SHORT COMMUNICATION

Phormium tenax (New Zealand Flax) — Norfolk Island native?

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***Abstract*:** *Phormium tenax* (New Zealand flax) was one of the first plants found on Norfolk Island by Cook's expedition in 1774, and its potential value to the British navy was considered so significant that it appears to be one of the main reasons Norfolk Island (lat 29° 02'S; long 167° 57'E), about 780 km north of New Zealand, was colonised in March 1788. *Phormium tenax* has always been considered native to Norfolk Island, despite the realisation that Polynesian settlers had been there before the British. The absence of any records of it on nearby Phillip Island until 1967 however, contrasts with its reported abundance on Norfolk Island in the 1700s. If *Phormium* had been present on Norfolk earlier than about 15,000 years ago it would be expected to have colonised Phillip Island, particularly in habitats similar to those it occupied on Norfolk, because the two islands (now 6 km apart) were then part of a single, much larger island. The absence of *Phormium* pollen from fossilised pollen recently collected on Norfolk Island suggested to researchers that flax had been introduced to Norfolk Island by Polynesian settlers and should therefore not be regarded as native or indigenous. The lack of any recorded distribution of *Phormium* on Phillip Island before 1967 and its distribution there in 1978 provide evidence reinforcing this conclusion.

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Introduction

In October 1774, after mapping, naming and taking possession of the New Hebrides (now Vanuatu) and New Caledonia, one island of which he named the Isle of Pines (after the distinctive *Araucaria columnaris*), Lieutenant James Cook in the *Resolution* discovered and named Norfolk Island (lat 29° 02'S; long 167° 57'E)(Figure 1).The boats were hoisted out and the ship's officers and supernumeries set out to explore the island.

William Wales, the ship's astronomer, noted that (Wales 1774) '*Near the shore the ground is covered so thick with the New Zealand flax Plant that it is scarce possible to get through it.* [This] *Plant was now in its greatest perfection, the flowers … just opening, and as might naturally be expected from the climate vastly more exuberant than at New Zealand;* [but a] *little way inland the woods are perfectly clear and easy to walk in*.' Many plants already known from New Zealand were recognised but the explorers did not notice any evidence of human occupation of Norfolk Island. Wales wrote: '*We saw no Inhabitants nor the least reason to believe it had ever been trod by Human feet befo*re.' Thus they believed everything they saw was natural, entirely free of human influence.

The expedition's botanists, father and son team Johann Reinhold Forster and Georg Forster, and Anders Sparrman, collected specimens of the flax plant on Norfolk Island, but in 1775 when the Forsters formally named it *Phormium tenax,* they used a New Zealand collection as the type specimen.

Cook was impressed by the potential of Norfolk Island (area 3450 hectares) to provide timber and fibre for the Royal Navy. The timber of the '*pines'* was '*exactly of the same nature as the Quebeck pines*' and the trees were huge and straight. They seemed ideal for masts and spars. Cook knew how highly the Maoris in New Zealand valued the flax as a fibre plant and thought it would be invaluable for making ropes and sails. Accordingly, of all the islands discovered on the voyage, tiny Norfolk stood out for its potential value to Britain, largely because of its flax.

Because of Cook's enthusiasm for the potential value of the flax, the British Government's 1787 instructions to Arthur Phillip, commodore of the First Fleet and first Governor of New South Wales, described the flax '*not only as a means of acquiring Clothing for the Convicts and other persons who may become settlers, but from its superior excellence for a variety of maritime purposes and as it may ultimately may become an Article of Export.*' Phillip was instructed: '*you are, as soon as circumstances will admit of it, to send a small Establishment* [to Norfolk Island] *to secure the same to us, and prevent its being occupied by the subjects of any other European Power*' (draft dated 20 April 1787 *Historical Records of New South Wales*, Vol. 2, Part 2).

Distribution of Phormium *on Norfolk and Phillip Islands*

Consequently, in February 1788 less than three weeks after the First Fleet arrived at Sydney Cove, Lieutenant Philip Gidley King set out to develop a British colony on Norfolk Island. Phillip's instructions to King were to '*immediately to proceed to the cultivation of the Flax Plant, which you will find growing spontaneously on the island*' (Phillip 1788). King was not told how to identify the flax. Although he searched for it he did not recognise it for more than two weeks. As he wrote, it '*in no manner resembles ye Flax of Europe its appearance being more like Flags*'.

At the time of European settlement of Norfolk Island in 1788 the only naturally treeless areas were the flax-covered sea cliffs (Macphail et al. 2001). All available information suggests flax was essentially coastal.George Raper, a midshipman of HMS *Sirius*, stranded on Norfolk Island when the ship was wrecked in March 1790, wrote of the flax '*As for the flax, I can only say, there is an abundance of it in all parts of the Sea Coast of this Island, (but not inland)*'.

In September 1792 the amateur naturalist William Patterson wrote to Sir Joseph Banks: '*Near the shore on the steepest places where there is any soil it is covered with the Flax plant and interspersed with very lofty pines, some of them growing even on naked rocks where there is not the smallest appearance of earth. The Pine and Flax plant seem to thrive best where they are exposed to the sea air, the latter indeed is never found inland*.' (quoted by Holloway, 1977).

Maiden (1904) said of the flax that '*Its natural habitat on the Island is the sides of steep banks or cliffs*.' R.B. Laing (1914) described the flax on Norfolk Island as '*undoubtedly native, growing on dry bare hillsides and in such situations as P. Cookianum is usually found in on the New Zealand hills.*' Laing did not see flax in any swampy places or beside watercourses.

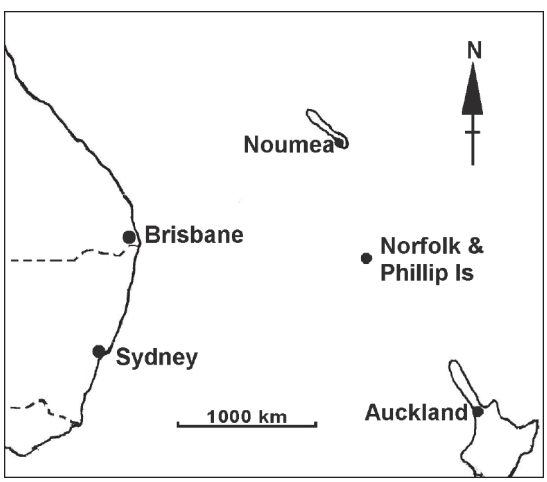

Fig. 1 Location of Norfolk Island in the South Pacific Ocean.

In December 1788 King made his first (and apparently *the* first) visit to Phillip Island (about 200 ha in area) 6 km south of Norfolk Island. He described the vegetation briefly but did not mention seeing any flax. As he was so familiar with flax and its importance this suggests he did not see it on Phillip Island.

Despite later visits to Phillip Island by Ferdinand Bauer (who was responsible for original drawings of Norfolk Island plant species) in 1804–05, Allan Cunningham in 1830, J.H. Maiden and J.L. Boorman in 1902 and R.B. Laing in 1912, flax was not reported there until 1967, when it was growing in a small area far from the coast at an altitude of about 140 m. Phillip Island was almost devoid of vegetation by then due to the effects of pigs, released there in 1793, and goats and rabbits released by 1830. The distribution of *Phormium* on Phillip Island prior to rabbit eradication in 1986 contrasts completely with its reported distribution on Norfolk Island in the early years of British occupation.

Opportunities for Phormium *to colonise during the ice ages*

Norfolk and Phillip Islands were formed by volcanic activity 2.3 to 3 million years ago (Jones & McDougall 1973). Both islands sit almost centrally on the Norfolk Plateau, the eroded top of a volcanic seamount 100 km by 35 km. Although 6 km apart, they would be connected by dry land at sea levels more than about 40 m below the present level (BPL). A sea level 50 m BPL would expose an island about 35 km long with Norfolk and Phillip forming mountains near its centre, and the entire Norfolk Plateau with ten volcanic hills or mountains (including Norfolk and Phillip), would be exposed when sea level was 75 m BPL.

Lambeck and Chappell (2001) present sea level data for the duration of the last ice age which show that sea level was at least 50 m BPL between about 71,000 and 10,000 years ago, and was at least 75 m BPL from about 37,000 to 13,000 years ago. Thus Norfolk and Phillip were part of a single island for at least 60,000 of the last 75,000 years, and for about 24,000 years that island was 100 km long and 35 km wide. Rabineau et al. (2006) provide sea level data for the last 600,000 years which show that sea level was at least 50 m BPL for more than half the time, whereas the present sea level occurred only briefly and rarely. At least 17 glacial cycles, each approximately 100,000-years-long, of sea level fall and rise have occurred during the last 1.8 million years (Cronan 2000).

An extinct *Phormium* (judged by fossil pollen) grew in New Zealand during the early Tertiary, prior to the evolution of the modern species, one of which, *Phormium tenax*, must have colonised Norfolk, the Chatham and Auckland Islands at quite a late Cenozoic date (post-glacially in the Auckland Islands) (Fleming 1976). Thus *Phormium* was apparently present on New Zealand and available, if the opportunity arose, to colonise Norfolk Island from the time Norfolk and Phillip Islands were formed by volcanic eruptions more than two million years ago.

If *Phormium* had been present on Norfolk Island during the last ice age it almost certainly would have migrated across the lowlands during the 60,000 years they were exposed and would have colonised Phillip Island, particularly around the (now) coastal cliffs. As its recorded distribution on Phillip Island contrasts with what would be expected from its distribution on Norfolk Island, *Phormium* would appear to have been absent from Norfolk Island up to perhaps 15,000 years ago.

Polynesian settlers on Norfolk

Less than a month after arriving at Norfolk Island in 1788, King was dismayed to find that some of the first agricultural seedlings to germinate were destroyed by rats. This was the first evidence, though not immediately recognised, that people had been on the island before Cook's discovery in 1774. The rats turned out to be *Rattus exulans*, the Polynesian or Pacific rat. A dugout canoe similar to those made by the Maoris in New Zealand was found on a beach well above high tide level, but it might have drifted there. By August 1788 wild bananas had been found growing by a creek near the settlement, providing further evidence of a previous settlement on the island. Stone tools of Polynesian style were later found. In November 1792 King wrote of a convict party which had gone out to Phillip Island and found a number of scorpions, lizards and centipedes. King (quoted in Cogger et al. 1983) observed '*It is remarkable that no reptile of that or any other kind have ever been found or heard of on* [Norfolk] *island*.' Phillip Island did not have rats. The rats had evidently been on Norfolk Island long enough to exterminate the scorpions, lizards and centipedes.

Progressively King recognised the ancient settlement of Norfolk Island by Polynesians, possibly from New Zealand (Anderson & White 2001). The Polynesians were seen to be the source of the rats and bananas. Polynesian voyagers were known to take with them plants and animals which were useful, but until about twenty years ago little consideration seems to have been given to what else the Polynesians might have brought to Norfolk.

In 1995 the Norfolk Island Prehistory Project found a Polynesian settlement site behind Emily Bay (Anderson et al. 2001). Field work continued until 1999 and Polynesian plant introductions were investigated by analysis of fossilised pollen grains and spores recovered from different depths in the soil profile. *Phormium* pollen was identifiable to species level. The investigation showed that some plant species which had been considered possible introductions were present on the island long before the earliest known Polynesian settlement, but failed to find fossilised *Phormium* pollen in a soil unit (at 147 – 167 cm depth) dated at about 1000 years before present and considered to represent soil conditions particularly suitable for establishment of *Phormium.* This led to the conclusion that Polynesians introduced *Phormium* to Norfolk Island some time between about 1200 and 1774 (Macphail et al. 2001).

Discussion

Phormium tenax (New Zealand flax) is an invasive plant in many parts of the world, and is proving a threat to sensitive floras (Trustees of the Royal Botanic Gardens, Kew 2009). The Global Compendium of Weeds (Randall 2007) lists flax as a weed in (*inter alia*) Pacific Islands, Hawaii, New South Wales and Victoria.

The natural introduction of *Phormium tenax* to Norfolk Island is hypothetically possible. Seeds might have been carried in mud on a bird's feet. This apparently did not happen in the first two million years, even during the many long periods of lower sea level when the island was much larger, and more suitable habitats were almost certainly available in the extensive lowlands below the present sea level. The apparent failure of *Phormium* to arrive naturally in the previous two million years suggests its natural arrival in the last 800 (or even 15,000) years is highly improbable.

Like Europeans, Polynesians have been responsible for the spread of exotic plants into the southwest Pacific. Obvious examples are food species such as bananas (*Musa paradisiaca*), coconuts (*Cocos nucifera*) and sweet potato (*Ipomoea batatas*). Less clear-cut examples are the New Zealand flax (*Phormium tenax*), Ti (*Cordyline*) and the sow thistle (*Sonchus oleraceus*) (Macphail *et al.* 2001).

The available evidence suggests quite strongly that Norfolk Island was colonised from Raoul Island by Polynesian people who had come from New Zealand or, if they came directly from somewhere else in East Polynesia, had lived on Raoul Island amongst people who had originated in or visited New Zealand (Macphail et al. 2001). New Zealand flax was the principal fibre plant of the Maori in New Zealand (Given & Harris 1994), and as their most useful fibre plant, Polynesian settlers could have brought it to Norfolk Island about 800 years ago. The complete absence of *Phormium* pollen at a site known to have been near a ridge described as being covered by this plant in 1774 is difficult to explain unless it was introduced onto Norfolk Island by Polynesians between about 1200 and 1774 (Macphail et al. 2001; Anderson and White 2001.

Phormium tenax has always been considered to be native (i.e. occurring naturally, unassisted by people) to Norfolk Island and therefore to Phillip Island (e.g. *Flora of Australia* – Green 1994). More recently it has been described as indigenous to New Zealand, Norfolk Island, and the Chatham Islands (Wehi & Clarkson 2007) and native to Phillip Island, specifically (Mills 2009).

Combining all the available evidence provides strong justification for considering that *Phormium* was brought to Norfolk Island by Polynesians, probably between 800 and 600 years ago, and so is not a native species. Similarly the Pacific rat (*Rattus exulans*) has long been recognised as having been brought to the island by Polynesians and thus is not generally considered native. Both Pacific rats and black

rats (*Rattus rattus*) have been controlled in Norfolk Island National Park by intensive baiting on the basis that they are not native and their impact on indigenous plants and animals is undesirable.

In 1986 the rabbits on Phillip Island were eradicated and plant regeneration has been spectacular. The issue of whether *Phormium tenax* is native has practical significance because the island is part of Norfolk Island National Park. Its manager, Parks Australia, is influencing the revegetation of the island, planting native species and controlling weeds in attempting to restore the natural vegetation. *Phormium* has been treated as native and actively propagated and distributed. As *Phormium* is a vigorous weed in some other places where it has been introduced, if it is not originally native to Phillip Island, spreading it could be ecologically detrimental, working against the restoration of the island's ecosystem.

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