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Plants Affecting the Digestive System (19-Feb-2003)

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Numerous toxic plants cause digestive problems in animals either through direct effects of the plant on the gastrointestinal system or indirectly by affecting other organs with a secondary effect on the digestive system. In this chapter, only plants that have a direct effect on the digestive system will be discussed. Excessive salivation, abdominal pain (colic), impactions of the stomach or intestines, bloat, constipation, and diarrhea are all signs that can be attributed to plants affecting the digestive system.

Excessive Salivation

Excessive salivation, characterized by drooling or frothy saliva around the lips, may be caused by a variety of things including chemical irritants fungal toxins, virus and bacterial diseases affecting the mouth, teeth problems, choking caused by esophageal obstruction, and various toxic or injurious plants. Grazing animals that eat sharp grass awns, spiny plants such as the prickly pear cactus (*Opuntia* spp.) (Fig. 3-1A), or those with burs such as burdock (*Arctium minus*) (Fig. 3-1B) and cocklebur (*Xanthium* spp.) (Fig. 3-1C) may injure the oral mucosa. Some common grasses such as foxtail barley (Fig. 3-2A), bristle grass (Fig. 3-2B) and sandbur (Fig. 3-2C) have seeds with sharp awns that can become embedded in the tongue and gums of animals eating them. Initially excessive salivation may be noticed, but in time the grass awns or spines that are imbedded in the mucosae create large ulcers. The awns are not easily visible in the ulcers because they become embedded in the granulation tissue filling the ulcer. It is not uncommon for some sharp grass awns to penetrate the skin of animals, migrate through the tissues, and act as a foreign body causing abscesses and draining wounds far from the site of penetration [1].

Grasses with sharp awns that commonly become embedded in the mouth, ears, and skin of animals are included in Table 3-1.

Profuse salivation has been observed in horses and other livestock eating clover or alfalfa pasture or hay that is infected with the fungus *Rhizoctonia leguminicola*. The mycotoxin responsible for the "slobbering" that animals exhibit has been identified as slaframine, an indolizidine alkaloid produced most commonly by the fungus *R. leguminicola* growing on red clover [2,3]. Slaframine is chemically similar to the alkaloid swainsonine produced by plants of the genera *Astragalus* and *Oxytropis* that are responsible for causing locoism. Under wet or humid conditions the fungus grows on the leaves producing black or brown spotting. After they eat the fungus-infected clover for several days, horses begin to salivate excessively and lose weight; pregnant mares may abort if they continue to consume the infected clover. Recovery occurs rapidly once horses are removed from the infected hay. Problem pastures can be used for animals if they are mowed, the affected hay is removed, and the regrowth has no brown spotting on the leaves.



Figure 3-1A. Prickly pear (*Opuntia* spp.). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-1B. Burdock (*Arctium minus*). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-1C. Cocklebur (*Xanthium strumarium*). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-2A. Foxtail barley (*Hordeum jubatum*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Table 3 - 1. Grasses that Cause Trauma	
Common Name	Scientific Name
Foxtail barley	<i>Hordeum jubatum</i> (Fig. 3-2A)
Needle grasses	<i>Stipa</i> spp.
Squirrel tail	<i>Sitanion hystrix</i>
Bristle grass	<i>Setaria</i> spp. (Fig. 3-2B)
Sandbur	<i>Cenchrus longispinus</i> (Fig. 3-2C)
Medusahead rye	<i>Taenatherum asperum</i>
Prairie three-awn	<i>Aristida oligantha</i>
Tanglehead	<i>Heteropogon contortus</i>



Figure 3-2B. Bristle grass (*Setaria* spp.). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-2C. Sandbur (*Cenchrus longispinus*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Miscellaneous plants cause irritation to the mouth of animals through the action of oxalate crystals present in the plants leaves and stems. The oxalate crystals become embedded in the mucous membranes of the mouth causing severe inflammation and swelling, excessive salivation, and difficulty in swallowing. In addition the soluble oxalates in the plants can induce kidney failure.

Protoanemonins

Plants including buttercups (*Ranunculus* spp.) and related species such as marsh marigold (*Caltha palustris*) (Fig. 3-3A), clematis (*Clematis* spp.) (Fig. 3-3B), anemone, and baneberry (*Actaea arguta*) contain substances that cause mouth irritation, excessive salivation, and diarrhea if eaten in quantity [4]. The buttercup family (*Ranunculus* spp.) contains an oily glycoside, ranunculin, that when converted by plant enzymes to protoanemonin becomes a strong irritant [5-7]. It primarily causes irritation to the mucous membranes of the mouth and digestive system and can blister the skin and cause liver damage and secondary photosensitization [8-9]. Sheep have been fatally poisoned by bur buttercup (*Ceratocephalus testiculatus*) [10] (see Fig. 3-5). Protoanemonin is rapidly polymerized to anemonin, which is nontoxic, and accounts for the fact that hay-containing plants with protoanemonins are not toxic. Feeding trials with cattle and sheep have shown that buttercups vary in their toxicity and do not seriously affect animals under most circumstances [11,12].



Figure 3-3A. Marsh marigold (*Caltha palustris*). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-3B. Clematis (*Clematis ligusticifolia*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Clinical Signs

Protoanemonins are toxic to all animals and cause reddening of the oral mucous membranes, salivation, gastroenteritis, colic, and diarrhea. In lactating animals, especially cows, protoanemonins produce a bitter taste to the milk and because of their irritating effects may cause blood to appear in the milk and urine.

Treatment

Because there is no specific treatment, severely affected animals should be given intestinal protectants until the toxic plant material is eliminated from the digestive tract.

Blister Buttercup

Ranunculus sceleratus - Ranunculaceae (Buttercup family)

Habitat

Blister buttercup is a plant of early spring that prefers borders of lakes, ponds, and streams and in general wet areas, from Alaska south to Iowa, New Mexico, and California.

Description

Blister buttercups are perennial herbaceous plants with fibrous roots. Stems are erect, stout, and glabrous or nearly so. The basal leaves are kidney-shaped, long petioled, and three-parted. The upper leaves are sessile or short-petioled. Flowers are few, sepals five, petals yellow, stamens number 10 to many, pistils many, and the fruit is an achene.

Principal Toxin

An oily glycoside, ranunculin, is converted to protoanemonin by the action of plant enzymes released when the plant is chewed. The protoanemonin irritates the mouth, causing excessive salivation and intestinal irritation that may result in diarrhea.

Signs of Poisoning

Signs of poisoning include excessive salivation, reddening of oral mucous membranes, and diarrhea. Cattle that consume excessive quantities of certain buttercup species may develop a severe gastroenteritis and hemorrhagic diarrhea that can be fatal. The bitter taste of the protoanemonin can also be passed into the milk of lactating animals.

Among the buttercups considered more toxic to animals than others are *R. sceleratus*, *R. flammula*, *R. parviflora*, *R. acris*, *R. abortivus*, *R. cymbalaria*, and *R. repens* (Fig. 3-4).



Figure 3-4. Creeping buttercup (*Ranunculus repens*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Bur Buttercup

Ceratocephalus testiculatus - Ranunculaceae (Buttercup family)

Habitat

Introduced from Europe, bur buttercup has become established commonly along roadsides and in disturbed areas in northwestern North America. It is a plant of spring and early summer.

Description

Bur buttercups are annual plants with stems 1 to 3 inches (3 to 10 cm) tall (Fig. 3-5). The flower-bearing stems have simple, three-parted, gray-green, hairy, basal leaves with lateral segments, cleft into linear divisions and a winged petiole. The five sepals are green and hairy. The five petals are yellow. The fruits are burlike, consisting of numerous individual seed capsules, each three-chambered, but with the two lateral chambers empty.



Figure 3-5. Bur buttercup (*Ceratocephalus testiculatus*) (Courtesy of Dr. Michael H. Ralphs, USDA Poisonous Plants Research Laboratory, Logan, Utah). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

The glycoside, ranunculin, which is converted to protoanemonin by the action of plant enzymes released when the plant is

chewed, is responsible for oral irritation causing excessive salivation and intestinal irritation that may result in diarrhea. Sheep are particularly susceptible to bur buttercup poisoning, and large numbers of sheep have died from eating as little as 500 g of the plant [10-12]. Affected sheep develop watery diarrhea, labored breathing, and weakness and cannot rise when approached. Hypocalcemia is not the cause of the muscle weakness and recumbency. Postmortem findings include inflammation of the rumen; congestion of the lungs, liver, and kidneys; and excessive fluid in the thoracic and abdominal cavities [10].

Baneberry

Actaea rubra - Ranunculaceae (Buttercup family)

Habitat

Baneberry prefers rich, moist soils of woodlands, often in deep shade of trees. It is found in most areas of North America except in the desert southwest.



Habitat of Baneberry. *Actaea rubra* - Ranunculaceae (Buttercup family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

Baneberry is an erect perennial herbaceous plant with thick root stalks. The leaves are large with the lower ones petioled and the upper nearly sessile. They are ternate with the divisions long petioled and pinnate. The leaflets are ovate-lanceolate and serrate, with three to five lobes. The raceme elongates in the fruit, often up to 4 inches (10 cm). The petals are shorter than the stamens and are white. Stamens are numerous with the filaments flattened. The pistil has one locule and is sessile. The fruiting pedicels are elongated up to 2 cm (20 mm) long with red or white berries (Fig. 3-6A and Fig. 3-6B).



Figure 3-6A. Baneberry (*Actaea rubra*). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-6B. White baneberry (*Actaea rubra*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

As a member of the buttercup family, baneberries contain the glycoside ranunculin and as yet other unidentified irritant compounds. Human or livestock fatalities associated with baneberry have not been recorded in the United States, but in Europe references are found concerning the death of children who have eaten the conspicuous red or white berries.

Tung Nut

Aleurites fordii

Candle nut (*A. moluccana*)

Lumbang nut (*A. trisperma*)

Euphorbiaceae (*Spurge family*)

Habitat

The tung tree was originally imported from China and grown in Florida and along the Gulf Coast to east Texas for the purpose of producing tung oil. Although the tung oil industry is no longer of major significance, many of the trees have persisted and are grown as ornamentals.



Habitat of Tung Nut. *Aleurites fordii* - Candle nut (*A. moluccana*), Lumbang nut (*A. trisperma*), Euphorbiaceae (*Spurge family*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

The tung tree may attain a height of 50 feet (20 meters) with stout branches, often in whorls. The leaves are simple, alternate deciduous, and palmately veined, reaching 12 inches (30 cm) in length (Fig. 3-7). Ivory-colored male and female flowers appear in the spring before the leaves. The lumbang nut tree (*A. trisperma*) has white flowers tinged with red. The fruits are conical and 2 to 3 inches (5 to 7 cm) long, turning brown when ripe. The thin shell splits open to reveal three to four round dark brown seeds that are white on the inside.



Figure 3-7. Tung nut (*Aleurities*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Saponins and possibly a toxalbumin are found in highest concentration in the tung nuts and leaves but not in the oil [13-15]. The toxicity of the various species is variable, the tung nut being the most toxic. Experimentally 0.35 percent of an animal's body weight of fresh macerated leaves induced a hemorrhagic diarrhea. Cattle do not readily eat the leaves off of the tree, but they will eat prunings. Most poisoning has been reported in people who have eaten the white-fleshed seeds [16].

Clinical Signs

Cattle become depressed and anorexic and develop an atonic rumen. A hemorrhagic diarrhea often develops after several days of consuming either the tung nuts or the leaves [17]. Chronic watery diarrhea and emaciation often develop in animals that do not die and can mimic chronic bovine virus diarrhea.

On postmortem examination the most common finding is hemorrhagic gastroenteritis, the abomasum and proximal small intestine being most severely affected.

Treatment

There is no specific treatment for tung oil poisoning. Affected animals should be removed from the source of the plant and given supportive oral and intravascular fluid therapy.

Chinaberry, Paraiso

White cedar, syringa berry, Persian lilac

Melia azadarach - Meliaceae (Mahogany family)

Texas umbrella tree - *M. azadarach* var. *umbraculiformis*

Habitat

The chinaberry tree is a fast growing tree that was introduced from China and has become established in the Southern United States from Florida to Southern California, Hawaii, and Mexico. The tree has escaped from cultivation and is commonly found growing in hedgerows and waste areas where birds have dropped the seeds.



Habitat of Chinaberry, Paraiso. *Melia azedarach* - Meliaceae (Mahogany family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

The chinaberry tree is a fast growing tree up to 40 feet (20 meters) in height, with compound, opposite leaves, 1 to 3 feet (0.5 to 1 m) in length, each leaflet being serrated and 1 to 3 (2 to 6 cm) inches long. The tree is deciduous, with the leaves turning yellow before falling. The white to lavender inch-sized flowers with 5 to 6 petals are produced in clusters and are heavily and pleasantly fragrant. The smooth green fruits (drupe) hang in clusters, turn yellow when ripe, and have a ridged pit surrounded by a little pithy flesh. Fruit clusters often remain hanging on the tree even in winter (Fig. 3-8). Fruit production is especially heavy in high rainfall years.



Figure 3-8. Chinaberry (*Melia azedarach*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Uncertainty exists as to the exact nature of the toxic compounds found in chinaberry, but saponins, alkaloids (azaradine, margosine, mangrovin), and tetranortriterpenes (meliatoxins) are thought to be responsible for the gastroenteric and neurologic signs [18-21]. All parts of the tree are poisonous, but most poisoning is associated with the consumption of the fruits. Humans as well as pigs, cattle, sheep, goats, rabbits, guinea pigs, poultry and dogs are susceptible to poisoning from chinaberries [18-20]. Pigs are most frequently fatally poisoned after consuming as little as 100 g of the fruits.

Clinical Signs

The usual signs associated with chinaberry poisoning are associated with either the gastrointestinal system (vomiting, constipation, hemorrhagic diarrhea, colic) or the nervous system (weakness, muscle trembling, ataxia, and generalized paresis leading to recumbency, coma, respiratory failure) [18-21]. Rumen impaction may develop in cattle eating large quantities of the ripe fruits that drop to the ground. Signs develop within a few hours to a day or two later depending on the quantity of fruits consumed. Death may occur 1 to 2 days after the onset of signs if a lethal dose of chinaberries was consumed.

Chinaberry poisoning has no known specific treatment and affected animals must be treated symptomatically. This may include inducing vomiting or gastric lavage in people and dogs to remove the berries from the stomach, oral administration of activated charcoal, and intravenous fluid therapy to counteract shock and maintain renal function.

At postmortem examination, the fruits and seeds may be evident in the stomach, which is often congested and hemorrhagic. The intestinal tract is usually congested and hemorrhagic. The meninges of the brain are often congested. Histologically the liver, kidneys, and heart show varying degrees of degeneration and coagulative necrosis.

Chinaberry trees should not be planted in or around livestock enclosures because of the high risk of poisoning.

Pokeweed, Pokeberry

Phytolacca americana - Phytolaccaceae (Pokeweed family)

Habitat and Description

Pokeweed grows mostly in the eastern and southern United States. It is a perennial branching herb from 3 to 10 feet (1 to 3 meters) tall, with a large tap root, green or purple stems, and large alternate, petioled, and ovate leaves. The flowers are small, white in color and without petals. The distinctive fruits are shiny purple-black berries carried on red stems (Fig. 3-9).

Habitat of Pokeweed. *Phytolacca americana* - Phytolaccaceae (Pokeweed family). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-9. Pokeweed (*Phytolacca americana*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

All parts of the plant contain saponins, oxalates, and the alkaloid phytolaccine with greatest concentrations in the roots and seeds. Pokeberry also contains a protein lectin, (a mitogen) that can have wide effects on the immune system. Pokeweed mitogen affects cell division and stimulates B- and T-cell lymphocyte proliferation. The plant should be handled with gloves because the mitogen can be absorbed through cuts and abrasions on the skin.

Clinical Signs

Depending on the amount of the plant consumed, animals may show mild to severe colic and diarrhea. Fatalities are rare unless large quantities of the plant are consumed. Other species of *Phytolacca* found in South America and Africa have been associated with higher mortality rates [22]. Humans appear to be more severely poisoned by pokeweed and develop mouth irritation, stomach cramps, vomiting, and diarrhea. Death may occur in children eating large amounts of the plant or berries.

Sheep, cattle, goats, horses, pigs, and poultry are susceptible to the toxic effects of pokeweed [23-26]. The signs of poisoning are varied and include oral irritation, excessive salivation, vomiting, colic, bloody diarrhea, depression, prostration, and death. Mild to severe gastroenteritis with ulceration of the gastric mucosa are common nonspecific findings on postmortem examination.

Treatment

Intestinal protectants and other supportive treatments should be given as appropriate.

Corn Cockle

Agrostemma githago - Caryophyllaceae (Pink family)

Habitat

Corn cockle was introduced from Europe and has become a common weed of wheat fields throughout North America. Its seeds become a problem to livestock when they contaminate grains fed to them. Wheat screenings are particularly hazardous to livestock because the corn cockle seeds tend to be concentrated in the screenings.



Habitat of Corn Cockle. *Agrostemma githago* - Caryophyllaceae (Pink family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

The corn cockle is an erect annual, with hairy stems, branching above and growing to 3 feet (1 meter) in height. The leaves are alternate, lanceolate, and grayish green due to the heavy covering of hairs. Flowers are showy, terminal, and purplish red in color with green sepals longer than the colored petals (Fig. 3-10). The urn-like seed capsules contain relatively large 0.2 to 0.3 cm (2 to 3 mm) black seeds, rounded with a flat side and covered by rows of sharp tubercles.



Figure 3-10. Corn cockle (*Agrostemma githago*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

A saponin, githagenin, which can comprise 5 to 7 percent by weight of the seeds, appears to be the toxin that causes gastrointestinal irritation and diarrhea [27]. Poultry, cattle, sheep, pigs, and horses are susceptible to corn cockle poisoning. Similar saponins are found in members of the genus *Drymaria* (*Alfombrilla*) common in Mexico.

Bouncing Bet

Saponaria officinalis - Caryophyllaceae (Pink family)

Habitat and Description

Widely distributed throughout the United States, *Saponaria* spp. are perennial erect herbs with jointed stems, opposite, lanceolate, simple leaves, which are sessile. The leaves are prominently veined. The white or pink flowers are produced in terminal clusters, with a calyx of five sepals that is green and tubular (Fig. 3-11). The flower has five petals, 10 stamens, and two styles.



Habitat of Bouncing Bet. *Saponaria officinalis* - Caryophyllaceae (Pink family). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-11. Bouncing bet (*Saponaria officinalis*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Saponins are the primary toxins present in *Saponaria* spp. If eaten in sufficient quantity, the saponins may cause acute liver degeneration and death [28]. The seeds, which are especially toxic, may be a contaminant of cereal crops. Cow cockle (*Vacaria pyramidata*, or *Saponaria vacaria*) is an annual weed introduced from Europe that is common in grain fields and has similar toxic properties.

Sesbania, Coffee Weed, Bladderpod

Sesbania ssp. (*Daubentonia* and *Glottidium*) - Fabaceae (Legume family)

Habitat

Various species of *Sesbania* are found in North America, most of which grow in the warmer climates from Florida to California and Hawaii. Some are vigorous annuals that form dense stands in the damp soils along streams. *Sesbania punicea*, red or purple sesbania (Fig. 3-12A), *S. drumondii* (coffee bean, rattlebox) (Fig. 3-12B), and *S. vesicaria* (annual bladderpod) are some of the more prevalent species [29]. Synonyms for the genus *Sesbania* include *Daubentonia* and *Glottidium*.



Figure 3-12A. Sesbania (*Sesbania punicea*). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-12B. Rattlepod sesbania (*Sesbania drummondii*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

Sesbania plants are perennial shrubs or small trees growing to 12 feet (3.5 meters) tall. Leaves are alternate, pinnately compound with 12 to 40 leaflets. Red, orange, and yellow flowers are produced in showy pendant racemes. Pods are hairless, fourwinged, and contain glossy, kidney-shaped seeds.

Principal Toxin

Saponins are believed to be the principal toxins present in all parts of the plants and especially the seeds. The green seeds are most poisonous, and the seeds remain toxic for years. The leaves appear to be least toxic. Birds, with the exception of ducks, are especially susceptible to poisoning. Sheep, cattle, and goats are also susceptible to poisoning, sheep being fatally poisoned after eating less than 2 oz of seeds per hundred weight [29]. As few as 10 seeds of *S. punicea* are lethal to poultry. The primary effects of the toxin are severe gastrointestinal irritation and liver degeneration [30]. Hemolysis may also occur when large quantities of seed are consumed.

Clinical Signs

Severe hemorrhagic diarrhea is often the presenting sign of *Sesbania* poisoning in cattle and sheep. Anorexia, abdominal pain, dehydration, and prostration may also be observed before death. Poultry develop similar signs of poisoning. Postmortem findings include a severe hemorrhagic abomasitis, enteritis, and liver and kidney degeneration with necrosis. Diagnosis of poisoning is based on the signs and evidence that the plant or the seeds have been consumed. The finding of *Sesbania* seeds in the rumen, coupled with the clinical and post mortem signs is strongly supportive of a diagnosis *Sesbania* poisoning.

Treatment

Laxatives to evacuate the intestinal tract, activated charcoal via stomach tube, and intravenous fluids are helpful in treating the effects of the hemorrhagic diarrhea. The prognosis is poor if extensive liver and kidney degeneration occurs.

Prevention

Mowing of the plants before the formation of seed pods is the best way to contain the plants. Herbicides (2,4-dichlorophenoxyacetic acid) are effective in controlling young plants.

Gastrointestinal Impaction and Obstruction Caused by Plants

Adult horses and cattle may swallow poorly chewed or entire fruits and seeds of some plants that can become lodged in the pharynx or esophagus. The resulting esophageal obstruction is referred to as "choke". Fruits that may cause esophageal obstruction include apples, sugar beets, turnips, onions, and persimmons. Animals that are choked generally make frequent attempts at swallowing and drool saliva profusely because they are unable to swallow it. In cattle that are choked, severe bloat usually develops because they cannot belch to allow rumen gases to escape.

If large fruits or masses of seeds are swallowed successfully, they may cause an impaction of the stomach or obstruct some portion of the intestinal tract. Plants that can cause rumen impaction and intestinal obstruction include chinaberry (*M. azedarach*), mesquite pods and beans (*Prosopis* spp.), mescal bean pods and beans (*Sophora secundiflora*) (See Chapter 6), and persimmon fruits (*Diospyros virginiana*). Occasionally sheep may eat large quantities of pasque flowers (*Anemone patens*) that are covered with poorly digestible hairs. The fibrous hairs can form a large mass in the rumen that can cause

rumen impaction.

Mesquite

Prosopis glandulosa (Honey mesquite) - Mimosaceae (Mimosa family)

Habitat

Various species of mesquite are found in the drier areas of the southwestern states from California and Mexico to Texas and Oklahoma.



Habitat of Mesquite. *Prosopis glandulosa* (Honey mesquite) - Mimosaceae (Mimosa family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

Mesquite plants are shrubs or small trees to 15 to 20 feet (5 to 6 meters) in height. Leaves are alternate, bipinnate, with 6 to 15 leaflet pairs. Mature branches often have stout spines at the nodes. Flower spikes, 3 to 4 inches (7 to 10 cm) long, are produced in the axils. The fruits are leathery pods 6 to 10 inches (15 to 25 cm) in length, constricted between the seeds (Fig. 3-13). Mesquite beans are reddish brown.



Figure 3-13. Mesquite leaves and pods (*Prosopis juliflora*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

A specific toxin has not been identified in mesquite. In times of drought cattle may eat excessive quantities of mesquite pods and beans that result in rumen impaction. The seeds and pods form a sticky mass when in contact with water which contributes to their poor digestion. The high carbohydrate content of the beans may also result in rumen acidosis. At other times livestock eat the beans in the process of foraging and do well on them.

In some areas of the world where sugar cane and mesquite are fed together to cattle, an enzyme in the mesquite releases cyanide from glycosides in the sugar cane that causes cyanide poisoning [31].

Clinical Signs

After consuming large quantities of mesquite over a period of time, cattle may show weight loss and poor appetite. Affected animals have frothy salivation, continuous chewing movements, and loss of rumen activity; the tongue may protrude between the lips. Ketosis may be present in the chronically affected animal. Horses eating mesquite pods may develop intestinal obstruction due to the formation of an indigestible mass (phytobezoar) consisting of the pods and seeds.

Valuable cattle that are not in the advanced stages of emaciation may benefit from a rumenotomy to rid the rumen of the impacted mesquite beans. Intestinal obstructions in horses require surgical intervention to remove the phytobezoar.

Prolonged consumption of mesquite pods (*P. juliflora*) by goats and cattle will cause a neurologic syndrome characterized by

difficulty in chewing and eating, salivation, and tongue protrusion due to masseter muscle atrophy resulting from fine vacuolar degeneration of the trigeminal nuclei [32].

American Persimmon

Diospyros virginiana - Ebenaceae (Ebony family)

Description

The American persimmon is a large deciduous tree of warm temperate regions, with distinctive "alligator-hide" bark. The leaves are glossy, alternate, and elliptical to oblong, turning red in the fall. Flowers are greenish yellow, both male and female flowers on the same plant or on separate plants. The 1.5 to 2 inches (4 to 5 cm) fruits are conical shaped, yellow when ripe, fleshy, and sweet. The seeds are oblong and flat, with one straight edge, the other rounded; they have a pale brown, hard, wrinkled coat.

Principal Toxin

Persimmon fruits contain water soluble tannins, which precipitate in the acidity of the stomach to form a sticky coagulum of fruit skin, pulp, seeds and gastric protein that becomes a solid mass or phytobezoar. Once formed, the phytobezoar is abrasive and can lead to ulcers and even rupture of the stomach of horses that have eaten large quantities of ripe persimmon fruits [33-35]. Severe colic results when impaction of the stomach occurs, or when the phytobezoar causes an intestinal obstruction.

Clinical Signs

Intermittent colic and weight loss are often the non specific presenting signs associated with persimmon ingestion in horses. The severity of the colic depends on the degree of obstruction or impaction. Persimmon phytobezoars can be difficult to diagnose, but can be suspected in the fall when the fruits are ripe, the horse has had access to the fruits, and the persimmon seeds can be visualized in the stomach using an endoscope.

Treatment for phytobezoars is aimed at softening the mass with mineral oil and dioctyl sodium sulfosuccinate to allow its passage through the gastrointestinal system. Surgical intervention becomes necessary when medical treatment fails or if colic is severe and unrelenting.

Persimmon trees should not be planted in animal enclosures where animals could have access to the fruits.

Vomiting

A group of about 40 related plants commonly referred to as bitterweeds or sneeze-weeds cause a syndrome of sneezing and vomiting in livestock that consume them. Sheep and goats are most frequently affected, but the sneezeweeds are also poisonous to cattle and horses. Sneezeweeds and bitterweeds that have caused the greatest sheep losses include *Hymenoxys odorata*, *Hymenoxys richardsonii*, *Helenium autumnale*, *Helenium amarum*, and *Dugaldia hoopesii* [36-41]. Other species of bitterweed and sneeze-weed can be assumed to be toxic if eaten in sufficient quantity. Desert baileya (*Baileya multiradiata*) also contains hymenoxon, the principal toxin in the bitterweeds and sneezeweeds [42].

Principal Toxin

The sneezeweeds and bitterweeds contain sesquiterpene lactones, which are highly irritating to the nose, eyes, and gastrointestinal tract. The primary toxins isolated from members of the *Helenium* and *Hymenoxys* genera are hymenovin (dugaldin), helenalin, helenanolide, tenulin, and hymenoxon, all of which have similar effects [38]. The amount of dried bitterweed to induce severe poisoning in sheep is 2.9 to 8.5 g/kg body weight [43]. Other than the direct irritant effects on the digestive system, the lactones (hymenoxon) have a profound effect on metabolism through their ability to bind with sulfhydryl groups, resulting in metabolic acidosis and hypoglycemia [44,45]. In light of this, the toxicity of the lactones can be reduced if sulfur-containing amino acids (cysteine, methionine) or antioxidants such as butylated hydroxyanisole are fed before the bitterweed is consumed [46,47].

Clinical Signs

Orange sneezeweed (*Dugaldia hoopesii*), bitter sneezeweed (*Helenium amarum*), common sneezeweed (*Helenium*

autumnale), and bitterweed, or pingue (*Hymenoxys richard-sonii*), induce sneezing, vomiting, and diarrhea. "Spewing sickness" is a name given to the syndrome of projectile vomiting associated with sheep eating orange sneezeweed over a period of weeks. If vomiting is not observed, affected sheep often have green rumen contents around the mouth and nostrils indicative of vomiting [40]. Anorexia, bloating, and teeth grinding indicative of abdominal pain may be observed. Muscle weakness, tremors, and severe weight loss often accompany the gastrointestinal signs. Liver degeneration as indicated by elevations in serum enzymes may be seen in severe cases [48]. Coughing may be an indication that inhalation of rumen contents and pneumonia have occurred. In such cases the prognosis is poor and the mortality rate is high.

The lactones in bitterweeds and sneezeweeds may also impart a bitter taste to milk, rendering it unpalatable [41].

Treatment

Affected animals should be removed from the pasture containing the sneezeweed and given good quality hay or pasture. Antibiotics are indicated if pneumonia is present. If a large amount of the sneezeweed or bitterweed has been consumed in the previous few hours, activated charcoal and osmotic laxatives may be helpful in eliminating the plant from the digestive system. The use of L-cysteine, a sulfur containing amino acid, is only of benefit counteracting the effect of the toxic lactones if it is given before clinical signs appear [46,47].

Postmortem findings in sneezeweed/bitterweed poisoning include severe glomerulonephritis and degeneration of the kidney cortex and medulla. Congestion of the abdominal organs and gaseous and fluid distention of the forestomachs, abomasum, and cecum are common. The liver often shows vacuolar degeneration around the central vein [48].

Prevention

The best way to reduce sheep losses to sneezeweed/ bitterweeds is to avoid herding sheep in areas heavily infested with the plant so that the sheep do not overgraze an area to the extent that they are forced to eat the weed. Moving the herd frequently prevents heavy consumption of the plant and reduces overgrazing an area that facilitates the proliferation of the sneezeweed or bitterweeds [49].

Orange Sneezeweed

Dugaldia hoopesii (*Helenium hoopesii*) - Asteraceae (Sunflower family)

Habitat

Orange sneezeweed is a perennial plant of high mountain rangelands from Montana and eastern Oregon south to New Mexico. It prefers moist areas at altitudes between 5000 and 10,000 feet and will become invasive in overgrazed mountain meadows.



Habitat of Orange Sneezeweed. *Dugaldia hoopesii* (*Helenium hoopesii*) - Asteraceae (Sunflower family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

The broad, basal clasping leaves are up to 12 inches (30 cm) in length. Flowers are large and showy with three to five toothed yellow-orange ray flowers. The disc is rounded and yellow in color (Fig. 3-14).



Figure 3-14. Orange sneezeweed (*Dugaldia hoopesii*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Orange sneezeweed contains sesquiterpene lactones, which are irritating to the nose, eyes, and gastrointestinal tract. The primary toxin is hymenovin (dugaldin), but other lactones including helenalin, helenanolide, tenulin, and hymenoxon, probably play a role in the toxicity [38]. Other than the direct irritant effects on the digestive system, the lactones have a profound effect on metabolism through their ability to bind with sulfhydryl groups [44,45]. In light of this, the toxicity of the lactones can be reduced if sulfur-containing amino acids (cysteine, methionine) or antioxidants such as butylated hydroxyanisole are fed before the bitterweed is consumed [46,47]. Lambs with sneezeweed poisoning develop a syndrome of weakness that results in them "falling behind" the flock specially when they are being herded.

Bitter Sneezeweed

Helenium amarum (*H. tenuifolium*) - Asteraceae (Sunflower family)



Habitat of Bitter Sneezeweed . *Helenium amarum* (*H. tenuifolium*) - Asteraceae (Sunflower family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Habitat and Description

A common weed preferring sandy soils in fields, woods, and waste areas of the southeastern States to Texas, *H. amarum* is an annual growing to 3 feet (1 meter) in height. The stems are not winged and branch terminally. The leaves are numerous, linear, and 1 to 3 inches (2.5 to 7 cm) in length. The flowers are produced terminally, the ray flowers being yellow and the disc flowers either yellow or purple (Fig. 3-15A).



Figure 3-15A. Sneezeweed (*Helenium amarum*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Bitter sneezeweed contains sesquiterpene lactones, which are irritating to the nose, eyes, and gastrointestinal tract. Tenulin is the most poisonous of the lactones found in bitter sneezeweed, but other lactones including, hymenovin, helenalin, helenanolide, and hymenoxon appear to contribute to the toxicity of the plant. Tenulin appears to be the principle compound that imparts a bitter taste to milk. Other than the direct irritant effects on the digestive system, the lactones (hymenoxon) have a profound effect on metabolism through their ability to bind with sulfhydryl groups causing a metabolic acidosis and hypoglycemia [44,45]. Consequently, the toxicity of the lactones can be reduced if sulfur-containing amino acids (cysteine, methionine) or antioxidants such as butylated hydroxyanisole are fed before the bitterweed is consumed [46,47].

Sneezeweed, Bitterweed

Helenium autumnale - Asteraceae (Sunflower family)

Habitat

Various forms of *H. autumnale* are found throughout North America except in the very north and southwestern states. Its preferred habitat is moist areas in meadows, waste areas, and roadsides.



Habitat of Sneezeweed, Bitterweed. *Helenium autumnale* - Asteraceae (Sunflower family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

Sneezeweed is a perennial growing to 4 feet in height. Stems arise from a fibrous root system, are winged, and branch terminally. The leaves are lanceolate, sparsely toothed, and 2 to 6 inches (5 to 15 cm) in length. The flowers are produced singly at the ends of branches. The ray flowers are yellow with three lobes and reflexed at maturity; the disc flowers are yellow (Fig. 3-15B).



Figure 3-15B. Bitterweed (*Helenium autumnale*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Sneezeweed contains sesquiterpene lactones, which are irritating to the nose, eyes, and gastrointestinal tract. The primary toxin is helenalin, but other lactones including helenanolide, tenulin, hymenovin, and hymenoxon, all of which have similar effects on the digestive system, contribute to its toxicity. Weight loss, vomiting, and secondary inhalation pneumonia are common clinical signs seen in animals with bitterweed poisoning.

Sneezeweed

Helenium microcephalum - Asteraceae (Sunflower family)

Habitat and Description

Primarily found in Texas and Mexico, it prefers moist soils of pastures and open woodlands. It is an annual herb, growing to 3 feet (1 meter) in height. The stems are winged and leaves are lanceolate, sparsely toothed below, entire above. The flowers are produced terminally and are smaller than those of *H. amarum* and *H. autumnale*. The yellow ray flowers are equal or shorter than the diameter of the reddish brown disc (Fig. 3-15C).



Figure 3-15C. Small head bitterweed (*Helenium microcephalum*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Sneezeweed contains sesquiterpene lactones (dugaldin, helenalin, helenanolide, tenulin, and hymenoxon), which are irritating to the nose, eyes, and gastrointestinal tract. Weight loss, vomiting, and secondary inhalation pneumonia are common clinical signs seen in animals with bitterweed and sneezeweed poisoning.

Colorado Rubberweed, Pingue

Hymenoxys richardsonii - Asteraceae (Sunflower family)

Habitat

Preferring drier sandy soils, Colorado rubberweed is found from Saskatchewan to Texas and westward to California.



Habitat of Colorado Rubberweed, Pingue. *Hymenoxys richardsonii* - Asteraceae (Sunflower family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

Rubberweed is a shrub-like perennial growing to 2 feet (0.5 meters) in height. Stems branch upward from a woody base. The stems have a conspicuous mass of white or brown hairs among the lower leaves. The leaves are linear, one to three times alternately divided. The basal leaves are densely grouped around the stem base. The yellow flowers, one to five per stem, are about 0.5 inch (1 cm) in diameter with 6 to 10 three-lobed ray florets, and 60 or more disc florets (Fig. 3-16A).



Figure 3-16A. Rubberweed, pingue (*Hymenoxys richardsonii*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Sesquiterpene lactones, which are irritating to the nose, eyes, and gastrointestinal tract are similar to those found in bitter sneezeweeds. The principle lactone involved with poisoning is hymenovin, with other compounds playing a role.

Bitterweed

Hymenoxys odorata - Asteraceae (Sunflower family)

Habitat and Description

A common weed of semiarid rangeland from Texas to Southern California, *H. odorata* is an erect, branching, annual weed growing up to 2 feet (0.75 meters) in height, and forming large stands (Fig. 3-16B). Leaves are alternate, once to three times divided into very narrow, hair-covered divisions. Showy flower heads are formed at tips of branches, bright yellow, up to 0.5 inch (1 cm) in diameter, with 6 or more ray florets, each trilobed.



Habitat of Bitterweed. *Hymenoxys odorata* - Asteraceae (Sunflower family). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-16B. Bitterweed (*Hymenoxys odorata*) (Courtesy Dr. Darrell N. Ueckert, Texas Agricultural Research and Extension Station, San Angelo, Texas). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Bitterweed contains sesquiterpene lactones, which are irritating to the nose, eyes, and gastrointestinal tract. The primary toxins are dugaldin, helenalin, helenanolide, tenulin, and hymenoxon, all of which have similar effects. Other than the direct irritant effects on the digestive system, the lactones (hymenoxon) have a profound effect on metabolism through their ability to bind with sulfhydryl groups. Consequently, metabolic acidosis and hypoglycemia develop rapidly [44,45]. In light of this, the toxicity of the lactones can be reduced if sulfur-containing amino acids (cysteine, methionine) or antioxidants such as butylated hydroxyanisole are fed before the bitterweed is consumed [46,47].

Desert Bailey, Desert Marigold

Baileya multiradiata - Asteraceae (Sunflower family)

Habitat and Description

Common to the semiarid region of the southwestern states and Mexico, desert bailey is an annual or in some areas a perennial. The plant is woolly, extensively branched from its base, growing to 18 inches (46 cm) in height. The leaves are numerous, alternate, with those at the base having long petioles and those higher up being smaller without a petiole. Showy yellow flowers are produced on long stems, each with one flower (Fig. 3-17). The flower heads, 1 to 2 inches (2.5 to 5 cm) in diameter, have 25 to 50 ray florets, which are reflexed when the flower matures.



Habitat of Desert Bailey, Desert Marigold. *Baileya multiradiata* - Asteraceae (Sunflower family). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-17. Desert bailey (*Baileya multiradiata*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Sesquiterpene lactones, which are irritating to the nose, eyes, and gastrointestinal tract, are similar to those found in bitter sneezeweeds.

Other common species of plant that contain sesquiterpene lactones with the potential to cause poisoning in livestock that eat them include paper flower (*Psilostrophe* spp.), *Gaillardia* spp., and copper weed (*Oxytenia* spp.) [38].

Field Bindweed, Morning Glory

Convolvulus arvensis - Convolvulaceae (Morning glory family)

Description

Bindweed is an extremely persistent, invasive, perennial noxious weed. It is a twining or creeping weed with alternate leaves and white or pink funnel-shaped flowers (See Fig. 1-14). The plant reproduces readily from seed and its extensive root system.

Principal Toxin

Tropane alkaloids (pseudotropine) with atropine-like action are present in all parts of the plant [50,51]. Calystegins present in bindweeds (*Calestegia* and *Convolvulus* spp.) inhibit glucosidase enzyme activity and therefore possibly play a role in poisoning animals that eat the plants (Fig. 3-18A and Fig. 3-18B) [52]. The glycosidase inhibitory activity of the calystegins is comparable to that of swainsonine, an indolizidine alkaloid found in locoweeds (*Astragalus* and *Oxytropis* spp.). Mice fed an exclusive diet of bindweed developed severe gastritis and liver necrosis possibly as a result of the combined effects of the toxins present in the plant [51]. Bindweed may also accumulate toxic levels of nitrate (See Chapter 1).



Figure 3-18A. Field bindweed (*Convolvulus arvensis*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Bindweed is most likely to cause poisoning in animals when pastures are over grazed and the bindweed becomes the predominant plant available for the animals to eat. Hay contaminated with large amounts of bindweed seed may also cause

colic especially in horses.



Figure 3-18B. *Calestegia sepium*. - To view this image in full size go to the IVIS website at www.ivis.org . -

Clinical Signs

Horses develop colic as the result of intestinal stasis and flatulence induced by the tropane alkaloids. An increased heart rate and dilated pupils may result if toxic levels of the bindweed are consumed. Affected horses should be removed from the source of the bindweed, and given symptomatic therapy for colic.

Nightshades

Solanaceae (Nightshade family) -

This large family of plants with some 88 genera and more than 2300 species has long been associated with poisoning of humans and animals. Deadly nightshade or belladonna (*Atropa belladonna*) was used in ancient times to dilate the pupils of women to enhance their beauty, and it has found use as a potent hallucinogen [53]. The black berries of belladonna, the showy red berries of Jerusalem cherry (*Solanum pseudocapsicum*), and bittersweet (*S. dulcamara*) have caused poisoning in people who eat them. Animals are rarely poisoned by belladonna and are more likely to be poisoned by various genera that include *Solanum* spp. (nightshades), *Datura stramonium* (jimson weed), *Hyoscyamus niger* (black henbane), *Lycopersicon* spp. (tomato), *Cestrum* spp. (jessamine), and *Physalis* (ground cherries or Chinese lanterns) [54,55]. The more common members of the nightshade family associated with poisoning in animals are presented in Table 3 - 2. Livestock may be poisoned if they are fed potatoes (*Solanum tuberosum*) after they have sprouted and the skins turned green [56]. Similarly green tomato vines may cause poisoning if fed to livestock. Potato plants, however, can be effectively used as a source of food for livestock if ensiled, or fed with grass hay or cereal grains [57].

Principal Toxin

A variety of steroidal (tropane) glycoalkaloids are found in the Solanaceae, especially in the green parts of the plant and the unripe fruits [58,59]. The more common alkaloids including solanine, hyoscine (scopolamine), and hyoscyamine (atropine) act similarly on the parasympathetic autonomic nervous system by competitively antagonizing the effects of acetylcholine at its receptor sites. This results in the accumulation of the neuro- transmitter acetylcholine, and consequently inhibition of the parasympathetic nervous system, causing decreased salivation and intestinal motility, dilated pupils, and tachycardia. The alkaloids also have a direct irritant effect on the digestive system causing colic, constipation, or hemorrhagic diarrhea.

In addition to the effects of the tropane alkaloids, some members of the Solanaceae have other toxic compounds, not least of which is the highly toxic alkaloid nicotine found in the tobacco plant (*Nicotiana* spp.). Livestock that have access to either cultivated or wild tobacco are easily poisoned by nicotine [54]. Sudden death of cattle has been attributed to the consumption of the wild tree tobacco (*N. glauca*) [60,61]. Also within the tobacco plant are alkaloids that cause fetal deformities if eaten by pigs and pregnant cows or sows [62]. (See Chapter 8).

Some species of *Solanum* including *S. fastigiatum*, *S. kwebense*, *S. dimidiatum*, *S. cinerum*, *S. suriale*, and *S. viarum* (tropical soda apple) have been associated with a neurologic disease in cattle, sheep, and goats characterized by loss of equilibrium, falling down, tremors of the head, incoordination, opisthotonus, and seizures [63-66]. The lesions produced in the brain are confined to the cerebellum and include finely vacuolated cytoplasm of the Purkinje cells and neurons, with degeneration and necrosis [65-67]. (See Chapter 6).

Table 3 - 2. Common Nightshades with the Potential for Causing Poisoning	
Common Name	Scientific Name
Black nightshade	<i>Solanum nigrum</i>
Huckleberry, wonderberry	<i>S. americanum</i>
Hairy nightshade	<i>S. sarrachoides</i>
Cutleaf nightshade	<i>S. triflorum</i>
Silverleaf nightshade	<i>S. elaeagnifolium</i>
Horse nettle, bull nettle	<i>S. carolinense</i>
Sodom apple	<i>S. sodomaeum</i>
Buffalo bur	<i>S. rostratum</i>
Tropical soda apple	<i>S. viarum</i>
Bittersweet, climbing nightshade	<i>S. dulcamara</i>

One species, *S. malacoxylon*, found in South America, contains vitamin D-like compounds toxic to cattle [69]. Affected animals absorb excessive amounts of calcium, which is deposited in tissues and results in severe lameness and weight loss (See Chapter 9).

Livestock will eat members of the nightshade family when other forages are scarce, or when crop residue products such as green-sprouted potatoes (*S. tuberosum*), potato vines and tomato plants are fed to them [55]. Signs of poisoning can be expected when 0.1 to 0.3 percent of an animal's body weight in green plant is eaten [54]. Grain contaminated with seeds of jimson weed (*Datura stramonium*) can be a significant source of poisoning [70]. Compared to other livestock, cattle may be more susceptible to the toxic effects of solanine alkaloids [71].

Clinical Signs

Initially there may be central nervous system excitement, but depression follows with increased heart and respiratory rate, muscle weakness, dilated pupils, colic, and watery diarrhea. Rupture of the stomach and paralysis of the digestive system in horses can be a sequel to the effects of the tropane alkaloids [70]. If large amounts of the tropane alkaloids are consumed over a short period of time, cardiac arrest may lead to death before digestive signs have time to develop.

Treatment

Animals showing severe anticholinergic signs consisting of muscle tremors, hyperesthesia, dilated pupils, intestinal stasis, and depressed respiratory rate may be treated with physostigmine [72,73]. Many animals, however, recover if treated symptomatically. Oral administration of activated charcoal as an adsorbent may be effective if given soon after the plants have been eaten.

Jimson Weed, Thornapple, Peru Apple, Stinkweed

Datura stramonium (*D. tatula*) - Solanaceae (Nightshade family)

Habitat

Introduced from the tropics, jimson weed has become a naturalized weed throughout North America, established in disturbed soils, disused corrals, roadsides, edges of cereal grain fields, and so on. Seeds are probably dispersed in cereal grains at harvest time. The name jimson weed or "Jamestown weed" was given to the plant in 1676, when a large number of soldiers were poisoned after eating the plant in Jamestown, Virginia.



Habitat of Jimson Weed, Thornapple, Peru Apple, Stinkweed. *Datura stramonium* (*D. tatula*) - Solanaceae (Nightshade family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

This erect, branching, glabrous, herbaceous annual often reaches heights of 3 to 6 feet (1 to 2 meters). Leaves are large, alternate, and simple with irregularly toothed edges. When crushed, the leaves have a strong, unpleasant odor. The showy, white, and sometimes purple fragrant flowers are carried singly in leaf axils (Fig. 3-19A). The large 2 to 4 inches (6 to 10 cm), funnel-shaped flowers with a flared end have five sections with tapering points. The characteristic fruit is a spiny capsule that, when ripe, splits open into four sections exposing many dark brown, flattened, kidney-shaped seeds with a pitted surface (Fig. 3-19B).



Figure 3-19A. Jimson weed flower and seed capsule (*Datura stramonium*). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-19B. Jimson weed seed capsule. - To view this image in full size go to the IVIS website at www.ivis.org . -

There are several similar poisonous species of *Datura* including sacred Datura (*D. meteloides*) (*D. innoxia*), oak leaf thornapple (*D. quercifolia*), and *D. metel*.

Sacred Datura, Tolguacha, Angel's Trumpet, Moonflower

Datura Wrightii (*D. meteloides*, *D. metel*) - Solanaceae (Nightshade family)

The sacred datura differs from jimson weed in that the leaves are grayish in color due to the covering of fine hairs, and the flowers are much larger 10 to 12 inches (20 to 30 cm). The fragrant white flowers open at night and last only a day (Fig. 3-20A). The nodding fruit capsules are covered with long, fine spines (Fig. 3-20B).



Figure 3-20A. Sacred datura (*Datura wrightii*). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-20B. Sacred datura seed capsule. - To view this image in full size go to the IVIS website at www.ivis.org . -

Angel's Trumpet

Brugmansia suaveolens (*Datura suaveolens*) - Solanaceae (Nightshade family)

Habitat and Description

Common in the southern states as an ornamental treelike shrub, angel's trumpet grows to 15 feet (5 meters) in height and produces numerous white, yellow, or pink, pendulous, large trumpet-like flowers 10 to 12 inches (20 to 30 cm) in length (Fig. 3-21). *Brugmansia* hybrids do not produce fruits but are easily propagated from cuttings.



Figure 3-21. Angel's trumpet (*Brugmansia* spp.). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxins

Datura species contain the tropane alkaloids hyoscyamine (atropine) and hyoscyne (scopolamine) [74]. Most poisoning of animals occurs when *Datura* seeds contaminate cereal grains that are fed to animals and birds [54,70,75-77]. The plant itself is rarely eaten because of its pungent odor and taste. Human poisoning most frequently occurs when the seeds are deliberately or unintentionally eaten or the leaves smoked or made into a tea [78-80]. The signs of jimson weed poisoning are essentially those attributable to atropine poisoning. In humans there is a period of hallucination before characteristic signs of decreased salivation, intense thirst, mydriasis, tachycardia, intestinal stasis, and eventual respiratory and cardiovascular collapse. In animals and birds the main effects seem to be on the digestive system causing intestinal stasis, decreased food consumption, and poor growth rates. Muscle tremors, disturbances in locomotion, hyperesthesia, rapid respiration, and decreased water consumption have been observed in sheep and goats experimentally poisoned with jimson weed [81].

Cattle fed approximately 107 *Datura* seeds per kilogram body weight experimentally developed anorexia and rumen stasis and did not succumb to severe atropine intoxication because they stopped eating the seeds [76]. Similarly pigs find the seed quite unpalatable and are likely to reject the contaminated food before becoming seriously intoxicated [77]. Horses fed jimson weed seed in corn developed anorexia, weight loss, thirst, tachycardia, dilated pupils, diarrhea, and excessive urination [70]. Death resulted from rupture of the stomach and paralysis of the digestive system. Treatment of jimson weed poisoning is rarely necessary, and the use of physostigmine to counteract the atropine-like effects of the alkaloids is controversial [82].

Conflicting reports exist as to the effects of jimson weed on the developing fetus. Piglets were reported to have developed bony deformities (arthrogryposis) after sows had consumed jimson weed in early gestation [83]. However, this teratogenic effect could not be reproduced experimentally [84].

Deadly Nightshade, Belladonna

Atropa belladonna - Solanaceae (Nightshade family)

Habitat and Description

Introduced from Europe, deadly nightshade has escaped from cultivation on occasion. It is a robust herbaceous plant arising from a perennial root and grows up to 5 to 6 feet (1 to 2 meters) in height. The leaves are large, ovate, entire, and alternate and occur in pairs at each node, one member of the pair always being smaller. The flowers are solitary, nodding, five-parted, tubular and purple in color. The fruit, a berry, turns purple to black when ripe (Fig. 3-22).



Figure 3-22. Belladonna flowers and fruits (*Atropa belladonna*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

The entire plant is poisonous because of the presence of the atropine-like alkaloid L-hyoscyamine, the isomeric form of atropine. The incidence of animal poisoning from deadly nightshade is rare. Because it is occasionally cultivated as an ornamental plant, it is a real hazard to children who are attracted to the black fruits.

Black Henbane

Hyoscyamus niger - Solanaceae (Nightshade family)

Habitat and Description

Black henbane is listed as a noxious weed in some areas, as it can be invasive in cultivated fields, roadsides and waste areas. It is a coarse, very hairy, sticky, branching annual or biennial, erect herb that grows to 5 feet (1 to 2 meters) in height. The leaves are alternate, simple, sessile, coarsely toothed, and 6 to 8 inches (10 to 18 cm) long. The flowers are greenish yellow or white with prominent purple veins. The flowers are produced in the leaf axils and are surrounded by a five-pointed calyx that enlarges to form the characteristic globular fruits (Fig. 3-23). The top of the capsular fruit detaches to release many gray-brown hard-coated seeds.



Habitat of Black Henbane. *Hyoscyamus niger* - Solanaceae (Nightshade family). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-23. Black henbane (*Hyoscyamus niger*). Inset: Flower and partially dissected fruit. - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

The tropane alkaloids, hyoscyamine, hyoscyne, and atropine, are found in all parts of the plant. Henbane has the potential to poison animals but because it is unpalatable, it is rarely eaten.

Black Nightshade

Solanum nigrum - Solanaceae (Nightshade family)

Habitat

Solanum nigrum is found throughout North America, preferring disturbed soils along roadsides, fences, and cultivated fields.



Habitat of Black Nightshade. *Solanum nigrum* - Solanaceae (Nightshade family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

Black nightshade is a hairless, spineless, erect, or trailing branched annual plant with simple ovate to lanceolate sinuate-toothed leaves. The flowers have five white petals arranged in a 0.5 to 1 cm (6 to 10 mm) star. The clusters of flowers arise from a stalk that is situated between leaf nodes. The smooth, round, 0.5 to 1 cm (5 to 10 mm) fruits are initially green, turning black when ripe (Fig. 3-24). The green fruits containing solanine are toxic but the ripe black fruits are edible.

Distinguishing between eastern black nightshade (*S. ptycanthum*), plains black nightshade (*S. interius*), and black nightshade (*S. nigrum*) is difficult and some consider these species to be identical. *S. americanum* is very similar, with edible black berries that are often referred to as "garden huckleberry" or "wonderberry" [54].



Figure 3-24. Black nightshade unripe and ripe berries (*Solanum nigrum*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

A variety of steroidal (tropane) glycoalkaloids are found in black nightshade, especially in the green parts of the plant and the unripe fruits [58,59]. The more common alkaloids including solanine, hyoscyne (scopolamine), and hyoscyamine (atropine) have similar effects on the parasympathetic nervous system by competitively antagonizing the action of acetylcholine at its receptor sites. This results in decreased salivation and intestinal motility, dilated pupils, and tachycardia. The alkaloids also have a direct irritant effect on the digestive system causing colic, constipation, or hemorrhagic diarrhea.

Bitter Nightshade, Climbing Bittersweet

Solanum dulcamara - Solanaceae (Nightshade family)

Habitat

Introduced from Europe, bitter nightshade has become established in most of North America, preferring moist soils of hedgerows, ditches, streams, and residential landscapes.

Description

Bitter nightshade is a trailing or climbing perennial with stems up to 10 feet (3 meters) in length. The leaves are heart-shaped with one to several basal leaflets. The flowers are star-shaped, with purple petals and prominent yellow or orange anthers. The fruits are berries that turn from green to yellow to red as they ripen (Fig. 3-25).



Figure 3-25. Bittersweet (*Solanum dulcamara*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Like other members of the nightshade family, glycoalkaloids are present in all parts of the plant. Livestock are not commonly poisoned by bittersweet unless they have access to a large quantity of the plants. Children are more likely to be affected after eating the attractive berries.

Silver Leaf Nightshade, White Horse Nettle, Tropillo

Solanum elaeagnifolium - Solanaceae (Nightshade family)

Habitat

Silver leaf nightshade is a weed of drier soils along roadsides, prairies, and unused areas, especially in the southern and western states.



Habitat of Silver Leaf Nightshade, White Horse Nettle, Tropillo. *Solanum elaeagnifolium* - Solanaceae (Nightshade family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

This nightshade is a perennial, branching, erect, spiny plant reaching 1 meter in height. It has an extensive root system. The leaves and stems are covered with white hairs. Leaves are simple, thick, linear to lanceolate, alternate, with spines along the main veins. Flowers are blue to purple and the fruits yellow to orange (Fig. 3-26).



Figure 3-26. Silver leaf nightshade (*Solanum elaeagnifolium*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Silver leaf nightshade contains the tropane alkaloid solanine that has similar properties to atropine, and acts on the gastrointestinal system [71]. Solanidine, a steroidal alkaloid, is also present and acts on the nervous system. All parts of the plant are toxic, the ripe yellow berries being most poisonous.

Horses that have recently been treated with the antiparasitic drug ivermectin and which then eat *S. elaeagnifolium* can develop a neurotoxicity due to the increased uptake of ivermectin in the brain [72]. Affected horses become severely depressed and ataxic. Drooling saliva, drooping lips and ears, and head pressing may develop and deaths have been reported [72]. High levels of ivermectin are detectable in the brains of fatally poisoned horses.

Horse Nettle, Bull Nettle

Solanum carolinense - Solanaceae (Nightshade family)

Habitat

This perennial weed is found in disturbed soils and unused areas along roads and field edges especially in the southern states.



Habitat of Horse Nettle, Bull Nettle. *Solanum carolinense* - Solanaceae (Nightshade family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

Horse nettle is an erect 16 feet (5 meters) high, branching plant with yellow spines on leaves and stems. The flowers are simple, alternate, oblong, and irregularly lobed. The flowers are pale violet to white in cluster near the top of the plant (Fig. 3-27). The five petals tend to be united. The fruits are yellow when ripe.



Figure 3-27. Horse nettle (*Solanum carolinense*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

The toxin is solanine, a tropane alkaloid with toxic properties similar to atropine.

Buffalo Bur, Kansas or Texas Thistle

Solanum rostratum - Solanaceae (Nightshade family)

Habitat

This is a common weed of drier, disturbed soils of the plains, roadsides, and so forth throughout the western and southern states.



Habitat of Buffalo Bur, Kansas or Texas Thistle. *Solanum rostratum* - Solanaceae (Nightshade family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

This annual weed grows 1 to 2 feet (0.5 to 1 meter) tall, with prominent long spines on the leaves and stems (Fig. 3-28). The flowers are yellow with five partially united petals and a very spiny calyx, which encloses the berry. Numerous seeds are produced.



Figure 3-28. Buffalo bur (*Solanum rostratum*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Solanine, a tropane alkaloid with toxic properties similar to atropine, is the main toxin. More often buffalo bur is a problem because the spiny burs cause mechanical injury, and devalue the fleece of sheep when it becomes entangled with burs.

Tropical Soda Apple

Solanum viarum - Solanaceae (Nightshade family)

Habitat

A common weed of South America, tropical soda apple has now invaded Florida and is spreading, being reported in states from Pennsylvania to Alabama and Mississippi. Cattle, goats, and wildlife that eat the fruits and pass the seeds through their feces to infect other areas spread this aggressive weed.



Habitat of Tropical Soda Apple. *Solanum viarum* - Solanaceae (Nightshade family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

Soda apple is a robust, erect, branching, perennial that grows to 4 to 6 feet (1 to 2 meters) in height. The stems and leaves are covered with sharp spines that deter animals from eating it. Fruits are about 1 inch (2.5 cm) in diameter, turning yellow when ripe (Fig. 3-29).



Figure 3-29. Soda apple (*Solanum viarum*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

The toxin responsible for causing cerebellar degeneration and the resulting neurologic disease has not been identified. Similar neurologic signs and cerebellar lesions have been seen in goats that have eaten *S. dimidiatum* and *S. cinereum* [65,67,68]. To date, goats seem to be the only livestock to develop this neurologic syndrome from eating soda apple.

Clinical Signs

Goats develop a neurologic syndrome that consists of fine head and neck tremors and occasional general muscle spasms [68]. The tremors become pronounced during attempts to eat and drink. Affected goats maintain a base-wide stance and have a jerky, uncoordinated gait affecting the hind limbs most severely. General muscle weakness is common. Blindness is not a feature of the disease, but if blindfolded, the goats become dis-oriented and cannot maintain their balance.

There is no known specific treatment for soda apple poisoning. Affected animals should be denied further access to the plants and a nutritious diet provided. Recovery from the cerebellar lesions depends on the severity and duration of the disease. Histologic lesions in the brain consist of fine vacuolation of the Purkinje cells and neurons [68].

Ground Cherries

Physalis spp. - Solanaceae (Nightshade family)

There are many species of *Physalis* throughout the United States that are potentially toxic to livestock and people owing to the presence of glycoalkoids including solanine. Symptoms of poisoning would therefore resemble those seen in poisoning caused by other plants of the genus *Solanum*. Only a few of the more common species will be described because they have characteristic features common to all species of *Physalis* that make them easily recognizable.

Ground Cherry

Physalis virginiana - Solanaceae (Nightshade family)

Habitat

The plant prefers the dry soils of the plains, roadsides, and waste ground.



Habitat of Ground Cherry. *Physalis virginiana* - Solanaceae (Nightshade family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

Ground cherry is an erect, 2 to 4 inches (5 to 10 cm) high, branching herbaceous, hairy plant. Leaves are alternate, ovate, and broadly toothed. The five-lobed, bell-shaped, drooping flowers are pale yellow with a dark center and are produced at the leaf axils. The characteristic fruit is covered by an enlarged podlike calyx that turns papery brown when the enclosed berry is mature (Fig. 3-30A).



Figure 3-30A. Ground cherry (*Physalis virginiana*). - To view this image in full size go to the IVIS website at www.ivis.org . -

A closely related plant is the Chinese lantern *P. lobata* (*Quincula lobata*). It is a more prostrate plant and has showy blue flowers (Fig. 3-30B).

Principal Toxin

The main toxin is solanine, a tropane alkaloid with toxic properties similar to atropine.



Figure 3-30B. Ground cherry (*Physalis lobata*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Diarrhea

A variety of common plants may cause diarrhea when they are eaten by animals that do not have good quality forages available to them. Invasive pasture plants such as *Euphorbia esula* (leafy spurge), *Iris missouriensis* (wild iris), *Equisetum arvense* (horse tail, scouring rush), *Helenium* spp. (bitter weeds), pokeweed (*Phytolacca americana*), and a variety of *Brassica* spp. (mustards) may cause colic and diarrhea. English ivy, which can invade animal pastures and fence rows accessible to livestock, may cause gastroenteritis, colic, and diarrhea (Table 3-3).

Leafy Spurge

Euphorbia esula - Euphorbiaceae (Spurge family)

Habitat

Introduced from Eurasia, leafy spurge has become a troublesome weed of North America where it has infested millions of acres in Canada and the north-central United States. It is listed as a noxious weed in most states because of its ability to proliferate and displace normal forages.



Habitat of Leafy Spurge. *Euphorbia esula* - Euphorbiaceae (Spurge family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

Leafy spurge is a prolific perennial, up to 3 feet (1 meter) tall, that reproduces by seeds and an extensive root system. Leaves are alternate, narrow 1 to 4 inches (2 to 10 cm) long. Multiple stems arise from root crowns. The plant contains a milky sap in the stems and leaves. The flowers are small and yellowish green in color and are arranged in terminal clusters. Conspicuous yellowish green heart-shaped bracts (often mistaken as the flower) surround each flower (Fig. 3-31A). Seed capsules explode when dry, scattering the seeds widely, which aids in the plant's rapid proliferation.



Figure 3-31A. Leafy spurge (*Euphorbia esula*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Other spurges are potentially toxic to animals and include the tropical pencil tree (*Euphorbia tirucalli*), and snow on the mountain (*E. marginata*) (Fig. 3-31B). Myrtle spurge (*E. myrsinites*) (Fig. 3-31C) has a particularly irritating sap that causes dermatitis in some people who handle the plant.



Figure 3-31B. Snow on the mountain (*Euphorbia marginata*). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-31C. Myrtle spurge (*Euphorbia myrsinites*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

The specific toxin in leafy spurge has not been defined. Cattle, through negative feedback, learn to avoid eating the plant once they have initially consumed small amounts of the plant [85]. Terpenes appear to be the aversive chemical in the plant [86]. Even ensiling leafy spurge does not improve its palatability [87]. Sheep and goats readily eat leafy spurge and appear to be unaffected by it.

Table 3 - 3. Miscellaneous Plants Infrequently Associated with Gastrointestinal Poisoning		
Scientific Name	Common Name	Symptoms
<i>Achillea milleform</i>	Yarrow	Colic, diarrhea
<i>Baccharis halimifolia</i>	Eastern baccharis	Colic, diarrhea, staggering, trembling
<i>Brassica</i> spp.	Mustards	Colic, hemorrhagic diarrhea
<i>Cephalanthus occidentalis</i>	Button bush	Vomiting, weakness, death
<i>Datisca glomerata</i>	Durango root	Anorexia, diarrhea, depression, death
<i>Hedera helix</i>	English ivy	Colic, diarrhea
<i>Hydrangea</i> spp.	Hydrangea	Hemorrhagic diarrhea
<i>Iris</i> spp.	Iris	Colic, diarrhea
<i>Phoradendron</i> spp.	Mistletoe	Severe colic and diarrhea
<i>Tulipa</i> spp.	Tulips	Colic, diarrhea

Clinical Signs

Spurges are usually not eaten by cattle when other forages are available. Sheep and goats, however, will eat the plants without apparent problem [88]. Spurges cause excessive salivation in some animals due to the irritant effects of the plant sap. Cattle frequently develop diarrhea if they are compelled to eat leafy spurge. Recovery is rapid once animals are provided more nutritious food.

Note - Leafy spurge is a noxious weed that should be vigorously controlled to prevent its rapid invasion of pastures and rangeland where it will displace nutritious forbes and grasses. Sheep are effective biologic controls for leafy spurge and can be profitably used to graze rangeland heavily infested with leafy spurge [89]. Sheep can eat diets containing up to 40 to 50 percent leafy spurge without any evidence of disease or decrease in weight gain [90]. The sheep can reduce the plant's biomass and density but will not eradicate it. Approximately 5 percent of leafy spurge seeds eaten by sheep remain viable in the feces, and, therefore, sheep can help spread the plant if not appropriately managed. Ideally sheep should be used to graze the leafy spurge before it flowers and the seeds are produced. If sheep are grazing the plant when it has seeds, they should be kept confined for at least 5 days before they are moved to leafy spurge-free areas [91].

Lectins

A group of unrelated plants including castor bean (*Ricinus communis*), rosary pea (*Abrus precatorius*), and black locust (*Robinia pseudoacacia*) contain highly poisonous compounds called lectins that are capable of causing severe poisoning in humans and animals. Lectins are some of the most toxic of known plant compounds, and as glycoproteins (toxalbumins) are capable of binding to receptor sites on cells causing inhibition of protein synthesis and cell death. Lectins are concentrated in the seeds, and it is the consumption of the seeds that is most commonly the cause of poisoning in humans and animals. The seeds have a tough outer coating and unless it is disrupted through chewing, the seeds will pass through the digestive system without causing problems. Castor beans and rosary peas have a long history of causing poisoning in children and adults [92-95]. Cattle, goats, horses, poultry, and dogs have been poisoned by castor beans, and less frequently by rosary peas when they contaminate animal foods [95-101]. Cattle fed "cake" made from castor beans following the extraction of castor oil may be poisoned unless the cake is first treated with heat to destroy the ricin [95,102]. Properly detoxified castor bean meal is a useful protein source for cattle.

Principal Toxins

The principal toxins in castor beans, rosary peas, and black locust are the glycoproteins ricin, abrin, and robinin, respectively. Castor oil derived from the beans contains ricinoleic acid, an irritant that can cause severe intestinal irritation with profound purgation. Various other alkaloids and proteins are present in the seeds but are generally not toxic and have been used for a multitude of medicinal purposes [103]. Some of the proteins act as agglutinins and are capable of causing red blood cell agglutination in vitro [96]. Agglutination is not a feature of orally ingested castor beans, and ricin, when injected systemically, does not cause hemolysis, indicating that compounds other than ricin are involved [104].

Lectins, comprising two peptide chains joined by sulfide bonds, are capable of binding to certain cell receptor sites and inhibit cellular protein synthesis in the ribosomes [105]. Because this process takes time to occur, clinical signs of poisoning do not occur for several days after the ingestion of the lectins [105]. An additional property of lectins, being proteins, is their ability to induce antibody formation when injected into animals, a factor that has been explored in an attempt to develop antitoxins to ricin and abrin [104]. The allergic reaction encountered in humans exposed to dust from castor beans is not a reported problem in animals [103,107]. Ricin is also capable of inhibiting the growth of tumor cells that may have potential for treating some tumors [108].

Ricin and abrin are some of the most poisonous plant compounds known, especially when administered by injection. As little as 1 mg ricin is lethal to humans [93]. Reports of castor bean poisoning have varied considerably as to the number of beans that will induce poisoning and death [89]. This may be accounted for by variations in the quantity of ricin present in some castor beans and the degree to which the beans had been chewed before they were swallowed. Human poisoning has occurred when 2.5 to 20 castor beans have been eaten, and animals may be fatally poisoned with 4 to 11 beans [103]. A dose of 2 g/kg body weight of ground castor beans is reported as lethal in cattle [109]. Horses are reportedly fatally poisoned by as few as 60 seeds; ruminants appear to be less susceptible because abrin is broken down in the rumen [110]. Goats experimentally fed 1 to 2 g/kg body weight of ground *A. precatorius* seeds died 2 to 5 days later [96]. Thousands of wild ducks have been fatally poisoned by eating castor beans, and experimentally domestic ducks could be poisoned by three to four seeds [111]. Studies in mice and dogs in which pure abrin and ricin were injected experimentally demonstrated that the minimum lethal dose was 0.7 and 2.7 $\mu\text{g}/\text{kg}$ body weight, respectively [104].

In reexamining the literature on castor bean poisoning in humans, Rauber and Heard propose a much less severe prognosis for poisoning in humans in light of modern medical practices [93]. Rapid removal of the castor beans from the stomach and aggressive fluid and electrolyte therapy to counteract the primary effects of diarrhea and dehydration greatly reduce the incidence of fatalities.

Plant parts of castor beans and rosary peas, other than the seeds, are rarely reported as a cause for poisoning in animals. Although the leaves of the castor bean plant are rarely eaten, they are reported to be toxic [112]. Cattle fed castor bean leaves develop signs distinct from those associated with ricin. Affected animals develop neuromuscular impairment characterized by muscle weakness, tremors, salivation, and excessive eructation [112]. Recovery may occur after a short period or the animal dies, presumably as a result of the quantity of leaves consumed.

Clinical Signs

The signs of castor bean and rosary pea poisoning are primarily associated with severe gastrointestinal irritation, and begin several days after the consumption of a toxic dose of lectins [96,100,101,109,110]. Affected animals stop eating and develop

a severe hemorrhagic diarrhea. Lactation stops abruptly. Abdominal pain is often severe. In the case of black locust poisoning, horses, in particular, may also develop dilated pupils and cardiac arrhythmias [114]. Rapid loss of water and electrolytes through the diarrhea results in dehydration and hypovolemic shock. Increases in serum liver enzymes, creatinine, urea nitrogen, and sodium and potassium levels, and a decrease in serum total protein reflect the loss of fluid and electrolytes and the effects of the lectins on organ function [96]. Animals left untreated die from hypovolemic shock.

Postmortem findings include severe pulmonary congestion, ulceration of the stomach and intestines, and fatty degeneration and necrosis of the liver and kidneys [96].

Diagnosis

The diagnosis of castor bean or rosary pea poisoning can be difficult to confirm unless animals are observed eating the seeds or the intact seeds or parts thereof are identifiable in the digestive tract at postmortem examination. Because it resembles sunflower and cotton seed cake, castor bean meal can be recognized in animal feeds by microscopic examination for the characteristic seed hull fragments [110].

Treatment

Treatment is directed at removing the seeds from the stomach and digestive tract as quickly as possible. Vomiting can be induced in dogs and cats, or endoscopy can be used to remove the seeds from the stomach. Orally administered activated charcoal is of benefit. If cattle are known to have consumed feed contaminated with castor beans within the past day, purgatives such as magnesium hydroxide may be helpful in removing the toxin from the digestive system. Animals with diarrhea and resulting dehydration and hypovolemic shock should be given intravenous fluids and electrolytes. Such treatment has been the main reason that fatalities in humans who have consumed castor beans have been virtually eliminated [93,115]. The use of immune serum to treat ricin poisoning is rarely necessary [115].

Castor Bean

Ricinus communis - Euphorbiaceae (Spurge family)



Habitat of Castor Bean. *Ricinus communis* - Euphorbiaceae (Spurge family) - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

Castor bean is an annual herb or short-lived perennial, and small tree in warmer areas. It is often cultivated as a garden annual. The leaves are alternate, large, and palmate, with 5 to 11 serrate lobes (Fig. 3-32A). The petioles have conspicuous glands. New leaves are usually purple. The plants are monoecious. The flowers have no petals and are borne in terminal panicles with staminate (male) flowers below and pistillate (female) above. The calyx is of three to five parts, and the stamens are numerous, with many branched filaments. The ovary has three cells with one ovule in each cell; the styles are deep red with fine feather-like hairs. The fruit is a spiny capsule, which splits into three sections, each containing a shiny seed with gray and brown mottling (Fig. 3-32B).



Figure 3-32A. Castor bean plant with flower spike and spiny seed capsules (*Ricinus communis*). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-32B. Castor beans (*Ricinus communis*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

A lectin, ricin, is the principal toxin. All parts of the plant are toxic with the seeds containing the highest concentration of ricin, a heat-labile glycoprotein (toxalbumin). Other compounds in the seeds are responsible for agglutination and hemolysis. Ricinoleic acid present in castor oil is primarily responsible for its purgative action.

Note - Castor oil cake is poisonous to ruminants unless it has been heat treated. Castor bean plants should not be planted in or near livestock enclosures.

Precatory Bean, Rosary Pea, Jequirity Bean, Crab's Eye

Abrus precatorius - Fabaceae (Legume family)

Habitat

A weed of fence rows, roadsides and citrus groves, precatory bean was introduced from tropical countries. It has become established in Florida.



Habitat of Precatory Bean, Rosary Pea, Jequirity Bean, Crab's Eye. *Abrus precatorius* - Fabaceae (Legume family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

Precatory bean is a twining, perennial vine, 10 to 20 feet (3 to 6 meters) long, using other plants for support. Lower, older portions of the stem become gray; the younger portions remain green. The leaves are alternate, opposite pinnately compound with 8 to 15 pairs of leaflets. The flowers are in axillary racemes and are red to purple in color. The fruit is a legume pod, 2 inches (4 cm) long, and produces ovoid seeds that are glossy red with a jet black eye (Fig. 3-33A and Fig. 3-33B). Some varieties have seeds that are black with a white eye or are white with a black eye.



Figure 3-33A. Precatory bean vine and pods with seeds (*Abrus precatorious*). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-33B. Precatory beans (*Abrus precatorious*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Abrin, like ricin from castor beans, is a potent lectin found in highest concentration in the seeds. Other toxic compounds are also present in the seeds. Only if the seeds are chewed and swallowed is the lectin released. Abrin is one of the most toxic compounds known, requiring as little as 0.00015 percent of a person's body weight to be fatal. Animals are infrequently poisoned.

Black Locust

Robinia pseudoacacia - Fabaceae (Legume family)

New Mexican Black Locust

Robinia neomexicana - Fabaceae (Legume family)

Habitat

Usually around dwellings and along fence rows, black locust is common in the southwestern states. It occasionally forms

dense stands. *Robinia neomexicana* often grows along streams and in valleys.



Habitat of Black Locust / New Mexican Black Locust. *Robinia pseudoacacia* / *Robinia neomexicana* - Fabaceae (Legume family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

Black locust is a small tree up to 70 feet (21 meters) tall. The trunk is straight and slender; branches are spiny and glabrous when young. The leaves are alternate, pinnately compound with entire, elliptical leaflets in 3 to 10 pairs. The individual flowers are showy, white, and pealike, forming drooping clusters, 4 to 8 inches (10 to 20 cm) long (Fig. 3-34A). The fruit is a straight, flat, many-seeded brown legume pod.



Figure 3-34A. Black locust (*Robinia pseudoacacia*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Robinia neomexicana differs from *R. pseudoacacia* in that it has rose-pink flowers, hairy leaflets, finely haired young twigs and glandular hairy pods (Fig. 3-34B).



Figure 3-34B. Black locust (*Robinia neomexicana*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Robin, a lectin, is similar to but less toxic than ricin found in castor beans. The bark and seeds have the highest concentrations of lectins; the flowers are not toxic.

Note - Locust trees of the genus *Gleditsia*, commonly referred to as honey locusts, are unrelated to the black locust and are not poisonous.

Mistletoes (*Phoradendron* spp.) and *Viscum* spp. (English mistletoe) also contain toxic lectins that can cause severe gastrointestinal irritation resulting in vomiting and diarrhea. Cardiovascular collapse with brady- cardia and hypotension may occur when a large dose of mistletoe has been eaten. Animals are rarely poisoned by mistletoe. Children are most likely to be poisoned after eating the white berries when mistletoe is brought into the house for festive occasions.

Mayapple, Mandrake

Podophylum peltatum - Berberidaceae (Barberry family)

Habitat

Mayapple is an indigenous plant of eastern North America extending westward to Minnesota and Texas. It prefers moist, fertile soils of woodlands and pastures.



Habitat of Mayapple, Mandrake. *Podophylum peltatum* - Berberidaceae (Barberry family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

Mayapple is a perennial herb, 1.5 to 2 feet (0.5 to 0.60 meters) tall, with a simple stem bearing two large umbrella-shaped, five to nine lobed, hairless leaves. A single, white, nodding, flower, with six to nine petals is produced at the junction of the two leaf stems. The fruit is a 1 to 2 inch (2.5 to 5 cm) fleshy berry that turns yellow when ripe (Fig. 3-35). The plant spreads by a fibrous creeping root system.



Figure 3-35. Mayapple, mandrake (*Podophyllum peltatum*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Podophyllin, a bitter, resinous compound, is found in all parts of the plant. The ripe yellow fruit, however, is edible. Podophyllin acts as an irritant and has strong laxative properties. It also interferes with cell division and may have anticancer properties [116]. Livestock generally will not eat the plant unless deprived of their normal forages. Human poisoning occurs more commonly when unripe mayapples are eaten or when parts of the plant are inappropriately used as a medicinal herb.

Clinical Signs

Colic and diarrhea are the major signs of mayapple poisoning. Excessive salivation and swelling of the muzzle, intermandibular area, and eyelids may result from the irritant effects of the resinous toxin [117]. Excitement lasting about a day is a reported symptom of mayapple poisoning. Most animals will recover once they are prevented from eating the plant.

Privet

Ligustrum vulgare - Oleaceae (Olive family)

Description

Privet is a deciduous shrub, with opposite, lanceolate leaves 1 to 2 inches (2 to 5 cm) long. The leaves are dark green on the upper surface and paler underneath. Some varieties have yellow or white marbling. Numerous small, white flowers are produced in clusters at the ends of the branches (Fig. 3-36). The fruits are drooping clusters of black berries containing one to four seeds.



Figure 3-36. Privet (*Ligustrum vulgare*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

The toxin has not been identified. However, it has irritant properties that cause gastroenteritis, hypotension, and kidney damage. The berries and leaves are toxic. Animals rarely eat the plant unless they are hungry and deprived of normal forage.

Privet hedges should be avoided around livestock corrals or pastures and pruned leaves and branches should not be given to livestock.

Clinical Signs

Vomiting, abdominal pain, and diarrhea are common signs of privet poisoning. Hypotension and kidney failure will occur in severe cases, and death may occur within a day of eating a lethal amount of the plant [118].

Rhododendron - Ericaceae (Heath family)

Rhododendrons and closely related species including azaleas (*Rhododendron* spp.), laurel (*Kalmia* spp.), fetter-bush (*Leucothoe* spp.), mountain fetter-bush (*Pieris* spp.), maleberry (*Lyonia* spp.), mock azalea (*Monziesia* spp.), and Labrador tea (*Ledum* spp.) are both wild and cultivated plants of North America. All are poisonous to animals that eat them [119-128]. The honey produced by bees feeding on the nectar of rhododendrons is also poisonous to people eating it [129,130].

Principal Toxin

Members of the *Ericaceae* (Heath) family contain grayanotoxins (andromedotoxin, deacetylandromedol, deacetylanhydroandromedol) that are water-soluble diterpenoid compounds. All parts of the plant, including the nectar of the flowers, contain the toxins.

Animals are most often poisoned during the winter because rhododendrons retain their green leaves year round in milder climates. As little as 0.2 percent of an animal's body weight of green leaves can cause poisoning. Cattle, sheep, goats, occasionally horses, and rarely other animals and birds have been poisoned by members of the *Ericaceae* [121,123,125,131]. Goats seem to be particularly susceptible to poisoning by rhododendrons. Grayanotoxins act by binding to cell membranes, thereby affecting sodium channels and causing prolonged depolarization of cells. The primary effects are on the heart, nervous system, and gastrointestinal tract [132-134]. A glycoside, arbutin, present in the plants may contribute to the toxicity of the *Ericaceae*.

Clinical Signs

Animals poisoned by rhododendrons initially have clinical signs of digestive disturbances characterized by anorexia, excessive salivation, vomiting, colic, and frequent defecation [119-128]. In severe cases, muscle weakness, bradycardia, cardiac arrhythmia, weakness, paralysis, and coma may precede death. Regurgitation of rumen contents may result in inhalation pneumonia. Fetal mummification has been reported in goats following severe Japanese pieris poisoning [135]. Depression, vomiting, slow erratic heart rate, painful neck, and weakness are reported in people who have consumed "mad honey" made by bees feeding on rhododendrons or who have consumed tea made from the leaves of rhododendrons [124,130,135-137].

Diagnosis

A diagnosis of rhododendron and laurel poisoning is usually based on the clinical signs and evidence that the plant has been consumed. Postmortem findings are not specific and generally consist of multiple hemorrhages on internal organs. The detection of grayanotoxins in the rumen contents is also possible and is a means of confirming rhododendron poisoning [137].

Treatment

Animals should be removed from the source of the toxic plants and given supportive therapy. Osmotic laxatives such as magnesium sulfate and activated charcoal may be useful early in the course of poisoning to reduce further intestinal absorption of the toxins. Oral and intravenous fluids should be given as necessary to counteract the effects of vomiting and diarrhea. If cattle, sheep, or goats are observed eating significant quantities of rhododendron or other related plants containing grayanotoxins, a rumenotomy may prove life-saving to remove the rhododendron leaves and prevent further absorption of the toxins. If severe bradycardia is present, atropine to increase the heart rate is indicated.

Rhododendron (Azalea)

Rhododendron spp. - Ericaceae (Heath family)

Habitat and Description

There are at least 250 species of rhododendrons found mostly in the acidic soils of western and eastern North America. Many hybrids have been developed for their showy flowers. Generally they are large shrubs or open trees growing to heights of 30 feet (10 meters) or more. The leaves are alternate, simple, leathery, lanceolate, and often evergreen. The flowers are produced in large, showy, terminal clusters, ranging in color from white to purple, to red (Fig.3-37A and Fig.3-37B). The fruits are elongated capsules that split into five sections to release the small, scalelike seeds.



Habitat of Rhododendron (Azalea). *Rhododendron* spp. - Ericaceae (Heath family). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-37A. Catawba rhododendron (*Rhododendron catawbiense*). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-37B. Great laurel (*Rhododendron maximum*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Azaleas are considered by some to be a subgenus of rhododendron (Fig. 3-37C). Azaleas are generally deciduous and have been extensively hybridized to produce showy garden and house plants in a wide spectrum of colors.



Figure 3-37C. Flame azalea (*Rhododendron calandulaceum*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

All parts of the plant including the nectar contain grayanotoxins. Most poisoning occurs in the winter months because the leaves are generally evergreen and are attractive to animals when other forages are unavailable. Animals eating approximately 0.2 percent of their body weight of leaves are likely to develop signs of poisoning.

Mountain Laurel

Kalmia latifolia - Ericaceae (Heath family)

Habitat and Description

Laurels are common to the eastern and southern areas of North America. They are common branching shrubs or small trees with glossy green, alternate, lanceolate leaves. The characteristic white to pink flowers are produced in showy clusters (Fig.3-38A and Fig.3-38B).



Habitat of Mountain Laurel. *Kalmia latifolia* - Ericaceae (Heath family). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-38A. Mountain laurel blooming shrub (*Kalmia latifolia*). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-38B. Mountain laurel flowers (*Kalmia latifolia*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Grayanotoxins (andromedotoxin) and a glycoside arbutin are the principal toxins present in all parts of the plant. Similar toxins are also present in the genera *Rhododendron* (azalea), *Leucothoe* (fetter-bush), *Pieris* (mountain fetter-bush), and *Lyonia* (maleberry). The principal actions of the toxin are gastrointestinal irritation and disruption of myocardial activity.

Clinical Signs

All animals are susceptible to laurel poisoning. Affected animals may show excessive green frothy salivation, vomiting, colic, frequent defecation, depression, weakness, and ataxia. Depending on the quantity of laurel that has been eaten, affected animals may become recumbent and comatose before death.

Treatment

Mineral oil via nasogastric tube and intravenous fluid therapy should be administered as necessary.

Japanese Pieris

Pieris japonica - Ericaceae (Heath family)

Habitat and Description

Introduced from Japan, *P. japonica* is grown as an ornamental flowering shrub in the acidic soils of eastern and western North America. Several species of *Pieris* are indigenous. Leaves are generally alternate, dark green, toothed, and evergreen. New foliage is bronze in color. The terminal flowers are in drooping panicles and white to pink in color (Fig. 3-39).



Habitat of Japanese Pieris. *Pieris japonica* - Ericaceae (Heath family). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-39. Japanese pieris (*Pieris japonicus*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Grayanotoxins (andromedotoxin) are the principal toxins and are present in all parts of the plant.

Fetter-Bush, Black Laurel

Leucothoe spp. - Ericaceae (Heath family)

Habitat and Description

Several species are grown for their attractive foliage and flowers in the eastern and western regions of North America. Shrubs 4 to 6 feet (1 to 2 meters) in height, with leaves evergreen or deciduous, alternate, and carried on arching branches. Some cultivars have reddish purple leaves. Flowers are white to pink, borne along or at the tips of branches, and with five small teeth at the top of the flower (Fig. 3-40).



Habitat of Fetter-Bush, Black Laurel. *Leucothoe* spp. - Ericaceae (Heath family). - To view this image in full size go to the IVIS website at www.ivis.org . -



Figure 3-40. Fetter-bush (*Leucothoe* spp.). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Grayanotoxins (andromedotoxin) are the principal toxins in fetter-bush and are present in all parts of the plant.

Maleberry

Lyonia ligustrina - Ericaceae (Heath family)

Description

These shrubs are 2 to 3 feet (0.5 to 1 meter) tall with alternate, deciduous, hairless, elliptical leaves, growing mostly in the southeastern region of North America. Flowers are white, 0.3 to 0.5 cm (3 to 5 mm) in length, in clusters at the ends of branches. Fruits are round capsules (Fig. 3-41).



Figure 3-41. Maleberry flowering branch (*Lyonia ligustrina*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

Grayanotoxins (andromedotoxin) are present in all parts of the plant.

Common Box

Buxus sempervirens - Buxaceae (Box family)

Habitat

Originally from Europe and Asia, box is widely grown in North America as an ornamental shrub or hedge.



Habitat of Common Box. *Buxus sempervirens* - Buxaceae (Box family). - To view this image in full size go to the IVIS website at www.ivis.org . -

Description

Box is a heavily branched, perennial woody shrub, with dark green, opposite, leathery leaves up to 1.5 inches (4 cm) in length (Fig. 3-42). The undersides of the leaves are lighter green or grayish in color. Small star-shaped yellow-green flowers are produced in the leaf axils.



Figure 3-42. Box (*Buxus sempervirens*). - To view this image in full size go to the IVIS website at www.ivis.org . -

Principal Toxin

All parts of the plant contain toxic alkaloids, the mode of action of which is yet to be defined. Horses, cattle, sheep, pigs, and camels are susceptible to poisoning from *Buxus* spp. [138]. Approximately 1.5 lb of green leaves may be lethal to an adult horse. Most poisoning occurs when box clippings are carelessly fed to animals or when box hedges are placed around animal enclosures.

Clinical Signs

Severe gastroenteritis, colic, and hemorrhagic diarrhea can be expected in poisoned animals. In acute poisoning, death results from respiratory failure [138].

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