

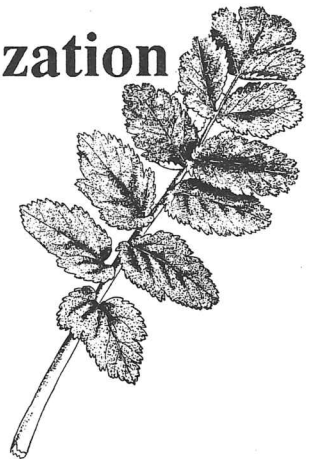
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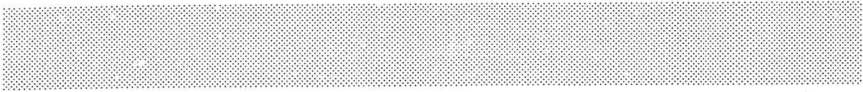
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Plants in Australia which when eaten produce photosensitization in livestock

By T.E.H. Aplin, Botanist



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Plants in Australia which when eaten produce photosensitization in livestock

By T.E.H. Aplin, *Botanist*

Photosensitization is the term used to describe inflammation of the skin (usually unpigmented) caused by photodynamic compounds, circulating in blood stream, becoming bound to dermal cells and fluorescing when the animal is exposed to ultraviolet light (290-400 nm).

Photosensitization usually occurs when an animal eats certain plants that contain photodynamic compounds. These compounds can be deposited unchanged in the skin after ingestion, the normal liver being incapable of excreting the native fluorescent compound. This is termed type 1 photosensitization and the compounds involved are naphthodianthrone derivatives. Photodynamic compounds can also be produced through aberrant metabolism by the liver due to a genetic deficiency of specific metabolic enzymes. This is termed type 2 photosensitization.

The most common type of photosensitization is hepatogeneous (type 3) photosensitization. This occurs when a functionally damaged liver fails to excrete a photodynamic metabolite of green feed. All plants contain chlorophyll in their leaves and when ingested by a herbivore this compound is converted to phylloerythrin by the action of microbes in the gastrointestinal tract. Phylloerythrin, a photodynamic compound, is usually excreted in the bile by the normal liver. However, any pathological process that interferes with the excretion of bile by the liver for more than a few days is

likely to result in a build-up of phylloerythrin in the blood stream and photosensitization of the unpigmented skin of the animal.

Photosensitization caused by plants may be distinguished from true sunburn by differences in activating wave lengths of light. Photosensitivity has been shown to occur following exposure to a wide range of wave lengths at the blue end of the visible spectrum and in the longer ultraviolet. True sunburn on the other hand is brought about by exposure to light in the short ultraviolet wave lengths.

In cases of photosensitization the capillary walls become abnormally permeable in the surface beds where reaction takes place. There is some evidence to suggest that proteins (particularly the amino acids histadine, tryptophan and tyrosine) in the presence of photodynamic compounds, provide the substrate for light-enhanced oxidations to take place. These oxidations result in cellular damage or in the alteration of the permeability of the cell membrane. Both the reactant substance and light are necessary for photosensitization to take place.

Photosensitization usually occurs in areas of unpigmented or lightly-pigmented skin which are not covered by a dense light-screening coat of hair.

Animals affected by photosensitization are at first restless. This is followed by reddening of the skin, which is in turn followed by fluid build-up (oedema) under the skin of affected parts. The oedema is caused by leakage of serum from the capillary beds. In severe cases there is leakage of serum through the skin. Death of tissues follows and in time varying amounts of skin slough off, depending upon the severity of photosensitization. In severe cases lips may be lost and ears seriously deformed. Intense itching and rubbing trauma is commonly followed by secondary invasion by bacteria. Deaths result from starvation, other secondary effects or from liver damage. The inability to eliminate pigmented molecules results in generalized icterus (jaundice) and the intensely coloured livers found in typical cases of hepatogenic photosensitization. In sheep which recover, areas of affected skin do not grow further wool.

Animals showing symptoms of photosensitization should be removed from the offending plant source. They should be taken to a shaded area and left their undisturbed to recover.

There is a condition known as percutaneous photosensitization caused by contact of the skin with certain substances, particularly furano-coumarins, found in plants. Percutaneous photosensitization is a photogenic dermatosis which occurs when skin, brought into contact with substances such as furano-coumarins, is simultaneously exposed to sunlight. Percutaneous photosensitization has been recorded in humans. It is not dealt with in this article.

This article lists under their respective family or relationship groups those plants, found in Australia, which when eaten are capable of causing photosensitivity in animals and consequent photosensitization when exposed to sunlight.

Algae

Cyanophyta, blue-green algae, can multiply rapidly under favourable conditions to form large masses or "water blooms". In the water bloom form certain of these organisms may be ingested by livestock in sufficient quantity to cause blue-green algae intoxication. Most cases of blue-green algae poisonings are associated with rapid death. The most commonly incriminated species is *Anacystis cyanea*, which has been recorded from

a number of localities in Australia and has been the cause of numerous livestock mortalities recorded here. In uncommon cases where death does not rapidly intervene, symptoms of icterus and typical photosensitization have been recorded with algae poisoning. Lesions in various organs, principally the liver and kidney, have been associated with algae poisoning. The liver is reported to be swollen and mottled with areas of yellow. There is however no direct evidence to link photosensitization with liver dysfunction. (3, 4)

Raphanus raphanistrum, *wild radish*



Apiaceae (Umbelliferae), carrot family

Hydrocotyle sp. An unidentified species was suspected of causing "swelled head" and death of rams in New South Wales. No further details were provided. (1)

Pastinaca sativa L., parsnip, widely grown for its edible roots, causes contact dermatitis including percutaneous photosensitization. Two ducks fed parsley seed developed dermatitis when placed in the sun. (1, 2)

Asteraceae (Compositae), daisy family

Zinnia pauciflora L., Wild zinnia, was suspected of causing photosensitization in stock. No confirmatory evidence is available. (1)

Boraginaceae, borage family

Heliotropium undulatum Vahl., one of the native heliotropes, found in central and tropical Australia, was suspected in the death of a bull in Western Australia. Symptoms of liver damage including jaundice and photosensitization were observed. (8)

The weed species *Echium plantagineum* L., Paterson's Curse, and *Heliotropium europaeum* L., common heliotrope, contain pyrrolizidine alkaloids which produce liver damage. Affected animals often show jaundice and/or photosensitization. (4)

Brassicaceae (Cruciferae), mustard family

Brassica napus L., rape, cultivated as an oilseed crop, has been reported to cause "rape scald" in New Zealand. This condition was reported to occur in weaned lambs and is manifested by severe photosensitization associated with irritation and discomfort. A similar condition affecting pigs and other white-skinned animals has been noted in the U.S.A. Symptoms of poisoning in lambs include watery swellings on the ears and head and sometimes along the midline of the back, with sloughing of skin on affected areas. No liver damage has been recorded although this plant has been recorded as a hepatogenous photosensitivity producing species. (3, 9)

Raphanus raphanistrum L., wild radish, a common weed of crops and arable land, was the predominant species in a paddock in which 12 lambs were affected with photosensitization in Western Australia. The radish had been heavily grazed. Two live lambs submitted for examination failed to reveal all the classical signs that might be expected. Further investigation is needed. (8)

Chenopodiaceae, goosefoot family

Bassia scoparia, Schrad., summer cypress, an annual species, cultivated in gardens, has been suspected of causing photosensitization in cattle, sheep and horses. Jaundice and enlargement and change in consistency of the liver were observed. No definite evidence of toxicity has been noted. (1, 3)

Combretaceae, combretum family

Terminalia oblongata F. Muell., yellow-wood, is found in Queensland and north-eastern New South Wales. Yellow-wood has caused photosensitization in cattle, and occasionally in sheep. It is also associated with acute poisonings. Symptoms in cattle include abdominal pain and dehydration; in sheep there is commonly a nervous syndrome. Cattle tend to seek shade. There is excessive blinking, watering of the eyes and, two to four days later, drying and cracking of the muzzle. At autopsy the liver is swollen, slightly congested and orange coloured. The kidneys are swollen, and the cortex has a peculiar green pigmentation. There is green pigmentation and ulceration in the fourth stomach. The toxic principle is probably a tannin which is found in the leaves. (4)

Cucurbitaceae, cucumber family

Cucumis trigonus Roxb., smooth paddy melon which resembles the more common paddy melon (*Cucumis myriocarpus* Naud.) has small, smooth,

elliptic fruit. It is found in inland tropical and subtropical regions. This plant has been suspected of causing mortalities in sheep in Queensland. Symptoms appear to resemble those of photosensitization. (5)

Fabaceae (Leguminosae), legume family

Acacia salicina Lindl., doolan, cooby or black sally wattle, a widely distributed species, has been suspected of poisoning cattle in Queensland. It is listed as a species which causes poisonings with symptoms of photosensitivity. (4)

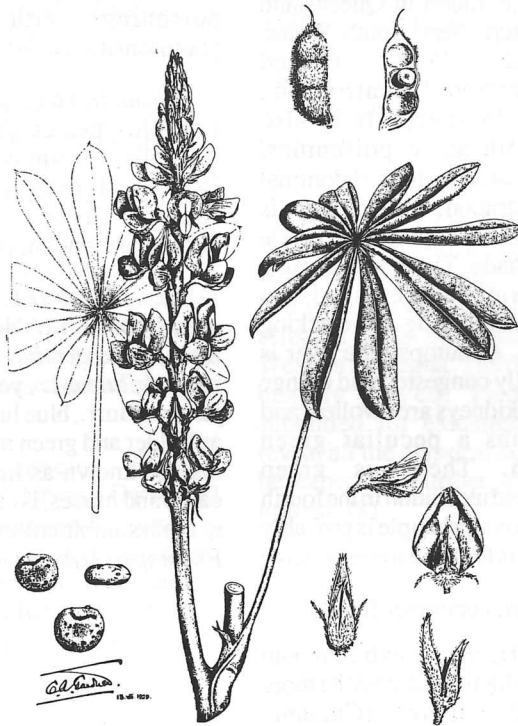
Crotalaria trifoliastrum Willd., is a variable species found in tropical Australia. A form of this plant, in the Northern Territory, was reported to cause liver lesions and photosensitization. (4)

Lupinus albus L., white lupin, *L. angustifolius* L., New Zealand blue lupin, *L. cosentinii* Guss., sandplain lupin, *L. luteus* L., yellow lupin, and *L. pilosus* Murr., blue lupin, are cultivated as fodder and green manure plants. The disease known as lupinosis, in sheep, cattle and horses, is caused by ingestion of lupin stubble colonized by the fungus *Phomopsis leptostromiformis*.

Photosensitization may be seen in acute cases of lupinosis. In most cases jaundice is present and affected animals show dullness, loss of appetite and loss of condition. The liver is greatly swollen and bright yellow or orange. The gall bladder is also greatly enlarged and filled with a dark green bile. (4, 6)

Lupinus cosentinii, *sandplain lupin*

Medicago minima L., small burr medic, *M. polymorpha* L., burr medic, and *M. sativa* L., lucerne, are cultivated as, or are volunteer species, in pastures. There is strong field evidence to indicate that consumption of burr medic and lucerne can, under certain conditions cause "trefoil dermatitis" and photosensitization in stock, particularly when the plants are in luxuriant growth. Small burr medic has also been suspected of causing "trefoil dermatitis" and photosensitization.



Symptoms are inflammation of unpigmented skin, chiefly the lips, nostrils and the region of the eyes and ears, along the back and exposed sides and on the elbows. There is accumulation of fluid under the skin, followed by exudation of plasma with formation of scabs. The ears droop, become hard and dry and sometimes the tips become necrotic and slough off.

It is not clear whether "trefoil dermatitis" is due to hepatogenous photosensitivity. Jaundice has been observed in some cases.

Lucerne is more commonly incriminated in cases in bloat in cattle, while one case of nitrite poisoning was recorded in cattle in Queensland. This was attributed to high nitrate levels in lucerne hay. (4)

Medicago polymorpha, *burr medic*



CA Gardner,

Mimosa pudica L., sensitive plant has been reported to have caused photosensitization in newly imported sheep in Fiji. No details were available. (7)

Swainsona microphylla A. Gray sp. *affinis* A. Lee, has been suspected of having caused poisoning and photosensitization in New South Wales. A feeding test with sheep proved negative. (5)

Trifolium hybridum L., Alsike clover, *T. pratense* L., red clover, *T. repens* L., white clover, and *T. subterraneum* L., subterranean clover, are volunteer species, or sown species, in pastures in Australia. Outbreaks of photosensitization have been attributed to these and other species of *Trifolium*. This condition, known as "trifoliosis"

Trifolium repens, white clover



C.A. Gardner.

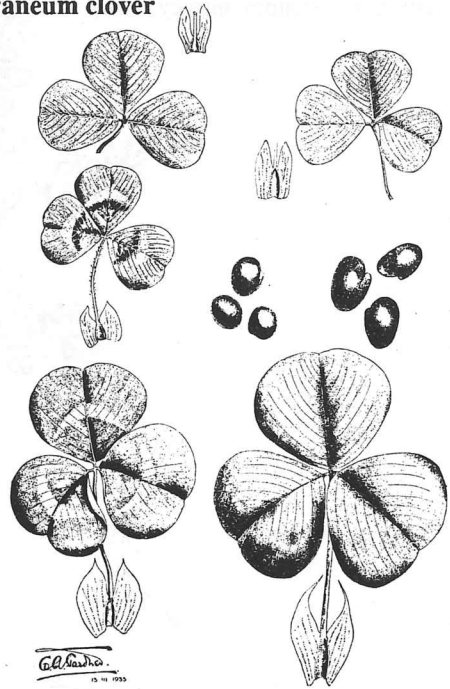
or "bighead" is thought to be due to the ingestion of a photosensitizing agent in the plant. Symptoms and signs are similar to "trefoil dermatitis". Cyanide poisoning has been associated with white clover, while livestock infertility has been associated with subterranean clover. (2, 4, 7)

Vicia sativa L., common vetch, has been reported to produce liver lesions in horses, and to have produced photosensitization. It also causes cyanide poisoning. (3)

Geraniaceae, geranium family

Erodium cicutarium (L.) L'Herit., common crowfoot, and *E. moschatum* (L.) L'Herit., musky crowfoot, have been suspected on rare occasions, of causing photosensitization in sheep. Musky crowfoot was suspected of causing photosensitization in a calf in Western Australia. This animal had been stall fed until it was allowed to graze in a paddock where musky crowfoot was a dominant component.

Trifolium subterraneum, subterranean clover



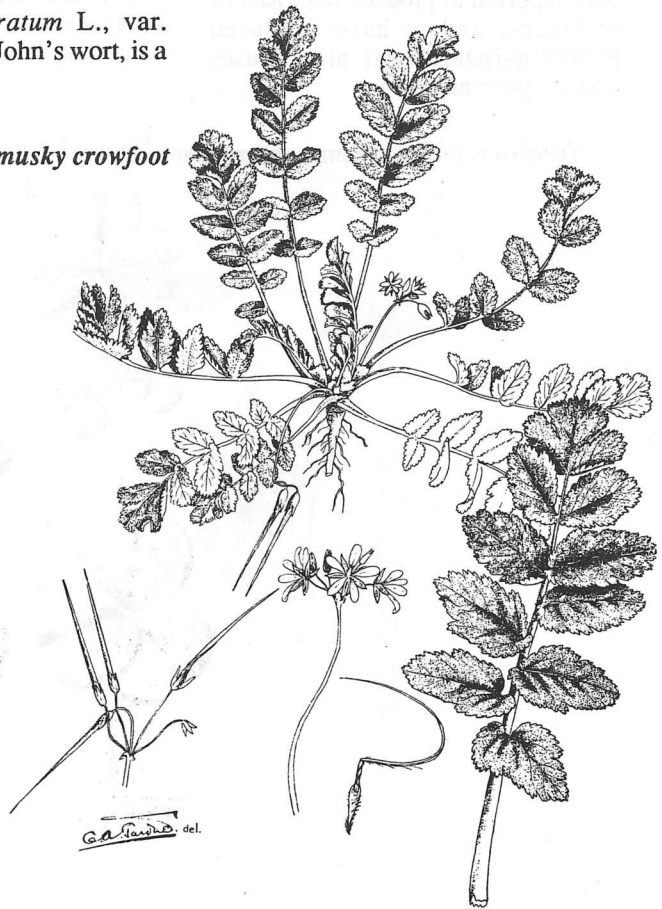
Both common and musky crowfoot are normally considered to provide excellent and abundant forage and are generally grazed by stock without ill effects. The photosensitization agent is not known. Symptoms are similar to those of "hypericium". (8, 9)

Hypericaceae (Guttiferae), hypericum family

Hypericum perforatum L., var. *angustifolium* DC., St John's wort, is a

naturalized weed of temperate regions. It causes a condition of photosensitization known as "hypericium", which has been recorded in sheep, cattle, goats, pigs and horses. Hypericium is due to primary photosensitivity caused by the fluorescent pigment hypericin, which is a mixture of a number of closely related, complex dianthrones.

Erodium moschatum, *musky crowfoot*

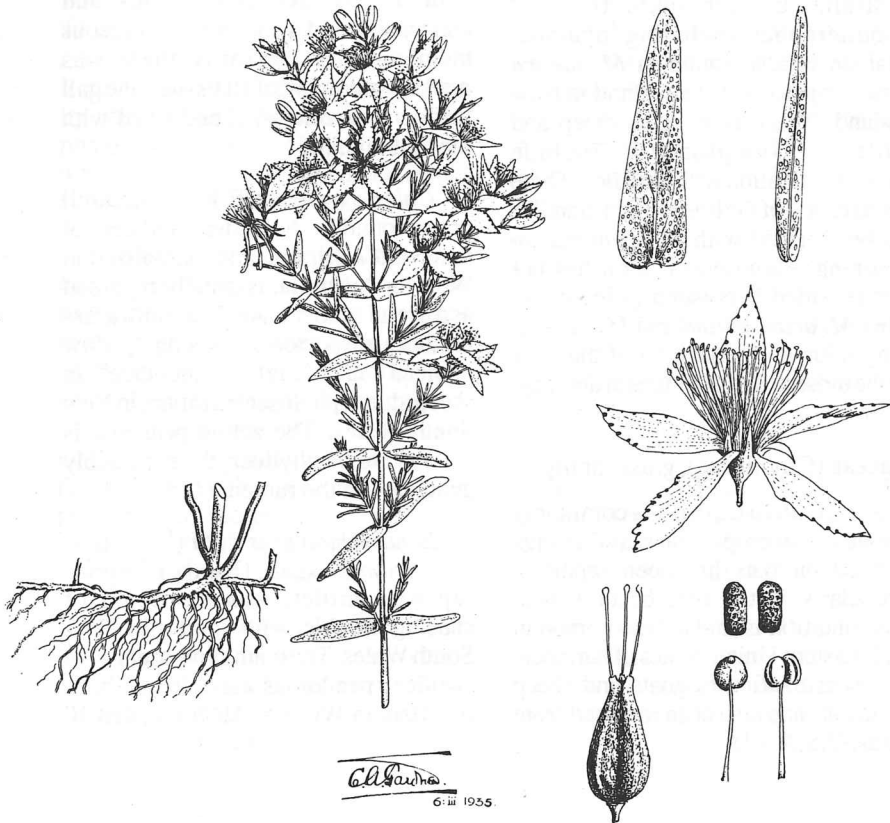


Symptoms are typically without jaundice and consist of blistering or scabby condition on the unpigmented areas of the affected animal, general restlessness and itching of affected parts. High temperature, rapid pulse, accelerated respiration, a tendency of diarrhoea and depression, mental confusion and dilation of the pupil have also been recorded. (2, 4)

Lamiaceae, mint family

Mentha satureiodes R.Br., native pennyroyal, has been suspected of causing photosensitization and mortalities in sheep in New South Wales. There is no conclusive evidence to support these suspicions. (4)

Hypericum perforatum var. angustifolium, St. John's wort



Liliaceae, lily family

Bulbine semibarbata (R.Br.) borzi, native leek, has been suspected of causing photosensitization in sheep in Queensland. There is no positive evidence of toxicity. (4)

Myoporaceae, myoporum family

Myoporum acuminatum R.Br., boobialla, of eastern Australia and *M. deserti* A. Cunn., Ellangowan poison bush or Turkey bush, of inland areas of Australia, contain toxic furanoid sesquiterpenes including ngaione. Ngaione is also found in *M. laetum* Forst.f., ngaio, a species found in New Zealand. Ngaio is toxic to sheep and cattle. Symptoms include photosensitization with jaundice. There is congestion of the liver. Slight jaundice has been noted with *M. acuminatum* poisoning. Photosensitization has not been recorded in poisonings involving either *M. acuminatum* and *M. deserti*. Congestion and reddening of the liver are the most striking features at autopsy. (4, 9)

Poaceae (Gramineae), grass family

Avena sativa L., oats is a commonly planted cereal crop. "Sun scald" in pigs pastured on oats has been reported, particularly if the oats become wet. This condition is said to be common in south-eastern United States of America. Photosensitization in goats and sheep due to oats has also been reported from Texas, U.S.A. (4)

Brachiaria brizantha (Hochst. ex Rich) Stapf, St Lucia grass or signal grass, cultivated in tropical eastern Australia, has been reported to cause photosensitization in sheep confined to test plots of this species. Under normal field conditions there appears to be little risk.

Symptoms were marked loss of condition, loss of appetite, photosensitization and jaundice marked by drooped ears, swelling under the skin of the face and eyelids and congestion and yellowing of mucous membranes. At autopsy there was marked yellowing of all tissues; the gall bladder was congested and filled with mucoid bile. (4)

Chloris truncata R.Br., windmill grass, found in the eastern and central mainland Australia, and naturalized in Western Australia, is usually regarded as a useful fodder plant. Windmill grass has been suspected of causing "yellow bighead" and "bighead jaundice" in sheep, due to photosensitization, in New South Wales. The active principle is believed to be phylloerythrin, possibly generated in the rumen. (1, 5)

Echinochloa grus-galli (L.) Beauv. var. *frumentacea* (Roxb.) Wight, Japanese millet, was suspected of causing trouble with lambs in New South Wales. The main symptoms were swollen, pendulous ears. It has been reported, in Western Australia, that 10

rams in a flock of 200, isolated after grazing this plant species, showed photophobia, photosensitization, intense yellowing and skin irritation. One died. (5, 8)

Lolium perenne L., perennial ryegrass, is a pasture species of temperate regions. "Facial eczema" which occurs mainly in sheep, but has also been noted in cattle, is caused by hepatogenous photosensitivity, due to ingestion of perennial ryegrass infected with a fungus *Pithomyces chartarum*. This parasitic fungus develops on ryegrass under certain conditions. The liver damaging toxic principle produced by the fungus is sporodesmin. The photosensitizing agent is phylloerythrin which increases in the blood of affected sheep as a result of liver damage.

Symptoms include the shaking of head, stamping of feet, obvious discomfort, rubbing on rough surfaces to relieve intense irritation, seeking of shade, watery swelling and drooping of the ears and swelling of the eyelids, face, legs and other areas of the skin exposed to light. There is seepage of fluid through the skin which later progresses to encrustations over much of the exposed skin surface. Very severely affected animals may die.

At autopsy there is marked liver damage, with fibrosis. In severe cases the liver may be stained green or yellow by bile pigments. The gall bladder is distended and the bile duct walls show slight thickening. (4, 7)

Panicum coloratum L., coolah grass, *P. decompositum* R.Br., var. *tenuis*, native millet, *P. effusum* R.Br., hairy panic, *P. laevifolium* Hack., sweet grass, *P. maximum* Jacq., Guinea grass, and *P. miliaceum* L., French millet, have been implicated in, or have been suspected of causing "yellow big head" disease or photosensitization in sheep. This condition is known in South Africa as "dikoor".

"Yellow big head" is characterized by swelling and drooping of the ears, followed by swelling of the face, nose and lips and eventually the whole head. This is accompanied by intense irritation and a tendency for the animal to seek shade. In shade, the animal recovers after sloughing of skin from affected parts. In the absence of shade the condition of the animal deteriorates and it may develop jaundice. Death may result from suffocation or starvation. At autopsy, in poisonings associated with *P. effusum*, there is congestion of the liver and sometimes congestion of the mucosa of the large bowel. The toxic principle is unknown. (2,4)

Setaria italica Beauv., Italian millet, has been reported to cause illness in cattle, resembling photosensitization. No details are provided. (5)

Sorghum sudanense (Piper) Stapf, Sudan grass, is grown as a forage grass. Sheep have developed photosensitivity while grazing on Sudan grass pastures in California and Texas in the U.S.A.

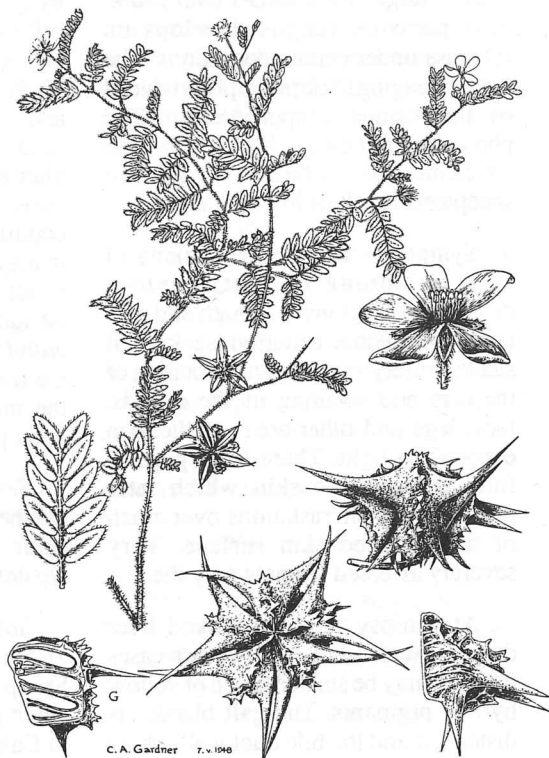
Symptoms and lesions were those of primary photosensitization and ceased when the animals were removed from the Sudan grass. (3)

Polygonaceae, buckwheat family

Fagopyrum esculentum Moench, buckwheat, is grown to a limited extent for its seed in Australia. All parts of the plant, fresh or dry, are capable of

producing photosensitization. Cases of "fagopyrism" the name given to this condition, have been reported in cattle, sheep, pigs, goats, horses and fowls exposed to sunlight. Fagopyrism is a primary photosensitivity condition produced by several fluorescent compounds in the plant including protofagopyrine, a light-sensitive precursor of fagopyrine, which is closely related to hypericin (in St. John's wort).

***Tribulus terrestris*, caltrop**



Fagopyrism affects only white or unpigmented parts of the skin. The skin on the affected parts swells and becomes congested, hot, itchy and red. If feeding is continued, the condition progresses to blistering and severe dermatitis. Death of tissues and gangrene may set in. Nervous symptoms such as excitement, restlessness, convulsions and delirium, followed by narcotic-like condition may also develop. The eyes, pharynx, larynx, and bronchial tubes may also be affected. (2,4)

Muehlenbeckia cunninghamii (Meissn.) F. Muell, lignum, has been suspected of causing "yellows" and death in sheep in New South Wales. There are no details provided. (1)

Polygonum orientale L., a tropical species of smartweed, has been suspected of causing photosensitization in pigs in Queensland. *P. aviculare* L., wireweed, *P. lapathifolium* L., *P. persicaria* L., persicaria and *P. prostratum* R.Br., creeping knotweed, have been suspected of causing dermatitis, sometimes with death of affected tissues. (4,5)

Rhamnaceae, buckthorn family

Ventilago viminalis Hook, supplejack, found in the drier tropics, is generally regarded as one of the best fodder trees in inland Australia. It is, however, listed as a plant whose symptoms of toxicity (in one recorded case only) include photosensitivity. No further details are available. (4)

Stackhousiaceae, stackhousia family

Stackhousia monogyna Labill., an eastern Australian species, has been reported poisonous in New South Wales. Horses developed swollen heads and lost patches of hair, while sheep developed swollen heads and wool tended to come off. A feeding trial with a guinea pig caused no sensitization but the animal was found dead after seven days. (1, 5)

Ulmaceae, elm family

Trema aspera Bl., peach-leaf poison bush, can cause heavy mortalities in cattle. On one occasion cattle developed dermatitis and showed photosensitization effects. (5)

Verbenaceae, vervain family

Lantana camara L., lantana, includes a large number of plants, some of which may be separate species or varieties. At least 17 different kinds are recorded as naturalized in eastern Australia, eight of these are important weeds. Lantana may be divided into red-flowered, pink-flowered, white or very pale pink flowered and orange-flowered forms. Most forms are toxic. Lantana poisoning is quite common in cattle. Sheep, although susceptible, are rarely involved in field cases.

Early symptoms in sub-acute lantana poisoning are depression, loss of appetite and constipation and frequent urination. In a day or two there is jaundice of visible mucous membranes,

dryness and increased warmth in the muzzle, slight discharge from the eyes and inflammation of the conjunctiva. As photosensitization progresses the skin of the muzzle becomes inflamed and moist (the so-called 'pink nose') and very painful. As the inflammation progresses and becomes more severe it affects the nostrils, eyes and mouth, with reddening ulceration, swelling and hardening of nostrils, gum, cheek and tongue, swelling of the eyelids and discharge from the eye sockets. The ears often become thickened and scabby and in white-faced cattle itching of the face becomes so severe that the animals injure themselves with rubbing, the injuries frequently leading to blindness. Death commonly occurs in one to four weeks after the appearance of symptoms, due to kidney failure with retention of urine, starvation and dehydration, accompanied by stasis of the bowel and consequent loss of appetite.

At autopsy there is evidence of jaundice, swollen ochre-coloured liver, much enlarged gall bladder, yellow, swollen, moist kidney and stasis of the large intestine.

Acute lantana poisoning, where death occurs three to four days after consumption of the plant, is characterized by haemorrhagic gastro-enteritis and generalized jaundice.

The poisonous principle in lantana is almost certainly a triterpene. Lantadene A was reported to be the

poisonous principle, but it is now considered that the reduced form, 22b angeloyloxyoleanolic acid, is the hepatotoxic substance. Other pentacyclic triterpenes with a particular molecular configuration are known to be similarly toxic. They contain a 22b angeloyl side chain as well as a hydroxyl group at the C(3) or the C(24) position. (4)

Lantana montevidensis (Spreng.) Briq., creeping lantana, often referred to as *L. sellowiana*, occurs as a naturalized form and a garden form in Australia. The plant has been suspected, on field evidence, of producing symptoms in cattle similar to *L. camara*. (4)

Verbena officinalis L., common vervain, an introduced species naturalized in temperate Australia, has been reported to cause photosensitivity in South Africa. (7).

Verbena rigida Spreng., a naturalized species, has been suspected of causing constipation and fever in cattle, sometimes accompanied by photosensitization and swelling under the throat and neck. (4).

Zygophyllaceae

Tribulus terrestris L., caltrop, a weed of significance, has a wide distribution and is particularly abundant in inland areas in disturbed habitats. In South Africa, caltrop has been shown to cause, under certain conditions, a hepatogenous photosensitization in

sheep known as "yellow big head", or "geeldikkop". Cases of "yellow big head" in Australia are few. This condition is seen only when the plant is making vigorous growth and the weather is hot.

"Yellow big head" results from the accumulation in the peripheral blood circulation of phyloerythrin as a result of liver damage. Three sapogenins, diosgenin, ruscogenin and gitogenin, found in caltrop are capable of causing liver damage. Sheep deaths ascribed to consumption of caltrop were attributed to nitrate in the plant, as symptoms were typical of nitrite poisoning.

Symptoms of "geeldikkop" are similar to other hepatogenous photosensitization with a generalized jaundice and marked photosensitization. (2, 4)

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