



## Variation in *Phormium cookianum* (Agavaceae)

P. Wardle

To cite this article: P. Wardle (1979) Variation in *Phormium cookianum* (Agavaceae), New Zealand Journal of Botany, 17:2, 189-196, DOI: [10.1080/0028825X.1979.10426888](https://doi.org/10.1080/0028825X.1979.10426888)

To link to this article: <https://doi.org/10.1080/0028825X.1979.10426888>



Published online: 10 Feb 2012.



Submit your article to this journal [↗](#)



Article views: 126



View related articles [↗](#)



Citing articles: 13 View citing articles [↗](#)

Variation in *Phormium cookianum* (Agavaceae)

P. WARDLE

Botany Division, DSIR, Private Bag, Christchurch, New Zealand

**Abstract** *Phormium cookianum* contains two well marked geographic forms, one characteristic of lowland parts of the North Island, and the other of southern and mountainous parts of the South Island and the axial ranges in the North Island. They are clearly distinguishable by the colour of the outer tepals, which are green or yellow in the northern-lowland form, and red in the southern-mountain form. Other characters also distinguish them, although not so decisively.

Along both shores of Cook Strait, especially near Wellington, there are populations which include both forms and intermediates. Very robust plants in eastern parts of the South Island may reflect introgression with *P. tenax*.

Published names are available for the two forms. Southern plants with red outer tepals fit *P. cookianum* Le Jolis, while the new combination *P. cookianum* ssp. *hookeri* (Gunn ex Hooker f.) Wardle is proposed for northern plants with yellow or green outer tepals.

## INTRODUCTION

The two species of *Phormium*, *P. tenax* J. R. et G. Forst. and *P. cookianum* Le Jolis, are distinguished by their flowers and fruits (Table 1), and by less distinctive vegetative and ecological features. *P. tenax* grows throughout New Zealand and on Norfolk Island, usually as a plant of swamps and banks of sluggish streams, but it is also abundant on coastal slopes and dune hollows, and on open hillsides in the lowland and montane belts. *P. cookianum* is smaller and not quite as widely distributed. It grows on coastal and inland cliffs, and in subalpine grassland and scrub. Where the two species meet in coastal localities, *P. cookianum* is more or less rupestral, whereas *P. tenax* is on deeper soils. Both species increase, often to become dominant, where fire has destroyed woody vegetation and sometimes form mixed stands in these circumstances.

*Phormium* species are regarded as highly variable (e.g., Cross 1915), but the situation has been compounded and obscured through selection of numerous ornamental and fibre-producing horticultural forms by both Maoris and Europeans. The species can be crossed artificially (Allan & Zotov 1937), and there are also putative wild hybrids.

My interest in the variability of *P. cookianum* derives from a comment by the late Mr Peter Fletcher, former chief ranger of Westland National Park, that he could scarcely regard the plants of the North Island Volcanic Plateau and the Southern Alps as the same species. Since herbarium material usually does not show diagnostic characters well, nor portray variability, I mainly studied fresh material, exam-

**Table 1** Comparison of *Phormium* species, based on Moore & Edgar (1970).

	<i>P. tenax</i>	<i>P. cookianum</i>
Length of leaves	1-3 m	Usually <2 m
Height of scape	To 5-(6) m	To c. 2 m
Colour of tepals	All mainly dull red	Inner green, outer yellow to red
Tips of inner tepals	Slightly recurved	Usually strongly recurved
Capsules	Not twisted, erect, usually <10 cm long	Usually twisted, often pendulous, occasionally to 20 cm long

ined or collected over localities ranging from the South Auckland district to Stewart Island. Plants were also grown at Botany Division, DSIR, Lincoln. The following characters were investigated: width of the "petiole" and widest part of the lamina; colour of the scape; angle at which the inflorescence branches and capsules are borne; colour of flowers; colour, length, and width of the capsules. Colour characters were assessed on fresh material, and metric characters on herbarium specimens. The results are summarised in Table 2.

The nature of these characters precluded a strictly quantitative, randomised approach amenable to statistical analysis. For example, colour of the outer tepals, which proved to be the most significant character, is imparted by the relative importance of a pale (usually green or yellow) background colour, and dark (usually red) flecks; moreover, the overall colour pales from the tepal tip to the base, from the

**Table 2** Data show numbers of plants assigned to each category of a character in each district, except for the two rows of mean values. For "tints in inner tepals", the same plants were examined as for "colour of outer tepals", but only plants showing tints additional to the prevailing green are indicated in the table. Under the character "colour of outer tepals", "/" indicates that the first colour(s) are dominant over the second.

	North Island Lowlands	North Island Ranges	Wellington	Marlborough Sounds	Abel Tasman	Nelson West Coast	Kaikoura Peninsula	Kaikoura Coast	Nelson-Marlborough Mountains	Central South Island	Banks Peninsula	Fiordland Mountains	Fiordland Coast
<b>Colour of outer tepals</b>													
Yellow or green	6	—	8	—	2	—	—	—	—	—	—	—	—
Yellow or green/red	2	—	9	1	1	—	3	—	—	—	—	—	—
Yellow or green = red	—	—	5	—	1	—	3	1	—	—	1	—	—
Red/yellow or green	—	—	5	2	—	—	4	3	1	1	8	—	—
Red	—	6	2	1	—	6	—	6	6	16	5	2	4
No. of plants	8	6	29	4	4	6	10	10	7	17	14	2	4
<b>Tints in inner tepals</b>													
Orange to red-brown	—	—	3	1	1	—	1	1	—	—	—	—	—
Brown	—	—	2	—	1	—	—	—	—	—	1	1	—
Pink to purple margins	—	—	—	1	—	—	2	1	—	3	1	—	1
<b>Capsule colour</b>													
Green to yellow	8	—	1	2	1	—	—	—	—	—	—	—	—
Intermediate	1	2	1	1	—	2	—	—	1	—	—	—	2
Dark	1	1	4	2	1	5	1	5	—	4	—	1	—
<b>Scape colour</b>													
Light to medium	8	—	6	1	2	2	—	—	—	—	—	—	1
Very dark	4	5	24	2	2	2	1	5	3	8	14	2	1
<b>Laxness of inflorescence</b>													
Lax	17	2	1	1	—	—	—	—	—	—	—	—	1
Medium-lax	5	4	3	1	1	2	1	3	4	1	—	—	2
Medium-fastigiate	2	1	8	2	—	4	9	2	7	7	—	1	4
Fastigiate	1	1	2	—	—	—	1	6	1	11	1	2	3
<b>Capsule length</b>													
> 14 cm	7	—	—	1	1	—	—	—	—	—	—	—	—
12–14 cm	6	—	2	2	1	4	1	—	—	—	—	—	2
10–<12 cm	8	2	3	—	2	1	—	2	1	4	—	2	—
< 10 cm	—	3	6	—	—	1	1	4	2	5	—	2	5
<b>Capsule width</b>													
< 10 mm	9	1	1	1	—	2	—	—	—	—	—	—	3
10–12 mm	11	1	4	—	1	2	—	4	3	6	—	—	4
> 12 mm	—	1	3	—	—	2	—	2	1	2	—	—	2
<b>"Petiole" width</b>													
< 10 mm	8	2	3	3	1	—	—	1	2	—	—	—	1
10–14 mm	9	1	9	1	4	1	3	1	4	1	1	—	6
15–19 mm	4	1	1	—	—	—	—	8	2	5	1	—	2
> 19 mm	—	—	—	—	—	1	—	2	—	8	—	—	—
Mean	11	12	11	11	12	17	12	17	12	19	16	—	13
<b>½ lamina/petiole width</b>													
> 2.4	1	—	2	1	—	—	—	1	—	—	—	—	1
2.0–2.4	5	—	6	2	—	—	1	—	1	—	—	—	1
1.5–1.9	11	—	5	1	1	—	1	4	3	5	1	—	4
< 1.5	—	3	—	—	4	2	1	7	4	9	1	—	3
Mean	1.9	1.3	2.1	2.1	1.2	1.3	1.7	1.6	1.5	1.4	1.6	—	1.7

outer to the inner tepal surfaces, and from the dorsally-placed to the ventrally-placed outer tepals. Observation of flowers and capsules was also hindered by the periodic flowering of *Phormium*, which tends to be at 3- to 4-yearly intervals. Leaf dimensions also posed difficulties, in that they are affected by age and vigour of the plant, and position on the plant.

Nonetheless, it became evident that a number of districts could be recognised (Fig. 1) in which particular combinations of characters prevail.

### VARIATION IN INDIVIDUAL CHARACTERS

#### Outer tepals

Scoring was based on the colour of the distal, outer surface of incurving (as opposed to reflexed) tepals, with some allowance being made for the colour of the rest of the outer perianth.

All North Island Lowland plants showed green and/or yellow as the predominant colour, although in a few there were enough red flecks to give an overall orange tint.

In North Island Ranges, Nelson West Coast, Nelson-Marlborough Mountains, Central South Island, and Fiordland nearly all plants had red or dark red outer tepals. Two slight departures were dark orange-red recorded in a southern Nelson plant, and brownish tints in some Central South Island plants.

At Wellington, where 29 coastal plants were scored, 1 was yellow, 7 were greenish yellow or yellowish green, in 9 plants red flecks were subordinate to green and/or yellow, in 5 the two components were about equal, in 5 the red flecks were dominant over green and/or yellow, and 2 were red. Similar mixing of the basic colours was recorded in coastal populations on the southern side of Cook Strait, at Abel Tasman, Marlborough Sounds, and Kaikoura Peninsula; brown tints were also noted, especially at the last site.

Of 10 plants scored along the Kaikoura Coast, 6 were red or dark red, 1 was orange-red, in 2 red was dominant over green or yellowish green, and in 1 the two components were equally expressed. On Banks Peninsula, all plants, though scored as red, had a purplish tinge, and in most a brownish green or yellowish green background also showed through.

#### Inner tepals

Inner tepal colour is much less variable than that of the outer tepals. In all plants the surfaces were green, the inner being paler than the outer, with North Island Lowland plants possibly being paler than those from other districts. However, some plants in coastal districts near Cook Strait showed red, orange, reddish brown, or brown flushes; brown tints were also recorded in some Banks Peninsula and Fiordland plants.

Distinct pink, red, or purple inner tepal margins were seen over a wide range of South Island localities, from coastal to subalpine, and from Fiordland to Marlborough Sounds.

#### Capsule colour

The colour of mature capsules depends partly on whether the background is yellow to bright green at one extreme or dark green to brown at the other, and partly on the abundance of dark brown or black flecks.

Green and/or yellow capsules predominate through North Island Lowlands, with only occasional plants having dark capsules. South Island populations (excluding the northern coasts) and those of North Island Ranges all vary from brown or dark green through to nearly black. Both the light and dark colour types were recorded from Wellington, Abel Tasman, and Marlborough Sounds, again indicating that the Cook Strait coasts form a zone of intermingling.

#### Colour of scape

As with the capsules, colour of the scape depends on the balance between a background (usually light or dark green) and flecks (usually black, sometimes red), with the overall colour becoming darker distally.

Through inland and eastern parts of the South Island and North Island Ranges only dark colours (black, dark brown, very dark green) were recorded. Other districts show a wide range of colour, but only in North Island Ranges do light colours (green, light brown) predominate, although some plants with dark scapes occur to at least as far north as northern Taranaki.

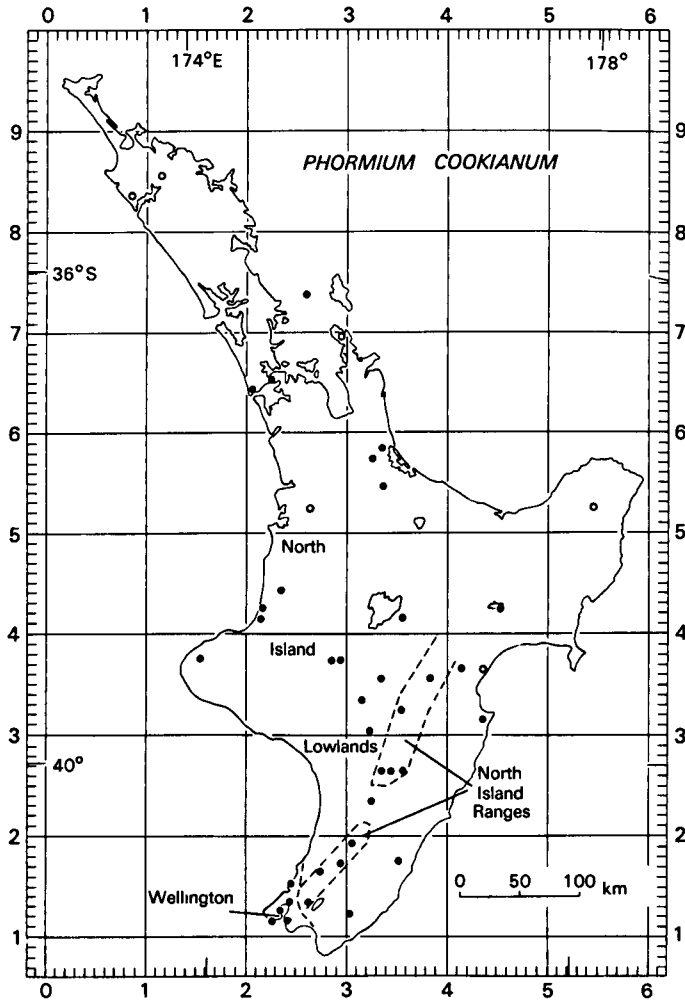
#### Laxness of inflorescence (Fig. 2)

Plants were scored as lax, medium-lax, medium-fastigiate, or fastigiate. The extremes, on one hand, are scapes with primary branches spreading at right angles from the scape axis, and freely hanging pods, and on the other, scapes with fastigiate primary branches and inclined to nearly-erect pods.

Lax forms predominate in the North Island Lowlands, with only three plants scored as medium-fastigiate to fastigiate. In Central South Island and Fiordland Mountains, in contrast, nearly all plants scored were fastigiate or medium-fastigiate. A predominance of fastigiate plants also characterises Kaikoura Coast, but other South Island and Wellington coastal populations, as well as the few plants scored from North Island Ranges, fell mainly into the "medium" categories.

#### Capsule length (Fig. 3)

Capsules were measured following the curvature from the top of the receptacle to the base of the



**Fig. 1** Distribution maps. Grid lines are spaced at 100 000-yd-intervals and bear the numbers of the National Grid as they appear on the NZMS maps. The margins of the maps show further subdivision into 10 000-yd-intervals.

Black circle = presence of *Phormium cookianum* is confirmed by a herbarium specimen held at Botany Division, DSIR. White circle = record from the literature or field notes.

slender, usually deciduous, part of the style. Mature, well-developed capsules were selected—most scapes also carry a proportion of smaller capsules, which do not figure in this analysis.

All well-developed capsules exceeded 10 cm in North Island Lowlands, Marlborough Sounds, and Abel Tasman; and in these, and only these, districts capsules exceeding 14 cm were also measured.

Capsules did not exceed 12 cm, and were often less than 10 cm, in North Island Ranges, Kaikoura Coast, Nelson-Marlborough Mountains, Central South Island, and Fiordland Mountains. In the remaining districts, i.e., Wellington, Nelson West Coast, Kaikoura Peninsula, and Fiordland Coast, capsules may exceed 12 cm (but not 14 cm), and be less than 10 cm.

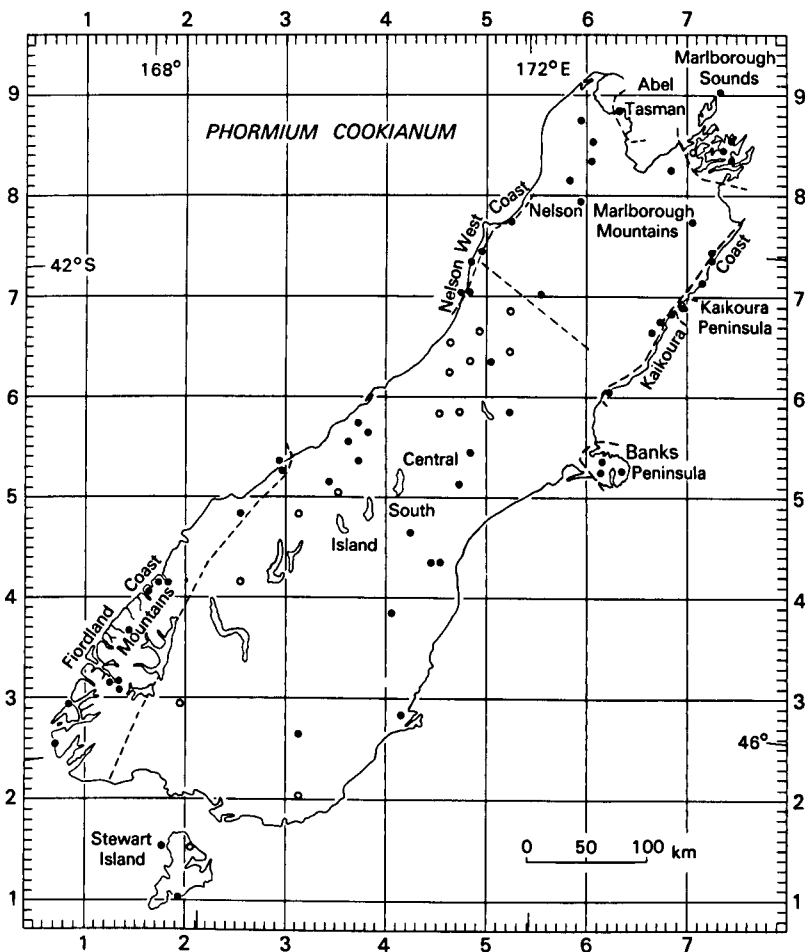
#### Capsule width

This is a very approximate measurement, since the width of dried capsules varies according to degrees of compression. However, it can be generalised that only North Island Lowlands or South Island coasts have capsules < 10 mm wide, and that most districts other than North Island Lowlands yield capsules > 12 mm wide. On the whole, Central South Island populations have the thickest capsules, the North Island Lowlands the thinnest, and Cook Strait populations the most variable.

#### “Petiole” width

In *Phormium*, the lower part of the leaf is tightly folded, fused, and narrowed into a form of petiole. The narrowest part was measured from the margin to

Fig. 1 Continued.



the midrib. Despite considerable variability, and the limited basis provided by herbarium material, a pattern emerged.

Plants from North Island Lowlands, Wellington, and Marlborough Sounds had the narrowest petioles, with those from North Island Ranges, Abel Tasman and Nelson-Marlborough Mountains, Kaikoura Peninsula, and Fiordland Coast being scarcely wider. Much thicker petioles characterise Central South Island plants, some being as wide as 23 mm. Kaikoura Coast and, to judge from inadequate samples, Banks Peninsula and Nelson West Coast plants approach Central South Island plants in petiole thickness.

#### Leaf width and robustness

Widths of the widest part of the lamina (measured on herbarium material from midrib to margin) roughly parallel those of the petiole. However, it is more instructive to compare the ratio  $\frac{1}{2}$  lamina width/

petiole width, as this gives an expression of "flaccidness", which is a distinguishing feature between populations that is otherwise difficult to quantify (Fig. 4).

North Island Lowlands yielded an average ratio of 1.9, which was exceeded by Wellington and Marlborough Sounds. All these plants had soft, drooping leaves, an aspect that was heightened in the Cook Strait plants by relatively wide laminae.

Central South Island plants had a mean ratio of only 1.4, which reflects a tendency to thick, stiffly erect leaves. Low ratios were also measured in the few plants available from North Island Ranges, Nelson West Coast, and Abel Tasman (although the last are, nevertheless, quite flaccid). Intermediate ratios were measured in Kaikoura Peninsula, Nelson-Marlborough Mountains, Fiordland Coast, and Banks Peninsula. The Kaikoura Coast specimens, though intermediate on average, ranged from 1.1 to 3.0. Plants growing on ultramafic rocks of D'Urville



**Fig. 2** Segments of scapes from cultivated plants, photographed from the same aspect. Left: Totaranui, Abel Tasman National Park (lax). Right: Porters Pass, Canterbury, Central South Island (fastigate).



**Fig. 3** Ripe capsules of *Phormium cookianum*; from each of eight cultivated plants. Provenances, from left to right are: 1: Mt Messenger, N Taranaki (North Island Lowland); 2-4: Mangaweka Gorge, near Taihape (North Island Lowland); 5-7: Totaranui, Abel Tasman National Park (a coastal Cook Strait intermediate population); 8: Porters Pass, Canterbury (Central South Island).



Fig. 4 Leaves of cultivated plants. Left: Totaranui, Abel Tasman National Park (flaccid). Right: Porters Pass, Canterbury, Central South Island (stiffly erect).

Island and the Nelson mineral belt have much stiffer, more erect leaves than plants of adjacent coasts and hills (G. Y. Walls, pers. comm.).

The leaf measurements were repeated on 5 living mature leaves of each of 16 plants grown at Lincoln or Christchurch, together with 2 plants of *Phormium tenax* included for comparison. Mean values are shown in Table 3.

The petioles are wider, and the lamina/petiole ratios smaller than those measured from herbarium material. This is because collectors tend to select less robust leaves, and also because the rather fleshy petioles shrink more than laminae\*. Nevertheless, the same trend is evident, especially in the ratios, from slender plants prevailing in the North Island except on the ranges, to robust plants in the South Island except for some on the north and west coasts.

### SYNTHESIS OF RESULTS

A preliminary account of the results has been given in *New Zealand's Nature Heritage* (Wardle 1975). Synthesis of the preceding section indicates that there are two distinct entities differing in appearance, habitat, and geographic range, which may be informally designated the northern-lowland and southern-mountain forms.

\*When 5 leaves, each from a different plant, were dried, the petioles shrank to an average of 59% of their fresh width, and the laminae to 76%.

Table 3 Leaf measurements for *Phormium cookianum* grown at Lincoln or Christchurch.

	"Petiole" width (mm)	½ lamina/petiole width
E of Lake Taupo	13	1.3
Mt Messenger, N Taranaki	23	1.3
Mt Egmont National Park	27	1.2
Mangaweka Gorge (near Taihape)	28	1.4
Ruahine Range	20	1.0
Ruahine Range	18	1.1
Ruahine Range	19	1.2
Abel Tasman National Park (coast)	16	1.5
Ten-mile Creek (coast N of Grey-mouth)	25	1.0
Porters Pass, Canterbury	31	1.1
Hohonu Range, Westland	24	1.1
Hohonu Range, Westland	20	1.1
Cole Creek (S Westland coast)	35	1.1
West Cape (W Fiordland coast)	15	1.3
West Cape (W Fiordland coast)	30	1.1
Mountains near Lake Fraser, W Fiordland	20	1.1
<i>Phormium tenax</i> , New Plymouth	29	1.1
<i>Phormium tenax</i> , near Christchurch	44	1.1

The northern-lowland form has flaccid leaves, greenish yellow outer tepals, green inner tepals, yellow or bright green hanging capsules up to 22 cm long, and long inflorescence branches which diverge widely from the inclined, usually greenish scape. It grows at its purest and most distinctive in the North Island from the Manawatu Gorge northwards, mainly on damp cliffs of soft mudstone. The highest locality noted is at 670 m on Mt Ruapehu.

The southern-mountain form has stiff, erect leaves and a black or very dark, erect scape, as in *Phormium tenax*. The outer tepals are dark red, the inner ones green and often with pink to purple margins, the inflorescence branches are often fastigiate, and the capsules are dark coloured, erect or inclined, and 8–12 cm long. It grows throughout the mountains of the South Island, except in the driest districts such as Central Otago. It also extends to Stewart Island, to the Tararua and Ruahine Ranges in the North Island, and perhaps as far north as Mt Hikurangi, but the form there has yet to be verified. At one time, this form would have been largely confined to a narrow belt of scrub, rock outcrops, and grassland extending c. 100 m above timber line, but its range has increased with the burning of forest.

*Phormium cookianum* is also abundant on coastal slopes and cliffs on both sides of Cook Strait. Plants here vary between the southern-mountain and northern-lowland forms, with respect to flower colour, capsule size and shape, and habit. Especially around Wellington, the coastal populations seem to consist of mixtures of the two forms and their hybrids. In the South Island, coastal populations extend along the east coast to Amberley, and along the



west coast to southern Fiordland and Stewart Island. However, there is a gap between Greymouth and Paringa, where moraine cliffs do not provide suitable habitats. To at least well south of Kaikoura (especially on Kaikoura Peninsula) and as far west as Abel Tasman National Park, these coastal plants show intermediate characters. On the west coast, at least from Punakaiki southwards, all coastal plants more closely resemble the southern–mountain form, except that they are more slender and flaccid, both in the wild and in cultivation.

### ORIGIN AND RELATIONSHIPS

*Phormium tenax* and the northern–lowland form of *P. cookianum* are very distinct species, despite their ability to hybridise. The southern–mountain form on the other hand, as it appears in the Central South Island district (Fig. 1) has traits which seem to place it close to *P. tenax*, in its stiff, robust leaves, erect, fastigiate, dark scapes, and short, thick, erect capsules. However, a continuous cline of variation links it with the northern–lowland form, whereas no more than an occasional putative hybrid links it with *P. tenax*. Moreover, many typical southern–mountain populations are far removed geographically from populations of *P. tenax*.

On the other hand, it is not improbable that at least the extreme southern–mountain form has resulted from past episodes of introgressive hybridisation. One may imagine that in the east of the South Island, harsh conditions during glacial periods eliminated coastal populations of *P. cookianum*, and caused inland populations to mingle with, and genetically absorb, decimated remnants of *P. tenax*. Support for this suggestion possibly lies in the purplish tints recorded in the flowers of *P. cookianum* on Banks Peninsula, where there are no coastal populations and even the highest upland populations are not far distant from stands of *P. tenax*.

The most constant distinctive character of the southern–mountain form, that separates it from both the northern–lowland form and *P. tenax*, is the sharp colour contrast between the outer and inner tepals. Slender plants with this characteristic probably survived glacial periods on the milder, western coasts of the South Island.

### NOMENCLATURE

*Phormium cookianum* was described formally from a plant collected at "Chaldy Bay" (46°30' latitude, 166°23' longitude) and cultivated at Cherbourg (Le Jolis 1848). Features noted in the Latin description include red outer and green inner tepals, black, subterete capsules, black-brown pedicels, and rigid leaves. The description clearly refers to the southern–mountain form, and the locality is certainly Chalky Inlet in Fiordland, although one would expect less-rigid plants to prevail on the coast there.

Type: *P. Le Jolis* (ref. Moore & Edgar 1970).

*Phormium hookeri* was collected in 1864 by Ronald Gunn "at the Waitangi River, about 30 or 40 miles from the mouth, where it grows pendulous from almost perpendicular rocks", and named by him in manuscript. Hooker (1888) published this name formally, after seeing similar material grown at Torquay (Devon, England) from seed collected by "Mr Grace, a missionary, who . . . resides at Wanganui". Features noted in the protologue, and clearly illustrated in the accompanying plate, include golden sepals, green petals, long, hanging, twisted capsules, inclined scapes, and flat, flaccid, recurved leaves. Although the name Waitangi is applied to several localities in New Zealand, the description and habitat obviously fit the northern–lowland form.

Even though the southern–mountain and northern–lowland forms are so distinct, the existence of a full range of intermediate plants indicates that they should be recognised as subspecies rather than species. The prior name is *Phormium cookianum* although, until reinstated by Moore & Edgar (1970), it was supplanted by the later synonym *P. colensoi* Hook.f. When *P. cookianum* Le Jolis is subdivided into two subspecies, the southern–mountain form including Le Jolis' type therefore becomes *P. cookianum* subsp. *cookianum*, while the new combination *P. cookianum* subsp. *hookeri* is applied to the northern–lowland form. Formal descriptions of both entities are available in the literature, and the new combination is:

***Phormium cookianum* subspecies *hookeri* (Gunn ex Hooker f.) Wardle comb. nov.**

Basionym = *Phormium hookeri* Gunn ex Hooker f. *Bot. Mag.* 114, t. 6973, 1888.

LECTOTYPE: *K, Gunn* (ref. Moore & Edgar 1970).

### ACKNOWLEDGMENTS

Much of the fresh material was collected by colleagues at Botany Division, DSIR, and also by Mr R. L. Martin of the Hawke's Bay Catchment Board and Mr G. D. McSweeney of the Tussock Grasslands and Mountain Lands Institute. I am also very grateful to Dr L. B. Moore for access to her unpublished notes on type specimens and original descriptions.

### REFERENCES

- ALLAN, H. H.; ZOTOV, V. D. 1937: An artificial cross between *Phormium colensoi* and *P. tenax*. *N.Z. Journal of Science and Technology* 18: 799–804.
- CROSS, B. D. 1915: Investigations on *Phormium*. *Transactions and Proceedings of the New Zealand Institute* 47: 61–6.
- HOOKE, J. D. 1888: *Phormium hookeri*. Native of New Zealand. *Curtis's Botanical Magazine* 114: Tab. 6973.
- LE JOLIS, A. 1848: On a new kind of *Phormium* or New Zealand flax. *London Journal of Botany* 7: 533–7.
- MOORE, L. B.; EDGAR, E. 1970: Flora of New Zealand. Volume II. Indigenous Tracheophyta. Monocotyledones Except Gramineae. Government Printer, Wellington. 354 pp.
- WARDLE, P. 1975: Flax. *New Zealand's Nature Heritage* 6(79): 2206–9.