

Genus *Pimelea* (Thymelaeaceae) in New Zealand 1. The taxonomic treatment of seven endemic, glabrous-leaved species

Colin J. Burrows

To cite this article: Colin J. Burrows (2008) Genus *Pimelea* (Thymelaeaceae) in New Zealand 1. The taxonomic treatment of seven endemic, glabrous-leaved species, *New Zealand Journal of Botany*, 46:2, 127-176, DOI: [10.1080/00288250809509760](https://doi.org/10.1080/00288250809509760)

To link to this article: <http://dx.doi.org/10.1080/00288250809509760>



Published online: 18 Feb 2010.



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



Article views: 547



View related articles [↗](#)



Citing articles: 10 View citing articles [↗](#)

Genus *Pimelea* (Thymelaeaceae) in New Zealand 1. The taxonomic treatment of seven endemic, glabrous-leaved species

COLIN J. BURROWS

School of Biological Sciences
University of Canterbury
Private Bag 4800
Christchurch 8140, New Zealand

Abstract The nature and taxonomic history of the Australian and New Zealand shrub genus *Pimelea* are summarised, emphasising its manifestations in New Zealand. Five previously recognised glabrous-leaved *Pimelea* species are redescribed here and typified: *P. longifolia*, *P. gnidia*, *P. buxifolia*, *P. traversii*, and *P. poppelwellii*. *Pimelea crosby-smithiana* is merged, without any formal status, into the otherwise variable *P. gnidia*. Two new subspecies are defined for *P. traversii*: subsp. *boreus* and subsp. *exedra*. This group of species constitutes a distinct subunit in New Zealand *Pimelea*.

Two new glabrous-leaved species are described: *P. actea* from coastal Manawatu-Wanganui, and *P. telura* from Three Kings Islands. They are not closely related to each other or to any of the five species considered above. A notable common feature of *P. actea* and *P. telura* is possession of only bisexual flowers, whereas other New Zealand *Pimelea* species that have been closely examined are gynodioecious. *P. actea* is now very rare and in serious danger of extinction, and a major conservation effort to save it is recommended. *P. longifolia* is also under threat and needs conservation in the Auckland City area.

Hybridisation is rife between *P. longifolia* and *P. gnidia* but unaffected populations are present where their distributions do not overlap (locally, or on a geographic scale). Some hybrids are also present in places where one or another parent is no longer present. Attempts are made to explain these anomalies. The numerous hybrid forms are given no formal status. Hybridisation is not known between

other members of this group. A few putative hybrids are recorded between *P. traversii* and representatives of other *Pimelea* subgroups, and between each of *P. actea* and *P. telura* and at least one other *Pimelea* taxon.

Keywords Thymelaeaceae; *Pimelea*; New Zealand; Australia; taxonomic history; Cook's voyages; defining characters; glabrous leaves; gynodioecy; bisexuality; hybridisation; new taxa; conservation

INTRODUCTION

This introduction is the preamble to an overall revision of New Zealand *Pimelea* as well as to the present article. *Pimelea* (Sol. ex Gaertn., nom. cons.) is an Australasian genus in the family Thymelaeaceae (which has about 45 genera, spread through tropical and temperate parts of the world). The subfamily Thymelaeoideae, into which *Pimelea* is placed, has wide distribution of its representatives, including species in the well-known genus *Daphne* and less familiar but species-rich *Daphnopsis*, *Gnidia*, and *Wikstroemia* (Ding Hou 1960; Rye 1990; Herber 2003; Heywood et al. 2007).

The generic name *Pimelea* arises from the Greek *pimele* (fatty), referring to oily seeds or cotyledons or glossy leaves. It is used here in a restricted sense, following Rye (1990). This excludes annual herbs now placed in the genus *Thecanthes*, of Malesia and northern Australia. The common name often applied to the family Thymelaeaceae is “daphne” after a genus from which species with pleasantly perfumed flowers have been developed as temperate zone garden cultivars. In New Zealand, *Pimelea* species are sometimes called “New Zealand daphne”. In Australia they are called “rice flower” or “banjine”.

The 19 species of *Pimelea* (all endemic) presently recognised from New Zealand (Allan 1961; Burrows 1962; Parsons et al. 1995) range from small, prostrate shrublets or longer stemmed decumbent shrubs, to erect shrubs, up to about 2 m. In Australia the more than 90 species of *Pimelea* include a similar

range of forms, with some shrubs 3 m or more tall and some perennial, suffruticose plants.

Most species of *Pimelea* found in Australia are endemic to the continental mainland and adjacent islands. Six are endemic to Tasmania and one to Lord Howe I. (Rye 1990, 1999). Records of *P. laevigata* (= *P. prostrata*) from Norfolk I. were shown to be incorrect by Green (1990). *Pimelea arenaria* lives on mainland New Zealand and the Chatham Is. Other species occur on islands near the New Zealand mainland.

Much greater floral and vegetative diversity in *Pimelea* is evident in Australia than in New Zealand. Rye (1990) placed *Pimelea* species into seven sections. According to her scheme, Section *Pimelea* contains the New Zealand species and about 20 Australian species, some spread widely over the continent but most concentrated in Tasmania or eastern Australia. Some New Zealand species of *Pimelea* do not fit well with this infrageneric classification, and it is not used here.

Some New Zealand members of the genus are relatively easily recognised but others are difficult to distinguish. From the very beginning of scientific study of *Pimelea*, with the Banks and Solander collections made during Cook's first voyage to New Zealand in the *Endeavour* (1769/70), and the Forster collections made on Cook's second voyage, in the *Resolution* (1773/74), there has been confusion about definitions and species boundaries. It is apparent from later Flora treatments by Hooker (1853, 1867), Cheeseman (1906, 1925), and Allan (1961) that they too were puzzled by the variability of some of the New Zealand entities.

Colenso described 13 *Pimelea* species in the late 19th century. None of these was retained formally at species rank by Allan (1961) (the most recent comprehensive treatment). One of Colenso's species (*P. microphylla*) and *P. urvilliana*, described by Richard earlier in the 19th century, but not accepted by Allan, have recently been revived by New Zealand botanists (Parsons et al. 1995).

Allan's (1961) treatment of *Pimelea* left the glabrous-leaved *P. prostrata* and *P. urvilliana* species groups (with most representatives common, respectively, inland or along coasts) in a state of taxonomic irresolution. Allan clarified some hazy areas among the hairy-leaved group, however, by describing two new species. Burrows (1962) described another two hairy-leaved species. Since then the only progress towards developing a comprehensive taxonomic coverage has been as field workers, especially the late A. P. Druce, noted various entities

which appear to possess distinctive character combinations. Publications of illustrations of New Zealand woody plants by Eagle (1982, 2006) and Wilson & Galloway (1993) have covered some of these forms, which are usually identified by informal "tag" names.

Interspecific hybridisation has compounded the problems of definition of species boundaries of *Pimelea* in New Zealand. Cockayne & Allan (1934) commented on the extensive field evidence for hybrids and identified examples. A study by Burrows (1958, 1962) examined the role of hybridisation among four species in the upper Waimakariri Valley in generating variation in their populations. Long-term and profound introgression of genes of some species into others (cf. Anderson 1949) was evident. In some cases, hybrids occur between *Pimelea* species with very different phenotypes. In New Zealand, a considerable degree of uncertainty about species' identity and limits in the genus persists to this day. This is partly because some distinct entities have not been formally recognised. Also, some closely related entities need clearer resolution and there are many hybrids.

In this paper, the first in a series on taxonomic revision of the genus *Pimelea* in New Zealand, the intention is, firstly, to outline the history of the genus and then to summarise the defining characteristics of members of the genus as they are manifest in this country. As this work on *Pimelea* has proceeded, for convenience, and without necessarily implying phylogenetic connections, the New Zealand taxa have been placed in two groups: those with leaf hair and those without. It would be premature here to try to define formal infrageneric groups, or to develop a key for identification of the taxa. A full revision of the genus is needed before those matters can be dealt with.

A revised taxonomic treatment is presented here, with typification for five glabrous-leaved species, including definition of two new subspecies for one of them. These five species had been recognised by Allan (1961). Two new glabrous-leaved species are described. Some other features of the *Pimelea* species, including biogeography and conservation needs, are also dealt with.

As the state of the taxonomic structure for New Zealand *Pimelea* stands, only two of the presently recognised species (cf. Parsons et al. 1995) of glabrous-leaved taxa, *P. prostrata* and *P. urvilliana*, have been left out of this treatment. However, they are both complex and will require subdivision into several specific or infraspecific units. They and

hairy-leaved species will be covered in subsequent papers.

Since Allan's (1961) account was published, progress has been made, internationally, on understanding of the general biology of *Pimelea* (Bunniger 1972; Threlfall 1982; Rye 1990; Walsh & Entwisle 1996). In the past half century some advances have also been made in New Zealand on knowledge of morphology, ecology, floral biology, pollen, seed biology, cytology, evolution, and conservation of *Pimelea* (Burrows 1958, 1960, 1962, 2001; Moar 1993; Dawson MI 2000; Dawson & Beuzenberg 2000; Webb & Simpson 2001; Dawson PAC 2003; Clarke 2005; Dawson et al. 2005).

HISTORY OF *PIMELEA*

First use of the generic name *Pimelea* was in a handwritten, unpublished manuscript by Solander, entitled *Primitiae Florae Novae Zelandiae sive catalogus Plantarum in Eahei No Mauwe & T'avai Poenamoo* (pp. 386–388), prepared during James Cook's first voyage to New Zealand (1769/70). Banks would have been involved with the composition of the text but it is attributed to Solander (Stearn 1968). Four species were described (Table 1) and S. Parkinson, artist on the voyage, made excellent watercolour life paintings of each. The generic name was ignored by Forster & Forster, when they published their account (1776) of the botany of Cook's second voyage (1773/74), with very brief descriptions of three species (Table 2). They had had access to Banks' and Solander's named collections and manuscripts in London (Stearn 1968), but chose to publish their own generic name *Banksia* and new

specific names for the two entities that were also collected by Banks and Solander.

The younger Forster published fuller descriptions for these three (1780). The specific name of *B. tomentosa* was changed then to *pilosa* without explanation. Meanwhile, Linnaeus f. (1782) shifted the Forsters' *Banksia* species into a genus *Passerina*, otherwise African (and used *Banksia* as the generic name for some members of the family Proteaceae) (Rye 2002). Forster f. (1786) then very briefly republished those three New Zealand species, under the name *Passerina*. However, Gaertner (1788) took up Solander's name *Pimelea*. The validity of this name was eventually confirmed by a decision under the terms of the International Code of Botanical Nomenclature (ICBN No. 5467, 1988), thus, the name *Pimelea* has been conserved. The type species for the genus is *P. prostrata* (J.R.Forst. et G.Forst.) Willd. (1797), so the Forsters' specific name endures.

Other generic names (*Cookia*, *Gymnococca*) have been applied to species now placed in *Pimelea* but these are made redundant by the prior publication of *Pimelea* by Gaertner (1788). Some Australian species published under other generic names have been subsumed into *Pimelea* (cf. Rye 1990).

In the 19th century, as botanical exploration in New Zealand advanced, more New Zealand species of *Pimelea* were described, particularly by Hooker (1853, 1867) and Kirk (1880, 1894). Colenso's species were published in 1886, 1888, 1889, 1890, 1896, and 1899 but were relegated to synonymy with others, treated as hybrids, or listed as unresolved forms by Allan (1961). Other local botanists Petrie (1912, 1917) and Cockayne (1921) added further species to *Pimelea* in the early 20th century and Allan (1961) published two more.

Table 1 Original Solander manuscript (1770) and present names for four *Pimelea* species.

Solander names	Present names
<i>Pimelea villosa</i>	<i>P. arenaria</i> A.Cunn
<i>P. laevigata</i>	<i>P. prostrata</i> (J.R.Forst. et G.Forst.) Willd. <i>pro parte</i>
<i>P. axillaris</i>	<i>P. tomentosa</i> (J.R.Forst et G.Forst.) Druce
<i>P. longifolia</i>	<i>P. longifolia</i> Sol. ex Wickstr.

Table 2 Forster & Forster (1776) and present names for three *Pimelea* species.

Forster names	Present names
<i>Banksia gnidia</i>	<i>Pimelea gnidia</i> (J.R.Forst. et G.Forst.) Willd.
<i>B. tomentosa</i>	<i>P. tomentosa</i> (J.R.Forst. et G.Forst.) Druce
<i>B. prostrata</i>	<i>P. prostrata</i> (J.R.Forst. et G.Forst.) Willd.

CHARACTERS OF *PIMELEA* IN NEW ZEALAND

The information summarised below is based on examination of herbarium specimens and live plants in the field and in cultivation. Structures and some functions are covered. Terms used generally follow Stearn (1973), Threlfall (1982) (stamens), Rye (1990) (flowers, involucre), Moar (1993) (pollen), and Webb & Simpson (2001) (seeds). A few are new. Illustrations of structures are included with the taxonomic coverage.

Stem and root systems

Gross differences in sizes of shrublets and shrubs and the range of growth habits were noted above. Stems and roots of the plants have abundant bundles of phloem fibres and are difficult to break. Stem branching often takes the form of opposite pairs just beneath the terminal receptacles (i.e., is sympodial, but superficially like dichotomy). The unprotected new buds arise in axils of the second pair of involucral bracts (q.v.). These branches begin to develop when flowers are present. In many species branching is also initiated, in a less regular pattern, further down the stem and this is a major branching mode in some species. These lower lateral shoots (which may bear inflorescences at their tips) are often thin, and relatively short. In some species, however, they are stout and may become leading branches.

Internode lengths on branchlets are often regular, the lengths depending on the species and habitat conditions. Below each leaf axil is a usually smooth and hairless, often brown, sometimes black projection, the **node buttress**. It may be short or long, narrow or wide, depending on the species. In some species a pair of buttresses occupies the whole length and much or all of the width of the internode. Node buttresses are prominent, or not, on different species after the leaves have abscised. Ordinary internode bark colour on young shoots (wherever node buttress tissue is absent) is usually light brown, reddish brown, or dark brown. As stems age and grow the node buttress tissue becomes less evident and in some species peels off. Old node positions usually remain apparent, however. The bark colour changes to pale brown, grey, or in some species very dark grey or black on old stems.

Roots are usually extensively branched. Their outer bark is dull white or yellowish. In most species, roots extend deeply into the substrate. Adventitious roots may develop on stems of some prostrate or decumbent species, but vegetative proliferation by layering is unusual.

Hairs

Simple epidermal hairs varying in length, width, degree of stiffness, attitude, and density on the various organs (strigose, hirsute, villous, pilose, sericeous) are found on *Pimelea* species. They are universally present on stems, receptacles, pedicels, flowers, and young ovaries and fruits. Even on apparently glabrous stems, hairs occur in the axils of young leaves. They occur on leaves of many species. They may be shed early from stems and leaves so that species with initially sparse hair can appear glabrous.

Leaves

Leaf sizes differ markedly on different species. Some species have petioles a few millimetres long whereas in others they are much shorter and in some species the leaves are virtually sessile. The leaf laminae are simple, entire and flat, keeled, or adaxially concave. They are arranged in a decussate fashion but may appear distichous in appressed plants. In almost all species, leaves are markedly longer than they are wide. Leaf colour in some species is light green and in others medium or dark green. Many species have glaucous leaves. In some species, leaves develop a deep blue green colour when they are dried. Some species often have red leaf margins and petioles.

Midveins are often distinct on both sides of the leaves and in some species they are very prominent on the abaxial side. Several larger leaved species have an evident camptodromous pattern of lateral branch veins on the abaxial side. In small-leaved species, lateral veins are often not visible. Some species have stomata on both adaxial and abaxial leaf surfaces whereas others have none on the adaxial or abaxial surface. Leaf margins are notably thickened in some species.

Many species of *Pimelea* have glabrous leaves while others have hairy leaves. Among the latter, some have hairs on both sides of the leaf, but most species are hairy only on the abaxial side, including the tips and margins. The location of hair and degree of hair density is highly variable from species to species. For some species it may vary from region to region. A silvery-white or sometimes yellowish colour is imparted to the leaves of some species by the dense hair cover.

In some species the leaves are spread up much of the stem, while in others they are crowded (often imbricate) on younger branches and the older stems are naked. Lateral branch development ensures that older parts of the plant remain leafy in some species (especially those that are prostrate). This is true of

a few upright species, also. Leaf persistence for at least some species is for 2 yr or more.

Involucre and inflorescence

The young inflorescences, terminal on branchlets, are protected by two pairs of very close-set leaf-like organs, the involucre bracts. On some species a gradient of increasing leaf size can be perceived up a flowering branchlet, and there is no sharp differentiation between the highest leaves and the bracts proper. However, on other species, the bracts are markedly wider than the leaves below them. Bracts are often sessile or nearly so.

Inflorescences are highly condensed racemes with few (1–8) to many (up to 30) crowded flowers on short, hairy pedicels (<0.5–2.0 mm long, on different species). The receptacles are usually slightly wider than the branchlet stems, with a flat or very slightly convex and very hairy summit.

Flowers

Pimelea flowers have actinomorphic hypanthia (or “flower tubes”). Each is a narrow, trumpet-shaped organ (with a hair-covered outside) that surrounds the gynoecium. Hairs may also occur internally. Hypanthia are derived from fused axis, corolla, calyx, and filament tissues (Bunniger 1972). The base of each is often inflated and more or less fusiform, especially in female flowers. This lower part of the hypanthium is termed the **ovary portion**. The **style portion** is the narrower tube above it, usually long in male or hermaphrodite flowers, short in females.

Flower tube colour in New Zealand is white, creamy white, or, in some species, occasionally white tinged with rose pink. Some species have flowers with red ovary portions and the red colour may extend to the lower part of the style portions. The ovary portion contains the effectively monocarpellate, single-ovuled, superior, sessile ovary, usually hairy at its summit and with the style inserted slightly to one side of, and lower than, the summit. According to Heinig (1951), initially the ovary contains two carpels, but only one of these develops.

At the top of each hypanthium, two imbricate pairs of petaloid, often glistening calyx lobes open, usually in salverform fashion; in some species they are ascendant. No separate corolla is evident. Hermaphrodite flowers each have two, near-basifixed stamens, with filaments inserted at or below the mouth of the tube, opposite the outer calyx lobes. The stamens usually project beyond the mouth of the tube, and the yellow to reddish-orange anthers dehisce inwards (introrse) or to the sides (latrorse).

A broad connective lies at the back of introrse anther lobes. In species with latrorse dehiscence a narrow connective lies between the lobes. Intermediate conditions are known (Threlfall 1982). Here, these will be termed semi-latrorse.

Most New Zealand *Pimelea* species that have been closely examined are gynodioecious (Burrows 1960, 2001 and unpubl. data). In such species many plants in a population have functional female flowers with short tubes, small calyx lobes, sterile staminodes, relatively wide ovaries, initially relatively short styles (as long as the tube or eventually longer), and relatively wide stigmas bearing long, simple papillae. The remainder of the plants in the population have structurally bisexual (hermaphrodite) flowers with functional stamens, slimmer ovaries, and longer tubes with larger calyx lobes. Their styles are often eventually very long and stigmas narrow, with very short papillae. These hermaphrodite flowers have often been referred to as males by earlier authors (e.g., Allan 1961). For *P. longifolia*, Cheeseman (1914, pl. 172) showed three flower types, female, male, and hermaphrodite, but did not indicate whether or not these were from separate plants. Close observation of several other species shows that, although the ovaries of some such flowers in a head abort when their styles are very short (and are functional males), some other hermaphrodite flowers in the same head can be found bearing fruits with full seeds. Within days of opening, the styles of both hermaphrodite and female flowers in gynodioecious species extend beyond the mouth of the flower tube.

The seed-producing capability of hermaphrodite flowers of several New Zealand *Pimelea* species has been proved experimentally (Burrows 1960; Dawson et al. 2005). A further complication is that Burrows (1958) noted ostensibly hermaphrodite plants of *P. oreophila* and *P. sericeovillosa* producing a few female flowers late in the flowering season. Dawson et al. (2005) also found mixed-sex flower heads on *P. arenaria*. The term **gynodioecious** is used here for species with structurally female and hermaphrodite flowers on different plants and at least some of the latter having their ovules fertilised and producing viable seeds.

Two species with only bisexual flowers, all capable of producing seeds (this paper), are known so far in New Zealand. They have relatively short flower tubes. Their stigmas have intermediate lengths of stigma papillae relative to those of females and hermaphrodites of gynodioecious species.

Flowering times vary for different species but most flower in spring to early summer. Other species

have long-extended flowering periods, or several flowering episodes in a year.

Pollen and pollination

Pollen grains of *Pimelea* appear to vary in size from species to species but their morphology seems similar (Moar 1993; C. J. Burrows unpubl. data). The grains are spherical, apolar, and periporate (c. 30 recessed pores). The evident ectexine is arranged in a regular, stellate pattern of triangular suprategal processes (Moar 1993, p. 47, pl. 21).

Pollination of flowers in some New Zealand *Pimelea* species is by solitary bees, a range of flies, including syrphids, and butterflies and moths (Burrows 1960; Dawson et al. 2005). Nectar is produced internally near the base of the flower tube, and the flowers are pleasantly fragrant. The hermaphrodite flowers are protandrous, so that cross-pollination is usual. However, selfing of some hermaphrodite flowers has been demonstrated for some species and may occur in others; the anthers are close to the stigmas as the flowers mature (Burrows 1960). The likely role of long-tongued moths as pollinators of the longer flowered *Pimelea* species in New Zealand is uninvestigated.

Fruits and seeds

After fertilisation the ovaries of most New Zealand *Pimelea* species develop into succulent, drupe-like fruits. Their pericarp colours are red, orange, yellow, white, or black. Other species have dry, achene-like fruits that are first green then become brown. The flower tubes of nearly all New Zealand fleshy-fruited species break off irregularly as the fruits swell and ripen. In many plants of three New Zealand species—dry-fruited *P. gnidia*, fleshy-fruited *P. tomentosa*, and an undescribed species from Mt Manaia in North Auckland—there is a regular zone of weakness between the style and ovary portions of the hypanthium where the upper tube eventually breaks off and is shed. This circumscissile feature is found commonly in Australian *Pimelea* species. The old hypanthia remain in place in most dry-fruited species and become dry and brown. They appear to disperse with the seeds inside them.

Pimelea seeds, attached basally, are narrowly ovoid in shape, pointed at the distal end, and covered by a thin, fragile layer of endocarp tissue. A thickened strip of endocarp, the **crest**, lies longitudinally down the ventral side of the seed. It may extend as a **hook** at the summit end of the seed and a **tail** at the base. The seeds proper have black, shining outer coat surfaces with a reticulate cell pattern and a

single, central pit in each cell (Threlfall 1982; Webb & Simpson 2001). At the apex, seeds of different species have either a blunt point or a blunt lateral extension or pointed hook.

Seed dispersal is not well understood for New Zealand *Pimelea* species. It is likely that fleshy fruits are swallowed by birds (including seabirds for coastal species), but this has not been observed (Burrows 1958; Dawson et al. 2005). Some species may have their seeds dispersed (over short distances) by lizards (Whitaker 1987; Wotton 2002). Wind is the probable agent of dispersal for seeds of dry-fruited species.

Chromosomes

Few counts are available from New Zealand. The base number is $n = 9$ and the lowest number recorded is $n = 18$. Meiotic counts were obtained from anther pollen mother cells and mitotic counts from root tips. Five species listed among those presently recognised and one unresolved form yielded $n = 18$, while $2n = 36$ has been recorded for one presently recognised species and five unresolved forms. Only two counts of $2n = 72$ are known so far (Rattenbury 1957; Burrows 1958; Beuzenberg & Hair 1983; Dawson & Beuzenberg 2000). Higher levels of ploidy are suspected to occur in some taxa (M. Dawson pers. comm.).

Other features of New Zealand *Pimelea*

Toxicity

One form of the *P. prostrata* complex, “Strathmore weed”, is known to have poisoned horses and cattle in New Zealand (Connor 1992). Irritants and carcinogens were identified from *P. prostrata* by Zayed et al. (1982).

Parasites and predators

Scale insects (Hemiptera: Eriococcidae; Coccidae) are often found on the stems of *Pimelea* plants. Black bark on some species appears to be caused by a sooty mould living on the excreta of these animals. Witches broom galls formed on *Pimelea* plants are infested by tiny mites (Acarina: Eriophyidae) which attack the growing tips of branchlets. The plants are stimulated to form small, fasciculate, thin-stemmed and small-leaved clumps by these animals. Unthrifty plants are usually the result of combined effects of the mites and scale insects. Leaf-eating caterpillars, the larvae of unidentified moth species, have often been seen on *Pimelea* plants (cf. Burrows 1958).

Uses

Fibrous tissue of *P. arenaria* stems was used by Maori to make strips of fabric to fasten their hair. The fruits were also eaten (Hooker 1867). One of the names of this species was autetaranga, suggesting a connection with a similar use of bark of aute (*Broussonetia papyrifera*, paper mulberry). The latter had been brought to New Zealand from Hawaiki by emigrating Polynesians, but did not thrive here. *Pimelea urvilliana* and *P. prostrata* also are recorded as having been used to make fabric strips (Hooker 1867).

Horticultural use is made of New Zealand plants from the genus, in New Zealand and Europe. In this country prostrate species are used for ground cover and upright species in low, open shrubberies. *Pimelea* species are not easily transplanted. Seeds of some species are slow to germinate. Cuttings can be struck from young wood, using rooting hormone. The often showier Australian *Pimelea* species are grown in gardens in Australia and New Zealand.

Some possible pharmacological materials from *Pimelea* include antineoplastic agents from *P. prostrata*, identified by Pettit et al. (1983). A very toxic potential anti-HIV compound, *prostratin*, has been extracted from *P. prostrata*. Preliminary work has not been followed up (N. Perry pers. comm. 1994).

CONCEPTS AND METHODS

Approach to species definition

The taxonomic revision of *Pimelea* in New Zealand, of which this paper is the first instalment, elaborates on the treatment of the genus by Allan (1961). Allan's account recognised 15 species, left some species untypified, did not cover Colenso's numerous species descriptions in detail, and, in footnotes, listed a host of unresolved forms, including two that had been validly described as species in the 19th century and that have since been revived (cf. Parsons et al. 1995).

The chief objective of the present work has been to obtain sets of data on as many clear-cut characters as possible (Table 3), and use them to develop a comprehensive classification of the genus as we know and understand it today. The main method used was examination of herbarium specimens from local and some overseas collections, and high quality photographs of critical specimens from overseas, to extract data on qualitative and quantitative features of the plants. Wherever possible, live plants in wild

populations or in cultivation were also examined. Species were defined by their consistent possession of distinctive combinations of readily observed characters. The most useful character states for this purpose are listed in Table 3.

A widely accepted criterion for establishing plant species boundaries is the presence of reproductive isolation between entities (Mayr 1982; King 1993). However, in the genus *Pimelea* in New Zealand, there are many instances of hybridisation, often between forms that are phenotypically disparate. From distributions in areas where habitats are still relatively intact it is usually possible to discern that the sets of morphological differences must have evolved when the forms grew in distinct habitats and were physically separated (particularly by the presence of dense forest, uninhabitable by the low-growing *Pimelea* species). Within the past 800 yr, gross disturbance of the landscape, especially through volcanism (Wilson & Houghton 1993; McFadgen 2007) and removal of large tracts of forest by human intervention, especially with fire (Molloy et al. 1963; McGlone 1983; McGlone et al. 1994), has allowed different *Pimelea* "morphospecies" to meet. Where breeding barriers were incomplete, small-scale or in some cases large-scale hybridisation has occurred.

The Ecogenetic Species Concept of Levin (2000) has been used as a guiding principle during the present work. Major relevant points are that species are ecologically and genetically distinct through evolutionary divergence and occupy different niches by differing, for example, in tolerances of habitat conditions, in the timing of vital processes such as growth spurts, flowering, and in various other reproductive phenomena such as pollination, fruit maturation time, and seed dispersal. Genetic differences are usually manifest in the morphology of the species, and there are often at least partial genotypically based barriers to interbreeding. Hybrids are often infertile. In instances where interbreeding barriers are incomplete, however, partially or totally fertile hybrids may occur.

The Ecogenetic Species Concept is flexible enough to encompass hybridisation and introgression as normal processes which are compatible with what we understand of the ways in which species evolve. Morphospecies that potentially can or actually do hybridise with others are not excluded from having species status.

It is important to realise that species defined purely in terms of morphologic criteria are not the same as ecogenetically defined species (which require experimental investigations for their validation).

Nevertheless, morphologically determined species can be close to if not identical with those determined, for example, by biosystematic or molecular methods. Field evidence of presence or lack of hybridisation often provides support for morphologically defined sets of species. Geographic patterns of distribution and local habitat preferences also provide valuable background to species boundary determinations.

Footnotes in Allan's (1961) treatment of *Pimelea* list many previously described varieties that he did not accept. Close scrutiny shows that these are of several fundamental kinds. Some are hybrids; others are morphological variants based on one or a few character differences from the typical species; others have distinct form and habitat at infraspecific level; and a few are distinct species.

In the present work the category subspecies is used for forms with strong resemblance to the usual form of the species, but with some distinct morphological features. They may live in the same region as the usual form but in distinct habitats, or occupy their own separate geographical ranges. This concept of the subspecies category is in keeping with the view that continuing evolution may be occurring in portions of a species and, in due course, might give rise to new species (Levin 2000).

A problematic situation for taxonomic treatment, even when using the flexible Ecogenetic Species Concept, is the case of species (facultative outbreeders in *Pimelea*) that occupy wide areas and, from population to population, possess variable, apparently genetically controlled, vegetative form (e.g., in leaf size). Numerous local manifestations of this variation (that results from ecotypic developments in varied habitat conditions) may be apparent. The view taken here is that it would be unwise to try to recognise formally every small local population that in any case merges, more or less imperceptibly, with those adjoining. It is more realistic to treat such species as single, large, and variable units.

Another kind of difficulty for taxonomy of *Pimelea* is the array of phenomena that result from inter-specific hybridisation. Populations of exceedingly varied form, intermediate between the parents, can be observed in some cases. The approach taken here, reconciling this natural variation with the need to define the limits of parental morphotypes in a realistic way, is to set arbitrary limits, at least for some species pairs. These denote the boundaries between the parental species. All other intermediate forms are treated as hybrids having no formal nomenclatural recognition.

Table 3 The most useful character states for defining *Pimelea* species in New Zealand.

Growth habit (gross size, attitude of branch system—procumbent, decumbent, suberect, erect).
Hairiness of internodes of young branchlets (glabrous, or hairy, distribution and degree of hair cover).
Length of node buttresses; proportion of internode covered; degree of their prominence after leaf fall.
Spacing of leaves on young branchlets (internode length) affecting degree of overlap (none to imbricate).
Attitude of leaves (normally ascendant or patent; eventually leaves that are initially ascendant may become patent and then deflexed).
Mature leaf sizes.
Cross-section of leaf (flat; keeled; adaxially concave).
Petiole length
Hairiness of leaves (glabrous or hair only on abaxial side including margins, tip; or on both sides; degree of hair cover).
Thickness of leaves (leathery and stiff, thin and pliable).
Leaf margin thickened or not and flat, upturned or downturned.
Leaf veins clearly evident or not.
Leaf tip obtuse, acute or acuminate.
Stomata present on both sides of leaf or only on either of abaxial side or adaxial side.
Involucral bract size in relation to ordinary leaf size.
Sexual expression (gynodioecious, bisexual).
Flower sizes (both ♀ and ♂ in gynodioecious species), including sizes of calyx lobes.
Hairiness or not of inside of hypanthium.
Direction of anther dehiscence (introrse, semi-latrorse, latrorse).
Fruits dry or fleshy.
Colour of fleshy fruits.
Seed sizes, shapes.

A further manifestation of hybridisation, often deep-seated and probably of very long standing, is introgression of one or both (or sometimes three) parents with each other's genes. Some of the variation in *Pimelea* populations, spread over extensive areas, can best be explained in terms of this introgressive infiltration of species by the genes of other species. Again, arbitrary decisions are required for determining specific or possibly subspecific boundaries.

Methodological details

Plant size conventions used here for *Pimelea* plants are: **small shrub**, plant less than 10 cm tall and 25 cm wide; **medium shrub**, from 10 cm to 100 cm tall and more than 25 cm wide; **large shrub**, more than 1 m tall.

Flower, fruit, seed, and leaf morphology features were examined from live specimens wherever possible. Measurements of many morphological characteristics (leaves, bracts, seeds, node buttresses, internodes) were made from dried specimens using a stereomicroscope, clear plastic ruler, and (for small organs and seeds) a caliper. The dimensions of mature organs (stem dimensions only on young branchlets) were obtained from at least five specimens per taxon. Modal values are given for: internode lengths, node buttress lengths, pedicels, calyx lobes, fruits, seeds, and stigma width (the range, where given, is for the array of modes for the specimens examined). Modal to largest values are given for leaf and involucral bract lengths and widths, but the limits are arbitrarily set for *P. longifolia* and *P. gnidia* leaf dimensions. Largest values are given for flower tube lengths. Flower measurements are of: the full length of the tube from base of calyx lobes to base of ovary portion, the length of the ovary portion alone, and length and width of one of the largest pair of calyx lobes. They were taken either on fresh specimens or specimens that had been preserved in dilute methylated spirit or on dried specimens that had been soaked in a dilute detergent/water mixture to reconstitute their form.

Plant heights are from herbarium label records and field observations. Degree of hair cover is estimated in three classes: **dense**, covering the organ (stem or flower) so that no more than 10% of underlying tissue is visible; **moderately dense**, from 10 to 90% of underlying tissue is visible; or **sparse**, 10% or less of the surface is hair-covered. Types of hair covering are seldom stated as their classification is rather subjective. However, sometimes the terms strigose, hirsute, villous, sericeous, pilose, or tomentose may be used. Hair length is short (up

to 0.9 mm); medium (1.9 mm); or long (2 mm or more).

In referring to leaf laminae, for example in relation to hair or stomatal distribution, the term **side** is used exclusively to mean the broad leaf surfaces (adaxial or abaxial). The term **margin** refers exclusively to the edges of the leaf laminae.

Examination of live plants augmented the analyses with respect to colours and expression of features such as growth habit, anther dehiscence, and fruit sizes. Some features (including flower hair inside tube, ovary hair distribution) were examined on dried specimens that had been reconstituted when fresh specimens were unavailable. Stomatal presence or absence on leaves often could be seen at 25× or 40× under a stereomicroscope, but checks were made on all species by clearing leaves with 5% sodium hydroxide followed by 5% hydrochloric acid, then washing with water before examination.

Habitat information was gathered in the field by myself or other botanists (notes on herbarium labels). Altitudes from herbarium labels have been standardised to metric. Date formats have also been standardised. Information which I have added to herbarium specimen citations or elsewhere in the text is enclosed by square brackets.

Representative specimens from New Zealand herbaria covering the geographic ranges are cited for each taxon. Dot maps show the known distributions of the taxa. Most of the entries date from 1950 onward; a few only are from earlier in the 20th century. Some 18th and 19th century occurrences are noted in the text.

Abbreviations for authors of taxa follow Brummitt & Powell (1992). Herbarium codes follow Holmgren et al. (1990) (*Index Herbariorum*). Maslin & Cowan (1994) and McNeill et al. (2006) were used as guides for typification. The Australian Plant Name Index was used to check generic synonymy citations.

TAXONOMY

Pimelea Sol. ex Gaertn. *De Fruct. et Semin. Plant.* 1, 186 (1788); nom. cons. (I.C.B.N. 1988, No. 5467).

= *Banksia* J.R.Forst. et G.Forst. *Char. Gen. Plant.* 7, t4 (1776); and G.Forst. *Dec. Plant. Nov. ex Ins. Mar. Aust.* 171 (1780); nom. rej.

= *Passerina* L. f. *Supplem. Plant.* (1781); G.Forst. *Flor. Ins. Aust. Prodrum.* 28 (1786).

= *Cookia* J.F.Gmel. *Syst. Nat. II* (1791); nom. illeg.

= *Gymnococca* C.A.Mey. *Index Sem. Hort. Petrop.* 10, 47 (1845).

TYPE SPECIES: *P. laevigata* Gaertn. (1788) nom. illeg.
= *P. prostrata* (J.R.Forst. et G.Forst. (1776)) Willd.
Spec. Plant. 1, 1 (1797).

Small to medium-sized, sometimes tall shrubs. Branches prostrate, decumbent, or erect, mainly sympodially branched. Simple, usually white hairs on stems and flowers and on leaves of some species. Leaves with short petioles or sessile, opposite–decussate, mainly narrow to broad elliptic or ovate, acute or obtuse. Involucral bracts leaf-like and similar in size to or broader than ordinary leaves. Inflorescences condensed, one- or few- to many-flowered racemes, terminal on branchlets.

Receptacle summit flat, very hairy, pedicels short, hairy. Plants gynodioecious, with ♀ flowers markedly longer and calyx lobes larger than ♀; or all flowers bisexual in a few species. Hypanthium white or sometimes cream or faint pink with a red base; narrow, tubular style portion and shorter ovary portion, often wrinkled; very hairy outside; inside glabrous or slightly to moderately hairy. Flowers fragrant, with nectar in ovary portion. Calyx lobes four, imbricate. Stamens two; filaments inserted at or below mouth of tube opposite outer calyx lobes. Small staminodes on ♀ flowers. Ovary hairy at summit, single-loculed; ovule one. Style insertion excentric and subterminal; stigma with very short (♀) or long (♂; bisexual) simple papillae. Hypanthium persistent in dry-fruited species; irregularly breaking off at maturity in most fleshy-fruited species; circumscissile above ovary portion in some populations of a few species. Seeds ovoid to pyriform, black, covered with thin endocarp, often with a projection to one side at the apex.

1. *Pimelea longifolia* Sol. ex Wickstr., *Konig. Svenska Vetensk. Akad. Handl.* 82, 280 (1818).

= *Passerina longifolia* Sol. ex Thunb. *Mus. Nat. Acad. Upsal.* 22, 32 (1792).

TIPIFICATION: The original unpublished description of the species (Solander 1769–c. 1775, p. 388), was from specimens gathered at Tolaga Bay (where Banks and Solander were ashore between 23 Oct and 28 Oct 1769), Opuragi (= Mercury Bay) (3 Nov to 14 Nov 1769), and Sinum Admiralitatis (the sound between D’Urville I. and the mainland; the *Endeavour* was anchored in a small bay on the north-eastern side of D’Urville I. on 27 Mar 1770, just before Cook’s first visit to New Zealand ended) (Begg & Begg 1969).

The first description under the name *Pimelea* (Wickström 1818) will have used Solander’s specimen at S (G-4889) (Fig. 1) as its basis and it is chosen as the lectotype. A second specimen at S (07-3111) (Fig. 2) has a less clear attribution, though both Banks and (?G.) Forster are noted in handwriting on the reverse side of the sheet. There can be no doubt that it originated from Banks’ and Solander’s gatherings because the Forsters did not collect this species. It is regarded as a paralectotype. The Parkinson watercolour (Ic. No. 158), (Fig. 3) and engraving made from it, published in *Banks Florilegium Part 26* (pl. no. 543) show a plant of similar aspect and leaf size. A specimen at the British Museum in London (BM 894144) labelled “New Zealand, 1769–70, Banks & Solander”, has smaller leaves. All three specimens could have come from different locations.

LECTOTYPE (chosen here): Naturhistoriska Riksmuseet, Stockholm (Herbarium Alstroemer) S G-4889 Dr Solander, Nova Zelandia, 1769! (Fig. 1). [Label on obverse, by A. Dahl; herbarium name in J. E. Wickström’s hand.]

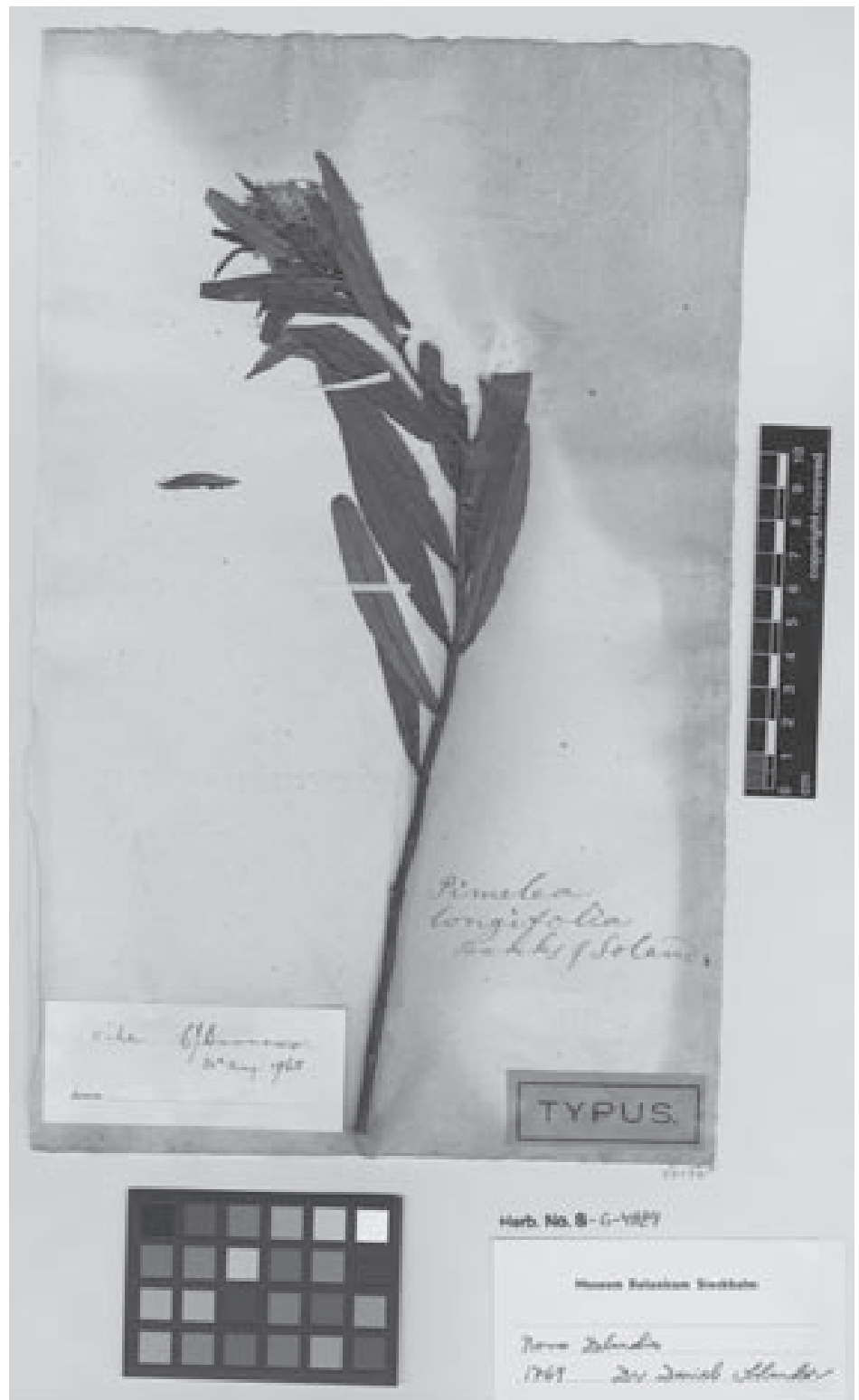
PARALECTOTYPE: (Herbarium Montin) S 07-3111 Nova Zelandia! (Fig. 2). [Label on obverse reads “Habitat in Nova Zelandia, shrub – specimen e collect. Forsterianus misit generos Baron: Dr Banks anno 1781”.]

MAORI NAME: taranga; kokomuka taranga; koromiko taranga.

DESCRIPTION: A much-branched, erect shrub up to 2 m tall. Branches and branchlets ascending, glabrous except at leaf axils and on receptacles. Node buttresses occupy whole internode, smooth, brown, sometimes prominent after leaf fall on small specimens; internodes 8–14 mm long. Bark ages to grey. Leaves decussate, in distant opposite pairs, ascending to patent or deflexed, on petioles 3–5 mm long. Lamina medium green, stiff, somewhat leathery, very variable in size and shape on the same plant; largest 40–110 × 10–22 mm, elliptic or ovate, sometimes obovate, oblong or lanceolate; flat, acuminate, base cuneate. Margins slightly thickened and downturned; midvein prominent abaxially, sunken adaxially; lateral vein pattern camptodromous; stomata on abaxial side only.

Inflorescences many-flowered; pedicels 1–2 mm long, persistent. Involucral bracts four, smaller than or sometimes the same size as largest ordinary leaves (20–40 × 8–10 mm). Plants gynodioecious. Flowers hairy on outside; inside hairless; fragrant, white or flushed rose, lower tube often red. Calyx lobes

Fig. 1 Lectotype of *Pimelea longifolia* (S-G-4889). (Image by courtesy of the Naturhistoriska Riksmuseet, Stockholm, 2007.)



open in salverform fashion. ♀ tube to 10 mm long, ovary portion 4 mm, calyx lobes 3.2×1.8 mm; staminodes short, at mouth of tube. ♂ tube to 15 mm long, ovary portion 3.5 mm, calyx lobes 5×2.5 mm. Anther filaments long, inserted at mouth of tube; anthers dehisce laterosely. Ovary densely hairy at summit. Fruits ovoid, green, drying brown, 5 mm

long. Seeds narrow ovoid, 4×1.8 mm. Flowering time spring–early summer. Dried hypanthia persist and must disperse with fruits inside. Chromosomes: $n = 18$ (Rattenbury 1957).

REPRESENTATIVE SPECIMENS: NORTH ISLAND: AUCKLAND REGION: CANU 2904 Piha, West Coast Auckland, 185 m, dry sunny bank in



Fig. 2 Paralectotype of *Pimelea longifolia* (S 07-3111). (Image by courtesy of the Naturhistoriska Riksmuseet, Stockholm, 2007.)

valley behind Piha. *G. Atkinson*, 10 Nov 1957; CHR 326923 Paremoremo Escarpment, North Shore, in open kauri, *R.O. Gardner*, 12 Jun 1978; AK 27669 Kaitarakihi Point, Huia Bay, *K. Wood*, 17 Sep 1949; CHR 321472 Summit of Mt Hobson, Great Barrier I., 615 m, “very rare now”, *J. Bartlett*, 12 Dec 1977; CHR 313448 Table Mt, Coromandel Ra,

740 m, canopy gap in forest (steep bank) *A.P. Druce*, Oct 1977; CHR 313559 Kaimai Ra, 525–615 m, *J.K. Bartlett*, Jul 1977. EAST CAPE–GISBORNE: CHR 517527 Wainahura Bay Scenic Reserve, East Cape area, open coastal forest under *Pseudopanax arboreus* and *Pittosporum crassifolium*, *P.B. Heenan*, 5 Oct 1995; CHR 11625 Panikerikeri Bluff,

Fig. 3 Sydney Parkinson water-colour of *Pimelea longifolia* (Ic. No. 160, 1770). (Image by courtesy of the Natural History Museum, London, 2006.)



Waikaremoana, forested bluff, c. 925 m, *A.P. Druce*, Jan 1954. TARARUA RANGE: CHR 132801 Te Matawai, Tararua Ra, scrub, *A.P. Druce*, Jan 1965. SOUTH ISLAND: MARLBOROUGH: CHR 416876 Southeast of Editor Hill, 1020 m [on ridge between Croisilles Harbour and Opouri tributary of Rai catchment], subalpine zone, rocky outcrop, also in nearby forest, *G.Y. Walls*, 12 Aug 1981; CHR 152789 On saddle overlooking Greville Harbour, D'Urville I., *A. Hutson*, 28 Sep 1964. NELSON—

BULLER—NORTH WESTLAND: CHR 467635 Pohara, north-west Nelson, limestone bluff, *P. Simpson*, 25 Oct 1976; CANU 12239 Pakawau Bush Rd, Westhaven Inlet in bush at river margin, *D.G. Lloyd*, 10 Dec 1967; CANU 24953 Boulder Lake, head of Aorere R., *W.R. Philipson*, 1965; CHR 313159 North of Heaphy R., 90 m, limestone cliff, *A.P. Druce*, Nov 1977; CHR 218532 South of Four Mile R., west of main highway, South of Charleston, *P. Wardle*, 12 Jan 1971; CANU 26100 Schulz Ck, western Paparoa

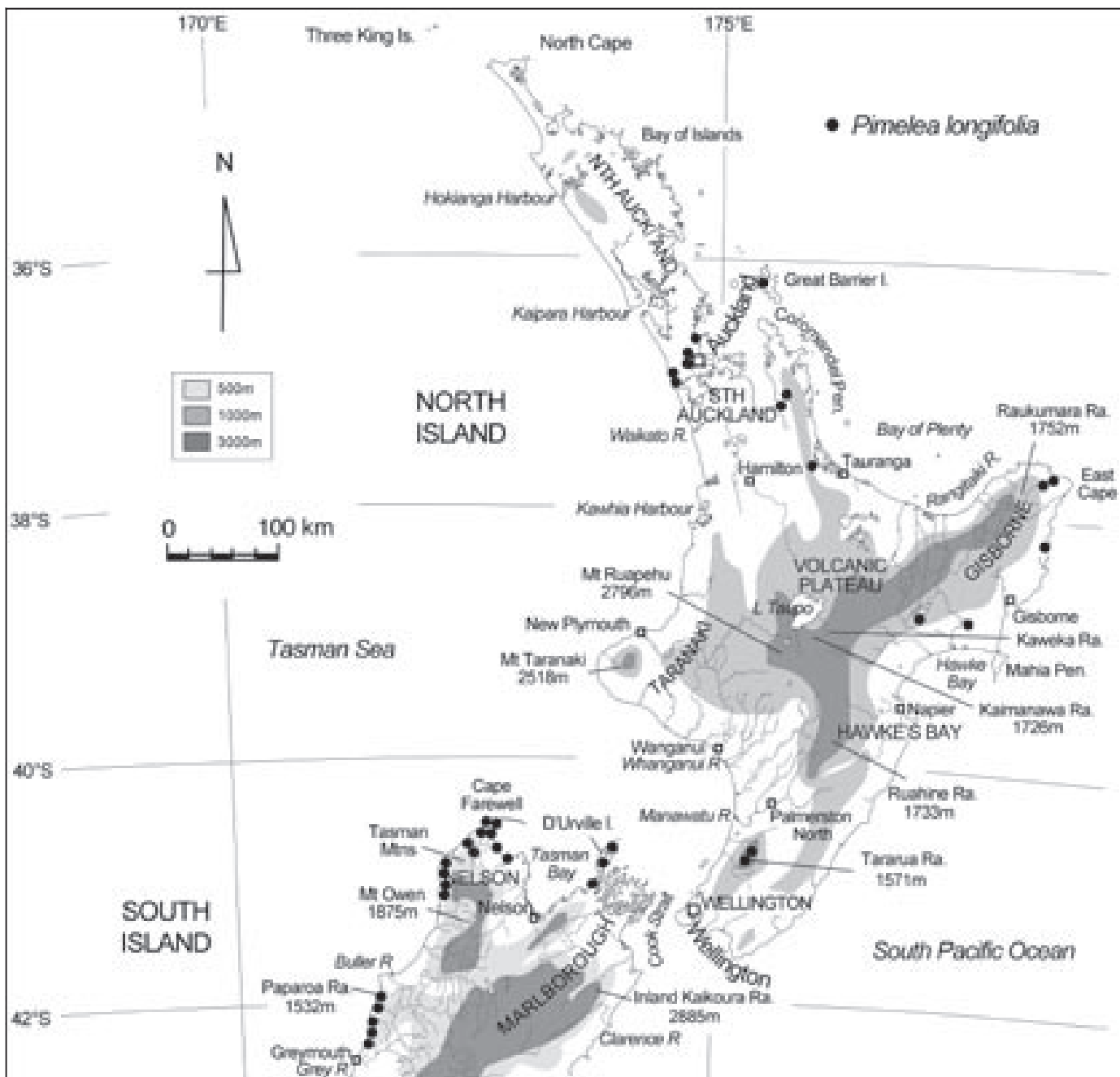


Fig. 4 Distribution of *Pimelea longifolia*. Old records (1870s to early 20th century) from parts of what is now Auckland City are not mapped.

Ra, mixed heath scrub on old burn, *C.J. Burrows*, Oct 1976; CHR 391172 Mt Davy, southern Paparoa Ra., 615 m upper margin of forest, *G. Brownlie*, 13 Dec 1954.

DISTRIBUTION: Auckland City region; Great Barrier I.; Coromandel Peninsula; Kaimai Ra; eastern Bay of Plenty; East Cape area; Waikaremoana; Taranaki Ra. (local to rare). Marlborough Sounds; D'Urville I.; western Nelson; Buller; Paparoa Ra. to about 42°30'S (local to moderately common) (Fig. 4).

HABITAT: Open forest; rock outcrops, especially limestone; forest margins and scrub areas disturbed by fire. Near sea level to 770 m (East Cape), 790 m (Taranaki Ra.), 1000 m (Marlborough Sounds), and 600 m (Southern Paparoa Ra.).

CONSERVATION STATUS: *Pimelea longifolia* has not hitherto been recognised as a threatened species. However, its situation is similar to that of taxa placed in a category "Chronically threatened; gradual decline" (de Lange et al. 2004). The areas occupied by this

species have diminished substantially since the time of Cook's voyages. Settlement of the lowlands and removal of the original forest cover have destroyed its habitat. Nevertheless, it survives (somewhat precariously) within the metropolitan area of greater Auckland, for example in Centennial Regional Park, Waitakere Ranges, and more safely in reserves in the Coromandel area, Urewera National Park, and in the Marlborough Sounds, Nelson, Buller, and North Westland regions. It is evident in some places that recent forest disturbance by fire has actually increased the area inhabited by *P. longifolia*. It appears to be secure (in one sense) in reserves in Marlborough and north-west Nelson, including Kahurangi National Park and the Paparoa Ra., including Paparoa National Park. However, at the same time, in most of those areas it is vulnerable to hybridisation with *P. gnidia* in disturbed locations. The survival of the *P. longifolia* genome in most places depends on maintenance of well-forested land down to sea level, to keep it apart from *P. gnidia* populations. In the southern North Island, hybridisation of *P. longifolia* with *P. gnidia* has eliminated pure populations of the former, with the exception of occasional individuals, in the Tararua Ra. (Fig. 4). See also the account of this phenomenon in relation to *P. gnidia*. A good opportunity for the preservation of the *P. longifolia* genome in pure form would be through positive action to expand its presence in Auckland City and nearby forested areas (see Appendix 1).

ILLUSTRATIONS: Cheeseman (1914, pl. 172); Eagle (1975, pl. 50; 2006, p. 149); Moore & Irwin (1978, p. 63).

NOTE: The abundant presence of hybrids between *P. longifolia* and *P. gnidia* affects the identification of specimens in field populations, especially in East Cape, Tararua Ra., Marlborough Sounds, and north-western Nelson regions. This is considered fully below.

2. *Pimelea gnidia* (J.R.Forst. et G.Forst.) Willd. *Spec. Plant.* 1, 1 (1797).

≡ *Banksia gnidia* J.R.Forst. et G.Forst. *Char. Gen. Plant.* (1776); G.Forst. *Dec. Plant. Nov. Ex Ins. Mar. Aust.* (1780).

= *Passerina gnidia* L.f. *Supplem. Plant.* (1782); G.Forst. *Flor. Ins. Aust. Prodrum.* 28 (1786).

= *Cookia gnidia* J.F.Gmel. *Syst. Natur.* II, 24 (1791).

= *Pimelea gnidia* var. *menziesii* Hook. f. *Fl.N.Z.* 1, 222 (1853). Type material (Dusky Bay, *A. Menzies*, ?K) not seen.

= *Pimelea crosby-smithiana* Petrie *Trans N.Z. Inst.* 44: 186 (1912). Holotype: WELT SPO44226/A,B: The Hump near Lake Hauroko, Southland, 900 m, W.J. Crosby-Smith, end Jan. 1911!

TYPIIFICATION: The species was described (as *Banksia gnidia*) from specimens gathered in Dusky Sound, southwest Fiordland by J.R. Forster, J.G.R. Forster, and Anders Sparmann during Cook's second voyage to New Zealand in the *Resolution* in the period 26 Mar to 29 Apr 1773. In this locality it occurs from near sea level to about 1000 m a.s.l.

It is significant that the Forster collections from this area include relatively long-leaved individuals (leaves 22 × 6.6 mm) such as can be found now at lower altitudes and short-leaved individuals (10 × 4 mm) like those that live on rocky, waterlogged or infertile sites at low levels, and also near treeline (cf. the type sheet at BM). However, no leaf dimensions were given in their accounts, although this variation must have been in the Forsters' minds as the original brief description was drawn up. A line drawing of a branch of *P. gnidia*, partly filled in with dark green watercolour, was made by G. Forster, possibly from a live specimen (Fig. 5), and this depicts a plant with medium-sized, ovate leaves. On the sheet the name is given as *Passerina gnidia*. Engravings were also made (Nicolson & Fosberg 2003).

G. Forster's (1780) redescription of *Pimelea gnidia*, when he was still using the generic name *Banksia*, is relatively full. However, his (1786) description under the generic name *Passerina* is very brief. The (1780) habitat description is translated as: "Near rock fissures at the edge of the sea, found also on the northern side of these islands on summits of mountain peaks, but dwarfed—around two feet". The islands are those in Dusky Sound. In the main description, the plants from the coast are noted to be "two to three fathoms [high]", that is, 3.7–5.5 m. This is an error as the plants are, at most, between 1 and 2 m tall.

The piece second from the right hand side of a sheet, BM 829816, with four pieces, gathered by the Forsters at "Dusky Bay", is here chosen as the lectotype (Fig. 6). This piece matches G. Forster's sketch of *P. gnidia* quite well. The other three pieces on the sheet are paralectotypes. Others are on sheet BM 894148 (three pieces). Paralectotypes are also present among Forster collections at the Linnean Society in London (LINN); at the Royal Botanical Gardens, Kew (K); and in the Willdenow Herbar, Botanischen Museum Berlin-Dahlem (B). Many other specimens are present in European herbaria (e.g., FR, GOET, LE, MW, P, S). All were gathered



Fig. 5 Georg (J.G.A.) Forster pencil drawing (partly watercoloured) of *Pimelea gnidia* (= *Banksia Gnidia*; *Passerina Gnidia*), (Ic. No. 170, 1773). (Image by courtesy of the Natural History Museum, London, 2007.)

Fig. 6 Lectotype of *Pimelea gnidia* (BM 829816). The piece second from the right on the sheet is the lectotype, the other three are paralectotypes. (Image by courtesy of the Natural History Museum, London, 2007.)



in Dusky Sound. None record precise locations; collectors names are rarely noted.

An account of the complex story of the fate of the Forster collections is given by Carolin (1963). Nicolson & Fosberg (2003) provide an exhaustive description of the Forster contributions and list the specimens in the various repositories.

LECTOTYPE (chosen here): Forster collection, Natural History Museum, London BM 829816 Nova Zelandia, Dusky Bay [1773]! (second piece from the right hand side of sheet) (Fig. 6).

PARALECTOTYPES: Forster collection BM 829816 (three other pieces on the same sheet as the lectotype) (Fig. 6); these appear to originate from different individual plants; BM 894148 G. Forster Herbarium. 83, 170 *Passerina Gnidia*, Linn. Suppl. 226, M.S. V 374, in pencil *Pimelea Gnidia*, printed label "Type Specimen"; Royal Botanical Gardens, Kew K 356695 (presented by the Corporation of Liverpool, August 1885)!; LINN 40.12-1 N. Zeeland (as *Banksia Gnidia*) H.L. fil.; 40.13 (as *Banksia Gnidia* Forst.)? H.L. fil.; Botanischen

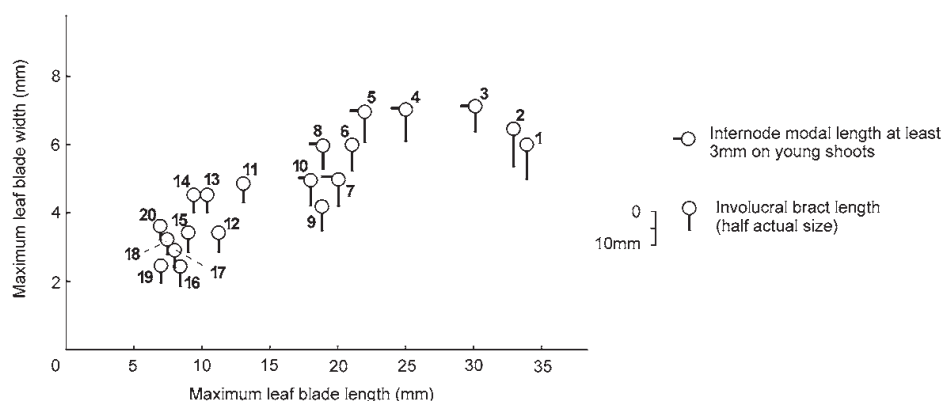


Fig. 7 Leaf size ranges of *Pimelea gnidia* from Dusky Sound and some other Fiordland locations (two other correlated character states are depicted). (See Appendix 1.)

Museum, Berlin-Dahlem B, Willdenow Herbar, 142.

REDUCTION OF *PIMELEA CROSBY-SMITHIANA* TO SYNONYMY: *Pimelea crosby-smithiana* Petrie is here merged with *P. gnidia*. Similar small-leaved specimens occur in parts of both western and eastern Fiordland. Throughout its entire range, populations of *P. gnidia* have varied leaf lengths and shapes. Some of the largest-leaved come from sea-level locations in Fiordland, not far from Dusky Sound (e.g., CHR 92913, Fisherman's Bay [Chalky Inlet] *H.H. Allan*, no date) with leaves up to 33 × 7 mm. Specimens from upper Cook Channel, (CANU 10864, Lake Mike Valley head, in scrub, *C.J. Burrows*, Jan 1967) have leaves very like those in G. Forster's sketch, but only 8–10 mm long. They also resemble specimens from the Hump Ridge east of Lake Hauroko, the type locality for *P. crosby-smithiana* (e.g., CHR 472390 Hump Ra, Southland, 970 m, tussock grassland, *B.D. Rance*, 2 Jan 1988). Other small-leaved forms for comparison are: CHR 218654 E. of L. Fraser, near West Cape, Fiordland National Park 600 m, occasional shrubs in needle grassland where treeline is depressed, *A.F. Mark*, 9 Feb 1972; CHR 112003, ridge between Big R. and Jeannie Burn [Cameron Mts, Fiordland], subalpine tussock, *W. Ramsay*, 27 Jan 1960. A similar specimen purporting to come from eastern Central Otago (CHR 92926, Rock and Pillar Range, *G. Simpson*, no habitat or date) is not accepted here. Corroboration of such an easterly location is needed.

The range of characters found in plants from the Hump Ridge, including the "quadrate" branchlet cross-section (Petrie 1912) (caused by widening of the short internodes as they grow, with four sides occupied by the dark, hairless node buttresses), is found on other small-leaved specimens from above timberline in Fiordland. They are features resulting from reduction in size of plants growing in relatively severe conditions.

Pimelea gnidia is a variable species and its populations exhibit differences in stature and leaf size and shape, according to local conditions. For example, in Dusky Sound local clines of size reduction of whole plants and leaves are apparent in specimens from low to high altitudes or places with good or poor growing conditions of the substrate (Fig. 7). Accordingly, there is no sound reason for maintaining the *crosby-smithiana* forms at specific level, or even at subspecific level. They are no more different from the other small forms of *P. gnidia* in the southwestern South Island than are plants in many other *P. gnidia* populations.

DESCRIPTION: An erect to suberect much-branched shrub up to 1.5 m tall (reduced in stature on exposed sites and poor soils). Branches and branchlets ascending, glabrous or sparsely hairy at leaf axils and hairy on receptacles; internodes usually short. Node buttresses, brown or black, occupy the whole internode and may be prominent after leaf fall; internodes 2–7 mm long. Bark ages to grey. Leaves decussate, ascending, later sometimes patent or deflexed, often imbricate, on petioles 1–3 mm long. Lamina pale to medium or olive green, coriaceous, elliptic, ovate or sometimes oblong, obovate or lanceolate, 5–35 × 2–7 mm, keeled, acute, blunt-pointed or slightly apiculate, base cuneate. Margins thickened, slightly downturned; midvein prominent abaxially, sunken adaxially; lateral vein pattern camptodromous but not clearly evident; stomata only on abaxial side. On dried plants a blue-green colour is evident on leaves of some specimens. Inflorescences few to many-flowered, pedicels 1–2 mm long, persistent. Involucral bracts 4, similar to leaves but usually wider. Plants gynodioecious. Flowers hairy on outside; inside hairless, fragrant, white or flushed rose, often with lower tube red. In some populations in Marlborough and Nelson flowers are circumscissile above the ovary portion. Calyx lobes open in salverform fashion. ♀ tube to 5.5 mm long, ovary

portion 3 mm, calyx lobes 3.5×1.8 mm. ♀ tube to 9 mm long, ovary portion 3.5 mm, calyx lobes 3.2×1.8 mm; staminodes short, at mouth of tube. Anther filaments inserted below mouth of tube; anthers dehisce latrorsely. Ovary with short hairs at summit and to about half-way down. Fruits ovoid, green, drying brown, 4 mm long. Seeds ovoid 3.4×1.6 mm. Flowering time summer. The dried hypanthia must disperse with fruits inside. Chromosomes: No counts are known.

REPRESENTATIVE SPECIMENS: NORTH ISLAND: CHR 366360 SW of Mt Rimutaka, Rimutaka Ra., 678 m, short, open scrub on steep slope, *A.P. Druce*, Feb 1980; CHR 6472 NE of Mt Matthews, 617 m, Rimutaka Ra., *V.D. Zotov*, 24 Dec 1932; CHR 165461 Pahaoa Gorge, E Wairarapa, c. 310 m, sandstone cliff, *A.P. Druce*, Jan 1969; CHR 197385 Mt Mangatoetoe, Aorangi Ra., S Wairarapa, 833 m, open scrub on rocky ridge, *A.P. Druce*, Mar 1954. SOUTH ISLAND: MARLBOROUGH: CHR 387223 N end D'Urville I., 308 m, shrubland, *A.P. Druce*, 1981; CHR 23501 Onahau, northern ridge, Kenepuru Sd, *R. Mason*, 29 Feb 1940; CHR 94 Strachans Pk, *H. Jenkins*, Nov 1928*; CHR 366682 Mt Richmond, Richmond Ra., 925–1235 m, *J. Townsen*, 8 Dec 1961; NELSON: CHR 278068 Torrent Bay, near sea level, forest margin, *A.P. Druce*, Nov 1974; CHR 511578 Wangapeka R., Chummie Ck, 900 m, poor sedimentary soil on rock, low manuka-mountain beech scrub, *G. Jane*, 17 Jan 1997*; CHR 478734 Waiwhero Rd, Lower Motueka, 30 m, flowers white, flushed pink on tube, strong pink on ovary portion, *G. Jane*, *S. Courtney*, Nov 1989; CANU 38884 Mt Lunar near Nguroa, c. 200 m, low manuka scrub on poor soil, *C.J. Burrows*, 6 Dec 2007; CANU 6716 Heaphy Tk by Monument Ck, c. 830 m, scrubland, *B.D. Bell*, 11 Jan 1964. BULLER: CANU 29663 Denniston Plateau, *D.G. Lloyd*, 6 Jan 1984. WESTLAND: CHR 228416 Cascade Plateau, South Westland, 155 m, common in low shrub vegetation on ultramafic moraine, *P. Wardle*, 1 Apr 1977. FIORDLAND: CHR 65474 Henry Saddle, George Sound, 925 m, scrub above bush edge, *R. Mason*, 17 Apr 1947; CHR 67170 Upper Stillwater R., Caswell Sd, *Lepidothamnus intermedius* bog forest, *A.L. Poole*, 14 Mar 1948; CANU 60802 Pk C above Piriti R. (Bradshaw Sound), 1000 m, exposed ridge with mixed scrub and snow tussock, *C.J. Burrows*, Jan 1963; CHR 96261 Te Au Saddle to Irene Saddle, *M. Cookson*, Jan 1955; CHR 279800 Doubtful Sd, Bauza I., coastal dune, *G.I. Collet*, Jul 1973; CANU 1111 Secretary I., 1000 m, subalpine scrub, *P. Wardle*, Feb 1960; CHR 261622 Breaksea I.,

coastal scrub, *P.N. Johnson*, Dec 1974; CHR 92913 Fisherman's Bay [Chalky Inlet], *H.H. Allan*, no date; CANU 13657 Lower true left branch of Windward R., Fiordland, 1235 m, scrub on exposed rocky outcrop, *B.R. Manson*, 10 Dec 1969; CANU 9127 Lake Monk head basin, Cameron Mts, Fiordland, 1170 m, scrub, *C.J. Burrows*, Jan 1965. (*specimens with circumscissile hypanthia).

DISTRIBUTION: Rimutaka Ra.; Pahaoa R., E Wairarapa and Aorangi Mts, local; Marlborough Sounds; D'Urville I.; Pelorus catchment; NE Wairau Valley; Nelson; Buller including Denniston Plateau, Mts Rochfort and William, local to moderately common. Cascade Plateau, South Westland; widespread in Fiordland; W Southland, local to common (Fig. 8).

HABITAT: Open forest, forest margins and scrub on stream margins, landslides, valley heads, moraines, heathlands, burnt forest areas. At sea level in Fiordland and sometimes at low levels in north-west Nelson; above timberline (1250 m in the north, 1000 m or less in Fiordland) in scrub and tall tussock grassland in Tararua Ra., Mt Stokes (Marlborough Sounds), and parts of Nelson region, Denniston Plateau, and many parts of western and eastern Fiordland. Substrates include rock, rock debris, leached acidic mineral soil, and peaty loam. Rock types include sandstone, conglomerate, schist, granite, granodiorite, gneiss, and ultramafics.

CONSERVATION STATUS: *Pimelea gnidia* is not at risk of extinction. As the partner in hybridisation with *P. longifolia*, *P. gnidia* is in much the same situation as that species wherever their distributions closely overlap. As indicated below, there are many places in the North Island where no pure populations of *P. gnidia* remain. Since it is hardier, *P. gnidia* can inhabit some soils and high level locations that are unavailable to *P. longifolia*. In the South Island (but not the North Island), its populations appear not to have suffered as much from the influences of settlement of the lowlands over the last two centuries as has *P. longifolia*. Fiordland National Park is the stronghold of *P. gnidia* and it is not at risk there. It seems to be unpalatable to browsing mammals.

ILLUSTRATIONS: *P. gnidia* Eagle (1982, pl. 21; 2006, p. 161) (two specimens); Wilson & Galloway (1993, fig. 110).

Hybrids between *Pimelea longifolia* and *P. gnidia*

In many locations both within and outside the present range of overlap of *P. longifolia* and *P. gnidia* (Fig. 4, 8) occur populations of plants with

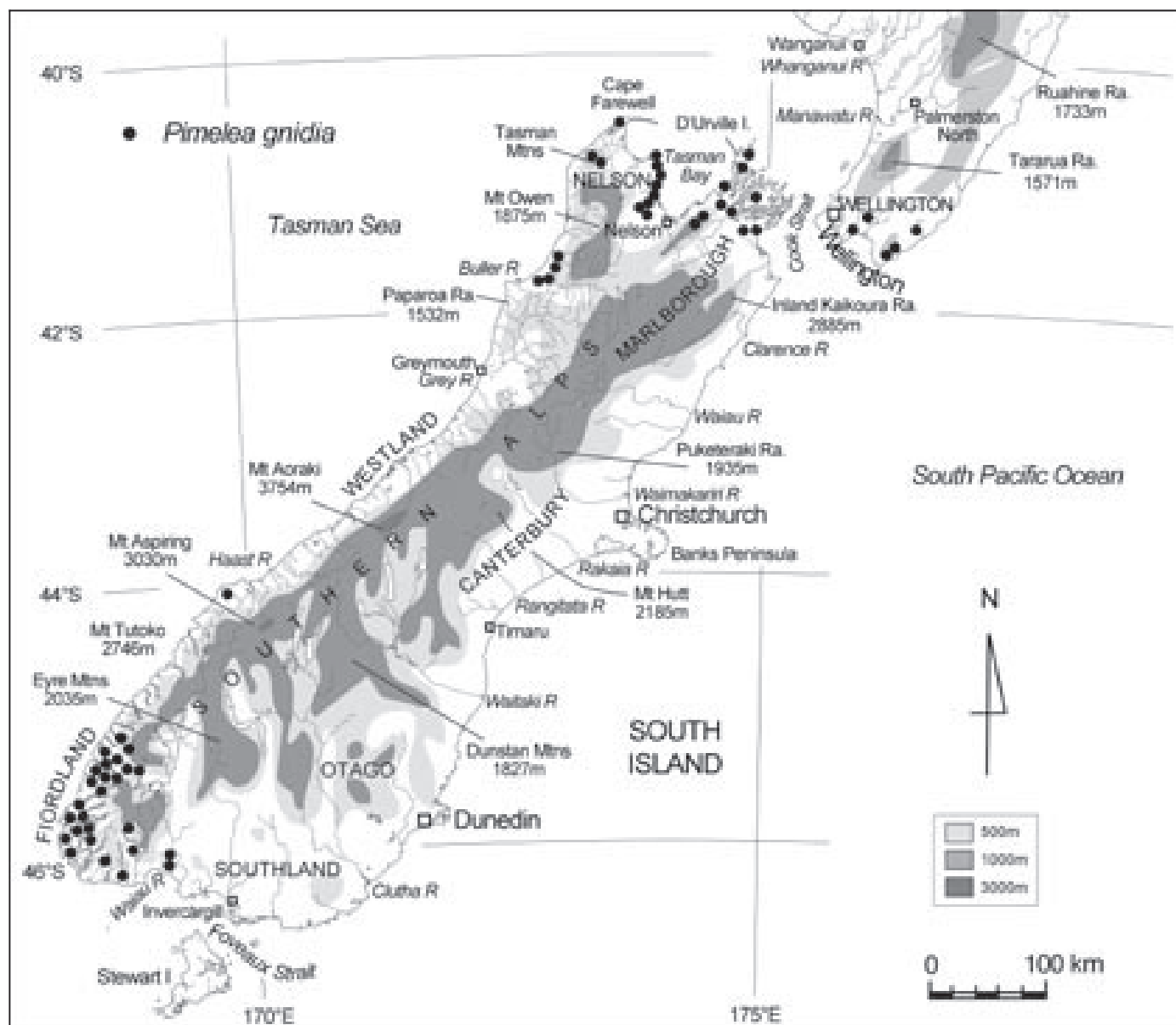


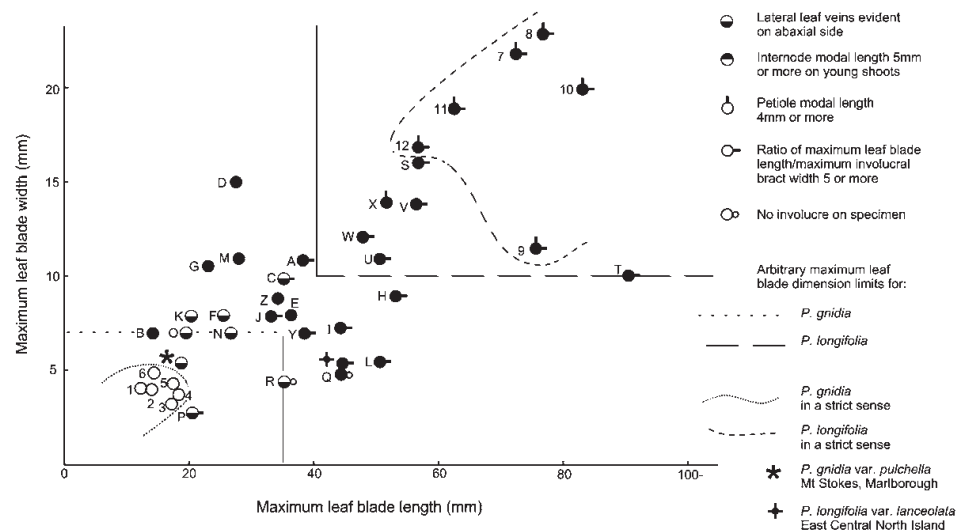
Fig. 8 Distribution of *Pimelea gnidia*. The old (1889) record for the Kaweka Range, Hawke's Bay, is not mapped.

characters (especially leaf sizes) intermediate between the two. Some examples of the range of variation are shown in Fig. 9, which is drawn mainly from specimens from north-west Nelson, with a few others from elsewhere for comparison. The evident abaxial lateral veins in hybrids and obtuse to acuminate leaf tips indicate the influence of *P. longifolia* genes, while short petioles and internodes and relatively wide involucre bracts indicate influence of *P. gnidia* genes.

This variation pattern is a strong indication that widespread hybridisation between the two species has taken place over a long period. Some plants may be F_1 hybrids, but the wide range of leaf forms of different individual plants, from long and wide to short and narrow, with assortments of long and

short petioles and internodes, suggests that F_2 or later generations are present. There could also have been back-crossing of hybrids with either parent. Cockayne & Allan (1934) concluded that crossing between the two species had given rise to "hybrid swarms". Intermediate forms are often marked as hybrids in herbaria. However, some forms that are clearly hybrids are also often attributed to either parent by field botanists. As each of the two parents retains its integrity outside regions of geographic overlap and also within them in areas where large areas of natural forested landscape survive (e.g., in Kahurangi National Park, north-west Nelson), these morphologically very different forms (*P. longifolia* and *P. gnidia*) can be accepted as distinct species, in spite of their capacity to hybridise so freely.

Fig. 9 Leaf size ranges of specimens of *Pimelea longifolia*, *P. gnidia*, and hybrids between them from north-west Nelson and some other locations (other correlated character states are depicted). (See Appendix 1.)



Some arbitrary limits are needed for field or herbarium identification of the two species. *Pimelea longifolia* (which always has very varied leaf sizes on the same plant) is identified by its largest stem leaves being at least 40 mm long and 10 mm wide. *Pimelea gnidia* also has varied leaf sizes on each plant, but to a lesser degree. It is identified by its largest leaves being no more than 35 mm long and 7 mm wide. All other plants, with varied combinations of leaf length and breadth, are regarded as hybrids. Some plants that fall within the *P. gnidia* dimension limits are clearly hybrids, also. Their leaves are often obovate, have acuminate tips, and lateral veins are clearly visible on the abaxial side (all features of *P. longifolia* sens. strict.). Some other specimens that fall into the *P. longifolia* dimension limits (Fig. 9) bear features that appear to originate from *P. gnidia* (especially short petioles).

REPRESENTATIVE HYBRID SPECIMENS: NORTH ISLAND: SOUTH AUCKLAND: CHR 480573 Lonely Bay, Tairua, Coromandel, in exposed scrub with *Leptospermum*, *Pomaderris*, *Olearia*, on clay soil over rhyolite, *P.J. de Lange*, *G.M. Crowcroft*, 22 Sep 1992; CHR 330440 Thames Hills, *W. Townson* (no date); CHR 417737 Eastern Bay of Plenty, Whangaparaoa Bay, on broad, dry ridge under hard beech, tanekaha forest, *S. Courtney*, 24 Oct 1984. GISBORNE–HAWKE’S BAY: CHR 409737 Lake Waikaremoana, Waihirere Bluff, 650 m, *W.B. Shaw*, *S. Beadel*, 31 May 1984; CHR 535059 Ahimanawa Ra., Hawke’s Bay, rock pinnacle, *N. Elder* (no date); CHR 131795 Kaweka Ra., 1080 m, scrub, *A.P. Druce*, Dec 1964. RUAHINE–TARARUA–AORANGI RANGES: CHR 25815 Herricks spur, Ruahine Mts, 1080 m, *V.D. Zotov*, 31 Dec 1943; CHR 45827 Mt Holdsworth, Tararua Ra., 1326 m, *A.P. Druce*, Jan 1962;

CHR 192487 near Mt Barton, Aorangi Ra., 863 m, growing mixed with *P. gnidia*, *A.P. Druce*, Dec 1968. SOUTH ISLAND: MARLBOROUGH: CHR 92919 Mt Stokes summit area, *J. Hay*, 25 Feb 1954; CHR 274580 Mt Ears, D’Urville I., 400 m, *D. & G.D. Kelly*, Jun 1975. NELSON: CHR 366176 Mt Misery, Matiri R., 1295 m, tussockland, *A.P. Druce*, Mar 1981; CHR 511908 Mt Burnett, dolomite, *P.B. Heenan*, *P. Bellingham*, 5 Feb 1997; CHR 77864 Puponga, NW Nelson, *J.A. Petterson*, 13 Nov 1954. BULLER–NORTH WESTLAND: CHR 463893 Mokihinui, *D.M. Calder*, Jan 1954; CHR 330457 Buckland Peaks N Paparoa Ra., 1048 m, *D. Petrie*, 18 Dec 1913; CHR 212423 Blackball Mine, Grey Val., *I. Robins*, 13 Nov 1978 (Fig. 10).

Attempts have been made to describe and name hybrids between *P. longifolia* and *P. gnidia* at specific or subspecific level:

P. angulata Colenso *Trans. N.Z. Inst.* 18, 265 (1886). Holotype: WELT 24330 “Open hilly country in the interior at Patea, between Napier and Taupo”!

= *P. longifolia* var. *lanceolata* (Colenso) Cheeseman in Cheeseman *Man. N.Z. Flora*, 579 (1925).

P. lanceolata Colenso *Trans. N.Z. Inst.* 22, 483 (1890). Holotype: WELT 22990, base of Mt Ruapehu, *H. Hill*, 1889! Syntype: K33173, no locality!

= *P. longifolia* var. *lanceolata* (Colenso) Cheeseman in Cheeseman *Man. N.Z. Flora*, 609 (1906); 579 (1925).

P. similis Colenso *Trans. N.Z. Inst.* 22, 483. Type material (“edges of thickets base of Mt Ruapehu, *H. Hill* 1889”) not seen.

= *P. longifolia* var. *lanceolata* (Colenso) Cheeseman in Cheeseman, *Man. N.Z. Flora*, 579 (1925).

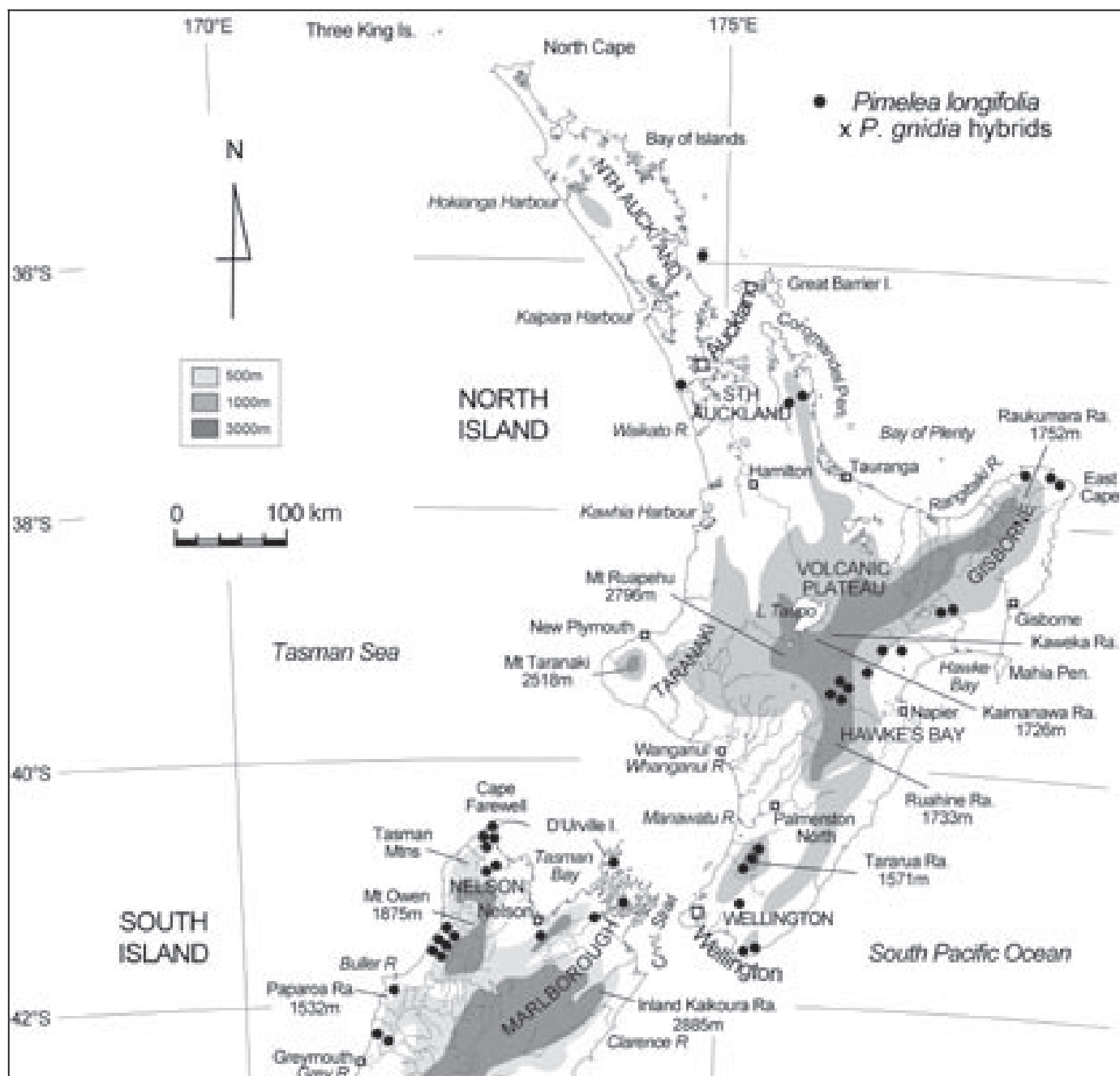


Fig. 10 Distribution of *Pimelea longifolia* × *P. gnidia* hybrids.

P. gnidia var. *pulchella* Cheeseman, *Man. N.Z. Flora*, 609 (1906). Lectotype (chosen here): AK 5357. Mount Owen, Nelson, 4000 ft, *T.F. Cheeseman*, Jan 1882! Paralectotypes: AK 5356 Mount Stokes, Marlborough, *P. McMahan*, no date!; AK 5358 Near Westport, *W. Townson*, n.489, no date!

The views expressed by Cockayne & Allan (1934) and Allan (1961) (pp. 290, 291) were that these forms were all of hybrid origin. The stance taken here is that formal names should not be used for any of the presumed *Pimelea* hybrid forms. No testing of the degree of hybridity and the nature of the genome

of the various forms has ever been done. Accordingly, it is proposed here to dispense with formal nomenclature for these *P. longifolia* × *P. gnidia* intermediates. The forms described by Colenso and Cheeseman represent only small portions of the total array of hybrid forms that can be found, for example in the Ruahine and Tararua Ranges or on the hills above the Cape Farewell coast of north-west Nelson (cf. Fig. 10).

As indicated in Fig. 4 and 8, there are wide gaps in the distributions of *P. longifolia* and *P. gnidia* in the eastern North Island mountain ranges. Only

one genuine *P. gnidia* herbarium specimen has been seen from north of the Rimutaka Ra. (WELT 52830a Kuripapango, upper Ngaruroro, Hawke's Bay [?B.C. Aston] Jan 1889). Some hybrid specimens that are close to *P. gnidia* are CHR 141828 Mt Holdsworth, Tararua Ra., D. Franklin, 1 Mar 1956 and WELT 52896 Ruahine Ra., H. Tryon, no date. Numerous *P. longifolia* × *P. gnidia* hybrids have been gathered in places where one or both of the parents are not now present (Fig. 10). These distribution patterns are puzzling; both species are absent where habitat conditions would seem to be suitable for them (and their former presence is indicated by hybrid populations). A general explanation is that where either occurs without the other and hybrids are present, the missing parent must initially have been present in the form of small populations that were overwhelmed by hybridisation. Absence of both parents where hybrids occur indicates a further stage in this process, particularly in the Ahimanawa and Ruahine Ranges of Hawke's Bay. These matters will be briefly addressed again when *P. buxifolia* is considered.

A specimen AK 50036 from Hen Island (Taranga) [east of Bream Bay, North Auckland] J. Dingley, Nov 1938 (with leaves up to 35 mm long × 6.5 mm wide and involucre to 8 mm wide) resembles *P. longifolia* × *P. gnidia* hybrids from other locations. It has the usual strong abaxial leaf vein pattern of such hybrids. Its leaves also have abaxial stomata and none on the adaxial side, and it has long branchlet internodes, but short petioles. Its long flowers (up to 10 mm) appear to be circumscissile. This plant was gathered well north of the present mainland extent of *P. longifolia* (Whangaparaoa Peninsula). A few specimens from the vicinity of Auckland and Coromandel also appear to be *P. longifolia* × *P. gnidia* hybrids (e.g., AK 180307, Piha, Waitemata County, coastal scrubland, R. Afford, Sep 1943; AK 5348 rocky peaks in the Kaueranga Valley, Thames, W. Townson (no date)).

Some *P. longifolia* × *P. gnidia* hybrids form local populations with relatively uniform characteristics. It is as though their genotypes and phenotypes have become “fixed” in the local areas. It is understood in the plant world generally that, in some circumstances, the results of hybridisation can become new species (Briggs & Walters 1997; Levin 2000). This could be the subject of further study.

Populations of *P. longifolia* and *P. gnidia* (in the sense of the arbitrary definitions noted earlier) where hybrids are abundant are likely to have been generally introgressed by genes of the other, and the

range of variability expressed in Fig. 9 is indicative of that, but the situation is not addressed further here. Both species are simply regarded as being naturally variable.

ILLUSTRATIONS: *P. longifolia* × *P. gnidia* Eagle (1982, pl. 37; 2006, p. 151) (two forms).

3. *Pimelea buxifolia* Hook. f. *Handbook N.Z. Flora* 2, 243 (1867).

= *P. stylosa* Colenso *Trans. N.Z. Inst.* 20, 205 (1888). Holotype: WELT 22996 “High lands near Mt Ruapehu”!

= *P. subsimilis* Colenso *Trans. N.Z. Inst.* 28, 609 (1896). Lectotype: (chosen here) WELT 22997 Ruahine Mountain Range, H. Hill [1895]!

= *P. montana* Colenso *Trans. N.Z. Inst.* 31, 279 (1899). Lectotype: (chosen here) WELT 22995 Ruahine Mountain Range, E. Olsen [1898]!

LECTOTYPE (chosen here): Royal Botanical Gardens, Kew, Hooker Herbarium, K 356691 N. Zealand, Dieffenbach (no locality or date)! (Fig. 11).

The two pieces on the sheet, received by Hooker prior to 1867, would probably have been gathered by E. Dieffenbach during a visit to the Central North Island Volcanic Plateau near Mts Tongariro and Ngauruhoe in 1840 or 1841. Both pieces have flowers. Each is regarded as an element of the lectotype.

A second sheet at Kew has four gatherings: K 356684, Colenso 967 (one piece); K 356687, Colenso 1538 (two pieces), possibly paralectotypes, and two others, K356685, K356686. Hooker (1867) cited two W. Colenso specimens from “base of Tongariro and top of Ruahine range”.

DESCRIPTION: A much-branched, erect shrub up to 80 cm tall. Branches and branchlets ascending; branchlets muricate, clad in short, villous, often brownish, hairs. Node buttresses short (0.5 mm), lunate, dark brown or black, and may be prominent after leaf fall (Fig. 12). Internodes 2–4 mm long. Bark grey-brown, aging to grey or black. Leaves decussate, usually uniform in size, imbricate, ascending, later patent, on petioles 0.5–1 mm long. Lamina dull green to olive green, thick and coriaceous, 5–10 × 3–5 mm, elliptic to ovate, keeled, acute (often blunt-pointed), sometimes obtuse, base cuneate to angustate. Margins thickened, slightly downturned; midvein prominent abaxially; lateral vein pattern camptodromous but often obscure; stomata only on abaxial side. On some dried plants a blue-green colour is evident on upper leaves. Inflorescences few to many-flowered, pedicels 0.3 mm long, persistent. Involucral bracts 4, the

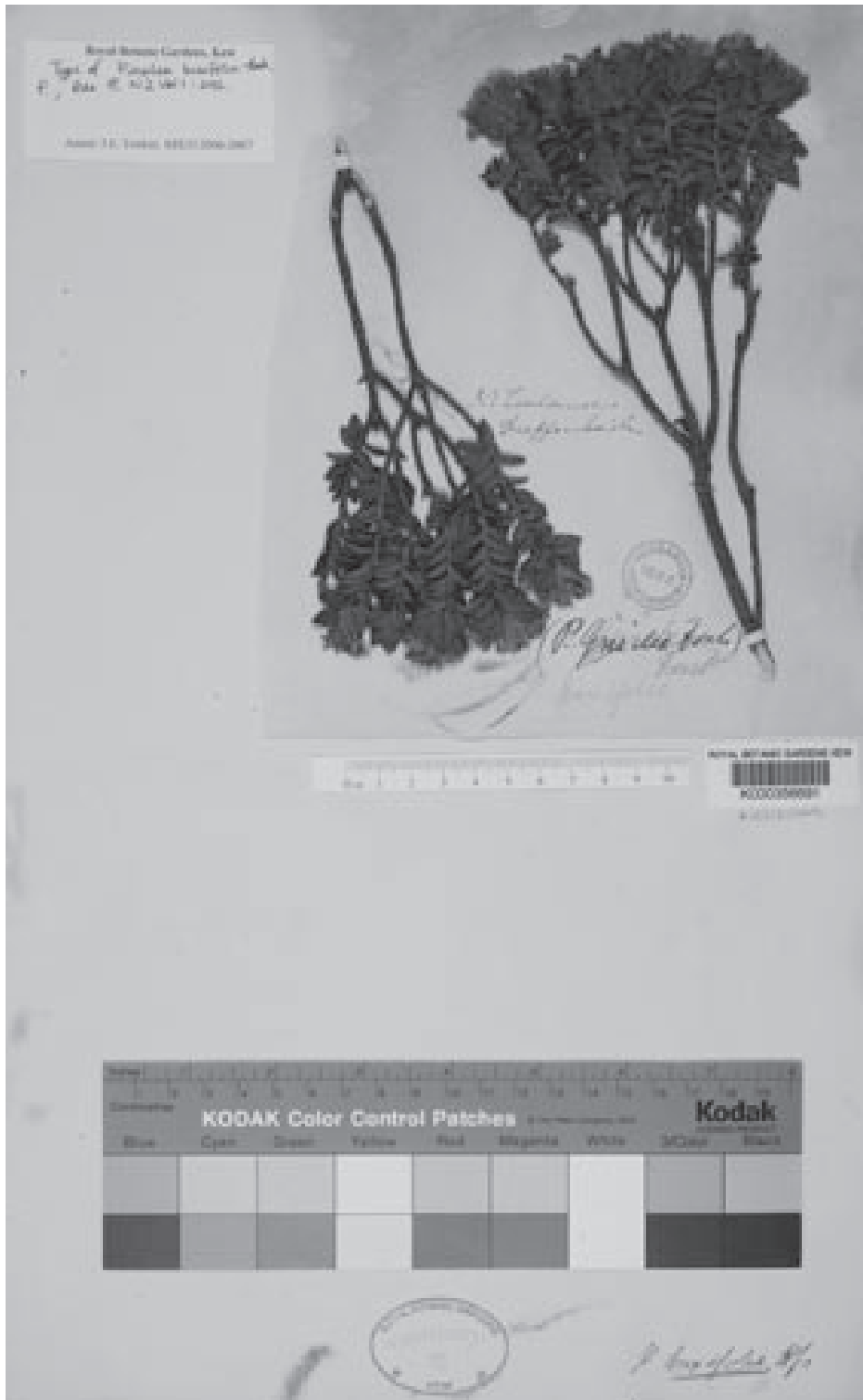
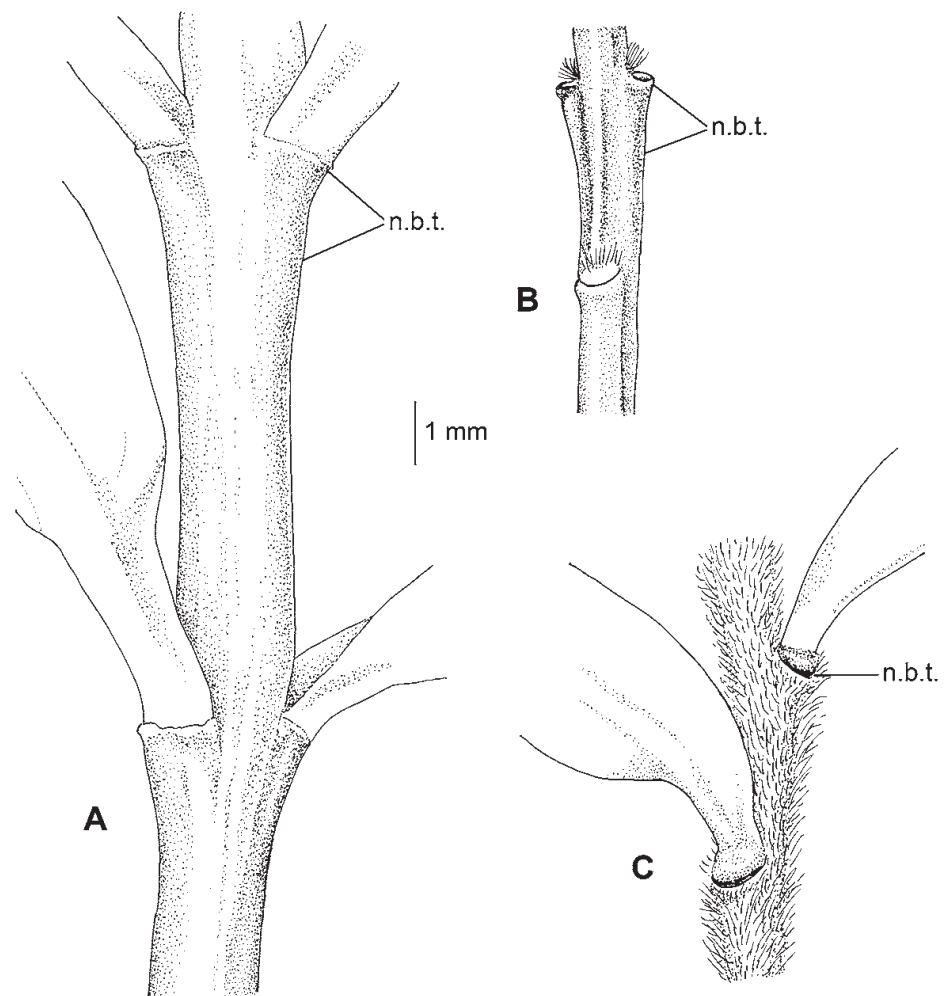


Fig. 11 Lectotype of *Pimelea buxifolia* (K 356691). Both pieces are regarded as elements of the holotype. (Image by courtesy of the Royal Botanical Gardens, Kew and Allan Herbarium, CHR 2008.)

same size as leaves or broader (10×7 mm). Plants gynodioecious. Flowers hairy on outside; inside sparsely hairy in tube, hairless in ovary portion; fragrant, white or sometimes faint pink, lower tube red. Calyx lobes open in salverform fashion. ♀ tube to 5.5 mm long, ovary portion 3 mm, calyx lobes 2.5×1.3 mm, staminodes short, at mouth of tube. ♂ tube to 10 mm long, ovary portion 3 mm,

calyx lobes 3.5×2 mm. Anther filaments inserted below mouth of tube; anthers dehisce laterally. Ovary with abundant hair at summit and sparsely hairy to base. Fruits ovoid, green, drying brown, 4.2 mm long. Seeds ovoid 3.8×1.7 mm. Flowering spring–summer–autumn. Dried hypanthia persist and must disperse with fruits inside. Chromosomes: No counts are known.

Fig. 12 Internodes and node buttresses of: **A**, *Pimelea longifolia*; **B**, *P. gnidia*; and **C**, *P. buxifolia*. n.b.t. = node buttress tissue. (Ink drawing by Rebecca Wagstaff, 2007.)



REPRESENTATIVE SPECIMENS: WELT 52939 Head of Kaueranga Valley, Thames, *W. Townson*, Dec 1922; AK 61898 Mt Hikurangi, Raukumara Ra., *P. Hynes*, 3 Jan 1960; CHR 33943 Near upper Tama Lakes, Mt Ngauruhoe, subalpine scrub, *A.J. Healy*, 25 Jul 1938; CANU 67379 Mt Ruapehu, 1540 m, scrub on scoria, *M.T. Kalin*, 11 Feb 1967; CHR 260151 Near Azun Gorge, Moawhango R., Kaimanawa Ra., 1110 m, streambank, *A.P. Druce*, Jan 1974; CHR 275338 Kiwi Ck headwaters, Kaweka Ra., 1420 m, scrub beside stream, *A.P. Druce*, Dec 1974; CHR 73747 Between waterfall and Rangiwahia Ski Club hut, Whanahuia Ra., Ruahine Mts, 1360 m, subalpine scrub, *J. Hay*, 20 Jan 1952; AK 101223 Mitre Pk, Tararua Ra., *L.B. Moore, L.M. Cranwell*, 1 Jan 1933.

DISTRIBUTION: Thames region, Coromandel Peninsula; Volcanic Plateau; Mt Hikurangi, Raukumara, Kaimanawa, Kaweka, Ruahine, and Tararua Ranges.

Very abundant in places on the central volcanoes (Fig. 13).

HABITAT: Scrub-grassland with tall tussocks and other herbaceous plants and shrubs, sometimes forming dense shrubberies. Substrates on the volcanoes and nearby are young volcanic ejecta (tephra, lapilli, and coarser debris). More distant locations are on soils derived from older, more extensive eruptions of ignimbrite and tephra which blanket the sandstone hills and mountains on all sides. Altitude range c. 500–1650 m.

CONSERVATION STATUS: The species is plentiful and well protected in Tongariro National Park and probably not at risk throughout most of the North Island axial mountains from Raukumara to Ruahine Ranges. *Pimelea buxifolia* is now very sparsely distributed or extinct in some peripheral areas noted in the text and in Fig. 13, however.

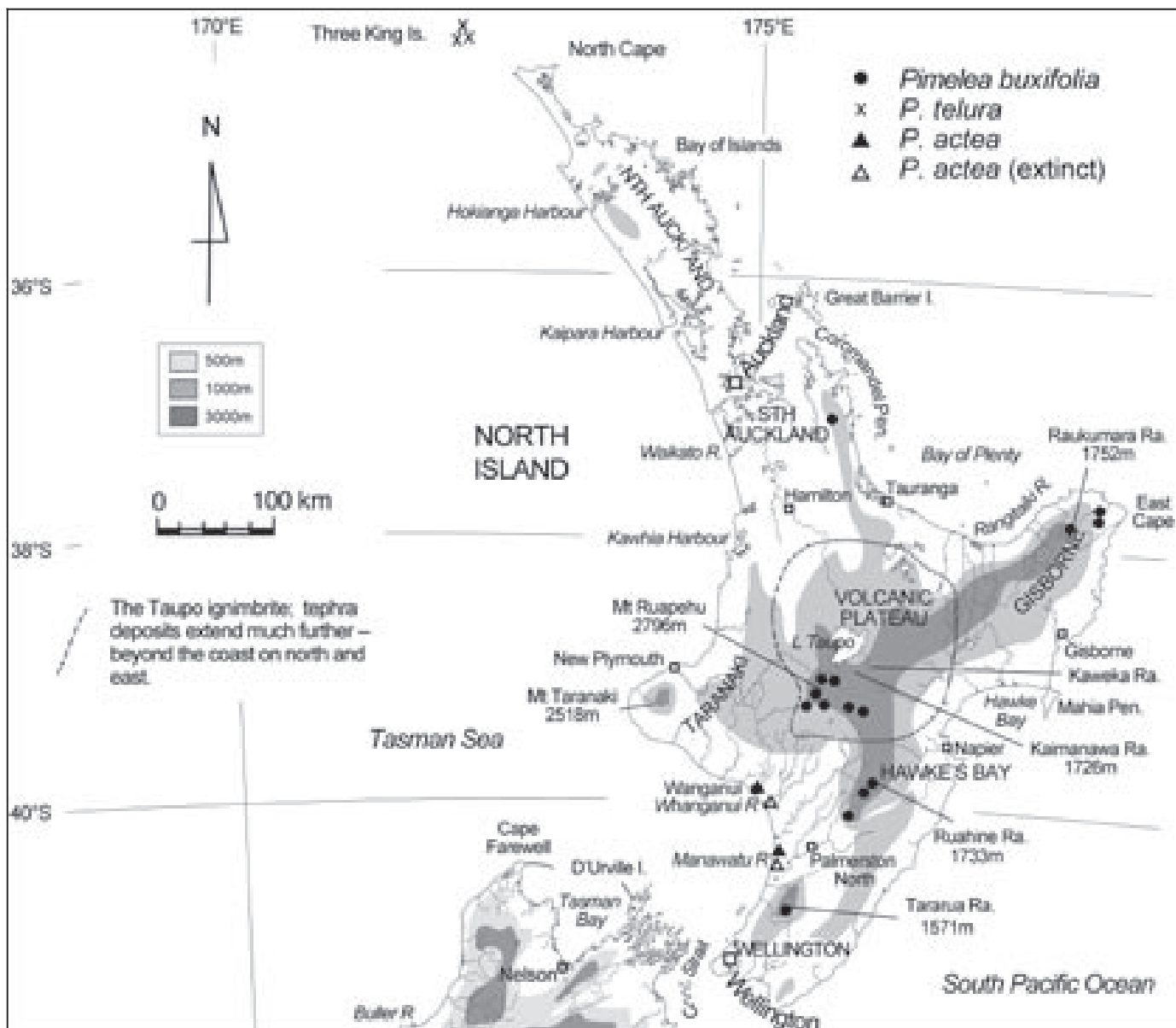


Fig. 13 Distribution of *Pimelea buxifolia*, *P. actea*, and *P. telura*.

ILLUSTRATIONS: Cheeseman (1914, pl. 173); Eagle (1982, pl. 27; 2006, p. 165).

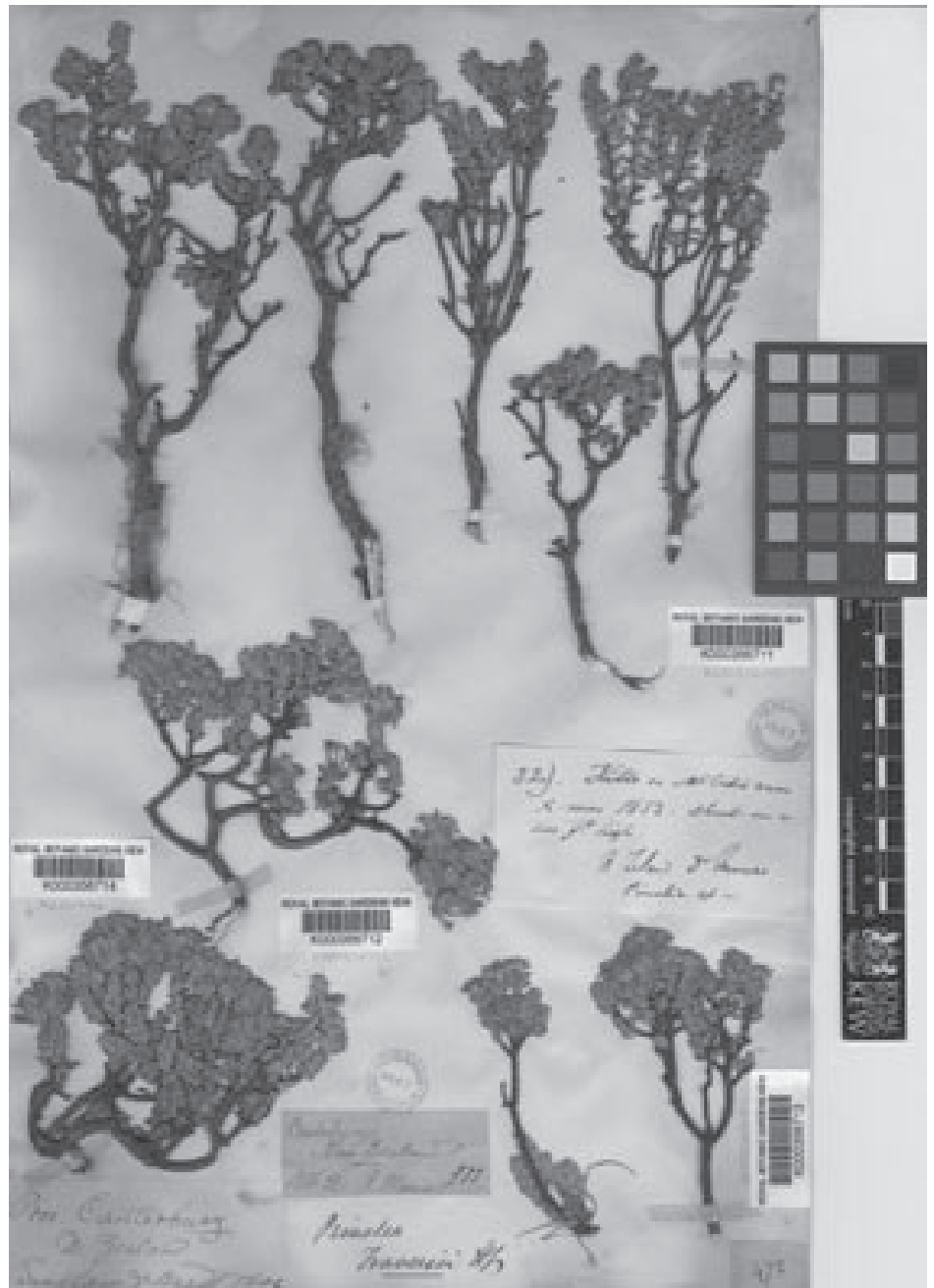
Relative biogeography of *Pimelia buxifolia* and *P. gnidia*

The relative distributions of *P. buxifolia* and *P. gnidia* on the eastern North Island axial mountain ranges, with representation of the *P. gnidia* genome in the form of hybrids with *P. longifolia* in the Tararua and Ruahine Ranges and Hawke's Bay, Gisborne, Bay of Plenty, and Coromandel regions, suggests that these patterns may have had a common origin. The hypothesis proposed here specifically to account for almost complete mutual exclusion of *P. buxifolia* and *P. gnidia* on the axial ranges and reduction of the *P. gnidia* genome to hybrid forms in the north

central and north-eastern North Island, is that the catastrophic Taupo volcanic eruption of 1800 yr BP wiped out most populations of *P. gnidia* (and probably *P. longifolia*) along with their adjacent forest habitat, in the whole area peripheral to the Central Volcanic Plateau. This was effected by burial by tephra airfall, by pyroclastic immolation, and by fires associated with the volcanic events (Wilson & Houghton 1993).

Subsequently, *P. buxifolia* appears to have spread onto the tephra- and ignimbrite-covered terrain. The uniformity of *P. buxifolia* suggests that it may be a relatively young species. *Pimelea longifolia* may have survived the catastrophe more abundantly than *P. gnidia*. The latter subsequently has had its genome diluted comprehensively by hybridisation

Fig. 14 Lectotype of *Pimelea traversii* subsp. *traversii* (K 356711). The five uppermost pieces are regarded as elements of the lectotype, and the remaining pieces are paralectotypes. (Image by courtesy of the Royal Botanical Gardens, Kew, 2007.)



with *P. longifolia*. This could have been initiated at the time of the volcanic disturbance. However, it has probably continued as a result of human disturbance. Some of the areas in question (Thames, Bay of Plenty, Gisborne, Hawke's Bay) were sites of dense Maori settlement, with clearance of forest by fire (Begg & Begg 1969). There is no evidence for hybridisation of either of *P. longifolia* or *P. gnidia* with *P. buxifolia*.

4. *Pimelea traversii* Hook.f. *Handbook N.Z. Flora* 2, 243 (1867)

LECTOTYPE (chosen here): Royal Botanical Gardens, Kew, Hooker Herbarium, No. 32, K 356711. Hills on

McCrae's run, Xmas 1853. "Shrub one or two ft high. N. Zeland", Dr Munro. *Pimelia* sp. [sic]!(Fig. 14).

PARALECTOTYPES: No. 472, K 356712, K 356714 Prov. Canterbury, N. Zealand, Sinclair & Haast 1860(-2) (two pieces); No. 573, K 356713 Canterbury, New Zealand 1862, J. Haast (two pieces).

Five pieces from the same location at the top of the sheet (K 356711) are all regarded as elements of the lectotype. MacCrae's Run was a sheep station in the upper Awatere Valley in what is now Marlborough and the collector was Dr D. Monro. The lower four pieces on the sheet (K 356712, K 356714, K 356713) are the paralectotypes. A. Sinclair was with

J. Haast in the Rangitata Valley from late February 1861 until his death by drowning a month later. It is most likely that the bottom left-hand pieces on the sheet were gathered on mountains in the middle Rangitata Valley, Canterbury, and the bottom right-hand pieces in the Mackenzie Basin, Canterbury, where Haast was exploring and mapping in 1862. The number 472 is thought to refer to 356712 and 356714, because of the numerical and thus chronological order.

DESCRIPTION: A much-branched small to medium-sized shrub up to 80 cm tall (reduced in stature on exposed sites, rocky substrates, and poor soils). Branches often fastigiate, or more widely spread; branchlets hairy at leaf axils and on receptacles, glabrous or, in some forms, with bands of hair between node buttresses on internodes. Node buttresses occupy the whole or most of the internode, medium to dark brown or black, usually prominent after leaf fall, stems aging grey-brown, grey or black. Internodes 1–4 mm long. Leaves decussate, ascending to patent, often closely imbricate, on very short petioles (0.2 mm) or sessile. Lamina medium green to olive green, sometimes red-margined, usually thick and coriaceous, broad elliptic to broad ovate, sometimes oblong or obovate, 3–9 × 2–6 mm, slightly keeled, adaxially concave, obtuse, base angustate or cuneate. Margins thickened, slightly downturned; midvein evident on abaxial side, lateral veins usually obscure. Stomata only on abaxial side. On some dried plants a blue-green colour is evident on many leaves. Inflorescences many-flowered, pedicels 0.2 mm long, persistent. Involucral bracts 4, usually wider than the leaves (6–9 × 4–8 mm). Plants gynodioecious. Flowers hairy on outside; inside densely hairy in ovary portion and lower tube, sometimes sparsely hairy in upper tube; fragrant, white, sometimes pinkish with red lower tube. Calyx lobes open in salverform fashion. ♀ tube to 6 mm long, ovary portion 4 mm, calyx lobes 2.5 × 1.3 mm. Staminodes short, at mouth of tube. ♂ tube to 9 mm long, ovary portion 3 mm, calyx lobes 4 × 2.2 mm; anther filaments inserted below mouth of tube; anthers dehisce laterally. Ovary with abundant hair at summit, less densely hairy to about half-way down. Fruits ovoid, green, drying brown, 4 mm long. Seeds ovoid, 3.5 × 1.6 mm. Flowering spring–summer. Dried hypanthia persist and must disperse with fruits inside.

DISTRIBUTION: Widespread in the South Island mountains east of the Main Divide, near the coast (90 m) on the north-east and inland further south, at higher altitudes. Altitudinal range 90–1850 m, usually above 500 m in inland Marlborough, Canterbury,

Central Otago, and western Southland. There are three subspecies.

4a. *Pimelea traversii* Hook.f., subsp. *traversii*

Stems to 60 cm tall, branches erect and fastigiate on larger specimens, internodes glabrous or sometimes very sparsely hairy (in strips not covered by node buttress tissue). Leaves thick and leathery, though small, (3–6 × 2–4 mm), olive green, sometimes with red margins, lateral veins obscure. Narrow ♀ flower tubes (1–1.5 mm just beneath calyx lobes) and narrow calyx lobes (1–2 mm). Chromosomes: $n = 18$ (Burrows 1958).

REPRESENTATIVE SPECIMENS: MARLBOROUGH: CANU 1036 Upper Clarence R., 1390 m, fellfield, *R.M. Laing* (no date); CHR 176052 Upper Kowhai R., Mt Manakau, Seaward Kaikoura Ra., c.1230 m, rocky outcrop, *I.M. Ritchie*, 13 Jan 1967. CANTERBURY: CHR 550057 Mt Terako, N Canterbury, 1520 m, exposed rocky ridge, with *Podocarpus nivalis*, *K. Platt*, 20 Jan 1988; CHR 322579 Mt Brown, Waipara, 250 m, roadside, on limestone bluff, in crevices, *C.J. Webb*, 12 Oct 1974; CHR 259221 Whistler Track, Lees Valley, exposed rock outcrop, *L.R. Stenman*, 26 Mar 1974; CANU 22988 Cass Hill, Cass, Waimakariri Val., 620 m, rock faces, *G. Brownlie*, 17 Nov 1954; CHR 512248 Cameron Val. near hut, moraine, *D.R. Given*, 24 Jan 1978; CHR 323460 Bush Stm, Rangitata Valley, 650 m, stable riverbed near Sawtooth Ridge, *D.R. Given*, *H. Wilson*, Oct 1975; CHR 498132 Mt Nimrod, Hunters Hills, N of summit, coarse talus with scattered tussocks and herbs, *D.R. Given*, 19 Apr 1979; CANU 8851 Mt Kirkliston, 1540 m, exposed rock ridge, *C.J. Burrows*, Jan 1965; CHR 254393 Mount Cook National Park, behind Blue Lakes, moraine, *H.D. Wilson*, 7 Nov 1969. OTAGO: CHR 480992 Above Lindis Pass, rocky bluff facing W to NW, cliff face ledge, *W.R. Sykes*, 22 Mar 1993; CHR 420886 Dansey's Pass, N Otago, N side, 1280 m ridge leading to Trig Y, *E.H. Woods*, *B.H. Macmillan*, 21 Feb 1986; CANU 9227 Mt St Bathans, Central Otago, 1850 m, *J. Ward*, 28 Mar 1965.

DISTRIBUTION: Inland Marlborough, Canterbury, Central Otago, on relatively dry mountains, at altitudes c. 500–1850 m (Fig. 15). (A specimen from Nelson, AK 100727 Goulard Downs area near Mt Goul, 1219 m, *P. Hynes*, 31 Jan 1964, is not accepted here. Presence of the species at this location needs further corroboration.)

HABITAT: Rock outcrops and stable stone fields, moraines, landslides, sometimes in scrub or grassland

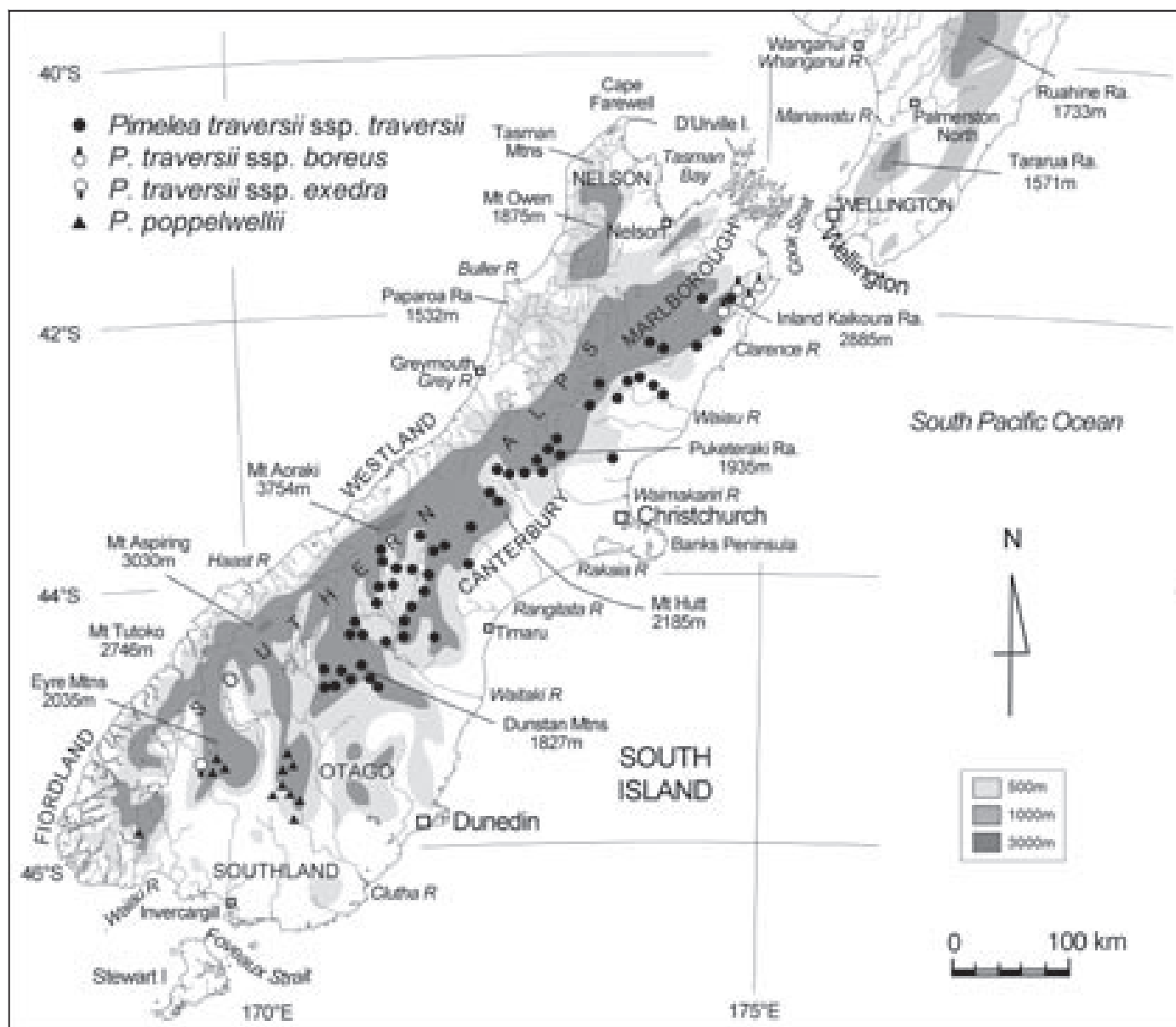


Fig. 15 Distribution of *Pimelea traversii* and *P. poppelwellii*.

on deeper soils; substrate Torlesse sandstone, or Haast schist, rarely on limestone.

ILLUSTRATIONS: Wilson & Galloway (1993, fig. 115).

HYBRIDS: Occasional putative hybrids of *P. traversii* subsp. *traversii* with hairy-leaved species have been observed in field populations, for example: CHR 77230 Clarence Valley, Marlborough, N of Carters Saddle, slide of fine shingle, semi-prostrate, *L.B. Moore*, 22 Apr 1952 (hairs on abaxial sides of leaves, and stems)? \times *P. concinna*; CHR 12915 Jacks Pass (near Hanmer), Canterbury, high rocks to west of pass, *L.B. Moore*, 24 Nov 1962 (middle specimen on sheet) \times *P. oreophila*; CHR 270985 Castle Hill, Canterbury, *H. Talbot*, Nov 1945, upright habit (hair

on abaxial sides of leaves) \times *P. oreophila* or *P. sericeovillosa*; CANU 38855 Cass, Waimakariri Val., damp area at Goldney Saddle, \times *P. sericeovillosa*, *C.J. Burrows*, 1965.

4b. *Pimelea traversii* subsp. *boreus*

C.J. Burrows, subsp. nov.

DIAGNOSIS: A subspecies typica magnitudine majore, in exemplis paucis pilis in internodiis praeditis differt. Differs from subspecies *traversii* by larger plant size and presence of sparse hairs on internodes.

HOLOTYPE: CANU 6618 Woodside Ck, S of Waima (Ure) R. mouth, Marlborough, c. 90 m, scrub on side of limestone cliff, *C.J. Burrows*, Nov 1963 (Fig. 16).



Fig. 16 Holotype of *Pimelea traversii* subsp. *boreus* (CANU 6618). Each piece is regarded as an element of the holotype. (Image by courtesy of the Allan Herbarium, CHR, 2007.)

DESCRIPTION: Stems to 80 cm tall, branches erect and more or less fastigate. Node buttresses relatively narrow and intervening internode surfaces sometimes covered with short, villous hair. Leaves large, light green, elliptic or broad elliptic (6–10 × 3–6 mm) and, on some specimens, notably thin. Midvein evident on abaxial side, lateral veins obscure (Fig. 17).

REPRESENTATIVE SPECIMENS: WELT 15233 Weld Cone, limestone cliff, *W.R.B. Oliver*, 19 Dec 1949; CHR

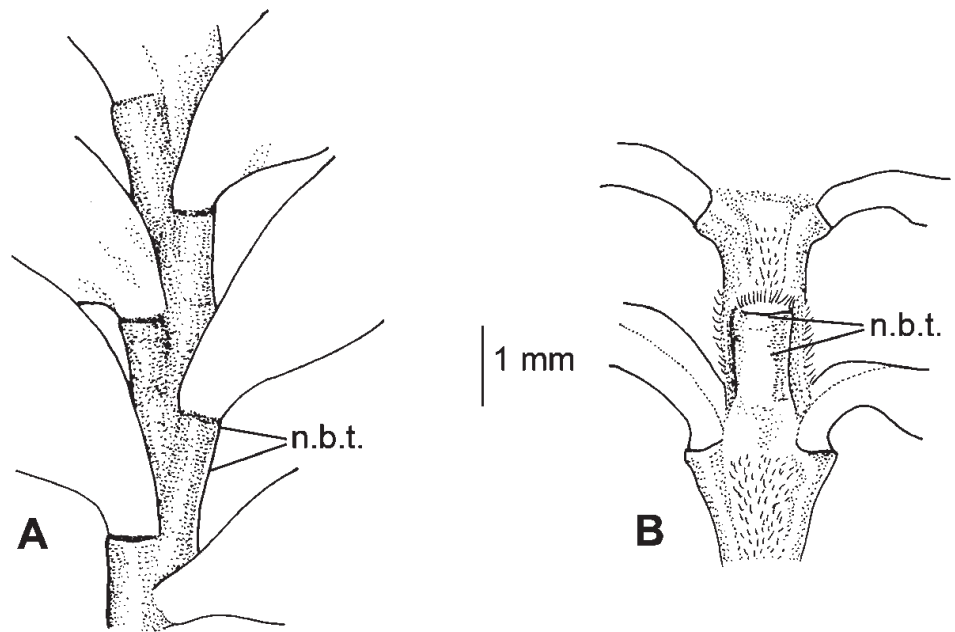
277512 Flaxbourne R. mouth, 123 m, limestone cliff, *A.P. Druce*, Apr 1975; CHR 274882 Chalk Ra., Marlborough, 895 m, limestone cliff, *A.P. Druce*, Mar 1975; CHR 85205 Muzzle Ck, Clarence Valley, 830 m, *R. Mason*, *D.R. McQueen*, 1 Jan 1954.

DISTRIBUTION: Northeastern Marlborough: Flaxbourne R.; Woodside Ck; Chalk Ra., and lower Clarence Valley.

HABITAT: Limestone cliffs and outcrops.

ETYMOLOGY: From the Latin *boreus* (north).

Fig. 17 Internodes and node buttresses of: **A**, *Pimelea traversii* subsp. *traversii*; and **B**, subsp. *boreus*. n.b.t. = node buttress tissue. (Ink drawing by Rebecca Wagstaff.)



ILLUSTRATIONS: Eagle (1985, pl. 32; 2006, p. 166).

4c. *Pimelea traversii* subsp. *exedra*

C.J. Burrows, subsp. nov.

DIAGNOSIS: A subspecie typica habitu humili, floribus maioribus atque substrato e rupe serpentina composito differt. Differs from subsp. *traversii* by low growth habit, larger flowers, and serpentine rock habitat.

HOLOTYPE: CHR 515528 Mt Cerberus, Livingstone Mts, Western Southland, on stable ultramafic scree, P.B. Heenan, 27 Jan 1998 (Fig. 18). Each piece is regarded as an element of the holotype.

DESCRIPTION: Stems to at least 15 cm tall, generally spreading, with some upright branchlets, with very short, sparsely hairy internodes. Node buttresses dark brown. Leaves usually small, thick, light green, lateral veins obscure. ♀ flower tubes relatively large (2–3 mm wide just below calyx lobes which are 3–4 mm wide), white with reddish lower part.

REPRESENTATIVE SPECIMENS: CHR 514969 Mt Cerberus, Livingstone Mts, ultramafic scree, P.B. Heenan, 27 Jan 1998; CHR 515529 Mt Cerberus, Livingstone Mts, P.B. Heenan, 27 Jan 1998; OTA 44932 Mt Cerberus, Livingstone Mts, 1430 m, A.F. Mark, K.J.M. Dickinson, 6 Dec 1986 (no flowers).

DISTRIBUTION: As far as is known only Mt Cerberus, Livingstone Mts, Western Southland.

HABITAT: “20–30 plants scattered over an area of stable scree, amongst boulders”.

ETYMOLOGY: From the Greek *exedros* (strange, extraordinary).

Key to the *Pimelea traversii* subspecies

- 1 Low-growing plants (to 25 cm) on serpentine rock and having notably large ♀ flowers. subsp. *exedra*
Larger plants on other rock types and with smaller ♀ flowers. 2
- 2 Plants up to 80 cm tall, with leaves up to 10 mm long, on limestone. subsp. *boreus*
Smaller plants, up to 60 cm tall, with leaves up to 6 mm long, usually on sandstone or schist. subsp. *traversii*

NOTE: CHR 87245 and CHR 91629, Garvie Mts [western Southland] (no location or dates) represent plants grown in a garden in Dunedin in the 1940s, by G. Simpson. They differ from *P. traversii* subsp. *traversii* plants by having narrower leaves with reddish veins and profusely leafy clusters of spreading branches. Field search is needed to determine whether any other similar, distinctive plants occur in Otago–Southland.

CONSERVATION STATUS: *Pimelea traversii* subsp. *traversii* is not under threat as it inhabits many high mountain locations which are unlikely to be disturbed. It may be browsed by hares, goats, and thar. It is well protected in Canterbury in Arthur’s Pass National Park, reserve areas in the Torlesse Range, Arrowsmith Range, and Mount Cook National Park. Because their total ranges are small, the other subspecies are at much greater risk, and effort is needed to assess them and ensure their protection. This is especially so for subsp. *exedra* which, at present, is known from only one location.



Fig. 18 Holotype of *Pimelea traversii* subsp. *exedra* (CHR 515528). Each piece is regarded as an element of the holotype. (Image by courtesy of the Allan Herbarium, CHR, 2007.)

5. *Pimelea poppelwellii* Petrie *Trans. N.Z. Inst.* 49, 54 (1917)

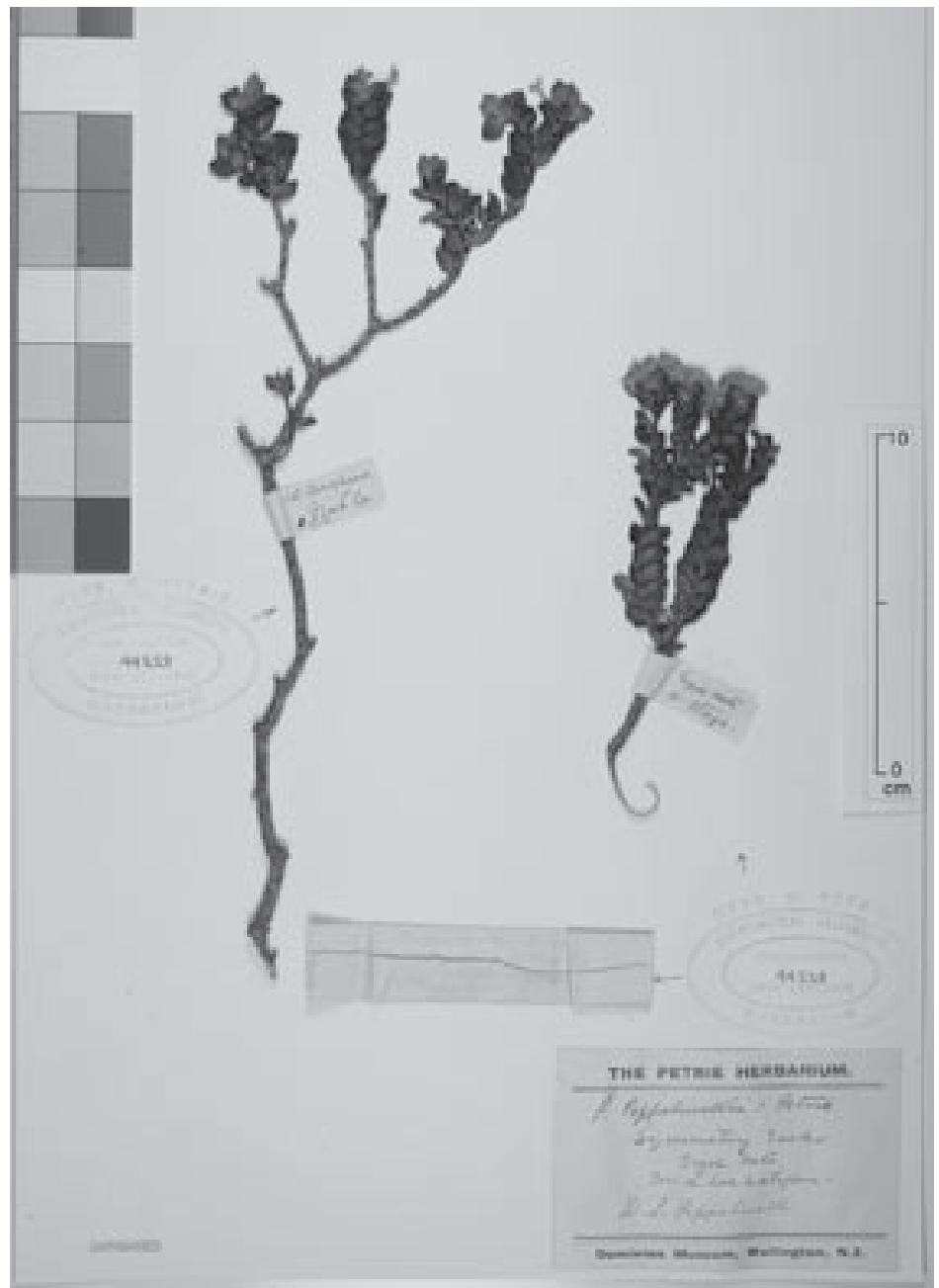
LECTOTYPE (chosen here): Te Papa, Wellington Museum, WELT SPO44228 Symmetry Rocks [Peaks], Eyre Mts, nr L. Wakatipu, *D.L. Poppelwell* (no date)! (Fig. 19).

PARALECTOTYPE: WELT SPO44229 Mt Cleughearn [near L. Monowai], Fiordland, *J. Crosby-Smith* (no date)! (Fig. 19). Along with these specimens, Petrie (1917) listed (and Allan (1961) cited as "Type") a specimen gathered by D. L. Poppelwell from the

Garvie Ra., western Southland, in the herbarium now known as WELT, but this cannot be found (B. Sneddon pers. comm.). In any case, Allan did not properly typify the specimen (cf. the argument in Brownsey (1979)). A recent gathering from the Garvie Ra. is depicted here, also (Fig. 20).

DESCRIPTION: A much-branched erect shrub up to 80 cm tall, lower and spreading in severe sites. Branches and branchlets usually ascending, relatively thin, with leaves on the upper branchlets. Stems glabrous except in leaf axils and on receptacles.

Fig. 19 Lectotype of *Pimelea poppelwellii*; Eyre Mountains, Southland (WELT SPO 44228) on right. Paralectotype (44229) (from Mt Cleughearn, Fiordland) on left. (Image by courtesy of the Wellington Museum WELT and Allan Herbarium, CHR, 2007.)



Node buttresses prominent, brown, occupying the whole internode. Internodes 3–5 mm long. Leaves decussate, ascending, closely imbricate, on petioles 0.5–2 mm long. Lamina dark or lighter green, thick and coriaceous, broad elliptic to broad ovate, 8–12 × 4–5 mm, slightly keeled, obtuse to acute, base cuneate. Margins thickened, downturned; midvein prominent abaxially, lateral veins obscure. Stomata only on abaxial side. On dried plants a blue-green colour is evident on many leaves. Inflorescences few to many flowered, pedicels 1 mm long, persistent. Involucral bracts 4, usually wider than leaves (10 × 7 mm). Plants gynodioecious (Fig. 21). Flowers white, but often lower part of tube red, hairy on

outside; inside moderately hairy in ovary portion, sparse short hair in tube. ♀ tube to 6 mm long, ovary portion 4 mm, calyx lobes 2 × 1.5 mm. ♂ tube to 13 mm long; ovary portion 5.5 mm, calyx lobes 3.2 × 2.2 mm. Anther filaments inserted below mouth of tube; anthers dehisce latrorsely. Ovary very hairy at summit. Fruits ovoid, green, drying brown, 4.8 mm long. Seeds ovoid 4 × 1.8 mm. Flowering time summer. Dried hypanthia persist and must disperse with the fruits inside. Chromosomes: No counts are known.

REPRESENTATIVE SPECIMENS: CHR 439570 Garvie Mts, Mt Tennyson, E of top, 1400 m, damp hillside among *Chionochloa macra*, *Celmisia lyallii*,



Fig. 20 Habit of *Pimelea poppelwellii* from one of the localities cited by Petrie (1917) in the protologue for this species, Garvie Mountains, Southland. (Image by courtesy of the Allan Herbarium, CHR, 2007.)

P.N. Johnson, 25 Jan 1988; CHR 322549 N end of Old Man Range, Otago on rocks in peaty soil, *C.J. Webb*, 5 Feb 1974; CHR 431250 Ridge Crown Rock to Stronach Hill, Black Umbrella Ra., 1160 m, *Chionochloa rigida* dominant tussock, *K.M. Dickinson*, *B.D. Rance*, 25 Nov 1985; OTA 43818 E catchment to Mt Whitecoombe, 1300 m, Umbrella Mts, *Chionochloa macra-Dracophyllum uniflorum*

shrub tussockland, *K.J.M. Dickinson*, *A.F. Mark*, 9 Mar 1986; OTA 44201 Mid Dome, near Nokomai, 1190 m, snow tussock–*Aciphylla*, *K.J.M. Dickinson*, *A.F. Mark*, 11 Dec 1986; CHR 261240 Eyre Ck near head, Eyre Mts, 1080–1235 m, stable scree slopes, N side of valley, numerous plants forming semi-prostrate low subshrubs, *D.R. Given*, *J. Anderson*, Nov 1971.

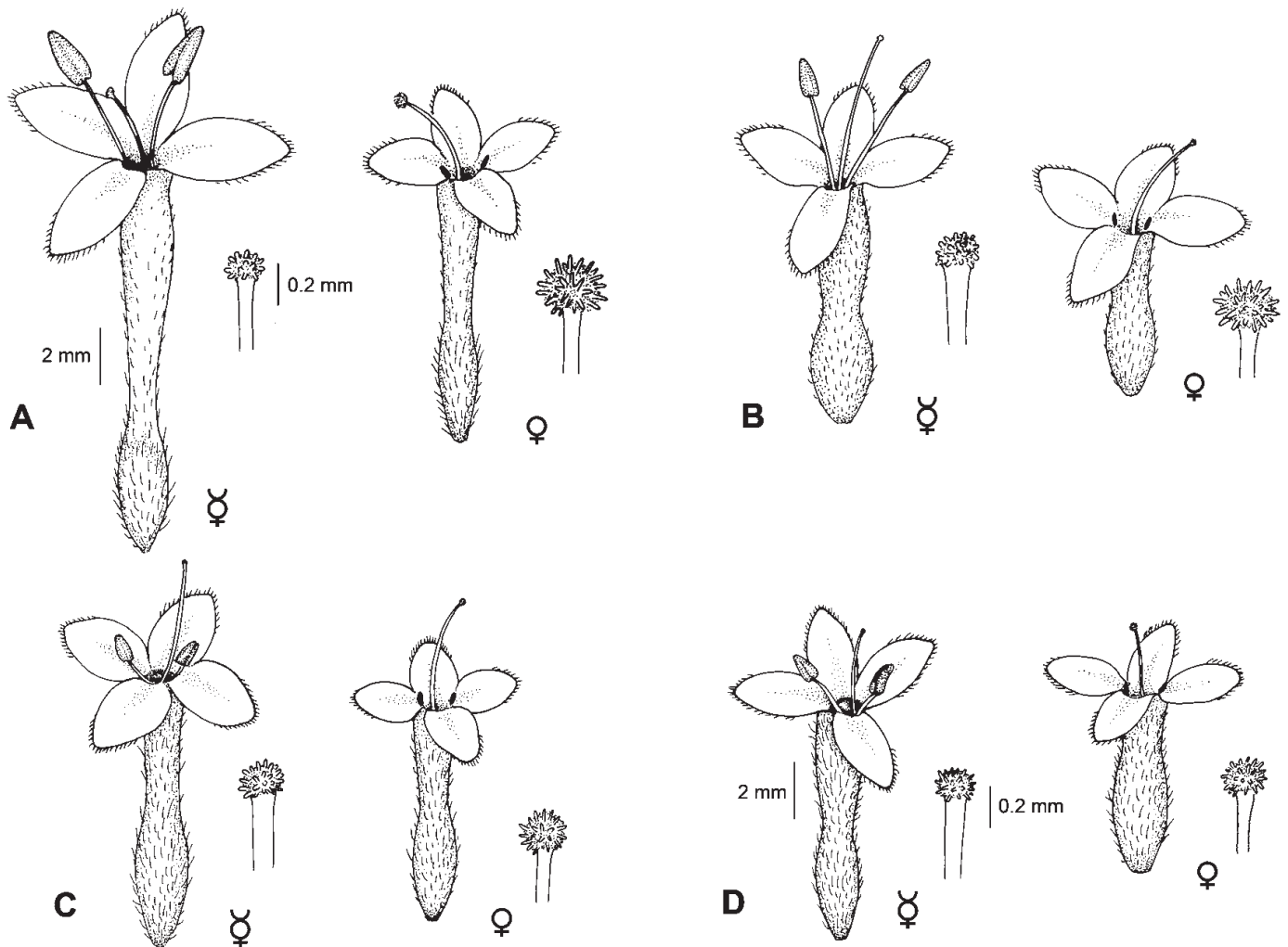


Fig. 21 Flowers of: **A**, *Pimelea longifolia*; **B**, *P. gnidia*; **C**, *P. poppelwellii*; and **D**, *P. traversii* subsp. *traversii* comparing hypanthia, filament lengths, anthers (♂), staminodes (♀), and stigma sizes. (Ink drawing by Rebecca Wagstaff, 2007.)

DISTRIBUTION: Eastern Fiordland; western Southland; western Central Otago (Fig. 15).

HABITAT: Snow tussock grassland with herbs, shrubs; rocky sites, 1000–1400 m.

CONSERVATION STATUS: The species appears to have limited occurrences throughout its range. It is listed in de Lange et al. (2004) and Hitchmough et al. (2007) as “At risk; sparse”. A full investigation of its conservation situation is required.

ILLUSTRATIONS: Eagle (1982, pl. 29; 2006, p. 169).

NOTE: A minimum number of 20 specimens of *P. poppelwellii* could be sexed without dissecting flowers. Of these, 18 were bisexual (7 with seeds set) and 2 were female. This probably represents a real bias towards bisexuality. The hermaphrodites have larger stigmas than is usual in gynodioecious species (Fig. 21).

***Pimelea actea* C.J.Burrows, sp. nov.**

DIAGNOSIS: A speciebus omnibus cognitis gregis *Pimeleae* prostratae ramis gracilibus, systemate rhizali debili, fructibus albis translucentibus atque floribus perfectis differt. Differs from other *Pimelea prostrata* group species by its slender branches, weak root system, translucent white fruits, and perfect flowers.

HOLOTYPE: Auckland Museum, Tamaki Paenga Hira, AK 216124 Himatangi, Manawatu, *A.E. Esler*, 9 Jan 1968! (Fig. 22, 23, 24). Both specimens on the sheet are regarded as elements of the holotype.

DESCRIPTION: Small shrubs up to 50 cm tall, usually less, with slender, sparsely branched, erect to suberect stems, notably sympodially branched. Root system small and weak. Young branchlets sparsely hairy in leaf axils and on receptacle and there may

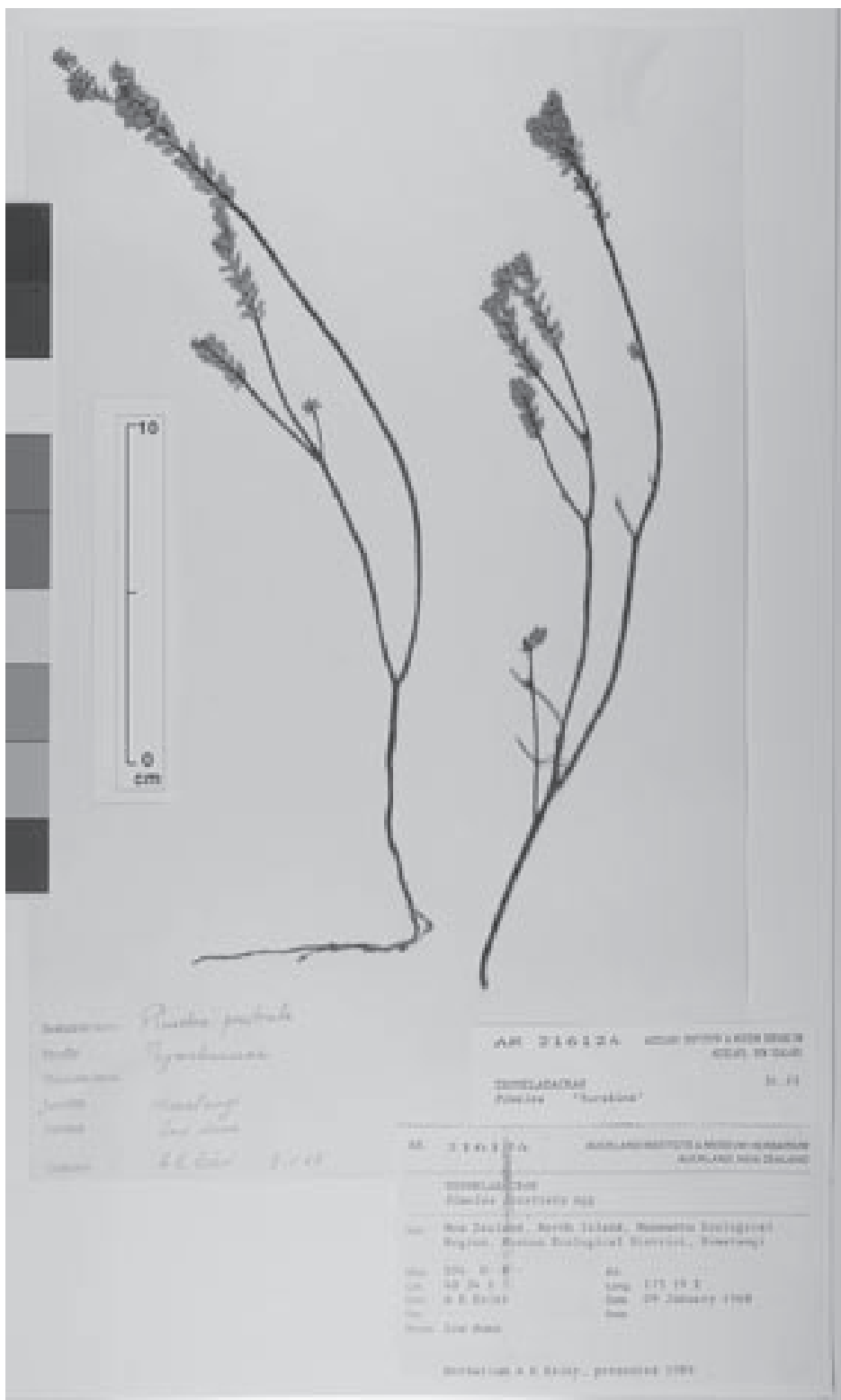


Fig. 22 Holotype of *Pimelea actea* n. sp. (AK 216124). Both pieces are regarded as elements of the holotype. (Image by courtesy of the Auckland Museum AK and Allan Herbarium, CHR, 2007.)

be well-defined narrow bands of short hair along the full length of the internode; older stems hairless, grey or brown. Node buttresses smooth, brown, and occupy the whole internode or form hairless strips, sometimes prominent on leafless stems. Internode length 3.0 mm or less. Leaves decussate, ascendant, becoming patent, persistent, on short (0.5–0.8 mm)

red petioles; lamina glabrous, pale green, 3–5.5 × 1.2–3.5 mm, elliptic to slightly obovate, slightly adaxially concave, obtuse, base cuneate to truncate. Stomata only on adaxial side. Inflorescences terminal on branchlets, loose, 3–11-flowered. Involucral bracts 4, broad elliptic to ovate (6 × 3 mm) partly hiding the flowers. Plants bisexual. Flowers white,



Fig. 23 Habit and habitat of *Pimelea actea*, Himatangi Beach, Manawatu. (Photo: C. J. Burrows, Mar 1997.)

on short pedicels (0.8 mm); tube and calyx lobes moderately hairy outside, inside glabrous, or rarely with sparse hair near the mouth; tube to 3 mm long, ovary portion 1 mm long, calyx lobes 1.3×1.0 mm. Anther filaments inserted at mouth of tube; anthers dehisce semi-latrorsely. Ovary with a few hairs at summit. Fruits globose, fleshy, translucent white, 5×4.5 mm. The hypanthium breaks off, irregularly, near the base as the fruits ripen. Seeds narrow-pyriform, with very thin crest 2.8×1.7 mm (Fig. 24). Flowering spring, summer. In late-flowering plants in cultivation in Christchurch a few ♀ flowers (with aborted anthers) were seen in 1998. Chromosomes: $2n = 36$ (Dawson & Beuzenberg 2000, p. 8, as *P. "Turakina"*).

RECOGNITION: The bisexual flowers, slender, erect to suberect stems and translucent fruits (Fig. 24) immediately distinguish *P. actea* from other forms in the *P. prostrata*–*P. urvilliana* species complexes as was indicated in a phenetic study comparing *P. actea* with several entities from those groups (Burrows 2001). Otherwise, its more or less continuous spring–summer flowering and easily germinated seeds also set it apart from other New Zealand

Pimelea species. *Pimelea actea* from Himatangi retains its sparsely branched stems in cultivation, though the stems tend to straggle as they elongate (cf. CANU 38871, received from Jill Broome, Percy Reserve, Lower Hutt).

REPRESENTATIVE SPECIMENS: CHR 2512 Himatangi Sands, *V.D. Zotov*, 10 Mar 1931; CHR 179559 Sand flat, Turakina River Mouth, *A.P. Druce*, Oct 1967; CHR 477435 Himatangi Beach, wet hollows in dune slack, *P.J. de Lange*, 14 Apr 1992; CHR 568144 Castlecliff, old mudstone slip on sea cliff, *C.C. Ogle, J. Campbell*, 25 May 2003.

DISTRIBUTION: Formerly at Turakina River Mouth and Foxton Beach, Manawatu District, now extinct at those localities; present at Himatangi Beach, Manawatu and Castlecliff Beach, Wanganui (Fig. 13).

HABITAT: In Manawatu with *Isolepis nodosa*, *Juncus caespiticius*, *Lobelia anceps*, *Schoenus nitens*, *Selliera rotundifolia*, *Triglochin striatum*, scattered *Apodasmia similis*, and *Cortaderia* sp. on sand flats and dune slacks inundated with fresh to brackish water in winter–spring. In Wanganui on sand pockets on an old mudstone slump on sea cliff; associated with short turf vegetation with *Schoenus nitens*, *Selliera*

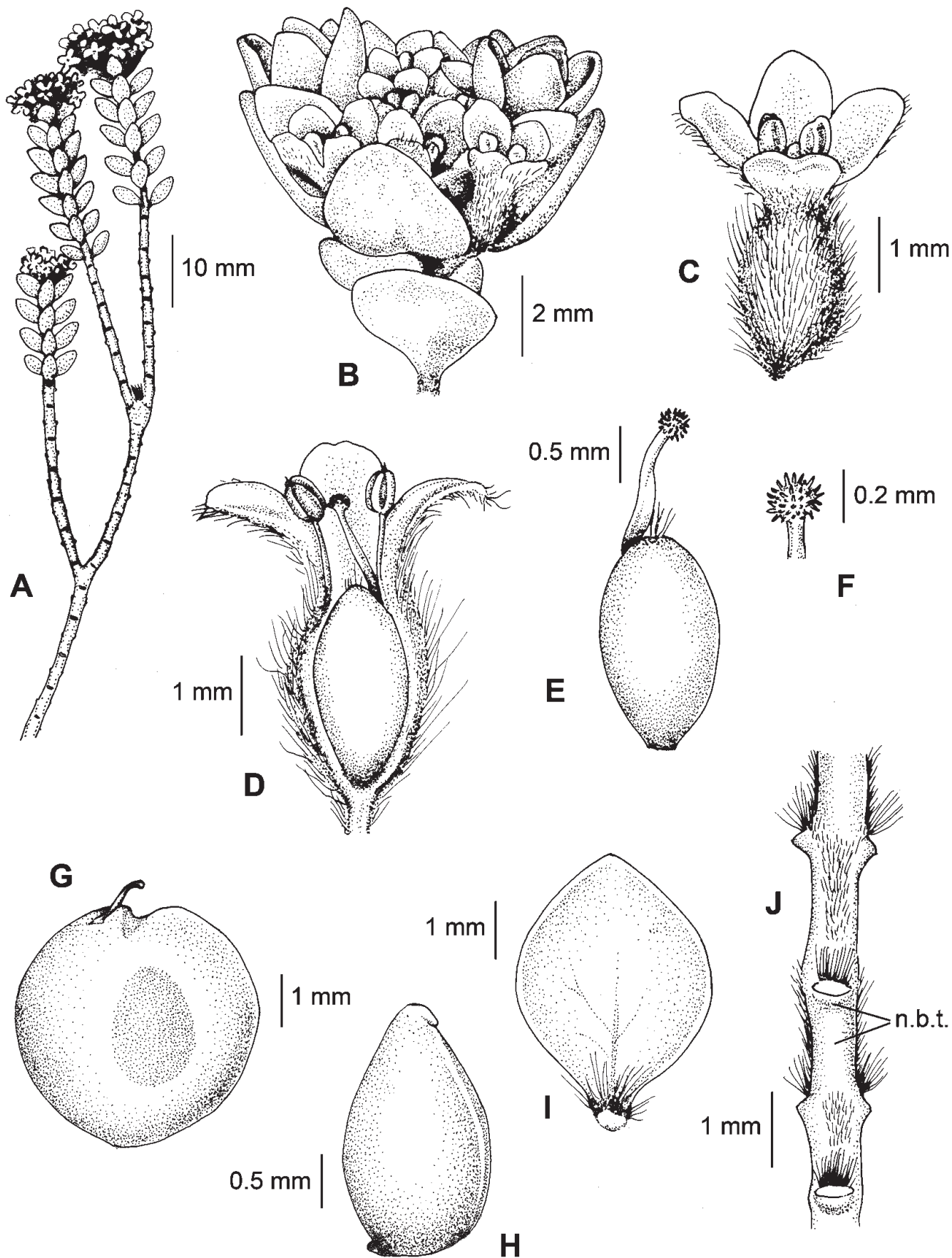


Fig. 24 Habit of *Pimelea actea* and detail of organs: **A**, plant habit; **B**, involucre and inflorescence; **C**, flower; **D**, cut away flower with ovary and style; **E**, ovary and style; **F**, stigma; **G**, fruit; **H**, seed; **I**, leaf, adaxial view; **J**, internodes and node buttresses. n.b.t. = node buttress tissue. (Ink drawing by Rebecca Wagstaff, 2007.)

sp., *Samolus repens*, *Lobelia anceps*, and occasional *Apodasmia similis* and *Isolepis nodosa*.

CONSERVATION STATUS: The listing in de Lange et al. (2004) and Hitchmough et al. (2007) is “Acutely threatened: nationally critical”. The surviving populations are very small. At Himatangi the threats are from trampling, overwhelming by blown sand, and weed incursion. This is one of New Zealand’s plant species most in danger of extinction and a determined effort is required to save it, by propagation and transplants (see Appendix 1).

ETYMOLOGY: From the Greek akte (coast), referring to the coastal habitat.

ILLUSTRATION: Eagle (2006, p.153).

NOTE: A number for *P. actea* will appear in a later paper on the *P. prostrata* species complex. Additional hazards affecting natural populations of *P. actea* are attacks by larvae of an unidentified moth, and frost. Specimens in cultivation in a shade house in Christchurch in 2002 were killed by a frost of about -8°C .

A further threat to the integrity of the *P. actea* genotype is introgressive hybridisation with a prostrate form (?*P. sp. aff. urvilliana*), for example, CHR 2003 Foxton, no collector named (probably V. D. Zotov), 28 May 1929; CHR 2512 Himatangi sands, V.D. Zotov, 10 Mar 1931; CHR 221438 Turakina Beach, cultivated at Taita, A.P. Druce, Jan 1969. On this last specimen, a note indicates that the leaves are thick and fleshy and the plant was erect at first but later collapsed and became more or less prostrate. Plants originally from Castlecliff and recently propagated at Percy Reserve, Lower Hutt (CANU 38872) have developed a semi-prostrate form with abundant lateral branchlets. These appear also to be hybrids (*P. actea* \times *P. sp. aff. urvilliana* or *P. prostrata*).

Pimelea telura C.J.Burrows sp. nov.

DIAGNOSIS: A speciebus omnibus cognitis gregis Pimeleae urvilliana magnitudine ampla robusta, ramis decumbentibus vel suberectis, foliis magnis crassis atque floribus perfectis differt. Differs from other *Pimelea urvilliana* group species by its large size, robust, decumbent to suberect branches, large, thick leaves, and perfect flowers.

HOLOTYPE: Auckland Museum, Tamaki Paenga Hira AK 182959 Great Island, landing in South East Bay, A.E. Wright, Coll. No. 8725, 28 Feb 1989! “Occasional 30–40 cm high, rounded shrubs on rocky outcrops, growing with renga lily, *Poa anceps*, taupata, *Hebe insularis*, *Asplenium oblongifolium*,

Dichondra repens, and *Disphyma australe* beneath” (Fig. 25, 26, 27). Both pieces on the sheet are regarded as elements of the holotype.

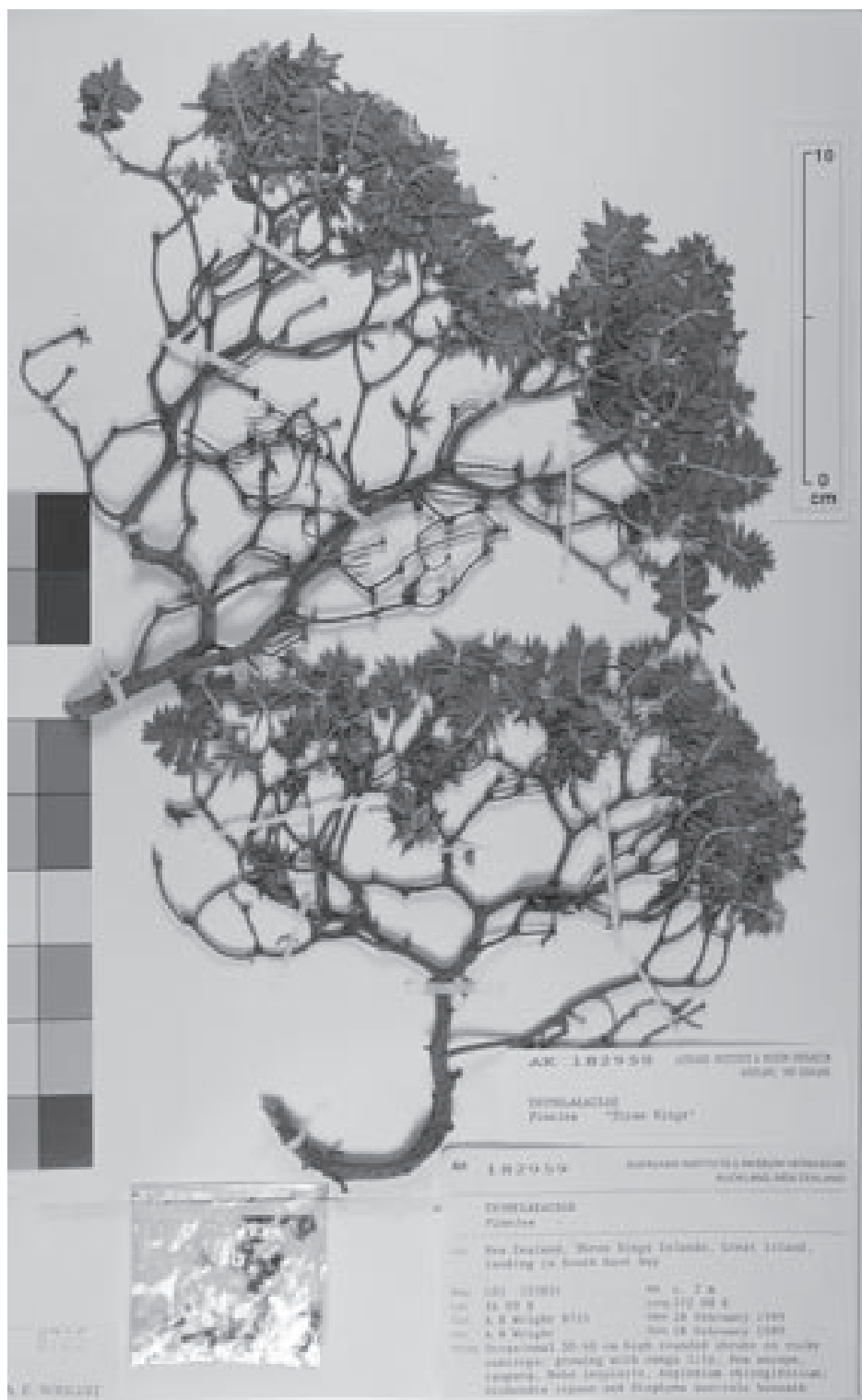
DESCRIPTION: Shrubs, to 1 m tall and 1 m wide with thick, stiff stems, decumbent to suberect or erect, notably sympodially branched. Young branchlets densely covered with appressed, short, white, villous hair, older stems less hairy, pale brown. Node buttresses short (0.2 mm), lunate, hidden by hair on young branchlets, prominent after leaf fall. Internode length 1.5–3 mm. Leaves decussate, crowded on young branchlets, on short, brown petioles (0.5–0.8 mm), ascendant, becoming patent or deflexed. Lamina glabrous, glaucous, 8–14 \times 3–6 mm, leathery, flat to slightly adaxially concave, to cymbiform, ovate to narrow ovate or broad elliptic to narrow elliptic, acute to slightly acuminate (but blunt-pointed), base cuneate. Stomata only on adaxial side. Inflorescences crowded, compact, 3–8-flowered. Involucral bracts 4, ovate to elliptic 8–12 \times 4–5 mm. Receptacle very hairy. Plants bisexual. Flowers creamy white, on very short pedicels (0.3 mm). Outside of tube and calyx lobes densely covered with hair; inside hairless or sometimes with sparse hair; tube to 5 mm long, ovary portion 4 mm long, with vertical “stripes” of hair when dry, calyx lobes 3 \times 2 mm. Anthers dehisce semi-latorse. Ovary summit with dense short hair, extending two-thirds of the way to the base. Fruits ovoid, fleshy, creamy white, 6 \times 3 mm. The hypanthium breaks off, irregularly, near the base as the fruits ripen. Seed broad-pyriform, with very thin crest, 3.5 \times 2 mm. Flowering spring–summer. Chromosomes: no counts known.

RECOGNITION: The large plants with robust habit, large, thick leaves, dense hair covering on branchlets, and bisexual, cream-coloured flowers with vertical “stripes” of hair on the ovary portion distinguish *P. telura* from other species (Fig. 27).

REPRESENTATIVE SPECIMENS: AK 22806 Great Island, G.T.S. Baylis, 4 Dec 1945; AK 162653 Great Island, coastal forest on rock scree between Castaway Valley and Tasman Valley, A.E. Wright, 15 Dec 1982; CHR 475019 Great Island, North East Bay rope landing, P.J. de Lange, 16 Oct 1991; AK 175052 South West Island, A.E. Wright, 26 Nov 1983; CHR 475049 South West Island, Three Kings Islands, cliffs on western side of summit ridge (greywacke), P.J. de Lange and B.D. Clarkson, 17 Oct 1991; AK 231918 West Island, 100 m, P.J. de Lange, 5 Dec 1996.

DISTRIBUTION: Three Kings Islands: Great Island; South West Island; West Island (Fig. 13).

Fig. 25 Holotype of *Pimelea telura* n. sp. (AK 182959). Both pieces are regarded as elements of the holotype. (Image by courtesy of the Auckland Museum AK and Allan Herbarium, CHR, 2007.)



HABITAT: Sandstone cliffs and talus or soil, with forbs, ferns, shrubs, *Phormium tenax*, and scattered trees.
CONSERVATION STATUS: The species is locally abundant on Great Island where it is represented by several vigorous populations. In the threat lists (de Lange et al. 2004; Hitchmough et al. 2007) it is recorded as “At risk; range restricted”, but it is protected by the remoteness of the location.

ETYMOLOGY: From the Greek telouros (remote) referring to the island location 60 km north-west of Cape Reinga.
ILLUSTRATION: Eagle (2006, p. 153).
NOTE: A number for *P. telura* will appear in a later paper on the *P. urvilliana* species complex. Hairy-stemmed, glabrous-leaved plants, superficially similar to *P. telura*, occur at North Cape, North Auckland,



Fig. 26 Habit and habitat of *Pimelea telura*, Great Island, Three Kings Islands. (Photo: A. E. Wright, Feb 1989.)

and on some North Auckland offshore islands. However, they are smaller and more slender than *P. telura*, and are gynodioecious, with relatively small flowers. Some are erect and others semi-prostrate. On a herbarium sheet label (CANU 37474, duplicate of AK 228145) P. J. de Lange noted that *P. telura* on Great Island, near Bald Hill, was associated with and apparently hybridising with *P. sp. aff. urvilliana*. One of the putative hybrids (AK 228138 Great I., near Bald Hill, 189 m, P.J. de Lange, 2 Dec 1995) is erect with imbricate, broad-elliptic leaves 3.5×2 mm and slender branchlets with lunate node buttresses.

CONCLUSIONS

The established taxa

The “*P. gnidia*” group of five species forms a distinct subunit in the genus *Pimelea* in New Zealand. Their common features are summarised in Table 4. Although only a few features are exclusive to the group in this country (and some of the species do not conform with the rest for some characteristics), the

dry fruits, long ♀ flower tubes, flowers sometimes coloured pink, and blue-green colour of dried leaves in all but *P. longifolia* are definitive features. They also occur in some Australian species (cf. Hooker 1853, p. 222; Rye 1990). Floral, pollination, and seed dispersal biology of all these species require intensive study.

The work of the early botanists (Solander, the Forsters, Hooker) has stood the test of time with respect to four of the five long-established *Pimelea* species. Petrie’s eye for distinctive characters also proved effective for the fifth, *P. poppelwellii*, but not for *P. crosby-smithiana*. Wider botanical exploration of the Fiordland mountains and valleys and other areas in western Southland and western Central Otago has led to a better understanding of the complex of forms that constitute *P. gnidia* and, thus, to the demise of the name *P. crosby-smithiana* for a taxonomic unit.

Further investigation of the genotypic and phenotypic complexities to be seen in *P. gnidia* populations is warranted, but the variability evident in populations in the south-western South Island is normal for such a wide-ranging, ecologically flexible species.

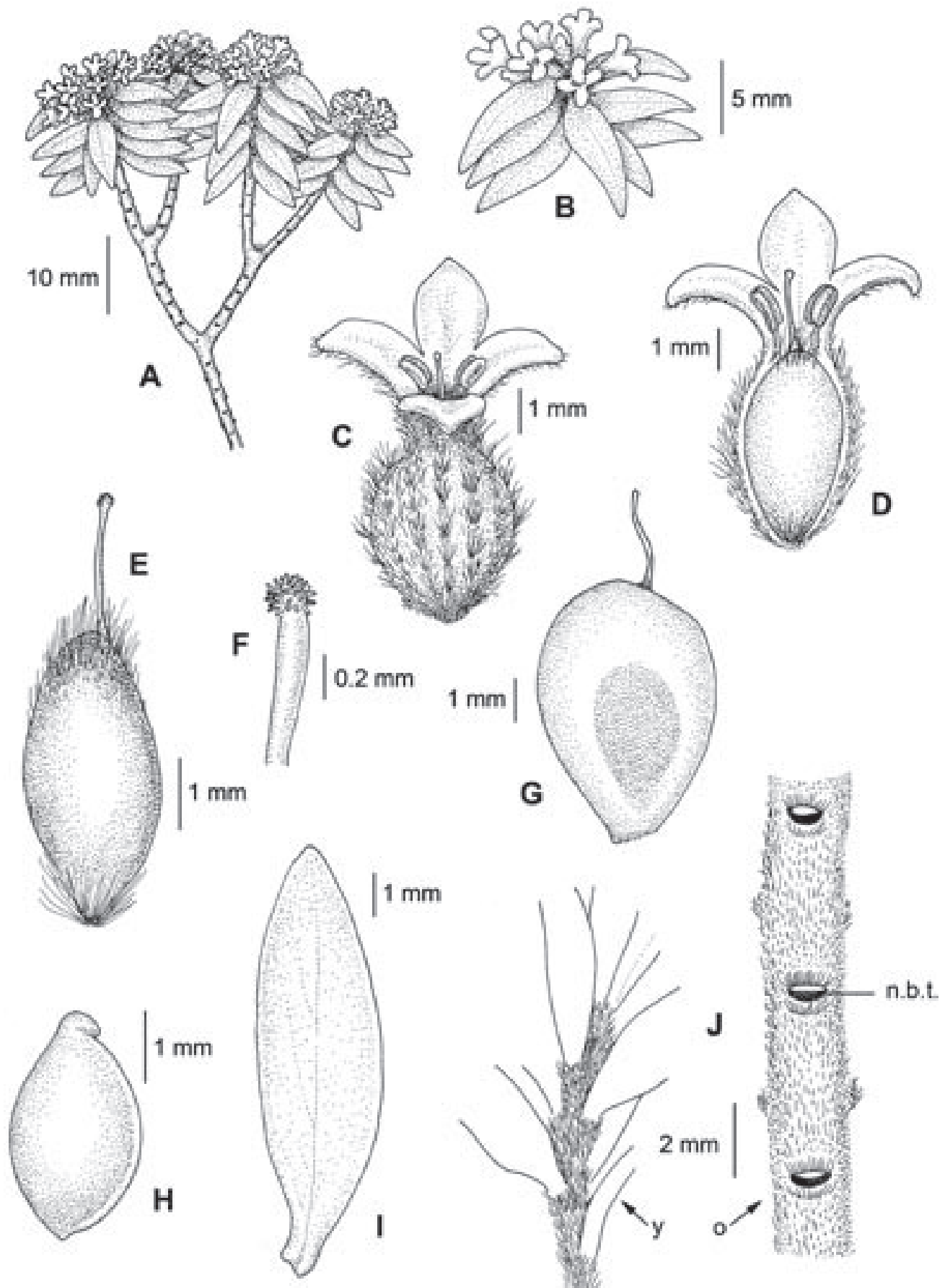


Fig. 27 Habit of *Pimelea telura* and detail of organs: **A**, plant habit; **B**, involucre and inflorescence; **C**, flower; **D**, cut away flower with ovary and style; **E**, ovary and style; **F**, stigma; **G**, fruit; **H**, seed; **I**, leaf, adaxial view; **J**, internodes and node buttresses on young (y) and old (o) branchlets. n.b.t. = node buttress tissue. (Ink drawing by Rebecca Wagstaff, 2007.)

Table 4 Character distribution among species covered in this paper. (A, node buttress tissue covers whole internode; B, node buttress tissue strips extend the length of internode, with strips of ordinary tissue between them; C, node buttresses are very short and lunate.)

	Branchlet node buttress prominence on leafless branchlets	Max. leaf length (mm)	Max. leaf width (mm)	Leaf margin	Leaf lateral veins clearly evident	Leaf tip	Leaf stomatal distribution	Blue-green colour of some dried leaves	Sexual expression	Longest ♀ flower tubes 9 mm or more	Fruit type	Usual habitats
<i>Pimelea longifolia</i>	A rarely	40–110	10–22	down-turned	yes	acuminate	abaxial only	no	gyno-dioecious	yes	dry	open forest, rock (limestone) forest margin scrub, lowland open forest, forest margins, scrub (coast to low alpine)
<i>P. gnidia</i>	A sometimes	5–35	2–7	down-turned	no	acute, blunt-pointed	abaxial only	yes	gyno-dioecious	yes	dry	open forest, forest margins, scrub (coast to low alpine)
Hybrids <i>P. longifolia</i> × <i>P. gnidia</i>	A sometimes	14–90	2.5–16	down-turned	yes	obtuse, acute or acuminate	abaxial only	some-times	gyno-dioecious	yes	dry	scrub (coast to subalpine)
<i>P. traversii</i> sens lat.	A or B usually	6–9	3–6	down-turned	some-times	obtuse	abaxial only	yes	gyno-dioecious	yes	dry	rock, rock debris (including limestone, serpentine), scrub montane–alpine, sometimes lowland
<i>P. poppelwellii</i>	A yes	12	5	down-turned	no	obtuse sometimes acute, blunt-pointed	abaxial only	yes	gyno-dioecious (but few ♀s)	yes	dry	snow tussock grassland with shrubs, rock, subalpine–low alpine
<i>P. buxifolia</i>	C sometimes	10	5	down-turned	no	acute, blunt-pointed	abaxial only	yes	gyno-dioecious	yes	dry	scrub-tussock grassland on volcanic soils subalpine–low alpine
<i>P. actea</i>	B rarely	5.5	3.5	flat or slightly upturned	no	obtuse	adaxial only	no	bisexual	no	fleshy, white translucent	coastal sand, wet hollows
<i>P. telura</i>	C usually	14	6	flat or slightly down-turned	no	acute to slightly acuminate, blunt-pointed	adaxial only	no	bisexual	no	fleshy white opaque	rock, rock debris, open soil, scrub, near sea level

Fisher (1965) found variability of even greater magnitude in species among wide-ranging alpine *Ranunculus* in New Zealand (e.g., in *R. insignis*). *Pimelea gnidia* exhibits the intriguing feature of clines of variation between forested fiord shorelines and alpine grassland, over relatively short distances in Fiordland. Clines are also present in this region in populations from the western coast to the eastern valleys and mountains.

Geographic separation of *P. gnidia*—populations at either end of the South Island and a wide gap in the middle—provides a clue to the minimum evolutionary age of that species. Disjunctions like this are found among other, unrelated species. They occur, for example, in *Nothofagus fusca*, *Celmisia traversii*, and *Hebe salicornioides*. The most economical hypothesis to account for such distributions is that severe conditions of the last (Otira) glaciation, about 70 000–14 500 yr ago (Burrows & Wilson 2008), created a gap in plant distributions in the central South Island which, for some species, has not yet been filled by migration into the gap from north and south. If these ideas are correct, *P. gnidia* in its present form must predate the last glaciation.

The apparent anomalies of *P. buxifolia* and *P. gnidia* distributions in the east and north of the central North Island (and their relationship to the 1800 yr BP Taupo volcanic eruption) may be a means for gauging the age of *P. buxifolia*. However, although its present distribution appears to be the outcome of provision of abundant habitat on the ejecta, it is probably older than 1800 yr BP.

As *P. traversii* subsp. *traversii* is a specialist on sandstone or schist rock outcrops, it is likely to be an old species that evolved in these habitats. It was noted earlier that *P. poppelwellii* could have originated by a hybridisation event between *P. traversii* and *P. gnidia*. Its geographic range is small so it might be a relatively young species. Alternatively, it may be old but particularly habitat limited. The species is poorly understood in many respects. *Pimelea longifolia* is probably old. It may have needed a frost-free haven in the far north in glacial times. DNA sequencing may eventually provide some answers to the phylogenetic and relative age questions that have been raised here.

Other than *P. gnidia* itself, in which the population to population variation appears to be more or less continuous, the only species in the “*P. gnidia*” group which shows clear signs of variation resulting from evolutionary modifications in local distinctive environments is *P. traversii*. On the periphery of the geographic range of the widespread and uniform

P. traversii subsp. *traversii* are the variant forms which have been described here as subspecies. For subspp. *boreus* and *exedra* a special substrate factor correlates with the variant form, but the selective causes of maintenance of large-sized stems and leaves, or flowers, respectively, are unknown.

Hybrids between *Primelea longifolia* and *P. gnidia*

The two largest-leaved species of the “*P. gnidia* group” *P. gnidia* itself, and *P. longifolia*, pose a dilemma for systematic treatment because of their propensity to hybridise wherever their populations meet. The field situation and the way in which the taxonomy can be handled were outlined above. It did not seem to have been apparent to the botanists from the *Endeavour* in 1769 that there were hybrid populations. The first mention in literature of hybrids was by Cheeseman (1906) who noted (as *P. gnidia* var. *pulchella*) a form intermediate between *P. longifolia* and *P. gnidia*. However, without specifying the taxa, Hooker (1867, p. 242) wrote, “The species are most variable and difficult of discrimination. I have forms that appear intermediate between the best-marked species.” Colenso (1886, 1890) published descriptions of *P. angulata*, *P. lanceolata*, and *P. similis*. Each is based on hybrid specimens. It was not until Cockayne & Allan (1934) listed “hybrid swarms” between *P. gnidia* and *P. longifolia* that the magnitude of this hybrid phenomenon began to be understood.

The lack of 19th or 20th century collections of *P. gnidia* in pure form from sites north of the Rimutaka Ra., except for one specimen from the Kaweka Ra. cited above (WELT 52830 a. Kuripapango, upper Ngaruroro, [?B.C. Aston], Jan 1889), suggests that *P. longifolia* and *P. gnidia* crossing in that area might have been proceeding long before European settlement (or even before arrival of the Maori, about 800 yr ago; McFadgen 2007). That hybridisation between the two is an ongoing phenomenon is indicated by recent finds of both parents and young hybrid plants in parts of the north-west Nelson region.

In heavily forested, pristine New Zealand, before widespread human forest disturbance (McGlone 1983; McGlone et al. 1994; Burrows 2006), it seems probable that these two species occupied different though overlapping altitudinal zones in their North Island and northern South Island distributions. *Pimelea longifolia* was the species of lowland habitats (cliffs, rock outcrops, especially on limestone and forest margins near the coast, where the botanists

of Cook's first voyage found it, and along river and lake edges). It extended upslope on cliffs and other natural openings and is found most commonly in such habitats today. *Pimelea gnidia* grew on infertile soils at higher levels on the same kinds of sites, as well as above the forest limit on those mountains high enough to have a timberline. However, now it also inhabits some lower level sites in Marlborough and Nelson, possibly as a result of forest disturbance. Both *P. longifolia* and *P. gnidia* now often grow in shrubby vegetation where forest has been burnt. Hybrids between them also occur very abundantly in such habitats.

In Fiordland *P. gnidia* grows at sea level on rock and on deeper, leached, infertile and sometimes acidic, peaty soil. Higher on the slopes it lives on gashes in the forest caused by landslides, on open heath areas with poor soils, in scrub in deep valley heads, and at timberline. Overall it seems to be generally more versatile with respect to the range of substrates occupied than is *P. longifolia*.

Experimental studies on crossing, isozyme analysis, and DNA sequencing might help to unravel the degrees of hybridity. Whether or not some of the hybrid forms have become "fixed" through back-crossing could be tested. Hybridisation is not evident between other members of the "*P. gnidia* group", except perhaps for the origin of the uniform *P. poppelwellii*; however, *P. traversii* has been able to cross, occasionally, with hairy-leaved *Pimelea* species.

New specific taxa

The two new species, *P. actea* and *P. telura*, are not closely related to any of the "*P. gnidia*" group, nor to each other. Their closest similarities are to members of the species complexes which, respectively, include *P. prostrata* and *P. urvilliana*. With these, the two new species share white, fleshy fruits and glabrous, glaucous leaves. However, *P. actea* with its slender, erect to suberect habit and *P. telura* with its suberect, robust habit and large leaves are amply distinct from one another and from any other entities of the *P. prostrata*–*P. urvilliana* aggregate (Burrows 2001). Nevertheless, apparent hybridisation of each of *P. actea* and *P. telura* with a *P. urvilliana* group species requires further investigation.

An exceptionally important feature of each of *P. actea* and *P. telura* is their bisexual breeding system. All other New Zealand *Pimelea* species that have been well investigated are gynodioecious. It is generally accepted that the gynodioecious breeding system is derived from a hermaphrodite (bisexual)

flower state, in *Pimelea* and in various other genera (Webb et al. 1999). *Pimelea actea* and *P. telura*, thus, could be primitive forms. For species with limited population size, however, it might be that bisexuality is a derived state, originating from a gynodioecious condition through loss of females. The situation in *P. poppelwellii* is suggestive of this. Testing of the phylogenetic relationships of these and other species by DNA analysis and biochemical methods would be needed to examine the validity of this postulate.

Conservation

All of the *Pimelea* species considered here are worthy of efforts to ensure their preservation in wild habitats. Fortunately, *P. gnidia* and *P. buxifolia* are abundant and well protected in National Parks. The remoteness of the location of *P. telura* safeguards it. *Pimelea traversii* subsp. *traversii* is also cared for in National Parks (and guarded by its remote mountain-top habitats in many places elsewhere). The other *P. traversii* subspecies are more vulnerable because of small areas occupied. An assessment of their populations from a conservation point of view is needed. *Pimelea poppelwellii* seems to occur sparsely, but its populations are well scattered. Fire and some farm practices such as topdressing could be a threat to it.

The most threatened species is "Acutely threatened; nationally critical" *P. actea*, as its populations are very small and vulnerable to multiple disturbances. It could become extinct overnight. A major effort to preserve it is required, if for no other reason than retention of a form with an unusual breeding system.

Pimelea longifolia is not in the same danger of total obliteration by vagaries of habitat destruction as is *P. actea*. However, this could happen to some populations of *P. longifolia* that are not at risk of being overwhelmed by hybridisation with *P. gnidia*, including those in the neighbourhood of Auckland City. The beautiful shrub *P. longifolia* could be a subject for protection near Auckland in much the same way, as has occurred for *Metrosideros excelsa*. Effort is needed to preserve and expand its populations in the city's vicinity. *Pimelea longifolia* seems to be maintaining itself in north-west Nelson and Buller in spite of much hybridisation with *P. gnidia*. Thorough investigation of the situation there is needed, however.

The conservation programmes suggested in Appendix 2 (or something very similar) are essential for the rescue of *P. actea* from extinction and *P. longifolia* as a "pure" entity. The Department of

Conservation presumably has resources that can be applied in emergency cases. For *P. actea* the situation is as dire as it is for the black stilt, black robin, takahe, and kakapo. A vigorous and sustained effort is needed to save it. Fortunately, it is easier and cheaper to build up “captive” populations of plants for putting out in suitable habitats than is the case for animals.

ACKNOWLEDGMENTS

I am deeply grateful to the many people who have helped during the preparation of this work: Brian Molloy, Josephine Ward, David Glenny, Barbara Rye, Aaron Wilton, Colin Ogle, Anthony Wright, Shannel Courtney, Robin Smith, Barry Sneddon (WELT), Ewen Cameron (AK) for technical advice or assistance with plant specimens, translation of Latin texts, methodology or text; Ines Schönberger, Mary Korver, Debby Redmond (Allan Herbarium, CHR, Lincoln), Jenny Tonkin (Kew), Steve Cafferty (British Museum), Reijel Gardiner (Canterbury University), Janice Lord (Otago University), Arne Anderberg (Stockholm (S)), and Ulricke Starck (Berlin (B)) for help with herbarium search, loans of specimens, photographs, and other images and old scripts. Jenny Tonkin’s help at BM, LINN, K, and P has been vitally important. I also warmly thank Murray Dawson (chromosomes), Neville Moar (pollen), Rebecca Wagstaff (drawings), Patricia Eckel (Latin diagnoses), Marney Brosnan (maps), and other helpers including Janet Warburton and Julia Burrows (typing), librarians at Canterbury University and Landcare Research, Lincoln (document search), Donavin Campbell (photo-imaging), Dave Conder (glasshouse), Jill Broome (live specimens), Adam Burrows and Susan Daltroy (liaison in the USA), and the School of Biological Sciences, University of Canterbury, for essential logistic support. The dedicated efforts of many plant collectors, spread over 236 years, have also been exceedingly valuable. My wife, Vivienne, has, as always, been very patient and supportive.

REFERENCES

Allan HH 1961. Flora of New Zealand Vol. I. Wellington, Government Printer.

Anderson E 1949. Introgressive hybridisation. London, Chapman & Hall.

Begg AC, Begg NC 1969. James Cook and New Zealand. Wellington, Government Printer.

Beuzenberg EJ, Hair JB 1983. Contributions to a chromosome atlas of the New Zealand flora—25. Miscellaneous species. New Zealand Journal of Botany 21: 13–20.

Briggs D, Walters SM 1997. Plant variation and evolution. 3rd ed. Cambridge, England, Cambridge University Press.

Brownsey PJ 1979. Type material in the herbarium of the National Museum of New Zealand (WELT). 1. New Zealand pteridophytes. National Museum of New Zealand Records 1(15): 243–269.

Brummitt RK, Powell CE 1992. Authors of plant names. Kew, Royal Botanic Gardens. 735 p.

Bunniger L 1972. Untersuchungen über die morphologische Natur des Hypanthiums bei Myrtales – und Thymelaeales – Familien II Myrtaceae. III. Vergleich mit den Thymelaeaceae. Beitrage Biologische Pflanzen 48: 79–156.

Burrows CJ 1958. Variation in some species of the genus *Pimelea*. Unpublished MSc thesis, University of Canterbury, Christchurch, New Zealand.

Burrows CJ 1960. Studies in *Pimelea*. I—The breeding system. Transactions of the Royal Society of New Zealand 88: 29–45.

Burrows CJ 1962. Studies in *Pimelea*. II—Taxonomy of some mountain species. Transactions of the Royal Society of New Zealand (Botany) 1: 217–233.

Burrows CJ 2001. Characterising *Pimelea* “Turakina”. Conservation Science Newsletter 40/41: 10–11.

Burrows CJ 2006. Forest regeneration patterns in New Zealand’s turbulent environments. Polish Botanical Studies 22: 95–122.

Burrows CJ, Wilson HD 2008. Vegetation of the mountains. Chapter 10 in: Winterbourn M, Knox G, Burrows C, Marsden I ed. The natural history of Canterbury. Christchurch, Canterbury University Press.

Carolin RC 1963. J.R. and J.G.A. Forster and their collections. Proceedings of the Linnean Society of New South Wales 88: 108–111.

Cheeseman TF 1906. Manual of the New Zealand flora. Wellington, Government Printer.

Cheeseman TF 1914. Illustrations of the New Zealand flora Vol. 2. Wellington, Government Printer.

Cheeseman TF 1925. Manual of the New Zealand flora. 2nd ed. Wellington, Government Printer.

Clarke J 2005. Serious decline: distribution and habitat of *Pimelea tomentosa*. Unpublished dissertation for the Diploma of Environmental Management, Bay of Plenty Polytechnic, Tauranga and Report to the Department of Conservation. 68 p.

Cockayne L 1921. The vegetation of New Zealand. Leipzig, Die Vegetation der Erde 14. 356.

Cockayne L, Allan HH 1934. An annotated list of groups of wild hybrids in the New Zealand flora. Annals of Botany 48: 1–55.

- Colenso W 1886. A description of some newly-discovered and rare indigenous plants. Transactions of the New Zealand Institute 18: 256–287.
- Colenso W 1888. On new phaenogamic plants of New Zealand. Transactions of the New Zealand Institute 20: 188–211.
- Colenso W 1889. A description of some newly-discovered phaenogamic plants. Transactions of the New Zealand Institute 21: 80–108.
- Colenso W 1890. A description of some newly-discovered phaenogamic plants. Transactions of the New Zealand Institute 22: 459–493.
- Colenso W 1896. Phaenogams: a description of a few more newly-discovered indigenous plants. Transactions of the New Zealand Institute 28: 591–613.
- Colenso W 1899. Phaenogams: a description of a few more newly-discovered indigenous plants. Transactions of the New Zealand Institute 31: 266–281.
- Connor HE 1992. The poisonous plants of New Zealand. 2nd ed. Department of Scientific and Industrial Research Bulletin 99. Wellington, New Zealand.
- Dawson MI 2000. Index of chromosome numbers of indigenous New Zealand spermatophytes. New Zealand Journal of Botany 38: 47–118.
- Dawson MI, Beuzenberg EJ 2000. Contributions to a chromosome atlas of the New Zealand flora. 36—Miscellaneous families. New Zealand Journal of Botany 38: 1–23.
- Dawson PAC 2003. Regeneration of the native sand dune plant *Pimelea arenaria* in the lower North Island, New Zealand. Unpublished MSc thesis, Massey University, Palmerston North, New Zealand.
- Dawson PAC, Rapson GL, Robertson AW, Fordham RA 2005. Limitations on recruitment of the rare sand daphne *Pimelea arenaria* (Thymelaeaceae), lower North Island, New Zealand. New Zealand Journal of Botany 43: 619–630.
- De Lange PJ, Norton DA, Heenan PB, Courtney SP, Molloy BPJ, Ogle CC, Rance BD, Johnson PN, Hitchmough R 2004. Threatened and uncommon plants of New Zealand. New Zealand Journal of Botany 42: 45–76.
- Ding Hou 1960. Thymelaeaceae. Flora Malesiana Ser. 1(6): 1–48.
- Eagle A 1975. Eagle's trees and shrubs of New Zealand. 1st series. Auckland, Collins.
- Eagle A 1982. Eagle's trees and shrubs of New Zealand. 2nd series. Auckland, Collins.
- Eagle A 2006. Eagle's complete trees and shrubs of New Zealand. Wellington, Te Papa Press.
- Fisher FJF 1965. The alpine *Ranunculi* of New Zealand. Department of Scientific and Industrial Research Bulletin 165. Wellington, New Zealand.
- Forster JGA 1780. Decas plantarum novarum ex insulis maris Australis. Nova Acta Koninglinga Vetenskapi Societe Upsala 3: 171–186.
- Forster JGA 1786. Florulae insularum Australium prodromus. Gottingen.
- Forster JR, Forster JGA 1776. Characteres generum plantarum quas in itinere ad insulas maris Australis. London.
- Gaertner J 1788. De fructibus et seminibus plantarum 1. 186.
- Green PS 1990. Notes relating to the floras of Norfolk and Lord Howe Islands III. Kew Bulletin 45: 252–253.
- Heinig K 1951. Studies in the floral morphology of the Thymelaeaceae. American Journal of Botany 38: 113–132.
- Herber BE 2003. Thymelaeaceae. In: Kubitzki K, Bayer C ed. The families and genera of vascular plants. Vol. V Flowering plants. Dicotyledons Malvales, Capparales and non-betalain Caryophyllales. Berlin, Springer. Pp. 373–396.
- Heywood VH, Brummitt RK, Culham A, Seberg O 2007. Flowering plant families of the World. Kew, Royal Botanic Gardens. Pp. 320–321.
- Hitchmough R, Bull L, Cromarty P comp. 2007. New Zealand threat classification lists, 2005. Department of Conservation Scientific and Technical Publishing.
- Holmgren PK, Holmgren NH, Barnett LC 1990. Index Herbariorum Part 1, The Herbaria of the World. Regnum Vegetabile 120. 693 p.
- Hooker JD 1853. Flora Novae-Zelandiae. London, Reeve & Co.
- Hooker JD 1867. Handbook of the New Zealand flora. London, Reeve & Co.
- King M 1993. Species evolution: the role of chromosomal change. Cambridge, Cambridge University Press.
- Kirk T 1880. Descriptions of new flowering plants. Transactions of the New Zealand Institute 12: 893–897.
- Kirk T 1894. Description of a new species of *Pimelea*. Transactions of the New Zealand Institute 26: 259–260.
- Levin DA 2000. The origin, expansion and demise of plant species. Oxford, Oxford University Press.
- Linnaeus C 1782. Supplementum plantarum 26. Braunschweig.

- McFadgen B 2007. *Hostile shores*. Auckland, Auckland University Press.
- McGlone MS 1983. Polynesian deforestation of New Zealand: a preliminary synthesis. *Archaeology in Oceania* 18: 11–25.
- McGlone MS, Anderson AJ, Holdaway RN 1994. An ecological approach to the Polynesian settlement of New Zealand. In: Sutton DG ed. *The origins of the first New Zealanders*. Auckland, Auckland University Press. Pp. 136–163.
- McNeill J and 11 others ed. 2006. ICBN (Vienna Code). Ruggell, Liechtenstein, A.R.G. Ganter.
- Maslin BR, Cowan RS 1994. What type of type? *Australasian Systematic Botany Newsletter* 81: 2–7.
- Mayr E 1982. Speciation and macroevolution. *Evolution* 36: 1119–1132.
- Moar NT 1993. *Pollen grains of the New Zealand dicotyledon plants*. Lincoln, Manaaki Whenua Press.
- Molloy BPJ, Burrows CJ, Cox JE, Johnston JA, Wardle P 1963. Distribution of subfossil forest remains, eastern South Island. *New Zealand Journal of Botany* 1: 68–77.
- Moore LB, Irwin JB 1978. *The Oxford book of New Zealand plants*. Wellington, Oxford University Press.
- Nicolson DH, Fosberg FR 2003. The Forsters and the botany of the second Cook expedition (1772–1775). *Regnum Vegetabile* 139: 759 p.
- Parsons MJ, Douglass P, Macmillan BH 1995. Current names list for wild gymnosperms, dicotyledons and monocotyledons (except grasses) in New Zealand as used in Herbarium CHR. Lincoln, New Zealand, Manaaki Whenua Press.
- Petrie D 1912. Descriptions of new native species of phanerogams. *Transactions of the New Zealand Institute* 44: 179–187.
- Petrie D 1917. Descriptions of new native flowering plants. *Transactions of the New Zealand Institute* 49: 51–55.
- Pettit GR, Zou J-C, Goswami A, Crag GM, Schmidt JM 1983. Antineoplastic agents 88. *Pimelea prostrata*. *Journal of Natural Products (Lloydia)* 46: 563–568.
- Rattenbury JA 1957. Chromosome numbers in New Zealand angiosperms. *Transactions of the Royal Society of New Zealand* 84: 936–938.
- Rye BL 1990. *Pimelea*: Thymelaeaceae. *Flora of Australia* 18: 134–211.
- Rye BL 1999. An updated revision of *Pimelea* sect. *Heterolaena* (Thymelaeaceae) including two new taxa. *Nuytsia* 13: 159–192.
- Rye BL 2002. *Pimeleas—the original Banksias*. *Western Wildlife* 2: 6–7.
- Stearn WT 1968. The botanical results of the Endeavour voyage. *Endeavour* 27: 3–10.
- Stearn WT 1973. *Botanical Latin*. Newton Abbot, David & Charles.
- Threlfall S 1982. The genus *Pimelea* (Thymelaeaceae) in eastern mainland Australia. *Brunonia* 5: 113–201.
- Walsh NG, Entwisle TJ ed. 1996. *Flora of Victoria. Vol. 3 Dicotyledons: Winteraceae to Myrtaceae*. Melbourne, Inkata Press.
- Webb CJ, Simpson MJ 2001. *Seeds of New Zealand gymnosperms and dicotyledons*. Christchurch, Manuka Press.
- Webb CJ, Lloyd DG, Delph LF 1999. Gender dimorphism in indigenous New Zealand seed plants. *New Zealand Journal of Botany* 37: 119–130.
- Whitaker AH 1987. The roles of lizards in New Zealand plant reproductive strategies. *New Zealand Journal of Botany* 25: 315–328.
- Wickström JE 1818. Granskning af de till Thymelaeorum vaxtordning horand slagten och arter. *Koningsla Svenska Vetenskapi Handlingar, St. II* 23: 263–349.
- Willdenow KL 1797. *Species Plantarum* 1: 51.
- Wilson CJN, Houghton BF 1993. *The Taupo eruption*. Institute of Geological & Nuclear Sciences, Wairakei Research Centre, Taupo, New Zealand.
- Wilson H, Galloway T 1993. *Small-leaved shrubs of New Zealand*. Christchurch, Manuka Press.
- Wotton DM 2002. Effectiveness of the common gecko (*Hoplodactylus maculatus*) as a seed disperser on Mana Island, New Zealand. *New Zealand Journal of Botany* 40: 639–648.
- Zayed S, Adolf W, Heckler E 1982. Active principles of Thymelaeaceae 1. The irritants and carcinogens of *Pimelea prostrata*. *Planta Medica* 45: 67–77.

Appendix 1 Locations of specimens in Fig. 7 and 9.

Specimen	Location, altitude (n.s.l., near sea level; t, near treeline)
Fig. 7	
1	CHR227437 Cooper I., head of Sportsmans Cove, Dusky Sound, n.s.l.
2	CHR 92913 Fisherman Bay, Chalky Inlet, n.s.l.
3	CHR 279800 Bauza I., Doubtful Sound, n.s.l.
4	LINN 40.13 (paralectotype) Dusky Sound, n.s.l.
5	BM 829816 (lectotype) Dusky Sound, n.s.l.
6	CHR 79854 Nancy Sound, n.s.l.
7	CHR 188870 Cascade Stm, Dusky Sound, 300–600 m
8	CHR 92924 Facile Harbour, Dusky Sound, n.s.l.
9	CHR 92914 Facile Heights, Dusky Sound
10	CHR 261622 Breaksea I., Dusky Sound, n.s.l.
11	CHR 92923 Facile Harbour, Dusky Sound, 650 m, t
12	CHR 175027 Lake Mike, Dusky Sound 680 m, t
13	CANU 60802 Peak C, Bradshaw Sound, 925 m, t
14	CHR 183394 near Dusky Sound, 770 m, t
15	CANU 10865 Lake Mike cirque, Dusky Sound, 700 m, t
16	CHR 218654 near West Cape, east of Lake Fraser, 600 m, t
17	CHR 183401 Dusky Sound to Preservation Inlet traverse, c. 500 m
18	CHR 472390 Hump Range, 970 m, t
19	CANU 9129 Lake Monk, 1000 m, t
20	WELT 44226A The Hump (type specimen for <i>P. crosby-smithiana</i>). c. 900 m, t
Fig. 9	
<i>P. gnidia</i>	
1	CANU 6716 Heaphy Track, Monument Creek. c. 600 m
2	CHR 476133 Mackay Downs, 840 m, t
3	CHR 478734 Waiwhero Rd, Lower Motueka, 30 m
4	CHR 278068 Torrent Bay, n.s.l.
5	CHR 389211 Motueka Valley, 50 m
6	CHR 511578 Wangapeka R., Chummie Creek 900 m
<i>P. longifolia</i>	
7	CHR 277907 Westhaven Inlet, n.s.l.
8	CANU 26070 Near Westhaven Inlet, n.s.l.
9	CHR 117719 Gunner Downs
10	CHR 190230 Knuckle Hill, Westhaven, c. 400 m
11	CHR 19982 road to Kaihoka Lakes, c. 30 m
12	CHR 279781 Bullock Creek, Buller, c. 100 m
Hybrids	
A	CANU 38845(a) Knuckle Hill, Westhaven, c. 450 m
B	CANU 38845(b) Knuckle Hill, Westhaven, c. 450 m
C	CHR 115297 near Puponga
D	CHR 77864 Puponga, 60 m
E	CHR 463893 Mokihinui
F	CHR 249570 Granity Pass, Owen Range, 1235 m, t
G	CHR 511908 Mt Burnett
H	CHR 268789 Takaka Hill, 760 m
I	CHR 404862 Takaka Hill
J	CHR 322653 Blue Creek, Owen Range
K	CHR 395979 Shelter Rock Basin, Scarlett Range, t
L	CHR 358318 Takaka Valley (cultivated at Pinehaven, Upper Hutt)
M	CHR 41194 Puponga
N	CHR 366176 Mt Misery, Matiri Range, 1300 m, t

(continued)

Appendix 1 (continued)

Specimen	Location, altitude (n.s.l., near sea level; t, near treeline)
O	CHR 91227 Pakawau Gorge (cultivated <i>in situ</i>)
P	CHR 358321 Takaka Valley
Q	CHR 275519 Takaka R., 155 m
R	CHR 273509 Takaka Valley below Cobb Power Station, 300 m
S	CHR 418987 Scotts Hill, Karamea
T	CHR 467635B Pohara, c. 60 m
U	CANU 24953 Boulder Lake, c. 1200 m, t
V	CANU 12239 Pakawau Bush Rd.
W	CHR 92918 Onekaka, c. 100 m
X	CHR 418945 Kohaihai Estuary, Karamea, n.s.l.
Y	CHR 268790 Aniseed Valley, Roding R., eastern Nelson
Z	CHR 9219 Mt Stokes, Marlborough Sounds, c. 1000 m, t
*	AK 5356 “ <i>Pimelea gnidia</i> var <i>pulchella</i> ”, Mt Stokes Marlborough Sounds (specimen from a paratype area), t
+	WELT 22987 “ <i>Pimelea longifolia</i> var <i>lanceolata</i> ”, east-central North Island (specimen from lectotype area)

Appendix 2 Conservation programmes for *Pimelea actea* and *P. longifolia*.

For both species, the imperative is to preserve their genotypes. Bold, determined, thorough, and effective efforts are needed.

In cultivation in a shade house in Christchurch, *P. actea* proved to be easy to grow and easy to propagate from seeds. As many as 20 seeds per individual can be produced in a year. The plant propagators at Percy Reserve in Lower Hutt have found similar responses of this species in cultivation. Spontaneous seedlings appear near the parents. Unfortunately, in Christchurch, frost killed the whole population that was being grown on, in 2003.

The requirements for a conservation programme for this species are:

1. Identify all wild and cultivated surviving populations of the species in its “pure” state (i.e., uncontaminated with genes from other species). Use a number of these plants as the basis for a rescue culture. Make sure that insect pests are kept at bay.
2. Using seeds, cuttings or (very few) whole plant transfers, begin a culture in a contained glasshouse facility where no genetic cross-contamination can occur.
3. Build up a relatively large population of individuals (a few hundred). This could be done in about 3 years.
4. While keeping the breeding programme going, begin to transfer groups of propagated individuals to at least two safe natural sites. I know of none in the North Island, but could be mistaken. Island sites are desirable. However, in my opinion, there is an excellent

opportunity to build up planted-out populations on Farewell Spit, in north-west Nelson, where there are wet hollows like those present in winter in dune slacks at Himatangi. This may seem a radical proposal, but it would be worthwhile if the species can be saved; the principle is the same as that used to save kakapo and other birds. No existing native species would be displaced.

5. When the cultivated glasshouse population has build up to 500 or more, some relatively safe North Island areas could be used as plant-out sites.

For *P. longifolia* a similar programme is needed. I have no experience of growing it, but I am sure that cuttings would grow readily. I have grown many *Pimelea* plants from cuttings. Again, purity of the source plants is of utmost importance. A search is needed for “pure” *P. longifolia* populations in the greater Auckland region. Transplants of small individuals may be possible but cuttings can be struck from adults. Suitable plant-out sites might include reserves in the Waitakere Range and elsewhere in the area (in shrublands that are manipulated for the purpose by clearing off dense cover). Care must be taken to avoid contamination with genes of other *Pimelea* taxa. When I have tried to germinate seeds of several other *Pimelea* species, they have proved to be very slow. However, *P. longifolia* may be an exception. Also, the propagators at Percy Reserve in Lower Hutt have much experience at raising *Pimelea* species from seeds. Seed-grown plants are desirable.