Hepatogenous Photosensitizers  (9-Aug-1999)

V. Beasley
Department of Veterinary Biosciences, College of Veterinary Medicine, University of Illinois at Urbana-Champaign, Urbana, IL, USA.

Chapter Sections
Tetradymia - Artemisia Poisoning
Panicum spp. - Panic Grasses
Tribulus - Puncture Vine
Nolina
Agave Lecheguilla - Agave
Additional Toxicants

Tetradymia - Artemisia Poisoning
T. glabrata - Littleleaf
T. canescens - Horsebrush, coal oil brush, spring rabbitbrush
T. axillaris
A. nova - Black sagebrush

<table>
<thead>
<tr>
<th>Major Species</th>
<th>Usual Time of Onset</th>
<th>Usual Duration (if survives)</th>
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<tbody>
<tr>
<td>Sheep</td>
<td>Hours to days</td>
<td>Days to weeks, potentially lethal</td>
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</table>

Family (both genera) - Compositae (Composite or Sunflower Family)

Images
- Horsebrush, Tetradymia spp.. Source: Cornell University, Poisonous Plants Informational Database (www.ansci.cornell.edu/plants/index.html). - To view this image in full size go to the IVIS website at www.ivis.org . -
- Littleleaf, Tetradymia glabrata - Google Image Search. - To view this image in full size go to the IVIS website at www.ivis.org . -
- Horsebrush, Tetradymia canescens - Google Image Search. - To view this image in full size go to the IVIS website at www.ivis.org . -
- Tetradymia axillaris - Google Image Search. - To view this image in full size go to the IVIS website at www.ivis.org . -
- Black sagebrush, Artemisia nova - Google Image Search. - To view this image in full size go to the IVIS website at www.ivis.org . -

Description (Tetradymia)
- Plant - low spreading, strongly scented shrub; 1 - 3 feet high.
- Stem - woody, densely branched. Young branches pale green, older ones gray; early on they are covered with white wooly hairs.
- Leaves - alternate, densely branched. Young branches pale green, older ones gray; early on they are covered with white wooly hairs.
- Flowers - yellow, maturing to gray. Disk flowers with yellow corolla. Inflorescence is a composite head with peduncles about the periphery of the plant. Each head is composed of 4 yellow florets.
Fruit - achenes, 5-nerved, capillary, bristly.

Habitat

- Rocky Mountain states. Hills of arid areas, deserts, well-drained sites.
  - *T. canescens* - sagebrush areas and foothills.
  - *T. glabrata* - one of first plants to become green in spring.

Toxic Principle

- **Tetradymia**
  - Hepatotoxin.
  - Cumulative resin.
  - Furanoeremophilanes (furanosesquiterpenes), especially tetradyinol is metabolized by mixed function oxidases to a more toxic substance. Furanoeremophilanes uncouple oxidative phosphorylation in electron transport.
  - Phylloerythrin from other plants must be eaten to result in the development of photosensitization.
- **Artemisia**
  - When consumed at about the same time as *Tetradymia*, the highly pigmented *Artemisia nova* (black sagebrush), which generally contains sesquiterpene lactones, often sets the stage for *Tetradymia*-associated photosensitization.

Susceptible Species

- Sheep.
  - Note cattle and horses reportedly won't eat *Tetradymia*.

Toxicity

- General
  - *T. glabrata* is about 2.5 times more toxic than *T. canescens*.
  - Toxicity is greatest in April to late July.
- Sheep
  - 2 lb per head per day for 2 days (of young *Tetradymia* buds) is a fatal dose.
  - Approximately 1/2 lb of leaves of little leaf horsebrush or 1 1/4 lb of spineless horsebrush will usually cause bighead in a 100-lb sheep.

Signs

- Sheep
  - Acute signs may develop within a few hours.
  - Weakness, collapse, death after coma or convulsions.
  - Subacute signs develop in 1 - 3 days.
  - "Bighead" - itching, uneasiness, swelling of head, inflammation of eyes, blindness, serum oozes from scabs, etc.
  - Abortion and sterility may occur.

Clinical Pathology and Lesions

- Degenerative changes in liver and kidney.
- Serum enzymes elevated.
- Icterus is not typical.

Diagnosis

Identification of *Tetradymia*, evidence of consumption, appropriate signs and lesions.

Prevention

Sheep will selectively avoid *Tetradymia* unless nothing else is available. May consume the plant if pushed along the trail too rapidly.
Comments

*T. glabrata* appears in the early spring when other forage is unavailable and poisoning occurs largely at that time, however, poisoning occasionally occurs in the fall as well.

**Panicum spp. - Panic Grasses**

- *P. antidotale* - Blue panicum
- *P. coloratum* - Kleingrass 75
- *P. dichotoflorum*
- *P. schinzii*
- *P. virgatum*

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<td>Cattle, goats, and esp. sheep</td>
<td>Days to chronic</td>
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Images

- Switchgrass, *Panicum virgatum* - U.S. G.S. Northern Prairie Wildlife Research Center. - To view this image in full size go to the IVIS website at [www.ivis.org](http://www.ivis.org).
- *Panicum virgatum* - Google Image Search. - To view this image in full size go to the IVIS website at [www.ivis.org](http://www.ivis.org).

Descriptions

- *P. antidotale*
  - Plant - perennial, warm-seasoned bunchgrass, grows in large dense tufts, bluish-green, drought resistant, 4 feet tall.
  - Stem - branches freely at nodes; when mature is woody and coarse.
  - Rootstock - short, bulbous rhizomes.

Habitat

New Zealand, Australia, South Africa, South America, Afghanistan, India, South Texas plains, high plains, Edward's Plateau, and
Trans-Pecos area of Texas. Kleingrass is a warm-season bunchgrass, introduced from Africa, and is established on at least 500,000 acres in Texas.

**Poisonous Principles**

- Lithogenic (stone-forming) steroidal saponins are responsible for formation of crystals in the bile ducts.
- Note: Saponins = a sapinogenin + a sugar moiety. The sapinogenin in *Panicum* is believed to be a diosgenin, that is the same as, or similar to those, of several poisonous plants that also cause photosensitization and crystals in the bile ducts, including *Tribulus*, *Nolina*, and *Agave*.

**Mechanism of Action**

- The sapinogens reportedly crystallize out in bile ducts resulting in hepatogenous photosensitization.
- At this time it seems likely that another compound in addition to the sapinogen is needed for photosensitization to develop.

**Susceptible Species** (see also Toxicity)

Sheep, cattle. Note: Cattle do well on Kleingrass 75, but it tends to be toxic to sheep.

**Toxicity**

- Sheep.
  - In Kleingrass toxicosis (of lambs), age is a factor; adults are more resistant.
  - Thirty to 50% losses of flocks of sheep on irrigated blue panicum following heavy application of nitrogen fertilizer have been documented.
  - Twenty-one of 40 lambs were affected by Kleingrass toxicosis after grazing for 5 - 8 days.
  - In 2 other outbreaks, 25 and 60% of the lambs on the pasture were affected.
  - Kleingrass with flowers or seeds is apparently more toxic.
- Cattle.
  - Cattle on Kleingrass were unaffected on pastures which were subsequently associated with severe illness and death after photosensitization in lambs.
  - Severe losses of cattle may occur, however, from grazing irrigated, fertilized blue panicum.

**Signs**

- Sudden illness.
- Possibly hepatogenous photosensitization.
- Rapid breathing.
- Death may occur within a few minutes of the first clinical signs.
- Swollen heads, necrosis of the skin of the ears, mild icterus and lassitude.

**Lesions**

- Hepatocellular damage is likely to be found on histopathology.
- In Kleingrass toxicosis, there were enlarged and vacuolated hepatocytes, mild degenerative changes in the renal tubules and a degenerative focal myocarditis concentrated at the base of the papillary muscles.
- Birefringent crystals may be evident in the bile ducts, skin, kidney, adrenal gland, and heart. Frozen sections are necessary since processing for paraffin embedding is likely to dissolve the crystals.
- Horses experimentally exposed to Kleingrass pastures or given Kleingrass hay had increased amounts of collagen in hepatic sinusoids.
- Pulmonary edema and emphysema occurred in blue *Panicum* toxicosis.
- In lambs, the thoracic cavity may be partially filled with straw-colored fluid containing fibrin.
- Blood is dark, almost black suggesting antemortem anoxia.

**Diagnosis**

Identification of *Panicum*, evidence of consumption, appropriate clinical signs and lesions.
Treatment

Nursing care, good nutrition and shelter (shade) to reduce exposure to sun is appropriate.

Prevention

Cattle and sheep should not be allowed to graze blue Panicum for at least 40 days after fertilization and irrigation should be closely regulated.

Comments

- Blue Panicum is a valuable forage crop, when properly managed for grazing and hay.
- Rotational grazing in small blocks is necessary to obtain good utilization during peak production periods.
- The coarse unpalatable stems that are not grazed should be mowed to force nutritious basal growth for the next rotational grazing period.
Flower head (panicle)—open, 8 to 25 in. long, with single or clustered, wavy, ascending or somewhat spreading branches, long-exserted from top leaf sheath.

Individual flower groups (spikelets)—commonly purplish, about ¾ in. long, hairless, somewhat pointed at tip, 2-flowered; lower flower imperfect; upper flower perfect.

Leaves—8 to 24 in. long and ⅛ to nearly ⅚ in. wide, flat, erect or ascending, somewhat harsh, especially on upper surface, often hairy near base.

Stalks (culms)—tufted, erect, 3 to 7 ft. high, stout, smooth, with hard, bulblike enlargements ("corms") at base.

Roots—fibrous, strong.

Imperfect flower—reduced to a 5-nerved bract (sterile lemma) which rarely encloses a male flower.

Lowest (2) spikelet bracts (glumes)—very unequal, both falling with "seed"; 1st, usually 3-nerved, about ½ as long as 5-nerved 2d glume.

Outer flower bract (lemma)—about as long as spikelet, soon folded around "seed", transversely wrinkled.

*Panicum bulbosum* - Panic grass
**Tribulus - Puncture Vine**

*Trublius terrestris* - Puncture vine, caltrop, goathead

**Family** - Zygophyllaceae

**Images**

- Puncture vine, *Tribulus terrestris* - Google Image Search. - To view this image in full size go to the IVIS website at www.ivis.org.

**Habitat**

- Colorado west to California and south to Mexico, Pacific Northwest.
- Less common in the Atlantic States.
- Waste places, along trails, roadsides, overgrazed pastures.

**Description**

- Plant - a prostrate annual weed.
- Stem - Prostrate or trailing, branched, up to 3 feet in length from the base.
- Leaves - opposite, pinnate, compound; leaflets - 4 - 7 pairs; oblong to elliptical, 1/2 inch long.
- Flowers - single, small axial, short-peduncled; 4 or 5 pale, yellow petals; 4 or 5 sepals; pistil of 5 carpels; 2 - 4 spreading prickles, 10 stamens.
- Fruit - small, bony capsule, 5 nutlets with strong spikes, one or few seeded at maturity; flattened.
- Rootstock - taproot.

**Poisonous Principles and Mechanism of Action**

- See Poisonous Principles and Mechanism of Action section in the *Panicum* section of these notes. It has been suggested that *Panicum, Tribulus, Nolina,* and *Agave* all have poisonous principles and toxic effects similar to those of *Panicum*.
- May also contain dangerous concentrations of nitrate.

**Toxicity**

- Spiny burs cause mechanical damage.
- Toxin in leaves of preflowering to fruiting plants.
- High mortality among young animals.

**Susceptible Species**

Sheep.

**Clinical Signs**

Bighead, swelling of ears and head and other signs reflecting photosensitivity.

**Lesions**

- Intensely yellow fat throughout body.
- Lesions of the skin reflecting photosensitivity.
- Crystals may be noted in the bile ducts.

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Diagnosis

Identification of *Tribulus*, evidence of consumption, appropriate clinical signs and lesions.

**Puncturevine** *Tribulus terrestris* - L. 1, plant; 2, seed pod showing burs. **Annual**, reproducing by seeds. **Root system** simple taproot. **Stems** hairy, prostrate, branching from base to form dense mats of slender trailing branches 6 to 8 feet (1.8 to 2.4 m) long. **Leaves** oblong, opposite, hairy, divided into pinnate leaflets. **Flowers** small, yellow, 5-petaled, produced in axils of leaves. **Seed pods** contain 5 burs, each having 2 sharp, long, stout, rough spines, strong enough to penetrate shoe soles or bicycle tires. **Burs** separate as they mature and often lie in the soil for years before germinating. **Found** in pastures, roadsides, and waste places, along railroad tracks, and sometimes in cultivated fields. A serious weed, listed as noxious in some states. Cattle do not graze areas infested with puncturevine.

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**Nolina**

*Nolina texana* - Bunchgrass, Sacahuiste

*N. microcarpa*

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**Family** - Liliaceae (Lily Family)

**Images**

- *Nolina microcarpa* - Google Image Search. - To view this image in full size go to the IVIS website at [www.ivis.org](http://www.ivis.org).
Description

- N. texana.
  - Plant - perennial, grows in clumps, 6 inches tall, 1 foot in diameter.
  - Stem - short; woody, enlarged at base, most buried, much branched; branches stubby; stem and branches form a trunk-like structure.
  - Leaves - cluster of basal, linear, leaves, finely serrate margins, numerous, 1/4 inch broad to 5 feet long; prominent ridge in concave upper surface; distinctly triangular in section near tip.
  - Flowers - several flowering stems, erect; numerous, flowers, white, long-lived, small, 6-parted, in a large panicle with persistent white perianth of 6 parts.
  - Fruit - 3-valved capsule with few seeds; mostly separate carpels.

Poisonous Principles and Mechanism of Action

- See Poisonous Principles and Mechanism of Action section in the Panicum section of these notes. It has been suggested that Panicum, Tribulus, Nolina, and Agave all have poisonous principles and toxic effects similar to those of Panicum.
- May also contain dangerous concentrations of nitrate.

Susceptible Species

Cattle, sheep, goats.

Toxicity

- General.
  - Retains toxicity upon drying.
  - Flowers and fruit are toxic to livestock.
  - Foliage appears to be non-toxic.
  - Minimum toxic dose and minimum lethal dose are almost the same.
  - Most poisonings occur in early spring when plants are blooming.
  - Heavy blooms occur once every 5 or 6 years.
  - Severe outbreaks of poisoning may occur during years of heavy blooms.
- Sheep.
  - Minimum toxic dose is approximately 1.1% of animal's body weight of buds or blooms.

Signs and Lesions

- Anorexia, lassitude.
- Icterus occurs in 1 or 2 days.
- Yellow or red urine most likely due to hemoglobinuria.
- Yellow nasal and ocular discharges.
- Progressive debilitation, death within 1 week of onset of symptoms.
- Crystals may be present in the bile ducts.
- Photosensitization may occur (swollen face and ears).
- Dermatitis with itching may occur in early stages of photosensitization.
- A purplish band may appear around the top of the hoof above the coronary band.

Lesions

- Generalized jaundice.
- Yellow-brown liver and greenish black swollen kidneys.
- Centrilobular degeneration of liver.
- Fatty and albuminous degeneration of liver and kidney.
- Kidneys swollen.

Diagnosis

Identification of Nolina and evidence of consumption and appropriate clinical signs and lesions.
Treatment

- Shade and nutritious feed, remove from access to plant.
- Most animals developing severe jaundice will die.

Prevention

Remove animals from sacahuiste-infested pastures during the time the plant is in bloom and early fruit.

Comments

When grasses are dry, sacahuiste leaves are green; they are browsed and some nutrition is obtained.

Agave Lecheguilla - Agave

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Family - Amaryllidaceae (Amaryllis family)

Images

- Agave, Agave lechuguilla - Google Image Search. - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

- A. lecheguilla
  - Leaves - 1 - 1 1/2 inches wide, 12 - 24 inches long, ascending with recurving prickles, terminate in a sharp spine; basal, thick, spiny 4-12 inches long.
  - Flowers - narrow, yellow, elongated clusters with 2-6 flowers per cluster. Each flower is 1 1/2 - 2 inches long. After 10 - 15 years of vegetative growth, the plant flowers once, producing a large, spikelike panicle on a thick stalk 6 - 12 feet tall and then dies. New plants may be formed from the seeds and also from the offsets from the parent plant. Flowers are tubular with 3 sepals, 3 petals, 6 stamens, and a 3 carpellate pistil which matures into a leathery capsule containing many black, flattened seeds in its 3 cavities.

Habitat

Texas and New Mexico to Mexico; Trans-Pecos area of Texas. Dry hills, elevated valleys, edges of canyons, low limestone hills, dry valleys, low rainfall areas along the Rio Grande. Several species are cultivated and used for the production of alcoholic beverages (mescal, tequila). Fiber of the leaves is used to make rope or twine.

Poisonous Principles and Mechanism of Action

- Contains a diosgenin that results in crystal formation in bile ducts. See Poisonous Principles and Mechanism of Action section in the Panicum section of these notes. It has been suggested that Panicum, Tribulus, Nolina, and Agave all have poisonous principles and toxic effects similar to those of Panicum.
- Agave also has a separate photodynamic agent, which is independent of liver and kidney damage.
- May also contain dangerous concentrations of nitrate.
Susceptible Species
Sheep, goats, humans, cattle, rarely horses.

Toxicity
- The sap, thorns, and other parts are toxic.
- Liver damage is of primary significance in toxicosis, photosensitivity is of secondary importance.
- The photodynamic agent is toxic to animals exposed to direct sunlight after feeding on the plant.
- The hepato-renal toxin is not activated by the light.
- Consumption of as little as 1% of an animal's body weight may produce serious toxicosis and death.
- One-half to 1 lb daily fed to sheep or goats produces photosensitization in less than a week and death due to liver and kidney damage in 1 - 2 weeks.
- A puncture wound from an Agave plant in a human was reported to cause shock.
- Animals are most commonly poisoned during the winter and spring, especially in drought years when other forage is scarce.
- Morbidity may reach 30% along with some mortality.

Signs
- Contact dermatitis on contact with the plant, especially the sap.
- Listlessness, lag behind the flock or herd.
- Progressive decrease in water and feed consumption.
- Progressive weakness and emaciation.
- Icterus.
- Photosensitization.
- Edema of face and ears; "swell-head", "goat-fever".
- Yellow discharge about the eyes and nostrils.
- Purplish zone beneath the coronary band of the hoof.
- Urine is dark (port wine) colored.
- Plant may cause laxative or irritant effect, especially when eaten in quantity.
- Coma of short duration may precede death.

Clinical Pathology
- Pronounced icterus.
- Albuminuria.

Lesions
- Acute toxic hepatitis and nephritis.
- Liver may be light brownish-yellow, capsule thickened.
- Crystals may be present in the bile ducts.
- Kidneys may be swollen and greenish-black; numerous pinpoint gray specks.
- Gallbladder may be distended but bile usually appears normal.
- Decreased erythrocyte count in some cases.
- Polymorphonuclear leukocytes may comprise 90% of the leucocyte count.

Diagnosis
- Identification of Agave lecheguilla, evidence of consumption, appropriate clinical signs and lesions.

Treatment
- Shade to minimize exposure to the sun (applies to all cases and types of photosensitizition).
- Nutritious diet.

Prevention
- Supplement feed when the animals are exposed to the plant and are inclined to consume it.
- Reducing the stocking rates of the range.
## Additional Toxicants

<table>
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<th>Major Species</th>
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<tr>
<td>Blue-green algae</td>
<td>(see Poisonous Plants that Affect the Liver)</td>
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<td>Pyrrolizidine alkaloids plants</td>
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<tr>
<td>Lantana</td>
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<tr>
<td>Rape</td>
<td>(see Goitrogenic Plants)</td>
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<tr>
<td>Moldy post-frost Florida Bermuda Grass</td>
<td>Herbivores</td>
<td>Days to weeks</td>
<td>Weeks to months</td>
</tr>
<tr>
<td>(Cynodon)</td>
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<tr>
<td>Sporodesmin</td>
<td>(Mycotoxin) (see Mycotoxins that Affect the Liver)</td>
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- *Sporodesmin (Mycotoxin) (see Mycotoxins that Affect the Liver)
- Pyrrolizidine Alkaloid Plants (see Poisonous Plants that Affect the Liver)
- Lantana (*Lantana*) (see Poisonous Plants that Affect the Liver)
- Moldy post-frost Florida Bermuda Grass (*Cynodon*)
- Blue-green Algae (*Microcystis* spp.) (see Poisonous Plants that Affect the Liver)
- Rape (*Brassica*) (see Goitrogenic Plants)
- Kochia (*Kochia scoparia*) (see Poisonous Plants that Affect the Liver)
- Alsike Clover (*Trifolium hybridum*) (see Estrogenic Toxicants)
- Congenital Liver Anomale - Southdown sheep

### References

**Panicum** spp. - Panic Grasses


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