SEED DYNAMICS OF BONESEED AND COASTAL WATTLE IN RELATION TO THEIR POTENTIAL INVASIVENESS

P.W. WEISS

Department of Environmental Biology
Research School of Biological Sciences
Australian National University
Box 475 P.O.
Canberra City A.C.T. 2601

Summary. Boneseed or bitou bush (*Chrysanthemoides monilifera* ssp. *rotundata*), a native of South Africa and coastal wattle (*Acacia longifolia* var. *sophorae*), a native of Australia, are invasive plants in Australia and South Africa respectively. One of the main reasons is a prolific seed production only in the host country, predators being responsible for low seed levels in the native country. In the reproductive phase up to mature seed, coastal wattle is approximately 100 times more successful in South Africa than Australia, with soil seed levels 500 times greater. Boneseed produces a soil seed pool up to 30 times greater in Australia than in South Africa.

After 12 months burial, seedlings plus viable seed remaining in the soil accounted for only 17% and 10% of the original seed population for coastal wattle and boneseed respectively. In Australia, this is compensated in the case of boneseed by an annual production of 4 200 seeds m^{-2} but in coastal wattle only 14 seeds m^{-2} are produced.

INTRODUCTION

Much of the littoral area in New South Wales is being invaded by boneseed, introduced from South Africa and formerly extensively planted as a sand-binder from 1946 to 1968 (Aveyard 1971, P. Zaborowski, personal communication, 1981). It is also spreading into inland native vegetation (Mears *et al.* 1976) and occurs in some National Parks in New South Wales (Catford 1978). It is reputed to compete strongly with native species, particularly coastal wattle (Gray 1976), although there is no experimental evidence for this.

Boneseed is regarded as a desirable sand-binding plant in South Africa and is used for grazing in some areas (J.G.V. Joubert, personal communication, 1978). Various predators limit its growth and reproduction in South Africa. These include a defoliating chrysomelid, a stem-boring cerambycid, a root and crown-boring buprestid, a cecidomyid gall-former which stunts plants, an eriophyid mite in young growth, a rust and a lonchaeid fly which often destroys a large proportion of the seeds (S. Neser, personal communication, 1979).

Coastal wattle has been sown in South Africa on the coastal dunes from 1827 to 1835 and has since spread inland along rivers and into mountain fynbos vegetation (Boucher and Stirton 1978). The seed production potential of coastal wattle is not realised in Australia because of such predators as gall-wasps (New 1979), lepidopteran larvae (van den Berg 1977), ants (Majer 1978) and birds (N. Ford, personal communication, 1980). Barbour and Lange (1967) found no seed in the top-soil of a site in Australia dominated by this species.

The aim of the present investigation was to compare seed dynamics of each of the above plants in Australia and where possible compare these with results from South Africa to see if seed production and longevity were correlated with the behaviour of the plants in each country.

MATERIALS AND METHODS

An area on the sand dunes near Moruya, New South Wales was selected where boneseed and coastal wattle were the dominant species. Measurements of seed fall of each species were made by placing circular seed traps 1 m in from the edge of 20 plants of each species. Extra traps were placed at the centre of some plants as a check on overall seed production. Seeds were removed and counted monthly. Flowers on representative branches were counted and tagged and seeds and pods counted as they appeared. Seed abortion was estimated by the number of shrivelled seeds in the pods. The viability of seeds in fallen pods was tested with tetrazolium chloride.

The soil seed pool was estimated every two months by sampling 10 areas, each 50 by 50 cm, 1 m in from the edge of established plants to a depth of 7.5 cm, sieving the litter and soil and counting whole and fragmented seeds. Extra areas at 1 m intervals towards the centre of the plant were also taken at two sample times.

Seed longevity was investigated by placing 50 seeds of each species in fibreglass insect-screen bags, the top of which were sown onto metal rings. Each bag was filled with sieved sand and the seeds placed in rows at depths of either one, two, five or 10 cm to provide for six sampling times. Each bag was then buried so that the top was level with the surface of the sand. This was repeated at three sites.

Plants were counted as they emerged and the bags removed after six or 12 months. Seeds which germinated in a growth cabinet were classified as being in enforced dormancy; those in the remainder which were viable when tested with tetrazolium chloride as being in innate dormancy. Seed was also kept for similar times in dry sand in a laboratory and tested similarly.

RESULTS

Seed production of coastal wattle. Seed production of coastal wattle in Australia and South Africa is given in Table 1. Seed fall took place from November to December. Figures for South Africa are unpublished data of Milton and Hall. Data on seed fall and soil seeds in South Africa are means from random areas under plants. There were no significant differences in seed numbers between the centre and edge of plants sampled in Australia.

Table 1. Reproductive performance of coastal wattle in Australia and South Africa.

Attribute	Australia	South Africa
Inflorescences leading to mature pods	2.1%	22.5%
Flowers leading to mature pods	0.06%	0.4%
Seed abortion	75%	6%
Viability of seed in fallen pods	44%	98%
Seed fall	14 ± 3 [1] m^{-2}	5200 ± 500 m^{-2}
Soil seeds	16 ± 4 m^{-2}	7600 ± 2500 m^{-2}

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The difference between the two countries in percentage of pods formed is magnified in Australia by the number of aborted seeds and by low viability. The latter was due largely to 34% of the seeds being parasitised. Further losses caused by birds and ants in Australia result in still larger differences in the soil seed pool.

Seed production of boneseed. In contrast to coastal wattle, seed fall of boneseed occurred in each month throughout the year, with a total yearly production in Australia of 4 200 ± 700 whole seeds m^{-2} and 2 500 ± 1200 open or fragmented seeds m^{-2}.

The only figures available from South Africa are for the closely related sub-species *C. monilifera* ssp. *monilifera* which produced a soil seed pool of 100 to 300 whole seeds m^{-2} and 4 000 to 6 000 open or fragmented seeds m^{-2} (Milton 1980). For ssp. *monilifera* in Australia, over 2 500 whole seeds m^{-2} have been found in the soil (D.W. Lane, personal communication, 1978). In the present study of ssp. *rotundata*, 3 800 to 9 500 whole seeds m^{-2} and 6 300 to 20 200 open or fragmented seeds m^{-2} were found in the soil.

Seed longevity. The results of seed tests six and 12 months after burial are shown in Table 2. Means for the four soil depths from 1 to 10 cm are given; numbers of missing seeds generally decreased with depth and plants emerging in the field were least from 10 cm. The viability (including seedlings) of coastal wattle seed fell from 26% to 17% between six and 12 months and that of boneseed from 15% to 10%. There were three times as many dormant seeds of coastal wattle as boneseed after 12 months burial in the field. These differences were not apparent in laboratory-stored seed.

Table 2. Seed longevity of boneseed and coastal wattle after six and 12 months in the laboratory and field (means of four soil depths)

Classification	Field		Laboratory	
	6 months (%)	12 months (%)	6 months (%)	12 months (%)
		Boneseed		
Missing	11.3(4.7)[1]	12.8(4.9)	-	-
Empty	65.8(5.2)	74.3(5.5)	6.7(2.4)	2.7(1.8)
Dead	8.4(2.7)	2.5(0.8)	33.0(9.7)	61.3(8.7)
Emerged	4.7(3.0)	7.2(3.1)	-	-
Dormant (enforced)	6.8(2.2)	1.7(0.7)	26.0(9.9)	4.7(2.3)
Dormant (innate)	3.0(1.1)	1.5(0.7)	34.3(9.4)	31.3(8.1)
		Coastal wattle		
Missing	69.5(5.8)	73.9(4.2)	-	-
Empty	1.5(0.5)	4.0(1.1)	28.7(9.8)	29.0(9.9)
Dead	2.9(0.7)	5.5(1.6)	22.7(2.6)	43.7(7.3)
Emerged	4.8(2.9)	5.7(2.6)	-	-
Dormant (enforced)	14.1(3.6)	1.9(0.5)	23.3(3.3)	12.0(4.2)
Dormant (innate)	7.2(1.4)	9.0(2.7)	25.3(8.5)	15.3(3.5)

[1]Figures in brackets are standard errors.

DISCUSSION

It is apparent that in terms of seed dynamics, both boneseed and coastal wattle can become invaders or weeds when their reproductive potential is able to be realised in the comparative absence of predation. Thus, boneseed produced a soil seed pool up to 30 times greater in Australia than in South Africa. Coastal wattle was 100 times more successful in South Africa up to the stage of seed in the pods, with a difference of 500-fold in the soil seed pool.

Despite the lower percentage of viable seed (including seedlings) of boneseed compared to coastal wattle in the field, there would still be left, from the data on annual seed production, 440 seeds m^{-2} of boneseed and only 2 m^{-2} of coastal wattle before the next year's seed input. This difference in seed production between the two species is likely to be a major factor if in fact boneseed is displacing coastal wattle and other native species in Australia.

Invasion of new areas in Australia by boneseed is caused largely by birds as evidenced by piles of regurgitated seeds, and seedlings some distance away from established plants. However, up to 37% of seeds can be damaged by some birds, leaving only the endocarp. Again, this has little effect as a control measure in Australia because of the large numbers of intact seeds left.

It appears likely that boneseed will continue to move off the dunes into other native bushland in New South Wales. This has occurred with coastal wattle in South Africa, where it is a problem in inland areas and not where it was sown on the dunes. Coastal wattle has had much longer to do this in South Africa (150 years) compared to boneseed in Australia (up to 35 years).

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