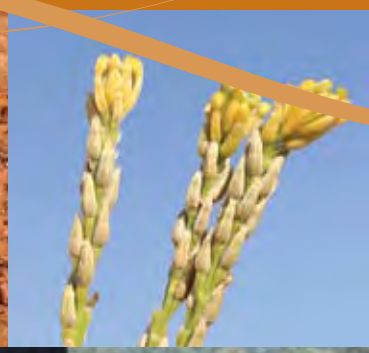
Understanding
Pimelea Poisoning of Cattle



Government of South Australia
Primary Industries and Resources SA
NSW DEPARTMENT OF PRIMARY INDUSTRIES
Queensland Government
The University Of Queensland
AUSTRALIA
Natural Heritage Trust
AGFORCE

Contributing Authors

Mary Fletcher, Queensland Primary Industries and Fisheries
Richard Silcock, Queensland Primary Industries and Fisheries
Selina Ossedryver, Queensland Primary Industries and Fisheries
Jenny Milson, Queensland Primary Industries and Fisheries
Sharon Chow, Queensland Primary Industries and Fisheries

Editor

Anne Collins, Rural Solutions SA

Case Study Contributors

Maree Winter, Queensland Primary Industries and Fisheries
Trent Scholz, Primary Industries and Resources SA
Jenny Milson, Queensland Primary Industries and Fisheries
Sarah-Jane Wilson, Queensland Primary Industries and Fisheries
Charlotte Cavanagh, NSW Department of Primary Industries
Richard Silcock, Queensland Primary Industries and Fisheries

(Department of Employment, Economic Development and Innovation gratefully acknowledges the involvement and financial contribution by the Commonwealth Government, AgForce Queensland, Primary Industries and Resources South Australia, Rural Solutions SA, New South Wales Department of Primary Industries, University of Queensland, Meat and Livestock Australia, Australian Agricultural Company and the cattle producers who made land available in helping the Department to complete this project.)

Contents

Acknowledgements

The authors wish to acknowledge the input to the NHT Pimelea Project provided by other members of the Project Management Team including Greg Curran (NSW Department of Primary Industries), Trent Scholz (Primary Industries and Resources SA), James De Voss (University of Queensland), Geoff Niethe (MLA), Ian Iker (AACo) and Amanda Parker and Oscar Pearse (AgForce Queensland), and also the numerous field staff and producers who made invaluable contributions.

Graphic Design by Jess Scholz (Pinch Creative).

Photos provided by:

Jenny Milson
Richard Silcock
Trent Scholz
Ross McKenzie
Garry Pidgeon
Mary Fletcher
Ross Newman
Dan Burton
Karina Sheehan
Charlotte Cavanagh
Sarah-Jane Wilson
Genevieve Hawkins
Maree Winter
Andrea Hewitt
Michael Mann

Introduction to Pimelea Poisoning

Toxic *Pimelea* species are native plants found throughout inland grazing regions of Queensland, New South Wales, South Australia, the Northern Territory and Western Australia, extending over about one third to a half of Australia's pastoral lands. In certain years, pimelea poisoning has serious economic consequences for the pastoral cattle industry through loss of production, stock deaths and the costs of supplementary feeding and agistment in South Australia, New South Wales and Queensland.

Pimelea poisoning has also been historically known as Marree Disease in South Australia and St George Disease in Queensland after the areas where it was first described. Cases of what is now understood to be classic pimelea poisoning were reported as early as 1921 in Queensland, with similar reports in New South Wales in 1930 and in South Australia in 1948.

Feeding trials in 1969 and1970 established pimelea as the cause of the poisonings that were being observed in cattle. The pimelea plant toxin "simplexin" was isolated and characterised in 1975. Attempts were made to develop a vaccine against pimelea poisoning in the 1990s. Field trials were unsuccessful and the experimental vaccine did not reduce susceptibility to poisoning in cattle (D'Occhio 1996).

Cattle are much more susceptible to pimelea poisoning than sheep, and increased cattle production in areas that were once predominantly used for sheep grazing has increased the problems associated with pimelea.

The occurrence of pimelea poisoning has been difficult to predict due to a lack of understanding of the contributing factors. In 2006, a forum on pimelea poisoning held in Roma, Queensland, attracted producers and animal health professionals from across Australia. The discussions demonstrated that much of the existing knowledge was based on anecdotal evidence, and there were large gaps in the understanding of why some properties or animals were affected by pimelea poisoning when others were not. Without a clear understanding of contributing factors, producers were not always able to predict or anticipate when pimelea poisoning may become a problem, and were not well enough informed to undertake preventative measures.

In November 2006 funding for a research project was obtained from the Natural Heritage Trust through a submission coordinated by AgForce Queensland. The project involved Queensland Department of Primary Industries and Fisheries, New South Wales Department of Primary Industries, Primary Industries and Resources South Australia, University of Queensland, Australian Agricultural Company (AACo) and Meat and Livestock Australia (MLA). One of the major aims of this project was to develop a better understanding of the ecology of pimelea plants and the epidemiology of pimelea poisoning and to, for example, determine if there is a minimum plant density required for pimelea poisoning, and to relate plant toxin levels with stage of plant growth and environmental factors.

Development of a chemical assay (analysis method) to measure toxin levels in plant material sourced from different locations and at different stages of growth was fundamental to this study. This was achieved using state of the art liquid chromatography-mass spectrometry (LCMS) technology not available to previous researchers (Fletcher 2008). The availability of this assay provides a sound scientific basis for epidemiological studies. Utilising this assay, a feeding trial was also undertaken to determine the minimum toxin intake required to induce pimelea poisoning in cattle. Trials were also conducted to assess the rate of breakdown of the toxin in plant material under field conditions.

Another aspect of this project included conducting herbicide trials to identify the most cost-effective herbicide for control of two *Pimelea* species. Germination studies were also conducted to provide a better understanding of field conditions under which seeds germinate and to discern the environmental triggers required for germination.

The results of these field and laboratory studies have been incorporated together with documented existing knowledge to form the basis of this guide, "Understanding Pimelea Poisoning of Cattle". It is hoped that this guide will enable landholders and advisors to identify the risk factors and deal proactively and more effectively with the incidence of pimelea thereby improving the sustainability of cattle production in regions susceptible to pimelea poisoning.

Several case studies from across Australia have been included at the end of this guide, and they detail the personal experiences of individual producers. There is not necessarily any scientific basis to the observations reported. They are included so that producers may see first hand how others have been affected by pimelea poisoning and what management strategies they have adopted to minimise the impact on their businesses.

Figure 1 *Hereford heifer exhibiting severe signs of pimelea poisoning including oedema of the jaw and brisket, diarrhoea, emaciation, rough coat, breathing difficulties, depression and reluctance to move. This animal was unlikely to recover and so was euthanased.*

Pimelea Poisoning

Pimelea poisoning is a uniquely Australian phenomenon occurring in the drier regions of western New South Wales, Queensland and northern South Australia. It is associated with the consumption of certain herbaceous pimelea plants. The occurrence of these plants is often spasmodic and related to seasonal conditions.

Signs of Pimelea Poisoning

Common clinical signs seen in cattle with pimelea poisoning include:

- fluid swellings (subcutaneous oedema) most often under the jaw, down the neck and brisket and sometimes extending under the belly
- diarrhoea which can be dark, foul smelling and sometimes contains blood
- weight loss that may be rapid in animals with persistent diarrhoea and leads to emaciation and a rough coat
- distended jugular veins with a prominent pulse
- pale mucous membranes (anaemia)
- breathing difficulties
- reluctance to move (forced movement is likely to cause sudden death in advanced cases)
- decreased appetite
- becoming depressed and standing alone from the mob
- becoming easily agitated and aggressive.

Individual cattle exhibit a variety of clinical signs. These signs may all occur together or some may be partially or completely absent.

Consumption of large amounts of pimelea plant material causes severe, potentially fatal diarrhoea and has been observed in both cattle and sheep. Prolonged consumption of smaller amounts of pimelea tends to result in pimelea poisoning with associated fluid build up, breathing difficulties and heart stress in cattle, although these signs are not observed in sheep. The onset of clinical signs in cattle usually occurs more than three weeks after initial exposure.

As part of the recent study (Fletcher 2008), experimental feeding of cattle with *Pimelea trichostachya* containing known quantities of the simplexin toxin for 125 days resulted in animals showing only mild scouring and swelling of the jaw for a short interval (further details page 24). This supports field reports that not all animals affected by pimelea poisoning die. Stock may exhibit signs for several weeks before either recovering or dying.

Figure 2 *Young steer with laboured breathing and showing oedema of the jaw, throat, brisket, front legs and, in particular, the prepuce.*

Figure 3 *Calf with persistent diarrhoea, rough coat and mild oedema.*

Figure 4 *Santa Gertrudis heifer showing oedema of the jaw, distended jugular vein, poor condition and rough coat.*

How Poisoning Occurs

Figure 5 *Brahman cow in poor condition and with oedema of the brisket due to pimelea poisoning.*

Simplexin, the principal toxin found in *Pimelea simplex, Pimelea trichostachya* and *Pimelea elongata* leads to the syndrome of pimelea poisoning in cattle through three major routes which usually, but not always, occur simultaneously. These are:

- activation of the enzyme protein kinase C. This enzyme acts on cell proteins, notably myosin, resulting in contractions of thick-muscled blood vessel walls leading to marked constriction of the vessels taking blood from the lungs to the heart. This constriction causes a build up of pressure, which leads to fluid leakage into the chest, right-sided heart dilation and subsequent fluid leakage under the skin (subcutaneous oedema)
- a significant increase in the volume of blood (110–178% in experimental cases) (Kelly, 1975b), exacerbating the circulatory issues mentioned above. This also has the effect of diluting red blood cells so that oxygen concentration falls and anaemia results
- irritation of the intestinal tract resulting in diarrhoea.

Cattle can be affected by pimelea by ingesting green or dried plant material. Living green plants of pimelea are unpalatable and as a rule are seldom eaten. Pimelea can potentially also enter an animal's system through:

- inadvertent ingestion of green or dry plant fragments with other feed
- ingestion of soil containing dry plant fragments or seeds
- drinking of water that contains plant fragments or seeds
- inhalation of dried fragments which are ultimately ingested.

Figure 6 Pimelea trichostachya *growing amongst dense buffel grass in summer.*

Early experimental work postulated that animals exposed to the toxin predominately through inhalation developed the circulatory failure signs, while those ingesting the toxin developed diarrhoea. However, most inhaled particles are likely trapped in the mucosa of the upper respiratory tract and expelled back into the throat, where they are ultimately swallowed. Feeding trials performed as part of the recent study (Fletcher 2008) delivered the toxic plants via ingestion (excluding inhalation as a means of exposure) and cattle developed both circulatory signs and diarrhoea. This confirms that the digestive system is the major route of toxin absorption.

Post-mortem Examination

Examination of carcasses may reveal the following findings:

- pale tissues (anaemia) and watery blood
- enlargement of the right ventricle of the heart (heart may appear 'flabby')
- large volumes of fluid around the heart and in the chest cavity
- the lower portion of the lungs may appear compressed due to pressure from fluid build-up in the chest
- the liver is engorged with a large amount of blood, has a dark blue-black discoloration, with a 'sponge-like' appearance in severe cases.

Figure 7 *Enlarged right ventricle.*
(Photo: © Ross McKenzie)

Figure 8 *Brisket filled with fluid.*

Figure 9 *Fluid-filled chest cavity.*

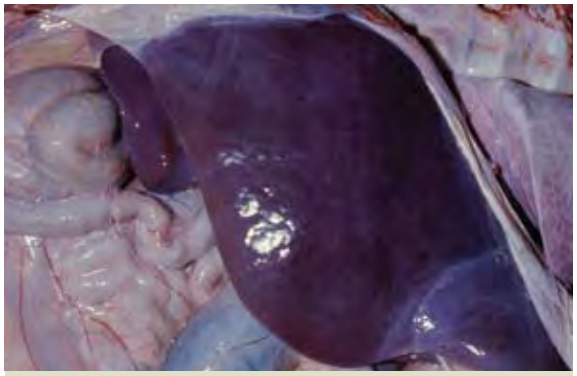


Figure 10 *Engorged liver with irregular surface.*
(Photo: © Ross McKenzie)

Timing of Outbreaks

Pimelea poisoning can occur at any time of the year. The conditions that favour pimelea poisoning have been examined through producer surveys and field observations (Trengrove 1982, Radunz 1989, Dadswell *et al.* 1994, Mossop 1998).

The conditions that favour outbreaks of poisoning include:

- low summer rain in the previous year
- good autumn and early winter rain
- low spring/summer rain with a feed shortage
- land with little perennial pasture either due to:
  - the nature of the land system,
  - insufficient summer rain to support perennial grasses, or
  - past or present grazing practices.

Most poisonings are reported between August and January when either flowering or dead plant material is likely to be present. Green pimelea plants have a strong unpleasant odour and are generally avoided by stock and are less likely to be eaten than dry pimelea plants, which have no odour. Plants are often most dangerous as they die off in late spring and early summer.

Producers also report that the plant is often not a problem when it grows on its own. Problems commonly occur when pimelea is growing amongst other feed and is consumed along with other palatable plants, even when pimelea is only a small proportion of the available pasture.

Animal Susceptibility

Species

In general, only cattle develop the full range of clinical signs. Sheep can be affected by the intestinal irritation component and eating green pimelea can cause diarrhoea (black scours) and may be fatal. Sheep do not experience the oedema seen in cattle (related to the vascular contraction), as the smooth muscles in a sheep's lung venules are not as well developed.

Horses are susceptible to the pimelea toxins and will develop severe gastrointestinal irritation and can die from it. Horses lack the thick smooth muscle found in the lung venules of cattle and this was originally thought to prevent the syndrome developing in horses. However, in 2002, it was reported that horses exposed to *Pimelea simplex* in the Marree area in South Australia developed severe oedema of the head, neck and brisket and also showed the characteristic liver lesions seen in poisoned cattle (Weaver 2002). More recently, horses near Roma in Queensland exposed to a dense population of *P. trichostachya* were reported as showing the full syndrome, including signs of circulatory failure, severe oedema, diarrhoea and liver engorgement (Wilson *et al.* 2007). Graziers with cattle affected by pimelea poisoning need to take caution with horses grazing the same pasture.

Kangaroos graze amongst dense stands of *P. elongata* and have not been reported to show signs consistent with pimelea poisoning.

Experienced versus Naïve Cattle

Cattle that are newly introduced to a property are often reported as being more susceptible to pimelea poisoning than homebred stock. It is not known for sure whether this difference in susceptibility is due to the learned behaviour of avoiding the plant in the pasture or whether previous exposure to the plant provides some level of resistance through changes in the rumen flora or liver detoxification capacity.

Reported instances of 'homebred' weaners that have succumbed to poisoning when separated from older animals suggests that it may be naïve animals that are more affected than those animals experienced in grazing pimelea infested pastures. Graziers should exercise caution with naïve animals (whether newly introduced or young stock) when risk of poisoning is high, and consider keeping them with more experienced stock if appropriate.

Breed

Although there is no scientific evidence to suggest differences in susceptibility between *Bos taurus* (British breed cattle), *Bos indicus* (Brahman breed cattle) and their cross breeds, there is some anecdotal information to suggest that *Bos indicus* are somewhat less susceptible than *Bos taurus*.

Class

Calves as young as three months have been affected by pimelea poisoning (Maunder 1947). Approximately half (54%) of Queensland producers responding to a survey (Pressland and Dadswell 1992, Dadswell *et al.* 1994), indicated that there were differences in class susceptibility, suggesting "bullocks, steers and calves were less susceptible than bulls, cows, heifers and weaners". This possibly reflects the fact that these latter classes of cattle place the highest demand on the affected pasture to fulfil their nutritional requirements and subsequently are at greater risk of exposure to the plant.

Stress is an important factor in the cause of sudden death in cattle with pimelea poisoning. On one Queensland case study property many cows showing signs of poisoning died while calving and it is suggested that the stress of calving precipitated their death (Dadswell *et al.* 1994).

Condition

Body condition does not appear to influence disease susceptibility (Trengrove 1982, Dadswell *et al.* 1994). However, many producers report that cattle previously affected and recovered from pimelea poisoning will be more susceptible if exposed to pimelea again.

Differential Diagnosis

Some of the clinical signs seen in cases of pimelea poisoning are also seen with other diseases. These should be considered before a definitive diagnosis is made. Deterioration in body condition and the accumulation of body fluid under the skin can be seen with:

- parasitic worm burdens
- urinary calculi
- protein deficiency
- lumpy jaw
- hardware disease - where a foreign body, eg. wire, perforates the digestive tract and a bacterial infection spreads to the heart.

The Plants Involved

Pimelea poisoning of cattle is attributed to the consumption of any of four herbaceous pimelea plants. There are three toxic species and within one of them, *Pimelea simplex*, there are two distinct subspecies.

The four toxic plants and their most frequently used common names are:

- *Pimelea simplex* subspecies *simplex* (desert rice-flower)
- *Pimelea simplex* subspecies *continua* (gibber rice-flower)
- *Pimelea trichostachya* (flax weed)
- *Pimelea elongata* (lakebed pimelea).

Distribution of Different Species

Figures 11, 12 and 13 show the collection sites across Australia where specimens of the three different species have been collected and positively identified by State herbaria. These maps do not necessarily reflect the relative density of a species in a given region, just that the species does occur in that area. Therefore, a relatively higher density of records could be expected from more regularly frequented areas.

These collections have been made over many years, and may include locations where the plants only occur spasmodically and where pimelea poisoning may never have been known to be a problem. The most widespread species is *Pimelea trichostachya*, while the most restricted in its distribution is *Pimelea elongata*.

These maps were drawn from the Australian Virtual Herbarium, which can be accessed at http://www.anbg.gov.au/avh/.

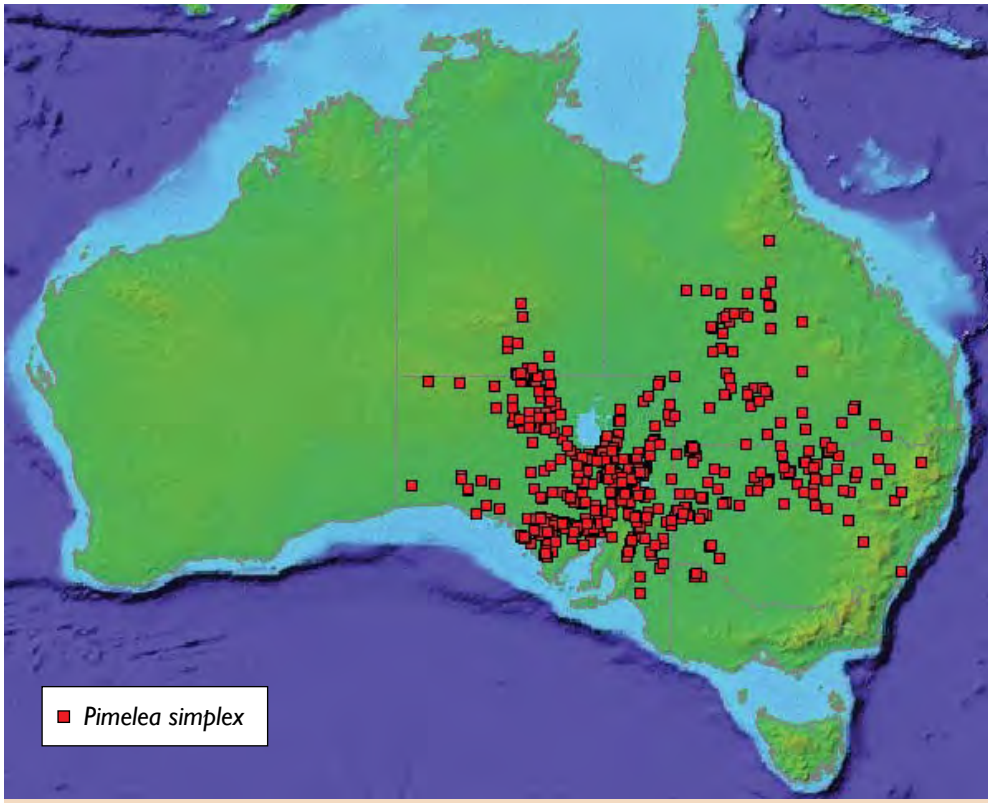


Figure 11 *Australian Virtual Herbarium collection records for* Pimelea simplex *(both subspecies).*

Pimelea simplex (both subspecies) has been recorded in the Northern Territory, South Australia, Victoria, New South Wales and Queensland (Fig. 11). It is found as far east as Inverell, north to Muttaburra and Winton, south as far as the southern Eyre Peninsula and Balranald and west as far as the South Australian/ Western Australian border. In some places the two subspecies closely intermingle, but usually one occurs exclusively over large areas.

P. simplex is found on alkaline, heavy clay soils and red desert loams. Sometimes there is a substantial stone and gibber content in these soils.

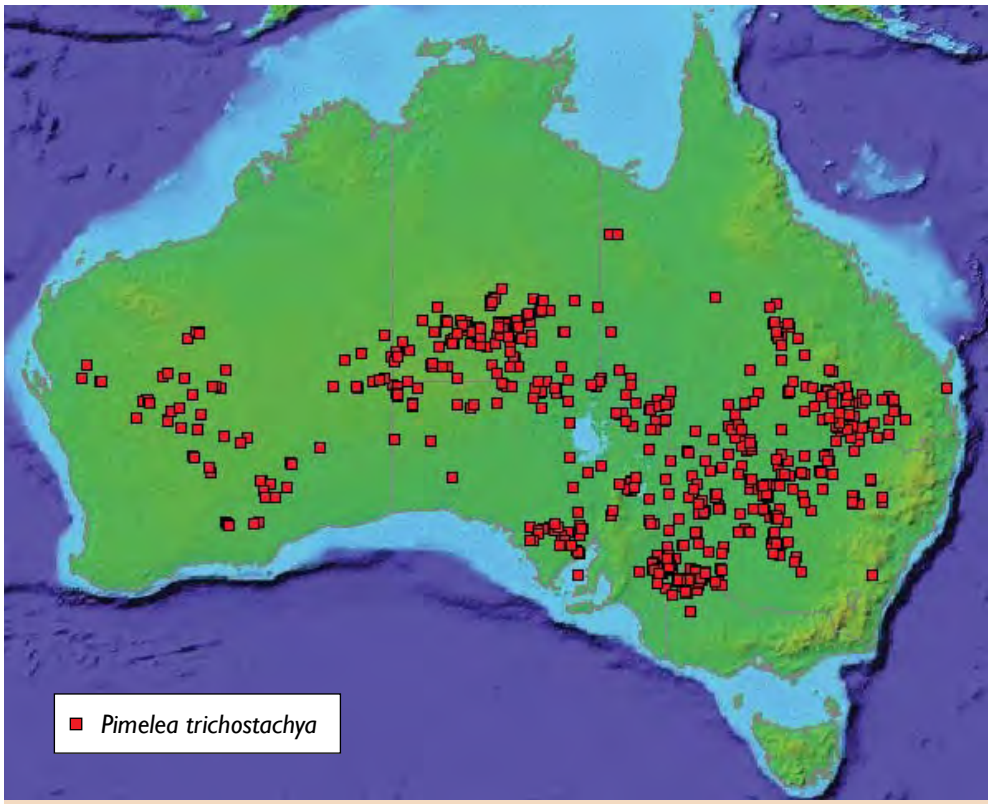


Figure 12 *Australian Virtual Herbarium collection records for* Pimelea trichostachya.

Pimelea trichostachya is shown to grow all across Australia from the eastern Darling Downs to almost the Western Australia coast near Carnarvon (Fig. 12). It is found as far south as Horsham and northern Eyre Peninsula and north to Alice Springs and the desert uplands country north of Muttaburra. It occurs in arid to subhumid climates where significant rain can fall at any time of the year. It tolerates frosts well and is usually found in areas of reduced perennial ground cover. It is rarely found growing where there is appreciable tree or shrub cover.

P. trichostachya is associated with sandy soils of varying colour and acidity as well as hard-setting duplex soils (red, brown and grey) such as those that occur in poplar/bimble box country. In New South Wales this species seems common on sand blows associated with lakes and river frontages.

Pimelea elongata is much harder to characterize in terms of its distribution and soil type preferences. It has been recorded in south-west Queensland, north-west New South Wales and north-east South Australia, but the number of collection sites is fewer than for the other two species (Fig. 13). Recent observations suggest that there are two forms, a yellow-leafed type that has narrower, darker brown seeds and a blue-leafed form with fatter, fawn-coloured seeds and relatively wider leaves.

P. elongata has been found on grey loams, mulga sandy red earths, alluvial loams, clayey ephemeral lakebeds, localized gilgais in a range of vegetation types, and on the margins of claypans. The grey clays tend to support the blue-leafed form, while the red earth sandy loams support the yellow-leafed form. The plant is commonly found in small internally draining areas where local water ponds often enough to minimize tree growth and leave an open herb-land. In the south-west Queensland mulga bioregion, *P. elongata* can be found almost anywhere that water ponds temporarily, including roadsides and gilgais. It will withstand short periods of partial inundation.

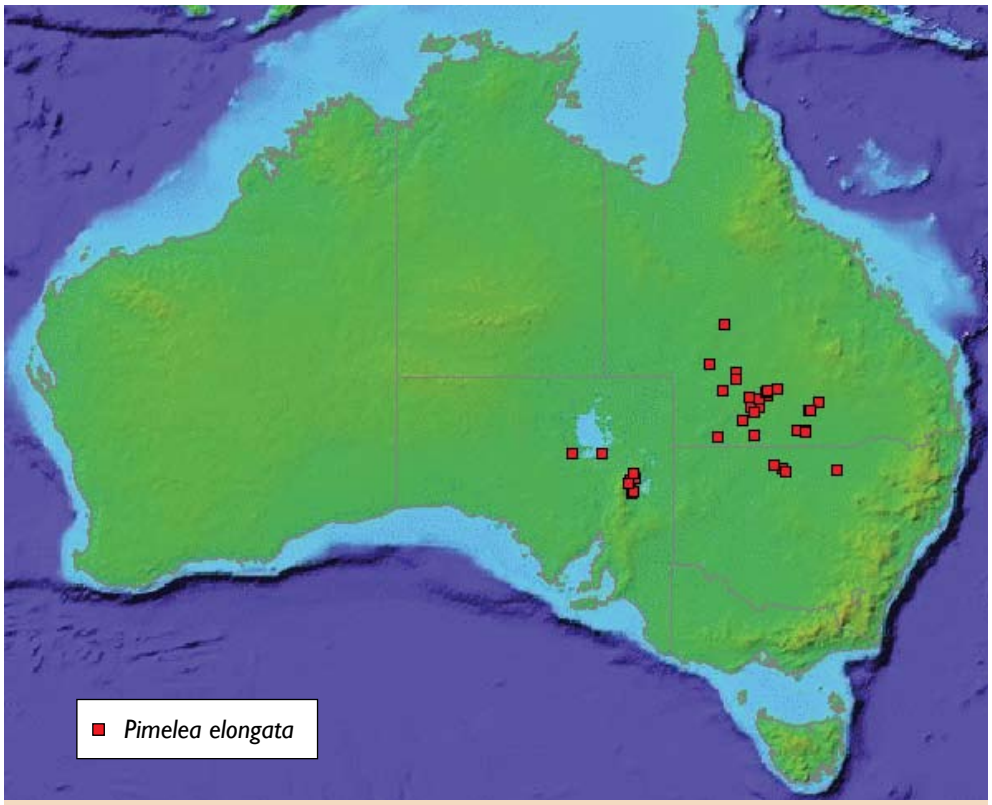


Figure 13 *Australian Virtual Herbarium collection records for* Pimelea elongata.

Distinguishing Between Species

It is important to be able to distinguish between the different species in the field because the toxin levels and animal susceptibility seem to vary between the species.

Pimelea simplex seems to have lower levels of toxin (simplexin) but high impact on cattle in the paddock (Fletcher 2008). *Pimelea elongata* seems to have high toxin concentrations but tends not to cause a lot of problems in the paddock. As the species tend to grow in distinct habitats, any effect on stock is often attributable to a single species rather than a combination of species.

Plants in the Landscape

In the paddock, each species can vary, as a flowering plant, from a single stemmed plant 10 cm tall with a single flower head to large, multi-branched plants at least 30 cm tall and in extreme cases over 75 cm tall with stems 1 cm thick at the base (particularly with *P. trichostachya*).

Figure 14 Pimelea simplex *growing under ideal conditions.*

Figure 15 Pimelea simplex *growing in less than ideal moisture conditions.*

Figure 16 Pimelea trichostachya.

The plants' size and degree of branching depends on the amount of moisture available to them and the degree of competition experienced. Big plants are most likely on the banks of dams, in old stump holes and on flats that are bare of grass and trees.

In general, all three species have a pink or burgundy colour on at least part of the main stem and their leaves are small and not obviously hairy. Plants have a distinct taproot and many branches, each of which ends in a flower head. The stem colour can be affected by growing conditions such as light intensity, moisture stress and frost. A reddish stem, though very common, cannot be used as an absolute identification feature.

Figure 17 Pimelea elongata *(blue-leafed form).*

Figure 18 *Healthy* Pimelea elongata *plants (yellow-leafed form).*

All three species can form dense, nearly mono-specific stands over significant areas if recruitment conditions and environment are suitable and significant competition is lacking. *P. elongata* can be virtually the only species over several hectares of an ephemeral lake while *P. simplex* can grow as the dominant plant over many hectares on undulating pebbly downs. However, all three species typically occur as small patches in slightly wetter parts of the landscape or in areas that have experienced extra disturbance such as along roads and powerlines and in cultivated areas. They are also more likely in areas where there are few perennial summer growing grasses.

Successful germination and establishment seems to require better moisture conditions than that needed by many other herbaceous species. In higher rainfall parts of their distribution, pimelea tends to germinate at the same time as the naturalised medics. In relatively dry seasons, if pimelea is found it will be in places where runoff water has ponded after smallish falls of rain (20-30 mm). This can be in roadside drains, gilgais, watercourses and even undefined drainage paths across quite flat landscapes. This distribution of pimelea plants where the best green pick occurs probably causes stock to accidentally consume pimelea plants that they would otherwise avoid. Seedling plants have high concentrations of simplexin in their tissues and so animals can ingest quite a lot of toxin in a short time if they concentrate their grazing in these green patches.

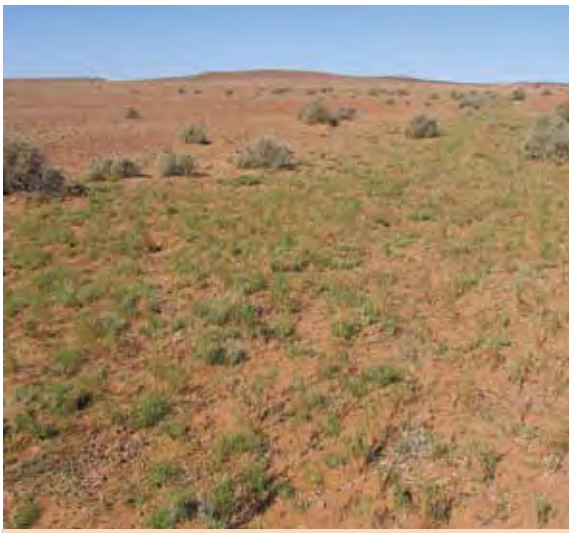


Figure 19 *Abandoned station track across a gibber plain in northern South Australia, which is typical of where* Pimelea simplex *can be found growing.*

It is also normal for a scattering of plants to be found amongst other pasture. *Pimelea simplex* can grow amongst and up through Mitchell grass (*Astrebla* spp.) tussocks even when the country is in good condition. *P. trichostachya* is commonly found growing in small patches in healthy buffel grass (*Cenchrus ciliaris*) pasture.

Figure 20 *Dead* Pimelea simplex *with seeds still attached, growing through a Mitchell grass tussock.*

In dense patches, the plants can be either a single age and stage of development or there can be several ages of plants, from seedlings to semi-senescent old plants. This is controlled by previous seed setting events and by the way recent rain has fallen to germinate seeds and grow plants.

Though the plants are generally classified as annuals, *P. elongata* and *P. trichostachya* have considerable capacity to last into a second growing season if conditions are suitable. Such plants are usually very large and sturdy, have relatively few leaves and retain a lot of flower heads that steadily produce more seeds (the most toxic part of the plant). Re-shooting of mature *P. simplex* may occur with early summer rains but live plants of this species do not normally persist through a full summer.

All the *Pimelea* species have a number of features that change as the plants grow and age, and it is a combination of these features that uniquely identify each one. The appearance and structure of the flower heads and of the seeds define the species. Prior to flowering, *Pimelea* species can be distinguished from other herbage by the characteristic shape and colour of the leaves and stem.

Figure 21 Pimelea simplex *covering many hectares of undulating pebbly downs.*

Figure 22 *Dense stand of* Pimelea elongata, *south west Queensland.*

Flower Heads

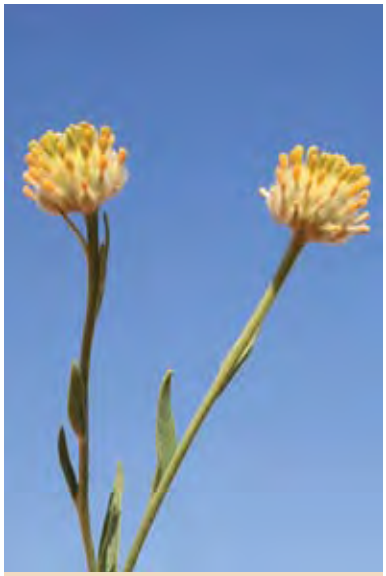


Figure 23 *Flower head* of Pimelea simplex *subsp.* continua.

Figure 24 Pimelea elongata *flower head.*

Figure 25 Pimelea trichostachya *flower head.*

Figure 26 Pimelea simplex *subsp.* simplex *flower head.*

Length of the flower head above the last leaf is a useful distinguishing feature. *Pimelea simplex* has a much shorter flower head compared with the other two species. It is generally less than 2 cm long. By comparison, the flower heads of *P. trichostachya* and *P. elongata* plants growing under reasonable conditions are often 5–7 cm long and commonly up to 15 cm long. Such stems show a series of well spaced bumps that mark where each individual flower was before turning into a seed and falling off. These bumps allow these two species to be distinguished from the more compact *Pimelea simplex*, even when most of the flowers have fallen off.

When the three species have immature flower heads, they all start off with a tightly packed collection of flowers in each flower head. The flowers then pollinate sequentially from the base of each flower head, often without obviously opening.

Species identification is challenging if severe moisture stress occurs soon after flowering begins, because elongation of the maturing flower head may hardly occur on some heads. In this instance, individual flower head length is not a reliable diagnostic feature and a number of flower heads need to be examined to be confident of a correct identification. This information must be used in conjunction with other features such as seed hair length and type.

While actively growing, *P. trichostachya* flower heads look greyish white to dirty pale pink, and those on *P. simplex* appear creamy coloured with a yellow fringe. *P. elongata* has a much more uniform yellow colour to its flower heads and lacks obvious hairs. The tips of the flowers of *P. elongata* and *P. simplex* open early in the morning and late in the day to allow for pollen release and this coincides with the release of a strong sweet aroma at around sunset and sunrise. The flowers of *P. trichostachya* appear to stay closed all the time whilst those of *P. elongata* and *P. simplex* close in strong sunlight.

Seeds

Initially, seeds of all species have a distinct, small elongated knob on the tip which is deep yellow and which breaks off fairly easily once the seed ripens. Mature seeds may or may not retain this knob after they ripen. Hairiness of the seeds and the hair morphology are quite useful and consistent features for distinguishing the species (Table 1).

Table 1 *Distinguishing between seeds of different* Pimelea *species.*

Species/ subspecies	Seed shape	Seed hairs
P. simplex subsp. *simplex*	Straight to slightly curved, fatter at the base, variable in size, often with the hairs aligned into 3 or 4 longitudinal ridges.	Moderate density, mostly short hairs. Sometimes with sparse straight hairs like those on *P. trichostachya*, more often short like *P. elongata.*
P. simplex subsp. *continua*	Curved (banana-shaped) and variable in size and with hairs of variable length.	Dense, cream hairs of varying length, mostly aligned upwards towards the tip of the seed. More hairy, larger seeds than the other subspecies.
P. elongata	Pear-shaped	Very short, crinkly hairs tightly felted on to the seedcoat. The yellow-leafed type has a less pear-shaped seed and often a 4-cornered cross-section (rather than circular).
P. trichostachya	Pear-shaped	Stiff, thin hairs that stick out from the seed coverings and are often quite sparse. May clump together after being wet. Plants in more arid regions and more southerly latitudes seem to have longer, denser hairs on the seeds.

Figure 27 *L-R Seeds of* Pimelea simplex *subsp.* simplex, Pimelea simplex *subsp.* continua *(with retained terminal knob),* Pimelea elongata *and* Pimelea trichostachya.

Seed Germination

Fresh seeds of all three species will not germinate. The embryo requires a maturation process to occur before germination and to date this is not well understood (Dadswell *et al.* 1994, Silcock *et al.* 2008a). The seedcoat also has to weather to some degree. The seedcoat is thick and probably impermeable to water. There is a small pore at the narrow end of each seed through which moisture probably enters. In fresh seed, that pore probably has a waxy, water repellent cover or the intact thin membrane between the seed and the hairy seedcoat may repel moisture in fresh seeds.

Field trials were conducted during 2007–2009 to investigate the effect of prolonged natural weathering on the germination rates of seeds of *P. simplex* subsp. *continua*, *P. trichostachya* and *P. elongata* left on the soil surface (Fletcher 2008). The trial sites were at Marree (South Australia), Broken Hill (New South Wales) and Longreach and Mitchell (Queensland). Seeds were also buried one centimetre below the surface at Longreach.

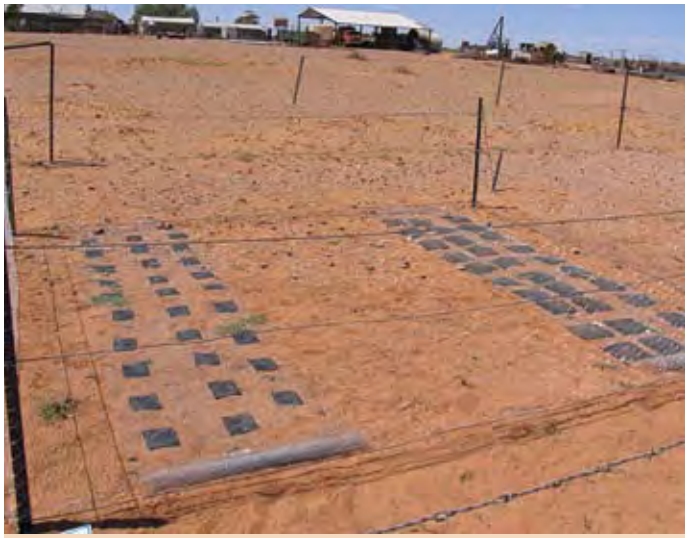


Figure 28 *Weathering trial site near Marree, South Australia.*

The germination rates of seeds of *P. trichostachya* and *P. elongata* seem to improve greatly after a few months exposure to field conditions, when compared with seed stored in a laboratory. In either case the degree of germination at any time is very unpredictable and in keeping with the unpredictable nature of seedling establishment in the field.

Burial appears to prolong the viability of seeds, as well as shelter them from theft by surface-active insects. After two years of average seasons near Longreach, buried *P. trichostachya* seeds still had 25% germination while surface seeds that remained after insect theft had almost zero germination. The amount of viable seed on the soil surface can be greatly reduced after two years, especially for *P. elongata*, the seeds of which are preferentially collected by insects.

Figure 29 Pimelea elongata *seed with full embryo.*

Pimelea elongata seed appears to have the weakest dormancy and many of its seeds (40%) germinated after only one or two month's exposure on the soil surface. The seed viability appears to reduce after about six month's exposure on the soil surface and in this trial was very low after 18 months (which included an average summer and rain events that germinated seeds in both winters).

By comparison, *P. trichostachya* seeds have a stronger dormancy and it normally takes over three months in the field before appreciable germination can occur. Seeds that were exposed to field weathering had higher germination rates than those stored in the laboratory. *P. trichostachya* seeds that were buried under one centimetre of soil retained their viability much longer than seed exposed on the soil surface.

Seed dormancy is strongest in *P. simplex*. In the germination trials, both buried and surface-weathered seeds of *P. simplex* largely failed all attempts at germination after nine month's field weathering. After twelve months of surface weathering at the Marree site, 5% of seeds germinated and this low proportion was achieved again at

several sites after 18 and 24 months. Laboratory stored seed also failed to germinate for at least 18 months. It is possible that there were only 5% viable seeds in the batch of seed used for this trial. Much higher proportions of viable seed are possible based on results from other seed collected subsequently.

Many seeds that look 'good' have no embryo inside them, while others have only a dry, shrivelled embryo sac. This is probably because the plants ran out of soil moisture before full development of the embryo. The growing of the thick dark seed wall always happens first and the embryo is the last thing to develop. Hence seeds may have different amounts of toxin in them depending on whether there is a full embryo inside. Tests have shown that the hairy outer layer of *P. simplex* seeds is very low in simplexin (<1 ppm) while naked seeds may contain 260 ppm (parts per million).

Figure 30 *Hairy* Pimelea simplex *seeds trapped amongst litter and pebbles.*

If fresh seeds fall on to water they float persistently and are only fully wet after much agitation. Dirt in the water can act as a wetting agent and speeds up the wetting of the seed hairs. Once fully wet, some seeds float while others slowly sink. This may depend on whether or not the seeds have an embryo in them.

Fresh seeds falling on to soil are quickly blown to areas where they can catch in litter or soil cracks or against rocks and pebbles. There they will stay and become entrapped in any loose surrounding surface materials. Thus seedlings are rarely found emerging from badly scalded areas of soil. They are more likely to come up amongst litter or on areas that have been disturbed prior to the seed dropping.

Dew and light falls of rain quickly stick the seeds to the soil surface. The wet hairs become flattened and pushed into close contact with the soil, particularly fine clays and silt. The fine soil seems also to act as a wetting agent and hasten the wetting of the otherwise water repelling hairs on fresh seeds. After the dew or rain dries, the seeds appear to be well stuck to the soil and they will not readily blow away or move on. Thus, seeds tend to be retained close to the parent plants and/or amongst nearby litter, stones, sticks or bushes. Newly ripened seeds blown away by strong winds can be moved great distances. Seeds can concentrate in sand blows, as a result of wind action and the mixing of fine sand and seeds in the process.

Figure 31 *Pimelea seedling with opposite leaves initially, changing to alternate leaves as it grew older.*

Leaves

The seedlings of all three species start with the leaves arranged in pairs up the stem. After 5 or 6 pairs of opposite leaves, subsequent leaves start to be offset slightly from each other and by the time branching occurs, all new leaves are alternate (arise singly and on alternate sides of the branch).

Leaves of young seedlings are hairless, then on older plants the leaves start to show a scattering of short hairs that keen eyes or a magnifying glass can discern. Hairiness, if it occurs, only becomes common as the plants approach flowering and then the short white hairs can be seen on the branches below the flower heads as well as on the leaves. Such hairiness is most common on *P. simplex* and least common on *P. elongata.*

The leaves of large *P. simplex* plants are often 3–4 mm wide at the widest part and then taper (often with a distinct curve) to a long point. Total length can be 3–4 cm. Leaves of the blue-leafed type of *P. elongata* can be as wide but their tip is more rounded than pointed, with their total length usually less than 2 cm. Leaves of *P. trichostachya* are usually up to 2 mm wide and 2 cm long, quite straight, and the tip is sharply tapered. The yellow-leafed form of *P. elongata* has similar shaped leaves to those of many *P. trichostachya* plants. At night and when under stress, the leaves of healthy plants of all species tend to fold upwards against the branch or stem.

Figure 32 *Two week old* Pimelea trichostachya *seedling with white root, long deep pink stem and narrow leaves in pairs.*

Figure 33 Pimelea trichostachya *seedling.*

Seedlings

New seedlings of all species have two initial leaves about 8–10 mm long, which sit well clear of the soil surface (often 1 cm above) and have a reddish stem below. *P. simplex* subsp. *continua* seedling leaves are often only 1 mm wide while those of *P. elongata* are often over 2 mm wide. There are no obvious hairs, no obvious mid-vein on the leaves and both sides of each leaf are a similar shade of green. The first pair of leaves (the cotyledons) looks very similar to the next few pairs of leaves in size, shape and colour. Successive pairs of leaves are at 90° to those below and there is usually a length of stem clearly visible between each pair.

Figure 34 Pimelea elongata *seedling with opposite early leaves with rounded tips.*

Figure 35 Pimelea simplex *subsp.* continua *seedling with opposite early leaves and no hairs.*

Figure 36 Pimelea simplex *subsp.* simplex *seedling.*

Figure 37 Pimelea simplex *and* Neobassia *sp. (soda bush) seedlings. Soda bush seedlings have hairy leaves and lack the long pink stem.*

Figure 38 Pimelea simplex *and* Calotis *sp. (burr daisy) (circled) seedlings. The pimelea seedlings have long dark-pink stems and their first pairs of leaves are similar in shape to later ones.*

Other species likely to emerge under similar conditions and with some similar features (but with discernable differences) include:

- copper burrs (*Sclerolaena* spp.) and soda bush (*Neobassia* spp.) - leaves have hairs on the surface and are sometimes purple underneath
- native flax (*Linum marginale*) - very rounded first pair of leaves
- native spurges (*Chamaesyce* spp.) - more rounded leaves with consistent red and purple tints
- smooth minuria (*Minuria integerrima*) - bigger, wider leaves
- young daisies of many species - most have obviously hairy leaves that rarely occur in pairs up the stem. The first pair of leaves is often very different in shape or size compared to subsequent leaves (Fig. 38).

Figure 39 Pimelea simplex *subsp.* continua *seedlings flowering.*

Figure 40 *Small* Pimelea simplex *subsp.* continua *plants flowering.*

All *Pimelea* species can flower while still very small, unbranched plants under 10 cm tall. *P. simplex* commonly flowers when only 5–7 cm tall, while the others are generally more than 10 cm high when first flowers are seen. Under unusual circumstances, *P. trichostachya* can grow as tall as 75 cm before flowering but it normally has some flowers once it is over 20 cm tall.

Influences on Plant Growth

Shade

All three *Pimelea* species are rarely seen to grow in shade. Plants can be found beneath isolated trees or shrubs where there is direct exposure to sunlight for a large proportion of each day. However, they are not seen where there is a continuous canopy of trees or shrubs, for example, dense mulga, poplar box and gidyea. Vigorous annual plants such as wild parsnip (*Trachymene* spp.) can suppress the growth of *P. elongata*.

Figure 41 Pimelea simplex *growth suppressed by moderately dense gidyea tree cover.*

The principle effect of shade seems to be through the control of seed germination and seedling establishment. Seeds will germinate in sparse pastures, such as Mitchell grass and wiregrass, and those seedlings will survive and grow later in competition with that grass. How large seedlings must be to survive amongst competitive grass is unknown, but *P. trichostachya* has been seen growing and flowering quite well in dense buffel grass pasture (Fig. 6). The pimelea had germinated in late winter and was well grown by November when good rains allowed the droughted buffel grass to resume vigorous growth.

Regular shade also seems to cause flowering to be delayed, even on large plants.

Immersion

Survival of short term immersion has been recorded for *P. elongata* growing in ephemeral swamps and drains, particularly in non-summer months. However, prolonged standing in stagnant water in summer seems to kill this species.

Insects

The foliage of all three *Pimelea* species is rarely attractive to insects, with a few exceptions. In the field, matting of seeds and aborted flowers amongst the foliage can indicate the presence of the sorghum seed head caterpillar (*Cryptoblabes adoceta*). The larval caterpillar stage makes a protective cocoon of the loose

Figure 42 *Moth of the sorghum seed head caterpillar.*

Figure 43 P. simplex *seed heads stuck together by the sorghum seed head caterpillar.*

pimelea seeds and then feeds on adjacent leaves and young bark of the upper branches. The adult is a non-descript, small grey moth about 1 cm long. It is not a native insect and is seen mostly on *P. simplex*.

A stippled-coloured shield bug (*Oncocoris* sp.) has been seen sucking on green, half ripe seeds of *P. elongata* and they are also suspected of producing curled, aberrant tips of the flowering stems on some shoots of a plant. Curling of tips has also been caused by thrips which are tiny (1 mm long) insects normally associated with flowers. Thrips may also be important pollinators of all the *Pimelea* species. They are found in very immature flowers that have the anthers ruptured and may move the pollen between flowers of *P. trichostachya* that are never seen to open, yet often set seed.

Small grasshoppers have been recorded consuming small *P. simplex* seedlings in their entirety.

Figure 44 *Shield bug feeding on immature* P. elongata *fruits.*

Figure 45 *Thrips damage to young* P. simplex *showing curling of leaf tips.*

Figure 46 *Virus affected inflorescence (right side of photo) on* P. trichostachya.

Fungi and Other Pathogens

Seedlings and adult plants of all species seem susceptible to damping-off fungi. Many times, large plants of *P. trichostachya* and *P. simplex* have suddenly wilted and died unexpectedly. On examination, the stems at ground level show the classic band of dead, grey stem indicative of collar rot. One confirmed case had the fungi *Fusarium oxysporum* and a *Pythium* sp. isolated from the dying stem.

As seedlings, *P. elongata* seedlings rarely suffer damping-off whereas this is common for *P. trichostachya* and *P. simplex* subsp. *continua*. Few adults of *P. elongata* exhibit signs of damping off. Powdery mildew (*Erisyphe* sp.) can attack the tops of *P. elongata* both in young plants and large mature plants.

In very wet summer conditions, well grown *P. trichostachya* plants can be quickly killed by fungal attack that turns the tops dark grey and causes all leaves to drop. Only tufts of immature flowers remain on the tips of branches. *P. elongata* seems less susceptible to this but field evidence from the Bollon area suggests that the same can happen to upright plants mixed with herbage in an ephemeral swamp.

No rust or smut diseases have been recorded but, on *P. trichostachya*, aberrant flower head growth with a flattened, widening rachis can be found on a small proportion of inflorescences and on a minor proportion of all plants in a region (Fig. 46). This is presumed to be caused by a viral agent transmitted by a sucking insect vector and was reported also in 1994 by Dadswell *et al*. It has not been seen on the other species.

The Toxin in the Plant

The major pimelea toxin is simplexin, a compound only found in *Pimelea* species, but with similar properties to toxins found in croton oil and spurges. Simplexin is a skin irritant and a known co-carcinogen or tumor promoter, so care should always be taken in handling these plants.

Simplexin is present as the major toxin in each of *P. simplex, P. trichostachya* and *P. elongata* and is accompanied in each species with a mix of minor, related compounds (Fletcher 2008) in variable proportions, depending on the part of the plant and the stage of growth. The chemical similarity of these minor compounds suggests a similar toxicity to simplexin.

Toxin Distribution in Pimelea Plants

Simplexin levels in both *P. trichostachya* and *P. elongata* species are higher (up to 580 and 540 ppm in flowering foliage respectively) compared with *P. simplex* with maximum simplexin levels in flowering foliage of only 230 ppm (all concentrations expressed as a proportion of dry plant weight) (Fletcher *et al.* 2009).

There are distinct differences in the location of toxins in plant parts of each species (Table 2). In *P. simplex*, flower heads and roots contain similar toxin levels with very little toxin detected in branches, stems and leaves. Flower heads of *P. trichostachya* contain high toxin levels with much lower levels seen in other plant parts including roots. In *P. elongata*, highest toxin levels were measured in roots and flower heads, but with significant levels also recorded in branches, stems and leaves.

Table 2 *Simplexin distribution in plant parts of representative flowering/post-flowering specimens of each* Pimelea *species.*

Plant Parts	Simplexin Concentration (ppm)		
	P. simplex* subsp. *simplex	***P. trichostachya***	***P. elongata***
Flowers & seeds	253	709	341
Branches	trace	70	161
Main stem	trace	48	195
Leaves	22	49	244
Root	281	66	409

P. elongata is rarely responsible for reported cases of pimelea poisoning despite having similar toxin levels to the other species. The presence of significantly higher levels of toxin in leaves, stems and branches of *P. elongata* may contribute to greater avoidance of this species by stock, as the irritant contact would be more immediate in these plants compared to seed-contained toxins, which would only be released during digestion. *P. elongata* generally occurs in a mono-specific stand. It is not usually mixed with other palatable forage as *P. simplex* and *P. trichostachya* often are, and this would further encourage grazing avoidance.

Simplexin Concentration in *Pimelea* Species at Different Stages of Growth

Analysis of more than 600 plant samples across the three *Pimelea* species has shown considerable variation in simplexin concentration even at the same growth stage (Fletcher *et al.* 2009), with higher levels seen in healthy, growing plants. Simplexin levels are generally highest in pre-flowering/flowering plants, and decrease through flowering to post-flowering stages. The loss of toxin in post-flowering plants correlates with the loss of flower heads and seeds during the seed dispersal phase as the plants age, as much of the toxin content is located in these plant parts. Loss of flowers, seeds and leaves in "dead" aged plants further reduces the toxin content in the remaining dried stalks.

Simplexin levels in standing dry, brown stalks can be less than 10–20% of the toxin level of green material. However, these dry stalks have lost their distinctive odour, and can still represent a significant poisoning risk particularly where they are present among pasture grasses and can be inadvertently consumed by stock.

Break Down of the Toxin in the Field

Field trials were conducted during 2007–2009 to investigate the effect of prolonged natural weathering on the toxin decomposition in litter samples (coarsely chopped dried aerial pimelea material), and seed samples. The trial sites were at Marree (South Australia), Broken Hill (New South Wales) and Longreach and Mitchell (Queensland).

There was a significant decrease in toxin levels in litter material after field weathering. Toxin levels in *P. trichostachya* litter (which had the highest original simplexin content of the three samples available) reduced by 50% in six months, during which time very little rain fell, and to less than 10% after twelve months of surface weathering. By comparison, *P. trichostachya* litter buried under 1–2 cm of soil retained higher residual toxin. This suggests sunlight and/or temperature may be key factors in the breakdown of simplexin. The decline in toxin in *P. simplex* and *P. elongata* litter was not as pronounced due to much lower initial simplexin levels in the material used.

In contrast, the toxin content of weathered seed, both on the surface and buried, did not greatly decrease. Simplexin levels remained relatively unchanged in *P. trichostachya* seed and *P. simplex* seed even after 18 months weathering on the surface. Unfortunately *P. elongata* seeds were stolen by insects in the field, and were not available for testing.

Figure 47 *Weathering trial near Longreach, Queensland.*

These results indicate that dried, weathered seedless plant material from previous seasons is unlikely to cause pimelea poisoning. However, seed material either consumed with soil, in drinking water or adhering to other plant material could be a source of pimelea poisoning problems when pimelea plants are not apparent in the pasture. Simplexin is a fat soluble compound and does not leach easily from seeds into water, e.g. in troughs or puddles. It is not usually detectable in soil that has been in close contact with pimelea plant litter or seeds, unless actual plant particles remain.

Minimum Plant Abundance and Distribution for Pimelea Poisoning

It has often been asked whether there is a minimum density or abundance of pimelea plants required to cause toxicity. Data collected in the recent project (Fletcher 2008) showed that cattle poisoning can occur with the most problematic species, *P. simplex* or *P. trichostachya*, at low densities (less than 5 plants per square metre) and where these species represent less than 5% of the available pasture. However, on other properties, cattle were observed to be unaffected by a much higher density and abundance of these species.

No instances of *P. elongata* poisoning were reported in the study areas during the project (and infrequently in the past) and stock generally appear to be unaffected by relatively high densities and biomass of this species

in parts of a paddock. It should be noted that there is experimental evidence that *P. elongata* can poison cattle (Clarke 1973, Kelly 1975a, Ross McKenzie unpublished), and chemical analyses show comparatively high simplexin levels in this species (comparable with *P. trichostachya* and higher than *P. simplex*).

Regardless of species, it is apparent that factors other than a simple measure of pimelea plant density and abundance contribute to instances of pimelea poisoning. Many cattle are able to exist in pastures with relatively high levels of pimelea without poisoning, and will generally avoid consumption of pimelea if at all possible. The actual level of toxin in the plant also does not necessarily correlate with toxicity. Pimelea poisonings are often associated with flowering plants of only moderate toxin level, and dried stalks with low toxin levels (Fletcher unpublished).

In all cases, the risk appears higher where pimelea grows interspersed with grass (common with *P. trichostachya* and less so with *P. simplex*) and where it grows through the grass foliage to the same height, as compared to situations where pimelea plants grow in isolated large patches or in small clumps (common with *P. elongata*). In these cases, the plants are more easily avoided by grazing stock.

How Much is Toxic?

A feeding trial was undertaken to determine the minimum toxin intake required to induce pimelea poisoning (Fletcher 2008). Four calves that had not previously been exposed to pimelea, consumed increasing amounts of milled *P. trichostachya*, commencing with 7.5 mg air-dried pimelea plant/kg bodyweight per day, increasing in 2.5 mg increments every 14 days, with careful monitoring, until clinical signs were observed. This milled material of shoots, flowers and immature seeds was analysed to contain approximately 200 ppm simplexin. This is comparable to the average simplexin concentration seen in *P. trichostachya* or *P. elongata*, although maximum levels in these species can be twice this level. By comparison, simplexin levels in flowering foliage of *P. simplex* are generally lower than 200 ppm, with average levels around half this.

Figure 48 *Calf with mild oedema under jaw but no diarrhoea (regular dung pat) at Day 35 of feeding trial.*

Figure 49 *2 g of* Pimelea trichostachya, *equivalent to feeding trial daily consumption at Day 35, which induced mild symptoms seen in Fig. 48.*

After initial mild diarrhoea for a period of 4 days, animals tolerated intake of *Pimelea trichostachya* with no adverse effects until day 35, when increased heart rates were noted and one animal had mild oedema under the jaw but no diarrhoea (Fig. 48). Fluid accumulation under the jaw developed in the remaining cattle at day 42, 63 and 84. Although still being fed pimelea, this swelling diminished over time and all four animals appeared normal from day 91 until the end of the experiment at 125 days.

At the time of the initial onset of oedema at day 35, the 160 kg calves were consuming approximately 2 g pimelea per day (equivalent to one plant, see Fig. 49) or 12.5 mg/kg bodyweight per day (approximately 0.07% of their daily ration). This 2 g of plant contains only 0.4 mg of simplexin.

This small dose of plant material required to induce mild pimelea poisoning demonstrates the high potential toxicity of these plant species. Pimelea plants are significantly more toxic than many other poisonous plants. Plants such as fireweed or heliotrope can be consumed at many more times this rate with no ill effect. This small toxic dose is also consistent with the field poisoning of animals where only minor, inadvertent consumption of pimelea plant material seems sufficient to cause poisoning.

As the feeding trial progressed, effects in all four calves diminished despite being fed increasing doses of pimelea with the same toxin content. It was concluded that these calves, when exposed to prolonged low doses, developed mechanisms for detoxifying the toxin, possibly through rumen bacteria or activation of liver enzymes.

Autopsy examinations showed that all four animals, although not severely affected by pimelea, had an increased volume of fluid surrounding the heart. Their lung tissue also showed evidence of constriction of spiral smooth muscle of the pulmonary venules, which is a primary pathological effect of the toxin simplexin. However, there was no evidence of the significant cardiac enlargement, pulmonary or subcutaneous oedema, or liver changes seen in severely affected natural cases of pimelea poisoning. Rumen fluid collected from these animals is currently being investigated for the presence of bacteria able to break down simplexin.

Toxin in Animal Tissues

A method to detect simplexin in animal tissues has been developed with good detection rates from a range of tissues to which a known amount of simplexin has been added. This method is able to detect amounts of simplexin in blood and animal tissues as low as 0.02 ppm. Weekly blood samples from the feeding trial animals, together with tissues (heart, muscle, liver, kidney, fat and blood) collected at autopsy, were analysed by this method, and in all samples, simplexin concentration was below the limit of detection.

A number of cattle badly affected by pimelea poisoning in the field were also euthanased and animal tissues collected and analysed for simplexin residues. No residues were detected in these tissues. This is indicative of the extremely low levels of simplexin required to cause toxicity and, unfortunately means that chemical analysis cannot be used as a diagnostic tool to identify pimelea affected animals. Fortunately, the fact that simplexin is not residual in animal tissues provides assurance of the safety of meat products from areas affected by pimelea.

Options Available to Manage Pimelea Poisoning

The options available to producers to prevent and manage pimelea poisoning will vary greatly depending on the local environment and grazing systems. In more extensively grazed, lower rainfall areas some of the options presented here will not be as applicable.

Prevention of Pimelea Poisoning

Strategies to prevent pimelea poisoning should be based on:

- the early identification of recently germinated pimelea plants
- keen observation of the plants in the context of the whole of the pasture available
- minimising interaction between toxic plants and susceptible stock.

Some key points to be aware of are outlined below.

Knowing the Plant in the Pasture

- *Pimelea trichostachya* and *P. elongata* appear to be capable of germinating and growing at any time of the year if conditions are cool, whereas *P. simplex* will generally only grow following good rains in autumn and winter, and particularly following a dry summer. Poisoning is most likely to be a problem in spring and early summer particularly with a poor spring/summer season.

- Each species will have a preferred habitat in any given region (refer to earlier chapter).

- After non-summer rain, check everywhere for pimelea germination. Remember areas where plants are known to have occurred before and revisit those exact places as a starting point after suitable rains. Careful inspection is required following any fall in excess of 20 mm in cooler times and 50 mm in autumn and spring, especially in slightly wetter parts of the landscape or in areas that have experienced extra disturbance such as along roads and powerlines, in gilgais, stump holes and blade ploughed or cultivated areas.

- Many small white daisies and foxtails (*Ptilotus* spp.) look like pimelea from a distance and even from close up if given only a cursory glance. Look closely at suspect plants to ensure a reliable identification of these particular poisonous *Pimelea* species.

Figure 50 *Band of* Pimelea trichostachya *in low lying area adjacent to a road.*

Figure 51 *Flowering* P. trichostachya *and musk sunray* (Rhodanthe moschata) *looking very similar in a mixed pasture - at a distance they can be indistinguishable.*

Figure 52 Pimelea elongata *not eaten amongst other well grazed herbage.*

Figure 53 Pimelea simplex *seedlings blend into green Mitchell grass pick.*

- Green pimelea contains higher toxin levels than dried stages but cattle appear to selectively avoid green pimelea. If there are few and isolated plants in the paddock, it is unlikely that stock will be adversely affected. If there is abundant pimelea and little other palatable feed, then it is likely that animals will be forced to eat it.

- If pimelea is taller than other edible forbs and grasses, cattle can eat around it. When the height is similar, the animals are more likely to accidentally ingest pimelea with a mix of palatable species, so they should be watched with increased diligence for signs of poisoning.

- If pimelea is the dominant plant species in a given area and there is accessible edible feed in other parts of the paddock, experienced animals are more likely to avoid pimelea and graze in safer areas.

- Dying pimelea plants **with adhering seed** have lower average toxin levels than green seedlings, even though toxin levels can still be significant in the seeds. The important factor is the **total toxin intake**, and as stock are more likely to consume dry pimelea plant material, managers need to be very cautious with stock exposure at this stage.

- Old, dry, dead pimelea material **without seeds**, standing or on the ground, has very low simplexin content and has a low probability of poisoning stock, unless significant amounts are consumed. Again the **total toxin intake** is the key and needs to be seriously considered since plants are more palatable at this stage.

- Anecdotally it is generally accepted that a reasonable fall of rain (25–50 mm) in mid to late summer, can end poisoning problems. This amount of rain may knock most remaining seeds off plants and incorporate any loose seeds into the surface soil or patches of accumulated litter, so that they are removed from the possibility of ingestion by stock. Summer rain may also stimulate fungal infections on surviving pimelea plants and stimulate pasture grasses which can out-compete any young pimelea plants.

Grazing Strategies

- If green pimelea is not growing in a situation where significant amounts could be ingested, strategic grazing of a pasture while the pimelea is still green should be possible. Stock may need to be removed once plants start to dry out. (Note: This may not preclude cattle from being affected by the plant, and if clinical signs such as diarrhoea, oedema or loss of condition occur, then it is advised to move cattle to an area of lower infestation immediately).

- Pimelea favours establishment in areas with bare ground or where the soil has been disturbed. This can include the gaps between dormant healthy tussocks of perennial pasture grasses such as buffel and

Mitchell grass. Endeavour to maintain good ground cover by lightly stocking pimelea areas and avoiding soil disturbance.

- Young and/or inexperienced stock are more susceptible to poisoning than older cattle with previous exposure to pimelea (probably through experience and/or induced resistance through changes in the rumen flora or liver detoxification capacity). Such naïve stock should be carefully monitored, particularly if kept separate from more experienced animals. Any movement of stock into an area with pimelea present is best avoided.
- Grazing sheep or goats in pimelea infested paddocks is a reasonable strategy. As sheep and goats lack the relatively thick pulmonary muscle structure of cattle, they are less susceptible to oedema and other effects related to contraction of these muscles by the simplexin toxin. Sheep can be susceptible to the irritant nature of the plant on the gastrointestinal tract and can develop diarrhoea and loss of condition, leading to death in severe cases. While it appears that some goats select pimelea without ill effect, if sheep and goats are used for grazing pimelea country they should be carefully observed for signs of diarrhoea or loss of condition and managed accordingly.

Figure 54 *Dead* Pimelea simplex *plant with some seeds still attached.*

- If possible keep pimelea-free paddocks in reserve so that stock can be moved there when poisoning signs are first observed.
- Provide water sources that are not contaminated with pimelea debris (such as raised water troughs). Pimelea seeds contain high toxin levels and new seeds readily float on water surfaces. Toxin levels in seeds are particularly persistent with little breakdown over many months. The toxin is not water soluble and does not leach into the water.
- Stock can be encouraged to frequent non-affected parts of the pasture, by the selective placement of water troughs, salt licks and supplementary feed. Supplementation blocks such as sulphos or urea (Dadswell *et al.* 1994) are also reported to aid in lessening the impact of poisoning.

Pimelea Control

- Where economically feasible, it may be possible through the use of herbicides to maintain pimelea-free paddocks as reserve 'hospital' paddocks to move affected cattle to when early signs of poisoning occur (see further discussion later in this chapter). This control method could also be used along roads, under powerlines and around watering points to limit the spread of pimelea.
- There is no good evidence to suggest that burning pastures helps reduce the incidence of pimelea. In theory, fire would consume loose seeds and adult plants but it also creates bare ground that favours seedling recruitment.
- Cutting back large plants generally does not produce healthy regrowth but some regrowth and renewed flowering will occur. Hence slashing will not completely remove a pimelea problem unless there is no more rain to promote growth. Loss of the growing tip of small plants is not always detrimental and they

Figure 55 *Large* Pimelea simplex *have grown where the soil has been disturbed. The adjacent undisturbed area shows negligible pimelea growth.*

usually quickly expand new shoots from buds at the junction between the leaves and the stem. Slashed pimelea foliage left on the ground will retain toxin for some months and could be hazardous to stock.

- Blade ploughing encourages pimelea, and should not be used if there are known to be problems with pimelea. In the short term, shallow blade ploughing will sever pimelea roots and kill many plants. In the long term such disturbances will most likely encourage pimelea infestations.

- Cropping a badly infested area probably controls pimelea in the short term, especially if a pre-emergent herbicide is used. However, a subsequent bare fallow may result in a dense stand of pimelea that is potentially hazardous and could be expected to set a large amount of seed. Burial of seeds during cultivation is likely to prolong the survival of viable seeds, so cultivation and fallowing do not help reduce potential recruitment, unless cultivation occurs when seedlings are established but have yet to flower.

- Sowing improved pastures such as buffel grass could be problematic. It is possible that the buffel seed could have unnoticed pimelea seeds with it, especially *P. trichostachya*. Obtain seed from a pimelea free area whenever possible. The disturbance associated with the sowing of buffel would favour pimelea recruitment if seeds are already in the soil.

Figure 56 *Almost pure* Pimelea trichostachya *in the fallow after a sorghum crop was baled for hay.*

Management of Pimelea Poisoning

There is no specific treatment for pimelea poisoning once cattle are affected. Some options for the management of pimelea poisoning are outlined below.

- Closely observe grazing stock to enable timely decisions to be made. Be alert for the first occurrence of diarrhoea, oedema or jugular vein distension.

- Remove affected stock to less infested paddocks when signs of poisoning are **first** observed. Minimise stress to animals. It should be noted that cattle showing obvious signs of pimelea poisoning are very unwell. They have reduced heart function and reduced ability to handle stress. Severely affected animals may die.

- Provide badly affected animals with high protein supplements to stimulate rumen metabolism. The use of Gastric Stimulant Powder to treat possible rumen stasis may be beneficial (D'Occhio 1996). The powder is mixed with molasses or honey and water and given as a drench, or sprinkled on dampened feed.

- Agist stock out of the affected area if feasible.

- Move stock away from paddocks with dams to paddocks where stock water at troughs. This reduces bogging of weak cattle and lowers the chance of pimelea plant/seed particles on the surface of the water being an additional poisoning risk.

- Valuable animals may get some symptomatic relief from swelling via the use of diuretics, but it is a symptomatic treatment only, not a causative or preventative treatment. Drugs to treat constriction of blood vessels and to sedate and relax may also provide symptomatic relief (Collins & Scholz 2006). Intestinal protectants, such as diarrhoea powder containing kaolin given for one to two days (Cantello 1969), are indicated to be useful in animals with diarrhoea and dehydration.

Herbicide Control of Pimelea

In more intensively grazed regions, identification of an appropriate herbicide treatment may enable the maintenance of pimelea free 'hospital' paddocks.

There are many things to consider when selecting a herbicide to control pimelea. These include:

- relative cost
- impact on non-target species
- withholding period for grazing stock
- whether you want to suppress flowering or kill the plant.

Trials under AgVet Permit PER 7250 were conducted at Bollon, Roma and Mungallala in southern Queensland in 2007–08 to assess the effectiveness of thirteen different herbicides (Silcock *et al.* 2008b). The site west of Bollon was a dense well-grown stand of *Pimelea elongata* on an ephemeral lake bed. The site south of Roma contained *P. trichostachya* in a grassy mixed pasture of buffel and native grasses, while the Mungallala site was in a disturbed powerline easement and had a sparse covering of native pasture dominated by pitted bluegrass (*Bothriochloa decipiens*).

Herbicides were mostly chosen for likely efficacy against *Pimelea* species. Some were included because they were known to be selective within non-grass weeds. It was hoped that a herbicide could be found that was toxic to pimelea but not to most winter herbages, especially naturalised medics and native legumes. Glyphosate was also tested because it is widely used in fallow management.

In the initial two trials, herbicide was applied to the foliage at two rates; that which is recommended commercially for control of similar annual weeds, and at double that rate. Herbicides were rated for their efficacy in stopping flowering and in killing pimelea plants. Active ingredients of the herbicides tested are listed in Table 3.

Table 3. *Herbicide active ingredients tested, the herbicide group* to which the chemicals belong, and the standard rate applied.*

Chemical Name	Herbicide Group	Rate used (g/ha)
2,4-D	I	500
2,4-DB	I	320
2,4-D + picloram	I	450+112
aminopyralid + fluroxypyr	I	5+70
dicamba + MCPA	I	1020+240
diflufenican	F	125
flumetsulam	B	10
fluroxypyr	I	150
glyphosate	M	1080
imazamox	B	17
MCPA + diflufenican	I + F	62+6
metsulphuron-methyl	B	6
triclopyr + picloram	I	300+100

*For further information on herbicide groups refer to: CropLife Australia (2008) Herbicide Mode of Action Groups, available as a PDF at http://www.croplifeaustralia.org.au/default.asp?V_DOC_ID=1954

Table 4 *Four highest ranked herbicides (of the 13 trialled) at suppressing flowering and causing foliar damage to* Pimelea *species in spring 2007 (1 = most damaging).*

		Roma Site ***Pimelea trichostachya*** 12 weeks after spraying	**Bollon Site** ***Pimelea elongata*** 8 weeks after spraying
Flowering suppression			
	1	glyphosate	glyphosate
	2	2,4-D + picloram	2,4-D
	3	2,4-D	triclopyr + picloram
	4	dicamba + MCPA	metsulphuron-methyl
Shoot & foliar damage			
	1	glyphosate	glyphosate
	2	2,4-D + picloram	dicamba + MCPA
	3	2,4-D	2,4-D
	4	dicamba + MCPA	diflufenican

The herbicides which were most effective at suppressing shoot growth and flowering at both the Roma and Bollon sites at twelve weeks and eight weeks respectively are shown in Table 4.

Glyphosate kills pimelea very readily. However, it also kills most other plants thereby exposing the pasture to weed invasion, pimelea seedling recruitment, and excessive water and wind erosion. There may be a role for its use to control pimelea in fallowed paddocks between crops. The actual rate used will depend on what other important weeds are also being targeted.

A number of the commonly used Group 1 hormone weed killers, namely 2,4-D, dicamba+MCPA, 2,4-D+picloram and 2,4-DB, were effective on both species. Cost would be a major factor in deciding which to use. 2,4-D is the least expensive of these and is a widely used, versatile, readily available broad-leaf weed killer. 2,4-DB is over twice as expensive as 2,4-D although its use may be warranted because its impact on important pasture legumes like annual medics and *Cullen* spp. (such as Bullamon lucerne) is minimal. Dicamba+MCPA is eight times as expensive as 2,4-D at the rates used but was very effective. The most expensive is 2,4-D+picloram (nearly twenty times the cost of 2,4-D) and so would be unlikely to be chosen unless some very specific selective toxicity for a companion weed is required. Metsulphuron-methyl was the least expensive herbicide tested (under half the cost of 2,4-D), and although it did quickly suppress flowering, its damage to shoot growth was less than that of 2,4-D in the initial two trials.

Diflufenican, metsulphuron-methyl and triclopyr+picloram definitely suppress pimelea growth in the short term even though they seem unable to rapidly kill the plants. As a result, good rains a month or so after spraying allowed some *P. trichostachya* plants affected by spray to re-shoot from high up on the stem. These new shoots flowered in early summer. The impact of these herbicides on seed production is not known.

The least effective herbicides (flumetsulam, imazamox, fluroxypyr, aminopyralid+fluroxypyr, MCPA+diflufenican) did little to reduce the biomass of green pimelea and were also least effective at suppressing flowering.

A follow up trial was run in mid-winter 2008 near Mungallala on a stand of *P. trichostachya* plants of varying ages. The aim was to test the most economical and potentially effective herbicides at a range of rates, including quite low ones. Metsulphuron-methyl, 2,4-D and 2,4-DB were trialled at 50%, 75%, 100% and 125% of the standard rate used in the previous two trials. Growing conditions were not good and cold, frosty mornings were common after the rain, which had revived the droughted adult pimelea plants and germinated new seedlings ten days prior to spraying.

All three herbicides suppressed flowering quite quickly and adequate kill of plants occurred after two months at 75% and 100% of the rate commonly used for broadleaf weed control in pastures. Metsulphuron-methyl worked very well on young plants. All three herbicides used at half the recommended rate were less effective at killing well established plants. Re-sprouting was most common in plants exposed to 2,4-DB if plants were not quickly killed.

Useful information has been gleaned from the herbicide trials to date. However, more trial work needs to be carried out, and a case must be mounted for registration with Australian Pesticide and Veterinary Medicine Authority (APVMA), before definite recommendations can be made on the most effective herbicides and application rates to control these poisonous *Pimelea* species. Withholding periods from grazing and maximum residual levels (MRLs) allowable for each herbicide also need to be taken into account.

It is not known whether the sprayed plants become more attractive to stock as has sometimes been reported for other herbicides. *P. simplex* was not included in these trials and the effect of these chemicals on this species cannot be meaningfully predicted.

Figure 57 *Effect of three hormone type herbicides on the growth of* Pimelea elongata *after eight weeks. From the foreground the treatments are unsprayed (green plants); 2,4-D+picloram; dicamba+MCPA (two strips of brown plants); another unsprayed strip; and 2,4-D (also brown).*

Case Studies

Mt Victoria Station, Longreach

Location: 70 km west of Longreach, Queensland
Size: 16 600 ha (41 000 acres)
Owners: Bernie and Adrienne Faggotter since 1973 (and managers 1967–1973)
Stock Numbers: 4700 sheep and 230 mixed breeders

The Faggotters first experienced significant problems with pimelea in 1983. At that time they had approximately fifty head of cattle and had experienced a dry summer followed by good winter rain, which produced significant winter herbage. The next year they did not have any problems with pimelea. In 1985, they once again experienced problems with pimelea.

On Mt Victoria, pimelea outbreaks occur when a wet winter follows a dry summer. There does not seem to be any discrimination in the class or type of cattle affected. Cows, bulls and young stock have all been affected. Bulls are the only introduced cattle on the property. Mr Faggotter has noticed that cattle that have been previously affected by pimelea poisoning are more prone to suffer from it again.

Figure 58 *Country typical of where* Pimelea simplex *can be a problem on Mount Victoria.*

The species of pimelea present on Mt Victoria is *Pimelea simplex* subsp. *continua*. *Pimelea elongata* has been found on one occasion only. Pimelea mostly occurs on the medium to heavy cracking clays with gidyea stone cover. It is often found in open country between the isolated clumps of gidyea (*Acacia cambagei*) typically found in this area. During the last 40 years, pimelea has not been observed on the harder mulga country on Mt Victoria. Only in exceptional pimelea years has the plant also been observed on the heavier Mitchell grass country where minimal stone cover occurs.

Mr and Mrs Faggotter believe in monitoring their stock and pastures closely. Should pimelea appear, its growth and prevalence, relative to other pastures, is monitored closely. Stock are checked for clinical signs such as ill thrift and/or dark scours, and shifted as soon as possible when signs of pimelea poisoning are observed. Depending on the severity of the disease, individual animals may be taken into a confined area and fed on hay. Pimelea generally appears during the bad seasons when stock are often already away on agistment. The Faggotters seek agistment early, especially if they have received insufficient rain by the end of March to carry existing feed through winter.

They consider early preparation and timely grazing decisions as integral in ensuring their successful property management.

The Faggotters have a 1540 ha (3800 acres) pimelea-free paddock. This paddock is conserved for use during outbreaks of pimelea poisoning and is only used for moderate cattle grazing in a good season. No sheep have access to this paddock at any time. The ability to exclude sheep from this area is also associated with a shift in grazing practices from predominately sheep to a 50/50 balance of cattle and sheep.

Moolawatana Station, Leigh Creek

Location: 200 km north-east of Leigh Creek, South Australia
Size: 188 000 ha (464 500 acres)
Owners: Michael & Audrey and Gerard & Karina Sheehan
Stock Numbers: Currently 500 head of cattle (2000 head carrying capacity)

Moolawatana consists of hills of the northern Gammon Ranges in the west of the lease, and tablelands and plains for most of the remainder.

Figure 59 *Moolawatana cattle receiving supplementary feed in order to reduce the impact of pimelea poisoning.*

Pimelea was first noticed to be a problem in the early 1990's after all sheep were destocked and the property concentrated solely on cattle. In those early years, losses to pimelea were up to 10% of the herd. These losses have since been reduced due to changed management practices.

Pimelea simplex seems to be the most prevalent and problematic plant. It grows best from rains in the cooler months and tends not to be a problem until it starts to dry off. It is especially a problem when it is scattered throughout other favoured pasture species. It doesn't seem to be as great a problem when it grows mainly on its own in large patches.

Pimelea appears to grow just about anywhere. In harder gibber country it is scattered throughout the other vegetation. In softer gilgai country it tends to grow in depressions where water accumulates. These depressions tend to support a monoculture of pimelea rather than the mix of pimelea and other pasture species seen in the harder gibber country.

Cattle affected are usually those under stress such as bulls, weaker stock that don't feed out as well, or introduced cattle.

The main management practice used to control the situation is to reduce stock numbers from problem areas. This starts by keeping an eye out for the early signs of poisoning (usually scouring) and acting immediately, before stock are too poor to handle. Once there is swelling from under the jaw down through the brisket to the legs, the animal cannot be moved far, if at all, and most of these will not recover.

Warrandaroo Station, Muttaburra

Location: 90 km north-north-west of Longreach, Queensland
Size: 18 210 ha (45 000 acres)
Owners: Richard and Helen Marsh since 1979
Stock Numbers: 1500 head of breeders

The property owners first experienced significant problems with pimelea in 1988 and in intermittent seasons since. In all cases, dry summers had prevented vigorous and healthy growth of perennial grass pastures, thereby reducing competition for annual species when winter rains fell.

This seasonal pattern occurred in 2005, 2006 and 2007 and led to healthy populations of pimelea growing after winter rains in those years.

On Warrandaroo, the species of pimelea present is *Pimelea simplex*. The plant is most prevalent on sparsely grassed pebbly Mitchell grass and boree ridges. It does not grow amongst Mitchell grass on the heavier clay soils of the softer downs country.

On Warrandaroo, the plant seems to cause few problems when it is green, visible and gives off its distinctive smell. It appears that home-bred, 'educated' cattle avoid pimelea at this stage as it appears to be unpalatable and these cattle leave prominent pads as they walk through areas of pimelea without stopping to graze.

Figure 60 *Boree/gidyea country, typical of where* Pimelea simplex *can be a problem on Warrandaroo.*

Most pimelea poisoning signs are observed in late spring and early summer when pastures have dried off. By this stage, the pimelea plants themselves have lost their smell and are barely visible unless the observer looks closely for the thin red stalk and dry leaves that remain. Most dried leaves have, at this stage, fallen from the plants to the ground.

About 100 mm of rain in early summer seems to be enough to knock over the dry pimelea plants and render the plant no longer a problem. Falls of 50 mm are generally not enough to achieve this, unless it is a very intense storm.

In general, the younger, lighter cattle are affected by poisoning while the larger cattle remain healthy. Mr Marsh believes this is mainly because the heavy cattle become sore-footed on the stony ridges and find it easier to graze the softer country where pimelea is not found.

In late 2006, ten out of 150 locally bred, two year old heifers were lost to pimelea poisoning. In late 2007, when two cows became affected, this same mob was moved to a holding paddock grassed with buffel. These cattle suffered no more signs of poisoning and were moved back to their home paddock once sufficient rain was received to render old pimelea plants harmless.

In past years, when pimelea grew to become a high proportion of the pasture following winter rain, Mr Marsh would stock the affected paddocks, not only with cattle, but with sheep as well, even if it meant buying a mob specifically for that purpose. He found that the sheep were more likely to graze the pebbly areas where pimelea grew and, while they occasionally showed some signs of diarrhoea, no sheep died as a result. In addition, Mr Marsh did not lose one beast from pimelea poisoning during these times

The sheep would stay in the affected paddock until there was enough rain to break down the pimelea. He concludes that the only years Warrandaroo has suffered cattle losses from pimelea poisoning have been when sheep haven't been run in affected paddocks.

Now that the property is no longer positioned to run sheep, Mr Marsh does incur occasional cattle losses as indicated above. To minimise these affects, he observes cattle for any signs of poisoning, especially signs of diarrhoea or swelling, and moves affected mobs to holding paddocks saved for this purpose. He believes that running sheep in pimelea paddocks has been his most effective form of management.

Womalbrook, Mitchell

Location: 26 km south of Mitchell, Queensland
Size: 3000 ha (7400 acres)
Owners: Warren and Kate Wilson
Stock Numbers: 500 cattle and 1000 sheep

Recent outbreaks of pimelea poisoning at Womalbrook have occurred in 2005–06 and previous to that in 1996–97. In the 2005–06 season, more than half the cattle were showing clinical signs of pimelea poisoning in varying degrees of severity.

There was no apparent difference in susceptibility between different breeds. However, more of the younger stock were affected. Clinical signs of pimelea poisoning that were observed include massive oedema of the jaw, brisket and belly, shortness of breath and scouring in some animals.

Figure 61 *Cow at Womalbrook with severe oedema of the jaw, brisket and belly.*

Womalbrook is predominantly soft mulga country with red, sandy loam soils. Pimelea seems to thrive on this soil type. On the river flats (clay soil) and the brigalow areas (swelling black soil), pimelea is not a problem. The main species present is *Pimelea trichostachya* with the occasional *P. simplex* and *P. elongata* plant. Densities in the worst areas are up to 60 plants per square metre.

Historically it has been accepted that pimelea germination will follow winter rain. However, at Womalbrook, pimelea will germinate and thrive at any time of the year, if the following favourable conditions occur:

- native pasture cover is depleted as a result of either drought, overgrazing, ploughing, or fire
- favourable rain falls, particularly after a period of well below average rainfall
- there are depressions in the surface of the soil, such as stump holes, that hold moisture and assist proliferation of pimelea.

A rotational grazing system is used at Womalbrook, and the Wilsons have tried to graze the paddocks with the highest density pimelea when the plant is young and green. This seems to have reduced the density of pimelea in the next season.

When the pimelea becomes dry, sheep are moved onto the worst affected country and every effort is made to keep the cattle out of those areas.

Once animals are badly affected by pimelea poisoning, there is little that can be done to help. If it is possible to get them away from the pimelea, supplementary feeding with good quality hay (fed off the ground) can help reduce the oedema.

Landsdowne Station, Louth

Location: Between Louth and Wanaaring, New South Wales
Size: 13 000 ha (32 000 acres)
Owners: Wal and Margaret Mitchell
Stock Numbers: 3000 sheep and 100 head of cattle

The Mitchells run a herd of Poll Hereford breeders with an infusion of Braford.

The present drought has necessitated feeding cattle and sheep since 2002 on mulga scrub pulled with a bulldozer plus a little supplement of cottonseed or molasses, mainly to control the grazing location of the cattle.

There have been a number of stock losses in this period, including two Hereford bulls, that Wal attributes to pimelea, as they were introduced cattle. This has been the pattern over his lifetime spent in this area. The bulls show oedema around the head and front legs, become immobilised, go down and die within a few days.

The main species present is *Pimelea simplex*. The Mitchells believe that, in normal seasons, pimelea cannot compete with other feed and so it is really only seen in dry periods when it grows very quickly after a shower of rain and can hang on. Whilst the pimelea can be in varying stages of growth at any one time on the property as a result of isolated showers, it has mainly been when it has dried off that there have been cattle losses.

Figure 62 *Wal Mitchell and the local ranger inspect pimelea growth on a gilgai.*

One paddock on the western boundary is not grazed at all with cattle because of the pimelea poisoning risk. Wal has looked into the possibility of spraying pimelea in small areas of concentrated growth, so that he can still utilise his large paddocks.

The Mitchells have found pimelea growing both on gidyea country with sandy soils and higher ground as well as on the edge of the Warrego floodplain on stony black ground that runs into the red flat country.

The gilgai country tends to grow pimelea when water dries back after brief storm rain. In these areas almost no other plant growth has survived during the drought. The plants tend to concentrate on the western sides of the gilgais.

Pimelea also tends to grow where windblown sand builds up, and it is likely that the pimelea seed is carried with the sand. The table drain of a main road through the property has now developed a stand of pimelea where water lay for a few days. Grazing by sheep may be a factor in eliminating competing forage plants during prolonged dry times.

Mundowdna and Wilpoorinna Stations, Marree

Location: South-east of Marree, South Australia
Size: 250 000 ha (617 800 acres)
Owners: Peter & Janine and Gordon & Lyn Litchfield
Stock Numbers: 2000 Santa Gertrudis & Shorthorn cattle, 2000 Dorper & Damara sheep

Pimelea poisoning was first observed at Mundowdna in 1958 when the Litchfield family purchased the property. This was a good season with winter rain, and 2200 head of cattle were bought from Oodnadatta and the Northern Territory to stock the property. Approximately half the herd was affected by pimelea poisoning and the property was destocked.

In 1960, 1300 cattle were purchased from the Territory and again cattle were affected by pimelea poisoning and the property was destocked. The cattle were walked further north for agistment and as soon as they were away from the pimelea they recovered. The property was then gradually restocked with cattle purchased from local stations.

Sporadic problems of cattle being affected by pimelea poisoning have been observed since this time. Cattle are generally moved into yards, if they can be, and fed a high protein diet. There is a high recovery rate once the high protein diet is available.

Figure 63 *Assessing the condition of a pimelea affected animal at Wilpoorinna station.*

Average rainfall in the district is around 150 mm, although this is aseasonal and highly variable. The landscape is a mix of gibber flats and sand ridges. *Pimelea simplex* is the main problem species. It seems to grow at any time of the year. A small amount of rain that does not seem to germinate any other species can produce a good crop of pimelea. It appears to favour areas historically over-grazed by sheep and prefers more clay type soils, tending to grow where water lies after a light fall of rain.

In 1995, approximately 10% of the herd was affected by pimelea poisoning. A trial was conducted on the property to investigate the use of a vaccine in the treatment and/or prevention of pimelea poisoning. The experimental vaccine did not reduce susceptibility to poisoning in cattle and had no apparent effect on the progression of the poisoning for cattle already affected (D'Occhio 1996). At the same time, the use of Gastric Stimulation Powder was trialled with a small number of affected cattle. This appeared to facilitate the recovery of cattle due to a much improved appetite. The treatment was given as an oral drench for five days.

In late 2001, pimelea poisoning in horses was confirmed for the first time at Wilpoorinna (Weaver 2002). A mob of horses was moved to a paddock following an isolated storm in November. A good covering of green pick had come up but there was also a lot of dried pimelea in the paddock. The horses were unwell within about three weeks, particularly an older mare and her foal which had a swollen brisket and scouring.

Ryandale Station, Cunnamulla

Location: 125 km east of Cunnamulla, Queensland
Size: 14 000 ha (34 600 acres)
Owners: Phil and Fran Brownhalls since 1982
Stock Numbers: 250 Brahman infusion breeders plus weaners

Ryandale is comprised of mostly hard mulga country with 3000 ha of soft mulga and 1000 ha of softer box hollows, watercourses and ephemeral lakes.

Pimelea elongata is the predominant *Pimelea* species here and grows prolifically on ephemeral lake country and in water courses and is largely confined to these areas. It appears to grow on any rainfall event regardless of season and is resilient, surviving drought conditions. Prolonged deep flooding of a lake from November 2007 to July 2008 killed all herbage, but pimelea regenerated quickly, along with other herbs, on the first rains after the soils dried out. Regeneration occurred progressively from the outer edges of lakes towards the lowest point, as the lake slowly dried back over several months. In many other run-on areas where grass grew prolifically, the majority of pimelea disappeared after excellent summer rains although it remained scattered along most tracks and roads.

P. elongata, although often in abundance, does not cause a lot of problems here. Young steers and bulls appear to be the most susceptible to pimelea poisoning. Brahman-content cattle are perhaps more likely to succumb to poisoning. Introduced cattle are the most at risk, with reports of significant losses in this area.

Cattle that are affected by pimelea poisoning at Ryandale seem to develop a taste for pimelea and continue to graze the problem areas. Problems are most likely to occur in autumn through to spring with storm rains often reducing the risk.

Management strategies implemented to reduce pimelea poisoning include not overstocking country where pimelea is present and to have mulga available when forage is scarce so that the cattle are browsing and are not having to search through the pimelea for feed. When the odd beast is seen to have black scouring or has lost weight quickly, that animal is removed and yarded or put in a hospital paddock (a smaller paddock where it can be easily observed and where there is no pimelea). There it is fed good quality lucerne hay.

This seems to be adequate for recovery from *P. elongata* poisoning. However, on the Brownhall's other property, Ardglen, in similar country 15 km to the north but where there is some *P. trichostachya* at times, affected cattle seem to benefit from an intense feeding of high protein fodder.

Figure 64 *Ephemeral lake on Ryandale covered in* Pimelea elongata *during winter 2007.*

References

Australian Virtual Herbarium (2009) http://www.anbg.gov.au/avh/ Accessed 10/6/09

Cantello, J.E. (1969) Does St. George disease occur in New South Wales cattle? *The Agricultural Gazette of New South Wales* **80**:418–420.

Clarke, I.A. (1973) The pathogenesis of St George disease of cattle. *Research in Veterinary Science* **14**:341–349.

Collins, A. & Scholz, T. (2006) Pimelea Poisoning of Cattle in Pastoral South Australia. Primary Industries and Resources South Australia, Port Augusta.

Dadswell, L.P., Graham, T.G., Newman, R.D., D'Occhio, M.J., Burton, D. & Schefe, C. (1994) Pimelea Poisoning in Beef Cattle: Plant Ecology, Epidemiology, Therapeutic Control and Immunogen Feasibility Studies. Project DAQ.072 Final Report, Part 3: Technical Report. Dept. of Primary Industries, Queensland.

D'Occhio, M.J. (1996) Further field studies on pimelea poisoning in cattle: testing of an experimental pimelea vaccine, gastric stimulant and experimental antidote. Meat Research Corporation. Final Report.

Fletcher, M.T. (2008) Development of sustainable management priorities of pimelea and pimelea poisoning and development of best practice management guide (Final Report NHT#60436), 50pp. AgForce: Brisbane.

Fletcher, M.T., Chow, K.Y.S., Silcock, R.G. & Milson, J.A. (2009) LCMSMS Analysis of Daphnane Orthoesters in Pimelea Species in Australia, *8th International Symposium on Poisonous Plants*, Joao Pessoa, Brazil. p.42.

Kelly, W. R. (1975a) The pathology and haematological changes in experimental *Pimelea* spp. poisoning in cattle ("St. George Disease"). *Australian Veterinary Journal* **51**:233–243.

Kelly, W.R. (1975b) ^{59}Fe utilisation and excretion in anaemia of cattle caused by *Pimelea trichostachya* intoxication. *Australian Veterinary Journal* **51**:504–510.

Maunder, J.C.J. (1947) St. George disease of cattle. *Australian Veterinary Journal* **23**:153–157.

Mossop, W. (1998) A Survey of the Extent and Economic Losses Caused by Pimelea Poisoning in South Australia. Primary Industries and Resources South Australia.

Pressland, A.J. & Dadswell, L.P. (1992) Vet Update 92, 'Ecological, Epidemiological and Managerial Aspects of Pimelea Poisoning in Queensland' pp 595–613. University of Queensland. Post Graduate Veterinary Science Committee.

Radunz, B. (1989) *Research Project Report. Management of St George Disease*. NSW Agriculture and Fisheries (Orana and Far Western Region, Dubbo), pp 1–15.

Silcock, R.G., Fletcher, M., Chow, S. & McNeale, C. (2008a) Pimelea poisoning – the plant enigmas. Proceedings *15th Biennial Australian Rangeland Society Conference*, Charters Towers. p. 84. [on CD also].

Silcock, R., Mann, M. & Morrissy, K. (2008b) Ecology and herbicide tolerance of the native weeds that cause pimelea poisoning. *Proceedings 16th Australian Weeds Conference*, Cairns. pp. 209–211.

Trengrove, C. (1982) Marree disease – Fact Sheet, Department of Agriculture; South Australia (Agdex 420/654).

Weaver, J. (2002) First recording of pimelea poisoning in a horse. *South Australian Animal Health Quarterly.* **6**:1.

Wilson, S.-J., Gibson, J.A., Taylor, J.D. & McKenzie, R.A. (2007) *Pimelea trichostachya* poisoning of horses. *Australian Veterinary Journal*. **85**:201–205.