

## The Small-leaved Species of the Genus *Pittosporum* occurring in New Zealand with descriptions of New Forms \*

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\* This paper has been much condensed for publication.

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## I. GENERAL INTRODUCTION.

IN our supplementary list of species of Arthur's Pass, we stated that we hoped to study further some of the plant forms of the Bealey River Basin, and to bring our knowledge of them as far as possible into harmony with modern taxonomic and ecological methods. This paper is an attempt to carry out this promise in connection with certain species of *Pittosporum*. In order to define the position of the forms of this genus at Arthur's Pass, we have had to consider similar forms throughout New Zealand; and although there can be no finality in such an attempt, at least it will provide a foundation for other workers to carry on the researches here initiated. It would require many years of work in the field, in the garden, in the laboratory, and with the microscope to fix the taxonomic position of all the plants we have had under investigation. We hope, however, that we have thrown some light on the bewildering series of forms met with in this section of the genus *Pittosporum*.

## II. THE SMALL-LEAVED FORMS OF THE GENUS *PITTOSPORUM.*

No attempt has yet been made to divide the genus *Pittosporum* into natural groups. Engler and Prantl (1910, p. 273) say, "Ein künftiges System der Gattung wird sich vor allem auf die Frucht zu gründen haben, und diese ist bei vielen Arten noch nicht genügend bekannt." While this is true, it is clear that certain minor divisions can be made, based upon leaf form, inflorescence, and seedling form.

We propose to deal with those forms of the genus *Pittosporum* occurring in New Zealand that have mature leaves usually not more than 2.5 cm. in length, and in the juvenile form more or less pinnatifid, and with the flowers solitary or in fascicles. By using the length of the leaf as a positive character we are, of course, making

an arbitrary distinction. Certain species that have pinnatifid juvenile leaves are also excluded from the group because of their umbellate flowers.

We get, however, a fairly natural division of the genus to deal with that includes the following species appearing in Cheeseman (1925, pp. 486-496):—

- P. obcordatum* Raoul.
- P. rigidum* Hook. f.
- P. divaricatum* Ckne.

To these we propose to add three new species:—

- P. crassicaule* (Ckne) Lg. et Gy.
- P. anomalum* Lg. et Gy.
- P. lineare* Lg. et Gy.

We are excluding *P. patulum*, *P. virgatum*, and *P. Turneri* because of their larger leaves and terminal umbellate flowers, and *P. reflexum* R. Cunn. ex A. Cunn. which, with Cockayne, we regard as a distinct species. This, so far as we know, has no juvenile or seedling form with pinnatifid leaves, and with the flowers dioecious and usually in umbels, cannot be regarded as a member of the group studied by us, and though its general appearance is not unlike that of *P. lineare*, it is probably not closely connected with that species.

We further add some remarks on habitat forms; but these statements must of necessity be only preparatory to a fuller consideration of the facts, which can only be ascertained by growing the forms from different localities under the same conditions, and with full knowledge of their parent species, and by a closer observation of the varieties occurring in all parts of New Zealand. Forms of small-leaved *Pittosporum* occur from Kaitaia in the extreme north to Preservation Inlet in the far south.

### III. POLYMORPHY.

It should first be noted that all the species dealt with, excepting only *P. lineare*, are highly polymorphic in length and rigidity of branchlets, leaf shape and size, and in habit generally. In addition to the polymorphic mature plant, each of the species under discussion (again excepting *P. lineare*) has also a distinct juvenile and shade form, differing in habit, leaf size and shape, from the corresponding adult plant. Sometimes there is more than one adult form, and the juvenile may go through many changes.

It is obvious that where there is such a mixture of forms in one coenospecies,\* it may be extremely difficult to discriminate the species from herbarium fragments, though generally, with a little practice and a knowledge of distribution, effect of environment, etc., they can be definitely separated in the field. However, difficulties crop up even there. Thus *P. rigidum* and *P. divaricatum* in some states rather closely simulate the habit and leaf form of *P. crassicaule*. Minor critical differences in the specimens still exist, but the inexpert

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\* These terms are used in the sense of Turesson. See glossary at the end.

will easily be deceived. However, attention to basal leaves, shade forms, and especially seedlings, will usually determine the plant. As the seedling forms themselves in the different species seem generally to be remarkably constant, they probably here provide the most reliable specific distinctions. A table of the chief seedling forms is set out below (p. 59).

#### IV. NOTES ON SPECIES ALREADY DESCRIBED.

##### 1. *Pittosporum obcordatum* Raoul.

Though first described in 1844 (Raoul, 1844, pp. 121-122), a fuller description was given by Raoul (1846, p. 24, t. 24) based on specimens collected between 1840 and 1842 at Akaroa. The living species was not again seen until a plant found at Kaitaia by the late Mr R. H. Matthews was so re-identified by Cheeseman (1907, p. 435). We doubt whether the Kaitaia plant is identical with the original form. Another form of the species was found near Wairoa, Hawke's Bay, by Mr G. O. K. Sainsbury [v. Sainsbury, 1923, p. 352]. At present, then, the species is known only from a few plants at Kaitaia—if they are not already destroyed—and from a few specimens of a different ecotype growing in wet scrub near Wairoa. Seed from both these localities has been obtained, and there are now also a few garden examples of both forms.

Sainsbury (loc. cit.) has described the seedlings of the Wairoa plant, and he has also forwarded us two one-year-old seedlings. Though we have not seen many seedling forms of either variety, yet on the whole the evidence is, we think, sufficient to establish the fact that the plants are sufficiently distinct to be regarded as varietal forms, when we consider also differences in the mature plants. The two Wairoa seedlings sent us by Mr Sainsbury have no leaflets of greater breadth than 3 mm., and the majority of the leaves are linear. Each specimen has some half-dozen leaves. There are no obovate or lanceolate leaves, and the general difference of appearance between the two groups of seedlings is so great that one would certainly not ordinarily regard them as belonging to the same species. (Pl. 8, figs. 1-3.)

The problem now is, which of these two forms is more nearly representative of the lost Akaroa plant. The examination of Raoul's description and plate (loc. cit.) shows a plant which apparently conforms exactly to the Wairoa form. In the sparse, almost glabrous leaves, bare tips to the branches, and in one or two other minor respects, it is unlike the Kaitaia plant. We propose therefore to consider the latter as a variety of *P. obcordatum* and to describe it as *P. obcordatum* var. *Kaitaiaensis*.

##### (a) *Pittosporum obcordatum* Raoul var. *Kaitaiaensis* Lg. et Gy.

Leaves 10 mm. to 15 mm. long, 8 to 10 mm. wide, young leaves fringed on the margins with white silky hairs, and bearing similar scattered hairs on the upper and lower surfaces. Young shoots covered with a silky pubescence. Seedlings and juveniles bearing obovate leaves up to 3 cm. long and 1.5 cm. wide.

Kaitaia—Matthews, Carse, etc.

## 2. *Pittosporum rigidum* Hook. f. (Pl. 12, fig. 2.)

*P. rigidum* was originally described by Hooker f. (1853, p. 22, t. 10) from specimens collected by Colenso near Lake Waikaremoana and on the Ruahines. It is distinguished from all other forms considered by us in the larger capsules (7 to 10 mm. in diameter), and the larger number of seeds, which usually number 7 to 12 in each capsule, and in some Tararua specimens at least by the larger leaves. The ovary and young capsules are downy with fulvous hairs.

### (a) DEVELOPMENT FROM THE SEEDLING STAGE.

#### i. *Seedling Form.*

So far we have been unable to grow seedlings from Mount Hikurangi seed, where the small-leaved type form of *P. rigidum* occurs. A few specimens have been raised for us from Mount Holdsworth seed by Miss E. Walker, of Christchurch, and Miss H. Jenkins has sent us a large number from the top of Mount Robertson, 1040 m., belonging apparently to this phenotype. Several of these we have in cultivation; but we are not at all certain that either of these forms necessarily represents the Mount Hikurangi genotype, nor are they exactly similar to each other. Both forms bear considerable resemblance to the seedlings of *P. divaricatum*, the Mount Robertson (Marlborough) forms particularly so.

#### ii. *Juveniles.*

Here we are on somewhat more solid ground. Though, unfortunately, we have only seen several juveniles of the type form, some of these were collected on Mount Hikurangi by Miss L. B. Moore.

(i) A juvenile 12 cm. high, in *Nothofagus Menziesii* forest, 1280 m., Mount Hikurangi. The leaves are about 1 cm. long, ovate to oblong or elliptical in outline, sharply toothed and pinnatisect, far more deeply cut than in any of the *P. divaricatum* juveniles, but not nearly so lacinate nor so long as is usually the case in *P. crassicaule* juveniles of the same size. A very small number of entire leaves is also present.

(ii) A second, older plant has rather more numerous entire leaves up to 1 cm. in length, and the dentate leaves are no longer deeply incised, but more or less pinnatifid with sharp or occasionally obtuse teeth.

(iii) A third, and still older plant, is some 60 cm. in length. There are a few entire oblong-elliptical to obovate leaves 8 to 10 mm. long, but the majority of the leaves are variously toothed, serrate or pinnatifid. It approaches some of the shade forms of *P. divaricatum*, but does not match any. Occasional leaves may be found to correspond in the two species, but, generally speaking, the leaves of *P. rigidum* are sharper at the apex, more reticulated on the upper surface, and have more acute teeth and lobes. It would, however, seem probable that *P. rigidum* and *P. divaricatum* are closely related, unless in these seedlings we have perhaps an example of convergent epharmony.\*

\* Similarity in appearance of genophenes of different genotypical constitution.

iii. *P. rigidum* and *P. divaricatum*.

Cheeseman (1925, p. 490) and Cockayne (1915, p. 111) gives the following characters of *P. divaricatum* as distinguishing it from *P. rigidum* :—

- (1) The thick, rigid, flexuose and interlaced branches;
- (2) the much smaller, more glabrous habit;
- (3) the much smaller polymorphous leaves;
- (4) the juvenile leaves largely evident in all stages of growth;
- (5) flowers on arrested branchlets.

Now, though these characters will often furnish distinctions between the two species, none of them can always be relied upon to do so. *P. rigidum* growing exposed upon a mountain top may exhibit all these characteristics of *P. divaricatum*. The most satisfactory, though not always reliable, distinctions as already insisted upon for separating the species are:—(1) the seedling form; (2) the juvenile form; (3) the size of the capsule and the number of seeds. There may also be floral differences, but we know too little about the flowers of *P. rigidum* to insist on these.

(b) POLYMORPHY OF *P. rigidum*.

*P. rigidum*, as at present constituted, is a highly polymorphic and plastic species of many genophenes, including at least two and perhaps three genotypes—(a) the type form of Mount Hikurangi, which extends southward to Marlborough and Nelson; (b) the larger-leaved form, so far known only from the Tararuas; (c) the third polymorphic form, found on the mountain tops from Hikurangi to Marlborough, which may or may not be genetically distinct from the type form.

3. *Pittosporum divaricatum* Ckne.

## (a) GENERAL.

[For original description, see Cockayne (1915, p. 111).]

According to Cockayne, this is a shrub  $\pm$  1.5 m. high, but we have seen a specimen 6 m. high with a bare trunk 8 cm. to 10 cm. through, at Arthur's Pass between Rough Creek and Halpin's Creek, and bearing leaves of the shade form at the top. The plant was growing under a canopy of *Nothofagus cliffortioides*.

*P. divaricatum* is a distinctly polymorphic species of much wider distribution than *P. rigidum*. At a short distance, the typical form is almost indistinguishable from *Aristotelia fruticosa*. According to Cheeseman (1925, p. 490), it is found on the volcanic plateau around Tongariro and Ruapehu; and it is not uncommon in mountain districts from Marlborough and Nelson southwards in the South Island.

(b) DISTRIBUTION OF *P. divaricatum*.

(i) We have examined, in addition to many forms collected by ourselves, a very considerable number of specimens in herbaria accumulated by various collectors, but the material is often insufficient for a full determination. However, there is evidence that the species

probably ranges from Ruapehu, the Waimarino Plains (Hahaungatahi) southwards, occurs at Puketiritiri (eastern foothills of the Ruahines), appears in Nelson at the top of the Piki-kiruna Range, on the Dun Mountain, on the Rahu Saddle, and passes through into the inland plains of Canterbury and possibly into Westland. It is abundant on the foothills of Marlborough from about 150 m. to 920 m. We have seen a plant labelled *P. divaricatum* from the Spey River, Lake Manapouri, but its identity was questionable. Its southernmost limit, so far as we at present know, is at Queenstown, Lake Wakatipu (H.W.G.). It is also found at Governor's Bush in the Mount Cook district. Thus it is found in the following botanical districts at least: Volcanic Plateau, Ruahine-Cook, Sounds-Nelson, North-Eastern, Eastern, North Otago, and probably Western districts of the South Island. So far we have not seen it at sea-level.

Cheeseman gives its altitude range as 500 to 3500 feet, but in the Maitai Valley, 8 miles from Nelson, it reaches the low altitude of 100 metres. At Arthur's Pass there is a sharp line of demarcation between *P. crassicaule* and *P. divaricatum*. On the north side of Rough Creek, *P. crassicaule* alone is found, and on the south side, *P. divaricatum*.

## V. DESCRIPTION OF NEW SPECIES.

### 1. *Pittosporum crassicaule* (Ckne.)\* Lg. et Gy.

#### (a) BOTANICAL DESCRIPTION.

Frutex  $\pm$  2-4 m. altus, fastigiatus, ramis principibus erectis, rigidis, et percrassis, ramulis  $\pm$  10 cm. longis, divaricatis frequenter spinosis, rigidis, non intertextis flexuosisque, ramis maturis glabris, junioribus pilosis. Folia matura  $\pm$  5-7 mm. longa, oblongo-elliptica, integerrima, ad apices ramulorum abbreviatorum, brevissime petiolata glabra; plantae folia in juvenili statu parce lobata, dentata, vel irregulariter pinnatifida,  $\pm$  3-12 mm. longa, lanceolata aut linearia, coriacea, folia in statu seminali, pinnatisecta, non nunquam bipinnatisecta. Flores parvi, solitarii aut fasciculati, terminales, sessiles ad apicem ramulorum abbreviatorum; sepala 5, lineari-lanceolata, fusca, persistentia cincta ad basem bractearum lignosarum involucri, corolla atropurpurea 5 mm. longa, petala lineari-spathulata, apicibus recurvatis, ovarium pilosum, capsula sub-globosa, 5-7 mm. diametro, carunculata, apice mucronata, semina 1-6, frequentius 2 aut 4.

#### (b) GENERAL DESCRIPTION.

##### i. *Type Form.* (Pl. 9, fig. 1.)

A hard, woody, and usually fastigiate shrub, becoming bushy in partial shade, 3 to 4 metres high, main branches erect, often closely compressed, branchlets up to 10 cm., not flexuose and interlaced, usually divaricating, often spinous at the tips, opposite or whorled with three or four at a node; older branches glabrous, young pilose with more or less appressed hairs. Seedling, juvenile and shade forms distinct.

\* In litteris to R.M.L.

ii. *Seedling Form.*

First leaves usually three in a whorl, but sometimes four, and in one case five were observed. (We do not know whether these are true cotyledons or not. They certainly do not bear the usual characteristics of such. The embryo is minute, and the germination so far has not been sufficiently closely observed to provide accurate information on this point.) These leaves may range according to circumstances of growth from 5 to 15 mm. in length. They are linear-oblong to broadly ovate in outline, deeply pinnatisect, bearing three or four acuminate laciniae on each side, which may again be toothed or pinnatisect. They are very distinct from the seedling form of any other small-leaved species of *Pittosporum*.

iii. *Juvenile Form.*

The first leaves are alternate, glabrous, up to 2 cm. in length, similar to the leaves of the seedling, but usually a little broader and larger, frequently bipinnatisect, with four or five acute linear lobes on each side, which are again toothed or lobed. There is, however, a considerable amount of polymorphy as to breadth and amount of lobing. This stage may last for a year or more, when a secondary stage appears, much resembling the shade form of the mature plant. In this stage the leaves are somewhat reduced in length, no more than 1.5 cm. long, and not usually more than 3 to 4 mm. wide, pinnatifid, or with variously indented margins. A very few may even be entire. They usually differ from the leaves in *P. divaricatum* at a corresponding stage by being narrower at the base, and they show more numerous and more regular indentations. (As a rule there is no difficulty in distinguishing the two species at a glance.) Similar leaf-forms may usually be found at the base of mature plants of *P. crassicaule*, particularly if not fully exposed to the sun. In this stage they bear considerable resemblance to those of the shade forms of the mature plants. The subsequent stages are those of the mature plant. The juvenile form is well figured by Cockayne (1912, pl. 8) under the name *P. divaricatum*.

iv. *Shade Forms.*

The plant is sun loving and is killed by deep shade. Thus in the second growth *Nothofagus cliffortioides* at the back of the railway cottages at Arthur's Pass, many plants may be found 2 to 3 metres high which have been killed by the dense shade produced by beech saplings growing above them. However, in semi-shade, the plant usually assumes a form similar to some of the juveniles. The branches become longer, somewhat more flexuous, less rigid, and sometimes interwoven. The leaves approximate to those of the later juvenile form, though with fewer and more rounded and less deeply indented lobes. They become more elongated and slightly reticulated on the upper surface, but scarcely so much so as in reduced forms of *P. rigidum*. However, some specimens in shade still produce many entire leaves, and the lobing when it occurs is not uniform on both edges of the leaves. Both in sun and shade, the branches and branchlets are grey and sometimes slightly silvery.



v. *Mature Sun Form.*

This is usually fastigiata owing to the fact that the main branches, originally divaricating, which arise in whorls of three or four at different points on the stem, immediately turn upwards so as to become more or less parallel with the erect main stem. These branches give rise to short, rigid, thick, almost spinous, divaricating branchlets, 2 to 4 cm. in length, and arising two or three at a node. They usually bear a few appressed hairs at the tips. A few small, hard leaves, 5 to 7 mm. long or even less, oblong-elliptical to ovate and very shortly petiolate are produced at the ends of arrested branchlets. They are entire or more rarely slightly dentate, though a few lobed leaves may usually be found even on the most exposed plants.

vi. *Flowers and Fruit.*

Flowers small, solitary, or up to three in a fascicle, terminal, sessile, on short arrested branchlets. Sepals five, linear lanceolate, usually persistent, short, about quarter the length of the corolla tube, brownish, with a few hairs on the margin and back, 1 to 1.5 mm. long, surrounded by an involucre of persistent, woody pilose bracts not reaching to their tips. Corolla dark purple, 5 mm. long, petals free, slightly imbricating, forming a tube 3 mm. in length, linear spatulate, with tips at first expanded, later recurved. Stamens 5, free, with rather broad purple filaments, anthers slightly exerted, protandrous. Style when fully developed usually slightly longer than the stamens; ovary pilose, stigma rounded. If the flowers are capable of being selfed, this must frequently occur. Capsule two valved, woody, sub-globose, 4 to 7 mm. in diameter, usually mucronate, valves irregularly rugose, often somewhat broader than long, at first thick and woody, flexible, seeds varying in number from 1 to 6, but most commonly 2 or 4. (Pl. 9, fig. 2.) Flowers October and November. In the middle of November, 1932, plants on the north side of Rough Creek (altitude 730 m.) were in full flower; those at Otira (altitude 380 m.) had finished flowering. Plants of *P. divaricatum* on the south side of Rough Creek were only in bud, and probably did not flower till a fortnight later.

## (c) NOTE ON XEROPHILY.

The xerophily of this plant has evidently much puzzled Dr Cockayne; but so-called xerophytes are not uncommon on the eastern side of the divide, in spite of the high rainfall of 457 cm. a year. Such are *Hebe ciliolata*, *Hebe lycopodioides*, *Exocarpus Bidwillii*, *Helichrysum selago*, and many other species. Indeed, one of the most striking features of the florula is the almost complete absence of large-leaved plants. Though it might be argued that the high evaporation rate, the porous sub-soil, and intense insolation result in drought conditions after the absence of rain for a few days, other factors have to be taken into consideration, such as the extreme range of temperatures and very frequent violent gales. At any rate, there can be little doubt that, in spite of a heavy rainfall, much of the Arthur's Pass region is physiologically dry. All the factors just

referred to doubtless modify the form of such a species as this, and will explain why *P. divaricatum* growing in apparently drier, typically xerophytic areas shows less xerophily than *P. crassicaule*. Confirmation of this hypothesis may be obtained both from Cass and Mount Robertson, where plants growing under similar conditions of rainfall present very different habits and leaf forms according to the amount of shelter they receive. Obviously exposure to wind and sun is an important factor in determining the size of the leaf.

#### (d) THE TYPE PLANT.

We have chosen as the type a plant by the roadside, growing in a fully-exposed position at an altitude of about 760 m. at Arthur's Pass. The species is abundant, and where in similar situations, very constant in characters on both sides of the divide from Nelson to Waiho and probably Milford Sound. The limits of its distribution are, however, not well known. At Arthur's Pass it suddenly disappears at an altitude of 730 m. on the north side of Rough Creek, and is replaced by *P. divaricatum* on the south side of the creek. So far we have seen no undoubted specimens from the North Island; and as *P. crassicaule* is found in the Otira Gorge, and near the Otira township between the railway houses and the Teremakau River at an altitude of about 580 m., the lowest level of its altitudinal range is apparently different on the western slopes from that on the eastern slopes of the Southern Alps.

#### (e) DISTRIBUTION.

We have identified with certainty specimens only from Arthur's Pass to Aleck's Knob (Waiho). It occurs therefore on the western faces of the Southern Alps from Otira to Waiho. The senior author has also seen a *Pittosporum* of which he has no specimens, on McKinnon's Pass and at Preservation Inlet, but which he believes to be the same as this. It is typically, therefore, a plant of the western flanks of the Southern Alps, and doubtless in many places crosses the divide at low passes. We have also seen specimens from a low altitude at Collingwood and West Wanganui which perhaps belong to this species.

#### (f) RELATIONSHIPS.

In its mature form, *P. crassicaule* approaches most closely in general appearance to the mountain-top forms of *P. rigidum*. It is, however, much more fastigate than these, and even more rigid in the branchlets. In flower, fruit, and leaf form there are also slight divergences between the two, though the reduced number of seeds, the smaller size of the capsule, leaves, and flowers of the mountain-top form of *P. rigidum* cause it to approximate very closely indeed to *P. crassicaule* in the characters referred to. However, in seedling, juvenile, and shade forms they always, so far as we know, differ markedly.

*P. crassicaule* is less closely allied to *P. divaricatum* than it is to *P. rigidum*. The characteristic narrow obovate leaf of *P. divaricatum*, the glabrous ovary, the intertwining, flexuous branches, the smaller and less carunculate capsule, as well as the seedling, juvenile, and shade forms will usually separate it from any form of *P. crassicaule*.

(g) TABLE OF DIFFERENCES BETWEEN *P. divaricatum*  
AND *P. crassicaule*.

<i>P. divaricatum</i> .	<i>P. crassicaule</i> .
<i>Cotyledons</i> : Entire.	Pinnatisect.
<i>First leaves</i> : Shorter than the cotyledons, pinnatifid.	Long, pinnatisect, or bi-pinnatisect.
<i>Growth form</i> : Highly polymorphic, but typically a spreading shrub with interlacing branches.	Varied, but typically a fastigate shrub.
<i>Mature entire leaves (exposed)</i> : Narrow linear to obovate, 6 mm. to 15 mm. long.	Oblong-elliptic, 5 mm. to 7 mm. long.
<i>Shade or juvenile leaves</i> : With usually 1 to 3 lobes or teeth on each side.	With usually 1 to 5 lobes or teeth on each side.
<i>Flowers</i> : (a) Solitary.	Solitary or in fascicles of 2 or 3.
(b) Sepals: fall before petals, pale green lanceolate to oblong lanceo- late, often acuminate, slightly ciliate, and extending about half- way up the corolla tube.	Persistent, brown, oblong to ovate, ciliate on the margins, and extending about quarter-way up the corolla tube.
(c) Corolla: rather narrower and longer than in <i>P. crassicaule</i> .	Corolla broader and somewhat shorter than in <i>P. divaricatum</i> .
(d) Ovary usually glabrous.	Ovary hairy.
(e) Capsule smoother and not quite so broad as in <i>P. crassicaule</i> .	Capsule 5 to 7 mm. broad and usually carunculate.

## 2. *Pittosporum anomalum* Lg. et Gy.

### (a) GENERAL.

We have had considerable difficulty in assigning this plant to a genus. In many of its characters it approaches closely to the Australian genus *Bursaria*, founded in 1797 for a coastal extra-tropical plant of Australia by A. J. Cavanilles (1797, t. 30, p. 350), *Bursaria spinosa*. But in some respects our plant does not fit in with the genus *Bursaria*, and as we have seen no specimens of any species of this genus, we are retaining it for the present in *Pittosporum*. It may, however, be necessary to describe a sub-genus for its reception. It certainly does not come within the limits usually recognised for *Pittosporum*. The small number of seeds (1 to 3), the absence of any viscid fluid, and the flat, compressed capsule, almost membranous in its later stages, are characters that do not agree well with those of this genus, but do agree better with *Bursaria*, which has a coriaceous, compressed, flattened capsule, with only one or two vertical seeds in each cell. On the other hand, in *Bursaria* the petals are narrow, spreading almost from the base, and in our

plant, though there is no definite corolla tube, the petals are comparatively broad and form a shallow cup. Further, in *Bursaria spinosa*, the type of the genus, the flowers are in terminal panicles, whilst in *P. anomalum*, as in some other species of *Pittosporum*, they are solitary. *P. anomalum* differs still more from the other Australian *Bursarias*, *B. incana* and *B. Pantoni*. In the absence of a corolla tube, in the aroma of the leaves, and to a less extent in the characters of the capsules, our plant somewhat approaches *P. eugenioides*, though very different in other respects. At present, at any rate, it seems better to retain it under the present genus.

## (b) BOTANICAL DESCRIPTION.

*Pittosporum anomalum* Lg. et Gy.

Frutex  $\pm$  1 m. altus, ramis longis, validis, glabris, intertextis, flexuosis, cumulum sub-globatum 1.5–2 m. diametro formans, ramulis juvenilibus pilosis vel parce tomentosus. Folia petiolis brevibus, alternata vel fasciculata ad ramulorum perabbreviatorum apices, exstipulata, lineari-pinnatifida  $\pm$  5–10 mm. longa, valde aromatica, unacum foliolis varioribus 5–7 mm. longis, integerrimis, diffusis. Flores  $\pm$  3 mm. longi, terminales ad ramulorum abbreviatorum apices, nonnunquam laterales axillaresque, involuero cincti bractearum fuscaram, iter leve ciliatorum membranacearum. Sepala 5, petalis dimidio minora, persistentia, fusco-flavida, oblongo-lanceolatis, petala 5, leve ciliata, erosa, sine tubo, flavida marginibus subpurpureis, ovarium glabrum; capsulae bivalvatae, fere membranaceae, semina 1, raro 2, non-mucosa, in tegmine papyraceo inclusa.

The type is a plant by the roadside near Jack's Hut (Arthur's Pass), at an altitude of about 850 m., and is a shade form. A typical plant of *P. crassicaule* grows on the bank two feet above it. (Pl. 10, fig. 4.)

## (c) GENERAL DESCRIPTION.

i. *Seedling.*

Cotyledons 3, more rarely 4 in a whorl, entire, linear, 10 mm. to 15 mm. long, 2 mm. to 3 mm. broad, more rarely pinnatifid. First leaves similar in outline, but broader and dentately lobed halfway to the midrib, the dentations, which are up to five in number, sometimes bearing one or two secondary teeth, often rounded and almost crenate, the whole plantlet sparsely pilose. (Pl. 10, figs. 1, 2, 3.)

ii. *Juvenile Form.*

In its earlier stages, *P. anomalum* is an erect plant without flexuous interlacing branches. Thus a plant near Jack's Hut at Arthur's Pass, about 1 metre high, growing in semi-shade, was without divaricating or interlacing branches, but was throwing out on all sides from below the surface of the ground rhizomes from which ascended erect shoots. These, no doubt, on producing longer branches, would at length develop the mature flexuous interlacing form. Plants grown from seed in the senior author's garden, two years old, are

now 10 to 15 cm. high. There are no entire leaves, but all are linear, dentato-serrate, pinnatifid, or even pinnatisect, almost sessile, about 1 cm. in length. At Arthur's Pass these plants and mature plants become red-brown in the winter, as do most of the shrubs in the neighbourhood, some of the brown coloration lasting till November. This winter coloration is still shown when plants are brought to sea-level or grown from seed there. It also appears in *P. divaricatum*. The first branches are usually in whorls of three or four, horizontal, but soon become ascending.

iii. *Growth Form of Mature Plant in Semi-shade.*

In this form, the plant is a spreading and semi-prostrate shrub with long interlaced flexuous branches, forming a sub-globose mass 1 metre high, 2 metres in diameter, branches stout, glabrous except on young shoots, which are pilose or slightly tomentose. Leaves are alternate or in fascicles at the tips of arrested branchlets, exstipulate, with a short, stout petiole, linear, deeply dentato-serrate to pinnatifid, 5 to 10 mm. long, highly aromatic; a few small entire leaves may be found distributed over the plant.

iv. *Growth Form in Sun.*

The plant becomes prostrate and more or less appressed to the ground; the branchlets much more rigid, and sometimes almost spinous. The habit is very much that of *Hymenanchera alpina* when growing in similar situations. More numerous entire leaves are to be found which are linear and similar in outline to the normal pinnatifid leaves.

v. *Flowers and Fruit.*

The flowers are solitary, terminal on short arrested branchlets, or occasionally lateral and axillary, minute, about 3 mm. long and the same in diameter, the base of the flower surrounded by an involucre of brown, membranous, obovate bracts, slightly pilose on the margins, sepals 5, not exceeding half the length of the corolla, persistent, brownish yellow, oblong lanceolate, petals 5, oblong lanceolate, about 3 mm. long, slightly erose with a few minute scattered hairs on the margins, without a claw, and distinctly separate, not forming a tube, creamy yellow, purple on the edges and tips, slightly reflexed in the older flowers; stamens 5, alternating with the petals, and about two-thirds of the length of the petals; style short, stout, 1 mm. long, stigma flattened, ovary and style glabrous; fruit two-valved, ovoid and acuminate, with thick fleshy valves when green, rather longer and flatter than in *P. crassicaule*, valves much less woody than those of *P. divaricatum*, and almost membranous when dehiscence takes place, and about 5 mm. long by 3 mm., containing usually only one seed, more rarely two, enclosed in a papery integument, non-mucilaginous. (Pl. 11, figs. 1-9.)

The plant is evidently a much-reduced form. Abnormal fruits may occasionally be found with three or four valves, and others with three or four ovules. Obviously the normal number of seeds is four, but of these several usually abort. When three are present, one is placed in the narrow end of the capsule, above the other two.

(d) DISTRIBUTION.

Till recently, *P. anomalum* was known only in a narrow strip between Jack's Hut and the top of Arthur's Pass. Cockayne (1899, p. 403) mentions a variety of *P. rigidum* with white flowers occurring in the Peg-leg area. This is quite probably *P. anomalum*; but so far we have been unable to find any specimens of it there. However, in March, 1933, we received specimens of undoubted *P. anomalum* from Hahaungatahi on the volcanic plateau in the North Island, collected at the forest margin by Misses L. B. Moore and L. M. Cranwell, and later from the edge of the Waihohonu Stream. Flowers December to January.

3. *Pittosporum lineare* Lg. et Gy.

(a) BOTANICAL DESCRIPTION.

Frutex ramosus 2–3 m. alt., saepe truncum brevem exhibens, stipitibus principibus erectis, ramis longis, gracilibus plus minus pendulis et ramulis divaricatis. Ramulorum juvenilium apices minute tomentosi, folia alternata, maturorum ad apices ramulorum abbreviatorum fasciculata, linearia, lineari-spathulata, 10–15 mm. longa, 1.5–2.5 mm. lata, marginibus leviter reflexis, integerrimis, apicibus obtusis. Flores solitarii, terminales, 5 mm. longi, sepala lanceolata, acuminata, petala 5, atropurpurea, apicibus recurvatis. Capsula 4–5 mm. longa, carnosocoriacea, apiculata, granulata. Semina 2–5 glutinosa.

(b) GENERAL DESCRIPTION.

i. *Seedling Form.*

Cotyledons 3–4 in a whorl, shortly petiolate, 10–12 mm. by 1–2 mm., linear, margins waved and with one or two notches on each side, finely ciliate. First leaves rather variable, usually similar to the cotyledons, but bearing on each side 1–3 teeth or lobes, which are usually opposite.

ii. *Juvenile Form.*

The juvenile stage, except slightly in leaf form, differs little from the mature form, and is quick growing. The first branch usually arises near the foot, grows erect, and provides a secondary stem. Secondary and tertiary branches are formed which soon turn the bush into a tangled mass. Some of the branchlets are divaricating, but soon turn upwards or downwards. The lower leaves on each branch are very irregularly lobed, and may even be pinnatisect, but

towards the top the lobing becomes less, until the narrow, linear, entire leaf form becomes common at the tips. These leaves, however, are usually narrower and more acuminate than in the mature form.

iii. *Mature Plant.*

*α Growth Form.*

A much-branched shrub 2-3.5 m. high and a metre or more in diameter. In the shade there is often a short trunk, but at other times there are several more or less erect or spreading main stems, branching from the ground or near it; in other cases the bush is fastigiate. The principal stems give rise to numerous ascending branches, more or less interlacing, and terminating in a mass of divaricating branchlets. Branchlets rather long and sometimes pendulous at the tips, free and not interlacing, often arising in whorls of three or four, but also singly thinner and less rigid than in *P. divaricatum*. Young branchlets with numerous white appressed hairs. (Type form: Pl. 12, fig. 1.)

It is doubtful whether *P. lineare* can be credited with any distinct shade form. A specimen from Koromiko growing in dense shade has somewhat narrower leaves than those in the open, but this trivial difference is probably not distinctive. Leaves on the young branches alternate, linear, later becoming fascicled at the tips of arrested branchlets, shortly petioled, petioles 2-3 mm. long, blades 1 cm.-1.5 cm. long, 1.5-2 mm. wide, linear, but usually slightly broader at the tips, margins usually entire, slightly recurved or flat, rarely with an occasional slight suggestion of a lobe, tips somewhat rounded, more rarely acute, midrib distinct below, indistinct above, venation obscure and lamina somewhat coriaceous. Specimens may sometimes be found which show considerably more lobing or incision of the leaves.

*β Flowers and Fruit.*

Inflorescence, solitary, sessile, terminating short arrested branchlets, or terminal on the young branches. Flowers fragrant, 5-7 mm. long. At the base of the peduncle is a whorl of woody scales, bearing within their circle several marginally ciliated almost membranous bracts, similar in shape to the sepals. Peduncles short, 3-5 mm. in length, pubescent. Sepals 5, linear lanceolate, acuminate, pale straw coloured, minutely ciliated on the margins, almost scarious. Petals 5, dark purple, valvate, claw 4-5 mm. long, limb recurved, tube narrow. Stamens 5, filaments dark purple, tips of the anthers reaching to the top of the corolla tube. Style usually shorter than the stamens, pale purple, ovary scarcely exceeding the style in length, pale straw coloured, glabrous.

Fruits usually two valved, solitary, valves somewhat woody, 4-5 mm. long and broad, apiculate, granulate, seeds sticky, usually 2-5. One specimen, not otherwise different, has capsules with the number of valves varying from two to five and 8 to 10 seeds. The valves in this case are thin and coriaceous.

(c) DISTRIBUTION.

Koromiko, between Blenheim and Picton—H. Jenkins.

Pelorus Valley—F. H. Macmahon.

As we have endeavoured to show that the seedling forms often provide the best material for discrimination, we tabulate underneath their chief characters.

VI. SEEDLING FORMS COMPARED.

(Pl. 10, figs. 1-3; pl. 13, figs. 1-3; pl. 14, figs. 1-4.)

<i>P. anomalum.</i>	<i>P. divaricatum</i> *	<i>P. crassicaule.</i>	<i>P. lineare.</i>
<i>Cotyledons:</i>			
3-4 in a whorl, shortly petiolate, 12-15 mm. long 2 mm. broad, linear margins entire, more rarely with one or two notches, ciliate.	3-4 in a whorl, shortly petiolate, $\pm$ 8 mm. by $\pm$ 3 mm., linear oblong, margins entire or waved, ciliate, rarely minutely dentate.	3-4 in a whorl, shortly petiolate, $\pm$ 10 mm. by $\pm$ 5 mm. at greatest breadth, ovate in outline, usually irregularly pinnatifid or pinnatisect, bearing 4-6 linear lobes or teeth on each side, not ciliate.	3-4 in a whorl, shortly petiolate, 10-12 mm. by 1-2 mm., linear, margins waved and with one or two notches on each side, ciliate.
<i>First Leaves:</i>			
Similar to cotyledons, but rather longer and broader, with 5-8 serrations on each side, which often bear a secondary notch on the lower side.	Shorter and broader than the cotyledons, pinnatifid, bearing on each side 2 or 3 lobes sharply toothed at the apex.	Similar to the cotyledons, but more deeply pinnatisect, the pinnules often bearing secondary teeth with up to 5 lobes on each side.	Rather variable, usually similar to the cotyledons, but bearing on each side 1-3 teeth or lobes, which are usually opposite.

VII. ARTIFICIAL KEY TO THE SPECIES.

- A. Mature capsules with normally only one ripe seed. *P. anomalum*
- " " " " at least several
- ripe seeds. .. .. . B
- B. Flowers white to pale purple. .. .. *P. obcordatum*
- Flowers dark purple. .. .. C
- C. Mature capsules with 7-12 ripe seeds. .. .. *P. rigidum*
- " " " fewer ripe seeds. .. .. D
- D. Mature capsules carunculate. .. .. *P. crassicaule*
- " " not carunculate. .. .. E
- E. Leaves in mature plant uniformly linear and almost invariably entire, up to 15 mm. long. *P. lineare*
- Leaves in mature plant of two kinds; either linear-obovate to obovate or irregularly lobed. .. .. *P. divaricatum*

\* This has been described and figured by Cockayne (1899, p. 362, pl. xxx, fig. 4). Further notes are given later (Cockayne, 1901, pp. 265-266). Here the plant appears under the name *P. rigidum*.



## VIII. GENERAL CONCLUSIONS.

All the species discussed, with the exception of *P. lineare*, show great polymorphy of habit and leaf form. Exposure to the sun tends to produce entire leaves, and to shade, leaves variously pinnatifid, lobed, and toothed. Harsh conditions may tend to produce the fastigiate form, as in *P. rigidum*, *P. divaricatum*, and *P. crassicaule*, but they do not always do so. In the full sun, *P. anomalum* becomes prostrate and *P. divaricatum* bushy. Bare stems are produced chiefly in dense shade, the basal branches dying off. The differences in seedling and juvenile forms show different genetical constitutions, and are probably more permanent under all circumstances than leaf and growth form, but only cytological investigation and further garden study of the large variety of forms included in this paper, together with field work in widely separate localities, will enable us to allocate with any certainty the various genophenes to their correct genotypes. However, the preliminary work described here should provide field botanists and others with a sufficient amount of material to enable them to do further investigation. At present it appears that:—

1. *P. obcordatum* is a rare and disappearing species, at one time perhaps widespread, with two distinct local forms and a possible third form, the type, which may be extinct.

2. *P. rigidum* is a widespread and plentiful plant with at least two converging forms which may be genotypically distinct. Under some circumstances, it produces growth and leaf forms resembling those of *P. divaricatum* and *P. crassicaule*.

3. *P. divaricatum* is also widespread and abundant on inland river banks and neighbouring hills, and shows much polymorphy, and can adapt itself to many varying conditions, except extreme sunshine and drought.

4. *P. lineare* is less polymorphic than the others, and grows, so far as is known, at lower altitudes than they.

5. *P. anomalum* is a distinct and remarkable species, so far known only from a few plants in two localities. It is quite possible that it may have been seen elsewhere, and confused with some form of *P. divaricatum*, as was done at Arthur's Pass by previous observers. We have seen one specimen from the Hawdon River, in the Dominion Museum, collected by A. Wall, which may be *P. anomalum*, but it was too fragmentary for certain identification.

*P. anomalum* differs from all other species of *Pittosporum* in its reduced capsule with usually only a single non-mucilaginous seed. It is obviously thus allied to the genus *Bursaria*, and it or its ancestors may possibly have entered New Zealand from the north with the Austral-Malayan migration. It does not seem probable that it was developed in New Zealand from any known species, or from any species similar to those at present here.

6. *P. crassicaule* is, on the whole, a well-marked species, probably fairly closely connected with *P. divaricatum* and *P. rigidum*. It has, however, a remarkably distinct seedling and juvenile form, but the

mature form is very constant in exposed sub-alpine situations. It is much less polymorphic than *P. divaricatum* or *P. rigidum*.

Specimens of the new species have been placed in the Canterbury Museum. It has been impossible to identify all the forms collected, and other species probably remain to be isolated.

IX. GENERAL DISTRIBUTION OF THE NEW ZEALAND SPECIES OF *PITTOSPORUM*.

Cheeseman (1914, l.c., pl. 15) states, "The northern distribution of *Pittosporum* is noteworthy. Out of the nineteen species found in New Zealand, nine are endemic in the North Island, two are confined to the South Island, and seven are found in both islands. Only four are found south of Banks Peninsula. The genus does not extend to the Chatham Islands, and only one species occurs in the Kermadec Islands."

These figures will now have to be somewhat modified in terms not only of the new edition of Cheeseman, but of this paper. Further, the senior author has found *P. Kirkii* in the neighbourhood of Karamea, in the South Island. We have now twenty-seven species to be dealt with, which may be arranged as follows:—

Three Kings Islands .. .. .	1
Common to North and South Islands ..	10
North Island only .. .. .	12
South Island only .. .. .	4 (1)

This includes *P. reflexum* as a distinct species.

The amount of endemism in the South Island is somewhat increased, and also the ratio of the number of species in the South Island compared with the number of species in the North; but the northern distribution of *Pittosporum* is still noteworthy.

We have to thank many fellow-workers for assistance by contribution of specimens and in other ways. Amongst these we would mention the late Dr L. Cockayne, F.R.S., Dr H. H. Allan, Miss L. M. Cranwell, Mr F. G. Gibbs, Miss E. M. Heine, Mr W. Martin, Miss L. B. Moore, Mr G. O. K. Sainsbury, Miss H. Jenkins, and Mr B. E. V. Parham.

GLOSSARY.

1. *Genotype*: Theoretically a unitary type, defined by its hereditary characters. This term corresponds fairly closely to the term Jordanon (*sensu* Cockayne).

2. *Coenospecies*: The sum total of the possible combinations, in a compound genotype, a Linnaean species.

3. *Ecotype*: A type, designated by hereditary characters, confined to a distinct habitat, and closely resembling similar genotypes in other habitats.

4. *Genophene*: A particular reaction form of a genotype, corresponding to epharmone (*sensu* Cockayne).

5. *Phenotype*: The plant as defined by its somatic characters. The phenotype may include one or more genophenes.

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## LIST OF PLATES AND FIGURES.

- Where no magnification, the dimensions are shown by a 30 centimetre rule.
- PLATE 8.—Seedling forms of *P. obcordatum*. Figs. 1 and 2.—7 months old from Kaitaia.  $\times 2$ . Fig. 3.—Younger specimen from Wairoa.  $\times 2$ .
- PLATE 9.—*P. crassicaule*. Fig. 1.—Type plant from Arthur's Pass. Fig. 2.—Branch with capsules from Waiho.  $\times 1\frac{1}{2}$ . Photo, A. Bathgate.
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Fig. 2

Fig. 3

Fig. 1

Seedling forms of *P. obcordatum*.

Figs. 1 and 2.—7 months old from Kaitaia;  $\times 2$ .  
Fig. 3.—Younger specimen from Wairoa;  $\times 2$ .



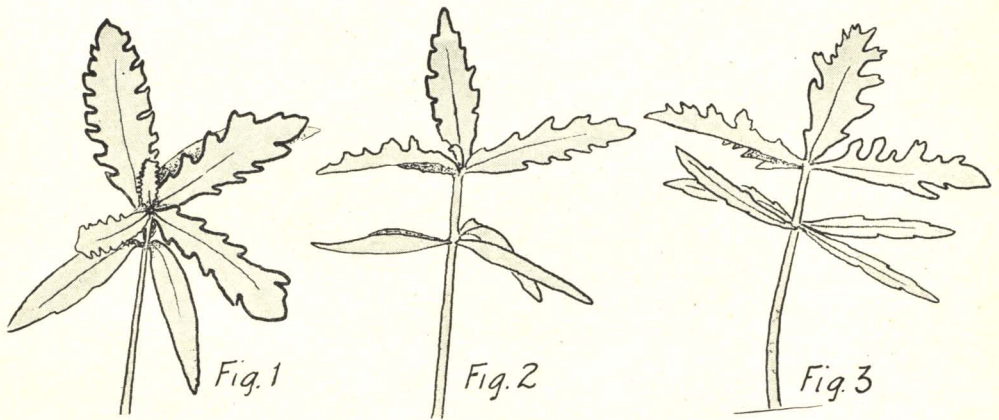


Fig. 1.—*P. crassicaule*: Type plant from Arthur's Pass.



Fig. 2.—*P. crassicaule*: Branch with capsules from Waiho;  
 $\times 1\frac{1}{2}$ . —Photo, A. Bathgate.

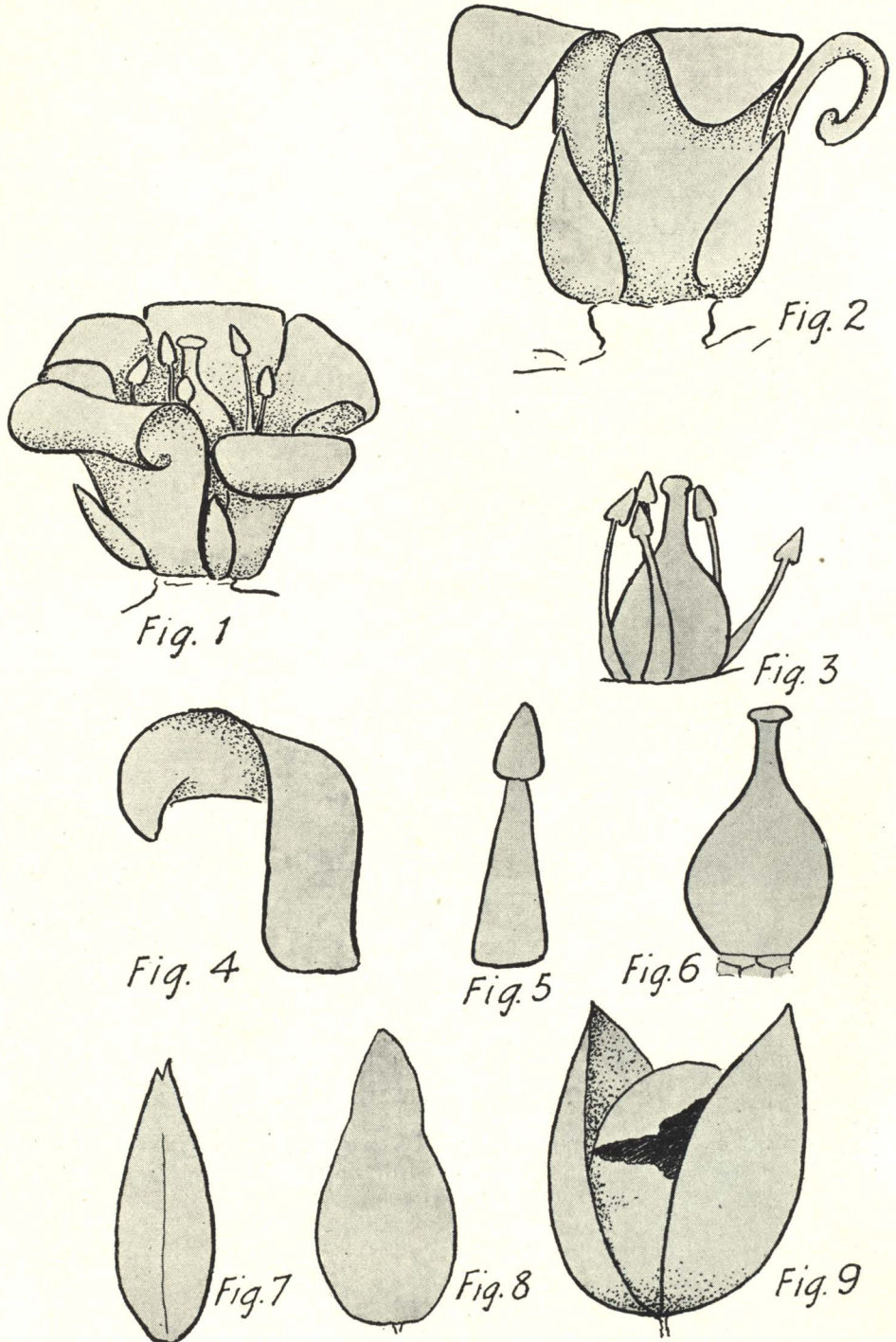




Figs. 1, 2, and 3.—*P. anomalum*: Seedlings;  $\times 4$ .



Fig. 4.—*P. anomalum*: Type plant at Arthur's Pass.



*P. anomalum*: Flower and fruit.

Figs. 1 and 2.—Complete flowers;  $\times 8$ . Fig. 3.—Stamens and pistil;  $\times 8$ .  
 Fig. 4.—Petal;  $\times 16$ . Fig. 5.—Stamen;  $\times 16$ . Fig. 6.—Pistil;  $\times 16$ . Fig.  
 7.—Sepal;  $\times 16$ . Fig. 8.—Green fruit;  $\times 10$ . Fig. 9.—Ripe fruit, showing  
 papery covering of solitary seed;  $\times 10$ .



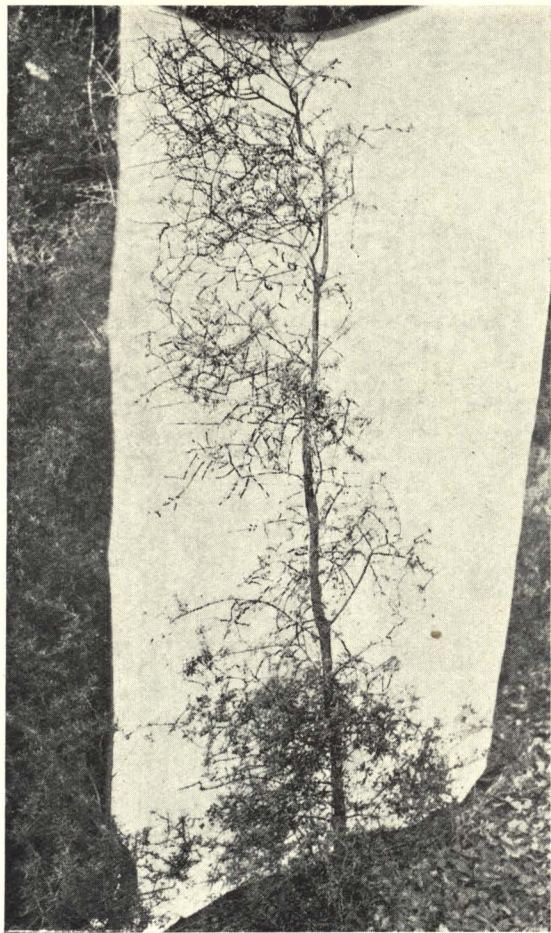
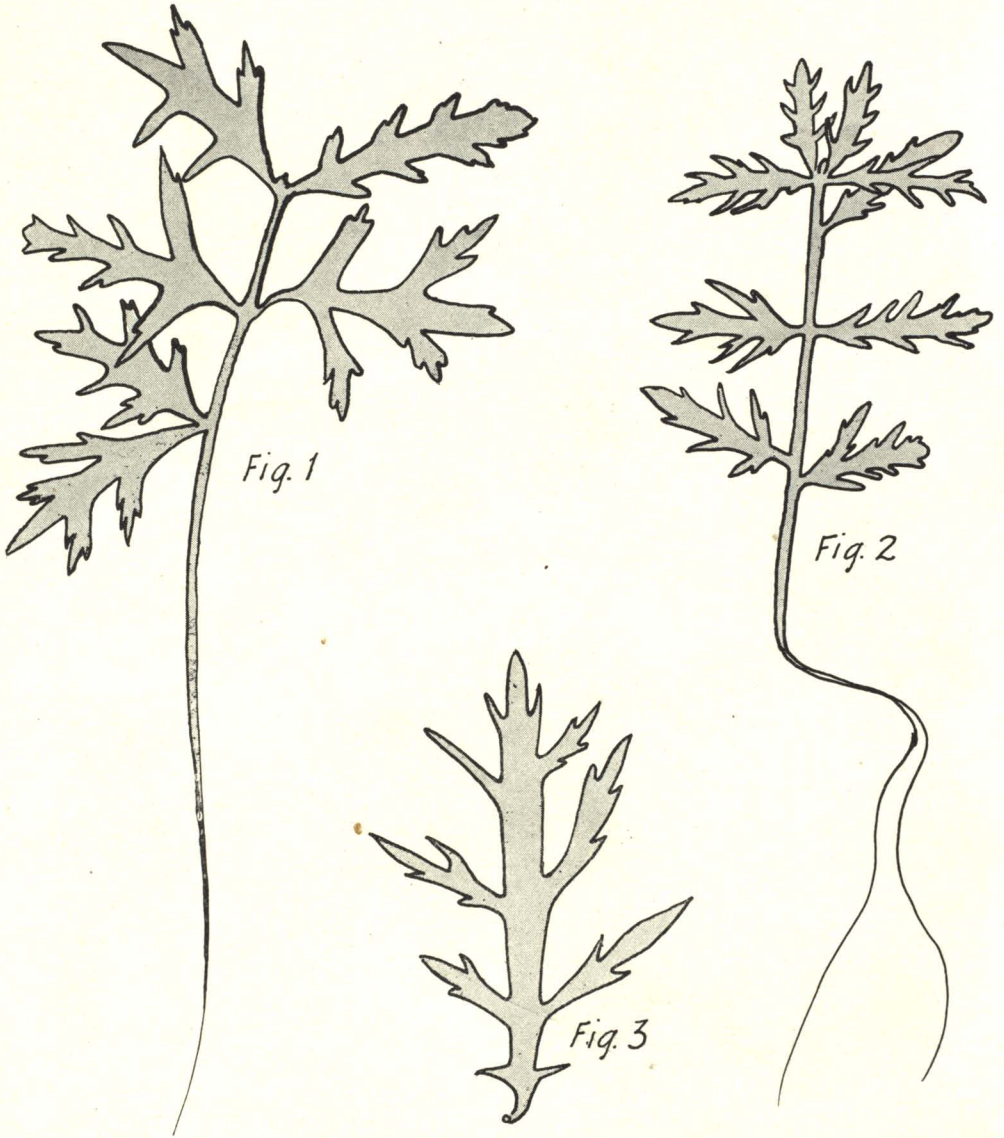


Fig. 1.—*P. lineare*: type plant at Koromiko to show growth form;  $\times \frac{1}{20}$ .



Fig. 2.—*P. rigidum*: branch of type form from Mount Hikurangi.





*P. crassicaule.*

Fig. 1.—Seedling;  $\times 6$ . Fig. 2.—Seedling;  $\times 4$ . Fig. 3.—Leaf of seedling;  $\times 10$ .



*P. lineare.*

Fig. 1.—Seedling;  $\times 4$ . Figs. 2 and 4.—Juveniles with lobed leaves;  $\times 4$ .  
Fig. 3.—Juvenile with entire leaves;  $\times 4$ .