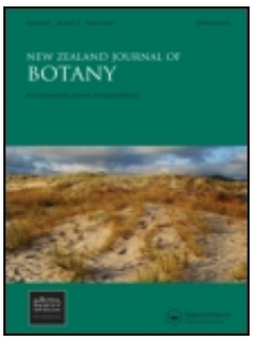

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Atriplex cinerea (Chenopodiaceae) in New Zealand

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Abstract *Atriplex cinerea* (Chenopodiaceae), a common coastal Australian salt bush, has been treated as adventive to New Zealand since 1940. Evidence is presented which refutes this claim and reinstates *A. cinerea* as indigenous to New Zealand. A detailed description and chromosome count (based on New Zealand material) for *A. cinerea* is provided, and a lectotype is selected for the species. Aspects of the ecology, means of seed dispersal, and the conservation of the species are reviewed. It is concluded that *A. cinerea* is a further example of a distinctive vagrant element within the indigenous flora of New Zealand.

Keywords Chenopodiaceae; *Atriplex*; *A. cinerea*; taxonomy; typification; indigenous status; conservation; vagrant; New Zealand flora

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INTRODUCTION

Atriplex cinerea Poir. (Chenopodiaceae) (Fig. 1), known in Australia and New Zealand as grey salt bush, is a common plant of boulder banks, estuaries, and sandy beaches in mainland Australia and Tasmania (Bentham 1870; Wilson 1984, 1986; Harden 1990) (Fig. 2). It has also been recorded from Lord Howe and Norfolk Islands (Bentham 1870; Green 1994) (Fig. 2). Within New Zealand, *A. cinerea* has been sparingly collected only from the Cook Strait region (Hooker 1853, 1864; Cheeseman 1906, 1925; Webb et al. 1988).

Although the species was historically treated as indigenous to New Zealand (Hooker 1853, 1864; Buchanan 1873; Armstrong 1879; Cheeseman 1906, 1925), Allan (1940) suggested that it may be adventive. In the most recent treatment of the Chenopodiaceae in New Zealand, Webb et al. (1988, p. 518) followed Allan (1940) in treating the species as adventive, but they cautioned that the "grey salt bush may be indigenous". Because of this doubt, the New Zealand Threatened Plant Committee has adopted the stance of treating *A. cinerea* as indigenous, and on account of the extremely restricted distribution this species has in New Zealand, it is presently listed as Endangered (Cameron et al. 1995).

In this paper, *A. cinerea* is accepted as indigenous to New Zealand. With the benefit of study of cultivated and wild specimens of New Zealand origin, the type specimen (P!), and a wider range of herbarium material than was available to Webb et al. (1988), we provide an expanded description (based on New Zealand specimens), and lectotypification of the name. We also provide a chromosome count from New Zealand specimens for the species. We conclude with a review of the ecology of the species in New Zealand, and discuss its indigenous and conservation status.

Fig. 1 *Atriplex cinerea* amongst *Sarcocornia quinqueflora* subsp. *quinqueflora* and *Stipa stipoides* on No Man's Island, Waimea Inlet, December 1995.

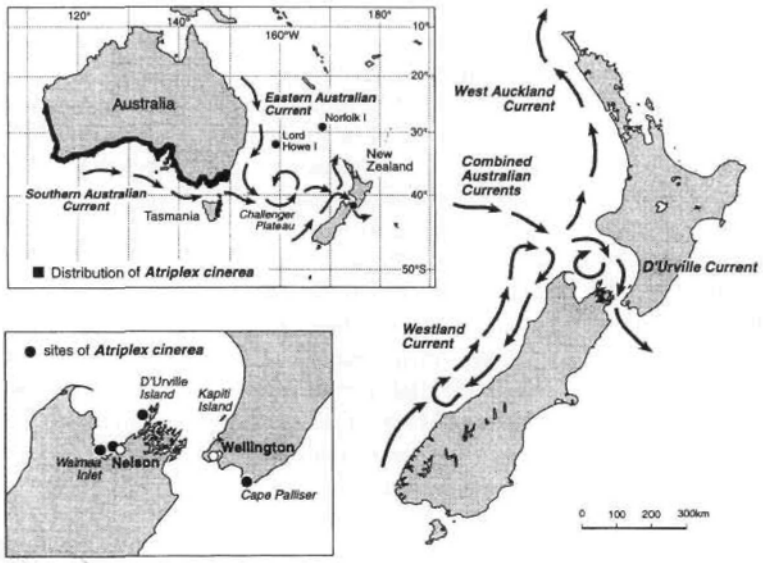

Fig. 2 Australasian and New Zealand distribution of *Atriplex cinerea* and location of main sea currents during an El Niño weather pattern.

TAXONOMY

Atriplex L. Sp. Pl., 2: 1052 (1753)

Type species: *A. hortensis* L. (*fide* McNeill et al. 1983).

Atriplex cinerea Poir., *Encyl. Méth. Bot. Suppl. 1*: 471 (1810) grey salt bush, barilla

Type collection: Australia, *J. J. H. de Labillardière*. Lectotype (here chosen, see below): "Novae Hollandiae", *Labillardière s.n.*, undated, P 94220! Herb. Poiret in Herb. Moquin-Tandon (Fig. 3). Isolectotype: P 94221!

NOTES: There are two sheets or specimens of *Atriplex cinerea* gathered by La Billardière within the Chenopod type collection of the Moquin-Tandon herbarium held at P, making lectotypification necessary. As both of these sheets were obtained by Moquin-Tandon (Stafleu & Cowan 1981, 1988) from the Webb Herbarium (FI) in which Poiret had described his species (Steinberg 1977) it is possible that further duplicates exist in FI and other herbaria holding Webb material (see Stafleu & Cowan 1988). The lectotype chosen above is the only one to be labelled in Poiret's handwriting (see Steinberg 1977)

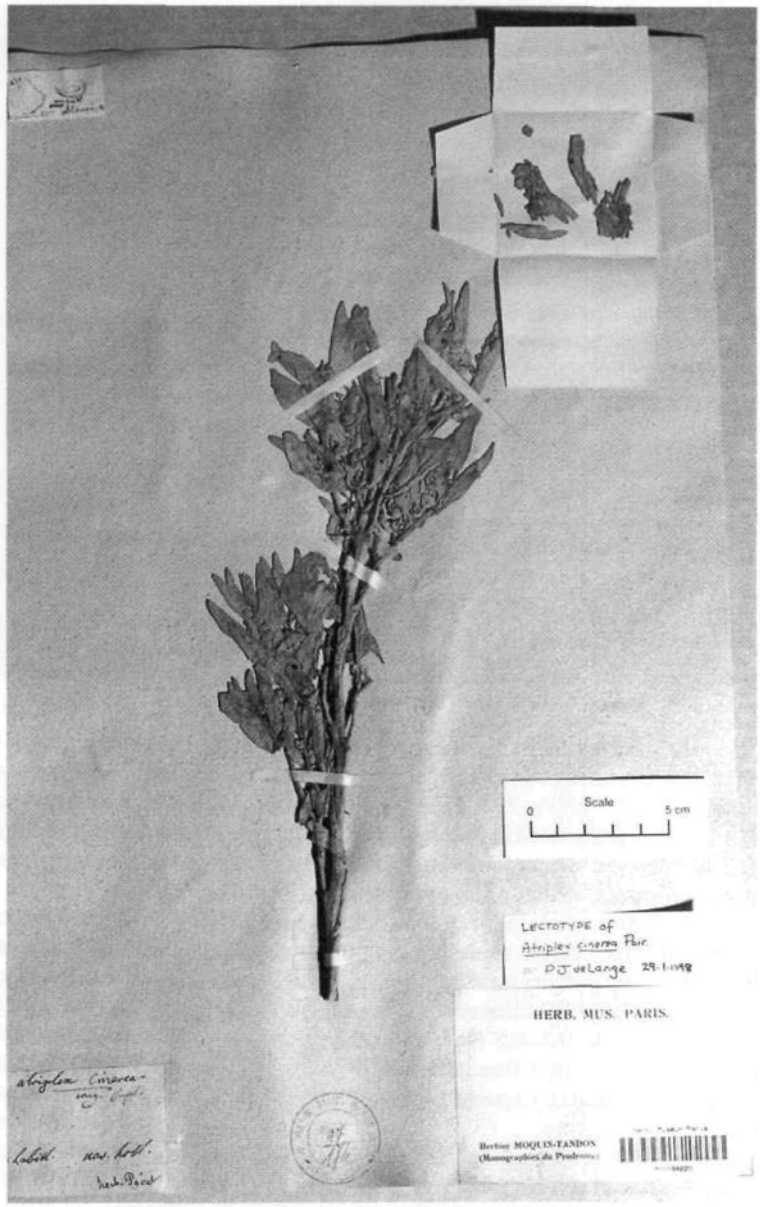

Fig. 3 Lectotype of *Atriplex cinerea* (*J. J. H. de Labillardière*, P 94220).

"*Atriplex cinerea, Ency. Supl. Labill. Nov. Holl.*" (Fig. 4), and includes his annotations, measurements, and pencil sketch of a bracteole and embryo. The sheet also agrees with the characters stated in Poiret's diagnosis, and matches his protologue as to locality. The specimen designated here isolectotype (P 94221) is annotated "*Atriplex cinerea* Poir." in Moquin-Tandon's distinctive handwriting (Burdet 1977) but bears a small pencil sketch attributable to Poiret.

DESCRIPTION: Sprawling, semi-erect, woody, heavily branched, leafy, dioecious or subdioecious shrub, forming mounds up to 1.5 × 4 m. Branchlets stout, rooting freely on contact with soil; stems at first ridged and angular, soon becoming terete and woody with age. All parts of young growth covered in a fine, scurfy, farinose pubescence; this coalescing with age to form silvery white scurfy scales. As stem matures and bark develops, scales are shed unevenly as pale yellow or silvery tabular, tissue-like flakes. Bark

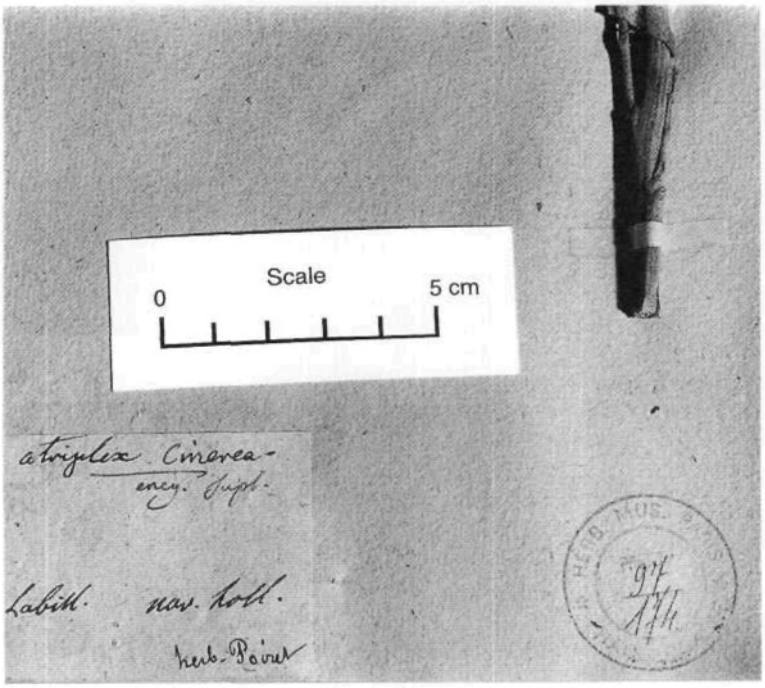

Fig. 4 Label details from the lectotype of *Atriplex cinerea*. The annotation "herb Poiret" is written by Moquin-Tandon, the remaining script is by Poiret.

initially pinkish brown, maturing dark brownish grey, often peeling in narrow strips.

Leaves (15–)20 × 32(–46) mm, linear-oblong, lanceolate, rarely weakly hastate, silvery grey, greyish white, or occasionally pinkish grey, abaxial surface with pale white, thickened midrib. Petioles short, 1–3 mm, stout, silvery white. Leaf surface ± mat, glabrous, cuticle soon cracking into irregular, anastomosing pattern made up of ± circular scales; apex white slightly thickened, apiculate, apiculus pink, deciduous, 0.5–0.8 mm; base acute, attenuate, rounded or very rarely truncate; margin entire, lightly curved, occasionally sparsely glandular hairy near leaf base.

Female flowers borne in leaf axils, either solitary, or in small axillary clusters, rarely forming axillary and terminal spikes. Female flowers occasionally found within the lower leaf axils of male plants (AK 224926). Perianth absent; bracteoles 2, 2 mm diam., lower half fused, margins initially entire, either remaining so or developing appendages in fruit; stigmas 2, c. 3 mm long, pink, filiform, slightly tapering, minutely plumose-papillate, ovary 0.35 mm, ovoid.

Male inflorescence 30–140 mm long, conspicuous, dense, forming large interrupted or continuous oblong or obovoid spikes, these often panicled toward branch apices; glomerules 5–30 mm long, purple-green, pinkish red or wine-red. Flowers unisexual; perianth lobes 5, pink or wine-red, 1.7 mm long, obovate, apex sharply inflexed, cucullate, exterior towards apex with dense vesicular covering; stamens 5–6, filaments 0.8 mm long, white, anthers 0.8 mm long, broad-oblanceolate, pollen yellowish golden.

Fruiting bracteoles subsessile or shortly stipitate; stipe turbinate, woody; bracteoles ovoid to broadly deltoid or rhomboid, 6–10 mm long and wide, united towards base, corky or ± woody and swollen toward the centre and base, otherwise coriaceous with an entire margin; surface smooth or ornamented with verrucose appendages on one or both sides.

Seed circular 3–4 mm diam., testa chestnut-brown, smooth and glossy; radicle lateral, erect.

FL Aug–Mar (male plants), Aug–Jun (female plants), FT Sep–Aug.

CHROMOSOME NUMBER: Meiotic metaphase I was studied in a single male plant grown from a cutting from No Man's Island (*P. J. de Lange 3371*, AK 234263). All pollen mother cells were observed to regularly form 27 bivalents (Fig. 5). The count obtained from the New Zealand specimen of *A. cinerea* is the same as that recorded for this species from Australia (Nobs 1979). Our observation suggests that *A. cinerea* is a hexaploid ($2n = 6x = 54$) since *A. billardierei* (Moq.) Hook.f. and 53 other *Atriplex* species have $2n = 18$ (Nobs 1975, 1979; de Lange

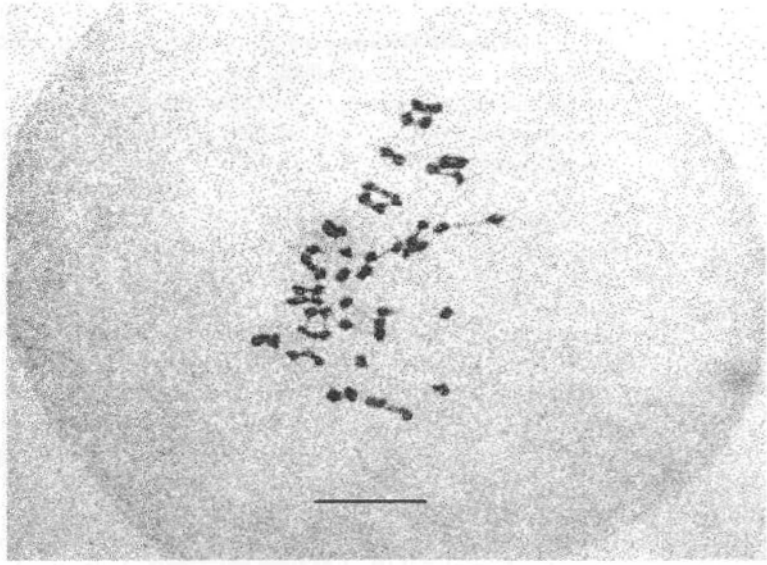

Fig. 5 Meiotic metaphase I in *A. cinerea* (AK 234263). Scale bar = 10 μm.

et al. 1997) which led Nobs (1975) to conclude that $x = 9$ is base number for the genus.

REPRESENTATIVE SPECIMENS: NEW ZEALAND: WELLINGTON: Palliser Bay, *Colenso*, n.d. [?Mar 1845],WELT 22523 (Duplicates AK 3957!, K!). MARLBOROUGH SOUNDS: D'Urville Island, *D. R. Given*, 18 Jan 1961, CHR 327192 [west side, shingle beach] (Duplicates AK 160103!, WAIK 12506!). NELSON: Nelson, *P. Lawson*, ?1867, WELT 62283; Boulder Bank, *B. B. Given*, Jan 1960, CHR 122787 [stony areas]; Waimea Inlet, No Mans Island, *S. Courtney*, 24 Sep 1989, CHR 467640 [narrow island barely above sea level]; Waimea Inlet, "Unnamed Islet" (near Hoddy's Road), *P. J. de Lange*, 19 Dec 1995, AK 224937 (Duplicate PERTH) [translocated population]; Waimea Inlet, "No Man's Island", *P. J. de Lange*, 19 Dec 1995, AK 224926 (Duplicate PERTH) [cockle shell bank].

AUSTRALIA: SOUTH AUSTRALIA: Eyre Peninsula, Fowlers Bay, *J. Z. Weber 6279*, 15 Aug 1980, AK 157400 [coastal sand dune]; Eyre Peninsula Region, Sir Joseph Banks Group, Reevesby Island, *E. N. S. Jackson 3967*, 19 Sep 1980, CHR 11260; Yorke Peninsula, *J. Z. Weber 4131*, 13 Sep 1974, AK 13950 [sand dunes]; Southern Lofty Region, Largs Jetty, *R. J. Chinnock 5038*, 2 Nov 1980, CHR 489498 [on sand on foreshore]. NEW SOUTH WALES: Botany Bay, *J. Banks & D. C. Solander*, 1770, AK 54681; Durras, Kiola State Forest, *M. Evans 2498*, 11 Oct 1966, CHR 175727 [top of sandy beach]. TASMANIA: Pelican Island, *J. E. J. Woods*, Jan 1876, AK 72677; Stanley, *W. M. Curtis*, 16 Feb 1948, CHR 180354; South Arm, *S. J. Jarman*, 8 Nov 1979, AK 154253; near Hobart, Lauderdale, *E. K. Cameron 8930*, 7 Nov 1997, AK 235901 [female]; near Hobart, Lauderdale, *E. K. Cameron 8929*, 7 Nov 1997, AK 235902 [male].

LORD HOWE ISLAND: Middle Beach, *R. M. Greenwood*, 21 Feb 1973, CHR 243087.

CULTIVATED (NEW ZEALAND): Hamilton, 9 Dover Road, *P. J. de Lange 1394*, 28 Jul 1992, CHR 478431 (Duplicate AK 210046, PERTH).

DISTRIBUTION: *Atriplex cinerea* is a common and widely distributed species in predominantly coastal locations along the southern coast of mainland Australia from Western Australia to New South Wales, Tasmania, and Lord Howe Island (Bentham 1870; Wilson 1984, 1986; Harden 1990; Green 1994). Bentham (1870) also recorded it from Queensland, citing a collection made from Moreton Bay by Allan Cunningham. The species was also reported once from Norfolk Island based on a collection made by von Hügel (Green 1994). However, because the voucher specimen on which this record is based was destroyed in Vienna toward the end of World War II, and no further collections of this species have been made from Norfolk Island, Green (1994) discounted the record. Instead, Green (1994) suggested that since von Hügel also collected in Australia, he might have accidentally mislabelled a specimen from there. We disagree and accept the record. Firstly, there is suitable habitat for *A. cinerea* on Norfolk

Island (R. O. Gardner pers. obs.); secondly, the location would not be unexpected for a species which also occurs on Lord Howe Island; and thirdly, von Hügel was a meticulous plant collector who kept detailed records of his specimens (J. Spencer pers. comm.) and was unlikely to have mislabelled his specimens.

Within New Zealand, *A. cinerea* has been reported from both sides of Cook Strait, D'Urville Island, and Canterbury (Hooker 1853, 1864; Buchanan 1873; Armstrong 1879; Cheeseman 1906, 1925; Allan 1940; Bagnall & Petersen 1948; Webb et al. 1988; Jane & Sykes 1995) (Fig. 2). However, only those records from the Cook Strait region represent *A. cinerea*. The Canterbury record (Hooker 1864; Armstrong 1879) was considered suspect by Cheeseman (1906, 1925) and was excluded by Webb et al. (1988). The specimen on which the Canterbury record is based was gathered by Julius von Haast from "near seashore, Timaru" during November 1863 (*Haast 49*, K!). As suspected by Cheeseman, this specimen is not *A. cinerea* but rather *Atriplex patula* L., a Northern Hemisphere species adventive to New Zealand (Webb et al. 1988).

INDIGENOUS STATUS: Since Allan (1940), *Atriplex cinerea* has been treated as an adventive species in New Zealand. However, no justification for this status has been advanced (see Allan 1940; Webb et al. 1988) and one is left to speculate on the reasoning behind this decision.

The first New Zealand collection of *A. cinerea* was made from Cape Palliser in 1845 (Hooker 1853; Bagnall & Petersen 1948). At that time, Cape Palliser was extremely remote from European settlement, shipping, and trade routes (Bagnall & Petersen 1948). Since then, the only confirmed records of *A. cinerea* have come from either side of Cook Strait (Fig. 2) in habitats like those naturally occupied by the species in Australia, i.e., boulder and sand beaches, sand dunes, estuaries, and shell banks (Wilson 1984; Harden 1990; Green 1994).

The Cook Strait distribution of *A. cinerea* is consistent with the distributions of a number of other indigenous species shared by New Zealand and Australia, e.g., *Atriplex australasica* Moq. (P. J. de Lange unpubl. data), *A. billardierei* (Wilson 1984; de Lange et al. 1997), *Lepidium flexicaule* Kirk (Garnock-Jones & Norton 1995), *Sebaea ovata* (Labill.) R. Br. (Ogle 1989), *Tetragonia tetragonioides* (Pall.) Kuntze (Allan 1961; P. J. de Lange unpubl. data), *Wilsonia backhousei* Hook.f. (Jane & Sykes 1995). Although the majority of these species have been recorded from elsewhere within New Zealand (Allan 1961), four of these species, *Atriplex australasica*, *A. billardierei*, *Tetragonia tetragonioides*, and *Wilsonia backhousei*, have life styles dependent on sea currents for dispersal. Significantly, in New Zealand *Wilsonia* is only known within the Waimea Inlet, one of the few places where *Atriplex cinerea* has been collected (Jane & Sykes 1995). How then did these four species reach such a specific locality in New Zealand?

The explanation seems to lie in the movement of sea currents off the Australian coast (Fig. 2). It is notable that *A. cinerea* occurs in exactly those locations where fruits could become incorporated into the East Australian and South Australian Currents which flow from the southern and eastern Australian coast (Harris 1990) (Fig. 2). Of particular relevance is that both of these currents, after mixing within the middle Tasman Sea, reach New Zealand waters near the Challenger Plateau (Harris 1990). At this point the mixed current divides into two. The major branch, the West Auckland Current, passes north up the New Zealand coastline towards the Three Kings Islands, and the smaller flows south along the western side of New Zealand. This latter current usually mixes with and is deflected north by the Westland Current (Harris 1990). Within the Cook Strait region a smaller current derived from the Australian and New Zealand west coast currents, the D'Urville Current, passes into the Strait (Harris 1990). However, the extent to which this current influences this area is determined by the prevalence of south-westerly winds (see Harris 1990, p. 136). For example, during El Niño weather patterns when south-westerly winds prevail, the D'Urville current passes directly through the Strait (Harris 1990). The ability of these currents to transport material from Australia to New Zealand was graphically demonstrated by Harris (1990), who presented data obtained from a study whereby drifters placed within these currents along the Australian Coast ended up within the Cook Strait/Taranaki bight. Although currents provide the mechanism for long distance dispersal, the rate with which objects move across these currents varies such that seed viability may be lost before a landfall is made (de Lange & de Lange 1994; W. P. de Lange pers. comm.). However, depending on wind velocities, the travel time for floating objects crossing the Tasman Sea to New Zealand during an El Niño weather pattern, is a minimum of c. 30 days (W. P. de Lange pers. comm.). Thus, it is quite possible for the seeds of many Australian littoral plants to reach New Zealand (and in particular Cook Strait) shores within a relatively short time.

In Australia *Atriplex cinerea* is a common species of the coastal strand, and the movement of fruits by near-shore currents is, therefore, the most likely means of seed dispersal for this species. In germination ecology studies, it was found that the bracteoles of *A. cinerea* and another species found in similar habitats in Australasia, *A. billardierei*, float in salt water for periods of 18–30 days (n = 10). It was also observed that seed retrieved from these samples, once washed in fresh water, germinated more easily than seed not subject to salt-water immersion (P. J. de Lange & D. A. Norton unpubl. data).

Lastly, indigenous status could be inferred from the observation that, until 1990, *A. cinerea* (although an attractive plant) was unknown from cultivation in New Zealand (see also Armstrong 1879). It is therefore unlikely to have escaped from cultivation.

We conclude that *Atriplex cinerea* has established naturally in New Zealand. Furthermore, it is quite possible that each population is the result of an independent trans-Tasman introduction. Its scarcity within this country probably derives from its predominantly dioecious habit, as seed of both sexes would need to be cast up within the same vicinity to ensure future seed set. This is probably critical to the survival of the species for, although some predominantly male plants are self-compatible and thus have the capacity to set occasional seed, the proportion of the male population exhibiting sexual inconstancy (*sensu* Webb 1996) is unknown. It would also seem that such individuals are unusual as they are scarcely mentioned in Australian literature dealing with the species (Bentham 1870 cf. Wilson 1984, 1986; Harden 1990; Green 1994). Thus, although New Zealand herbarium specimens may not necessarily be indicative of the sex structure of their respective collection localities, it is interesting to note that male specimens have been collected from two (Cape Palliser and No Man's Island) of the five locations, and females from all five. However, at only one site, No Man's Island, the only extant New Zealand population known, has fruit set been recorded. It is thus possible that elsewhere in New Zealand, and possibly Norfolk Island (cf. Green 1994), the species has established and then died out through lack of sexual reproduction.

CONSERVATION STATUS: *Atriplex cinerea* is a widespread and common species in Australia (Wilson 1984) and is not considered threatened (Briggs & Leigh 1995). In New Zealand, based on present evidence, it would seem that *A. cinerea* has always been scarce, its ability to successfully establish here being hindered by its dioecious habit. Accordingly, we consider *A. cinerea* to be a vagrant species within the New Zealand flora. Vagrants are defined by de Lange & Molloy (1995) and de Lange & Norton (1998) as: "taxa whose presence within the New Zealand botanical region is naturally transitory... which have failed to establish themselves significantly beyond their point of introduction through reproductive failure or for quite specific ecological reasons". As it is common in Australia, and its scarcity within New Zealand is primarily a natural rather than induced phenomenon, we suggest that it is inappropriate to consider it a threatened New Zealand plant. Rather, we see *A. cinerea* as another example of a small but biogeographically interesting group of plants which make periodic, temporary, and sometimes partially successful landfalls within New Zealand (see de Lange & Molloy 1995; de Lange 1997; de Lange & Crowcroft 1997; de Lange & Norton 1998). Therefore, this species does not warrant inclusion in the next revision of the New Zealand Botanical Society's Threatened and Local Plant Lists (see Cameron et al. 1995).

CULTIVATION: New Zealand material of *Atriplex cinerea* was introduced into cultivation by C. C. Ogle in 1990 from cuttings off a female plant sampled from No Man's Island. Several North Island botanic gardens, and at least two commercial nurseries, now hold plants of this provenance. As yet no male plants are known to be held by these institutions. Although the longevity of cultivated plants is still unknown, the species is probably reasonably long-lived (10 or more years), soon forming a large sprawling, woody shrub which responds well to periodic pruning. On account of its attractive silvery grey foliage, undemanding and hardy nature, and ability to tolerate a wide variety of soils and drought, *A. cinerea* may in time prove a popular garden subject, particularly in coastal districts. Although the frost resilience of the species is as yet unknown, material cultivated at Hamilton survived a –7°C air frost (P. J. de Lange unpubl. data.) with only minimal damage.

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