

ASPECTS OF THE DISTRIBUTION, PHYTOSOCIOLOGY, ECOLOGY AND MANAGEMENT OF *DANTHONIA POPINENSIS* D.I. MORRIS, AN ENDANGERED WALLABY GRASS FROM TASMANIA

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(with four tables and two text-figures)

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ISSN 0080-4703. Pap. Proc. R. Soc. Tasm. 131: 31-35. Parks and Wildlife Service, GPO Box 44A Hobart, Tasmania, Australia 7001, formerly Department of Geography and Environmental Studies (LG); Department of Geography and Environmental Studies, University of Tasmania, GPO Box 252-78, Hobart, Tasmania, Australia 7001 QBK).

Danthonia popinensis is a recently discovered, nationally endangered tussock grass, originally known from only one roadside population at Kempton, Tasmania. Six populations have been recorded, all from flat land with mildly acid non-rocky soils, and all in small roadside or paddock remnants, badly invaded by exotic plants. However, one site has recently been destroyed through roadworks. The species germinates best at temperatures of 10°C, indicating a winter germination strategy. Autumn burning at Kempton resulted in an increased cover of *D. popinensis* two years after the burn, but also resulted in an increased cover of competitive exotics. The future of the species needs to be secured by *ex situ* plantings, as almost all of its original habitat has been converted to crops or improved pasture.

Key Words: *Danthonia popinensis*, wallaby grass, tussock grass, endangered species, Tasmania.

INTRODUCTION

Danthonia popinensis was first collected in 1985 from a grassy roadside verge at Kempton, in southern Tasmania, and was subsequently described (Morris 1990) and listed as nationally endangered (Briggs & Leigh 1988, Leigh & Briggs 1992). It is a tall grass up to 0.45 m high, distinguished by abundant hairs scattered between the upper and lower rows of hair tufts on the lemma and the broad, flat blades of the lower leaves. Much of the native vegetation in the region has been modified or lost through agricultural or urban development (Gilfedder & Kirkpatrick 1995).

The Kempton site consists of a roadside which has suffered major soil disturbance during roadworks and is heavily invaded by exotic species, including suckers from a historic planting of elms (*Ulmus X hollandica*) in the adjacent sheep paddock on private land.

The site had been subject to roadside management normal in the area, in that it was regularly slashed to reduce the above-ground biomass. When the species was first discovered, there was concern that the practice of slashing might lead to the loss of *D. popinensis* individuals, through accidental deep mechanical scraping or the encouragement of competition from exotic plants. Cuttings were left *in situ* following slashing. This practice may favour the germination and establishment of exotic species over native species, many of which prefer bare intertussock spaces (Kirkpatrick 1986, Stuwe 1986). As a consequence of these concerns, slashing ceased on the section of the roadside with *D. popinensis* in 1989. However, *Ulmus* suckers and exotic grasses soon began to proliferate. At this point, it was decided that it was worth determining whether burning would favour *D. popinensis* and set back the exotic species.

Fire plays an important ecological role in temperate Australian lowland grassy ecosystems (e.g. Robertson 1985, Stuwe & Parsons 1987, McDougall 1989, Lunt 1995). In general, late summer or autumn burning has been the most

common fire management regime (e.g. McDougall 1989); this timing is particularly important for the regeneration of native legumes (Scarlett & Parsons 1982), although Lunt (1990) cautions that burning in this season favours many exotic species.

This paper reports the effects of an autumn burn on *D. popinensis* and associated native and exotic species at Kempton. It also documents the distribution, environment and phytosociological context of this endangered species, presents some data on its germination requirements and suggests means to ensure its future.

METHODS

Floristic Patterns

The distribution of *D. popinensis* was determined from herbarium collections, literature references and field survey data. At each site where *D. popinensis* occurred, floristic data were collected from a quadrat measuring 1 x 10 m. Data were stored on DECODA (Minchin 1990). The polythetic divisive technique TWINSpan (two-way indicator species analysis—Hill 1979) was used to obtain a sorting of samples. A dissimilarity matrix was calculated with this binary data, using the Czekanowski (Bray-Curtis) coefficient, and was used to help produce a sorted table. Environmental data were also obtained. Altitude, surface geology and soil type were noted in the field, and the slope and aspect of each site were determined using a clinometer and compass respectively. Climatic data were derived for each site, using the Bioclimatic Prediction System (Busby 1988), which produces 16 parameters characterising annual, seasonal and extreme components of the climatic environment. Species nomenclature follows Buchanan (1995).

Experimental Burn

The impact of an autumn burn was studied. Transects were placed parallel with the roadway and through the densest areas of *D. popinensis* at Kempton. Forty-five 0.4 x 0.4 m quadrats were placed at 1 m intervals along the transect line. Data were obtained on the number of *D. popinensis* individuals and the number of clumps or tussocks that these individuals cumulatively comprised, the number of flowers and the number of germinants, and the number of *Ulmus* suckers and individuals per quadrat. The distributions and covers of individual species and types of ground cover (litter, bare) were mapped. After mapping, half the site was burned on 20 May 1991. Twenty quadrats were in the burned plots and 25 quadrats were in the unburned vegetation. The vegetation in the quadrats was remeasured on 25 November 1993. Mann-Whitney *U* Tests (Siegel 1956) on the program MINITAB (Release 6.2, Macintosh® version) were used to determine if the densities of *D. popinensis* and *Ulmus* suckers, and the nature of the ground cover, were significantly different pre-fire from those in 1993 for both burned and unburned quadrats. Owing to the small size of the population, the experiment was pseudoreplicated, with the two sets of quadrats not being identical at their starting point. Therefore, differences in the rates of change within each treatment were looked for since, if the burned area had significant differences in values between 1991 and 1993 and the unburned area did not, burning was responsible for the direction of the significant change. Due to low numbers for some taxa, data were pooled into lifeform categories (i.e. annual exotic grasses, exotic perennial grasses and native perennial grasses) for analysis.

Germination Trials

Seeds were collected from 30 individual plants of *D. popinensis* from the Kempton population on 18 February 1991. Germination tests were carried out by placing the seed on moist double layers of filter paper (Whatman No. 1) in 90 mm Petri dishes on 16 June 1991. For each trial there were five replicates of 20 seeds placed in randomised blocks. The seeds were checked twice daily and watered with distilled water when necessary, ensuring that the filter paper was maintained in a moist but not wet condition. The seed was germinated in an incubator in dark conditions, with the seeds being exposed to light when watered. Four temperatures were used: 5°, 10°, 15° and 20°C, with no pretreatment.

RESULTS

Floristic Patterns

In the decade following the discovery of *D. popinensis*, an additional five collections of the species were made (fig. 1), all in small native vegetation remnants in the Midlands. All sites are on flat or extremely gently sloping ground, on rock-free soils. The underlying geology varies from sand sheets to dolerite (table 1). The topsoils are sandy loam or sandy clay loam, with a pH in the range 6.0 to 6.5. Mean annual precipitation varies from 555 to 625 mm, with the driest quarter receiving 115–119 mm (table 2). The mean temperature of the warmest month varies from 14.5–16.1°C,

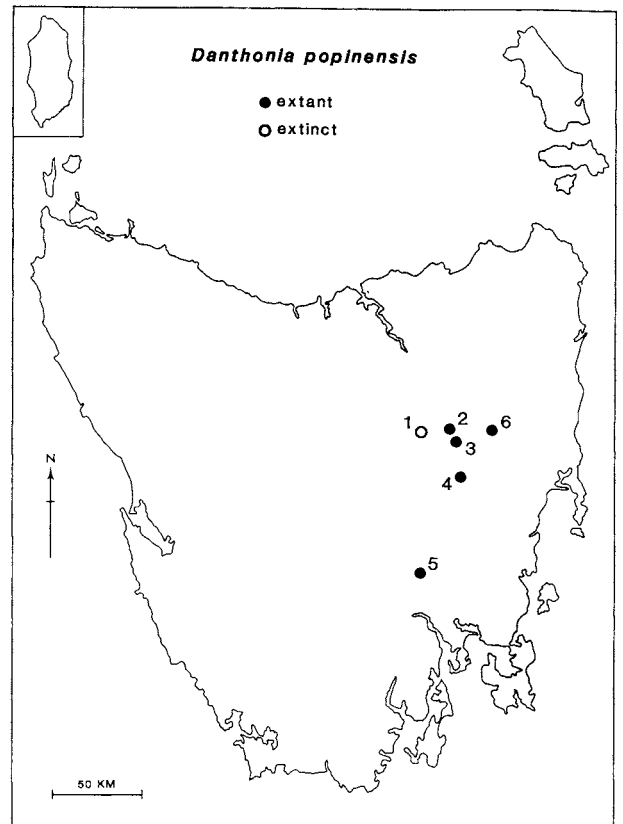


FIG. 1. — Distribution of *Danthonia popinensis*. 1 = Valleyfield Rd, via Campbell Town, 2 = Conara/Nile Rd, 3 = Conara/Midland Hwy, 4 = Ross, 5 = Kempton, 6 = Avoca.

while the mean temperature of the coolest month varies from 6.1–6.5°C (table 2).

The majority of records are of small populations in weed-infested vegetation on roadside verges (tables 1, 3). One roadside site has been destroyed through roadworks and road maintenance activities. At one site the species occurred as a rare component of *Eucalyptus amygdalina* grassy woodland, which has been ungrazed for more than 20 years. Another site is partly wetland, with species such as *Lythrum hyssopifolia* and *Eleocharis acuta* (table 3). The percentage of exotic species per site varied from 24% to 71%. The quadrats were highly dissimilar in their species composition, with eight out of 15 Bray-Curtis dissimilarity values exceeding 0.8 and the remainder exceeding 0.7.

Experimental Burn

The burn encouraged the resprouting of *Ulmus* rather than killing the suckers. Whilst the number of *Ulmus* individuals did not vary significantly between the burned and unburned site and between 1991 and 1993, there was a marked increase in the percentage cover of suckers in the burned plots (table 4). A similar trend was found for *D. popinensis* — the use of fire did not significantly influence the number of individuals or tussocks, but the percentage cover significantly increased in the burned plots (table 4). Only nine new germinates of *D. popinensis* were recorded as establishing in plots between 1991 and 1993, seven in the

TABLE 1
Features of sites with *Danthonia popinensis*

Quadrat number	Locality	Native species richness	Altitude	Geology	Tenure
1	Valleyfield Road	14	160	sandstone	roadside
2	Conara/Nile Road	18	200	wind-blown sand	private
3	Conara/Midland Hwy	13	180	dolerite	roadside
4	Ross	5	180	dolerite	roadside
5	Kempton	7	190	sandstone	roadside
6	Avoca	10	180	sands and gravels	roadside

TABLE 2
Climatic data for sites at which *Danthonia popinensis* occurs*

Climatic variable	Values†	
	Mean	Range
annual mean temperature (°C)	10.96	10.1-11.3
minimum mean temperature of the coolest month (°C)	1.40	1.1-1.8
maximum mean temperature of the warmest month (°C)	22.96	21.3-23.6
annual temperature range (°C)	21.48	19.3-22.6
mean temperature of the coolest quarter (°C)	6.42	6.1-6.5
mean temperature of the warmest quarter (°C)	15.64	14.5-16.1
mean temperature of the wettest quarter (°C)	8.30	7.3-11
mean temperature of the driest quarter (°C)	15.92	15.5-16.1
coefficient of variation of monthly precipitation (°C)	15.20	12.5-17.8
mean annual rainfall (mm)	591.25	555-625
rainfall of the wettest quarter (mm)	171.50	156-188
rainfall of the driest quarter (mm)	117.00	115-119
rainfall of the coolest quarter (mm)	165.25	143-183
rainfall of the warmest quarter (°C)	117.25	115-120

* Derived from Bioclim (Busby 1988).

† Mean values and range are from the six sites at which the species has been recorded.

burned plots. The flowering rate of *D. popinensis* decreased following fire (table 4).

The burn had a dramatic impact on the nature of the ground cover at the Kempton site. The percentage cover of annual grasses, such as *Briza minor*, *Vulpia myuros*, *Aira caryophyllea* and *Bromus hordeaceus*, increased significantly post-fire, up to a mean percentage cover of 46.2%, but remained at low levels in the unburned plots (table 4). Exotic perennial grass cover decreased in the burned plots (table 4), and the fire had no significant impact on the percentage cover of native perennial grasses (*Stipa*, *Danthonia*) (table 3). Bare ground was less at the end of the measurement period in the burned area than in the unburned area. Herb cover increased in both burned and unburned plots between 1991 and 1993 (table 4).

Germination Trials

D. popinensis failed to germinate at 5°C, with poor germination (<10% of seeds) at 20°C. Germination was moderate (<35%) at 15°C and best at 10°C with >70% of seed germinating (fig. 2).

DISCUSSION

The fact that the few known populations of *D. popinensis* are on non-rocky soils on gentle slopes on a range of soil types and geologies suggests that the species may have been more common before the agricultural and pastoral invasion, as most of the native vegetation on these types of sites in subhumid Tasmania has been destroyed or severely degraded (Gilfedder & Kirkpatrick 1995), including one of the recently discovered sites of *D. popinensis*.

The successful germination of *D. popinensis* at 10°C indicates that it is a species that may be adapted to germinate in winter, the coolest and the moistest season, and it has a relatively high fecundity at this temperature. The mean temperature of the wettest quarter for sites where *D. popinensis* occurs is 8.3°C and the annual mean temperature is 10.96°C, indicating climatic conditions favourable for germination. It is assumed that *D. popinensis* is capable of vegetative spread, as indicated by the increase in tussock size and an increase in the percentage cover between 1991 and 1993. The degree to which intertussock gaps are necessary to ensure replenishment of the population is uncertain, given that the species has survived, albeit in low

TABLE 3
Sorted table for quadrats with *Danthonia popinensis*

Species*	Site†			
	2	3	4	5
<i>Acaena agnipila</i>	1	1	-	-
* <i>Trifolium repens</i>	1	-	-	-
* <i>Acetosella vulgaris</i>	1	1	1	-
* <i>Trifolium subterraneum</i>	1	-	-	-
* <i>T. dubium</i>	1	-	-	-
<i>Acaena echinata</i>	1	1	-	-
* <i>Cirsium vulgare</i>	-	1	1	-
<i>Poa labillardierei</i>	-	1	1	-
* <i>Tragopogon porrifolius</i>	-	1	1	-
* <i>Dactylis glomerata</i>	-	1	1	1
* <i>Avena fatua</i>	-	1	-	-
<i>Cynoglossum suaveolens</i>	-	1	-	-
* <i>Bromus mollis</i>	-	1	-	-
* <i>Aira caryophyllea</i>	-	1	-	-
<i>Pentapogon quadrifidus</i>	-	1	-	-
<i>Carex breviculmis</i>	-	-	1	-
* <i>Plantago coronopus</i>	-	-	1	-
<i>Acacia dealbata</i>	1	-	-	1
<i>Danthonia popinensis</i>	1	1	1	1
<i>Themeda triandra</i>	1	1	-	1
* <i>Agrostis capillaris</i>	-	-	1	1
<i>Danthonia caespitosa</i>	1	-	-	1
<i>D. laevis</i>	1	-	1	1
* <i>Cynosorus echinatus</i>	-	-	1	1
* <i>Bromus diandrus</i>	-	-	1	1
<i>Pimelea humilis</i>	-	-	1	1
<i>Ehrharta stipoides</i>	1	-	-	1
* <i>Hypochoeris radicata</i>	-	1	-	1
<i>Lomandra longifolia</i>	-	-	1	1
Additional Species				
2: * <i>Arctotheca calendula</i> , <i>Banksia marginata</i> , * <i>Cerastium glomeratum</i> , <i>Gnaphalium collinum</i> , * <i>Holcus lanatus</i> , <i>Hypericum gramineum</i> , <i>Hypoxis glabella</i> , <i>Lagenifera stipitata</i> , <i>Leptorhynchos squamatus</i> , <i>Lissanthe strigosa</i> , <i>Oxalis perennans</i> , <i>Thelymitra</i> spp., <i>Wahlenbergia gymnoclada</i> .				
3: * <i>Centaurium erythraea</i> , <i>Chrysocephalum apiculatum</i> , <i>Convolvulus erubescens</i> , <i>Danthonia carphoides</i> , * <i>Petrorhagia prolifera</i> , * <i>Plantago lanceolata</i> , * <i>Poa bulbosa</i> , <i>Rumex dumosus</i> , * <i>Sonchus oleraceus</i> , <i>Stipa flavescens</i> , * <i>Trifolium pratense</i> , <i>Vittadinia gracilis</i> .				
4: * <i>Erodium cicutarium</i> , * <i>Medicago</i> spp., * <i>Rumex crispus</i> .				
5: * <i>Lolium perenne</i> , * <i>Moenchia erecta</i> , * <i>Poa pratensis</i> , * <i>Silene gallica</i> , * <i>Trifolium glomeratum</i> , * <i>Ulmus X hollandica</i> , * <i>Vulpia myuros</i> .				
1: * <i>Agrostis stolonifera</i> , <i>Amphibromus nervosus</i> , * <i>Anthoxanthum odoratum</i> , * <i>Cyperus tenellus</i> , <i>Dichondra repens</i> , <i>Eleocharis acuta</i> , <i>Eleocharis pusilla</i> , <i>Eryngium vesiculosum</i> , <i>Isolepis crassiuscula</i> , <i>Isolepis platycarpa</i> , <i>Juncus bufonius</i> , <i>Juncus holoschoenus</i> , * <i>Leontodon taraxacoides</i> , <i>Lythrum hyssopifolia</i> .				
6: <i>Acrotiche serrulata</i> , * <i>Briza</i> spp., <i>Dianella revoluta</i> , * <i>Erodium botrys</i> , * <i>Genista monspessulana</i> , <i>Hibbertia prostrata</i> , <i>Lepidosperma gunnii</i> , * <i>Pinus radiata</i> , <i>Pultenaea pedunculata</i> , * <i>Vulpia bromoides</i>				

* = Introduced species.

† 1 = Valleyfield Rd, via Campbell Town, 2 = Conara/Nile Rd, 3 = Conara/Midland Hwy, 4 = Ross, 5 = Kempton, 6 = Avoca.

TABLE 4
Mean and standard error of the number of *Danthonia popinensis*†, *Ulmus*‡, and the cover of bare ground§ per 0.16 m² in burned and unburned quadrats.

	1991	1993	Significance levels [¶]
<i>D. popinensis</i> tussocks			
burned	6.70 ± 1.05	6.30 ± 1.12	n.s.
unburned	4.76 ± 1.40	4.56 ± 1.30	n.s.
<i>D. popinensis</i> individuals			
burned	33.95 ± 5.35	37.00 ± 7.26	n.s.
unburned	28.56 ± 6.26	31.44 ± 6.63	n.s.
<i>D. popinensis</i> percentage cover			
burned	4.20 ± 0.186	5.60 ± 0.169	***
unburned	3.60 ± 0.294	3.76 ± 0.284	n.s.
<i>D. popinensis</i> flowers			
burned	3.80 ± 0.213	1.65 ± 0.196	***
unburned	4.28 ± 0.334	3.96 ± 0.329	n.s.
<i>Ulmus</i> suckers			
burned	1.10 ± 0.240	1.45 ± 0.328	n.s.
unburned	0.40 ± 0.129	0.40 ± 0.129	n.s.
<i>Ulmus</i> percentage cover			
burned	1.17 ± 0.459	4.75 ± 1.42	*
unburned	0.36 ± 0.114	0.36 ± 0.114	n.s.
bare ground percentage cover			
burned	29.65 ± 4.72	3.05 ± 0.803	***
unburned	49.04 ± 4.96	48.52 ± 4.71	n.s.
annual grasses percentage cover			
burned	13.45 ± 2.63	46.20 ± 6.27	***
unburned	14.39 ± 2.88	22.96 ± 4.17	n.s.
exotic perennial grasses percentage cover			
burned	24.55 ± 4.20	7.50 ± 2.19	***
unburned	20.39 ± 9.84	22.70 ± 10.3	n.s.
native perennial grasses percentage cover			
burned	17.00 ± 2.44	18.00 ± 3.05	n.s.
unburned	8.17 ± 1.22	9.48 ± 1.38	n.s.
perennial grasses percentage cover			
burned	41.55 ± 4.46	25.50 ± 3.02	*
unburned	28.57 ± 9.52	32.13 ± 9.84	n.s.
grass cover (Braun-Blanquet)			
burned	4.20 ± 0.186	5.60 ± 0.169	***
unburned	3.60 ± 0.294	3.76 ± 0.284	n.s.
herb cover (Braun-Blanquet)			
burned	2.30 ± 0.282	1.10 ± 0.069	***
unburned	1.12 ± 0.105	2.00 ± 0.163	***
exotic cover (Braun-Blanquet)			
burned	3.65 ± 0.209	4.90 ± 0.228	***
unburned	1.92 ± 0.264	2.24 ± 0.290	n.s.

† Individuals, tussocks, cover and flowers

‡ Suckers and covers.

§ Grass, herb, exotic species, annual grasses, perennial exotic grasses, native perennial grasses and perennial grasses.

¶ For the Mann-Whitney U Test: * = P<0.05, ** = P<0.01, *** = P<0.001, n.s. = not significant.

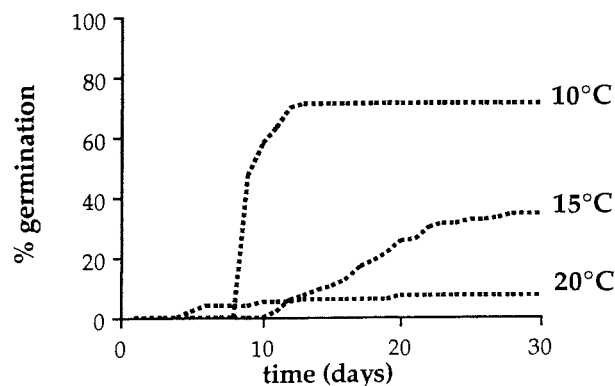


FIG. 2. — Germination curves for *Danthonia popinensis*

density, in a remnant undisturbed for 20 years. Also, the rate of establishment of new individuals at Kempton in the period 1991–93 was low, despite bare ground being available, particularly in the unburned plots, where exotic annual grasses were not favoured. Seven of the nine germinates of *D. popinensis* established in bare ground. Nevertheless, the rate of establishment is probably sufficient to maintain the population.

Autumn burning was not an effective strategy for weed control in the Kempton population. Although the biomass of *D. popinensis* increased significantly with burning, so too did the area of *Ulmus* suckers. Autumn burning at Kempton also favoured the germination of exotic annual grasses, particularly *Vulpia myuros*, in the bare ground characterising intertussock gaps. This has also been recorded in *Themeda triandra* grasslands in Victoria, where annual grasses were promoted by burning, and *V. bromioides* increased 100-fold, following an autumn fire (Lunt 1990).

At Kempton, the control of *Ulmus* suckers has recently been achieved in the short term by a return to the previous management of slashing. For roadside sites as a whole, the effects of spring burning should also be investigated. The selective use of herbicide is another option that deserves investigation for weed control, as an accidental spraying of the site in autumn with Roundup® did not appear to negatively affect *D. popinensis*.

The long-term security of *D. popinensis* in the wild is poor, as all the sites are small fragments of the original vegetation. The creation of an *ex situ* population at a secure and ecologically suitable site is recommended, as is the use of the species in roadside amenity plantings within its present range.

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