ASPECTS OF THE ECOLOGY AND CONTROL OF EUPHORBIA PARALIAS L. (SEA SPURGE) IN THE OTWAY NATIONAL PARK, VICTORIA, AUSTRALIA

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Abstract  Euphorbia paralias L. (Sea Spurge) is a coastal dune plant native to the Mediterranean region. It was first recorded in Australia in 1927, and is now widespread on coastal dunes in southern Australia. Environmental weed invasions by species such as E. paralias are believed to have a significant influence on ecological processes by altering landform morphology, reducing floral and structural diversity, and degrading fauna habitat.

The distribution of E. paralias within the Otway National Park was mapped, and species associations and other variables were used to derive habitat preferences. A field trial was conducted to assess the efficacy of hand removal of plants and the application of the herbicide 2,4-D ester.

E. paralias was recorded in disjunct populations on embryonic sand dunes, most commonly in association with Ammophila arenaria L. (Link) (Marram Grass) and within 10 m of the high tide mark. Hand removal of plants and the application of 2,4-D ester were both effective in reducing populations of E. paralias.

INTRODUCTION

Euphorbia paralias is a coastal dune plant native to sandy Atlantic shores from Mauritania to southern Ireland, England and the Netherlands, as well as Mediterranean and Black Sea shores (Bakker 1976; Heyligers 1985). The plant is a perennial with leafy, woody stems 2 mm to 5 mm wide. Stems grow to 1 m initially from the root crown and then later from a decumbent base (Butcher 1961). The somewhat fleshy leaves are glabrous and glaucous, and grow to 3 cm long (Harden 1990). Reproductive stems bear flowers in an umbel (Butcher 1961), and die off after flowering (Heyligers 1994).

Side branches can develop anywhere along the stems, allowing the plant to cope with high levels of sand accretion (Heyligers 1994). The plant has a long tap-root, which can grow to 15 cm within one week of germination (Ranwell 1975). A vigorous plant can produce 60 inflorescences in a season, with 25 to 40 fruits per inflorescence. Three round seeds, 5 mm in diameter are produced per fruit, and annual production can be around 5000 seeds per plant. Seed is shed throughout the year. The fruits open explosively, firing seeds about 2 m (Heyligers 1993), and seeds are often transported to hollows or crevices by wind action (Davies 1985). Germination of seed occurs throughout the year. Seeds retain over 50% viability after floating in salt water for two years (Heyligers 1994).

E. paralias is believed to have been introduced to Australia through the dumping of ship ballast, and was first collected in Albany, Western Australia in 1927. A second introduction probably occurred at Port Victoria in South Australia, where E. paralias was recorded in 1934 (Heyligers 1993). The species is now an important weed of southern Australian coastal dunes, and although its effects are largely unknown, it may alter natural dune building processes and replace native species (Heyligers 1985).

The Otway National Park is situated on the southern coast of Victoria, 200 km south west of Melbourne. The Park covers 12 877 ha, and extends 55 km along the coast between Apollo Bay and Princetown. Dune communities in the Otway National Park are typically shrublands dominated by Leucopogon parviflorus (H.Andrews) Lindl. (Coast Beard-heath) and Acacia sophorae (Labill.) R.Br. (Coast Wattle); with the foredunes typically dominated by Ammophila arenaria (L.) Link (Marram Grass), Spinifex sericeus R.Br. (Spinifex), Isolepis nodosa (Rottb.) R.Br. (Knobby Club-sedge), and L. parviflorus (Nugent 1993).

METHODS

The coast of the Otway National Park was surveyed for the presence or absence of Euphorbia paralias. Where E. paralias populations were found, a 25 m² quadrat was identified at random within the population for each homogeneous community association. Within each quadrat, all vascular plant species and their percentage canopy cover values were recorded after Braun-Blanquet (1932). The presence of organic litter, age profile, beach type, position on the beach profile and horizontal distance from the high tide mark were also recorded for each population.
A trial was conducted on the terraced foredunes at Johanna Beach in the Otway National Park to assess the effects of hand removal of *E. paralias* and the application of the herbicide 2,4-D ester. Changes in populations of *E. paralias* following treatment were assessed by analysing changes in the number and length of live stems after treatment. Three representative vegetation community types were selected, and three 7m by 7 m sites from each community type were selected at random. One of each of the treatment categories (2,4-D ester, hand pull, control) was allocated at random to a site from each of the vegetation communities. Three 25 cm by 25 cm quadrats were located within each site, and the number and length of stems of live *E. paralias* plants within each quadrat was counted. The sum of stem lengths per quadrat was used as a measure of change in biomass after treatment. The combination of the mean stem length and stem count per quadrat was used to derive an approximation of relative changes in the population profile of a site. Initial measurements were recorded and treatments conducted in May 1996. Final measurements were recorded in October 1996. The 2,4-D ester sites were sprayed with Nufarm® ester 40 (2,4-D ester) at a concentration of 75ml 2,4-D ester to 15 litres of water. Fifteen litres of mixture were applied to each of the sites using a knapsack sprayer. All visible *E. paralias* plants within each of the hand pull sites were grasped at or just below ground level and pulled from the ground. A site from each of the vegetation community types was left untreated for experimental control purposes. Data were analysed using Multiple Analysis of Variance (MANOVA) and Wilcoxon matched pairs signed rank tests. The MANOVA tests were conducted on before and after treatment measurements on the dependent variables mean stem length per quadrat, sum of stem lengths per quadrat, and stem count per quadrat. These variables were analysed against the independent variables treatment type and community type to assess the significance of changes in the dependent variables over time. The Wilcoxon tests were used to confirm the results of the MANOVA.

**RESULTS**

One hundred and forty eight quadrats were surveyed along the coastline of the Otway National Park, with 57 species including 23 exotics recorded. Populations of *Euphorbia paralias* most commonly had a 1% to 5% canopy cover, and occurred on bare sand within 10m of the high tide mark. Some dense stands with greater than 25% canopy cover were recorded. These were generally on terraced beaches above the normal tidal range. Table 1 shows the ten species most commonly recorded in association with *E. paralias*.

The removal of *E. paralias* plants by hand pulling had an obvious and dramatic impact on populations. Most of the *E. paralias* plants sprayed with 2,4-D ester were killed. There were no apparent effects of the herbicide on other species in the sprayed plots. In both the hand pulled and 2,4-D ester plots, some regrowth by either root fragment or seed was observed, however this was not quantified.

**Table 1.** Ten species most commonly recorded with *Euphorbia paralias* in Otway National Park, Victoria.

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
<th>No of records</th>
<th>% of quadrats</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Euphorbia paralias</em> L.</td>
<td>Sea Spurge</td>
<td>148</td>
<td>100</td>
</tr>
<tr>
<td><em>Ammophila arenaria</em> (L.) Link</td>
<td>Marram Grass</td>
<td>106</td>
<td>72</td>
</tr>
<tr>
<td>Spinifex sericeus R.Br.</td>
<td>Spinifex</td>
<td>56</td>
<td>38</td>
</tr>
<tr>
<td><em>Isolepis nodosa</em> (Rottb.) R.Br.</td>
<td>Knobby Club-sedge</td>
<td>53</td>
<td>36</td>
</tr>
<tr>
<td><em>Cakile maritima</em> Scop.</td>
<td>Beach Rocket</td>
<td>49</td>
<td>33</td>
</tr>
<tr>
<td>Apium prostratum Labill.</td>
<td>Sea Celery</td>
<td>42</td>
<td>28</td>
</tr>
<tr>
<td>Ozothamnus turbinatus DC.</td>
<td>Coast Everlasting</td>
<td>40</td>
<td>27</td>
</tr>
<tr>
<td>Senecio spathulatus A.Rich</td>
<td>Coast Groundsel</td>
<td>35</td>
<td>24</td>
</tr>
<tr>
<td><em>Senecio elegans</em> L.</td>
<td>Purple Groundsel</td>
<td>34</td>
<td>23</td>
</tr>
<tr>
<td>Actites megalocarpa (J.D.Hook) Lander</td>
<td>Coast Sow-thistle</td>
<td>32</td>
<td>22</td>
</tr>
<tr>
<td><em>Carpobrotus rossii</em> (Haw.) Schwantes</td>
<td>Karkalla</td>
<td>23</td>
<td>16</td>
</tr>
</tbody>
</table>

* exotic species.
The MANOVA analysis indicated that the stem count, sum of stem lengths and mean stem lengths of *E. paralias* populations were found to change significantly (F<0.01) over time for the hand pulled and 2,4-D ester plots, but not for the control plots (Figs 1 to 3). Confirmatory analysis using Wilcoxon tests indicated that the sum of stem lengths, mean stem length and stem count in the hand pulled plots were all significantly reduced (p<0.01) over time. The 2,4-D ester plots had a significant reduction (p<0.01) in sum of stem lengths and mean stem length over time, however the stem count for the 2,4-D ester treatment was not significantly reduced (p=0.05). There was no significant change (p>0.05) in the sum of stem lengths, mean stem length and stem count in the control plots.

**DISCUSSION**

The habitat preferences and species associations of *Euphorbia paralias* recorded in this study are consistent with the occurrence of the species in its native environment. *Euphorbia paralias* is well adapted to the highly disturbed foredune environment, where it was recorded at low densities, in locations that were largely devoid of other vegetation. The more dense populations found in less disturbed sites were probably excluding other species. It is considered likely that where suitable habitat and dispersal mechanisms exist, the distribution of higher-density populations will increase in the future. Any change to dune vegetation will influence dune morphology, and the ecological implications of this require further investigation.

Hand pulling and the application of 2,4-D ester both significantly reduced populations of *E. paralias*, and over the period of this trial, each method was almost equally effective. There was a high degree of replacement in the hand pulled and 2,4-D ester sites, confirming that *E. paralias* is capable of rapid recovery of populations following catastrophic disturbance. This suggests that control efforts must be maintained over a number of years in order to initially deplete the soil seed store and then compete with recruitment, particularly from water borne seed deposited during high tide events.

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**REFERENCES**


