**TERPENES AND TERPENOIDS**

**Definition** [adapted from Lewis’ Dictionary of Toxicology 1998]

**Terpene:** Any of a large class of naturally-occurring saturated hydrocarbons produced by plants that are formed completely by 5-carbon isopentyl (isoprene) C₅ units with the general formula (C₃H₆)n. Small terpenes give plants their characteristic odours. Large terpenes include carotinoids, squalene, vitamin A and natural rubber.

**Terpenoid:** Any compound with an isoprenoid structure similar to that of terpenes. Camphor is a terpenoid.

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### Furanosesquiterpenes

**Core data**

*Common sources:*
- *Eremophila deserti* [= *Myoporum deserti*] (Ellangowan poison bush)
- some *Myoporum* spp.

*Animals affected:* ruminants

*Mode of action:

*Poisoning circumstances:* travelling or hungry animals allowed access to plants

*Main effects:* acute hepatic necrosis (zonal lesion distribution depends on metabolic state of the xenobiotic biotransformation enzyme systems)

*Diagnosis:* pathology + plant access

*Therapy:* nil

*Prevention:* deny access

*Chemical structure:*
Sesquiterpenoids or furanoid ketones in the essential oils of source plants

*Sources:*
- Family Myoporaceae
  - *Eremophila deserti* [= *Myoporum deserti*] (Ellangowan poison bush [Qld], dogwood poison bush [NSW]) [Se77,130; DM130] (Bailey & Gordon 1887, Albert 1934)
    - *Eremophila deserti* populations contain morphologically-indistinguishable chemical races, some of which are non-toxic (Sutherland & Park 1967)
  - *Myoporum acuminatum* [= *M. montanum*] (water bush, boobialla) [Se77; DM129; Legg & White 1941a,b]
  - *Myoporum tetrandrum* (boobialla) (Allen et al. 1978)
  - *Myoporum laetum* (ngaio) in New Zealand (Webster 1926, Connor 1977), Argentina, Brazil, Uruguay (Raposo et al. 1998a,b)
Eremophila deserti (= Myoporum desertii) whole plant [RAM Photo]

Eremophila deserti (= Myoporum desertii) [RAM Photo (left)]
Myoporum acuminatum (boobialla) flowering branch [RAM Photo]

Toxicity:

ruminants

Myoporum acuminatum toxic doses in sheep were 12-25 g fresh leaf/kg body weight (Legg & White 1941b)

Mode of action:

Conditions of poisoning:

travelling or hungry animals allowed access to plants
drought conditions leading to increased browsing of shrubs (Legg & White 1941a)

Clinical signs: See acute hepatic necrosis chapter

Pathology: See acute hepatic necrosis chapter

Lesions may vary in location within the hepatic acinus from periacinar to periportal depending on the metabolic state of the xenobiotic biotransformation enzyme systems. Experimental rats dosed with ngaione developed periacinar hepatocyte necrosis, but if rats were pre-treated with phenobarbitone to induce xenobiotic biotransformation enzymes before being given ngaione, they developed periportal necrosis (Seawright 1968)

Diagnosis: See acute hepatic necrosis chapter

Therapy: See acute hepatic necrosis chapter

Prevention & control: deny access to hungry animals

References:


Lantadenes (pentacyclic triterpenes)

Core data

Common source: Lantana camara - toxic flower-colour forms: red & orange, Helidon white, pink (only north of Rockhampton)

Animals affected: ruminants

Poisoning circumstances: newly-introduced animals, lack of alternative feed

Main effects: hepatogenous photosensitisation + gall bladder paralysis + nephrosis

Diagnosis: access, pathology

Therapy: basic (as above) + activated charcoal or bentonite + fluids

Prevention: plant control - remove mechanically, burn, herbicides + pasture improvement

Syndrome name:
lantana poisoning
red nose, pink nose
secondary or hepatogenous photosensitisation

Chemical structure:
Lantadenes (includes rehmannic acid = lantadene A), icterogenins

Plant sources:
- *Lantana camara* (lantana) [Se68, DM136] → lantadenes A, B & reduced lantadene A
- *Lippia* spp. from southern Africa contain icterogenins and rehmannic acid capable of producing secondary photosensitisation, but are clinically unimportant. Secondary photosensitisation has been produced by experimental dosing of sheep with *Lippia rehmanni* and *L. pretoriensis* (Quin 1933). [Note: *Phyla nodiflora* (L.) Greene [= *Lippia nodiflora* L.] (lippia, no-mow lawn, fog-fruit) is a weed of pasture in southern Australia; no toxicity is recorded]

*Lantana camara*

- plants originate in Central & South America (Swarbrick 1986); listed as a Weed of National Significance for Australia
- 29 flower colour forms described as naturalised in eastern Australia (Smith & Smith 1982). Note that for identification of the biotype (colour form) of *L. camara*, a normal botanical specimen is needed, plus a coloured photograph of the mature flowerhead. Determination of the biotype can be difficult.

- + other garden-cultivated varieties
Toxicity:

Lantana poisoning: Australia, Southern Africa, Indonesia, India, Mexico, Central America
cattle (sheep, goats: Ide & Tutt 1998) Lantana camara was first demonstrated to be toxic to
cattle in experiments by Tucker in 1910 at Townsville (Tucker 1910-11) and subsequent
experiments were done by Pound in Brisbane (Pound 1913-14).
lantadene A is the significant toxin in Lantana camara plants, with lantadene B being less toxic
by some 2-3 times and reduced lantadene A being similarly toxic but present in only
small amounts (Seawright & Hrdlicka 1977)
horses are not affected; no convincing clinical cases reported; a sheep lethal dose of lantadene A
injected IV into a horse produced no detectable hepatic dysfunction, suggesting that
horses do not metabolise lantadenes to toxic metabolites (Pass MA, Seawright AA,
unpublished data)

Toxic forms (Seawright 1965)

Rule of thumb for recognising toxic colour forms of lantana
• most red & orange-flowered forms
• most pink-flowered forms north of Rockhampton
• Helidon white

Toxicity of Lantana camara biotypes (Smith & Smith 1982, NRM Facts Pest Series PP34 2001)

<table>
<thead>
<tr>
<th>Dominant Flower colour form</th>
<th>Geographic Range</th>
<th>Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smith’s snowflake</td>
<td>Near Laidley; Limestone Creek (north of Rockhampton); cultivated</td>
<td>Unknown</td>
</tr>
<tr>
<td>Pale Pink</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bundaberg large-flowered pink</td>
<td>Bundaberg</td>
<td>Highly Toxic</td>
</tr>
<tr>
<td>Helidon white</td>
<td>Burnett-Moreton Districts</td>
<td>Toxic</td>
</tr>
<tr>
<td>Coolum pink</td>
<td>Coolum</td>
<td>Toxic</td>
</tr>
<tr>
<td>Bundaberg small-flowered pink</td>
<td>Bundaberg</td>
<td>Non-toxic</td>
</tr>
<tr>
<td>Mt.Berryman pink</td>
<td>Lockyer Valley (rare)</td>
<td>Unknown</td>
</tr>
<tr>
<td>Spiny orange-centred pink</td>
<td>Rockhampton eastward to the coast (infrequent)</td>
<td>Unknown</td>
</tr>
<tr>
<td>Pink</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Townsville red-centred pink</td>
<td>Ayr-Cooktown</td>
<td>Very toxic</td>
</tr>
<tr>
<td>Small-flowered red-centred pink</td>
<td>Brisbane-northern NSW</td>
<td>Toxic</td>
</tr>
<tr>
<td>Mackay red-centred pink</td>
<td>Cooktown-St.Lawrence</td>
<td>Toxic</td>
</tr>
<tr>
<td>Rockhampton red-centred pink</td>
<td>Rockhampton</td>
<td>Toxic</td>
</tr>
<tr>
<td>Pink Minnie Basil</td>
<td>Brisbane-Gatton-Beenleigh</td>
<td>Toxic</td>
</tr>
<tr>
<td>Common pink</td>
<td>Cooktown-northern NSW</td>
<td>Non-toxic</td>
</tr>
<tr>
<td>Hawaiian pink [= L. camara var. aculeata (L.) Moldenke]</td>
<td>Halifax &amp; Ingham areas (locally common)</td>
<td>Unknown</td>
</tr>
<tr>
<td>Pink-edged red</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common pink-edged red</td>
<td>Atherton Tableland-northern NSW</td>
<td>Very Toxic</td>
</tr>
<tr>
<td>Proserpine pink-edged red</td>
<td>Gordonvale-Brisbane</td>
<td>Toxic</td>
</tr>
<tr>
<td>Balnagowan pink-edged red</td>
<td>Mackay</td>
<td>Toxic</td>
</tr>
<tr>
<td>Broad-edged pink-edged red</td>
<td>North-west of Brisbane [The Gap, Ferny Grove, Samford] (locally common)</td>
<td>Unknown</td>
</tr>
<tr>
<td>Red</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stafford red</td>
<td>Brisbane-northern NSW</td>
<td>Toxic</td>
</tr>
</tbody>
</table>
Toxicity of *Lantana camara* biotypes (Smith & Smith 1982, NRM Facts Pest Series PP34 2001)

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<thead>
<tr>
<th>Dominant Flower colour form</th>
<th>Geographic Range</th>
<th>Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round red</td>
<td>Cooktown-northern NSW</td>
<td>Toxic</td>
</tr>
<tr>
<td>Pale Stafford red</td>
<td>Rockhampton-northern NSW</td>
<td>Unknown</td>
</tr>
<tr>
<td><strong>Orange-red</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large-flowered orange</td>
<td>Port Curtis-Moreton District</td>
<td>Toxic</td>
</tr>
<tr>
<td>Oblong red</td>
<td>Gatton-northern NSW</td>
<td>Unknown</td>
</tr>
<tr>
<td>Chelsea Gem</td>
<td>Cultivated; naturalised sparingly in SE Qld</td>
<td>Unknown</td>
</tr>
<tr>
<td>Hawaiian orange-red</td>
<td>Cairns-Atherton Tableland-Cooktown</td>
<td>Unknown</td>
</tr>
<tr>
<td>Orange Minnie Basil</td>
<td>Margate (rarely naturalised)</td>
<td>Unknown</td>
</tr>
<tr>
<td>Rockhampton large-flowered orange</td>
<td>Rockhampton eastward to the coast (locally abundant)</td>
<td>Unknown</td>
</tr>
<tr>
<td><strong>Orange</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>True orange</td>
<td>Bundaberg-northern NSW</td>
<td>Toxic</td>
</tr>
<tr>
<td>Townsville prickly orange</td>
<td>Mission Beach-Ayr</td>
<td>Non-toxic</td>
</tr>
</tbody>
</table>

*Lantana montevidensis* (creeping lantana), a weedy prostrate perennial plant with purple flowers, was **non-toxic** in feeding experiments with sheep dosed at 6 g dried leaf/kg with plant collected from the Ipswich region (Seawright 1965) and neither lantadene A nor lantadene B nor any significant amount of any triterpene were detected in two samples of the plant, one cultivated and the other field-collected (Hart *et al.* 1976a).

Circumstances of poisoning

- newly-introduced animals
- lack of alternative feed (drought, flood)

Pathogenesis

- **large reservoir of toxin in rumen**
  - absorption of small amount from small intestine $\rightarrow$ hepatic damage $\rightarrow$ autonomic reflex slowing/atomy of rumen $\rightarrow$ feedback loop maintaining the intoxication
  - lantadenes damage hepatocyte biliary canalicular membranes $\rightarrow$ cholestasis.

Clinical signs- photosensitisation (see basic list above) +

- anorexia, depression, ruminal atony
- jaundice
- frequent urination
- dehydration
- constipation
  - transient diarrhoea (severe cases)
  - death in 2 days (severe cases) or 1-3 weeks

Pathology

- jaundice
- swollen, yellow-orange liver

  histologically (Seawright & Allen 1972):
  - hepatocyte degeneration: pronounced hepatocyte enlargement with vesication & enlargement of nuclei, feather degeneration (fine vacuolation and reticulated appearance, sometimes with brown pigmentation) of hepatocyte cytoplasm typical of biliary retention in hepatocytes, + multinucleated hepatocytes. In more severe cases, some or all of: periportal vacuolar degeneration of hepatocytes, midzonal foci of coagulative hepatocyte necrosis, fragmentation of hepatic cell plates with extensive shrinkage necrosis of individual hepatocytes
• cholestasis: deposits of bilirubin in hepatocyte cytoplasm, Kupffer cells and bile canaliculi
• mild biliary ductular hyperplasia and periportal fibrosis

**severe distension of gall bladder** (paralysis), watery bile (Pass & Heath 1977)
swollen pale kidneys (**nephrosis**)
histologically (Seawright & Allen 1972):
• vacuolar degeneration of renal tubular epithelium (coagulation necrosis in severe cases)
• cystic dilation of tubules
• hyaline and leucocyte casts
colon contents dehydrated

**Therapy**

- *inactivate rumen toxin reservoir* → adsorbents (**activated charcoal** or **bentonite** [much cheaper]) - repeat adsorbent dose in 24 hours if required
- *rehydrate* → electrolyte replacement solution- repeat electrolyte replacement fluids → full rehydration, stimulate rumen function
- **apply general case management measures** (above)

**Lantana camara therapeutic protocol**

- Activated charcoal @ 5 g/kg orally in electrolyte replacement solution: Adult cattle: 2.5 kg in 20 litres. Sheep: 0.5 kg in 4 litres.
- OR Bentonite @ 5-10 g/kg substituted for the activated charcoal (much cheaper, somewhat slower effect)

**Control**

- biological control of *L. camara* underway
  28 insects have been introduced as biocontrol agents since 1914, with 17 species established; 4 are currently effective and causing significant damage to *L. camara* populations, 4 others approved for release, 3 others under study
- widely-established insect agents (all from Brazil): leaf-mining beetles *Octotoma scabripennis* & *Uroplata girardi*, leaf-sucking bug *Teleonemia scrupulosa* and seed-mining fly *Ophiomyia lantanae*
  - insects under study: stem-sucking bug *Aconophora compressa* (from Mexico), stem-boring beetle *Aerenicopsis championi* from Mexico) and leaf-rolling moth *Ectaga garcia* (from Brazil)
- combine **mechanical removal, fire & herbicides** to remove plants followed by **vigorous pasture improvement program**
- protective immunisation may be possible (preliminary work only: Stewart *et al.* 1988)

**References:**

Andromedotoxins (grayanotoxins)

Core data

Common sources: Rhododendron spp. (rhododendrons, azaleas)

Animals affected: ruminants, horses

Mode of action: modifies cell membrane Na channels

Poisoning circumstances: access to garden waste

Main effects:
- vomiting
- cardiac arrhythmia
- aspiration pneumonia

Diagnosis: syndrome + access

Therapy:
- remove from source
- rehydrate, adsorbents, antiarrhythmics

Prevention: careful garden waste disposal

Syndrome names: Rhododendron poisoning

Chemical structure:

Andromedotoxins (grayanotoxins) = water-soluble diterpenoid compounds

Sources:

- garden plants (in Australia)

Family Ericaceae (the heath family):

Rhododendron spp. (rhododendrons, azaleas)

Andromeda spp. (bog rosemary)

Kalmia spp. (mountain laurels, lambkill, calfkill – USA)

Ledum spp. (black laurel, Labrador tea – USA)

Leucothoe spp.

Lyonia ligustrina

Menziesia ferruginea

Pieris spp.

Toxicity:

ruminants (cattle, goats), horses, kangaroos (Hough 1997)

humans (through honey from bees foraging on plants of family Ericaceae)

poisoning in Europe, India, North America, Australia

lethal dose of leaves = as little as 0.2% body weight

Mode of action:

bind to and modify the Na channels of cell membranes

→ prolonged depolarisation & excitation

→ ↑Ca movement into cells → positive inotropic effect (similar to cardiac glycosides)

Conditions of poisoning:

poisoning of ruminants (goats) with access to garden waste or gardens where shrubs may be browsed

honey produced from nectar of these plants contains andromedotoxins and can be toxic to humans

Clinical signs:

drooling saliva

vomiting

repeated swallowing, retching

diarrhoea, tenesmus

abdominal pain

cardiovascular effects
bradycardia
hypotension (through vasodilation)
atrioventricular block
± sudden death

± dyspnoea

Pathology:
gastroenteritis
± aspiration pneumonia

Diagnosis:
syndrome + access
assay rumen contents/faeces [limited availability of test] (Holstege et al. 2000)

Therapy:
remove from source
rehydrate + adsorbents + demulcents
for severe bradycardia: atropine
for heart block: isoprorenaline hydrochloride (isoproterenol) or sodium channel blockers (e.g. lignocaine, phenytoin)

Prevention & control: deny access (proper disposal of garden refuse)

References:
Ol390

Irritant diterpenoids of Pimelea spp. – simplexin (& huratoxin)

Core data
Syndrome names:
- Pimelea poisoning of cattle
- St.George disease
- Marree disease

Common sources:
- Pimelea trichostachya
- P. simplex
- P. elongata

Animals affected: cattle

Mode of action:
- constricted pulmonary venules
- alimentary irritation
- expanded plasma volume

Poisoning circumstances:
- dense Pimelea populations (overstocking, soil disturbance)
- above average winter rain followed by below average summer rain or drought
- dead plant fragments contaminating pasture/dust

Main effects:
- right-sided heart failure (distended jugular veins, subcutaneous oedema; dilated right ventricle, hydrothorax, distended hepatic sinusoids)
- diarrhoea
- anaemia

Diagnosis: syndrome + pathology

Therapy:
- no specific therapy
- remove cattle from toxic pasture

Prevention: avoid overstocking and soil disturbance

Syndrome names:
- Pimelea poisoning of cattle
St. George disease [named after the town in southern Queensland, not the patron saint of England]
Marree disease [named after the town in northern South Australia]
Sources:
*Pimelea* spp. (rice flowers, flax weeds); Family Thymeleaceae. There are 90 species of *Pimelea* recognised in Australia, all endemic (Rye & Heads 1990).
major plants (associated with multiple poisoning incidents):
southern inland Queensland, north-western NSW, northern SA
winter-growing annual herbs
*Pimelea trichostachya* (flax weed, rice flower, broom bush, Borgia’s bouquet) [DM101]
*Pimelea simplex ssp. simplex* (desert rice flower)
*Pimelea simplex ssp. continua* [DM102]
*Pimelea elongata* [DM102]
Pimelea simplex ssp. continua [RAM Photos]

Pimelea elongata [RAM Photo]
minor plants (associated with single or a few poisoning incidents):
    coastal or near-coastal Q
    perennial small shrubs
    *Pimelea latifolia* ssp. *altior* (Rogers & Roberts 1976)
    *Pimelea neoanglica* (Storie *et al.* 1986)
    *Pimelea strigosa* (RA McKenzie, unpublished data 1994)
    *Pimelea linifolia*

Toxicity:

Only cattle are affected by the full syndrome. Other species develop only diarrhoea.
Dosing with simplexin (a daphnane ester) reproduces the disease (Roberts *et al.* 1975).
*Pimelea* plants are very unpalatable; living plants are only eaten as the very last resort (and will cause severe diarrhoea).
Toxin intake is by inhalation or ingestion of fine dry particles of dead *Pimelea* plants on other pasture components. Most inhaled particles are probably trapped in mucus and ultimately swallowed.
The toxins are diterpene esters related to phorbol esters (esters of the tetracyclic diterpene phorbol) from *Croton tiglium*, the source of croton oil. These constituents of croton oil are responsible for purgative, skin-irritant and tumour promoting (co-carcinogenic) properties.
Diterpene ester types include tigliane, daphnane and ingenane esters. They have been found only in plant families Euphorbiaceae and Thymelaeaceae (Kinghorn 1991).

Mode of action:
The toxins are potent activators of protein kinase C (Pegg *et al.* 1994)
There are three facets to toxicity in cattle:
- **persistent constriction of pulmonary venules** causing chronic right-sided heart failure.
  Sheep and horses lack the powerful smooth muscle present in bovine pulmonary venule walls.
- **irritation of alimentary tract** causing persistent diarrhoea
- **expansion of the plasma volume** without stimulating erythropoiesis causing anaemia. The mechanism is unknown.

Conditions of poisoning:
Historically, widespread *Pimelea* poisoning of cattle emerged in 1960s after replacement of sheep with cattle on pastoral holdings with significant populations of the annual herbaceous *Pimelea* spp.
*Annual herbaceous Pimelea spp. population density* in pastures is boosted by heavy grazing pressure on palatable pasture species (overstocking), soil disturbance (abandoned cultivation) or fire.
Cattle grazing in pastures with living annual herbaceous *Pimelea* plants do not eat them and very seldom develop poisoning.
The greatest incidence of disease occurs after **above average winter rain** promotes the growth of annual *Pimelea* species and is followed by **below average summer rain** or **drought** preventing complete removal of dry *Pimelea* particles from the pastures by rain and the biodegradation of the toxins by soil microbes.

Clinical signs:
- usually > 3 weeks exposure before signs noted
- diarrhoea (absent in some cases)
- weight loss → emaciation
- distended jugular veins
- subcutaneous oedema of brisket & submandibular space → massive anasarca
- anaemia
- ↓ exercise tolerance

Pathology:
**dilation of right ventricle**
hydrothorax
subcutaneous oedema of brisket and submandibular space
liver: peliosis hepatitis = swollen blue-black liver engorged with blood in massively **dilated sinusoids** (Seawright & Francis 1971)
capillary dilation in adrenal glands and kidney

Diagnosis:
syndrome + pathology
note that the responsible *Pimelea* sp. is likely to be absent from pastures when animals are affected (winter plant growth → summer poisoning)

**Therapy:**
no recognised specific therapy
supportive therapy with diuretics may be justified in valuable animals (e.g. bulls)

**remove cattle from toxic pastures**
→ ↓↓ diarrhea, but heart failure signs and anaemia persist for months before eventual recovery; if death from circulatory collapse does not intervene
in practical terms, this can involve moving cattle to pastures on a different soil type where the local *Pimelea* sp. has not grown
cattle should not be returned to affected pastures until after significant rainfall (*Pimelea* plant fragments washed from the pasture and toxin biodegraded)

**Control** (after establishment of hazardous *Pimelea* populations):
reduce *Pimelea* population density in pastures (research is required on methods):
reduce grazing pressure (uncertain if large annual herbaceous *Pimelea* populations decline under low grazing pressure once they have become established)
fire regimens (unpredictable rainfall in affected areas makes it very difficult to reliably establish sufficient fuel loads in 2 successive growing seasons to allow burning of *Pimelea* plants before seeding)
herbicides: application restricted by cost and environmental considerations e.g. to abandoned cultivations; 1.5L atrazine + 0.5L 2,4-D/ha in 60 L water/ha with 250 ml Agral 60 kills 80-90% young *Pimelea* plants - $9/ha; 1L 2,4-D/ha also effective - $6/ha (Wells G, Queensland Wheat Research Institute, unpublished data 1995)

immunisation (failed): An attempt in the 1990s by CSIRO/University of Central Queensland to produce a protective immunogen against simplexin was not successful. Antibodies were produced by immunised cattle, but protection from poisoning was not demonstrated (Pegg et al. 1994).

**Prevention:**
avoid factors that favour increased density of annual herbaceous *Pimelea* spp., namely overstocking and soil disturbance

**References:**
Sel02
Clark IA (1973) *Res. Vet. Sci.* 14:341-
Irritant diterpenoids of Families Thymeleaceae & Euphorbiaceae

Core data

Common sources:
- *Pimelea* spp.
- *Euphorbia* spp.
- *Jatropha* spp.

Animals affected: ruminants, horses

Mode of action: direct irritation of alimentary mucosa

Poisoning circumstances: plants unpalatable, eaten only as last resort

Main effects: severe diarrhoea

Diagnosis: syndrome + access

Therapy: remove from source, rehydrate, adsorbents, demulcents

Prevention: deny access

Chemical structure:

highly irritant tigiane, daphnane and ingenane diterpenoid esters

Sources:

Family Thymeleaceae

*Pimelea* spp. (rice flowers, flax weeds) [DM99-103] 90 species in Australia (Rye & Heads 1990), 12 species associated with poisoning; some authorities regard all species as potentially toxic; examples include
- *Pimelea decora* (Flinders poppy) - horses (Hill 1970)
- *Pimelea haematostachya* (Pimelea poppy)
- *Pimelea trichostachya* (flaxweed, broom bush, rice flower, Borgia’s bouquet) (q.v.) - sheep (Legg & White 1940)

*Pimelea decora* [RAM Photo]
Pimelea haematostachya [RAM Photo]

Wikstroemia indica (tie bush) - cattle (Pound & White 1920) [DM133] Wikstroemia is a genus of about 70 species from tropical and eastern Asia to Australia with only 1 species native to Australia (Rye & Heads 1990).

Daphne spp. - cultivated in gardens
Daphne mezereum (mezereon)

Family Euphorbiaceae

Euphorbia spp. (spurges) 30-40 species in Australia (including at least 10 naturalised), about 14 species associated with poisoning

Jatropha curcas ( physic nut, Barbados nut, curcas bean, purge nut, purging nut, purgeerboontjie [S. Afr.], tuba [Philippines]) [see toxalbumins (lectins)]

Jatropha gossypifolia (bellyache bush, cotton-leaf physic nut)

Aleurites moluccana (candle nut tree) (Forster 1996) - native and cultivated in gardens and as a street tree

Toxicity:
ruminants and horses (humans)

Mode of action: direct irritation of alimentary mucosa

Conditions of poisoning:
plants are unpalatable, so poisoning only under conditions of nutritional stress (e.g. drought)
fruits of Daphne mezereum toxic to children (2-3 fruits can be fatal)

Clinical signs:
diarrhoea profuse
± blood in faeces
derhydration
abdominal pain (teeth grinding etc.)
death in ± 24 hours in severe cases

Pathology:
alimentary tract congestion
haemorrhagic, necrotising gastroenteritis
Diagnosis: syndrome + access
Therapy:
- remove from source
- rehydration + adsorbents + demulcents
Prevention & control: deny access (particularly when other feed is scarce or absent)
References:
Se102, 53, 146

Cucurbitacins (tetracyclic triterpenes)

Core data

Common sources:
- *Cucumis* spp.
- *Citrullus* spp.

Animals affected: cattle, sheep

Mode of action:
- direct irritation of alimentary mucosa
- ↑ vascular permeability
- damage to heart muscle

Poisoning circumstances: avid consumption of ripe fruit

Main effects: rumenitis, enteritis, sudden death (myocardial damage)

Diagnosis: syndrome + access

Therapy:
- remove from source
- rumenotomy
- rehydrate, adsorbent, demulcent

Prevention: deny access to ripe fruit

Chemical structure:

Cucurbitacins (bitter principles of cucurbits) = tetracyclic triterpenes. These compounds are feeding deterrents for most insects, excluding the cucumber beetle which is attracted by them (Lavie 1971). They have some structural affinities with cardiac glycosides (q.v.) and some similar pathological effects.

Sources:

Family Cucurbitaceae (Telford 1982)

* Cucumis myriocarpus* (prickly paddymelon, paddy melon, gooseberry cucumber) - naturalised; native of southern Africa (Telford 1982); (cattle toxicity - McKenzie et al. 1988)

* Cucumis melo* ssp. *agrestis* (Ulcardo melon) - naturalised; native to Africa, Asia (Telford 1982); (cattle toxicity - Jubb et al. 1995)

* Citrullus lanatus* (wild, pie, bitter or camel melon) - naturalised; native to tropical and southern Africa (Telford 1982)

* Citrullus colocynthis* (colocynth) - naturalised; native to northern Africa & SW Asia (Telford 1982)

* Ecballium elaterium* (squirting cucumber) - naturalised; native to Mediterranean region & SW Asia (Telford 1982)

Family Scrophulariaceae

* Stemodia kingii* F.Muell. (Allen & Mitchell 1998)
**Stemodia florulenta** (Benth.) W.R.Barker [= *Morgania floribunda* Benth.] (morganflower, bluerod) (?)

Toxicity:
ripe fruit of the cucurbits listed above are toxic
cattle, sheep
South Africa, Australia

Mode of action:
cucurbitacins → irritation of alimentary tract, ↑ permeability of blood vessels → oedema of stomach walls

Conditions of poisoning:
Cucurbitaceae
ripe fruits more toxic than unripe (have a larger cucurbitacin content)
poisoning from avid fruit consumption

Clinical signs:
sudden death
dehydration, haemoconcentration
diarrhoea
± jaundice

Pathology:
congestion/haemorrhage of alimentary tract
oedema of forestomach walls
seeds numerous in rumen contents
microscopic rumenitis
± focal myocardial degeneration & necrosis

Diagnosis: syndrome + access

Therapy:
remove from source
rumenotomy to remove fruits
rehydrate + adsorbents + demulcents

Prevention & control: deny access to ripe fruit of toxic species

References:

**Meliatoxins (tetranortriterpenes)**

**Core data**

*Common sources:* *Melia azedarach* var. *australasica*

*Animals affected:* pigs

*Mode of action:* undetermined

*Poisoning circumstances:* eating ripe fruit

*Main effects:* gastroenteritis

*Diagnosis:* syndrome + access

*Therapy:*
- remove from source
- rehydrate, adsorbents, demulcents

*Prevention:*
deny access to ripe fruit

*Chemical structure:*

Meliatoxins are tetranortriterpenes of the limonoid class (Oelrichs *et al.* 1983)

*Sources:*
**Melia azedarach var. australasica** (white cedar, cape lilac, china berry, mindi [Indonesia])

[DM154] - native in rainforest and cultivated in gardens and as a street tree or shade tree

**Toxicity:**

- **Pigs** (ruminants, poultry)
  - Experimental toxicity is reported with fruit in cattle in Brazil (Mendez et al. 2002). Toxic doses given were 5-30 g/kg PO. Fatal doses were 15-30 g/kg.

**Mode of action:** undescribed

**Conditions of poisoning:**

- **Ripe fruits** are toxic. Some individual trees are non-toxic.

**Clinical signs:**

- **Pigs**
  - Vomiting
  - Diarrhoea
  - ± excitement
  - ± depression
  - Dyspnoea
  - Cardiac arrhythmia

- **Dogs** (Hare et al. 1997)
  - Vomiting, hypersalivation
  - Abdominal pain
  - Diarrhoea
  - Bradycardia
  - Seizures

- **Cattle (experimental)** (Mendez et al. 2002)
  - Anorexia, depression
  - Ruminal stasis
  - Diarrhoea
  - Incoordination, muscle tremors
  - Recumbency
  - Hypothermia
  - Dyspnoea

**Pathology:**

- Severe gastroenteritis
  - Fatty degeneration of liver & kidneys; scattered or periacinar hepatocyte necrosis in experimental cattle (Mendez et al. 2002)
  - Necrosis of lymphoid follicles in alimentary tract
  - Myodegeneration and necrosis of skeletal muscles were reported in experimental rats (Bahri et al. 1992), and experimental cattle (Mendez et al. 2002)

**Diagnosis:** syndrome + access

**Therapy:**

- Remove from source
- Rehydrate + adsorbents + demulcents

**Prevention & control:** deny access to ripe fruit

**References:** Sc76


White CT (1920) The white cedar (*Melia azedarach var. australasica*): a plant poisonous to pigs. *Qd. Agric. J.* 14:146-147.


**Sesquiterpene lactones (probable aetiology) - nigropallidal encephalomalacia**

**Syndrome names:**
- chewing disease (USA)
- nigropallidal encephalomalacia

Chemical structure:
toxins uncertain, probably sesquiterpene lactones

Sources:
Centaura solstitialis (St.Barnaby's thistle, yellow burr, yellow star thistle)
Acroptilon repens (= Centaura repens) (Russian knapweed, creeping knapweed, hard heads, hardhead thistle, blue weed, Russian centaurea)

Toxicity:
Horses only are affected, with young horses the more susceptible.
Cases are reported in North & South America and (rarely) from Australia (NSW, Q) (Gard et al. 1973)
Several weeks of feeding on the plants elapse before clinical signs occur. Experimental poisoning requires intakes of 60-70% of body weight for A. repens and 86-200% for C. solstitialis. A lethal dose of green C. solstitialis is 1.5-2.5 kg/100 kg body weight/day (Cordy 1978).

Mode of action:
Lesions are suggested as the result of dopamine deficiency in the dopaminergic nigrostriatal pathway after an initial massive release of stored neurotransmitter into the corpus striatum (Cordy 1978).

Conditions of poisoning:
Pasture dominated by young plants before flowering. Mature plants are very spiny and probably uneaten except under extreme conditions of nutritional stress. The interval between first access to plants and onset of the clinical syndrome is about 30 days (Cordy 1978).
Cases seen in New South Wales in 1971 and 1972 were associated with good summer rains producing a substantial crop of thistles in autumn, followed by a dry early winter in which the thistles were the only green feed available for the affected horses (Gard et al. 1973).

Clinical signs:
Most cases die, but some milder cases adapt to the neurological deficit and survive.
- abrupt onset
- head drooped
- aimless walking
- drowsy inactivity
- impaired prehension & mastication (swallowing normal)
- mouth held half open, tongue protruding (paresis)
- tongue lateral edges curled upwards

Pathology:
Necrosis of discrete foci of neurones in the globus pallidus & substantia nigra (usually bilateral) - thus nigropallidal encephalomalacia.
Smaller necrotic lesions have been described in nuclei of the inferior colliculus, dentate nucleus, the mesencephalic nucleus and the tract of the 5th cranial nerve.

Diagnosis:
Clinical syndrome in association with the known causative plants supports a tentative diagnosis. Confirmation requires brain histopathology.

Therapy: nil
Prevention & control: deny access

References: Sc30

Vitamin A (hypervitaminosis A) (q.v.)
Rabbit fed almost exclusively on carrots (Daucus carota) developed hyperostotic polyarthritis after 4.5 years (Frater 2001).
See the account of hypervitaminosis A under Mammals.
Reference:

Terpenoids of Pachyrhizus erosus (yam bean)

Pachyrhizus Rich. ex DC. (Family Fabaceae) comprises 6 species from tropical America. Pachyrhizus erosus (L.) Urb. [= P. angulatus Rich. ex DC., P. palmatifolius Benth. ex Hook.f.] (yam bean, chopsui potato, jicama), a perennial herbaceous vine, is cultivated in tropical gardens in Australia for its edible tubers, eaten raw or cooked. Its pods (legumes) may be eaten, but only after thorough cooking. Eating uncooked pods causes gastrointestinal irritation with mild to moderate diarrhoea. The pods contain terpenoids that are held responsible for the irritation. The seeds have been reported to contain rotenone and pachyrhizid and have been used as fish poisons and insecticides (Blohm 1962, Burrows & Tyrl 2001). Young pods may be eaten, but mature seeds are poisonous (Vaughan & Geissler 1997).

References: