DUNE RESTORATION TRUST OF NEW ZEALAND

Dune Restoration Trust of New Zealand Annual Conference: Wanganui Sailing Club 5-7 March 2008.

Thank you to the sponsors of events:

Naturally Native (Wednesday barbeque and refreshments)

Department of Conservation (Friday field trip)

Taupo Native Plant Nursery (Wednesday morning tea)

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This is a collection of relevant information, rather than proceedings and summaries.

If you need any of the plant lists or full papers please speak to the authors or organisers (c/o Graeme La Cock, DOC, Private Bag 3016, Wanganui or glacock@doc.govt.nz)

Powerpoint presentations will be placed on the website: www.dunestrust.org.nz

Dune Restoration Trust of New Zealand Annual Conference 2008. Wanganui Sailing Club: 5-7 March.

Wednesday 5 March.
9 a.m. Powhiri
9.15 Acting Mayor Dot McKinnon: Welcoming address
9.25: Message from Minister of Conservation Steve Chadwick.
9.30: Harley Spence - welcome
9.35 Harley Spence – 10 years of dune vegetation research and implementation by the Dune Restoration Trust of New Zealand. - plus feedback on the international scene.

10 – 10.30 smoko.

10.30 - 11. Michael Shepherd: Geographical variation in dune development in New Zealand and the significance of the Manawatu dunefield'
11.00 – 11.30 Colin Ogle: The vegetation of the Foxton Ecological District, with an emphasis on the threatened plants and weeds of the region.
11.30-12. Student research session: Teresa Konlechner (Otago U.) - *Ammophila arenaria* dispersal and invasion in New Zealand.
Eva Robinson, Wyn Heh, Sam Jamieson (Victoria U.) - joint project.

12-1 lunch.

1-3. Regional roundup

3-3.30 smoko.

3.30- 4 Anthony Harris - Morphological, physiological and behavioural adaptations of sand-dwelling beetles on the Taranaki-Manawatu coast, and specifically at Castlecliff, and a discussion on other sand dune insects.

4- 4.30 Jonathan Welch – Where have all the Moa Bones Gone? The archaeology of duneland environments.'

4.30-4.50 Carolyn Lewis: Weedbusters

5 AGM

6. Free Barbie at yacht club

Thursday 6 March
8.30 – 10.30 Castlecliff dunes session.
e.g. Progress Castlecliff (overview, weed control, tracks) Beach grooming - Options for beach (Lockie Grant); use of dunes in education programmes, surf club concerns, subdivisions, vehicles

Smoko 10.30

11 – 3.30 Field trip 1 – Castlecliff
Pingao growing and planting by school
Education supersite
Subdivisions
Acacia problems
Groomed beach itself
Vehicles on beach, in dunes
Historical (pillboxes)
Insects
Perfect dunes for discussion

Lunch at Duncan Pavilion (beach)

3.30 smoko back at yacht club.

4-5 Panel discussion on Castlecliff issues (councils, consultants, interest groups, scientists)

7 optional conference dinner – Waimarie

Friday 7 March
8.30-8.50 Jim Campbell: The *Sebaea ovata* story and the role of the rest of the country.
8.50 – 9.10 Robert Southward: spinifex seed separation experiments.
9.10-9.20 Mark Deans and David Bergin: Commercialisation of a propagation technique
9.20-9.30 Discussion on propagation of coastal plants.

Introduction to field trip
9.30-9.45 Ruth English - Waverley Windfarm
9.45-10 coastal windfarm discussion
10–10.15 Graeme La Cock: Patea dunes stabilisation with greenwaste
10.15 -10.30 Harley Spence: wrap up and close conference.

10.30 smoko

10.45 Field trip 2 – Hawken's Lagoon (*Sebaea ovata* site), lunch, Waverley Windfarm, Patea greenwaste dump site, Return at 4.

Hon Steve Chadwick
Minister of Conservation

Message

Dune Restoration Trust of New Zealand

Message from Hon Steve Chadwick, Minister of Conservation to the Dune Restoration Trust of New Zealand on the occasion of their Annual Conference 5 – 7 March 2008.

I welcome the efforts of the Dune Restoration Trust to care for our remaining dune systems and rebuild some of what has been lost. The increasing number of community groups involved with dune care is, I think, a healthy sign that the significance of dunes as an integral part of our beautiful coastline and a unique habitat for indigenous species is becoming more widely recognised. As awareness of the risks of climate change spreads, I expect the value of dunes as natural defences against rising sea levels and storm surges will also become more generally understood.

A new draft New Zealand Coastal Policy Statement will soon be released for public consultation. Like the existing statement it will explicitly recognise the importance of dunes, within a context of clearer and stronger policies overall. I urge you as advocates of dune protection and restoration to take a close look at the draft statement and make your views known. Still, too often, dunes are thoughtlessly damaged or destroyed. Getting clearer and more effective national policy in place will be another step towards your goals.

I am sorry that due to another commitment I am unable to attend the conference. I hope you have an enjoyable conference.

Dr Mike J Shepherd - *B.A. hons, PhD*

Dr Shepherd, an Associate of Coastal Systems Ltd, has recently retired as Senior Lecturer in Physical Geography at Massey University. Dr Shepherd is an internationally recognized expert in coastal evolution, having spent 45 yrs studying and lecturing in NZ and Australia. In particular, Dr Shepherd has substantially contributed to our understanding of the development of sand plains, spits, beaches, foredunes, transgressive dune fields, and also karst (limestone) coasts. At present he is studying several Pleistocene-Holocene barrier systems around the New Zealand coast.

His professional associations include: the Geological Society of New Zealand; the New Zealand Marine Sciences Society and the Australasian Quaternary Association.

Selected Recent Publications:

Shepherd M.J. 1991: Relict and contemporary foredunes as indicators of coastal processes. In Brierley, G. and Chappell J. (eds.), *Applied Quaternary Studies*. Papers presented to a workshop at the Australia National University, July 2-3, 1990.

Shepherd M.J. 1994: Explaining spatial variations in coastal processes and landforms in New Zealand and Southern Australia. New Zealand Geographical Society Conference Series 16, 692-696.

Short, A D, 2002, The distribution and impacts of carbonate sands on southern Australia beach-dune systems. In Magoon, O T, Robbins, L L and Ewing, L (eds), Carbonate Beaches 2000 , American Society of Civil Engineers, Reston, 236-250.

Shepherd M.J. 1994: Higher energy coastal environments in Viti Levu, Fiji - location and landform development. New Zealand Geographical Society Conference Series 16, 697-700.

Shepherd M. J. and Eliot I. G. 1995: Major phases of coastal erosion ca. 6700-6000 and ca. 3000 2000 years B.P. between Cervantes and Dongara, Western Australia. *Quaternary International 27*, 125-130

Shepherd M.J. 1997: Formation, landforms, and palaeoenvironment of Matakana Island, Bay of Plenty, and implications for archaeology. *Department of Conservation Science and Research Series 102*, 100pp.

Shepherd M. J. 2000: Coasts - the Edge of the Land. Pp 34-39 in Saunders B.G.R. (*ed.*) *The South of the North - Manawatu and its Neighbours*. School of Global Studies, Massey University.

Shepherd M.J., Betts H.D., McFadgen B.G. & Sutton D.G. 2000 : Geomorphological evidence for a Pleistocene barrier at Matakana Island, Bay of Plenty, New Zealand. *New Zealand Journal of Geology and Geophysics 43*, 579-58

Shepherd M. J. & Hesp P. A. 2003: Sandy Barriers and Coastal Dunes. Chapter 8 in Rouse H, Goff J. and Nichol S. (*eds.*) *The New Zealand Coast: Te Tai O Aotearoa.* Dunmore Press.

Vegetation and threatened and adventive plants of the Wanganui sand country

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Introduction

In papers at two previous conferences Coastal Dune Vegetation Network (CDVN) (Ogle 2001, 2002) I used the term 'sand country' to include all land derived from moving sand, including elevated dunes and the land of low relief between the dunes – sand plains, swamps, and lakes. Although exotic plants predominate throughout the sand country, indigenous species occur, mostly as minor components, in grasslands, sedgelands, rushlands, herbfields, shrublands and fragments of dune forest. Sand country from Paekakariki in the south to Manutahi, west of Patea, in the north to has been defined as Foxton Ecological District (FED) (McEwen 1987; Ravine 1992). It is the largest continuous extent of sand country in New Zealand. At its inland limits, sand abuts elevated marine terraces (Manawatu Plains ED) where it often impedes drainage. Wetlands are common along this boundary.

Wanganui lies in the northern half of FED, about midway between the Manawatu River and Manutahi. The Manawatu River is also the boundary between the Wellington and Wanganui Conservancies of the Department of Conservation, and I have used it as a convenient southern limit for my studies of dune plants. This paper deals with this northern half of FED only, henceforth called the study area.

Threatened plants of Foxton Ecological District (FED)

In the study area, 31 indigenous plant species have been recorded that have a national conservation status of Threatened, Uncommon or Data Deficient. Many of the species are confined to sand habitats, here and elsewhere in New Zealand. Some have become extinct within the past several decades from some places (Table 1). This is an increase of seven species since last reported by me (Ogle 2002), although this is largely the result of more species being recognised as under threat nationally and the use of a modified scale of threat by de Lange et al. (2004). Some have become even rarer since I reported on them in 2002 (Ogle 2001, 2002), most obviously *Sebaea ovata*, the subject of a separate paper by Jim Campbell in this workshop.

Table 1 shows that two, or perhaps as many as four, species have probably become extinct across the study area since records and collections have been made. Presumed to have been extinct for some decades, sand fescue and a dwarf buttercup would have inhabited dry dunes and damp dune slacks, respectively. Dwarf mistletoe was known until the 1990s in just one site, where it grew on kanuka (*Kunzea* sp. aff. *K. ericoides*) trees that were felled to plant pines. An inconspicuous aquatic herb, *Lepilaena bilocularis*, has not been recorded in the past two decades (e.g. it was not found by Champion and Wells 2003). Several other threatened and uncommon species are known now from just one or two sites, having been recorded more widely in the past (Ogle 2001).

National ratings & Species	Common name	Present?[1]
ACUTELY THREATENED		
Nationally Critical		
Limosella 'Manutahi'	a semi-succulent mat-forming herb of wet sand	p
Pimelea "Turakina"	a native daphne of dune slacks	p
Pterosylis micromega	swamp hood orchid	p
Sebaea ovata	a gentian of dune slacks	p
CHRONICALLY THREATENED		
Serious Decline		
Carex litorosa	a small tussock of brackish mud	p
Isolepis basilaris	a minute sedge of dune slacks	p
Mazus novaezeelandiae subsp. *impolitus*	dwarf musk (of dune slacks)	p
Pimelea arenaria "southern"	sand daphne	p
DECLINING		
Austrofestuca littoralis	sand fescue	e
Crassula manaia	a minute succulent of coastal turf	p
Desmoschoenus spiralis	pingao	p
Eleocharis neozelandica	a dune wetland sedge	p
Epilobium chionanthum	a dune swamp willow-herb	p
Gunnera arenaria	sand gunnera	p
Leptinella dioica subsp. *monoica*	a button-daisy	p
Libertia peregrinans	sand iris	p
Potamogeton pectinatus	a submerged aquatic herb	p?
Ranunculus macropus	an aquatic buttercup	p
Ranunculus recens	a dwarf buttercup	e
Selliera rotundifolia	a half-star	p
Sonchus kirkii	native sowthistle	p
Urtica linearifolia	swamp nettle	p
AT RISK		
Sparse		
Crassula ruamahanga	a small semi-aquatic herb	p
Korthalsella salicornioides	dwarf mistletoe	(e)
Leptinella dispersa ssp. *dispersa*	a creeping button-daisy of dune lake edges	p
Leptinella tenella	A creeping button daisy of wet sand	
Range restricted		
Coprosma sp. aff. *acerosa*	Prostrate shrub of shallow sand on hard surfaces	
Leptinella dispersa ssp. *rupestris*	a creeping button-daisy of damp sand	p
DATA DEFICIENT		
Carex raoulii s.s.	a robust tussock of shady scrub	p
Centipeda aotearoana	a creeping daisy of lake edge mud	p
Euchiton polylepis	a tufted/cushion daisy of wet cliffs	p
Lepilaena bilocularis	a minute aquatic herb	(e)

[1] Recent and historic records indicate the species is regionally e = extinct; (e) = probably extinct; p= present

Table 1. Threatened and uncommon indigenous vascular plants of Foxton Ecological District, north of the Manawatu River.

Adventive plants (weeds) of FED

A discussion of the weeds and their impacts in FED was given in Ogle (2002). Topics covered included the origins, spread and control of the four grasses in the genus *Ehrharta*; the invasion of aquatic weeds and their possible impacts on native plants of dune lakes; the variety and spread of garden plants from planting and dumping at Patea and Castlecliff; weeds and the decline of the endangered native species, especially *Sebaea ovata* and attempts to manage it *in situ*.

My unpublished database of adventive plant species, including casual records (Heenan et al. 1998), from a range of places in the study area now contains 758 species, an increase of 178 species (23%) from my last reporting of this total to CDVN (Ogle 2002). Many of the adventive species are very common and widely distributed, but others are known from one site only. Both the number of species and presence of individual species vary through the length of the district (Tables 2, 3) and some have increased their ranges since 2002 (Table 3).

Some of the plants added to the database over the past 6 years are probably new to the study area as adventive species, since they were found in places that had been well-surveyed before 2002. Examples are *Paronychia brasiliensis*, *Eleusine tristachya*, *Chasmanthe floribunda*, *Eragrostis cilianensis*, *Ixia paniculata*, *Silene vulgaris* ssp. *vulgaris* and *Avena sativa*. Others result from surveys of areas not explored closely before. Some additions result from newly discarded plant material, especially in formal or informal garden weed dumps such as those at Patea and Koitiata. Other additions have resulted from an improved ability to recognise some species, such as *Oxalis chnoodes* and *Glyceria fluitans*, or the realisation that well-known species were actually escaping from cultivation, like Moreton Bay fig (*Ficus macrophylla*) and Norway spruce (*Picea sitchensis*).

Beach (north to south order)	Number of adventive species						
	Trees, shrubs, lianes	Grasses	Other monocots	Dicot herbs	Ferns & fern allies	Totals	% increase of totals
Patea	36 (21)	29 (18)	39 (25)	162 (118)	1 (1)	267 (183)	31
Waipipi	7 (3)	30 (11)	7 (6)	66 (34)		110 (54)	51
Waitotara R (right bank)	6 (5)	27 (24)	8 (7)	67 (58)		108 (89)	17
Castlecliff (west of town)	15 (12)	17 (16)	23 (20)	71 (53)		126 (101)	20
Castlecliff (town to river)	34 (29)	27 (24)	24 (21)	94 (80		169 (154)	9
Whitiau (Whangaehu R)	17 (13)	33 (31)	11 (9)	89 (88)	2 (2)	152 (143)	6
Koitiata (Turakina R)	32 (17)	29 (20)	32 (8)	106 (54)		199 (99)	50
Tangimoana	14 (10)	24 (17)	14 (7)	79 (50)	1 (1)	132 (85)	36

Table 2. Numbers of adventive species in coastal dunes in parts of Foxton Ecological District. Data presented in Ogle (2002) are shown in parentheses.

Two statements that I made previously (Ogle 2002) bear repetition here. It is a matter of simple observation to see that some indigenous species of sand country are more resilient than others in the face of human induced changes, including weeds. Spinifex, club sedge (*Isolepis nodosa*), sand convolvulus (*Calystegia soldanella*) and cabbage tree (*Cordyline australis*) are examples. While some such as kanuka have been targeted for firewood and matagouri (*Discaria toumatou*) was all but eliminated as a 'weed', it seems that many other indigenous species have declined with a rise in weed species diversity and weed abundance.

Beach (north to south order)	Locations of selected adventive species						
	Acacia sophorae Sand wattle	*Anredera cordifolia* Madeira vine	*Chrysanthemoides monilifera* Boneseed	*Cyperus congestus* Purple umbrella sedge	*Juncus acutus* Sharp rush	*Lobularia maritima* Sweet alyssum	*Senecio glastifolius* Pink ragwort
Patea		x				x	
Waipipi				x			
Waitotara R (right bank)				x			X
Castlecliff (west of town)	x					x	x
Castlecliff (town to river)	x	x	x	X		x	x
Whitiau (Whangaehu R)	x			1 on 1/00		x	x
Koitiata (Turakina R)	x		x			x	x
Tangimoana	x			1 on 3/96	x	x	x
Himatangi	x		X		x	x	?
Foxton Beach	x		x		x	x	?

Table 3. Distribution of selected adventive plants along the northern half of Foxton Ecological District (upper case 'X' indicates an addition since Ogle (2002)).

References

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More studies are needed to determine the impacts of certain weeds on indigenous plant species, particular on threatened species. Many authors have stated that weeds smother indigenous vegetation, suppress regeneration and cause a loss of indigenous species, but there are remarkably few studies in New Zealand which have examined precise interactions between weeds and indigenous flora in dune country, or other ecosystems for that matter.

WANGANUI PLANT LIST 6 - Vascular Plants of Coast from Castlecliff to Hawera.

0. Ototoka 12.9.89, 27.1.91
1. Castlecliff 5.10.88, 29.5.93, 6.12.94, 21.10.97, 10/98, 10/99, 3/00, 7/00, 4/01, 5/03 **(List 4)**
2. Mowhanau 24.10.88, 12.9.89, 1.12.89, 8.10.90
3. Waitotara River Mouth (left bank) to Snapper Rock, east of Waiinu 11.5.77, 12.9.89, 4.6.90, 27.01.91, 5.11.92; 11.2.03
4. Waverley 28.5.88, 29.11.89, 17.1.92, 4.10.92
5. Waitotara River Mouth (right bank) 10.4.89, 13.8.89, 2.11.89, 2.12.89, 22.1.90, 8-9/2000 (J Campbell)
6. Whenuakura River Mouth and east to Waipipi 24.12.78 (+ D Ravine pers. comm. 11/90); 29.9.91 (Wanganui Botanical Group); 14.12.94; (with J Campbell, G La Cock, M Bayfield) 26.10.00
7. Patea River Mouth and estuary 12.9.89 and many trips after **(List 119)**
8. Patea-Kakaramea-Manutahi (Waikaikai Stream) sea cliffs 11/90 (D Ravine), 23.10.91; 18.1.95
9. Manawapou-Tangahoe River mouths 26.12.74
10. Waihi Beach, Hawera 27.12.90, 29.01.91
11. Okehu Stream 8.10.90; 11.5.04
12.

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Last nomenclature update 11.5.04; additions from Bioweb processed 21/7/04 entered 8/9/04. Converted to Excel format 8/9/04

*: adventive species (including native species naturalised from planted specimens)
(in Leptinella) M = male; F = female; B = both sexes

List excludes species present as planted specimens which are not naturalising (eg pohutukawa, Tasmanian ngaio).

	Latin name	**Common name**	0	1	2	3	4	5	6	7	8	9	10	11
	Trees, Shrubs, Lianes													
*	Acacia longifolia	Sydney golden wattle		X										
*	Acacia sophorae	sand wattle		X										
*	Aloe ciliaris		X											
*	Anredera cordifolia	Madiera vine		X										
*	Artemisia arborescens	hedge artemisia		X										
*	A. verlotiorum	mugwort		X										
*	Asparagus asparagoides	smilax		X										
*	Atriplex halimus	salt-bush		X										
*	Banksia integrifolia							1						
*	Buddleja dysophylla	dysophylla		X										
	Calystegia soldanella	sand convolvulus	X	X	X	X	X	X	X		X			
	C. tuguriorum			X			X							X
	C. sepium	convolvulus	X	X				X					X	
	Cassinia leptophylla	tauhinu		X		X		X	X					
*	Clematis vitalba	old mans beard		X	X									
*	Coleonema pulchellum	breath of heaven		X										
*	Coleonema pulchrum (syn. C. puchellum?)	diosma		X										

AMMOPHILA ARENARIA DISPERSAL AND INVASION IN NEW ZEALAND

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Ammophila arenaria (Marram grass) is a major threat to the geomorphology and ecology of temperate dune systems in Australia and New Zealand. It was planted widely during the late1800s to stabilise mobile dunes, but became naturalised and spread to otherwise pristine dunes, primarily by marine transportation of rhizome. The marine dispersal of *Ammophila* poses a significant conservation threat to New Zealand's remaining dune systems which retain conservation values.

This dispersal process can be divided into three phases: (1) the entry of rhizome into the marine environment, during episodic dune erosion; (2) transportation of rhizome by surface drift; and (3) the deposition of rhizome and establishment of new plants on beaches. This paper presents the first systematic examination of phase two of this sequence.

The marine transport of *Ammophila* depends on the ability of rhizome to retain viability and buoyancy while immersed in seawater. The tolerance of rhizome to salt water was established by excavating rhizome from a foredune in summer and winter; immersing the rhizome for periods of between 1 and 60 days in both seawater and in freshwater; then growing rhizome in trays of beach sand in the glasshouse. Buoyancy was assessed by floating rhizome of various morphologies in seawater.

The tolerance of *Ammophila* rhizome to seawater immersion differed seasonally. During summer months rhizome remained viable up to 22 days in seawater. During winter experiments rhizome remained viable up to 60 days immersion. There was some decline in viability as the length of immersion increased. Rhizome exhibited considerably higher viability when immersed in freshwater than in seawater. *Ammophila* dispersal is not limited by rhizome buoyancy – most rhizome floated in seawater for longer than 60 days.

The potential exists for long distance alongshore dispersal of *Ammophila* rhizome, especially if dispersal occurs during winter. The exact distance will depend on the speed, direction and consistency of wind-forced surface drift. A persistent surface current of $0.1ms^{-1}$, for example, would be capable of transporting rhizome 518 km over 60 days.

CLARIFICATION OF THE NESTING BEHAVIOUR OF *PODALONIA TYDEI SUSPICIOSA* (SMITH) (HYMENOPTERA: SPHECIDAE) BASED ON FURTHER OBSERVATIONS AT CASTLECLIFF BEACH, NEW ZEALAND

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Abstract

Use of plant and dead animal material in the final stages of nest closure in *Podalonia tydei suspiciosa* (Smith) is recorded for 16 out of 17 nests studied. One individual used sand only to close the nest. Females cradled caterpillar prey with the forelegs. Female nesting behaviour, nests and cell size and shape were variable. Nests were made either before or after prey was captured. Nest cells were constructed in dry loose sand. All other sand-nesting solitary wasps nesting in the area constructed nest-cells in firm, moist sand. *Tachysphex nigerrimus* (Smith) (Larridae) competed with *P. t. suspiciosa* for nests, even usurping those of the latter, which it would then extend into firm, slightly moist sand. A number of mistakes in previous publications on the biology of *P. t. suspiciosa* are corrected.

Introduction

Podalonia tydei Fernald has a wide distribution in Southern Europe, Asia, North Africa, Australia and New Zealand, the subspecies *P. t. suspiciosa* (Smith) occurring only in Australia and New Zealand (Bohart and Menke 1976). Single-celled nests, containing one paralysed noctuid caterpillar, are made in loose sand.

Ethological data were summarised by Harris (2001) who, while primarily describing the larva, gave an account of nesting behaviour in *P. t. suspiciosa* on Castlecliff Beach (Wanganui, New Zealand), during late December 2000 to January 2001. In that study, females were not observed to cradle caterpillars, as had previously been observed in the Bay of Plenty (Harris 1994) and plant material was not used in nest closures, as had been reported by McCarthy (1917). Neither were females observed to use a stone to tamp down the nest closure, as had been reported in Australia by Chandler (1926), Bristowe (1971) and Rayment (1935). During the 2000-01 summer, my attention was at times diverted to other solitary wasps being studied and I sometimes interrupted final closure and disguising of the nest in order to more easily extract the prey and egg undamaged. Consequently, some details of final closure were probably missed.

The following summer, I revisited the Castlecliff sand dunes study area daily from 31 December 2001 until 31 January 2002. In this present study, 17 nests were observed until they were provisioned, closed and disguised and 32 prey items were observed being carried by females. Continuous, daily observations for a little over a month resolved some of the puzzling features of previous studies and provided a clear interpretation of the distinctive final closure of the nest.

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Cryptic colouration and melanism in the sand-burrowing beetle *Chaerodes trachyscelides* (Coleoptera: Tenebrionidae)

A. C. Harris*

The flightless, sand-burrowing beetle *Chaerodes trachyscelides* White is confined to the intertidal zone of sandy marine beaches in New Zealand. The dorsal surface varies from black to pale whitish-yellow, and most specimens closely match the colour of the sand they live on. On a beach with pale sand, about 98% of specimens are whitish on the dorsal surface, and about 1% are black. Conversely, on a beach with black sand, about 96% are black and about 1% are whitish. The beetles live under cast-up marine algae on which they feed, and burrow beneath it in the sand. When predatory sea birds pick up such algae, invertebrates, including *C. trachyscelides*, fall out, run a short distance, and burrow into the sand. I suggest that a higher proportion of beetles coloured less like the sand are eaten by seabirds, and that these predators exert differential selection (genetic or phenetic) against non-cryptically-coloured individuals. However, there is as yet no way of telling whether the genetic mechanism is the same as in the classical example of industrial melanism in the pepper moth *Biston betularia*.

Keywords: Cryptic melanism, sandy marine beaches, Chaerodes trachyscelides, *Coleoptera.*

INTRODUCTION

Colour and pattern in animals may be determined by the interaction of several different types of selection, of which thermoregulation, intraspecific communication and evasion of predators are the most significant (Endler, 1978). Numerous investigations involving visible genetic polymorphisms have paid attention to the pleiotropic effects of the genes for colour pattern, as well as the primary adaptive significance of the colour pattern of the phenotype (Ford, 1975; Kettlewell, 1973). In New Zealand, many species of insects display environmental melanism. Harris (1974, 1987) showed that several species of endemic Pompilidae (spider-hunting wasps), active as adults throughout New Zealand but generally only in sunlight, become progressively darker southwards with decreasing mean annual temperature and decreasing solar radiation. Harris (1974) showed that predictable degrees of melanism could be induced in some species by variably lowering the temperature experienced by the pupa during the period of pigment deposition in the cuticle. This melanism is related to thermoregulation in adults; conversely, melanism in *Chaerodes trachyscelides* appears to be a means of predator avoidance through cryptic coloration.

Chaerodes trachyscelides White is a highly convex, rotund flightless beetle about 7 mm long, greatly modified for burrowing in sand. It is confined to the intertidal zone of sandy marine beaches on New Zealand's three main islands. the adults live under the cast-up marine algae upon which they feed. Unlike the false wireworm larvae of most Tenebrionidae, the larva is white and u-shaped. The adult beetle is nocturnal.

If seaweed such as "flap jack" (*Carpophyllum maschalocarpum*), partially buried in sand, is pulled up during the day and shaken, adult beetles fall out, run along the beach a short distance and then burrow rapidly in the sand. Large numbers of adult beetles often congregate in the sand at depths of up to 150 mm below cast-up seaweed.

The beetles vary greatly in colour. While the undersurface of adult beetles is always uniform pale whitish yellow, the dorsal surface is highly variable, ranging from uniform

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Objective evaluation of colour variation in the sand-burrowing beetle *Chaerodes trachyscelides* White (*Coleoptera: Tenebrionidae*) by instrumental determination of CIELAB values

A.C.Harris* and I.L.Weatherall**

The objective evaluation of the different colours of individual sand-burrowing beetles *Chaerodes trachyscelides* White illustrates that instrumental techniques may replace visual assessments and subjective descriptions of colour variation. Colour measurements based on the principles established by the Commission Internationale d'Eclairage (CIE) provide quantitative specifications of colours as their coordinates in the 1976 CIE L*,a*,b* (CIELAB) uniform colour space. The established precision of the method enables rapid and reliable determination of the distribution of colours within collections made for studies on cryptic melanism.

Keywords: Colour measurement, Chaerodes trachyscelides, *CIELAB, cryptic melanism*

INTRODUCTION

There have been many studies of colouration in animals with particular reference to its primary adaptive significance, often in relation to its camouflage effect. Camouflage makes individual animals less conspicuous to predators, so different colours are required in different environments (Poulton, 1890; Cain and Sheppard, 1952; Kettlewell, 1973; Harris, 1988 and see summaries in Endler, 1978; Bishop and Cook,1980; Lees, 1981). In the above studies, colours were assessed subjectively and described by the use of general colour names, and this restricted the precision of the results. However, the limitations of visual observations and ill-defined descriptive terms for colours and colour differences may, in principle, be overcome by the use of instrumental techniques to provide objective specifications of colour values.

In this paper an application of the colour measurement system established by the Commission Internationale d'Eclairage (CIE, 1931) is introduced. The usefulness of a quantitative method providing CIELAB colour specifications is illustrated from samples of the sand burrowing beetle *Chaerodes trachyscelides* White. In a previously reported investigation on cryptic melanism in this species (Harris, 1988), the various colours of the beetles were described subjectively as pale whitish yellow, through shades of brown, to almost black. The animals were grouped into four categories on a subjective appearance scale. The present study aimed to provide an objective evaluation of those colours and their distribution in terms of CIELAB values.

CIE COLOUR SYSTEM

The perceived colour of an object depends on (1) the nature of the illuminating light, (2) its modification by interaction with the object, and (3) the characteristics of the observer's visual response (Billmeyer and Saltzman, 1981). The CIE system defines these conditions as

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The Larva of *Brullea antarctica* (Coleoptera: Carabidae: Broscinae)

A. C. Harris
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Summary

A description is given of the distinctive larva of *Brullea antarctica* Castelnau, an uncommon coastal psammophile.

INTRODUCTION

Brullea antarctica Castelnau is a large, specialised, burrowing psammophile confined to the supralittoral fringe of sandy beaches. Morphological adaptations for burrowing in firm sand are present in the larva as well as in the adult. The larva has been searched for intensively by a number of entomologists, but has hitherto remained unknown. This apparent rarity, together with the unusual features they present, suggested that a description of the present larvae should be placed on record, despite their rather unsatisfactory condition.

The following account is based on 2 specimens, one found by the author at Castlecliff, Wanganui, on 14 August 1971, at a depth of 11 cm at the spring high water level; the other by Dr G. W. Gibbs on the foreshore of Waikanae beach on 1 August 1972. Both specimens are damaged, the latter extensively so. Because they are very uncommon neither specimen was dissected, resulting in some minor details of the mouthparts being omitted from the description.

GENERIC DIAGNOSIS

Body stout, maxillary stipites bearing numerous long setae on dorsal and inner surfaces, ultimate maxillary palp segment broader than long, minute; legs stout, strongly armatus, with numerous very long, broad-based setae and bristles; abdominal tergites 4 and 5 very notably more setose than remainder; anal tube short, very broad, cylindrical, bearing many setae of different lengths.

DESCRIPTION (Castlecliff specimen)

Plate 1A-C; figs 1-7, 9

Body length 27 mm; head capsule width 5 mm.

Colour: mandibles very dark red, apex black; head dark reddish brown; pronotum reddish brown; metanotum, 1st abdominal tergite, 2nd abdominal epipleurites, and legs testaceous; rest of abdomen and urogomphi uniform pale creamy-yellow.

Head. Transverse, broader than long, strongly sclerotised; frontal piece concave, epicranial sutures very distinct, nasale with margin broadly convex; ocelli of normal development, 6 on each side; cervical keel and cervical groove prominent, latter meeting epicranial suture. Chaetology as shown in Figs 4, 5. (Habu and Sadanaga's (1961, 1965, 1973) names are used to facilitate reference to individual primary setae – no real phylogenetic homology is assumed). Ventrally a large puncture marks the usual site of seta V3. Some setae bilaterally asymmetrical (e.g., seta F2 and the secondary seta behind it (Fig. 4)). Antenna (Fig. 3) 4-segmented, 0.6× length of mandible, 1st segment with 2 internal setae, 3rd and 4th segments each with 1 internal and 2 external setae, the 4th with an additional fine apical seta; mandible with 1 external seta, retinaculum small,

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Geographic variation for colour in the sand-burrowing beetle *Chaerodes trachyscelides* White (Coleoptera: Tenebrionidae) on New Zealand beaches analysed using CIELAB L* values

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Received 31 October 1989, accepted for publication 19 April 1990

Chaerodes trachyscelides White is a highly specialized, flightless burrowing beetle confined to the narrow strip of sand at and just above high water level on sandy marine beaches in New Zealand. Although the ventral surface of the beetle is always pale, the dorsal surface varies from pale to almost black. Large samples of this beetle were taken, together with the sand, from 11 beaches on New Zealand's three main islands. The colour of the dorsal surface of each individual beetle and that of the sand samples was measured using reflectance spectroscopy and expressed as CIE L*,a*,b* (CIELAB) values. The L* values, which are objective, quantitative measures of the degree of lightness of the beetles, were subjected to statistical and frequency analysis. Although the species was very variable in colour and the variation appeared to be continuous, a highly significant correlation was obtained between the mean of the L* values for the samples on each beach and that of the sand, the correlation coefficient being 0.961. This close association between the lightness of the beetles and that of the sand suggests the variable melanism functions as cryptic colouration. On most beaches, the distribution of lightness among the beetles sampled conformed to a normal curve. For beetles from sites where the sand was relatively uniform, such as the black Taranaki beaches, the L* frequency distribution curves were narrow and the coefficient of variation of mean beetle colour was relatively small indicating low colour variability. In contrast, the greatest within-site variability occurred on the two Stewart Island beaches sampled, where in each case there was less uniformity in the colour of the sand. At one of these sites, Maori Beach, darker sand present below the high water level is often deposited on the zone occupied by the beetles after storms. On Lonneker's Beach, the distribution of L* values among the beetles sampled was actually bimodal. On this small beach, there was an area of intensely black sand in the zone occupied by the beetles, but most of the rest was covered with light golden sand. These results are interpreted as evidence that the variability of colour of *Chaerodes* beetles has the effect of populations being able to match the colour of the sand of their home beaches, presumably as a consequence of the differential survival of individuals.

KEY WORDS:—*Chaerodes trachyscelides* – Tenebrionidae – melanism – cryptic colouration – geographic variation – colour – CIELAB values

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PROGRESS CASTLECLIFF Inc.

P O Box 2036, Gonville, Wanganui

Castlecliff Coastal Reserve – a thumbnail sketch

Castlecliff Coastal Reserve is a 25-hectare area of coastal dunes, which are natural but indirectly are man-made. As the aerial map shows, the dunes have grown since the North Mole was built for harbour protection.

Before pakeha colonization, upriver Maori came to the river mouth for seasonal fishing and their village, Pungarehu, was located by the river mouth, under the prominence known as Castle Cliff. The hill was cut back, became the site of one of the pillboxes built for coastal defence and is the base of the present pilot station.

Whanganui River, from the river mouth up to and beyond the city centre, was a busy port from the earliest European colonization, but port activity steadily declined until the Japanese intrusion into the South Pacific caused the government to centralize shipping activity through main ports. Wanganui port was closed for the rest of the war. It remains active at a lower level.

One effect of the decline of the port was that after the war the Wanganui community's general level of interest in Castlecliff declined. Indifference would not be too strong a description for the attitude to Castlecliff. Sentimental support remains for Castlecliff Beach as the only swimming beach in the city and there have been sporadic efforts to help the suburb.

In the heyday of the Castlecliff, trams ran down to Rangiora Street and the remains of the tram terminus shelter can be seen on the boundary of the holiday camp on the corner of Seafront Road. .In the absence of the many counter-attractions today, the trams were crowded at weekends and families could step off the tram, directly on to the beach and into the sea. Later the large pavilion on the south side of Rangiora Street was removed to the softball ground in Gonville.

Little official attention was given to the coastal reserve, except that when the city administration needed to build up Springvale Park, which was swampy, a large quantity of sand was removed from the dunes on the northern side of Morgan Street. This area appears as a smooth area on the aerial photograph between the yellow and green lines, from Morgan Street to the pillbox, and remains a wasteland.

The coastal reserve was designated as a premier park, but has never been treated as one. Over the years a number of people have taken interest in the area, working on an uncoordinated voluntary basis. Marram grass and Australian wattle was planted on some dunes.

In the early 1990s the Wanganui District Council considered the future of the reserve and after the 1994 Coastal Reserve Management Plan was adopted. A budget was provided and early action included clearing an area of the Australian wattle. There was adverse public reaction, complaints about sand being blown to houses, and there did not appear to be an effective planting programme for the cleared areas.

Official support diminished and by the turn of the century the management plan had lapsed into inaction. Castlecliff community groups wanted the plan to be implemented and eventually the District Council agreed to review it. This was done and in August 2005 council adopted the current Castlecliff Coastal Reserve Management Plan.

For historic reasons Wanganui District has been financially stretched for many years. That pressure continues and the council has been unable to allocate the necessary resources to carry out an effective development programme . One of the other community groups in the suburb initiated a weedbusting programme in conjunction with the District Council, but personnel changes brought that to a halt.

In 2005 Progress Castlecliff decided to pick up the challenge of development of the reserve. Our work is focused on Section 8.4 of the management plan.

The need for expert guidance was evident, especially as there are differences of opinion about the use of the Australian wattle and marram grass. We set up a small consultative group with representatives of the District Council, Horizons Regional Council and DOC, which has proved most helpful, with advice and some resources. The District Council has agreed that there should be consultation with Horizons and DOC to put this consultative process on a more formal basis.

We have focused on the inner dunes in the area south of Rangiora Street, working with six to eight community service workers every Saturday. Where we have been working there has been heavy infestation of madeira vine, boxthorn and cape ivy. It was evident that just clearing was not enough – Horizons have sprayed extensive area of madeira vine and these have been left an resprayed to check fresh growth, and we found that boxthorn which had been cut back but allowed to regrow caused tangled vine-like growth that took much longer to remove than the original clearance. Continuous management including respraying is necessary.

We started some path cutting, as there are wide panoramas from the dune tops. We have lined the paths with flaxes to check acacia regrowth which can swallow the paths in one or two seasons. However, we found that as soon as we opened up a section of path it became a speed track for motor bikes, so we have temporarily discontinued that work.

Late in 1995 we started replanting and continued in 2006 and last year. Altogether we have planted up to 3000 seedlings, many of them flaxes donated from clearing and planted immediately. We had been warned to expect losses, but with reasonable rainfall in the first two summers we seemed to have considerable success. Salty gales in October and drought this summer have caused substantial losses.

The flaxes, taupata, karo, ngaios and cabbage trees have been the most successful. Other coprosmas and hebes have suffered most severely.

In the foredunes, dunes closest to the bathing beach have been planted with marram, and these have grown, with the marram rising to the crown leaving the lower levels bare and starting to erode. Further north and south there are well established spinifex dunes, with some pingao, and these are much lower, rolling dunes with the spinifex growing down to the high water mark. We are growing spinifex and pingao from seed gathered in the reserve and will be planting these. We have been advised that tops of the high marram-covered dunes should be bulldozed and shaped similar to the other dunes, but this will require a case to be made and resources allocated.

Ted Frost

E G A Frost
Chairman
28 February 2008

8.4 Objective: Landscaping and Weed Removal

To carry out in a gradual systematic way, the removal of weed species and exotic species in the dunes and replace them with more appropriate native species. To continue the programme of landscaping in the Domain Reserve using appropriate coastal tolerant species.

Justification

The 1994 Plan continually referred to Castlecliff Reserve and its "natural" features. This 2004 update has used the term "rugged" (as in rugged beauty) as it more accurately defines the area. The existing coastline is not natural when compared to pre-European settlement. The intention of this objective in the Plan is not to return the area to the way it was prior to European settlement. However, opportunities do exist to improve the area through the gradual removal of invasive vegetation such as boxthorn, wattle and scenecio. These invasive plants could be replaced with native pingao, spinifex, Coprosma and other species which are endemic to the area or other suitable native species found in the New Zealand coastal environment.

A further benefit in the gradual removal/replacement of exotic plant material is the ability to retain the sea views. These important views are gradually being lost, partly through the increasing height of the dunes, but also due to the existing vegetation growing up. There has already been pressure on the Wanganui District Council to take some action over this issue and the problem will only increase over time. However, there is the risk that by removing vegetation the sand dunes are more exposed to wind, and sand may get blown onto nearby properties. Therefore, great care should be taken to ensure that the process of removal and replacement of vegetation is gradual, and that the removal work is done in winter so that replanting can occur at a time that ensures the highest survival rate of newly planted native species.

Note: The Department of Conservation report that a more radical approach to the gradual growth in height of the sand dunes has been managed in other Coastal environments in New Zealand and other parts of the world by significantly reducing the size of the dunes and recontouring them. Whilst this course has not been seriously debated by the community during the course of writing this plan it does have features that would appeal to some stakeholders. Firstly it would allow better management of the growth in the dune height and overall stability of the dunes. Secondly it would provide an opportunity to completely replant large areas of the dunes with more suitable native species, and, lastly it would provide better views of the sea to many residents. However, any change to the current policy of gradual change to dune vegetation and shape need further public input and debate.

8.4.1 Implementation

1. Begin gradual removal of non-native and weed species in the dunes and replace with appropriate native species. Use pingao and spinifex grass in the foredunes, and plants such as NZ sand convolvulus, *Coprosma* and similar endemic species in the intermediate areas. Pohutukawa, karo, *Gnio* and *Coprosma repens* are to be used in more modified areas.

2. Encourage and support community groups to remove species such as pink scenecio weed, *Scenecio glastifolius*.

3. Target conservation grants to support the process of weed and non-native plant removal and replanting programmes so that the process occurs at little or no cost to the Wanganui ratepayer.

4. Contract local nurseries to propagate pingao grass, spinifex and other native endemic plants through the collection of seed and cuttings from the Reserve.

5. Continue landscaping within the Reserve on established dunes, the Domain and in other areas, using appropriate coastal tolerant plantings.

Costs

	Task	**Cost Breakdown**	**Total**
1.	Removal of exotic plants by contracted groups.	$5,000 (per annum)	$5,000
2.	Encourage volunteer groups to remove easier weed species.	no extra cost to Council	-
3.	Contract local nurseries to provide locally sourced native materials and propagate cuttings from the Reserve.	$10,000 per annum, divert from existing landscape budget.	-
4.	Planting and landscaping throughout the Reserve and surrounding areas.	Redirect money allocated to plant purchase within the existing Council budgets.	-
		Total	**$5,000 p.a.**

WANGANUI DISTRICT COUNCIL

Media Releases

Castlecliff Beach grooming - 05/03/07

Progress on options for grooming Castlecliff Beach will be reported to the Wanganui District Council's Community Development Committee tomorrow (March 6).

"The Council needs to decide on its preferred management option for Castlecliff Beach sand and we are working through discussions with key groups following receipt of a report by consultant Lachie Grant, of LandVision Ltd, who has investigated options for sand management at the beach," Committee chair Cr Nicki Higgie said.

The Council currently has a resource consent from Horizons Regional Council to groom the beach with a bulldozer, with a maximum of 5000 cubic metres of sand to be moved. The consent does not cover removal of sand from the car park.

A condition of the consent requires the Council to investigate alternatives to the current method of beach grooming and to provide a report on the preferred management option to Horizons by 1 May 2007.

The Community Development Committee will discuss progress at its meeting tomorrow (Tuesday, March 6).

show all articles

WANGANUI DISTRICT COUNCIL

Media Releases

Castlecliff Beach grooming will start now - 13/12/06

Mayor Michael Laws announced today that work to clear excess sand from Castlecliff Beach and surrounding areas will begin immediately and continue until Easter 2007.

"It is critical that we have a beach and beachfront that is inviting and accessible. It is one of the few free family facilities that we have," Mayor Laws said.

"It must be pristine for the summer, and especially for the festive season."

Grooming work will include the beach frontage, carpark and adjacent areas, upper lookout and carpark, and the children's playground. Work will start this week.

"I made an executive decision, but it has been strongly supported by my council colleagues, that any additional funds required can be recovered through the storm levy in next year's Annual Plan. We are having to do extra work in the beach area because of the adverse weather conditions that Wanganui has experienced over this past year."

Mayor Laws said the council rejected the idea that Castlecliff Beach should revert to nature.

"This is a beach and waterfront that has historically been open and accessible. That is the way it will stay."

show all articles

Sebaea ovata (Gentianaceae) and its habitat near Wanganui

Colin Ogle[1]

ABSTRACT

Sebaea ovata, once a widespread yet localised "gentian" in New Zealand, had its last confirmed sighting in 1971. The discovery in 1989 of numerous plants in a dune hollow on conservation land near Wanganui offers the prospect of maintaining this population and protecting the species as part of the indigenous flora.

INTRODUCTION

Sebaea ovata, an annual herbaceous member of the Gentianaceae, was recorded by Hooker (1867) as occurring in Australia, Tasmania, and New Zealand. Habitats included "bogs at Hokianga, *A Cunningham;* grassy places, Ahuriri [Napier], *Colenso;* Port Cooper [Lyttleton Harbour], *Lyall*". The Hokianga plants originated "in bogs at Mangamuka, Hokianga – 1834. R Cunningham" (A Cunningham, *in* Allan 1961).

Collections made since the publication of Hooker's "Handbook" and held in New Zealand herbaria are listed in Table 1. Several apparently early collections lack collection dates and specific locations, but *S. ovata* certainly occurred last century in scattered localities from Northland to Hawkes Bay and Canterbury.

Kirk's collections from Canterbury (two in WELT, one each in WELTU, AK) are all undated. Location on two is given as "Lake Ellesmere", and "Lake Ellesmere Flat near Lincoln" appears on the other two (Table 1). Actually the label on WELTU 5762 is not in Kirk's handwriting and reads "Ellesnore" instead of Ellesmere, but both Bryony Macmillan and Barry Sneddon (pers. comms.) attribute this to a mis-reading of Kirk's original label. Bryony Macmillan points out that Kirk's itinerary (in Hamlin 1965) shows he was collecting between Lincoln and Lake Ellesmere on 20 November 1883, which is the basis for that date in Table 1.

All records from the Wellington area were made early this century. Since then, all collections have originated from coastal dunes of the Wanganui, Manawatu, and Horowhenua Districts in the south-west of the North Island. There is one unconfirmed sighting of a few plants of *S. ovata* on the south head of Hokianga Harbour "several years ago" (Peter de Lange, pers. comm.).

In "Rare and endangered plants of New Zealand" (Given 1981) *S. ovata* was listed with an indeterminate conservation status, ie a species which is probably threatened but for which there is insufficient information to state whether the species is "rare", "vulnerable", "endangered", or even "extinct". This indeterminate status has been maintained in unpublished revisions of the threatened plants checklist by David Given and various co-authors, largely because there were no recent records of it.

This article reports the re-discovery of *S. ovata* in January 1989, and subsequent observations of the plants.

[1]Department of Conservation, Private Bag, Wanganui

Herbarium	Collector	Date	Location	Notes
Armstrong herbarium, on loan from Christchurch Botanic Gardens No. 6293	J B Armstrong	1869	Little Rakaia [Canterbury]	–
CHR 332485	J B Armstrong	–	Banks Peninsula	–
AK 11584A	J B Armstrong	–	Canterbury Plains	–
WELT 23420 AK 7154	W Colenso	–	Ahuriti [Napier]	–
WELT 47854	A Hamilton	–	Hawkes Bay	–
WELT 47837 (Herbarium of T Kirk)	Mr Tryon	–	Waimarama [South of Napier]	On cliffs (clay)
WELT 47624 (Herbarium of Wm Martin)	–	–	Lake Coleridge (or L Sarah)	–
AK 7132 (perhaps = WELT 47849)	Kirk	Perhaps all on 20.11.1883 (see text)	Lake Ellesmere	–
WELTU 5762 WELT 47847	T Kirk		Lake Ellesmere Flat near Lincoln	–
AK 7153	B C Aston and T F Cheeseman	–	Cape Turakirae [Cook Strait]	–
CHR 332486 WELT 47848	B C Aston	–	Palliser Bay	–
WELT 47836, 47855(prob. = CHR 332487, and close to Petrie's specimen WELT 6232)	B C Aston and D Petrie	2.2.1912	East of mouth of Orongorongo River, South Wellington	Wet land near sea, largely among large rocks
CHR 17645	H H Allan	20.4.1935	Foxton	Old salt meadow
CHR 23272	H H Allan	6.12.1939	Foxton	Salt meadow
CHR 77220	L B Moore	17.11.1946	Hokio Beach (west of Levin)	Flats between sand dunes
CHR 159786	A P Druce	Dec 1964	Hokio Beach (west of Levin)	Sand flat
CHR 197172	A P Druce	Nov 1967	Turakina Beach, Rangitikei District	Flowers not observed to open
WELTU 7215	B V Sneddon & A P Druce	14.12.1967	Hokio Beach	Inter-dunal hollow along with various rushes and sedges
WELTU 15678	K G Ryan	30.8.1971	Hokio Beach	Dune hollow, dune vegetation
CHR WELT 15677	C C Ogle	23.1.1989 6.2.1989	Whangaehu River mouth near Wanganui	(See text of this paper)

Table 1: herbarium collections of *Sebaea ovata* in New Zealand (in chronological order where date of collection is known). AK = Auckland Institute and Museum; CHR = Botany Division, DSIR, Christchurch; WELT = National Museum, Wellington; WELTU = Victoria University of Wellington.

REDISCOVERY OF *SEBAEA OVATA*

Members of the Wellington Botanical Society and Wanganui Museum Botanical Group held a combined field excursion over the period 21-23 January 1989. On 23 January, the party drove through the pine forests of the old Forest Service's Harakeke Block of Lismore Forest, south-east of Wanganui. Near the mouth of Whangaehu River is an unplanted area of some 250ha of dunes in predominantly native vegetation (Figure 1), locally known as the Harakeke Dunes.

On two brief visits to these dunes in 1988 I had noted a wide variety of native plant communities, particularly in dune hollows. One, a damp sandy flat

covered in short turf vegetation, I had ear-marked for a closer inspection on the January trip. Once gathered at the site, the entire party immediately fell to hands and knees, noting species such as sand gunnera[1], a round-leaved form of *Selliera radicans*, native lobelia, a small sedge *(Schoenus nitens* s.s.), and a milfoil *(Myriophyllum votschii)*. There were some adventives, too, such as hawkbit, stunted plants of Yorkshire fog, and a few centaury plants, pink flowered members of the gentian family.

It was some minutes and 20-30m from the start of our slow crawl of discovery that we encountered some slender erect herbs with tiny, bright yellow flowers. Though most plants were fastigiately branched, they were clearly similar in general form to the centaury plants, and hence in the gentian family.

None of us was sure as to whether we were among plants of the long-lost native species, *Sebaea ovata*, because we lacked suitable reference books in the field. However, we took photographs, and also two of the 50 or more plants around us as voucher specimens. Their identity was later confirmed by both Tony Druce and staff of Botany Division at Christchurch.

Habit and habitat

Figures 2 and 3 show the form of *S. ovata* and some details of its flowers. Each flower has five petal lobes which, in warm and sunny conditions just separate to expose the stigma (Figure 3.) Live plants have pale yellow-green foliage and stems, but after flowering the plants die, mostly remaining erect and pale brown. Flowering plants seen at the Whangaehu River dunes are 40-140mm tall,

Fig. 1 Right bank of mouth of Whangaehu River. Marram is in foreground, damp dune hollow beyond with clumps of *Isolepis nodosa;* toetoe in distance. January 1989.
Photo: Y Cave.

[1]Formal names of plants are given in Appendix 1.

although Allan (1961) gives plant height as being up to 250mm[1]. Specimen WELTU 7215 is about 230mm.

Because there does not appear to be a sketch or photograph of New Zealand plants of *S. ovata* in other publications, it is hoped that this paper will lead to more discoveries of the species. The plants are not large but because there are few other erect dicotyledon herbs in their sand dune habitat they are quite conspicuous.

Visits to Harakeke Dunes from February-May 1989 have revealed juvenile (non-flowering), flowering, and dead plants on each occasion. The colony of many hundreds of plants is now known to extend over an estimated area of 20m × 200m, with sparse or more dense patches of *S. ovata* in pockets separated by clumps of club sedge. On 2 July 1989 much of the same hollow was under water up to 100mm deep. A thin sheet of ice covered the surface, the result of frost the previous night. A short search revealed only three plants of *S. ovata,* each with a mixture of green and dead leaves.

On 21 February a one-metre square quadrat was placed over several of the densest patches. The highest density of *S. ovata* was 71 plants/m^2. Plant cover was measured in this quadrat, with the results in Table 2. Non-vegetated substrate (damp sand, rabbit droppings, dead leaves and small twigs) accounted for 40% of the cover. A flowering plant was dug up in a turf of some 100mm diameter, and potted in my greenhouse. The parent plant died soon after, but by April numerous seedlings appeared in its place. By mid-June there were 42 seedlings, the largest being 20mm tall with four pairs of leaves.

For continuous establishment of its seedlings, *S. ovata* needs short-stature, open vegetation with bare ground between the plants. The life-span of individual plants is not yet known, but is likely to be less than six months. Since flowering plants were present each month between January and May, it seems that there is production of seeds over a considerable part of each year. This allows the species to take advantage of open ground at any time.

Adventive plants are now common in dune hollows suitable for *S. ovata*. Even in the quadrat with a maximum density of *S. ovata* plants (Table 2), by far the most abundant species is hawkbit, whose leafy rosettes effectively cover bare ground. Throughout the area occupied by *S. ovata* there are other adventive plants, Yorkshire fog and strawberry clover being the most common. *S. ovata* appears to be unpalatable to rabbits. Rabbits may, in fact, help its survival by reducing the cover of adventive plants, and if rabbit numbers were to be much reduced *S. ovata* could disappear. This is to be tested experimentally with a rabbit exclosure.

[1]Australian plants bearing the same name are described as being about 500mm tall (Harris 1970). The same author states that *Sebaea ovata* occurs in "montane habitats in New South Wales, Victoria and Tasmania", while Galbraith (1977) gives its habitat as grassland from southern Queensland to Tasmania. The Field Naturalists' Club of Victoria (1928) states that around Melbourne *S. ovata* occurs in grassland on basalt plains, forest country, and in dwarf scrub. No Australian publications that I have seen make reference to coastal habitats. Such differences in form and habitat compared to New Zealand plants suggest that there may be different taxa under the name *S. ovata*. Allan (1961) accepted that New Zealand plants belonged in *S. ovata,* but cited the view of Allan Cunningham in 1839 that they differ from true *S. ovata* in several details, including their more slender form. Hooker's opinion, that Tasmanian specimens do not differ significantly from New Zealand plants, was also cited.

Vegetation of the dunes

Spinifex, pingao, and sand daphne are common on the foredunes, with club sedge, tauhinu, and sand coprosma increasingly common on dunes away from the sea. In dune hollows there is a wide variety of plant communities, ranging in stature from matted salt marsh plants, dominated by *Selliera* and *Samolus repens*, to taller jointed rush with club sedge, sand iris and *Schoenus nitens*.

Fig. 2 *Sebaea ovata* in mat of *Gunnera dentata*, Whangaehu Dune hollow. January 1989.
Photo: Y Cave.

Fig. 3 Close-up of flowers of *Sebaea ovata*. January 1989.
Photo: Y Cave.

Some hollows contain even taller shrubland of *Coprosma propinqua, Olearia solandri,* toetoe, and occasional cabbage trees, over-topping a dense sward of sand coprosma and jointed rush. Close to the river are freshwater swampy patches with flax and jointed rush. New Zealand mint plants grow to 600mm tall among the rushes.

Adventive plants are locally conspicuous; marram on the foredunes, pampas, evening primrose, and boxthorn further back. In July 1989, a start was made in a programme to eliminate boxthorn and pampas. Small plants were pulled and larger plants were cut, followed by poisoning of the stumps. Tree lupins, once abundant, have recently all but disappeared. Grazing by uncontrolled cattle, probably aided by rabbits, has induced some patches of rough pasture, but fencing to exclude cattle was completed in July 1989.

The flora of Harakeke Dunes is currently known to total 190 species, 87 of them indigenous. In addition to *Sebaea ovata,* there are several other notable occurrences, including pingao, sand daphne, and sand iris, the last-named a much-depleted and very rare species in the North Island. I found a single plant of a previously unrecorded *Coprosma* hybrid, *C. acerosa* × *C. propinqua,* here in April 1989. *Mazus* sp. *(M. pumilio* auct. NZ) and *Isolepis basilaris* are two other nationally uncommon plants of the dune hollows.

The future

The Harakeke Dunes were allocated to the Department of Conservation in 1987, and legal protection as a Scientific Reserve is currently being investigated. This will strengthen the Department's capacity to deal with unauthorised off-road vehicles and cattle, and to finance weed control. The area is probably the largest relatively natural dune system in the Foxton Ecological District (which extends from near Hawera to Paekakariki), and will be a nationally significant protected natural area for its representative dune communities.

The presence of several nationally threatened plant species makes the Harakeke Dunes additionally important. *Sebaea ovata* is the rarest of these in New Zealand, and ensuring its survival must be a priority in future management of the area.

Species	*Cover(%)*
Leontodon taraxacoides (hawkbit)	28
Bare sand	18
Litter	16
Schoenus nitens s.s.	14
Gunnera dentata var. (sand gunnera)	6
Rabbit droppings	6
Sebaea ovata	4
Holcus lanatus (Yorkshire fog)	4
Leptocarpus similis (jointed rush)	2
Juncus caespiticius	2
	TOTAL = 100%

Table 2: Species cover in a one-metre square quadrat containing 71 *Sebaea* plants. Estimates based on 50 points at 50mm intervals along diagonals of the quadrat. 21 February 1989.

ACKNOWLEDGEMENTS

I thank the curators of New Zealand's herbaria for information on their holdings of *Sebaea* specimens; Bryony Macmillan (Botany Division) for a continuing supply of historical information; Yvonne Cave of Wanganui for her excellent photographs; Flora Wisely (Department of Conservation, Wanganui) for typing the various drafts of this paper; Jocelyn and Ian Bell of Wanganui for locating references to *Sebaea ovata* in Australian publications; Susan Timmins, Rob McColl, Patrick Brownsey, and Tony Druce for comments on a draft of the paper; Tony Druce for advice on the status of the hybrid *Coprosma.*

Footnote

On 13 August 1989, after I had completed this paper, Graham Randle and I discovered some dead *Sebaea* plants in a dune hollow on the true right of the Waitotara River mouth, 40km north-west of the Harakeke Dunes. The size and extent of this population will be assessed in the summer when new plants appear.

APPENDIX 1: Formal Names of Plants named in the text

Common Name	*Formal Name*
boxthorn	*Lycium ferocissimum*
cabbage tree	*Cordyline australis*
centaury	*Centaurium erythraea*
club sedge	*Isolepis nodosa*
evening primrose	*Oenothera stricta*
flax	*Phormium tenax*
hare's tail	*Lagurus ovatus*
hawkbit	*Leontodon taraxacoides*
jointed rush	*Leptocarpus similis*
marram	*Ammophila arenaria*
native lobelia	*Lobelia anceps*
New Zealand mint	*Mentha cunninghamii*
pampas	*Cortaderia selloana*
pingao	*Desmoschoenus spiralis*
sand coprosma	*Coprosma acerosa* var. *acerosa*
sand daphne	*Pimelea arenaria*
sand gunnera	*Gunnera dentata* var. *(=G. arenaria)*
sand iris	*Libertia peregrinans*
spinifex	*Spinifex sericeus*
tauhinu	*Cassinia leptophylla* var. *leptophylla*
toetoe	*Cortaderia toetoe*
tree lupin	*Lupinus arboreus*
Yorkshire fog	*Holcus lanatus*

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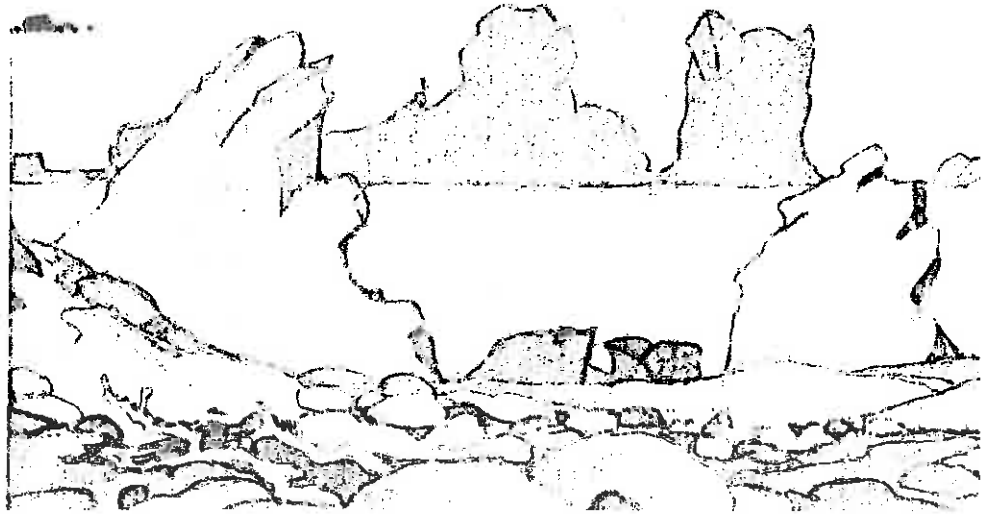

Growth and habitat of *Sebaea ovata* (Gentianaceae) in New Zealand and Australia

P.D. Champion[1], D.E Hofstra[1], M.E. Auger[2], and C.E.C. Gemmill[2]

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ABSTRACT

Sebaea ovata (Labill.) R.Br., a critically endangered indigenous annual herb, was locally common in coastal lowlands and swampy ground in New Zealand. It is now only present as two small populations (Whitiau and Waitotara) in dune flats in the Wanganui Conservancy. The field population of *S. ovata* at Whitiau Scientific Reserve (New Zealand) and field sites in Australia were investigated. Cultivation and morphological and genetic comparisons of New Zealand and Australian plants were made to guide the management of *S. ovata* in New Zealand. At Whitiau, *S. ovata* is restricted to an area of c. 300 m^2 with a total population of between 8757 plants (December 1998) and 641 plants (March 1999). Sediment core samples showed no evidence of an extensive seed bank. Soils were very low in available nitrogen compared to Waitotara. *S. ovata* requires open vegetation in which to establish and maintain its population. Winter flooding of the dune habitat excludes the more competitive perennial species. If flood events do not coincide with the life cycle of *S. ovata*, plants may be killed without contributing seed. A series of atypical seasons could lead to extinction, therefore the status of *S. ovata* in New Zealand is considered critical. The extinction of one or both populations is likely unless conservation management is undertaken. In southern mainland Australia, *S. ovata* occupies a different habitat. It occurs in open eucalypt forest amongst a diverse assemblage of native and introduced annual species which grow and reproduce in spring/early summer, influenced by seasonal rainfall. Differences in habitat and plant size have led to suggestions that *S. ovata* from New Zealand and Australia may be different taxa. Glasshouse cultivation of plants from both countries, and morphological comparison (supported by ITS sequence data) indicate they are indeed the same species. Successful cultivation of *S. ovata* has been achieved. Cultivated plants and seed have been returned to the Department of Conservation for replanting and resowing. The maintenance of *S. ovata* in culture, as well as the protection of suitable *S. ovata* habitat are the key to ensuring the survival of the species in New Zealand.

Keywords: endangered, annual herb, loss of habitat, weed encroachment, dune hollows, Whitiau Scientific Reserve, New Zealand, Warrandyte State Park

Champion, P.D.; Hofstra, D.E; Auger, M.E.; Gemmill, C.E.C. 2003: Growth and habitat of *Sebaea ovata* (Gentianaceae) in New Zealand and Australia. *Science for Conservation 229*. 32 p.

Seed production and processing of the indigenous coastal sand-binding plant *Spinifex sericeus*

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R.C.Southward@massey.ac.nz

ABSTRACT

Spinifex sericeus R.Br is an important indigenous sand-binding grass growing on coastal foredunes throughout the North Island and northern South Island of New Zealand. Utilising seed rather than vegetative propagation techniques has typically been more successful in establishing plants for sand dune stabilisation in New Zealand. Since 1998, caryopses (naked 'seeds') have been mechanically extracted at Massey University from 43 collections (or sub-collections) sent by interested parties from 16 North Island beaches. Although most collections received were from five beaches of the south western coast of the North Island (25), especially Hokio beach near Levin, a number were also received from a further five west coast and six east coast beaches. Weights of extracted whole seeds ranged from as little as 2.9g (approximately 210 seeds) to 142g (approximately 11,270 seeds) per 'packed' fertiliser bag of spinifex seedheads (av. 51.1g, about 3790 seeds). The ten highest yields obtained were collections from Hokio (8), Foxton (1) and Himatangi (1) beaches. Low yields were more typical of east coast beaches, although the lowest yields recorded were from the west coast beach Oakura, near New Plymouth. Fungal smut or rodents were identified as causes of low seed yield in some cases. Thousand seed weight varied from 11.7g (Patea) to 15.6g (Muriwai). A relationship of declining seed weight with increasing seed yield was only prevalent from the combined Hokio & 'Kapiti' collections (r^2=76%).

The seed extraction/cleaning process used is outlined in this paper and involves the use of four lab-scale seed threshing/cleaning machines plus ancillary equipment. Overall seed quality as a result of the extraction process was acceptable with losses through broken seed typically restricted to around 5%. In today's dollar terms, extraction costs ranged from 1.9c to $1.00 per seed, av. 5.5c, largely depending on the seed number able to be extracted, or 3.2c to $1.67, av. 9.2c per germinable seed based on a conservative germination rate of 60%.

Preliminary laboratory germination tests revealed no loss of quality from mechanical extraction and also confirmed naked seed germinated faster than seed still held in its bracts as spikelets. Subsequent occasional germination tests were conducted on only a few seed lots, at client request, with results ranging between 60-81% over 35 days.

Improvements to the process will depend on the scale of the operation desired but are definitely possible through modifications to existing machinery and/or access to and possible modification of other machines such as a cone thresher, hammer mill and de-awner.

Additional key words: seed extraction, seed cleaning, germination, thousand seed weight, beach revegetation

INTRODUCTION

Spinifex sericeus R.Br (also previously identified as *S. hirsutus*) is a stoloniferous, perennial, coastal sand dune grass that occurs along much of eastern Australia, New Caledonia and New Zealand, especially the North Island and northern South Island (Maze and Whalley, 1992; Edgar and Connor, 2000). As one of the few plants able to colonise the seaward face of coastal foredunes it makes an ideal foredune stabiliser and for this reason has often been used in conservation efforts on beaches (Anon., 1981; Barr et al., 1983; McDonald et al., 1983). It thrives on unstable sand, is tolerant of high winds, limited rainfall, salt spray, high light intensity, high temperatures and moderate sand inundation (Van Kraayenoord, 1986; Hesp, 1991). Spinifex, also known as silvery sand grass and most commonly by Māori as

April 28, 2007
New Zealand

$300 million wind farm for Waverley

A $300 million wind farm is planned for the coastline near Waverley, and providing resource consents are successful, work will start erecting up to 45 turbines in August next year.

Allco Wind Energy NZ (AWE) has been investigating an area at the northern end of the former Waipipi ironsands site.

The number of turbines being considered for the site would produce up to 135 megawatts of electricity, enough to power the equivalent of 59,000 homes.

Bernhard Voll, technical director for the Waverley wind farm, told the Chronicle yesterday that he would be in Waverley and Patea next week for two public meetings when the project will be explained to the community.

"Our meetings next week are to gain some input from the community and assess their views about a wind farm in their area,"□ Mr Voll said from his Sydney office.

"They may have some issues with ecological impact, visual impact or noise that they want to have answered."□

After the community meetings his company will finalise the wind farm layout, taking those views into account and then preparing its resource consent application. It is that consent which will determine whether or not the wind farm proceeds.

Allco Wind Energy NZ has interests in other wind farm projects around the country, including one in Manawatu and another in Wairarapa, but none of them are operational yet Mr Voll said their tests at Waipipi "" an isolated area of the coastline a few kilometres from Waverley "" were positive enough for the company to confirm the project and since then they have been negotiating with landowners.

"We would be leasing land from them but their farming operations could continue because the turbines don't affect the farming activity."□

It would take about a year to have all the turbines up and running.

Mr Voll said they would be importing the wind turbines because the sole New Zealand manufacturer "doesn't produce the type of turbines we want to use there"□.

Last year the project team installed wind monitoring masts to assess the potential of the prevailing winds and it showed up the potential of the site.

The idea of wind farming in the area is not new but Allco's involvement is the first tangible sign that the coastline's wind generation is being taken seriously.

The Energy Efficiency Conservation Authority (EECA) commissioned a report that looked at renewable energy resources in Taranaki, and that included the Patea and Waverley areas.

The study was done by Auckland firm Sinclair Knight Merz and released in July last year.

The report said while New Zealand's attention to wind farms was low compared to most other countries, rising electricity prices made it an attractive alternative.

There are no wind farms in the region but the Sinclair Knight Merz report said the Patea-Waverley area, because it was not heavily populated, might be able to handle "one or two large scale wind farms"□.

However, the report said developers would have to consider other factors including topography, population, distance to the national grid, accessibility and environmental factors such as proximity to native forests or DoC land.

Earlier studies showed wind speed on the Waverley and Patea coastline to be around 8-9 metres per second at about 60-80m height, which is the hub height of modern wind turbines.

Allco Wind Energy NZ is a wholly owned subsidiary of Allco Finance Group, an international financial services business which is listed on the Australian Stock Exchange.

It is currently investigating other wind farm opportunities in Australia and the United States and is involved in financing waste water facilities, power generation facilities, pipelines and port facilities around the world.

By John Maslin

wanganuichronicle.co.nz

28 April 2007

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Media Release

Waverley Windfarm Resource Consent Application Details **DATE: 18 October 2007**

NOTIFICATION OF APPLICATION FOR A RESOURCE CONSENT

THE APPLICANT IS:
NAME: Allco Wind Energy NZ Ltd
POSTAL ADDRESS: PO Box 12088, Palmerston North

THE PROPOSED ACTIVITY IS DESCRIBED AS: To construct and operate a wind farm comprising 45 wind turbines. The site is within the Coastal Protection Area. The proposal requires a resource consent, because it would be within the Coastal Protection Area and because it involves an activity which is not permitted by a rule in the District Plan.

THE SITE IS LOCATED AT:
Stewart Road, Waverley (Part Section 149 and Sections 148, 268-273, 280, 284, 362, 364-366, 369 and 530 Okotuku District).

SUBMISSIONS CAN BE MADE:
By any person in writing on the form available from any Council Office.
SUBMISSIONS will be received by the SOUTH TARANAKI DISTRICT COUNCIL at its office in Albion Street, HAWERA or at any LibraryPlus until 4.00 pm on Friday 16 November 2007.

Details of the above APPLICATION may be viewed at the SOUTH TARANKI DISTRICT COUNCIL OFFICE, ALBION STREET, HAWERA, and at the LibraryPlus Centres located at Opunake, Manaia, Kaponga, Eltham, Patea and Waverley, during normal office hours.

Graham Young
GROUP MANAGER ENVIRONMENT AND INFORMATION SERVICES

Pursuant to a delegation given to me by the South Taranaki District Council.

Back to media releases..

stuff.co.nz
Wednesday, 14 November 2007

Wind farm spawns battle

Waverley property and forestry millionaire Roger Dickie has declared war on Allco Wind Energy which plans to erect New Zealand's tallest turbine towers next to his coastal subdivision.

He says operational noise and visual landscape pollution from the 150m-high towers will effectively kill key parts of his high-cost land development plans and deny him $6 million in income.

Mr Dickie has hired heavyweight environmental lawyers Kensington Swan to fight Allco's resource consent bid to the South Taranaki District Council.

"I'll fight them all the way. There's so much at stake here I don't care what it costs me," he says.

Submissions on the Allco application close at 4pm on Friday.

Mr Dickie wants locals to support his stand. He began his public protest at the Waverley Show yesterday with an information display and submission forms.

"I need to stir this up because the locals don't seem to realise what's happening. This is a big Australian investment company which has picked on the Waverley coast because it's flat and close to the national grid. They will take all their profits offshore and only leave behind two operational staff.

"The towers need to be high because of the low wind speed at the beach. They could put their turbines in the hills inland, but that would cost more and require a much longer transmission link."

Some see the scenario as a scrap between Waverley's two biggest names - Mr Dickie and farmer businessman Warwick Lupton, on whose land half the wind farm will be built.

But Mr Dickie says: "It's not between me and Warwick. He's only trying to make a dollar. This is between the people and Allco."

Roger Dickie NZ Ltd bought the land after the Waipipi ironsand mining ceased and has transformed it into dairying pasture. He plans to be milking 1200 cows there from next spring.

He is developing (under a consent issued by the STDC) a 170-lot small-block wilderness-style subdivision. The 46-lot stage one earthworks have started.

"Stage four is the prime elevated land with magnificent 360-degree views. I won't be able to proceed with that because it's 2km inside Allco's 40 decibel noise zone. The loss of view is not the main issue, although our marketing plan promises `you won't see another building from your property'. That's useless now."

Mr Dickie says he was there first and demands the right to go about his business without interference from outside his boundaries.

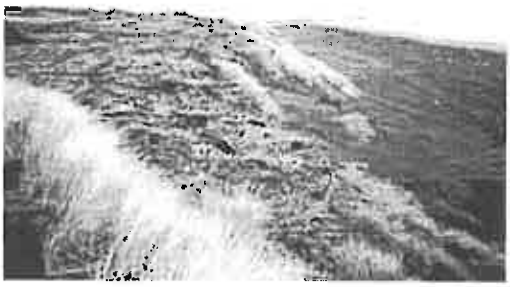
"If the STDC seriously considers consenting this project it will make a mockery of their so-called coastal protection zone, which is supposed to be protecting special landscape features.

"We want commonsense to prevail. Allco can do what they like on their side of the fence as long as it doesn't affect what I want to do."

So what does grow from green waste in coastal dunes?

Story and photos by Graeme La Cock, Wanganui Conservancy

Weeds establishing from illegally dumped garden waste are a problem throughout the country. Such dumps are seldom in mobile coastal dune systems and are seldom legal. In Wanganui Conservancy we're unfortunate enough to have a legal garden waste dump site on the dunes at the mouth of the Patea River. Although DOC doesn't approve of stabilising mobile dune systems with garden waste, it has given us the opportunity to determine what can establish from ordinary garden waste.



Green waste on mobile dune systems at Patea River

So what does establish?

Well, anything that's dumped, really! Over a period of four years we've recorded 249 species of exotic weed. There are also six indigenous species that have established from garden refuse. Virtually every common vegetable has established, with pumpkins and potatoes flourishing. Bulbs love the sand, and vines such as blackberry, convolvulus and climbing dock flourish. Tree mallow seems to persist as the canopy.

Graeme La Cock and Simon O'Connor at dumping site

The most disturbing aspect is the number of weeds that are considered problems or are included in the Taranaki Regional Council plant pest management strategy. Madeira vine is rampant, brush wattle and gorse have established from garden waste, and pampas is present. I wonder if strategy rules about distributing weed species applies to garden refuse that has a good chance of establishing. There are also weeds that are of concern in other areas of the country, e.g. tamarisk, boxthorn and three willow species have established from cuttings, and agapanthus, arums and cannas have taken hold.

Several weeds that are new to the country have been found at the Patea dunes dump, e.g. pineapple flower *Eucomis comosa*.

Obviously not all weed species persist at the site, as the garden waste is covered by a layer of clay occasionally. But several species do survive this clay topping and continue to flourish. The major concern remains the ease with which most groups of plants establish in nutrient-poor dune sand. The number of potential weeds at the site is probably governed by the number of plants in gardens around Patea. So if you have mobile dunes, don't

think that they're safe from a variety of weeds.

Green waste on mobile dune systems at Patea River

And in case you're wondering how we got to such a high number of weeds, we managed to get our retired botanist interested in the site.

If anybody is interested in a plant list, or would like to know more about this site, contact Graeme La Cock at Wanganui Conservancy (8855).

Review previous stories

Vascular Plants of Patea dunes: garden waste dump site

Wanganui Plant List 119

C C Ogle, G La Cock & S O'Connor
Wanganui Conservancy, Department of Conservation

List compiled from visits 14 July, 3 August, 14 & 25 Sept., 23 Nov. 1999, 6 March 2000; 11 Sept 2000; 5 March 2001 (GLC, Susan Timmins, Kate Blood); 18 Feb 2002 (GLC & CCO); CCO 17 April 02; GLC 1 Nov. 2002; CCO &GLC 14 Jan 2003; GLC 5 June 2003; CCO 31 July 03; GLC 30 June 2005.

Last amended 4.7.05

All species recorded below are established in the dune area from garden waste as seed or from bulbs, tubers, corms or other vegetative means, including rooted prunings, except for those as noted. The right hand column is for voucher specimens deposited in CHR (Landcare Research herbarium, Lincoln).

^ new since last edition of list

Trees & Shrubs	**Common names**	Voucher specimens CHR
Argyanthemum frutescens	marguerite daisy	
Artemisia arborescens	hedge artemisia	532890
Buddleja davidii	purple buddleia	
Coprosma repens	taupata [1]	
Corynocarpus laevigatus	karaka[2]	
Echium candicans	pride of Madeira	*CHR*
Echium pininana		
Ficus carica	edible fig	
Fuchsia sp. (unidentified)	garden fuchsia [young rooted piece with flower]	*CHR*
Hydrangea macrophylla	hydrangea	
Impatiens sodenii	shrub balsam	
Lupinus arboreus	tree lupin	
Lycium ferocissimum	boxthorn *Present before dumping (+from cuttings 5/3/01)*	
Olearia traversii	Chatham I akeake	
Paraserianthes lophantha	brush wattle	
Pelargonium Xasperum		
Pelargonium Xhortorum	zonal pelargonium	*CHR*
Phoenix canariensis	phoenix palm	
^Pittosporum crassifolium	karo	
Populus deltoides?	Necklace? Poplar	
Ricinus communis	castor oil plant (5/3/01)	
Rosa sp. (unidentified)	rose [young rooted piece – bush or scrambler?]	
Salix cinerea	grey willow	
Salix fragilis	crack willow	
Salix matsudana cv. "Tortuosa"	tortured willow	
Sambucus nigra	elderberry	
Solanum aviculare	poroporo (native, but from dumped garden waste; 5/3/01)	
Tamarix chinensis	tamarisk (30/3/01)	526027
Ulex europaeus	gorse *Present before dumping (seedlings- new site 5/3/01)*	
Vines		
Anredera cordifolia	Madeira vine	
Calystegia sepium agg.	convolvulus	

[1] Growing naturally and planted near the dump; seedlings self establishing among dumped materials.

[2] One karaka seedling on 17.4.02; c 10 on 14.1.03. Species is native to the district, but this dune occurrence is the result of seeds dumped in garden waste