazing system is practiced except for the time when cows are paddocked for calving. All six cows are depressed and are in poor body condition (score 1-1.5 on a 1- 5 scale). In addition cow #1 is passing frequent loose stools with straining in between; cow #2, which had the stillborn and is not lactating, is down, has a prolapsed rectum and continuous tenesmus; cow #3 has dermatitis on the face and subcutaneous edema with a bottleneck jaw; cow #4 has uncoordinated locomotion and is belligrent when approached or handled. Cows #5 and #6 are febrile and the mucous membranes are pale and icteric. The calves have roughened hair coats, and incoordination of the posterior limbs causing a slightly staggered walk .
On rectal examination, urine massaged out of urinary bladder is yellow-green in color and the liver is enlarged in cows #5 and #6 but not palpable in the other cows. You decide to take blood samples from all the cows and calves for laboratory analysis. Soon afterwards cow #2 collapses and dies.

WHAT ARE THE MAIN PROBLEMS?

PROBLEM LIST:

1. Severe weight loss.
2. Diarrhea, tenesmus, (in one case with rectal prolapse) and recumbency.
3. Pale mucous membranes and icterus.
4. Dermatitis, subcutaneous edema,
5. Roughened hair coat and incoordination.
6. Stillbirth.

WHAT ARE YOUR DIFFERENTIALS?

One of the stockmen remembers a horse which died this time last year after showing colic signs and was found to have had gastric impaction.

DIFFERENTIAL DIAGNOSIS:

1. Pyrrolizidine alkaloidosis.
2. Aflatoxicosis.
3. Herring meal poisoning,
4. Lead poisoning.
5. Coal tar pitch poisoning.
6. Rabies.
7. Hepatic abscessation secondary to *Fusobacterium necrophorus, Corynebacterium pyogenes.*
8. Fireweed poisoning (*Kochia scoparia).*

9. Gastrointestinal tract parasitism.

10. Babesiosis /anaplasmosis.

11. Oak *(Quercus spp.)* poisoning.

12. *Amaranthus retroflexus* poisoning.

WHAT WOULD BE YOUR DIAGNOSTIC PLAN?

DIAGNOSTIC PLAN:

1. Post mortem examination of cow #2 and take samples for histopathology and/or culture.

2. Submit blood for CBC, morphology and serum chemistry.

3. Test for bilirubin and protein in urine.

4. Feces for intestinal helminthology.

6. Survey pasture for toxic plants or any source of contamination.

DIAGNOSTIC FINDINGS:

1. Post mortem findings reveal a jaundiced carcass with a firm, shrunken, grayish liver; a distended gall bladder; a fluid-filled abdominal cavity; edematous abomasal and intestinal walls; and scattered hemorrhages in the abdominal serous membranes. You take a sample of the liver for histopathological examination.

2. Urinalysis using dipstick reveals +++ bilirubin.

3. Survey of the valley pasture reveals numerous clusters of composites a few of which are in flower and evidence of many other clumps of the same plants which have been grazed. Further uphill only occasional composites are encountered. You suspect these plants could have been responsible for this bizarre outbreak and collect a representative sample for laboratory identification.

WHAT IS YOUR TENTATIVE DIAGNOSIS?

TENTATIVE DIAGNOSIS:

Pyrrolizidine alkaloidosis from grazing *Senecio* spp.

WHAT LABORATORY FINDINGS WOULD CONFIRM YOUR TENTATIVE DIAGNOSIS?

LABORATORY FINDINGS:

a) **Hematology report:**

Serum chemistry		Hemogram	
GGT, (U/L)	478	RBC (x 10^{12}/L)	5.37
IDH, (U/L)	357	Hb (g/dl)	8.29
AST (U/L)	597	PCV, (%)	22
		WBC (x 10^{9}/L)	6.5
		parasites	none seen
Total bilirubin (Omol/l)	45	morphology	not remarkable

a). Histopathology report:

A section of liver shows diffuse fibrosis, hepatomegalocytosis and biliary hyperplasia. Fibrosis is more prominent in the periportal regions and extends into the lobules. Megalocytosis of hepatocytes and hypertrophy of Kupffer cells are remarkable features of this section. The pathology described is suggestive of pyrrolizidine alkaloid poisoning.

c). Toxicology Report:

The plant specimen submitted is identified as *Senecio riddellii,*

WHAT IS YOUR DEFINITVE DIAGNOSIS?

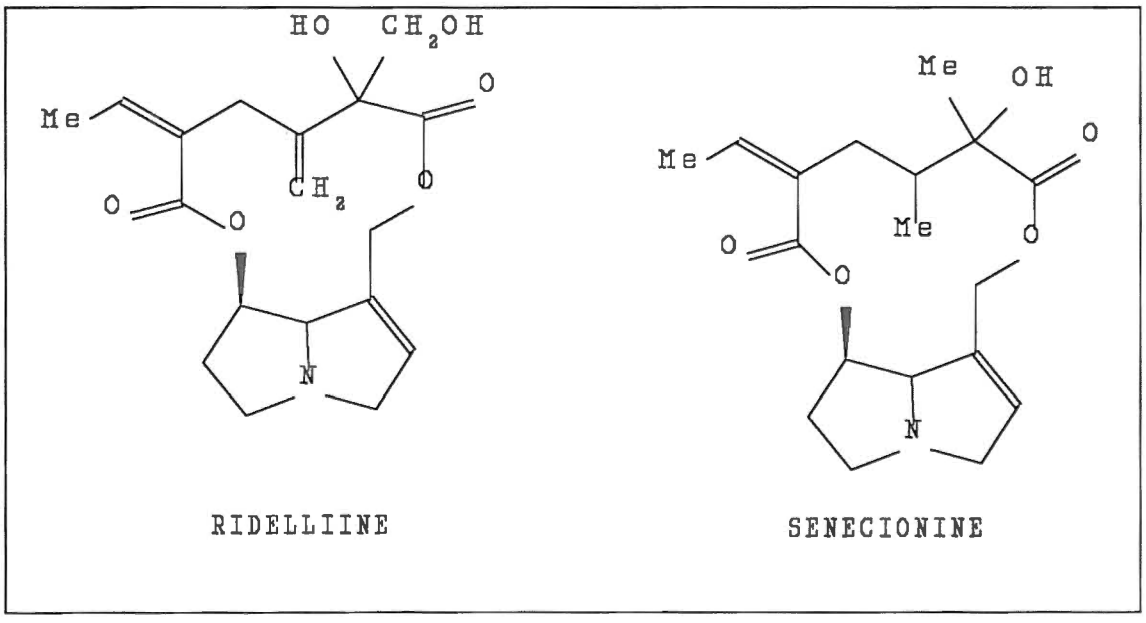
DEFINITIVE DIAGNOSIS:

Senecio riddellii plant poisoning.

Prognosis for affected animals is poor because signs appear when there has been substantial damage of the liver and regeneration fails to compensate for lost hepatic function. Treatment with a high carbohydrate and low protein diet may or may not be economical when the animals have been exposed twice to pyrrolizidine alkaloidosis.

REMARKS:

Pyrrolizidine alkaloid poisoning is a worldwide problem responsible for extensive toll on livestock production. Plants that elaborate toxic pyrrolizidine alkaloids generally belong to one of three families: Boraginaceae, Asteraceae, and Fabaceae. Of the Boraginaceae, *Cynoglossum officinale, Heliotropium europaeum, Amsinckia spp., Symphytum spp and Echium plantagineum* have been incriminated and proven to induce typical pyrrolizidine alkaloidosis. Of the Asteraceae, pyrrolizidine alkaloidosis has been attributed to the genus *Senecio* whilst of the family Fabaceae the genus *Crotalaria* is the culprit. The structure of examples of pyrrolizidine alkaloids is shown below.



Pyrrolizidine alkaloids are readily absorbed from the intestines and transported to the liver where microsomal cytochrome P450-dependent mixed function oxidases convert them into highly reactive electrophilic pyrrolic alcohols and esters. These reactive intermediates are responsible for degeneration and necrosis, damage to proteins, DNA and other macromolecules producing the characteristic antimitotic effect (cytomegaly), especially in the horse, degeneration and necrosis. Healing is by scar tissue formation. The resulting extensive fibrosis is characteristically periportal but may involve vascular walls causing veno-occlusion. The portal triads appear prominent due to extensive biliary hyperplasia, periportal and lobular fibrosis.

Treatment with cysteine or methionine and high carbohydrate may be attempted but is often not beneficial.

The clinical syndrome may develop following a period of daily exposure to large amounts of plant with a relatively short latent period or small amounts over a long period. Signs observed include anorexia, progressive loss of weight, preference for herbage not usually grazed, and periodic depression. Diagnosis of the intoxication is facilitated by finding the toxic plants in the pasture. Exposure to large doses of pyrrolizidine alkaloids over a short period may lead to occurrence of the clinical syndrome several months afterwards when the animals may be under a totally different management system. In such instances, diagnosis may be very difficult since the signs cannot be related to ingestion. Typically the animal is depressed, anorexic, has a distended abdomen and deteriorates rapidly to death. Post mortem would reveal ascites, hydropericardium, cirrhosis of the liver, distended gall bladder and severe *edema of the digestive tract viscera. Microscopically*, cytomegaly and karyomegaly accompanied by biliary hyperplasia and extensive fibrosis have been observed as long as 500 days after exposure to *Senecio longilobus*

Public Health Significance: Pyrrolizidine alkaloids are secreted into milk and may pose a health hazard due to their carcinogenic potential.

CASE 11

ANAMNESIS: 2 FRIESIAN COWS 475 KG BODY WEIGHT: EASTERN OKLAHOMA; MID-JULY.

HISTORY:

The two cows are part of a dairy herd comprising twenty-seven cows in various stages of lactation, thirteen dry cows and seventeen replacement heifers. The lactating cows are on zero-grazing being fed green corn chop whilst the rest of the herd is on native grass pasture. One of the affected cows has loose stools, straining and has quit eating. The other cow initially was treated for diarrhea a few days ago but since then has become depressed, reluctant to move and stumbles when forced. This morning the latter cow is down and does not respond to calcium borogluconate injections.

PHYSICAL EXAMINATION FINDINGS:

The down cow is alert and will eat and drink. She is dyspneic, and has distended jugular veins. Cutaneous sensation is present in all limbs, as is deep pain but the muscle groups in the hind legs lack tone. No swelling is detectable by palpation. Rectal examination reveals a non-gravid uterus, and moderately filled urinary bladder which on massage releases dark brown urine which does not clear on standing. The vital signs are: rectal temperature 37.7°C; heart rate 88 and irregular; mucus membranes, pink and capillary refill time, <2 seconds.
The other cow has fecal matting around the tail head, a stumbling gait and is displaying fasciculation of the cutaneous trunci muscles.

WHAT ARE THE MAIN PROBLEMS?

PROBLEM LIST:

1. Diarrhea, stumbling gait and muscle fasciculation in one cow.

2. Recumbency, muscle weakness, tachycardia and irregularity of heart rhythm, dyspnea and red urine in other cow.

these problems are most likely related; one may represent progressing severity of signs.

WHAT ARE YOUR DIFFERENTIALS?

DIFFERENTIAL DIAGNOSIS:

1. White muscle disease.
2. Monensin poisoning.
3. *Senna* spp poisoning.
4. Enzootic calcinosis (*Solanum malacoxylon*).
5. Oak poisoning.
6. *Amaranthus retroflexus* poisoning.

HOW WOULD YOU RULE IN OR OUT EACH OF THESE DIFFERENTIALS?

DIAGNOSTIC PLAN:

1. Solubility test for myoglobin in urine: adjust pH of urine to slightly alkaline with sodium hydroxide; to 5 ml urine add 2.8 g ammonium sulfate crystals and dissolve by mixing. Filter and examine filtrate for color.
2. Take blood sample from the down cow and allow it to clot and examine the color of serum. Retain serum for CPK and AST levels. Take a blood sample from the other cow for the same serum enzyme assays.
3. Take a biopsy of skeletal muscle from the down cow's posterior limbs.
4. Examine the feed supplement for monensin and the green chop for poisonous plants.

FIELD DIAGNOSTIC FINDINGS:

1. Filtrate after dissolving ammonium sulphate in urine remains abnormally colored; myoglobin is present in urine and not hemoglobin.

2. Serum is clear and therefore red urine is due to myoglobinuria and the problem is a myopathy.

3. Examination of the green chop reveals a slightly woody plant with pinnately compound leaves and long curved pods. Representative specimens of the plant and fruit are taken for laboratory identification.

4. There is no record of monensin use on the property.

WHAT IS YOUR TENTATIVE DIAGNOSIS:

TENTATIVE DIAGNOSIS:

Senna spp plant poisoning:
Of the plants that cause myopathy, the genus *Senna* is the only one that has pinnately compound leaves and long curved pods that split along two seams (legume).

WHAT IS YOUR THERAPEUTIC PLAN AND ADVICE TO THE FARMER?

THERAPEUTIC PLAN:

1. Down cow has a poor prognosis as myopathy is advanced and the animal has signs of cardiac and respiratory insufficiency already. It may die within the following few days and will not be fit for human consumption.

2. The second cow may be saved by symptomatic alleviation of diarrhea, fluid and electrolyte replacement and activated charcoal to prevent further absorption of the toxicant. Prevention of access to the toxic plant material should be instituted by changing the feed source for the cows under zero-grazing.

WHAT LABORATORY FINDINGS WOULD HELP CONFIRM YOUR TENTATIVE DIAGNOSIS?

LABORATORY FINDINGS:

I. Clinical Chemistry:

a) down cow		b) 2nd cow	
CPK IU/L	1995	CPK IU/L	1050
AST IU/L	760	AST IU/L	839

remarks: Elevated levels of CPK indicate that myonecrosis is active or has occurred in the last 2 days.

2. Histopathology report:

A section of striated muscle shows marked hyaline degeneration of myocytes and foci of myonecrosis. The absence of inflammatory cell infiltration is remarkable. The lesion can be attributed to a toxicosis.

3. Toxicology report:

1. Plant specimen identified as *Senna obtusifolia*. (previously *Cassia obtusifolia*) Histopathological and clinical chemistry findings can be attributed to intoxication by *Senna obtusifolia*.

REMARKS:

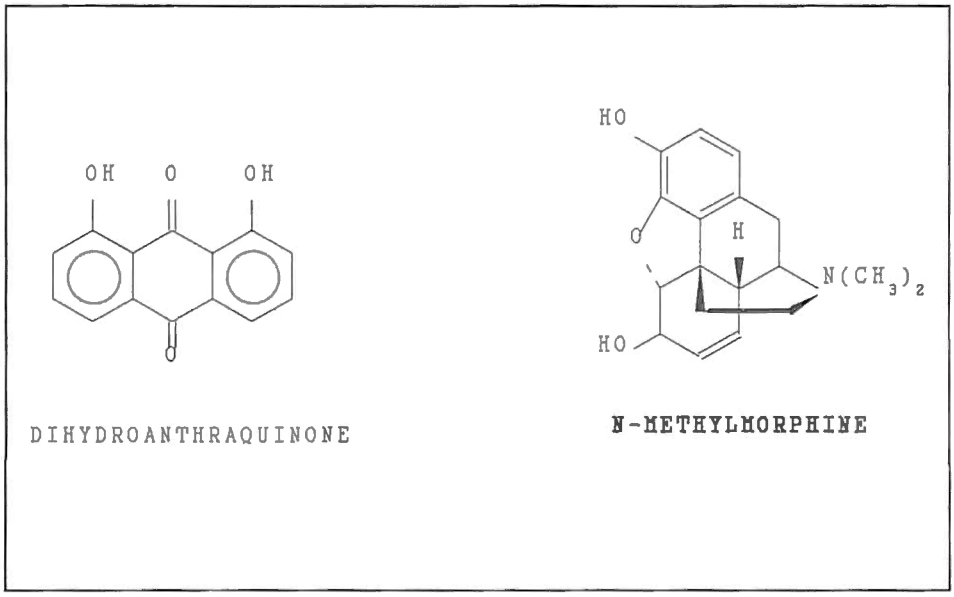
Poisoning with *Senna* spp (originally classified under the genus *Cassia*) occurs primarily in cattle and sheep but can also occur in horses and poultry. The disease has been associated with animals grazing fresh plants, hay and green chop. *Senna* species occur in a variety of habitats including roadside, old pastures, wastelands, fields, open woods in both tropics and subtropical regions.

Early signs of diarrhea and anorexia vary in severity. Later, reluctance to move, muscle fasciculation on exertion progress to stumbling and a swaying gait with increasing muscle weakness. Some animals become recumbent but will continue to eat and remain afebrile.

Clinical pathology is characterized by elevated serum creatinine phosphokinase and aspartate transaminase and myoglobinuria. Gross necropsy findings include varying degrees of pale to white muscles especially in the posterior limbs, pallor of the heart muscle, pulmonary edema, pleural effusions and swollen, mottled livers with foci of degeneration and necrosis centrally in the lobules. Microscopic lesions consist of hyaline degeneration and necrosis, particularly in striated muscles.

Differential diagnosis includes white muscle disease, monensin poisoning, and other plant intoxications such as *Karwinskia humboldtiana*. Enzootic calcinosis (e.g. as caused by *Solanum malacoxylon*) causes a syndrome similar in some clinical signs but differing in severity, progression and microscopic lesions which are dominated by severe calcification of soft tissues; the heart and aorta showing most severe pathology.

Toxic principles isolated from *Senna* spp include anthraquinone and N-methylmorpholine neither of which have specifically been shown to reproduce the muscle lesions experimentally. The chemical structures of these toxins are shown below.



Treatment is symptomatic but vitamin E and selenium are contraindicated. Prevention of access to *Senna* spp remains the best way to prevent losses.

CASE 12

ANAMNESIS: 5 SHORTHORN YEARLING STEERS.
SOUTH EAST TEXAS:

HISTORY:

It is early July and a heavy rain storm over the weekend has been followed by warm weather with temperatures not falling below 31°C during the past three days. A veterinarian is called to investigate cases of sudden death in Shorthorn yearling steers which were put out onto an overgrazed pasture which was overseeded last year with *Lespedeza cuneata* . This together with native *Vicia angustifolia* have helped restoration of grass species over the two hectres of pasture. Fifty-four Shorthorn yearling steers were put out on this pasture two weeks ago. This morning, three were found dead, and two were down both exhibiting paddling movements of all legs.

PHYSICAL EXAMINATION FINDINGS:

You find the herd grazing fifty yards uphill from the low point of the pasture, along the edges of a creek. The steers appear to be in good body condition. The rectal temperature of one of the sick steers is 36.5° C. The sick animals are extremely weak and 1 undergoes terminal convulsions and dies while the other slowly slips into a coma. *You are able to take blood samples* from the sick animals. Affected animals are in good body condition and the hair coat is unremarkable.

WHAT ARE THE MAIN PROBLEMS:

PROBLEM LIST:

1. Sudden death of animals in good body condition.
2. Severe weakness.
3. Hypothermia.
4. Paddling convulsions and coma.

WHAT ARE YOUR DIFFERENTIALS?

DIFFERENTIAL DIAGNOSIS:

1. Blackleg (*Clostridium chauvoei).*
2. *Xanthium strumarium* plant poisoning.
3. Cardiotoxic plant poisoning (*Asclepias spp / Taxus cuspidata).*
4. Prussic acid poisoning.
5. Blue-green algae intoxication.

HOW WOULD YOU RULE IN OR OUT EACH DIFFERENTIAL?

DIAGNOSTIC PLAN:

1. Conduct a post mortem examination on the most recently died steer and take samples for histopathology and culture if necessary.
2. Survey the pasture for toxic plants.
3. Re-examine history for any treatments and vaccination history.

FIELD DIAGNOSTIC FINDINGS :

1. Post mortem examination reveals a carcass with good muscle cover. On entering the abdominal cavity, there is free brownish fluid in the cavity with some fibrin strands; there is a distended gall bladder with thickened, edematous and hemorrhagic walls and a slightly swollen liver with a mottled appearance. The thoracic cavity contains free fluid and there is froth in the trachea and bronchi. The epicardium has numerous, scattered, agonal hemorrhages and the endocardium is similarly affected with extension into the myocardium of the left ventricle. Samples of liver, gall bladder, kidney, spleen, lung, abomasal wall, and heart are preserved in formalin for histopathology and stomach contents saved for toxicology.
2. Vaccinations for blackleg were completed 3 months ago and no intramuscular treatments have been given.

3. Survey of the pasture reveals a few dicot seedlings at the two leaf stage in the lower areas subject to flooding. There are numerous hoof prints around the site. A few of these seedlings are dug out and are associated with prickly burs. Samples are obtained for identification.

WHAT IS YOUR TENTATIVE DIAGNOSIS?

TENTATIVE DIAGNOSIS:

Cocklebur (*Xanthium strumarium.*) poisoning.

WHAT LABORATORY FINDINGS WOULD HELP CONFIRM YOUR TENTATIVE DIAGNOSIS?

LABORATORY FINDINGS:

1. **Hematology Report.**

hemogram		**leukogram**		**serum chemistry**	
RBC, (x 10^{12}/L)	9.5	WBC (x 10^{9}/L)	10	total protein (g/L)	7.0
Hb, (g/L)	13	DIFF %		IDH (SDH) (U/L)	50
PCV, (%)	42	neutr. segs	45	GGT (U/L)	350
		neutr. bands	0.3	AST (SGOT) (U/L)	1050
		eosinophil	13	glucose (mg/dl)	7.0
		lymphocytes	41.5		
		basophil	0.2		

2. Histopathology Report:

Sections of the liver have extensive acute centrilobular hepatocellular necrosis. Hepatocytes around the central veins have a more homogenous pink cytoplasm with pyknosis and karyorrhexis. There is an associated congestion of blood in these areas. No inflammatory infiltrate is present. The gall bladder section reveals mural non-staining edema with no inflammatory cell infiltration.
A section of the myocardium has an occasional focus of hemorrhage but no significant myocardial degeneration. In a section of the lung there is marked congestion of the capillary bed plus flooding of some alveolar spaces by eosinophilic edema. Interlobular septa are thickened with non-staining edema fluid. Airways are free of any inflammatory cell infiltrate.

Some renal tubules are mildly dilated and the epithelial lining is very flattened. No inflammatory cell infiltrate is present.
Sections of the abomasum and spleen are unremarkable.

3. Toxicology Report.

1. Dicot seedlings with associated burs are cotyledonary stages of *Xanthium strumarium*.
2. Stomach contents were extracted and analyzed by thin layer chromatography for the presence of carboxyatractyloside, the toxic principle of cocklebur. Test results are inconclusive.

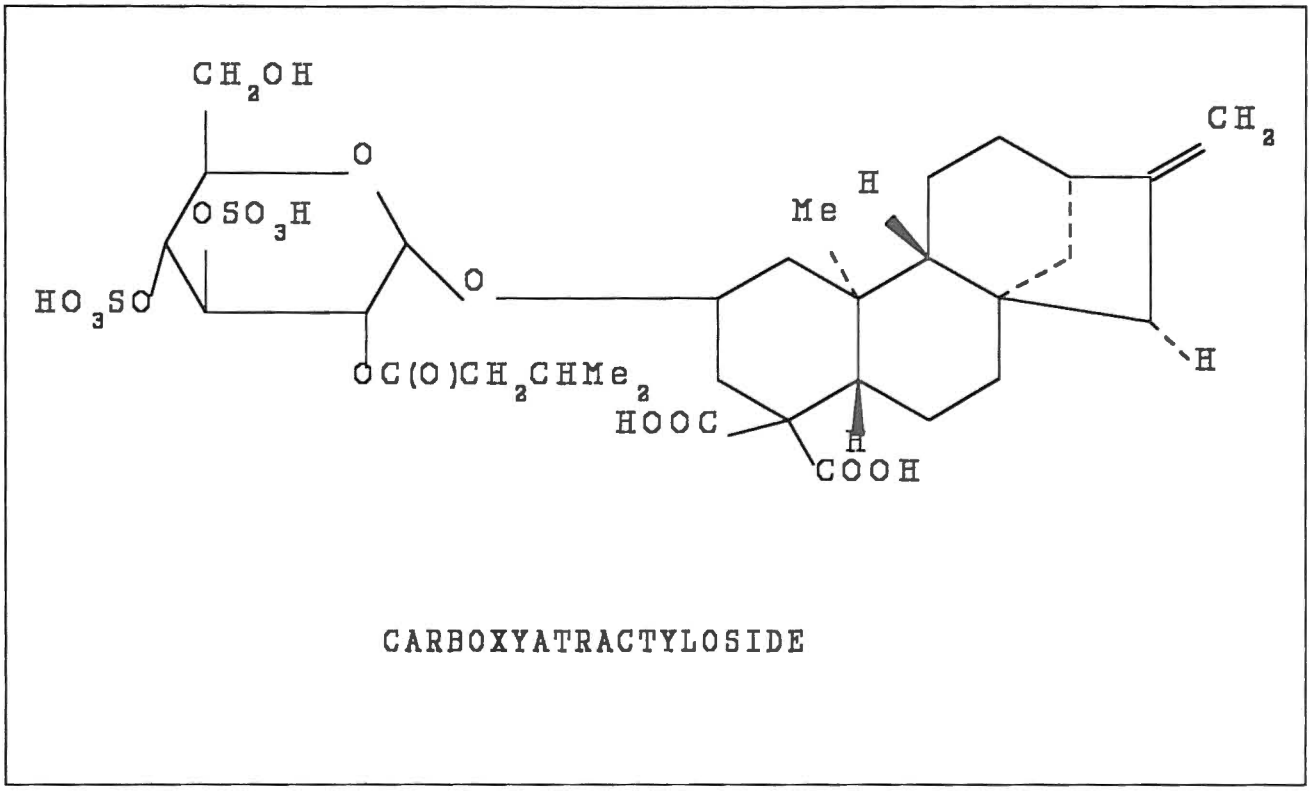
Remarks: Clinical signs, histopathological findings and evidence of ingestion of *Xanthium strumarium* at the cotyledonary stage strongly indicate cocklebur poisoning.

REMARKS:

Cocklebur poisoning in livestock has a sporadic incidence worldwide since it is mostly associated with ingestion of the cotyledonary seedling stage of the plant. Ingestion of burs can also produce intoxication but this is normally self limiting due to mechanical irritation. The toxic principle, carboxyatractyloside, is located in cotyledons of the plant and therefore the plant loses the toxic potential with the disappearance of the cotyledons by the 4-leaf stage. The short period of the presence of the toxin in the plant lends itself to a plausible disease prevention program in areas where disease has occurred before.

Carboxyatractyloside inhibits a mitochondrial membrane translocase enzyme which controls movement of ADP into mitochondria and therefore limits ATP formation resulting in a generalized metabolic shutdown. The structure of carboxyatractyloside

is given below for completeness.



CARBOXYATRACTYLOSIDE

Clinical signs include depression, weakness, incoordination, recumbency,paddling convulsions, coma and death. Typically, animals are found dead or recumbent shortly before death.Poor productivity has been the main sign observed in poultry.

Clinical chemistry would reveal a severe hypoglycemia, elevated serum iditol dehydrogenase (SDH), and arginase due to hepatocyte necrosis and elevated serum gamma-Glutamyl transferase due to cholestasis. Elevated serum creatine phosphate kinase is mainly due to excessive muscle activity during convulsions.
Post mortem findings vary from nothing remarkable grossly to hepatic congestion and centrilobular accentuation, gall bladder wall edema, serofibrinous ascites with fibrin strands and clots on visceral serosal surfaces. The longer the duration between ingestion and death the more likely it is to see gross pathological changes. Microscopically, the liver may show acute diffuse centrilobular to mid-zonal hepatocyte necrosis.

Diagnosis is based on post mortem findings of edematous gall bladder, protein-rich peritoneal and pericardial fluid exudation, evidence of grazing of cotyledonary seedlings growing on lowlands subject to periodical flooding and clinical signs in the

absence of a pyrexia. Blackleg is ruled out based on the absence of myositis on post mortem and a lack of predisposing factors in the history. Cardiotoxic plant poisoning and prussic acid poisoning are ruled out from absence of the causal plants from the pasture and the absence of shallow ponds excludes blue-green algae.

OKLAHOMA STATE UNVERSITY VETERINARY TEACHING HOSPITAL NORMAL HEMATOLOGIC AND SERUM CHEMISTRY VALUES

TEST	EQUINE	BOVINE
RBC, (x 10^{12}/L)	6 - 12	6 - 10
Hb, (g/dl)	11 - 18	8 - 15
HCT (%)	35 - 50	25 - 45
MCV, (fl)	35 - 55	40 - 60
CPK, (IU/L)	150 - 300	19 - 75
Glucose, (mg/dl)	87 - 120	46 - 82
Creatinine, (mg/dl)	0.9 - 2.5	1.1 - 2.1
BUN, (mg/dl)	8 - 21	2 - 15
ALP, (IU/L)	80 -305	35 -225
T. Bilirubin, (mg/dl)	<2.5	< 1.5
Plasma Protein, (g/dl)	5.2 - 7.9	5.9 - 8.0
WBC, (x 10^9/L)	6 - 14	4 - 12
SEGS, (x 10^9/L)	2.5 -8.5	1 - 4
BANDS, (/Ol)	0 - 300	0 - 120
LYMPHS, (x 10^9/L)	1.5 - 7.5	2.5 - 7.5
MONOS, (/Ol)	50 - 800	50 - 850
EOSIN, (/Ol)	0 - 600	100 - 2500
GGT, (IU/L)	3 - 38	12.2 - 39
IDH (SDH), (IU/L)	0.6 - 7.5	2.5 -7.5
LDH, (IU/L)	80 -275	176 - 365
AST(SGOT), (IU/L)	87 - 217	87 -217

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