North-Eastern Tasmanian Field Naturalists Club Inc.

The North Eastern Naturalist

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MISSION STATEMENT: It is the mission of this club to encourage the study, appreciation and preservation of our natural and cultural environment, the animals, plants, geology and landforms, including those of the coastal and marine areas in the North East region of Tasmania.

From the Editor: This is a supplement to the December issue of The North Eastern Naturalist. It consists solely of two fascinating articles—one from our Secretary Lou Brooker, and the other from Committee member Ross Coad.

Lou's article is a follow-up to the report in the December issue on our visit to Paradise Plains in October.

Ross's article is about a potentially explosive situation that occurred many years ago involving the humble grass tree *Xanthorrhoea* (and yes, that cryptic wording is intended to pique your interest!)

I hope you enjoy reading these articles as much as I did, and I wish you a happy and relaxing Christmas and New Year. The next issue of the North Eastern Naturalist will be published in March 2016.

Sphagnum Peatlands – Paradise Plains

Article by Lou Brooker, photos by Chris Forbes-Ewan

(Editorial note: This is a follow-up article to the report in the December newsletter on several walks conducted in the Paradise Plains area in October, with Sean Blake as guide.)

We are standing in the middle of the most amazing piece of sphagnum peatland. The ground is covered with rounded hummocks like pale-green and orange-green blankets. At the edges of the mounds and hollows are paths made by marsupials. We try to step only on these paths for fear of leaving our mark on this extremely fragile environment.

This is a unique experience for most of us, because precious little undisturbed sphagnum peatland remains in Tasmania. These bog mosses (or mires as they are alternatively named) make up such a small part of the landscape that they are ecologically unique. In total, they cover only about 1300 hectares (or 0.0015% of Tasmania's land area).

Most of the peatland community types are poorly conserved. In times past, sites were destroyed because of ignorance of their ecological significance, as a result of grazing, and due to their use in horticulture. Typical clearing activities—such as happened near the Ralph Falls car park—disturb and degrade these sensitive peatlands, where even small alterations to drainage and sediment flow can lead to permanent destruction.

Since the late 1990s, Jennie Whinam—a specialist in sphagnum ecology—has been instrumental in increasing knowledge about peatlands, and improving their conservation status in Tasmania.

Thirteen types of sphagnum communities have been identified, including heath and sedge peatlands, mountain and snow-patch moss beds, and habitats that also include blackwood, sassafras, melaleuca or celery top pine. Most occur at altitudes in the range 600–1300 metres.

Snow-patch sphagnum moss beds at Paradise Plains

Sphagnum is strongly associated with waterlogged sites, high rainfall and low evaporation, and peat formation. Peat comprises a layer of dead material—which can be several metres deep—from bog plants. It provides important paleo-ecological information such as vegetational sequences, changes in climate, and fire histories. Peat forms only very slowly—at a rate of about two centimetres per century.

The deepest peats in Tasmania—some in excess of three metres—show evidence of considerable antiquity. Radiocarbon dating of a mire at the Walls of Jerusalem indicates that peat accumulation began there about 8000 years ago.

Sphagnum moss in rainforest at Paradise Plains

Some sphagnum mires have formed in places where drainage has been slowed or blocked. High rainfall (e.g. ~2000 mm per annum at Paradise Plains), moderate aeration and minimal nutrient input seem to be essential to their formation.

Because of sphagnum's highly acidic nature, and because the high water table promotes low oxygen levels, the fungi and bacteria which would otherwise decompose the dead material are absent, allowing peat to build up. Coincidentally, many of the sites where mires have formed in Tasmania were in formerly glaciated areas such as the Central Highlands. The Blue Tier contains examples of tussock-sphagnum-mire communities which developed along the streams after the burning of the rainforest.

Sphagnum peatlands contain one or more species of sphagnum moss, of which there are seven in Tasmania, with *Sphagnum cristatum* being the most common.

Sphagnum cristatum at Paradise Plains

The moss is distinctive due to the spongy texture of its tendrils. The plant consists of a main stem that is sometimes quite hard, with short clusters of branches arranged along its length and forming a mop-like head. When these stems grow densely together in a hummock, only the mop-tops are visible.

Peat forms at the rate of about two centimetres per century

The growth rate of *Sphagnum cristatum* varies across Tasmania, depending on altitude and exposure to the weather. At one site at Mt Field (altitude 950 m) the growth rate was measured as 0.4 cm/year, while at a sheltered site in central Tasmania (altitude 530 m) it was growing at ten times this rate.

Sphagnum moss has an extremely high water-holding capacity: it can absorb 15 times its weight in water, making it a useful commodity in the nursery industry. It is favoured by orchid growers and is often used to wrap rose and fruit tree rootstock for transportation. Harvesting occurs on a very small scale and is closely monitored. Very little peat mining occurs in Tasmania.

Sources of Information:

Ellis, R.C. The Relationship between Highland Forest and Grassland in the Northeast. 1985. *Biogeography of Northeast Tasmania*.

Forest Practices Board—Flora Technical Note Series No. 6 Draft Version 2003.

Whinam, J. (1997). *Sphagnum moss: Sustainable Use and Management*. Tasmanian Parks and Wildlife Service, Hobart.

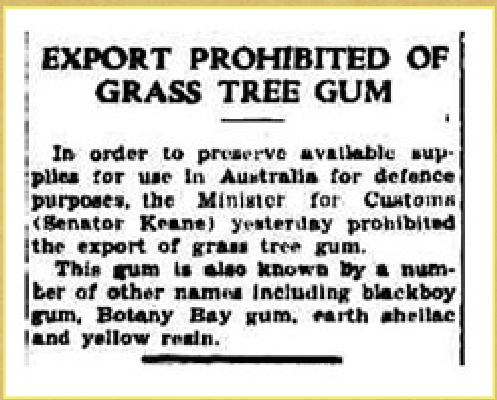
Pretty as a picture – sphagnum moss and mixed vegetation at Paradise Plains

Xanthorrhoea – they go off with a bang!

Article and photos by Ross Coad

The *Xanthorrhoea*, or grass tree (these terms are used interchangeably in this article), standing starkly against an arid landscape, or silhouetted against an orange sunset is an iconic Australian image. Most of you will have seen *Xanthorrhoea* species during field naturalist activities or during your own wanderings, either in Tasmania or on the mainland.

In November 1942—during World War II—the Canberra Times published the news article shown below, reporting that the Minister for Customs had prohibited the export of grass tree gum:



EXPORT PROHIBITED OF GRASS TREE GUM

In order to preserve available supplies for use in Australia for defence purposes, the Minister for Customs (Senator Keane) yesterday prohibited the export of grass tree gum.

This gum is also known by a number of other names including blackboy gum, Botany Bay gum, earth shellac and yellow resin.

This may prompt you to ask about the nature of grass tree gum and how it might contribute to the defence of Australia. Well gentle reader, read on and you will learn that within the grass tree rests the potential to unleash a force with more explosive power than TNT, and we wouldn't want the enemy getting their hands on that, would we!

Xanthorrhoea is a genus of 28 species of flowering plants, endemic to Australia and commonly known as grass trees. Tasmania has three species:

X. australis (southern grass tree) develops a trunk up to three metres high. It is found in several mainland states as well as in Tasmania, ranging from the northwest, across to the northeast and Furneaux Group and down the east coast (DPIWE, 2005b). The first picture shows *X. australis* on Cape Barren Island.

Xanthorrhoea australis on Cape Barren Island

X. Arenaria (sand grass tree) has a crown that arises directly from the ground and doesn't develop a trunk.

X. arenia is indigenous to Tasmania and is found in coastal sandy heath from Bridport in the northeast to Coles Bay on the east coast, including at One Tree Hill in the Waterhouse Conservation Area (DPIWE, 2005a).

X. bracteata (shiny grass tree) is also a trunkless species. It is endemic to Tasmania with a distribution ranging from the Asbestos Range in the north to Waterhouse Point in the northeast (DPIW, 2006).

The identification of and distinction between the Tasmanian *Xanthorrhoea* is difficult due to a large degree of variation within the species, considerable overlap of the characteristics between species and evidence of hybridisation.

Aboriginals throughout Australia have had many uses for the *Xanthorrhoea*. The stalk of the flower spike was used for making spear shafts, the stalks from old flowers and fruits were used as tinder in making fire, nectar from the flowers was used as a food, the soft bases of young leaves and roots around the stem base were also consumed, tough leaves could be used as knives and the plant's resin, or gum, was used as a glue.

The resin exudes from all species of *Xanthorrhoea* collecting at the base of leaves and the flower stalk. The resin also exudes from the trunk when heated or burnt by bush fire, collecting on the ground at the base of the plant as hard balls of fragrant material. In the case of *X. australis* the balls are reddish-brown in colour and have an aromatic aroma.

I first noticed the balls of hard resin several years ago on Cape Barren Island when I was visiting there with Revel and Helen Munro. The aromatic aroma reminded me of an organic chemistry laboratory and I wondered about their composition.

As early as 1788 the resin attracted the attention of settlers at Sydney Cove, where it became known as Botany Bay resin. At this time the main interest was in the similarity of the resin to fragrant balsams of the time, particularly Balsam of Tolu, and the medicinal properties that it was believed to possess. There was much interest in the resin and its potential uses. Over the next hundred years or so its reported uses include being burnt as a type of incense in churches; for the manufacture of varnishes; as a stove polish and metal coating for tins used in meat canning and on brass instruments; for sizing paper; in soap making and perfumery; for mixing with lime to colour walls; in the manufacture of early gramophone records; and for making picric acid (Watson, 2001; von Mueller, 1885).

Peter Woulfe, an Irish chemist, first obtained picric acid in 1771 by treating indigo with nitric acid to form a yellow solution. German chemist Justus von Liebig is credited with isolating the yellow crystals in 1827, but the name 'acide picrique', from the Greek *pikros,* meaning 'bitter', was introduced by French chemist Jean-Baptiste-André Dumas in 1836 because of the extremely bitter taste of its yellow aqueous solution. It was not unusual for chemists to taste their preparations, and in Dumas's case it didn't seem to shorten his life too much as he lived another 48 years to reach a ripe old age of almost 84.

Around the same time that picric acid was being 'discovered', the properties of Botany Bay resin were being investigated. In what were some of the earliest significant experiments on the resin, Lichtenstein (believed to be German chemist Georg Rudolf Lichtenstein) reported that he had treated the resin with nitric acid and obtained oxalic acid and "a yellow, earthy-like powder" that had a taste that was "exquisitely bitter like quassia" (Lichtenstein, 1799).

In 1810, French chemist André Laugier carried out experiments on the resin in an attempt to determine its chemical composition. He isolated benzoic acid, oxalic acid and, following reaction with nitric acid, crystals 'of a deep yellow colour, a very bitter taste, and a smell of bitter almonds' Laugier, 1813). The bitter, yellow substance that Lichtenstein and later Laugier isolated was picric acid, although they did not know it at that time. Almost three decades later, the formula for picric acid and a method for synthesising it from phenol were established (Laurent, 1841). (Note that Lichtenstein and Laugier apparently tasted these chemicals, a practice that was apparently common at the time, but would be considered a gross breach of safety now.)

The fact that picric acid may be prepared from the resin of *Xanthorrhoea* would be of little more than academic interest were it not for the value of picric acid as an explosive. The chemical name for picric acid is 2,4,6-trinitrophenol (TNP). If that sounds vaguely familiar it may be because it sounds a bit like 2,4,6-trinitrotoluene (TNT), a closely related and well known, powerful explosive. However, picric acid is about 20% more powerful than TNT.

X. australis in flower on Cape Barren Island

By the late 1800s picric acid was widely used in munitions, and manufacture of the chemical was an important industry.

By this time it was well known that picric acid could be manufactured from *Xanthorrhoea* resin and there was enthusiastic research into the yields that could be obtained from resins of the various species. The figures varied but averaged around 25%, i.e. 25 grams of picric acid could be prepared from 100 grams of resin. Resin was worth about £8 per ton in London and many species were exported from around Australia, including *X. australis* from Tasmania and Victoria (von Mueller, 1885a). The yield of resin was in the range 3–20 pounds per trunk, depending on the species and size of the trunk (von Mueller, 1885b).

Jump forward to the early 20th century and we find that in Australia resin producers were receiving £10-25 per ton (Bray, 1908). Bray goes on to express concern about foreign interest in our *Xanthorrhoea*, writing:

> During the last 15 years or more the Germans and Japanese, especially, the latter, have been exploiting the land of Australia (so far as regards our Australian grass trees) in securing considerable quantities of resin, for no other purpose than that relating to explosives.

While Bray was confident that resin going overseas was being used to make munitions, others were less sure, but obviously had suspicions. In 1916, during World War I, the following newspaper report was published in Melbourne's *The Argus:*

> Before the war Germany imported very large quantities of the resin of the grass tree from Australia, although what use has been made of it is not known in Australia. The export of the gum from Kangaroo Island was practically a German monopoly, nearly 1000 tons going direct to Germany during 1913, while much of that which was shipped to other countries probably reached Germany by a devious way.

Although there was no hard evidence that resin exported overseas during World War I was used to manufacture picric acid, there were rumours and the quantities were significant. During the period 1913-1919, 'a total of 1831 tons of resin were exported to England and 4826 tons to Germany' (Collins, 2011). At a time of war it seems unlikely that the resin was used to make varnish when it could be used to make munitions.

In 1915, when the supply of picric acid could no longer meet demand, Australia investigated the potential use of *Xanthorrhoea* resin for the preparation of picric acid (Collins, 2011).

X. australis near Mt Cameron – regenerating after fire

Although there is no doubt that considerable numbers of *Xanthorrhoea* plants were harvested, mainly for the extraction of the resin for the manufacture of varnish and picric acid, it is obvious that something happened to slow or reverse the trend otherwise none would remain today. Fortunately, several factors converged to save the grass tree from being exploited to extinction.

Let us assume that a large proportion of the *Xanthorrhoea* resin exported overseas was used to manufacture picric acid for munitions. It is likely that the main reason it was used for this purpose was that there was a huge demand for munitions and picric acid manufactured from resin was one of the means to feed the demand. However, there were other ways to make picric acid and it was not the only explosive being manufactured during WWI. Therefore, *Xanthorrhoea* resin was useful, but not essential.

The main method for making picric acid did not involve the use of the resin. The starting material for picric acid manufacture was normally phenol, which was obtained as a co-product of the manufacture of coke and gas from coal.

This limited the supply and what was produced was tightly controlled. In 1915, Monsanto and Dow Chemical commenced manufacture of synthetic phenol, thereby boosting supply and reducing the market price of picric acid (Collins, 2011). It is reasonable to assume that demand for the resin would have fallen as synthetic phenol became readily available.

Do you recall that earlier in this article I mentioned that the early settlers thought that Xanthorrhoea resin was similar to Balsam of Tolu? Those early settlers were certainly on the right track! In 1841, Henri-Étienne Sainte-Claire Deville isolated toluene from Balsam of Tolu, which comes from the *Myroxylon* genus of trees of Central and South America (Myers, 2007). What an interesting parallel, as Botany Bay resin is to picric acid (TNP), so too is Balsam of Tolu to TNT!

Xanthorrhoea flower spike,Tree Point, Cape Portland

Picric acid was not the safest explosive. This may sound an odd thing to say, but it is vitally important that explosives remain stable right up to the moment of detonation. Picric acid was especially unstable if it formed metal picrates by reaction with artillery shell casings, and there were some disastrous accidents.

TNT was more stable but it was in short supply as it was manufactured from toluene, which was less readily available than phenol. However, in 1915 the British found that by mixing TNT (20%) with ammonium nitrate (80%) to make 'amatol' the stocks of TNT could be greatly extended (Cotton, 2015). TNT started replacing picric acid in Germany from about the turn of the 20th century, and in Britain from the invention of amatol in 1915. Also, TNT was more effective; shells filled with TNT were more likely to penetrate armour before exploding, whereas the more sensitive picric acid would explode on contact resulting in less damage (Cotton, 2015).

Although declining in use, picric acid continued to be used in munitions up to and including during World War II. Japan had several types of bombs and mines that contained picric acid, but as far as I have been able to glean, the British and Germans had moved away from picric acid.

At a rather late stage in the history of the use of picric acid in warfare, the Australian government took decisive action. The Canberra Times (1942) reported that in order to preserve available supplies for use in Australia for defence purposes, the Minister for Customs (Senator Keane), on 13 November 1942, prohibited the export of grass tree gum.

It is doubtful that any industry requiring a steady, long-term supply of significant quantities of *Xanthorrhoea* would have been sustainable. The plant is very slow growing. Species with trunks may gain about 1-3 cm in height per year, depending on species and environmental factors. Large plants would have been hundreds of years old.

The normal practice was to harvest the whole plant and extract the resin from the trunk, which contained most of the resin, killing the plant in the process. The trunk may not have appeared above ground before the plant reached 30-50 years in age. Fortunately the industry wilted and died before the *Xanthorrhoea* met the same fate.

So, now you understand why this article is titled '*Xanthorrhoea*—they go off with a bang!'

References

Anon. (1942). Export prohibited of grass tree gum. The Canberra Times, 14 Nov 1942, p. 4.

Anon. (1916). The Grass Tree, Its Valuable Products, Manufacture of Lyddite. The Argus (Melbourne), 14 October 1916, p. 5.

Bray, J. S. (1908). Our Grass Trees. The Sydney Morning Herald, Thursday 22 October 1908, p. 4.

Collins, D. (2011). The First Chemists: An Australian Chronicle, Part 10. Chemistry in Australia, October 2011. Royal Australian Chemical Institute, Melbourne.

Cotton, S. (2015). Chemistry in its element – TNT. Downloaded from: http://www.rsc.org/chemistryworld/podcast/CIIEcompounds/transcripts/TNT.asp on 30 May 2015, published by the Royal Society of Chemistry, London, UK.

Department of Primary Industries and Water (DPIW), Threatened Species Section (2006). *Flora Recovery Plan: Threatened Tasmanian Grasstrees 2006-2010*. Department of Primary Industries and Water, Hobart.

Department of Primary Industries, Water and Environment (DPIWE), Threatened Species Unit (c. 2005a). *Xanthorrhoea arenaria* Notesheet. Department of Primary Industries, Water and Environment, Hobart

Department of Primary Industries, Water and Environment (DPIWE), Threatened Species Unit (c. 2005b). *Xanthorrhoea australis* Notesheet. Department of Primary Industries, Water and Environment, Hobart

Laugier, A. (1813). *Chemical examination of the yellow resin of the* Xanthorrhoea hastilis *and of the resinous cement employed by the savages of New Holland to fix the stone of their hatchets*. Journal of Natural Philosophy, Chemistry and the Arts, Vol. XXX. William Nicholson, London, p. 310-12.

Laurent, A. (1841). "Sur le phényle et ses dérivés" (On phenol and its derivatives), *Annales de Chimie et de Physique*, series 3, 3: 195-228; especially pages 221-228.

Lichtenstein, G.R. (1799). On Botany Bay resin. Crell's Journal ii, 242. Reproduced in Thomson, T. (1817) A System of Chemistry: In Four Volumes, Volume 4, 5th edition, London, p. 138-40.

Myers, R. L. (2007). The 100 Most Important Chemical Compounds: a Reference Guide. Greenwood Press, Westport, CT, USA, p. 283.

von Mueller, F. (1885a). Select extra-tropical plants readily eligible for Victorian industrial culture or naturalisation with indications of their native countries and some of their uses. J. Ferres, Melbourne, p. 407.

von Mueller, F. (1885b) *Zeitschr. Oesterr. Apoth. Ver.* 1885, p. 293, quoted in Gleanings in Materia Medica, John M. Maisch (ed.) *The American Journal of Pharmacy, Vol. 57, (August) 1885.*

Watson, P. (2001). The Grass Tree: Its Uses and Abuses. From the newsletter of ASGAP's Wildlife and Native Plants Study Group, Summer 2001-02.