Proc. VI Int. Symp. Biol. Contr. Weeds, 19–25 August 1984, Vancouver, Canada. Delfosse, E.S. (ed.). Agric. Can., pp. 341–9 (1985)

Biological Control of Blackberries: Resolving a Conflict in Australia

Ross P. Field and Eligio Bruzzese

Keith Turnbull Research Institute, Department of Conservation, Forests and Lands, P.O. Box 48, Frankston, Victoria 3199, Australia.

Abstract

European blackberry (*Rubus fruticosus* agg.) is an important pastoral and forest weed in high rainfall areas of south-eastern Australia. Foreign exploration for control agents commenced in 1978, but apiarists and berry canners opposed attempts to have blackberry approved as a candidate for biological control. This forced the need for extensive economic analyses on the impact of the weed on agriculture. Costs associated with blackberry were found to exceed $40 million annually whereas benefits were less than $1 million. Concern was also expressed over the biological control agent, the rust *Phragmidium violaceum*. Berry farmers saw the programme as a risk, even prior to the completion of specificity tests; however, graziers threatened to illegally import the rust if the programme halted. Specificity tests on the rust were completed in March 1983, but in February 1984, before the conflicts were resolved, the rust was recorded in Victoria.

Lutte Biologique Contre les Ronces — Résolution d'un Conflit en Australie

Les ronces (*Rubus fruticosus*) sont des plantes nuisibles pastorales et forestières importantes dans les zones de fortes précipitations du sud-est de l'Australie. En 1978, on a commencé à chercher des agents de lutte biologique contre ces mauvaises herbes à l'étranger. Cependent, les apiculteurs et les exploitants de conserveries de petits fruits se sont opposés à la lutte biologique contre les ronces, d'où la nécessité de faire des analyses économiques d'envergure sur les effets de ces plantes nuisibles sur l'agriculture. Les analyses ont permis de déterminer que les coûts d'élimination des ronces dépassaient 30 millions de dollars par an, tandis que les avantages tirés de ces plantes nuisibles étaient de moins de 1 million de dollars par an. Des préoccupations ont également été soulevées au sujet de l'agent biologique choisi, à savoir la rouille *Phragmidium violaceum*. Les propriètaires des exploitations de petits fruits jugeaient que le programme comprenait trop de risques, même avant la fin des essais de spécificité; toutefois, les exploitants de pâturages ont menacé d'importer illégalement la rouille si le programme était interrompu. Les essais de spécificité sur la rouille ont pris fin en mars 1983 mais, en février 1984, avant que les conflits ne soient réglés, la rouille a été relevée à Victoria.

Introduction

The procedure for introducing biological control agents for weeds into Australia has been under review since the late 1970s. The need for a procedure that formally addressed all potential conflicts associated with a given weed became evident when a High Court injunction, taken out by apiarists and graziers, prevented the CSIRO from releasing insects to control *Echium plantagineum* (L.) (Boraginaceae). A procedure was developed requiring submissions from all States on the importance of the candidate weed. In particular, submissions were to contain as much economic information as possible and identify any beneficial attributes that may cause a conflict of interest. Unanimous agreement between States was necessary before a weed could be declared a candidate for biological control.

This procedure was fully adopted in 1980, one month after the High Court injunction on CSIRO was granted. Whilst this protocol may identify potential conflict areas and halt programmes before costly foreign exploration work commences, it would not overcome legal challenges to programmes at a later time. Legislation has now been drafted and, if enacted, will limit the opportunity for legal action. This is dealt with more fully by Cullen and Delfosse (1985).

In Victoria, blackberry (*Rubus fruticosus* L. agg.; Rosaceae) is probably the most costly declared noxious weed. The most common chemical used to control it has been, and still is, 2,4,5-T ([2,4,5-trichlorophenoxy] acetic acid). Through the mid-1970s there was mounting public concern over the side effects of 2,4,5-T. This concern, along with the importance of blackberry to Victoria, and the recent success in biological control of blackberry in Chile (Oehrens and Gonzalez 1974, 1977), resulted in the commencement of a programme in Australia. Bruzzese (1980*a*, *b*) surveyed *Rubus* spp. in Victoria and recorded the phytophagous arthropods and diseases attacking the plants, and then in 1978, commenced similar surveys of *R. fruticosus* in Europe. By 1980 the rust *Phragmidium violaceum* (C.F. Schultz.) Winter (Uredinales), the disease introduced into Chile, and the stem-boring sawfly *Hartigia albomaculatus* (Stein) (Hymenoptera: Cephidae) were identified as the most likely potential control agents of blackberry.

The specificity tests on *P. violaceum* and *H. albomaculatus* had commenced when the procedure for having weeds declared candidates for biological control was approved by all State Ministers for Agriculture. This paper describes the nature of the conflicts of interest which arose during the early stages of the programme, the economic analyses undertaken to demonstrate the high cost of blackberry to Australia, and the means by which the programme proceeded without the conflicts being finally resolved.

The Candidate

The native range of *R. fruticosus* agg., is Europe, the Middle East and north-west Africa. *R. fruticosus* now also occurs in North America, Chile, South Africa, Australia and New Zealand, mainly in areas where the annual rainfall exceeds 760 mm and in the latitudes 30° to 65° N and 28° to 40° S (Amor and Richardson 1980). In Australia it occurs in all States except the Northern Territory. It is considered an important weed in New South Wales, Victoria and Tasmania, of lesser importance in South Australia, and of minor importance in Queensland and Western Australia. It is proclaimed under noxious weeds legislation in all States.

In Australia blackberry is an important weed of native bushland, commercial forestry operations and agriculture. The plant forms dense, prickly thickets, commonly 1 to 2 m high, that harbour vermin and are impenetrable to man and his domestic animals (Amor and Richardson 1980). Most of the blackberry in Victoria is in native forest. Dense infestations reduce plant diversity and limit access to streams for recreational purposes and the watering of stock (Amor and Harris 1979). On agricultural land blackberry excludes pasture, and sheep can become entangled in the canes. Whilst bushes are not grazed by either sheep or cattle, goats preferentially graze the plant and do reduce plant vigour.

Control of blackberry is difficult, particularly in hilly terrain where access by ground vehicles is poor. The most common control method is to spray with the herbicide 2,4,5-T but this chemical usually does not provide complete control even after two applications in the one season (Amor 1975). Alternative chemicals, although often more effective, are generally more expensive or have other drawbacks such as greater soil persistence.

Other control practices include mowing several times a year but this will only suppress and not eradicate the weed (Amor and Richardson 1980).

In 1975 there was an estimated 663,000 ha of land infested with blackberry in Victoria (Amor and Harris 1979). In 1981/82 the Government spent about $0.25 million on herbicides which cost $1.25 million to apply to blackberry on Crown Land. During that same year it sold to private landholders $0.267 million of herbicides for the control of blackberry. A further amount of $0.267 million is estimated to be purchased by landholders from non-Government sources.

In New South Wales blackberry is a significant weed of the tablelands and slopes and covers nearly 4,000,000 ha, although three-quarters of these infestations are sparse. The estimated total (State and private) expenditure on blackberry control in New South Wales in 1980 was $4.94 million (Mears 1981).

Blackberry does have some beneficial qualities. Approximately 100 tonnes of wild blackberry fruit is used commercially every year for producing blackberry jam in Victoria (Amor and Richardson 1980), and some jam-making also occurs in Tasmania and New South Wales. Apiarists utilize blackberry as a pollen and nectar source, the Tasmanian apiarists deriving more benefit from the plant than those from the mainland States. Before the weedy potential of the plant was recognized, blackberry was used to reduce soil erosion on creek banks, but more appropriate alternative plants are available for this (Amor and Richardson 1980). Some members of the *R. fruticosus* agg. have also been used in North America in breeding programmes for cultivated berry varieties, some of which are grown in Australia.

Despite an extensive spraying programme to control blackberry in Victoria and New South Wales over many years, there is every indication that infestations are increasing in these States (Amor and Richardson 1980; Mears 1981). However, the inaccessibility of many of the infestations and the restrictions on the use of aerially-applied herbicides make treatment difficult. Biological control would be an ideal method of containing the spread of this weed.

The Conflict

Opposition and concern about the biological control programme came from three main areas: apiarists, pickers and canners of wild berries, and growers of *Rubus* crops.

Apiarists

Blackberry is a useful plant in apiculture because of both its nectar and pollen production; however, its importance is almost entirely confined to Tasmania. In this State bees work both blackberry and clover at the same time, producing a high quality, white honey. The relative importance of the clovers (*Trifolium repens* L. and *T. pratense* L.; Leguminosae) and blackberry is unknown, although blackberry is a more reliable source, particularly in dry years, and could account for up to 90% of this honey type.

Blackberry is also considered important as it increases hive populations prior to the flowering of the leatherwoods (*Eucryphia lucida* Baillon and *E. milliganii* Hook.; Eucryphiaceae), which is the apiarists' most valuable crop in that State, contributing from 37–80% (average 57%) of the honey yield in the years 1973–78 (Anon. 1979). The value of blackberry in hive build-up is difficult to estimate but, if artificial food (candy made from sugar) was used to replace blackberry nectar it would cost approximately $5.00/hive for the 12,000 Tasmanian hives; i.e. $60,000/year. Furthermore, if blaekberry is considered to account for 80% of the non-leatherwood honey, then the average annual value of this honey would have been $163,000 for the

years 1973–78. Add to this the contribution blackberry makes to larger hives for the collection of leatherwood nectar and the total value of blackberry to Tasmanian apiculture becomes $223,000 (Table 1). Of the 57 apiarists in Tasmania with 40 or more hives in 1979–80, 10 accounted for more than 82% of the honey production (Anon. 1980).

The Tasmanian apiarists are, therefore, opposed to any programme of biological control of blackberry; mainland apiarists are less concerned.

Table 1. Benefits and costs of blackberry in New South Wales, Victoria and Tasmania.

State	Enterprise/Location	Benefit ($)	Cost ($)
New South Wales	Agriculture		20,000,000
	Forestry		400,000
	Crown Land		556,000
			20,956,000
Victoria	Agriculture		
	- Lost production on:		
	unsprayed land		3,115,582
	sprayed land		4,673,372
	- Chemical costs		
	(all sources)		534,849
	- Labour		3,336,950
			11,660,753
	Forestry		20,000
	Crown Land		1,675,350
			1,695,350
	Berry Collection		
	- Commercial	240,000	
	- Private	57,500	
		297,500	
Tasmania	Agriculture		6,500,000
	Crown Land		60,000
			6,560,000
	Agriculture		
	- Honey	163,000	
	- Hive build-up	60,000	
		223,000	
	Berry Collection		
	- Commercial	120,000	
	- Private	17,500	
		137,500	
	TOTAL	$658,000	$40,872,103

Collectors and Canners of Wild Berries

The major value of the fruit as a food is for jam manufacture. Because of the distinctive flavour of wild berries they are used in a 1 in 2 or 1 in 3 blend with cultivated berries. The collection of berries occurs mainly in Victoria (67%) and Tasmania (33%). The amount processed each year is variable and appears to be declining. New varieties of cultivated blackberries and importations of berries from New Zealand, both wild and cultivated, are replacing the use of wild berries from Victoria.

The estimated value of wild blackberries picked for processing is $360,000.

Berries are also collected by individuals for home consumption and for sale on the fresh fruit market. The total value of such berries is unlikely to exceed $75,000 (equivalent to 75 tonnes of fruit); however, no accurate figures are available.

Some commercial berry processors were concerned that a biological control programme would reduce their intake of wild berries and some individuals who derive income from the collection of berries are also opposed to any biological control programme. The total estimated value of wild blackberry fruit is $435,000 (Table 1).

Growers of Rubus *Crops*

During the process of consultation to achieve concensus between States, concern was expressed regarding the specificity of the likely biological control agent, *P. violaceum*. This confused the issue regarding the candidacy of blackberry to the extent that prejudgement on the specificity resulted in some opposition to the programme. For the same reason the New Zealand berry industry was apprehensive about the programme as any rust introduced to Australia was likely to be blown across the Tasman Sea, 2,000 km to New Zealand.

The Resolution

In Tasmania, the costs associated with blackberry in terms of lost agricultural production and cost of control, was considered to be between 4 and 20 times the benefits derived from the plant. But because that State has an important cultivated berry industry, the State Government decided not to support blackberry being declared a candidate for biological control. However, in some mainland States, in particular Victoria and New South Wales, the initial calculations for the cost of controlling blackberry alone, that is without accounting for lost agricultural production, was at least 10 times the benefits derived from the plant. Overall, the importance of blackberry as a cost to the nation dwarfed the benefits derived from within Tasmania and Victoria.

Following a change in the Tasmanian State Government, the attitude taken was re-assessed. The State no longer opposed the proposal that blackberry be declared a candidate for biological control but, stipulated that a substantial improvement was required in the economic analysis undertaken by the mainland States. However, the apiarists and berry collectors still remained totally opposed to the programme.

In Victoria, the economic analysis attempted to determine the value of lost agricultural production. The analysis was based on a number of assumptions, usually quite conservative, and relied heavily on information supplied by government field officers. These officers are a major outlet for the sale of herbicides in Victoria and supplied receipts from these sales which provided information on the type and amount of herbicide, weed to be controlled, name and address of the purchaser, and the cost. Receipts from all sales relating to blackberry were collated on a District basis. Herbicide sales for the control of blackberry occurred in 94 of the 139 Districts (Fig. 1). The

sales of each chemical and the estimated area treated are shown in Table 2. Total sales for 1981–82 amounted to $267,424.

The main assumptions used in the analysis were: (1) all herbicide purchased for blackberry control was sprayed only on blackberry in that year; (2) all herbicides were applied at the recommended rates; (3) only one application of herbicide was made to each blackberry patch that year; and (4) the area sprayed on each property was considered to be totally unproductive, but capable of producing returns equivalent to the District average for the enterprise operating on that farm.

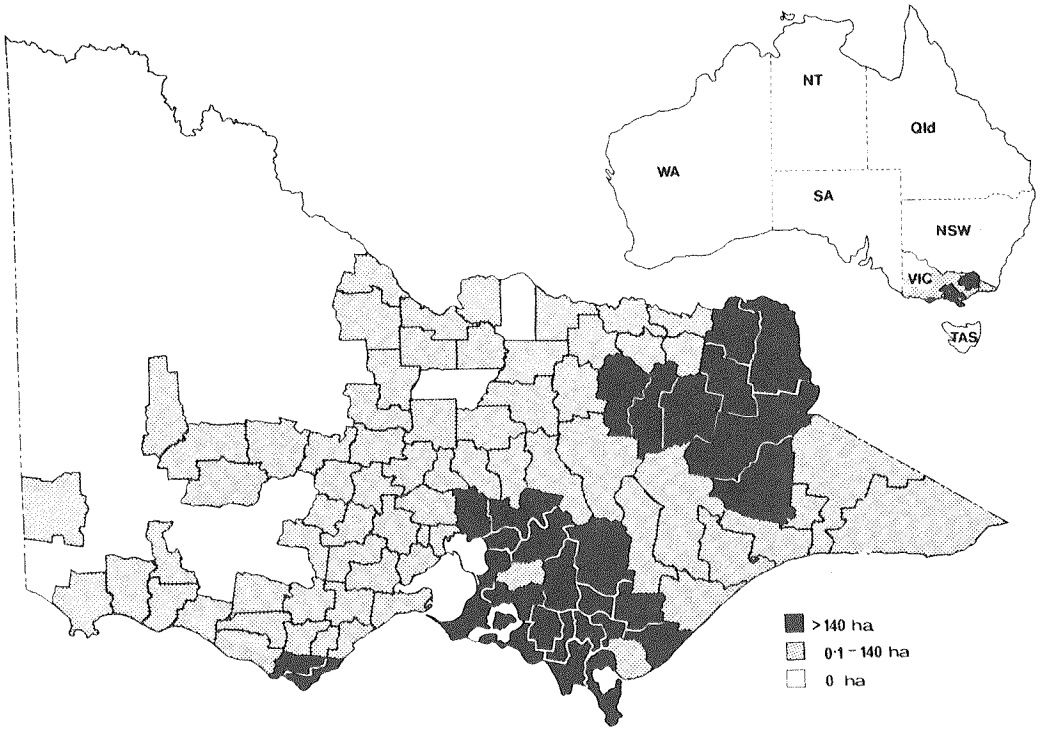

Fig. 1. Areas of dense blackberry infestations on agricultural land in Victoria sprayed with herbicides purchased from the Government.

From the recommended rates of use of each chemical, the area of densely infested blackberry on private property was calculated. From the receipts for the 29 most heavily infested Districts (Fig. 1) the government officers were able to identify the enterprise affected by the weed on each property. These Districts constituted 77.3% of the State's private land sprayed for control of blackberry with herbicide purchased from the Government.

The 29 Districts were then analysed to determine the value of lost agricultural production. Information on stocking rates and gross margins (gross returns less variable costs) for the major enterprises were obtained for the relevant Districts (Kinsella 1980; Trapnell 1982; McRae 1983). These enterprises occurred on 79% of the sprayed land. For the purpose of the analysis, the other 21% was considered not to be suffering economic loss. This land was used for hobby farms and enterprises such as piggeries, nurseries, poultry farms, orchards, pine plantations and even apiculture! The estimated value of lost production from the 29 Districts was $1,805,115, 68.5% of this on land used for dairying (Table 3). Assuming that the other 65 Districts have the same

enterprises at similar stocking rates to the average of those analysed, a further cost of $531,570 would occur. Therefore, the total cost of lost agricultural production from this source of herbicides becomes $2,336,686. Estimates from private company sales suggest that non-Government sources supply about 50% of the 2,4,5-T used on blackberry. The actual sprayed area in Victoria would, therefore, be twice that calculated above, and thus the total loss of production on sprayed land is estimated to be $4,673,372 (Table 1).

Amor and Harris (1979) reported that only 60% of the agricultural blackberry is sprayed annually. If the other 40% is capable of producing returns similar to the sprayed areas, a further $3,115,582 is lost, bringing the total loss of production in Victoria to $7,788,954. To this value can be added the cost of spraying blackberry (chemicals and labour but not machinery costs) estimated to be $3,871,799 when all sources of herbicide are considered. The total estimated cost to Victorian agriculture is, therefore, $11,660,752 (Table 1).

Table 2. Chemicals sold to landholders for control of blackberry by the Government and estimates of the areas sprayed (1981/82).

Chemical	Volume (L)	Area sprayed (ha)	Chemical Cost ($)
2,4,5-T 40%	43,299	8,027.1	181,855.80
2,4,5-T 80%	673	249.3	5,552.25
amitrol	11,519	192.8	24,765.85
picloram +2,4-D	1,885	31.4	21,960.25
glyphosate	1,600	53.1	25,600.00
hexazinone[1]	365	-	5,584.50
triclopyr	81	12.9	2,106.00
TOTAL		8,566.6	$267,424.65

[1] Area not included because used for total vegetation control.

Other known costs in Victoria associated with the control of blackberry include $1,529,000 spent by the Government on public and forest land and $20,000 spent by private foresters. However, all costs incurred in forestry operations are not known, nor was it possible to place an economic value on the loss in forestry production or the loss to the national heritage when blackberry infests native forests and national parks. In conclusion, the total cost of blackberry to Victoria is in excess of $14 million annually.

The economic analysis undertaken in New South Wales was confined to a detailed study of the Central Western region. Here an estimate of the potential wool production forgone during the 1982–83 season was $4,251,000 and Vere and Dellow (1984) estimated this cost would be substantially larger on a State basis and might be as high as $20,000,000.

In summary, the known costs associated with blackberry are about 60 times the benefits derived from the weed (Table 1).

The concern of the Tasmanian apiarists and berry collectors became known in mid-1983 when their case appeared nationally on television. However, there was also considerable moral support from individual graziers for the continuation of the blackberry programme. Many threats were made both verbally and in writing stating that the rust, *P. violaceum*, would be illegally introduced into Australia, from either Chile or Europe, if the programme was halted.

Host-specificity tests on the rust were completed in France in April 1983 but the economic analyses were not completed until the middle of 1983 (Victoria) and early 1984 (New South Wales). In February 1984 residents of Hiawatha Valley near Yarram, Victoria, submitted specimens of blackberry leaves to the Forest Commission claiming they showed evidence of herbicide spraying in the area. The leaves were found to be infected with *P. violaceum* (Marks *et al.* 1984). A number of other foci of infection were later found in Victoria, suggesting that the rust had been deliberately introduced to these sites within the previous few months.

Table 3. Value of lost agricultural production[1] in Victoria for major enterprises in 29 Districts heavily infested with blackberry (1981/82).

Enterprise	Areas sprayed (ha)	% of total area	Value of agricultural production	% of total value
Dairy	2,100.88	40.0	1,236,277.50	68.5
Beef	1,833.08	34.9	218,339.28	12.1
Sheep (lamb/wool)	417.92	8.0	76,289.94	4.2
Mixed grazing	629.86	12.0	86,626.82	4.8
Vegetables (plus potatoes)	164.74	3.1	179,565.24	9.9
Cattle/tobacco	101.44	2.0	8,016.89	0.5
TOTAL	5,247.92	100.0	$1,805,115.67	100.0

[1] Derived from the area sprayed with herbicides purchased only through the Government. Values derived from gross margin estimates for enterprises in each District.

Conclusion

Although *P. violaceum* now occurs in Australia and is spreading rapidly (Bruzzese and Field 1985), the conflicts surrounding the programme still remain. The effectiveness of the introduced strain(s) of the rust on the noxious blackberry taxa is still largely unknown. If some of the species are resistant to the rust there may be a need to import the tested strains from France. To do this, blackberry will still have to become a declared candidate for biological control and this will no doubt require a public enquiry when the proposed legislation is enacted.

Acknowledgments

We thank Mr. C. West of the Department of Agriculture, Victoria, for assistance with the economic analyses.

References

Amor, R.L. 1975. Ecology and control of blackberry (*Rubus fruticosus* L. agg.). IV. Effect of single and repeated applications of 2,4,5-T picloram and aminotriazole. *Weed Res.* **15**: 39–45.

Amor, R.L., and Harris, R.C. 1979. Survey of the distribution of blackberry (*Rubus fruticosus* L. agg.) in Victoria and the use and effectiveness of chemical control measures. *J. Aust. Inst. Agric. Sci.* **45**: 260–3.

Amor, R.L., and Richardson, R.G. 1980. The biology of Australian Weeds 2. *Rubus fruticosus* L. agg. *J. Aust. Inst. Agric. Sci.* **46**: 87–97.

Anon. 1979. Bee Farming, Tasmania. 1978–79. Australian Bureau of Statistics Catalogue No. 7206.6. ISSN 0519–5349.

Anon. 1980. Bee Farming, Tasmania 1979–80. Australian Bureau of Statistics Catalogue No. 7206.6. ISSN 0519–5349.

Bruzzese, E. 1980*a*. The phytophagous insect fauna of *Rubus* spp. (Rosaceae) in Victoria, a study on the biological control of blackberry (*Rubus fruticosus* L. agg.). *J. Aust. Ent. Soc.* **19**: 1–6.

_____. 1980*b*. A check list of the fungal pathogens of *Rubus* spp. (Rosaceae) in Victoria. *Australas. Plant Pathol.* **9**: 117–20.

Bruzzese, E., and Field, R.P. 1985. Occurrence and spread of *Phragmidium violaceum* on blackberry (*Rubus fructicosus*) in Victoria, Australia. Proc. VI Int. Symp. Biol. Contr. Weeds, August 22–25 1984, Vancouver, Canada, Delfosse, E.S. (ed.). Agric. Can. (*in press*).

Cullen, J.M., and Delfosse, E.S. 1985. *Echium plantagineum*: catalyst for conflict and change in Australia. Proc. VI Int. Symp. Biol. Contr. Weeds, August 22–25, 1984, Vancouver, Canada, Delfosse, E.S. (ed.). Agric. Can. (*in press*).

Kinsella, M.N. 1980. Commercial vegetable growing in Victoria. *Dept. Agric. Vic. Agnote* 1073/80.

McRae, C. 1983. Gross margins of grazing enterprises in South Gippsland: 1983. *Dept. Agric. Vic. Agnote* 2071/83.

Marks, G.C., Pascoe, I.G., and Bruzzese, E. 1984. First record of *Phragmidium violaceum* on blackberry in Victoria. *Australas. Plant Pathol.* **13**: 12.

Mears, A.D. 1981. The extent, distribution and cost of control of blackberry in New South Wales. *Aust. Weeds* **2**: 18–9.

Oehrens, E.B., and Gonzalez, S.M. 1974. Introduccion de *Phragmidium violaceum* (Schulz) Winter como factor de control biologico de zarzamora *Rubus constrictus* Lef. et M. y *R. ulmifolius* Schott. *Agro. Sur.* **2**: 30–3.

_____. 1977. Dispersion, ciclo biologico y danos causados par *Phragmidium violaceum* (Schulz) Winter en zarzamora *Rubus constrictus* Lef. et M. y *R. ulmifolius* Schott. En la zonas centro-sur y sur de Chile. *Agro. Sur.* **5**: 73–85.

Trapnell, L. 1982. Gross margins of some sheep and vealer enterprises in north-eastern Victoria. *Dept. Agric. Vic. Agnote* 1807/82.

Vere, D.T., and Dellow, J.J. 1984. Assessing the costs of blackberry in central western New South Wales. *Aust. Weeds Conf.* (*in press*).