WHY DO TALL HERBS RARELY DOMINATE TASMANIAN ALPINE VEGETATION? EVIDENCE FROM ISLANDS IN THE OUSE RIVER SYSTEM

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(with five tables, one text-figure and two plates)

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Tall alpine herbfield is largely absent from the Tasmanian alpine zone. This absence has been attributed to marsupial grazing. Small islands in the upper Ouse River valley are partly dominated by *Craspedia paludicola*, a showy tall alpine herb. The herbs dominate on the upstream ends of the islands. The surrounding vegetation on the banks is mainly grassland. The tall herbs are a very minor element of the shore vegetation, occurring on the undercut banks. Grassy islands close to the river banks are grazed and few tall herbs are found there. *Craspedia paludicola* also occurs in small numbers in damp areas on grassy heaths at other grazed locations, largely within bushes with pungent leaves. The distribution of *Craspedia paludicola* suggests that it is highly palatable and can thus only survive in larger numbers away from the influence of vertebrate grazers (rabbits and marsupials). It appears that this species requires both disturbance and a lack of grazing to dominate an area.
Key Words: tall alpine herbs, islands, grazing, Central Plateau, Tasmania, alpine vegetation.

INTRODUCTION

Tall alpine herbfield (sensu Costin *et al.* 1979) is one of the more widespread vegetation types in the Australian Alps. While many species that are found in mainland tall alpine herbfields occur in Tasmania, the community is largely absent from the Tasmanian alpine zone.

One of the main ecological differences between alpine areas in mainland Australia and those in Tasmania is the lack of grazing pressure from native herbivores on the mainland. The absence of marsupial herbivores on the mainland can be accounted for by the more continental climate of the Australian Alps, resulting in extended periods of snowlie (Carr & Turner 1959a, McVean 1969). As Tasmania has a maritime climate, persistent snowlie is restricted to the highest lee slopes, allowing vertebrate herbivores to survive and feed in the relatively unprotected vegetation of the alpine zone throughout the year (Kirkpatrick 1989).

The impacts of domestic stock and rabbit grazing on tall alpine herbs has been well documented for the Australian Alps (Carr & Turner 1959b, Wimbush & Costin 1979a,b,c, Leigh & Holgate 1979, Leigh *et al.* 1987, Williams & Ashton 1987, Wahren *et al.* 1994). However, very little information is available on the effects of native vertebrate herbivores on alpine vegetation. Leigh & Holgate (1979) found that plant survival and reproductive capacity were reduced by native vertebrate and rabbit grazing in the shrubby understorey of dry sclerophyll woodlands. Palatable forbs were considered to be the main food source of mammalian herbivores in subalpine environments (Leigh *et al.* 1991). However, the effects of native marsupial grazing have been found to be insignificant when compared to the effects of rabbits (Leigh *et al.* 1987).

In Tasmania, native herbivores (wallabies and wombats) affect the cover and heights of some shrubs and species of herbs in subalpine grassy woodlands (Gibson & Kirkpatrick 1989). Grazing by native herbivores and rabbits is considered to be the main mechanism for restricting the spread of exotic species across the Central Plateau (Kirkpatrick 1989, Whinam *et al.* 1994, Corbett 1996). In alpine *Sphagnum* bogs, epacridaceous shrubs are subject to heavy wallaby grazing (Whinam 1990). This study also indicated that grazing pressure was greater on individual palatable species in environments with relatively few palatable plants.

Rabbit numbers widely fluctuate on the Central Plateau and are heavily reduced during times of prolonged snowlie (Cullen 1995). Historical records detail the fluctuating numbers of kangaroo around the Great Lake area during the mid 1800s, where "... vast numbers of kangaroos perished through the cold" ... and during the summer of 1845 "... one man alone killed 1100 [kangaroos] in the vicinity of Lake Arthur...' (Breton 1846: 130).

Kirkpatrick (1989) postulated that the lack of tall alpine herbfield in Tasmania was due to the palatability of the herbs and the year round presence of introduced and native herbivores. He noted that tall alpine herbs were visibly abundant in places which were isolated from grazing, such as fenced plots and islands in fast-flowing, deep streams (e.g. the Ouse River system).

This paper documents the environments, vegetation and grazing incidence on several of the islands in the Ouse River system and the adjacent banks. Our working hypothesis was that the exclusion of grazing by a fast-flowing deep stream would result in a greater degree of tall herb cover than in adjacent, environmentally similar areas.

METHODS

In January 1997, five islands in the upper Ouse River valley, on the eastern Central Plateau, Tasmania, were surveyed (fig. 1). These islands were the first five seen on a traverse of the region. The closest adjacent area of the same size on the banks of the rivers was also surveyed.

The following data were recorded:

- dimensions of the island;
- minimum distance from the island to the shore;
- presence and cover of vascular plant taxa using the following

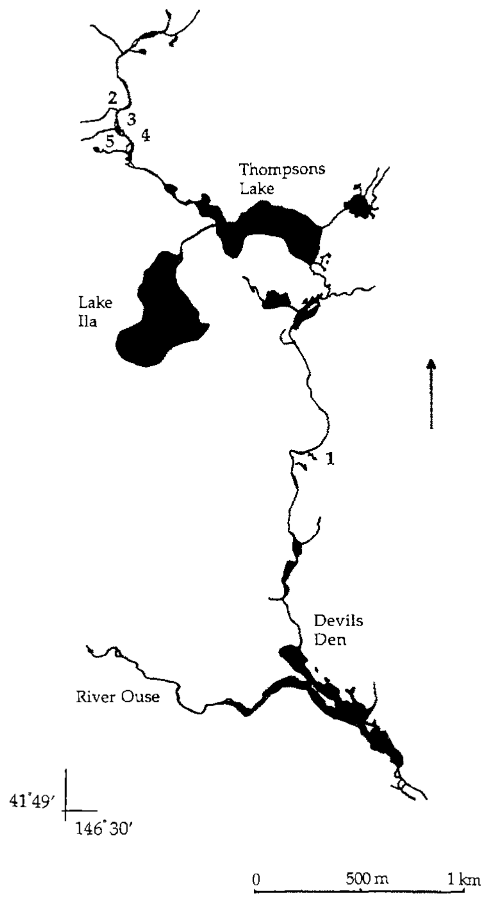

FIG. 1 — The upper Ouse River system showing the location of the island and shore sites (1–5) surveyed.

scale — 1 = <1%, 2 = 1–5%, 3 = 5–25%, 4 = 25–50%, 5 = 50–75%, 6 = 75–100%;

- presence, identity and number of scats present.

Plant nomenclature follows Buchanan (1995) except for *Chionogentias* spp. (L.G. Adams 1995).

Three bulked samples of surface soil (< 5 cm deep) were taken from each island and adjacent shore. These were analysed for copper, iron, manganese, zinc, ammonium N, nitrate N, total nitrogen, total phosphorus, total calcium, extractable phosphorus, extractable potassium, organic carbon, conductivity and pH, using the following methods — DTPA for Cu, Fe, Mn, Zn; KCl extraction for NH_4/N, NO_3/N; semimicro Kjeldahl, steam distillation for total N; ICP analysis for total P & Ca; bicarbonate-extractable P; bicarbonate-extractable K; organic C (Walkley & Black); pH($CaCl_2$) 1:5 soil/0.01M calcium chloride extract; conductivity 1:5 soil/water extract (Rayment & Higginson 1992).

Plant species were grouped according to lifeform: shrub, grass, herb (dicotyledons), graminoids (herbaceous monocotyledons other than members of the Poaceae). Herbs were further divided into three groups on the basis of stature; tall alpine herbs (*sensu* Costin *et al.* 1979), medium stature herbs (between 5 and 10 cm tall) and small herbs (less than 5 cm tall). All "small herb" *Ranunculus* species were grouped under the genus.

The numbers of Bennett's wallaby (*Macropus rufogriseus*) and wombat (*Vombatus ursinus*) scats and plant species richness were calculated for each pair of island/shore plots. The Mann-Whitney U test was used to determine whether there were any significant differences in soil characteristics or numbers of scats between the islands and the shores, while the Wilcoxon signed-rank test was used to test for significant differences in species richness between the paired plots. The Fisher's Exact Probability test was used to determine the significance of differences between the distribution of individual taxa on islands and shores.

The midpoints of the cover classes were used to estimate the total cover of lifeforms for each of the island/shore plots. The Fisher's Exact Probability test was used to determine the significance of different lifeform groups on islands and shores.

RESULTS

The islands varied in size from 2.25 to 24 m^2 and were from 1.5 to 12 m away from the shores (table 1).

The number of scats recorded for the islands and the shore was significantly different ($z = -2.643$, $p = 0.0082$). Not surprisingly, the only scats recorded on the islands were wallaby scats, whilst both wallaby and wombat scats were recorded on the shore. Scats were only found on islands four and five which lay less than 2 m away from the river bank (tables 1, 2).

There were no significant differences between the soils of the island and the shore sites (table 3).

In all, 40 plant species were identified on the islands and adjacent shores. Most of the species recorded were herbs (23/40) followed by graminoids and shrubs (table 4).

Only one species, *Plantago daltonii*, occurred in all ten plots, while 13 species occurred in one plot only (table 4). Species richness was consistently higher in the shore plots than on the islands ($z = -2.812$, $p = 0.0049$) (table 4).

The grass *Hierochloe redolens*, the graminoid *Carpha alpina* and the tall alpine herb *Craspedia paludicola* were the only species to have significantly different frequency distributions on the islands and the shores ($p = 0.004$ for all three species).

There was no significant difference in the presence or cover of shrubs, grasses, graminoids or small herbs between the islands and the shore sites. Medium stature herbs (h) and tall herbs (tah) were significantly more abundant on the islands ($p = 0.024$, $p = 0.004$ respectively).

Seven species occurred on the islands only, while 11 species were recorded for the shore sites only (table 5). Of these, small herbs made up the greater proportion of plants recorded for the shore sites only. Tall herbs and grass species were faithful only to the islands.

DISCUSSION

Visually, the tall herb *Craspedia paludicola* identifies the main difference in species composition and stature between the island and the shore sites (pl. 1). This difference in the vegetation cannot be attributed to differences in soil fertility (table 3). These islands do differ from the shores in the number of scats per unit area with several having none (table 2). We were unable to measure flood disturbance impacts but deduce that these would be greatest on the upstream ends of islands and least on the downstream ends. There seems little doubt that flood activity favours the establishment of tall herbs as these were concentrated on the

TABLE 1
Physical characteristics of the five paired sites

Island	Dimensions (m)	Distance to banks West	East
1	4 x 6	2 m	4 m
2	2 x 2	3 m	6 m
3	1.5 x 1.5	6 m	6 m
4	3 x 2	8 m	1.5 m
5	4 x 2	12 m	2 m

TABLE 2
Number of scats/m²

Site	Number of scats Islands	Shores	Identity of scats Islands	Shores
1	0	0.9		Wallaby
2	0	9.5		Wallaby/wombat
3	0	14.2		Wallaby
4	2.3	5.8	Wallaby	Wallaby
5	1	6.4	Wallaby	Wallaby/wombat

TABLE 3
Soils analyses for the island and the shore sites

	Cu ppm	Fe ppm	Mn ppm	Zn ppm	NH_4 ppm	NO_3 ppm	N %	P ppm	Ca ppm	ExtP ppm	ExtK ppm	C %	Cond. dS/M	pH $CaCl_2$
Shore														
1	0	0	0	0	39	0.05	0.81	643	2945	3	265	17.8	0.08	5.6
2	2.34	241.2	753	6.4	37	0.05	0.87	771	1485	1	530	14.8	0.07	6.1
3	3	293	432	12	149	0.05	0.88	794	954	1	340	15.5	0.06	4.9
4	4.95	495	513	13.5	22	0.05	0.83	865	537	1	260	13.5	0.05	4.7
5	3.15	614	507	15.3	37	0.05	0.8	790	801	2	410	15.4	0.06	4.9
mean	2.69	328.6	441	9.44	56.8	0.05	0.84	772.6	1344.4	1.6	361	15.4	0.06	5.2
sd	1.79	237.7	274.5	6.23	52		0.04	80.8	959.3	0.9	112.7	1.56	0.01	0.6
Island														
1	0	0	0	0	116	0.05	0.97	690	3355	2	350	16.5	0.08	5.3
2	2.88	386.4	285.6	5.57	23	0.05	0.94	710	1154	2	430	14.6	0.09	6
3	3.6	348	597	11.7	31	0.05	0.86	835	1548	2	590	12.9	0.11	5.1
4	3.12	383.4	678.6	12.7	42	0.05	0.78	840	737	3	275	14.9	0.06	4.8
5	2.76	279	282	7.83	35	0.05	0.74	766	824	2	190	11.5	0.07	5.8
mean	2.47	279.4	368.6	7.56	49.4	0.05	0.86	768.2	1523.6	2.2	367	14.1	0.08	5.4
sd	1.42	162	273.1	5.12	37.9		0.1	69.2	1072.3	0.5	153.1	1.93	0.02	0.5

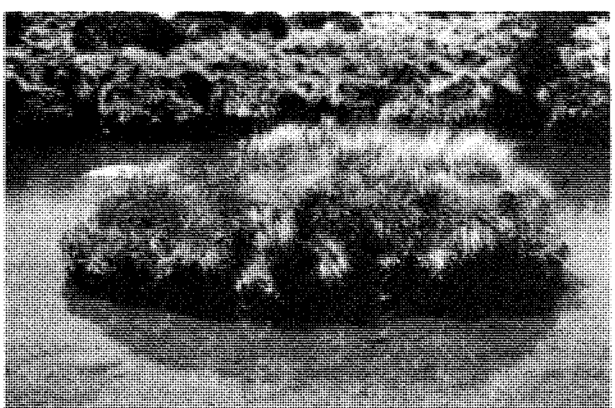

PLATE 1
An ungrazed island in the upper Ouse River system, dominated by Craspedia paludicola *on the upstream end. Vegetation on the opposite shore shows* C. paludicola *on the undercut banks only.*

upstream ends of islands and on the vertical banks of both the islands and the shore. However, on the shores the tall herbs are only found where the steepness of banks prevented grazing while on the islands they occurred throughout.

The dominant grass species *Hierochloe redolens,* which occurred on the downstream ends of the islands, was rare on the shore. Small herbs that were absent on the highly grazed shore were rare in the taller vegetation of the islands. Many of the species more common on the islands are reported to be palatable and/or not grazing resistant. The tall herb species on the islands are considered to be very palatable and relatively intolerant to grazing (Carr & Turner 1959a,b, Wimbush & Costin 1979a,b, Leigh *et al.* 1987, Wahren *et al.* 1994). The shrub *Bellendena montana* is also palatable to native herbivores. Of those species faithful to the shore (table 5), the following are grazing resistant; *Cotula alpina* (Gibson & Kirkpatrick 1989, Leigh *et al.* 1987), *Hydrocotyle sibthorpioides* (Gibson & Kirkpatrick 1989), *Hypericum japonicum* and *Viola betonicifolia* (Gibson & Kirkpatrick 1989, Leigh *et al.* 1987). *Astelia alpina* is palatable to native vertebrates when choice of food is limited (Whinam 1990). *Asperula gunnii* (Gibson & Kirkpatrick 1989, Leigh *et al.* 1987), *Epacris gunnii* (Gibson & Kirkpatrick 1989, Whinam 1990) and *Epacris serpyllifolia*

TABLE 4
Cover of species and lifeforms in the island/shore paired plots

	life	island 1	shore 1	island 2	shore 2	island 3	shore 3	island 4	shore 4	island 5	shore 5
Astelia alpina	gm				0.5		0.5				
Carex gaudichaudiana	gm			2.5	37.5	15	2.5	62.5	2.5	0.5	2.5
Carpha alpina	gm		0.5		0.5		37.5		15	2.5	15
Empodisma minus	gm	37.5	62.5								15
Oreobolus distichus	gm		0.5								
Restio australis	gm	2.5	15								
Deschampsia caespitosa	gr					2.5					
Hierochloe redolens	gr	2.5	0.5	37.5	0.5	0.5		0.5		62.5	2.5
Poa costiniana	gr	37.5	37.5	2.5	15	0.5	2.5		2.5	37.5	37.5
Acaena montana	hs		0.5								
A. novae-zelandiae	hs	0.5	0.5								
Asperula gunnii	hs		0.5				2.5				0.5
Cotula alpina	hs				0.5						
Dichosciadeum ranunulaceum	hs	0.5	0.5		0.5						
Diplaspis hydrocotyle	hs	0.5	0.5		0.5	0.5	0.5	0.5	0.5		
Hydrocotyle sibthorpioides	hs		0.5								2.5
Hypericum japonicum	hs		0.5				0.5				
Oreomyrrhis ciliata	hs			2.5	0.5		0.5	2.5	0.5	2.5	2.5
Ourisia integrifolia	hs		0.5	0.5	0.5	0.5	0.5	0.5	2.5		
Ranunculus sp.	hs	0.5	0.5	38.5	3	65	62.5	15.5	63.5	3	3
Viola betonicifolia	hs										0.5
V. cunninghamii	hs			0.5	0.5	0.5	0.5	2.5	0.5	0.5	0.5
Epilobium sp.	h		0.5								
Geranium potentilloides	h	2.5	0.5								
Plantago daltonii	h	0.5	0.5	15	0.5	15	0.5	2.5	2.5	2.5	0.5
Ranunculus lappaceus	h					0.5	0.5				
Chinogentias sp.	tah			0.5							
Craspedia coolaminica	tah	0.5									
C. paludicola	tah	2.5	0.5	62.5	0.5	37.5		0.5		2.5	0.5
Baeckea gunniana	sh	2.5	2.5								
Bellendena montana	sh	0.5									
Coprosma sp.	sh	0.5									
Epacris gunnii	sh		0.5								
E. serpyllifolia	sh		0.5								
Olearia obcordata	sh	2.5	0.5								
Orites acicularis	sh	15	15								
Richea acerosa	sh	2.5	15								
total graminoids	gm	40	78.5	2.5	38.5	15	40.5	62.5	17.5	3	32.5
total grasses	gr	40	38	40	15.5	3.5	2.5	0.5	2.5	100	40
total small herbs	hs	2	4.5	42	6	66.5	67.5	21.5	67.5	6	9.5
total medium herbs	h	3	1.5	15	0.5	15.5	1	2.5	2.5	2.5	0.5
total tall herbs	tah	3	0.5	63	0.5	37.5	0	0.5	0	2.5	0.5
total all herbs	h	8	6.5	120	7	119.5	68.5	24.5	70	11	10.5
total shrubs	sh	23.5	34	0	0	0	0	0	0	0	0
species richness/m^2		18/24	25/24	12/4	15/4	12/2.3	13/2.3	10/6	11/6	10/8	14/8

Life = lifeform group; gm = graminoid, gr = grass, hs = small herbs, h = medium stature herbs, tah = tall herbs, sh = shrubs.
Species names and lifeform groups in bold type have significantly different frequency distributions on the islands and the shores.

TABLE 5
Lifeforms of species occurring only on either the islands or the adjacent shores

Species	Island	Shore
Astelia alpina		graminoid
Oreobolus distichus		graminoid
Deschampsia caespitosa	grass	
Acaena montana		small herb
Asperula gunnii		small herb
Cotula alpina		small herb
Epilobium sp.		small herb
Hydrocotyle sibthorpioides		small herb
Hypericum japonicum		small herb
Viola betonicifolia		small herb
Ranunculus glabrifolius	small herb	
R. rivularis	small herb	
Chinogentias sp.	tall herb	
Craspedia coolaminica	tall herb	
Bellendena montana	shrub	
Coprosma sp.	shrub (mat)	
Epacris gunnii		shrub
E. serpyllifolia		shrub

PLATE 2
A lightly grazed island in the upper Ouse River system, showing Craspedia paludicola *only on the undercut banks of the island and the shore.*

(Whinam 1990) are palatable species, though they can tolerate some grazing.

Grazing can affect the overall stature of communities and individual taxa. The difference in stature of herbs that we found between the islands and shores is likely to be related to grazing pressure. Wimbush & Costin (1979a, c) found densities of minor herbs to be less in grazing exclosures over time while tall herbs increased. The dominance of small herbs on the shore sites suggests that grazing is important in creating and maintaining habitat requirements (and higher species richness) where small herbs are not outcompeted by taller species (Wimbush & Costin 1979a). Small herbs existing on the islands had suitable habitat provided for them by disturbance from the river itself, such as bank erosion and occasional flood events. Where grazing is present on the islands, the cover of *Craspedia paludicola* is less than where grazing is absent (table 4, see data for islands 4 and 5).

Similar reports on community composition on ungrazed islands have been noted elsewhere on the Central Plateau. Colonel Legge, on visiting the now drowned Pine Island in Great Lake, recorded a plant community dominated by "... the tall Alpine Holy grass *Hierochloe redolens*, the *Craspedia richei* whose tall stalk and downy, button-shaped flower towered above the dwarf *Poa* grass ..." (Legge 1902: 141). Other tall herbs such as "*Brachycome* sp.", "*Helichrysum bracteatum*" and "*Celmisia longifolia*" were also noted. Legge did not see any sign of vertebrate herbivores whilst he was on the island, and his companions only reported sightings of whip-snakes, echidnas and pipits.

Islands in the Ouse River system were grazed if they were in close proximity to the shore or to other islands. Where there were a series of islands linked together, scats were found on them all. While *Hierochloe redolens* was present on these grazed islands, *Craspedia paludicola* was noticeably absent or present only on the steep undercut banks (pl. 2). These islands were generally larger or more protected than the islands with tall herbs, due to their proximity to other islands, and they appear to be physically more stable. The dominance of *C. paludicola* on the upstream ends of the surveyed islands and along the undercut banks suggests that it is able to withstand physical disturbance and may indeed require it, in order to gain dominance in a strongly competitive environment.

The dominance of tall alpine herbs in herb-rich grasslands on the mainland may be partly a result of some disturbance event(s) (Carr & Turner 1959a, McVean 1969, Costin *et al.* 1979). Tall herbs such as *Craspedia* spp. are capable of colonising bare ground (Wahren *et al.* 1994), and they are also opportunistic when gaps appear in the vegetation, such as during the senescence of *Poa* tussocks or shrubs (Carr & Turner 1959b, McVean 1969, Costin *et al.* 1979). Where exogenous disturbances (such as domestic stock grazing) have been removed, the most commonly recorded effect in the plant community is an increase in species richness and cover of tall alpine herbs (Carr & Turner 1959b, Wimbush & Costin 1979a,b,c, Wahren *et al.* 1994). Whether tall alpine herbfields persist in the long term appears to rely on occasional extreme climatic events, such as drought or extended snowlie, or exogenous disturbance, such as fire. In Tasmania, climatic events may not be so extreme, but endogenous disturbance in the form of grazing exists. While disturbance itself may be a necessary requirement for tall alpine herbs to dominate in grasslands, they need to be able to reproduce to do so!

Given the above reasoning, we accept our working hypothesis by concluding that an absence of marsupial grazing is necessary for tall herbs to have the opportunity to obtain dominance in Tasmanian alpine vegetation on fertile soils. However, we also conclude that this has to be combined with physical disturbance to ensure tall herb dominance.

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