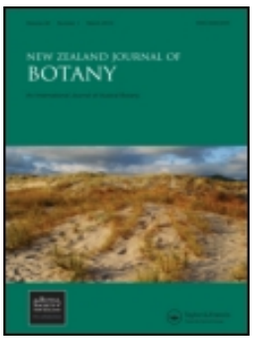

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Observations on Two Coastal Ecotypes of *Selliera radicans* Cav. (Goodeniaceae) Growing in the Manawatu District of New Zealand

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ABSTRACT

Morphologically distinct forms of *Selliera radicans* Cav. growing on silty flats in the estuary of the Rangitikei River and on sand plains in the dunes *c.* 1.3 km to the south are described.

Small pieces of *S. radicans* rhizome were collected from these two areas and planted in pots containing either sand from the sand plain site, sandy-silt from the estuary site, or a standard potting mix. All were grown for 10 months under identical conditions in a glasshouse. Measurements of leaf dimensions at the beginning and end of the experiment support the view that the two forms are genetically distinct, and can be regarded as ecotypes. A clone of the sand plain form was grown for 34 months in a garden, and the resulting changes in leaf form are illustrated.

Several other species have dwarf forms on the sand plains, and it is tentatively suggested that ecotypic differentiation has occurred in these species also.

INTRODUCTION

The genus *Selliera* comprises ". . . a few not fully understood spp. of Australia, Tasmania, N.Z., Chile" (Allan 1961). *Selliera radicans* Cav. is the only member of the genus present in New Zealand, and it is found also in the other countries listed. In New Zealand it occurs in both

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coastal and inland habitats. Coastal sites include estuarine mud, salt marsh, sand flats, and rocky places within reach of salt spray. Inland habitats are predominantly stream, lake, and tarn margins, especially on flushed ground in the mountainous areas of both Islands.

The differences in growth form, leaf shape, and anatomy of *S. radicans* growing at different stations in the Avon estuary and at Timaru have been described and illustrated by Cross (1910). Allan (1961) and Burrows (1964) have drawn attention to the polymorphic nature of the species, and the need for further study to ascertain the status and distribution of the various forms. Inland forms (mapped by Burrows 1964) tend to be smaller in all parts than coastal ones, and forms with broader laminae appear to be more common in the southern part of the range. The relative importance of genetic and environmental factors in determining the different forms is not known. This paper is a contribution to understanding the nature of this variation.

Habitats and Description of Forms

The west coast of the southern portion of North Island (between latitude 40°00′ and 40°50′S) comprises a series of sand dune systems of varying ages, and the estuaries of several rivers. The younger (coastal) portion of the sand dune area (Waitarere phase, Cowie 1963) is less than 200 years old and includes sandy flats immediately behind the foredunes. These flats are subject to periodic inundation due to rising ground water in the winter, and they carry a unique pioneer community of low growing herbs, in which *S. radicans* is an important species. These flats or "plains" extend down the coast from the Wangaehu River in the north, to Waikanae in the south, reaching their greatest extent in the Himitangi area, where they have been described by Esler (1969)*.

Esler (pers. comm.) has observed that the form of *S. radicans* inhabiting these plains in the Himitangi area has unusually small and rounded leaves, quite distinct from the elongate leaf form found on the salt marshes of the nearby Rangitikei and Manawatu River estuaries (Figs 1, 2). The two forms also differ in stature; that on the dune flats has elongate buried rhizomes with the leaves pressed against the sand surface, whereas that on the estuarine sites has rhizomes which are frequently superficial amongst the salt-marsh vegetation, and its leaves are held upright in small clusters. These two forms will be called respectively the dune form and the estuarine form.

In the Manawatu District the dune form has not yet been found north of the Rangitikei, nor south of Hokio, a total range of 34 km. Within this region it is confined to sand plains of recent origin in a

*The particular plain described in detail by Esler has been extensively modified by the expansion of Himatangi Beach township (1973), and little of the original plant community remains.

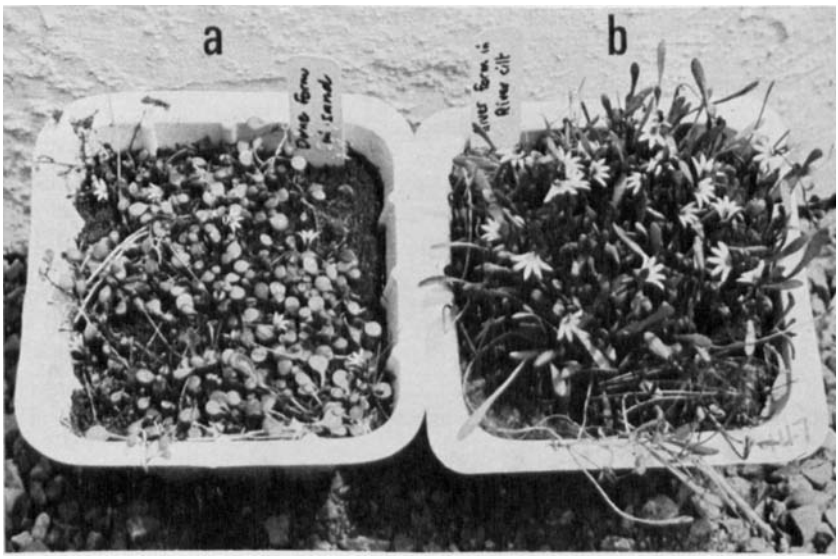

FIG. 1—*Selliera radicans* turves transplanted from the field into 10 cm square pots. (a) The dune form. (b) The estuarine form.

narrow coastal strip. The estuarine form is found growing on recently deposited sandy-silts in the estuaries of all the main rivers in the area, and appears to be more widely distributed in New Zealand.

Transplant experiments by Mrs F. C. Duguid† have shown that the dune form is capable of developing a more upright habit with larger and longer leaves, but that these retain their spathulate form and blunt tips, even after 3 years of cultivation (F. C. Duguid pers. comm. 1973, Fig. 3). Mrs Duguid concludes from her observations that the two forms differ mainly in the shape of the leaf tip, the estuarine form being "pointed" and the dune form "blunt". In the latter case this character is retained under cultivation and thus appears to be genetically determined. She suggests that the smalled-leaved form may have evolved to colonise the "less favourable" habitat of the sand plains, which are only seasonally wet, and presumably of lower fertility than the estuarine silts. Variation in the shape of the leaf apex was also remarked on by Cross (1910).

The purpose of the following experiment was to examine the influence of the substrate on the plasticity of leaf form in plants from both habitats, grown under identical conditions.

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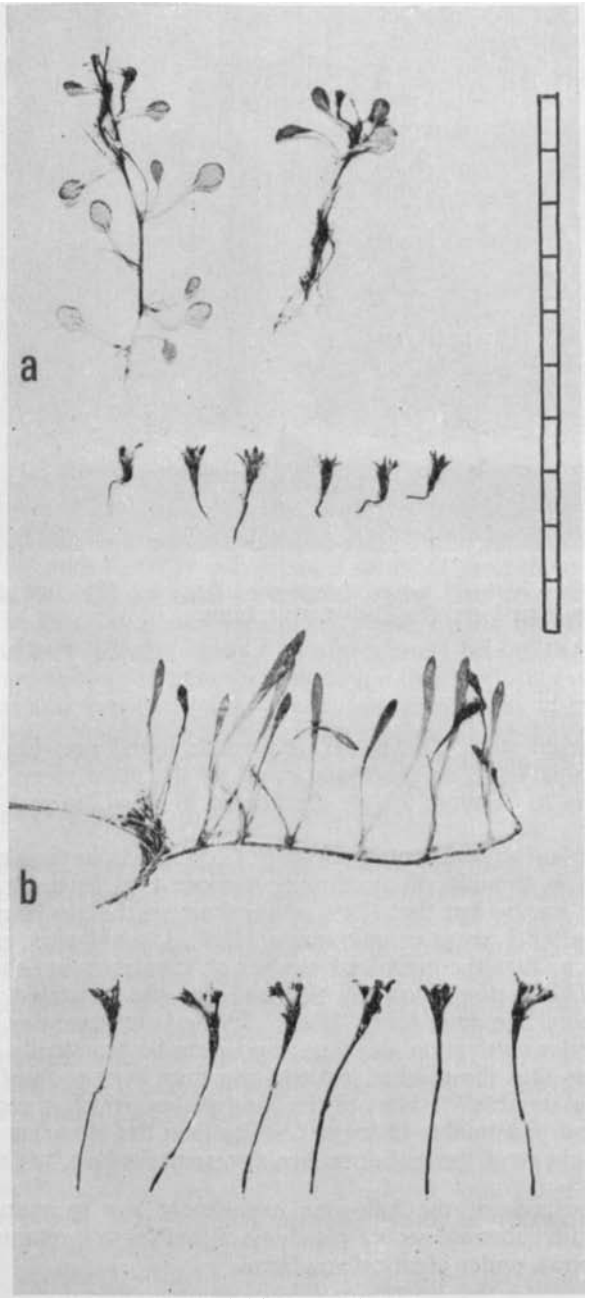


FIG. 2—Herbarium specimens of *Selliera radicans* showing the superficial rhizomes, and the difference in flower size and pedicel length in the two forms. (a) The dune form. (b) The estuarine form. The scale is in cm.

Botanical Description of Sites

(1) Rangitikei Estuary (Tangimoana Beach, NZMS 1, Sheet N148, grid ref. 750423).

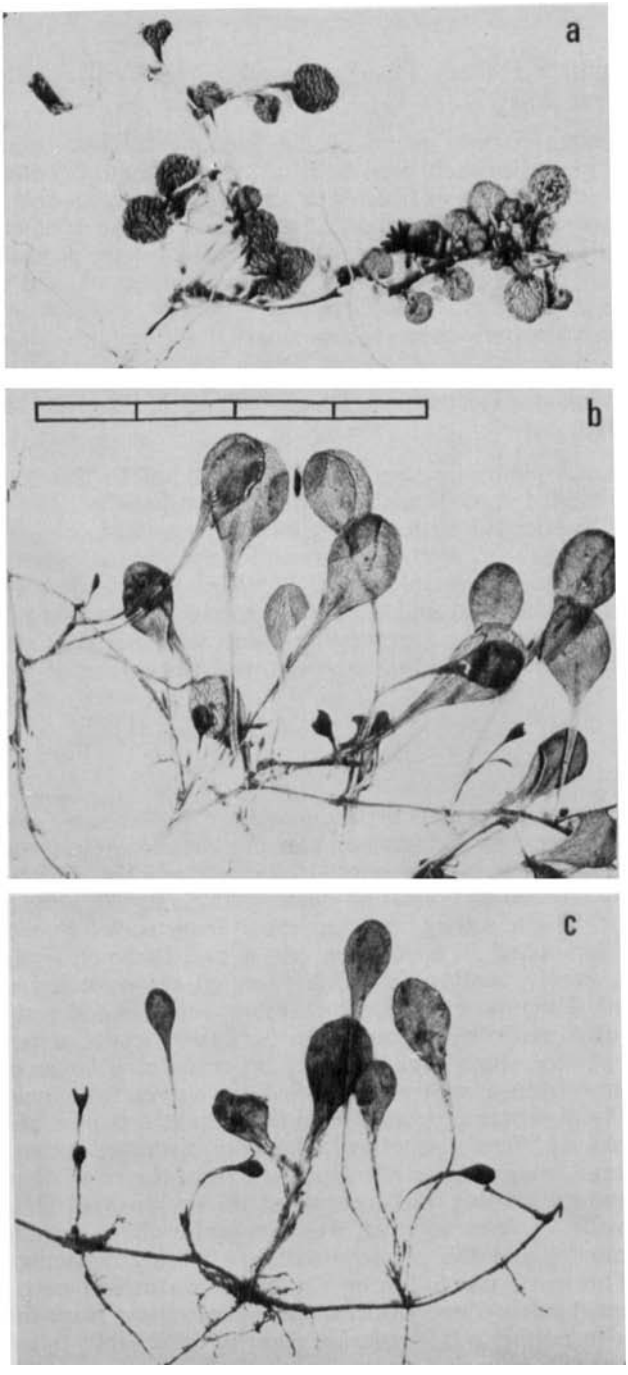
The estuarine salt marsh of the Rangitikei River mouth carries vegetation typical of such sites, being a low-growing turf composed of a few herbaceous species in which the relative proportions of the different species change over quite short distances. *Selliera radicans, Samolus repens, Scirpus cernuus, Gunnera arenaria, Salicornia australis, Triglochin striatum, Cotula coronopifolia, Plantago coronopus,* and the grasses *Polypogon monspeliensis, Lachnagrostis littoralis,* and *Agrostis stolonifera* are the main components of this mosaic.

(2) Sand plain (Tangimoana Beach, NZMS 1, Sheet N148, grid ref. 749410).

The sand plain site was situated *c.* 1.3 km to the south of the estuary. It carried vegetation similar to that described by Esler (1969) for Himitangi. Associated with the small-leaved form of *S. radicans* were diminutive forms of *Scirpus cernuus* and *Triglochin striatum,* abundant *Carex pumila,* and lesser amounts of *Elocharis neozelandica* and *Lobelia anceps. Scirpus nodosus* and *Cortaderia toetoe* were present around the margins of the flat. The surrounding dunes were partially stabilised by *Ammophila arenaria, Lupinus arboreus,* and *Coprosma acerosa.*

Methods

Eight turves composed predominantly of *S. radicans,* and a bulked soil sample, were collected from an area of about 10 m^2 in visually homogenous vegetation at both sites on 16 December 1972. The turves were subjectively selected as typical of the *S. radicans* sward in the area. They were about 15 cm square and separated from each other by several metres. A sample of 50 *S. radicans* leaves and 20 flowers was obtained from each site by random plucking from all the collected turves and was pressed. The turves were washed free of adhering soil and individual segments of *S. radicans* rhizomes bearing 50–60 leaves separated from them and planted singly into 10 × 10 cm pots. In so far as each ramet planted came from a separate turf, and the turves from one site were separated by distances of from two to ten metres, it is possible that each pot received a different genotype. The pots contained either (1) sand from the sand plain site, or (2) sandy-silt from the river mouth site, or (3) a standard potting mix composed of perlite and Hauraki peat (50:50), with nutrients supplied from superphosphate, uranite, and osmocote granules and the pH adjusted to 6.5 using dolomite limestone powder. This gave the following six basic treatments, each of which was replicated once: dune plant in dune sand; dune plant in river silt; dune plant in potting mix; estuarine plant in dune sand; estuarine plant plant in river silt; estuarine plant in potting mix.


a
b
c

The experiment was laid out as two randomised blocks in the heated glasshouse at the Department of Botany and Zoology, Massey University, Palmerston North in early January 1973. Complete turves from each site were also grown alongside the experiment. Measurements of leaf length and breadth at the widest part were made to the nearest 0.01 mm at the start of the experiment, and again on a random sample of ten leaves from each pot on 8 November 1973. During this 10 month period all the plants had identical growing conditions. Temperatures in the glasshouse ranged from an average night minimum of *c.* 20°C to an average daytime maximum of *c.* 30°C, and relative humidity similarly ranged between 90 and 60%.

Results

Table 1 shows that the estuarine form is significantly larger than the dune form in both vegetative and floral structures. The leaves of the dune form became longer and narrower under cultivation whereas the leaves of the estuarine form simply elongated. However, the shapes and dimensions of leaves from the two forms remained quite distinct after cultivation under identical conditions for 10 months, during which time abundant new leaf production had occurred and most clones had expanded to fill their pots.

TABLE 1—Comparison of dimensions of vegetative and floral parts of *Selliera radicans* grown in the field and in a glasshouse.

	Leaves			*Flowers*	
	Length	*Breadth*	*Length/ Breadth*	*Corolla width*	*Pedicel length*
Estuarine form in field	5.58±0.11*	0.35±0.01	16.09±0.27	1.13±0.03	3.70±0.10
Estuarine form in cultivation	6.14±0.12	0.35±0.01	18.22±0.49	—	—
Dune form in field	1.49±0.05	0.41±0.01	3.72±0.16	0.75±0.03	0.65±0.04
Dune form in cultivation	1.81±0.12	0.39±0.01	4.74±0.49	—	—

*Means with standard errors all in cm.
For plants grown under cultivation the overall means from the three soil treatments (60 measurements) are presented. For plants growing in the field the leaf characters are based on 50 measurements and the flower characters on 20 measurements. The corolla width was measured after pressing and therefore slightly overestimates the live diameter.

FIG. 3 (*left*)—Herbarium specimens of *Selliera radicans* showing the effects of garden cultivation. (a) Plants collected from a sand flat at Hokio beach on 2 May 1970. (b) A portion of the same clone after cultivation in a garden at Levin for 21 months. (c) The same clone after cultivation at Levin for 34 months. All on the same scale, given in cm on (b).

Mean leaf dimensions for the six treatment combinations, and overall means, are given in Table 2. A summary of the results of analyses of variance on leaf lengths, breadths, and the length/breadth ratio is given in Table 3. Leaf length shows a significant response to the nature of the substrate, leaves always achieving maximum lengths on sand, and minimum lengths on potting mix in both forms. However, the interaction between form and substrate is significant for length, indicating that the plants from the two sites have differential responses to the substrates provided. A second set of analyses excluding the potting mix data gave no significant substrate or interaction effects, suggesting that the substrate effect in Table 3 is due to the reduced leaf length of both forms when grown on potting mix and the interaction effect is because this reduction is much more marked in the estuarine form. These observations and experimental results support the view that the two forms of *S. radicans* present on recent coastal deposits in the Manawatu District are genetically distinct, and can be regarded as ecotypes in the sense of Stebbins (1960).

TABLE 2—Summary of mean leaf dimensions of two forms of *Selliera radicans* grown under cultivation for 10 months on the three substrates.

	Plant form	*Substrate*			*Overall means*	
		Silt	Sand	Potting mix		
	Dune	1.84*	1.98	1.59	1.80	
Length	Estuarine	6.82	7.03	4.58	6.14	
	Overall means	4.33	4.51	3.09	3.97	Grand mean
	Dune	0.37	0.41	0.40	0.39	
Breadth	Estuarine	0.36	0.37	0.30	0.34	
	Overall means	0.37	0.39	0.35	0.37	Grand mean
Length/	Dune	5.26	4.99	3.99	4.75	
breadth	Estuarine	19.83	19.59	15.23	18.22	
ratio	Overall means	12.55	12.29	9.61	11.49	Grand mean

*Means (cm) for each cell based on 20 measurements, for substrate overall means on 40, for plant form overall means on 60, and for the grand mean on 120 measurements.

TABLE 3—Summary of variance ratio (F) for leaf dimensions of two forms of *Selliera radicans* grown under cultivation for 10 months on three substrates.

Source of variation	*Degrees of freedom*	*F variance ratio*		
		length	*breadth*	*length/breadth*
Plant form	1	369.55***	9.27**	380.01***
Substrate	2	15.75***	2.36	7.38***
Interaction	2	8.97***	2.85	2.60
Error	114			

Significance levels: ** $P<.01$, *** $P<.001$.

Discussion

The close proximity of the two forms (1.3 km) suggests that either pollen and seed transport is very limited, or that strong selective pressures keep the two populations distinct.

Cheeseman's (1877) observations that *S. radicans* is highly adapted to insect pollination (mainly by Diptera) and that abundant fruits are produced tend to support the latter hypothesis. Cheeseman (*loc. cit.*) regarded self-pollination as an impossibility.

Seedlings cultivated from soil samples from both sites maintained their distinctive forms when grown together on potting mix in the glasshouse. In the field, seedlings of both types have been observed in their respective habitats, but the relative importance of seedling establishment compared to vegetative propagation is not known.

Of the 70 herbarium specimens held by Botany Division, DSIR, at Christchurch (CHR), only seven have distinctly rounded leaves. These are all from the west coast of New Zealand at widely separated sites ranging from Piha (lat. 38°S approx.) in the north, to Wet Jacket Arm, Fiordland (lat. 46°S approx.) in the south. Apparently the round-leaf form is widespread but restricted to particular types of sites. However, many collections have leaves intermediate betwen the two forms described in this paper (B. H. Macmillan pers. comm.).

Cross (1910) briefly described the changes which occurred in leaf anatomy and general appearance of plants taken from estuarine situations after 6 months of cultivation in an unheated glasshouse. Her data illustrate another aspect of the phenotypic plasticity of leaf characters, but do not establish a genetic basis for the differences in growth form and leaf shape that she describes. Commenting on the possible origins of the halophytic formation in New Zealand she suggests that the coastal *S. radicans* populations are derived from the inland "mesophytic" ones.

Two other species common to both habitats, *Scirpus cernuus* and *Triglochin striatum**, also have dwarf forms on the sand plain. *Gunnera arenaria* (not found on the sand plains studied but present on similar sites nearby) was represented in the estuary by plants with unusually elongate leaves (B. H. Macmillan pers. comm.). Observation of the turves from both sites grown alongside this experiment suggests that in these cases also the difference in stature is genetically determined rather than environmental in origin. Thus it may be realistic to view the sand plain habitat, expanding in the Manawatu during post-glacial times (*see* Cowie 1963), as having selected a limited number of species, and within species a limited number of genotypes, from the wide range potentially available. Rhizomatous species, able to survive on an accreting substrate

*Mentioned by Burrows (1964) as a species with marked inland/coastal disjunctions in its distribution.

and inhabiting periodically-wet coastal sites, such as estuaries, must have been favoured initially, although in post-European times alien annual weeds have also become a feature of the sand plain flora. In the case of *S. radicans*, and probably other rhizomatous species, the sand plain populations are now composed of dwarf genotypes when compared to the more widespread estuarine forms.

ACKNOWLEDGMENTS

I am grateful to Mr D. Sollit for help in measuring *Selliera* leaves. Mrs F. C. Duguid was responsible for the cultivation and preservation of the plants illustrated in Fig. 3. Miss B. H. Macmillan, Botany Division, DSIR examined herbarium material from both sites, and commented on the *S. radicans* specimens held by Botany Division. Dr Margot Forde criticised the manuscript.

REFERENCES

ALLAN, H. H. 1961: "Flora of New Zealand". Vol. I. Government Printer, Wellington, 1 085 pp.

BURROWS, C. J. 1964: Some discontinuous distributions of plants within New Zealand and their ecological significance — Part 1. *Tuatara 12:* 125–33.

CHEESEMAN, T. F. 1877: On the fertilisation of *Selliera. Transactions of the New Zealand Institute 9:* 542–5.

COWIE, J. D. 1963: Dune-building phases in the Manawatu District, New Zealand. *N.Z. Journal of Geology and Geophysics 6:* 268–77.

CROSS, B. D. 1910: Observations on some New Zealand halophytes. *Transactions of the New Zealand Institute 42:* 545–74.

ESLER, A. E. 1969: Manawatu sand plain vegetation. *Proceedings New Zealand Ecological Society No. 16:* 32–5.

STEBBINS, G. L. 1960: "Variation and Evolution in Plants". (Fourth Printing) Columbia University Press, New York. 643 pp.