Distribution of thistles of the genus *Onopordum* in Australia

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Summary

This paper integrates information, obtained by several methods throughout southern Australia, on the distribution and abundance of *Onopordum* spp. Distributions of *O. acanthium*, *O. illyricum*, *O. acaulon* and *O. tauricum* are shown on 10' X 10' grid maps. Estimates of area infested indicated that *O. acaulon* is the most widespread (ca. 1,600,000 ha), while *O. acanthium* and *O. illyricum* combined occupy ca. 1,100,000 ha. *O. tauricum* is restricted to two isolated areas of less than 100 ha. *O. acanthium* and *O. illyricum*, however, pose the most serious weed problems, particularly in southeastern New South Wales where they occupy large areas of productive grazing lands. *O. acaulon* is restricted to more arid, less productive country. The problems of using different methods of estimating the abundance of weeds are discussed and suggestions are made for their improvement.

Introduction

O. acanthium L. (scotch or cotton thistle), *O. illyricum* L. (illyrian thistle), *O. acaulon* L. (stemless thistle) and *O. tauricum* Willd. (taurian thistle), all native to the Mediterranean region, are weeds of pasture and rangeland in southern Australia. A fifth species, *O. leptolepis* DC. (Persian thistle) is known only as a single record from central Victoria (Willis 1972), and, as it is presumed extinct, is not considered further in this paper.

Distribution and abundance data is necessary in order to assess weed importance, to estimate their cost and to formulate management policies and research priorities (Campbell 1977, Auld *et al.* 1987). This information is only available in diverse formats since there is no national system for recording weed infestations. For instance, Parsons (1973) produced regional maps of the distributions of scotch, illyrian and stemless thistles in Victoria, based on the presence or absence of the weed in parishes (a geopolitical division), but did not estimate areas of infestation. Medd (1981) estimated the areas of land in New South Wales infested by scotch and illyrian thistle combined, based on subjective surveys of district agronomists during 1977-78, but did not publish distribution maps.

This paper describes the present distribution of the four *Onopordum* species in Australia, and estimates the areas infested, data which will provide a baseline for assessing future changes in infestation levels over time, particularly in view of a proposed biological control program against thistles of this genus (Briese 1989).

Methods

Data collection

Subjective estimates of the distribution and abundance of the *Onopordum* spp. were made throughout southern Australia using the different resources available in the various states. In 1986 questionnaires were forwarded to local government noxious weeds officers in New South Wales and to district agronomists in South Australia requesting information on: 1) the area of land and number of properties infested with light (scattered individual plants), medium (scattered dense patches with isolated plants in between) and heavy infestations (areas of continuous, dense infestation); 2) how the infestation had changed over the past three years; 3) the types of land use in which the thistles were found; and 4) they were requested to map the distributions on shire maps.

In Victoria, land protection officers were requested in 1980 to mark the distribution of various weed species on transparent overlays placed over a topographic map of their respective districts, colour-coded for light, moderate and heavy infestations. Sizes of infestations were then obtained by measuring the areas of each colour with a planimeter.

In Tasmania, infestations on individual properties have been assessed approximately every fifth year and recorded by grid reference and size for storage on a computer data base.

The Agriculture Protection Board of Western Australia has maintained a data base since 1981 and records area and density of infestations of declared plants on individual properties. Most properties would be inspected at least once every two years. Thus it was relatively easy to access the area covered by light, moderate and heavy infestations of stemless thistle (the only species of *Onopordum* present in that state) and their distribution in recent years up to 1986/87.

Precision of data

Because of the different methodologies of recording weeds between states, data are presented on the degree by degree-and-a-half (DDGH) grid system (Brook 1976), showing the presence or absence of a species in grids of 10' latitude X 10' longitude (the minor grid of the DDGH system) using the Mercator projection. These maps were sufficiently coarse-grained to eliminate any implicit suggestion of precise boundaries in plant distributions (as is the case with a conventional line map), yet were fine enough to adequately define the areas in which the plants occurred.

The data are presented where possible as estimates, by region, of the amount of land moderately or heavily infested and the total area infested. The latter gives an idea of the overall range of the weed, while the former reflects the amount of land alienated to some degree from productive uses.

Onopordum acanthium and Onopordum illyricum

Estimates of the areas of land infested (Table 1) show that scotch and illyrian thistle are important problems in the central and southern tablelands of New South Wales. These weeds, which were introduced in the early to mid 1800s (Medd 1981), now infest an estimated 995,000 ha, with about 288,000 ha considered to be moderately or seriously affected (on just over 3000 properties). Returns from the shire officers indicated that about 60% of this moderately to seriously infested land was occupied by *O. illyricum*. The main areas of infestations lie within the 500 - 850 mm rainfall zone, with illyrian thistle occurring mainly in the warmer northern and western parts of the combined range (Figure 1). At present, these weeds are proclaimed in 36 shires (Table 1). The increasing seriousness of scotch and illyrian thistle is demonstrated by the fact that, of the 35 shires listed in Table 1 as having moderate or severe infestations, 18 indicated that the problem had become worse over the previous 3 years, 12 reported no change, and only 5 reported a decrease in infestations of the thistles.

In shires with light infestations scotch and illyrian thistles occurred mainly as roadside weeds (Table 2). While always important as roadside weeds in more severely affected shires, they occurred mainly on arable land

Table 1. Areas of land infested by *Onopordum acanthium* and *O. illyricum* in local government regions of New South Wales.

New South Wales Region	Shire		Area infested (ha) Medium/heavy	Total (1)	Species present *O.ac.* (2)	*O.ill.* (2)
Shires with serious infestations						
South eastern	Boorowa	*	36000	64000	(+)	+
	Cooma-Monaro	*	20000	20000	+	
	Crookwell	*	25000	295000	+	+
	Gunning	*	18000	218000	+	+
	Harden	*	20000	90000		+
	Mulwaree	*	17000	17000	+	(+)
	Snowy River	*	18000	23000	+	
	Tallaganda	*	15000	35000	+	
	Yarrowlumla	*	1000	1000	+	+
	Yass	*	5000	5000	+	+
	Young	*	20000	87000	(+)	+
Murrumbidgee	Cootamundra	*	47000	82000	(+)	+
Central West	Cabonne	*	3000	5000	+	+
	Evans	*	1000	2900	+	(+)
	Forbes	*	10000	11000	+	(+)
	Rylstone	*	10000	10000	+	+
North western	Mudgee	*	10000	10000	+	+
	Wellington		10000	10000		+
Shires with moderate infestations						
South eastern	A.C.T.		220	720	+	
Illawarra	Shoalhaven		40	240	+	
	Wingecarribee	*	100	200	+	
Murray	Culcairn	*	50	250		+
	Holbrook	*	200	200		+
Murrumbidgee	Gundagai	*	200	200		+
	Junee	*	65	140		+
	Tumut	*	50	350		+
	Wagga Wagga	*	100	300		+
Central West	Bathurst	*	160	160	+	
	Blayney	*	140	940	+	+
	Cowra	*	50	100	+	+
	Greater Lithgow	*	160	660	+	
	Lachlan	*	400	700	+	
	Oberon	*	0	1000	+	(+)
	Orange	*	550	1550	+	+
	Weddin	*	40	210	+	(+)
Shires with light infestations						
South eastern	Bega Valley			5	+	
	Bombala	*	40	40	+	
Murray	Albury		50	50	+	
	Berrigan			+	+	
	Hume	*	10	10		+
	Tumbarumba		*	+	+	+
	Urana		10	10	+	
	Wakool			+	+	
Murrumbidgee	Coolamon		30	30		+
	Carathool			+	+	
	Temora	*		50		+
North western	Coonabarabran			+	+	
	Coonamble			+	+	
	Narromine			+	+	
Northern	Dumaresq			+	+	
	Manilla			2	+	
	Nundle			1		+
	Quirindi			3		+
	Walcha			10	+	
Hunter	Merriwa			+	+	
	Scone			+	+	

1) + = present at low level 2) + = species present, (+) = present, but forms only a small proportion of the combined infestation. * = declared as noxious weeds in shire/district

and non-arable improved pastures, as well as naturally fertile areas such as river flats/banks (Table 2). It is in these areas that the two species cause serious economic losses to landholders. Occurrence of these thistles on river flats/banks has undoubtedly led to their spread down the Murrumbidgee and Lachlan River systems.

Although present for the same period of time (Parsons 1973), the two *Onopordum* spp. do not pose such a severe problem in Victoria, where infestations are more scattered (Figure 1). Comparison of the present distribution with that found by Parsons (1973) indicates that there has not been any major change, although the occurrence of several new infestations in central and western Victoria during the 1970s suggests that some spread is occurring. The main areas of infestation are restricted to relatively inaccessible country in Gippsland (Table 3). In total, Land Protection Officers have estimated that there are about 80,000 ha infested with scotch thistle (3,400 ha moderately/seriously) and approximately 1,000 ha infested with illyrian thistle (350 ha moderately/seriously).

Only *O. acanthium* is present in Tasmania, where since 1968 it has been the target of an official eradication campaign (Hague 1979). The area infested (Figure 1) was estimated to be 2051 ha in 1974, but from the mid-1970s the effect of this eradication campaign have become apparent, and the incidence of scotch thistle was reduced to 264 ha in 1980. Many small infestations were eliminated and the size of larger ones reduced. The most recent survey in 1986-7 suggests that the area of infestation (250 ha) is being maintained at this reduced level.

Herbarium records indicate that *O. acanthium* has occurred in various localities around Adelaide, Port Lincoln and in the south-east of South Australia, while the survey of district agronomists suggests that presently it occurs only as a minor weed in isolated areas on the Yorke peninsular (Figure 1). *O. illyricum* is even rarer and causes no agronomic problems in the state. While not reported by field officers in the present survey, it has been previously recorded from Eyre Peninsular, Northern Lofty Ranges, Murraylands and southeastern areas of South Australia (Cooke 1986).

Onopordum acaulon

The stemless thistle, *O. acaulon*, introduced in 1844 (Kloot 1983), is the most widespread of the *Onopordum* spp. (cf. Figures 1 and 2). While the present distribution in Victoria (Figures 2) appears not to have changed since Parsons (1973) earlier survey, it remains one of the 10 most widespread weeds in that state (Lane, Riches and Combellack, unpublished report, 1980). The main region of infestation in southeastern Australia (Figures 2) appears to be restricted to the 250 - 450mm rainfall zone in which most precipita-

tion is received in winter. In New South Wales, field officers reported an estimated 100,000 ha of infestations. The map planimetry method provides an estimate of 3,853,000 ha infested by stemless thistle in Victoria (Lane, Riches and Combellack, unpublished data, 1980), but over 90% of the infestation is considered light. Figure 2 indicates a similar area of infestation in South Australia, where *O. acaulon* is widespread in alkaline and neutral soils of the northern cereal belt and River Murray regions.

More recently, *O. acaulon* has invaded the northern Tablelands of New South Wales and southwest Western Australia. The area of infestation in the Northern Tablelands of New South Wales is of interest because it is a relatively small area, is spreading, is geographically isolated (Figure 2a) and occurs in a climate that is considerably cooler and wetter (800mm annual rainfall).

The first record of stemless thistle in Western Australia was at Kulin in 1955, with further infestations being reported near Esperance (1959), Mingenew (1966), Lancelin (1972) and Lake Grace (1975). The Esperance and Lake Grace infestations, in particular, seem to have formed the focal points for the subsequent spread of the weed (Figure 2b). As in southeastern Australia, most infestations occur in lower winter rainfall areas (350-500 mm isohyets), though a few infestations are found in wetter areas (over 800 mm annual rainfall).

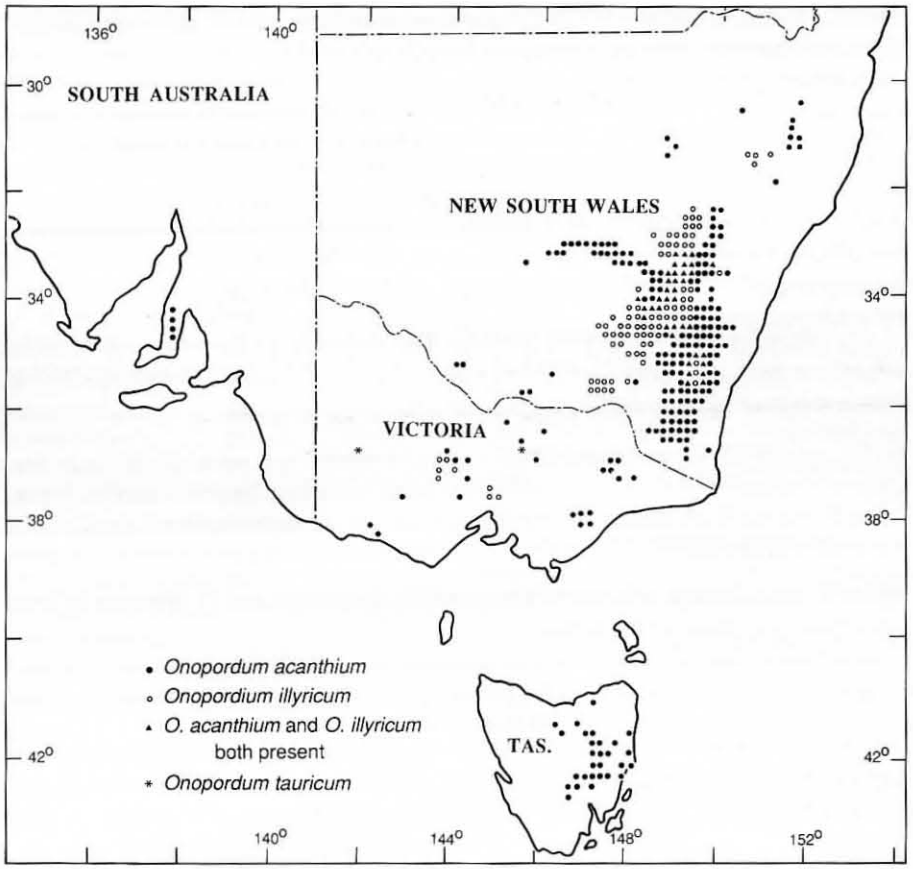

Figure 1. Distribution of *Onopordum acanthium*, *O. illyricum* and *O. tauricum* in Australia using the DDGH mapping system (see text for details).

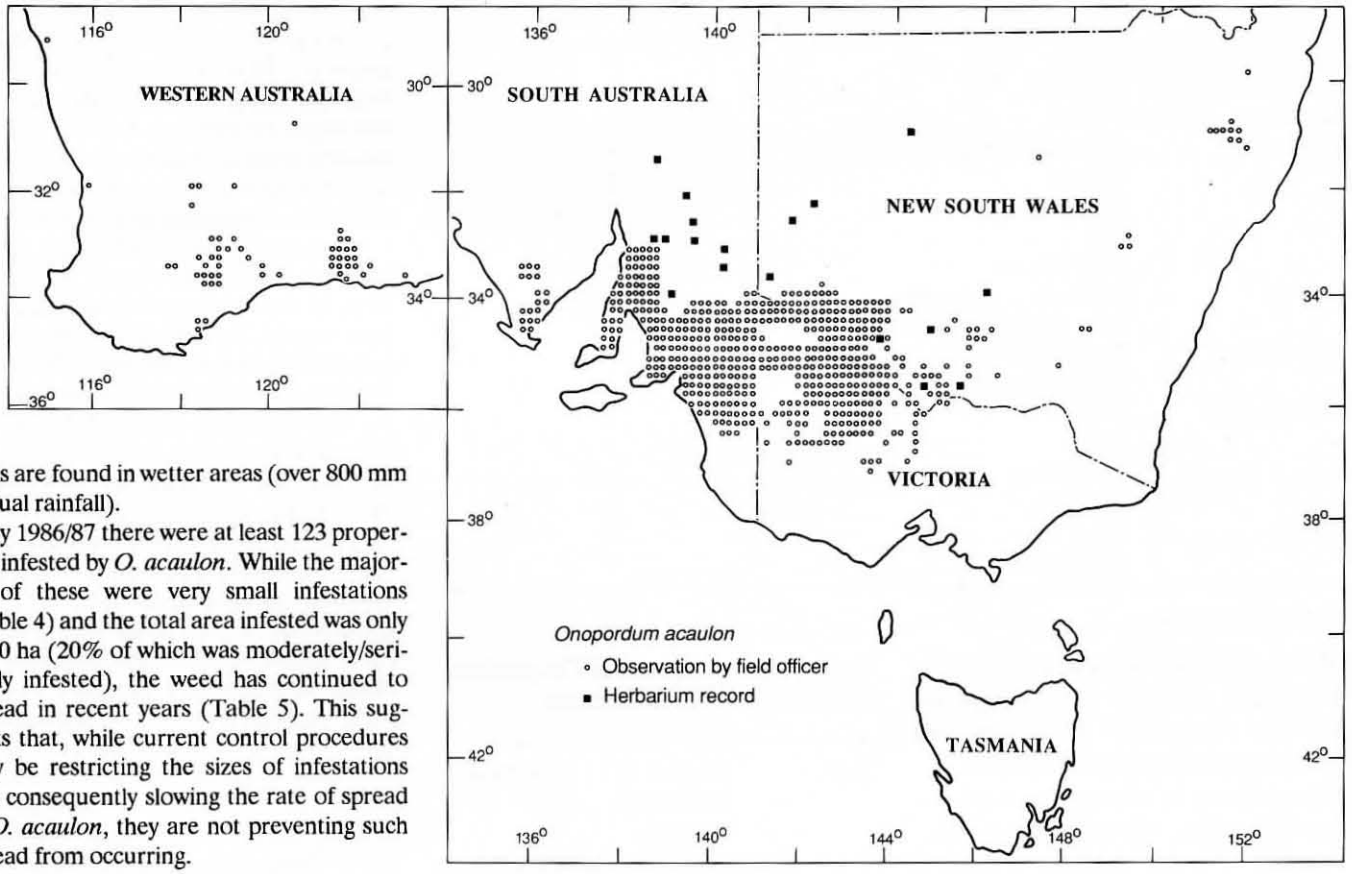

Figure 2. Distribution of *Onopordum acaulon* in a) eastern Australia and b) western Australia using the DDGH mapping system (see text for details).

By 1986/87 there were at least 123 properties infested by *O. acaulon*. While the majority of these were very small infestations (Table 4) and the total area infested was only 1000 ha (20% of which was moderately/seriously infested), the weed has continued to spread in recent years (Table 5). This suggests that, while current control procedures may be restricting the sizes of infestations and consequently slowing the rate of spread of *O. acaulon*, they are not preventing such spread from occurring.

Onopordum tauricum

The first recorded infestation of taurian thistle, *O. tauricum*, was at Goroke, in southwestern Victoria (Figure 3) in 1913. This has apparently remained relatively unchanged, although a second infestation of less than 1 ha was discovered near Natimuk, in the same region, in 1964, and a third small infestation found at Euroa in central Victoria a few years later (Figure 3). Both areas were chemically treated and reduced to scattered plants in

Table 2. Relative occurrence of *Onopordum acanthium* and *O. illyricum* infestations on different types of land use in New South Wales.

Land use	Reported infestations (%) in shires in which the thistle problem is considered: light (n=21)*	moderate (n=17)	serious (n=18)
Roadsides	43	71	83
Railway verges	19	29	39
Unused/waste land	10	29	33
Arable rural land	19	59	83
Non-arable land (improved)	10	68	83
Non-arable land (unimproved)	19	61	56
Irrigated land	0	24	6
Timbered land	0	29	11
River flats/banks	24	68	61

* n = number of shires

Table 3. Area of land infested by *Onopordum acanthium* and *O. illyricum* in local government regions of Victoria.

Region	District	Area infested (ha) Medium/heavy	Total	Species present *O.ac.*	*O.ill.*
Districts with serious infestations					
Gippsland	Omeo	0	18800	+	
	Stratford	3400	58400	+	
Districts with moderate infestations					
Central	Eltham	0	10		+
Northern	Bendigo 1.	0	900	+	
North Central	Castlemaine }				+
	Maryborough }	350	600		+
	Clunes }				+
Western	Streatham	0	1800	+	
Districts with light infestations					
Gippsland	Bairnsdale 1 & 2		+	+	
	Buchan		+	+	
	Heyfield		+	+	
	Sale		+	+	
	Swift's Creek		+	+	
Northern	Kyabram		+	+	
	Lake Boga		+	+	
North Central	Kyneton		+	+	
	Bacchus Marsh		+	+	
North Eastern	Benalla		+	+	
	Euroa		+	+	
	Wangaratta		+	+	
	Wodonga		+	+	
Western	Port Fairy		+	+	
	Warrnambool		+	+	

Symbols as for Table 1.

Table 4. Size distribution in 1985-7 of *Onopordum acaulon* infestations on Western Australian properties on which the weed has been recorded.

Size of infestation	Number of properties 1985/6	1986/7
up to 1 ha	66	55
between 1 and 10 ha	42	41
between 10 and 100 ha	13	23
more than 100 ha	1	2

Table 5. Recent spread of *Onopordum acaulon* in Western Australia.

Year	Number of properties infested	Area infested (ha)
1983/4	42	260
1984/5	103	470
1985/6	110	681
1986/7	123	1000

some years. In 1983, two further infestations (5 and 30 ha) were located at Euroa, and chemically treated. Scattered plants found there in 1986 were hand-hoed with a view to total eradication.

Discussion

Of the thistles surveyed, *O. acanthium* and *O. illyricum* pose the greatest problem, with a combined area of ca. 1,100,000 ha in southeastern Australia. The main infestations occur in south eastern New South Wales where ca. 290,000 ha is moderately to seriously affected. Much of this area is in prime grazing lands necessitating expensive control procedures to prevent reductions in productivity. *O. acaulon*, while more widespread, is not as serious a weed problem, for it occurs mainly as light infestations in less productive country where intensive control procedures are not considered justified. It does however pose a threat in recently invaded areas of Western Australia, where it is the subject of an eradication campaign, and in the northern tablelands of New South Wales. *O. tauricum*, also a relatively recent invader, is known only from two regions in Victoria, where it is also the target of an eradication campaign.

In the present study, the distribution maps do not define the level of infestation within each grid. The information content of such maps could be further increased by coding grid markers for light, moderate or heavy infestations. Monitoring of this kind would show changes in the large-scale distribution that might be expected to follow intensive chemical eradication campaigns or biological control programs, and would provide a reliable tool for evaluating their effectiveness.

The results of this study highlight inherent problems in methods used to estimate the areas of distribution of weeds, particularly with regard to calculating areas from mapped distributions and the definition of a boundary of light infestations. For example, the only previously published figures indicated that scotch and illyrian thistles occupied just over 20,000,000 ha in New South Wales alone, with 1,660,000 ha being moderately to seriously infested (Medd 1981). These estimates were obtained using a planimeter to calculate areas indicated on regional maps, and as Medd (1981) pointed out reflected overall impressions rather than detailed distributions. There was a 5-fold disparity between these values and those obtained by the present method of asking field officers to report directly their estimates of infestations (ca. 290,000 ha moderately to seriously infested). The disparity was even greater (20X) if one considers the total area infested, which indicates discrepancies in the definition of a light infestation. Differences of this magnitude could influence decisions about weed control policy and strategy and indicate the dangers that exist in trying to estimate actual areas of infestations.

In the present survey, estimated areas of infestation were also subjective and thus depended to some extent on the experience of officers. Variability was noted between districts/shires, especially in estimates of lightly-infested land, as it is particularly difficult to delineate the boundary of an infestation containing scattered individual plants. Moderate and severe infestations, by the same argument, are more easily definable and hence more accurate. However, it was clear that field-based officers attempted to estimate only the areas carrying the weeds, making the method more reliable than map planimetry which invariably includes a large proportion of uninfested land.

The accuracy of estimates could further be improved by reducing the scale at which estimates are made. This would best be done by a system of recording weed infestations on individual properties and using computer-based inventory systems, as has been instigated by some states. Such a system could also incorporate data on the land systems infested and estimates of their productivity, which would permit more accurate assessments of economic impact of the weed and the identification of areas at risk of invasion. However, in many areas the cost and logistic problems of such an exercise would be too great. Until such a system is possible, research workers and policy makers will be forced to rely on cruder estimates, such as produced here.

Acknowledgements

We would like to thank the many field officers who responded to our requests for information and without whose help the distribution maps could not have been prepared. Thanks are also due to Dr P. Kloot, who provided valuable information on the history of *O. acaulon* in South Australia. Work on the biological control of *Onopordum* spp. is being supported jointly by the Wool Research and Development Fund and the Australian Meat and Live-stock Research and Development Corporation.

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