

ORIGIN OF *SOPHORA CHATHAMICA* (FABACEAE) ON CHATHAM ISLAND

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INTRODUCTION

The tree species of *Sophora* (Fabaceae) indigenous to New Zealand grow in a variety of habitats including the margins and floodplains of rivers, lakes, or tidal estuaries. The easily recognisable hard yellow seeds, 6–8 mm long, are often found on our beaches. Seeds of the common, small-leaved kowhai, *Sophora microphylla*, are long-lived, provided the seed coat remains undamaged. Up to 27% of these long-lived seeds have been found to be buoyant in both fresh and salt water (Sykes and Godley 1968; Godley 1975). To test whether such seeds floated further afield in the New Zealand Botanical Region, attention was first focused on the Kermadec Islands, some 920 km north-east of New Zealand, where *Sophora* is not found. And so in 1966–67 when Mr W. R. Sykes of Botany Division, DSIR, joined expeditions to two of these islands, he was asked by Dr E. J. Godley to search for *Sophora* seeds in the beach drift there.

On Macauley Island, in July–August 1966 Mr Sykes found three *Sophora* seeds just above high-tide mark in the tiny Sandy Bay, the only beach on the island. He later spent from mid-November 1966 to late-June 1967 on Raoul Island and found 29 beach-drift *Sophora* seeds, most from the beach at Denham Bay in the south, and a few from Low Flat beach in the north (W. R. Sykes pers. comm.).

On his return to Botany Division, DSIR, Lincoln, 13 of the seeds were chipped to allow moisture in and 12 germinated within a week. The resulting seedlings corresponded with photographs of young plants of *Sophora* from northern New Zealand (Sykes and Godley 1968). This is confirmed by plants reared to maturity at Lincoln. They are *S. chathamica*, a taxon recently shown by Heenan et al. (2001) to occur in northern New Zealand with disjunct and possibly unnatural occurrences in the Wellington district and on Chatham Island.

The next locality studied, Chatham Island, and the subject of the present paper, lies about 850 km to the east of New Zealand (Fig. 1). Like the Kermadec Islands, *Sophora* seeds can be found in beach drift here also, but unlike the Kermadec Islands, Chatham Island supports a resident albeit restricted population of *S. chathamica*, at one time thought to be a Chatham endemic. This paper discusses the discovery and taxonomic treatment of *S. chathamica*; the progeny of beach-drift *Sophora* seeds collected from Chatham Island in 1985 and 2000; and the probable origin of the disjunct population of *S. chathamica* on Chatham Island.

SOPHORA CHATHAMICA — DISCOVERY AND TAXONOMY

During a six-month visit to the Chatham Islands in 1863–64, H. H. Travers collected a large number of plants from Chatham Island and Pitt Island, including specimens of the resident *Sophora*. A brief account of his visit was published separately in two almost identical papers (Travers 1865, 1869). Concerning the Chatham Island *Sophora*, Travers wrote (1865, p. 143): "I may mention that in a small tract of bush on the margin of the Great Lagoon [Te Whanga] I found three trees of the *Edwardsia*

microphylla, all growing close together, and being the only specimens of that plant that I saw on either island. They were not in flower or fruit at the time. They were apparently all of equal age, and were about 5 inches in diameter and 15 feet tall". Further on in the same article Travers wrote: "During one short absence, I lost a very large number of plants (including my only specimens of *Euphorbia*, *Edwardsia microphylla* and *Mesembryanthemum*), which, on my return, I found to be one mass of mildew".

One set of Travers' 1863–64 specimens was sent to Melbourne and formed the basis of Mueller's *The Vegetation of the Chatham Islands* (Mueller 1864, see also Connor 1998); another set was sent to Kew and included under Additions, Corrections etc. in Part II of Hooker's *Handbook of the New Zealand Flora* (Hooker 1867). Neither collection included specimens of *Sophora* for the reason cited above. Mueller (1864, p.13) listed the species under *Edwardsia grandiflora*, noting: "This plant is inserted into this list on the authority of Mr Travers who noticed in the bush on the margin of the great lagoon three trees of this plant, about 15' high, but at the time destitute of flowers and fruits". Hooker (1867, p.727) listed the species as *Sophora tetraptera* var. *a*, noting: "I have seen no specimen".

Travers revisited the Chatham Islands in 1871 and gathered a much larger collection of plants (Travers 1872; Travers and Travers 1873). One set was again sent to Melbourne; the other ultimately went to the Colonial Museum, Wellington. The Melbourne set was reported on briefly by Mueller (1873), but there is no mention of the Chatham *Sophora*. The Colonial Museum set formed the basis of Buchanan's article *On the Flowering Plants and Ferns of the Chatham Islands*, published two years later (Buchanan 1875). In Buchanan's account, the Chatham *Sophora* is listed as *Sophora tetraptera* Aiton var. *grandiflora*, and is supported by two specimens (WELT 38863, 33869), both with Travers' labels attached, and presumably collected by him during his second visit in 1871.

The next reference to the status of the Chatham *Sophora* is in Cockayne's detailed account of the plant-covering of Chatham Island, following his visit there in 1901 (Cockayne 1902). In his account, Cockayne described the Chatham *Sophora* briefly, but adequately, as a new species, *Sophora chathamica*, largely on the basis of its seedling form as distinct from other forms of *Sophora*, which he had pointed out earlier (Cockayne 1899, 1900). In contrast to Travers (1865), who did not specify the exact location of the three trees of *Sophora* he saw, and may not have seen other trees present during his visit, Cockayne (1902) described *S. chathamica* as occurring abundantly "in all the small woods along the lagoon" [Te Whanga] as a component of limestone forest. Cockayne's new species, *Sophora chathamica*, was not upheld by Cheeseman (1906, 1925) or Allan (1961) in their treatment of the New Zealand flora, but has recently been reinstated by Heenan et al. (2001), with a Cockayne specimen (WELT 19447) selected as lectotype. These authors gave it the common name "coastal kowhai".

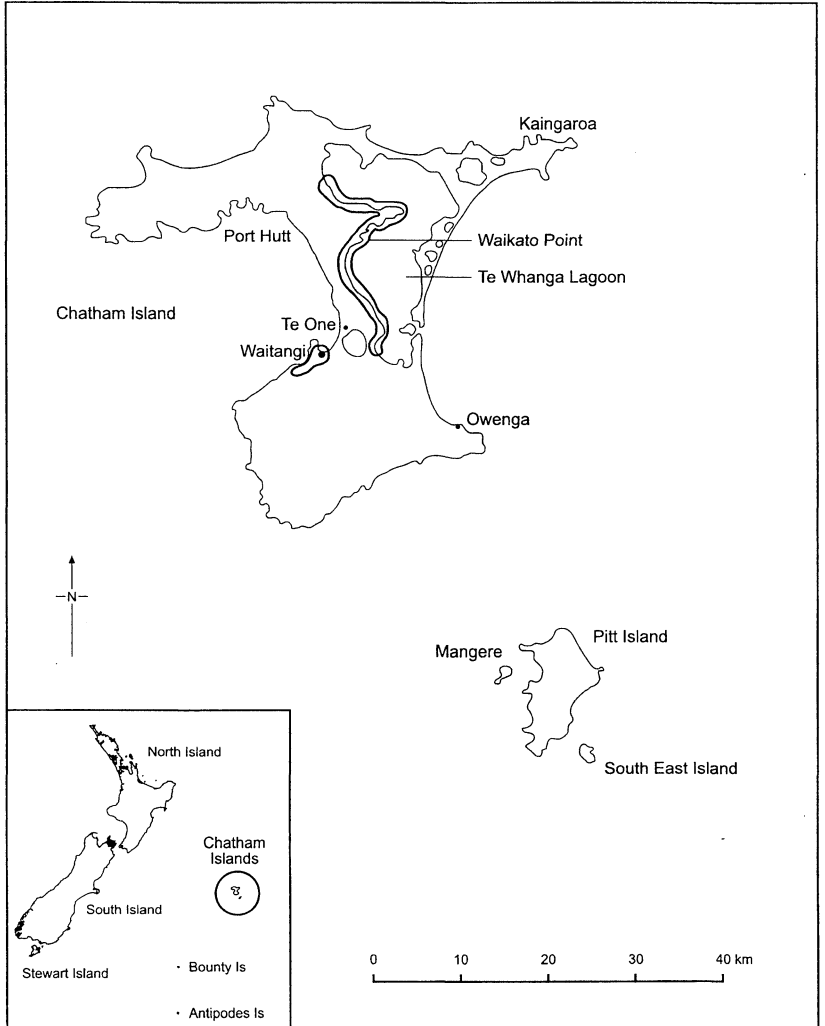


Fig. 1. Location map showing the general distribution of *Sophora chathamica* along the western margin of Te Whanga Lagoon and at Waitangi, Chatham Island.

BEACH DRIFT *SOPHORA* SEEDS—CHATHAM ISLANDS

During his first visit to the Chatham Islands in 1863–64, Travers made Pitt Island his headquarters, staying at the residence of Frederick Hunt and his family who had settled there in 1842 (Hunt 1866). In his account of the Chatham *Sophora*, Travers made the following pertinent statement: "During my residence at Pitt's Island, I was in the habit of examining the coast of the bay [NW Pitt Island] on which Mr Hunt's house is situated twice a day for some months; and on one occasion I found a sawn plank of *Totara*, and on another a seed of the same *Edwardsia* [*E. microphylla*] which had evidently been washed ashore, probably from New Zealand. The seed was hard and sound. I gave it to Mr Hunt, who sowed it; but there has been, as yet, no time to learn the result. I also saw, on the beach, logs of white and red Pines (*Podocarpus excelsus* and *Dacrydium mai*) [*Dacrycarpus dacrydioides* and *Prumnopitys taxifolia*] and *Totara*, which had been washed ashore some time previously. This would indicate the existence of currents direct from New Zealand to this place, probably favoured by the set from Cook's Straights during heavy north-westerly gales". (Travers 1865).

Travers' paper was read "with uncommon interest" by Charles Darwin who, in a letter to J. D. Hooker in October 1865, stated, "I remember your pitching into me with terrible ferocity because I said I thought the seed of *Edwardsia* might have been floated from Chile to New Zealand: now what do you say, my young man, to the three young trees of the same size on one spot alone of the island, and with the cast up pod [seed] on the shore? If it were not for those unlucky wingless birds I could believe that the group had been colonised by accidental means: but, as it is, it appears by far to me the best evidence of continental extension ever observed." (Darwin and Seward 1903, p. 475).

Almost 40 years later, Cockayne (1902), although probably unaware of Darwin's letter, disputed Travers' statement, and in his view, "The seeds of *Sophora* found on the beaches by Travers and others were most likely merely from the trees by the lagoon [Te Whanga], and had never come from New Zealand at all". However, as the outlet of Te Whanga Lagoon is normally closed off from the sea, the opportunity for seed dispersal from the lagoon is very limited.

On my first visit to the Chatham Islands in 1985, 122 years after Travers, I gathered 12 *Sophora* seeds from the strandline on the beach at Te One, Petre Bay on 5 February (Fig. 1). At the same time I collected ten samples of large driftwood at random. Three of these subsequently proved to be *Nothofagus*; three were *Podocarpus* (in the *totara/hallii* group); three were *Salix* sp; and one was *Dracophyllum*, probably the local tree species *D. arboreum*. The *Nothofagus*, *Podocarpus* and *Salix* logs had almost certainly drifted from New Zealand. Water-worn pieces of vesicular lava, or pumice, of similar origin, were also not uncommon along the beach at Te One.

On the same day I collected mature pods of *S. chathamica* from two trees at Waikato Point on the western shore of Te Whanga Lagoon (Fig. 1). On my return to Lincoln, the 12 beach-drift seeds and 50 seeds of *S. chathamica* were chipped to allow moisture in and sown on 14 March 1985, along with 30 seeds of *S. microphylla*

obtained from trees growing naturally at Halkett, on the Canterbury Plains. By 1 April all 12 beach-drift seeds, 43 *S. chathamica* seeds and 20 *S. microphylla* seeds had germinated.

All but one of the progeny of the beach-drift seeds grew into typical *S. microphylla* juveniles with leaves and a divaricate growth habit identical to that of progeny raised from Canterbury plants of *S. microphylla*. The one exception proved to be non-divaricate, with smaller leaflets, and may be a form of *S. microphylla*, or of hybrid origin. The seeds of *S. chathamica* gave rise to uniform, taller, non-divaricate juveniles typical of this species (Fig. 2). Several of these plants were distributed among the staff at Lincoln, and a small selection was grown on in the border gardens there. My own specimen of *S. chathamica*, derived from this seedlot, and now 17 years old, is approximately 6 m or 20 feet tall with a stem diameter of 13 cm or 5 inches; similar in dimension to the trees recorded on Chatham Island by Travers in 1863–64.

On a second visit to the Chatham Islands in 2000, I made a further collection of *Sophora* seeds from the strandline at Te One beach on 29 February, and also from trees of *S. chathamica* at Waikato Point on 6 March. This time *Sophora* seeds were plentiful along the strandline and I gathered 256 over a distance of 400 metres. On my return to Lincoln, all 256 beach-drift seeds and 160 seeds of *S. chathamica* were sown on 28 April in potting soil, without chipping, and placed outside in a cold frame protected overhead by shadecloth. During the following spring-summer period, 131 or 82% of *S. chathamica* seeds had germinated, resulting in typical non-divaricate seedlings (CHR 549883, 549884) from which a small selection has been grown on for further observation. No additional seedlings emerged from this seedlot in the spring of 2001, and only four rotting seeds were recovered.

By comparison, 60 beach-drift seeds (23%) germinated in the first spring, followed by a further 27 seeds in the spring of 2001, and 39 in 2002, giving a total germination to date of 49%. The majority of seedlings that emerged from the beach-drift seedlot have developed a divaricate growth habit and leaves entirely consistent with seedlings of *S. microphylla* (CHR 549881, 549882). Five seedlings depart to some extent from this pattern and are considered to be forms of *S. microphylla* or possible hybrids. Seedlings continue to emerge from this seedlot.

These results confirm previous observations and experiments on the buoyancy, longevity and retained viability of *Sophora* seed immersed in seawater, including those dispersed over long distances by ocean currents (e.g., Guppy 1906; Sykes and Godley 1968). According to these authors, the buoyancy of *Sophora* seed is controlled by the density of the kernel. Sykes and Godley (1968), also reported on the recovery and identification of wood samples of *Podocarpus totara*, or *P. hallii*, *Agathis australis*, and a species each of *Salix* and *Populus* from beaches on the Kermadec Islands, all almost certainly derived from New Zealand, as well as seeds of other temperate and tropical species

It is not difficult to explain how *Sophora* seed and driftwood get into the sea. Most species of *Sophora* in New Zealand often grow on river banks and flood plains, and their seeds, along with detached branches and trunks of various tree species, are periodically transported from such sites by water to the open ocean, especially by

major rivers in flood. Once there, further dispersal is facilitated by prevailing ocean currents, with seed and driftwood cast up on beaches in places remote from their source. However, on the Kermadec and Chatham Islands *S. chathamica* and *S. microphylla*, respectively, make a landing but not a bridgehead, but whereas there is no *Sophora* on the Kermadec Islands, there is a resident population of *S. chathamica* on Chatham Island. The question is, how did it get there?

DISPERSAL OF *SOPHORA CHATHAMICA* TO CHATHAM ISLAND

In his account of the plant-covering of Chatham Island, Cockayne (1902) remarked: "That *S. chathamica* is indigenous in Chatham Island there can, however, be no doubt. Even if, unaided by man in any way, it had arrived a few years before Mr Travers' visit it would have been indigenous, of course; but it has probably occupied Chatham Island since that land was first colonised by its arborescent plant inhabitants..... Why *S. chathamica* should be confined to the limestone and found in no other part of Chatham Island, when a closely allied species grows abundantly over volcanic rock in New Zealand, is a very difficult question to answer. It may simply be that it cannot compete in a wet position with the other forest trees, and that the limestone forest is drier than any other forest formations on the island. At any rate, it is a very striking example of the local distribution of a plant," . Cockayne advanced much the same argument in a later paper on coastal vegetation (Cockayne 1907).

Sophora chathamica does have a very local distribution on Chatham Island (Fig. 1) and, unlike some of its endemic tree associates, such as *Melicytus chathamicus*, *Plagianthus chathamicus* and *Coprosma chathamica*, it does not extend on to well drained soils derived from equally base rich volcanic or schist rocks which outcrop regularly in the northern part of Chatham Island (Hay et al. 1970). Nor does it occur in suitable riparian habitats on Chatham Island as it does in mainland New Zealand, except in one case, namely, on the banks of the Nairn River, near the township of Waitangi, as recorded by Heenan et al. (2001: AK227144).

In fact *S. chathamica* is not confined to limestone on Chatham Island, as often quoted, but occurs also in soils derived from calcareous tuff on the south-western margin of Te Whanga Lagoon, as well as around Waitangi, and in podsollic soils derived from pre-Holocene and Holocene aeolian sands along the western margin of Te Whanga Lagoon (see especially, Wright 1959). Such soils often cap the limestone, or form small pockets within it where *S. chathamica* and other trees grow. Thus the distribution of *S. chathamica* along the margin of Te Whanga Lagoon is more likely to be controlled by factors other than soil parent materials.

In contrast to Cockayne's view, I suggest that *S. chathamica* is a recent introduction to Chatham Island, and was most likely taken there as seed and deliberately planted as recently as Nov.-Dec. 1835, with the arrival of Maori tribal groups from the Wellington district (Holmes 1984), who originally came from Waikato and Taranaki (King 1989). As pointed out by Heenan et al. (2001), these people had a tradition of planting kowhai as a medicinal and ornamental plant, and probably introduced *S. chathamica* to the Wellington district from Waikato, and thence to Chatham Island. In the Wellington district *S. chathamica* is clearly associated with Maori occupation sites (see Heenan et al. 2001, p.32, Fig.7). Support for this view comes from the restricted distribution of *S. chathamica* on Chatham Island, mainly along the western margin of Te Whanga Lagoon, on sites noted for their Mori and Maori cultural

history, and the recent names Waikato Point and Waikato Bay in the same area. Perhaps more tellingly, there is no palynological evidence for the existence of *S. chathamica* on Chatham Island prior to human habitation there (see Mildenhall 1994). Likewise, there is no record of fossil wood of *Sophora* on Chatham Island.

Sophora chathamica is one of the fastest growing species of *Sophora*, and plants are known to flower at a relatively young age, e.g., three-years-old. Most of the trees of *S. chathamica* on Chatham Island, whether single- or multi-leadered, are mature individuals, and many have collapsed under the weight of heavy spreading branches, or been thrown by frequent strong winds. Eleven single-leadered trees, both erect and collapsed, were measured at two sites along the margin of Te Whanga Lagoon, and ranged in height from 7 to 12 m, with diameters at breast height of 24–60 cm. Six large multi-leadered trees at two other sites on the margin of the lagoon had basal stem diameters below the point of branching of 42–81 cm.

The upper dimensions of these trees are quite attainable in the 167 years that have elapsed since 1835 when it is postulated the species was introduced to Chatham Island. Their precise age-range is unknown, however, for although *S. chathamica* forms distinct growth rings, the stems are difficult if not impossible to core with a conventional softwood increment borer. Cross sections of individual tree trunks, though technically superior, are not readily obtainable today as most of the groves of *S. chathamica* and other trees along the margin of Te Whanga Lagoon are protected privately, or by conservation covenants.

On the other hand, the dimensions of trees of known age can provide a useful estimate of relative growth rates and age of *S. chathamica*. One such tree, derived from seed collected from Waikato Point on 5 November 1959 by Dr N. T. Moar, was planted in the more extreme environment of Lincoln in March 1960. This tree (accession number G2292) is now 42 years old and c. 7 m tall, with three leaders arising at ground level. Their basal diameters are 25, 40 and 43 cm; comparable to those of many multi-leadered trees of *S. chathamica* on Chatham Island.

Other features of *S. chathamica* on Chatham Island that suggest its recent introduction and planting there include its erratic distribution, unrelated to soil parent material or forest type; the large number of collapsed trees on precarious sites; the preponderance of older seemingly over-mature trees, and the general lack of recruitment. Many of the trees observed, particularly the multi-leadered ones, were most probably established in open or cleared situations and have since been surrounded by regrowth of endemic trees and shrubs. Some seedlings and juveniles are present, but these are very few in number and are confined to sunlit cliff edges near the canopies of existing trees where they are kept in check by animal browsing and strong competition from exotic pasture grasses and dense bracken (*Pteridium esculentum*).

CONCLUSION

Sophora chathamica is, in my opinion, a convincing example of the deliberate planting of a non-endemic species on Chatham Island for cultural and other purposes, in line with other non-endemic species there such as *Corynocarpus laevigatus* (Molloy 1990; Mildenhall 1994), *Fuchsia excorticata*, *Coprosma robusta*, *Cordyline*

australis, *Coriaria arborea*, and *Dodonaea viscosa* (de Lange et al. 1999), and perhaps even *Myoporum laetum*. But therein lies another story.

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Fig. 2. Comparison of one-year-old *Sophora* seedlings. Origin of seed (collected in 1985), left to right: Halkett, Canterbury (*S. microphylla*); beach drift, Chatham Island (*S. microphylla*); Waikato Point, Chatham Island (*S. chathamica*); beach drift, Chatham Island (form of *S. microphylla* or a hybrid). Scale in right-hand pot = 10 cm.