REVIEWS

Distribution of *Echium plantagineum* L. and its association with pyrrolizidine alkaloid poisoning in horses in New South Wales

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Summary

A survey of local government areas throughout New South Wales was conducted to define the distribution and abundance of *E. plantagineum* during spring–summer 1983–84. The survey revealed the plant to be widespread throughout the State, with heavy infestations being concentrated in central and southern New South Wales. The plant is proclaimed noxious in 73 of the 140 local government areas surveyed.

Independently, the New South Wales Department of Agriculture's Veterinary Laboratory records were reviewed to determine the plant species associated with pyrrolizidine alkaloid (P.A.) poisoning in horses throughout the State. These records showed *E. plantagineum* to be the most significant cause. A good relationship was found between the intensity of occurrence of *E. plantagineum* and the number of confirmed cases of P.A. poisoning in horses throughout New South Wales.

Introduction

Three herbaceous species of the genus *Echium* occur as weeds in New South Wales. The most important and most widespread is *Echium plantagineum* L. (syn. *E. lycopsis* L.), commonly known as Paterson's curse or salvation jane. The other species are *E. vulgare* L., viper's bugloss and *E. italicum* L., Italian bugloss. In New South Wales, *E. vulgare* is common only on the central and southern tablelands, whilst *E. italicum* is found occasionally in the south of the State along the Corowa to Albury road and near Young (Piggin 1977*a*).

In this paper we describe the distribution and abundance of *E. plantagineum*, as ascertained from a questionnaire survey of local government areas of New South Wales.

The plant

E. plantagineum is an erect, hairy, winter/spring annual or occasionally biennial forb growing to 1.2 m high. The growth of the plant is particularly favoured by a late summer/early autumn break followed by winter and early spring rains. Flowering generally occurs from October to December, but some plants in flower can be found during all months, particularly along roadsides.

The problem

The palatability and value of *E. plantagineum* as a fodder is a controversial subject. Piggin (1977*b*) showed *E. plantagineum* to have a similar nutritive value to *Trifolium subterraneum* L. and considered it a useful forage for livestock. Cunningham *et al.* (1981) state that in New South Wales it is a weed with few favourable characteristics. However, apiarists and some graziers consider it to be a valuable plant. It is particularly attractive to honey bees producing large quantities of light honey and a high quality pollen important in the nutrition of bees. In many areas it is alleged to produce valuable fodder in the critical late-summer period.

E. plantagineum contains up to 10 retronecine-based pyrrolizidine alkaloids (Peterson 1984) which are potentially hepatotoxic to grazing animals (Bull 1961). *E. plantagineum* has been reported to poison a variety of livestock species. For example, sheep mortalities due to hepatogenous chronic copper poisoning following the consumption of *E. plantagineum* have been recorded in South Australia (St George-Grambauer and Rac 1962) and in the Riverina and Central West areas of New South Wales (Bull *et al.* 1956; Seaman 1985). Sharrock (1969) and Seaman (1978) reported direct pyrrolizidine alkaloid poisoning in horses and Seaman and Walker (1984) reported mortalities in cattle and horses in New South Wales, both following the grazing of *E. plantagineum*. Toxicity has been demonstrated experimentally in pigs fed a diet containing 15% *E. plantagineum* (Peterson 1984) and in rats fed 20–40% *E. plantagineum* (Peterson and Jago 1984).

Status as a noxious plant

All three *Echium* species are proclaimed noxious plants under the Local Government Act, 1919 (Anon, 1919). *Echium* spp. are declared noxious weeds in 73 of the 140 surveyed local government areas in New South Wales. Under the 'Seeds Act 1982' and 'Regulation. Seeds Act 1983', *Echium* spp. are declared weeds and as such their presence in seed must be indicated; the number of *Echium* spp. seed per kilogram must also be stated on the label of the container.

Method

Plant distribution

A questionnaire survey was conducted by the New South Wales Department of Agriculture's Noxious Plant Advisory Officers in early 1984. Information was sought from weed control bodies in 140 local government areas in New South Wales (including the A.C.T.). The Sydney Metropolitan area was not surveyed. The area of the individual local government areas varied in size from Goulburn City, which is the smallest of the non-metropolitan municipalities (54 km^2), to the largest shire, Central Darling (52 000 km^2).

Respondents to the survey were required to indicate the degree of infestation of *E. plantagineum* on private property specifying one of four categories, namely: 1, heavy (numerous

dense infestations); 2, medium (numerous isolated plants or occasional dense infestations); 3, light (scattered isolated plants, i.e. recording that it occurs in the shire); and 4, nil (no plants present).

The method was similar to that of other weed surveys conducted in New South Wales (Campbell 1977). By relying on the four Noxious Plant Advisory Officers to contact weed officers in their region, a fast and cheap method was used to ensure a 100% response.

Pyrrolizidine alkaloid poisoning in horses

Independently, a review of pyrrolizidine alkaloid (P.A.) poisoning in cattle and horses in New South Wales was undertaken in early 1984 (Seaman and Walker 1984). This was based on information collected from the files of the Department of Agriculture's Regional Veterinary Laboratories at Armidale, Glenfield, Orange, Wagga Wagga and Wollongbar for the 6-year period 1978–1983. Diagnosis of pyrrolizidine alkaloidosis was based on field post-mortem findings and histological examination of liver and other organs to determine whether typical pathological changes associated with P.A. poisoning were present. The grazing history, including the plant species involved, was determined from the field report supplied by the submitting veterinarian.

The data collected on P.A. poisoning in horses is present in this paper to establish the relationship between the distribution of P.A.-containing plants and mortalities in horses. Horses are considered to be relatively susceptible to these alkaloids (Hooper 1978) and, accordingly, provide a sensitive indicator of livestock poisoning. Each 'case' represents a mortality investigation with submission of pathological material to a laboratory. The largest number of deaths in one 'case' was 14 horses, but by far the majority of investigations involved individual mortalities. Where the plant species involved was not indicated but where laboratory examinations revealed pathological changes typical of P.A. poisoning, the plant source of pyrrolizidine alkaloids has been classified as 'not stated'.

Results

Plant distribution

E. plantagineum is widely distributed throughout New South Wales (Figure 1). Table 1, based on the statistical regions, shows that 26 (19%) of the local government areas have heavy infestations of *E. plantagineum*, while medium and light intensities each occur in another 55 areas (39%). Four of the local government areas (3%) (in coastal areas) had no *E. plantagineum*.

E. plantagineum is more abundant in central and southern New South Wales (Table 1). These results are similar to those obtained by Jacobs and Pickard (1981) and Piggin (1977*a*). Some 85% of the heavy infestations were found in the central and southern areas of the State. The medium and light infestations were more evenly distributed, probably because of the severe drought conditions prevailing prior to the date of survey, and reflect post-drought establishment of *E. plantagineum*. The central and southern areas of the State account for 43% of the medium infestations and 40% of the light infestations.

Some 52% (73 out of 140) of the local government areas surveyed have *Echium* species declared as noxious plants (Anon. 1919). Table 1 and Figure 1 give the noxious status of *E. plantagineum* in the local government areas and statistical regions. It may be noted that 49% of the noxious declarations for *E. plantagineum* were in northern New South Wales where the plant has a lighter infestation density.

Table 1 Density of infestation of *E. plantagineum*, noxious status and number of confirmed cases of pyrrolizidine alkaloid (P.A.) poisoning in horses in New South Wales on a statistical region basis

Statistical regions	Category (no. of shires)				Noxious status (no. of shires)	Confirmed cases of P.A. poisoning in horses		
	1	2	3	4		Paterson's curse	Not stated	Other
1 Sydney	–	4	2	1	4	–	–	–
2 Hunter	–	4	9	–	12	–	2	1[A]
3 Illawarra	–	–	3	2	2	–	–	–
4 Richmond–Tweed	–	–	7	–	–	–	–	–
5 Mid North Coast	–	–	10	1	3	–	–	–
6 Northern	–	18	2	–	19	–	–	–
7 North Western	4	5	5	–	–	2	5	–
8 Central West	6	6	2	–	–	29	15	1[B]
9 South Eastern	1	6	10	–	15	1	2	–
10 Murrumbidgee	6	8	–	–	8	8	5	1[B]
11 Murray	9	4	3	–	10	2	–	–
12 Far West	–	–	2	–	–	–	–	–
Total	26	55	55	4	73	42	29	3

[A] Fireweed (*S. madagascariensis*); [B] Heliotrope (*H. europaeum*).

Pyrrolizidine alkaloid poisoning in horses

The distribution of pyrrolizidine alkaloid poisoning cases in horses, based on plant species involved and the geographical statistical region, is given in Table 1. The review of laboratory records showed 42 cases of confirmed P.A. poisoning in horses directly associated with grazing *E. plantagineum* over the 6-year period 1978–1983. Moreover, there were 29 cases (39%) in which the plant species was not stated but, except for a single instance in the Maitland shire, all occurred in local government areas where *E. plantagineum* has either a medium or heavy distribution. There were only three cases (4%) of P.A. poisoning in horses where *E. plantagineum* was clearly not involved. These included one case of fireweed (*Senecio madagascariensis* Poir.) poisoning from the Gloucester shire and one case of heliotrope (*Heliotropium europaeum* L.) poisoning from each of the Parkes and Narrandera shires.

Of the 42 cases of confirmed P.A. poisoning in horses associated with grazing *E. plantagineum*, 33 (79%) were diagnosed in shires with a heavy plant density (category 1). Eight cases (19%) were diagnosed from shires with a medium plant density (category 2), while there was only one case (3%) confirmed in a local government area where the plant species has only a light density (category 3, A.C.T.).

Twenty-nine cases (69%) of P.A. poisoning in horses associated with grazing *E. plantagineum* were confirmed from the Central West of New South Wales (Figure 1, Table 1). These included 14 cases from the Bathurst City area, four from each of Orange City and Evans shire, three cases from Cowra shire, two from Forbes shire and one from each of Cabonne and Weddin shires. These local government areas

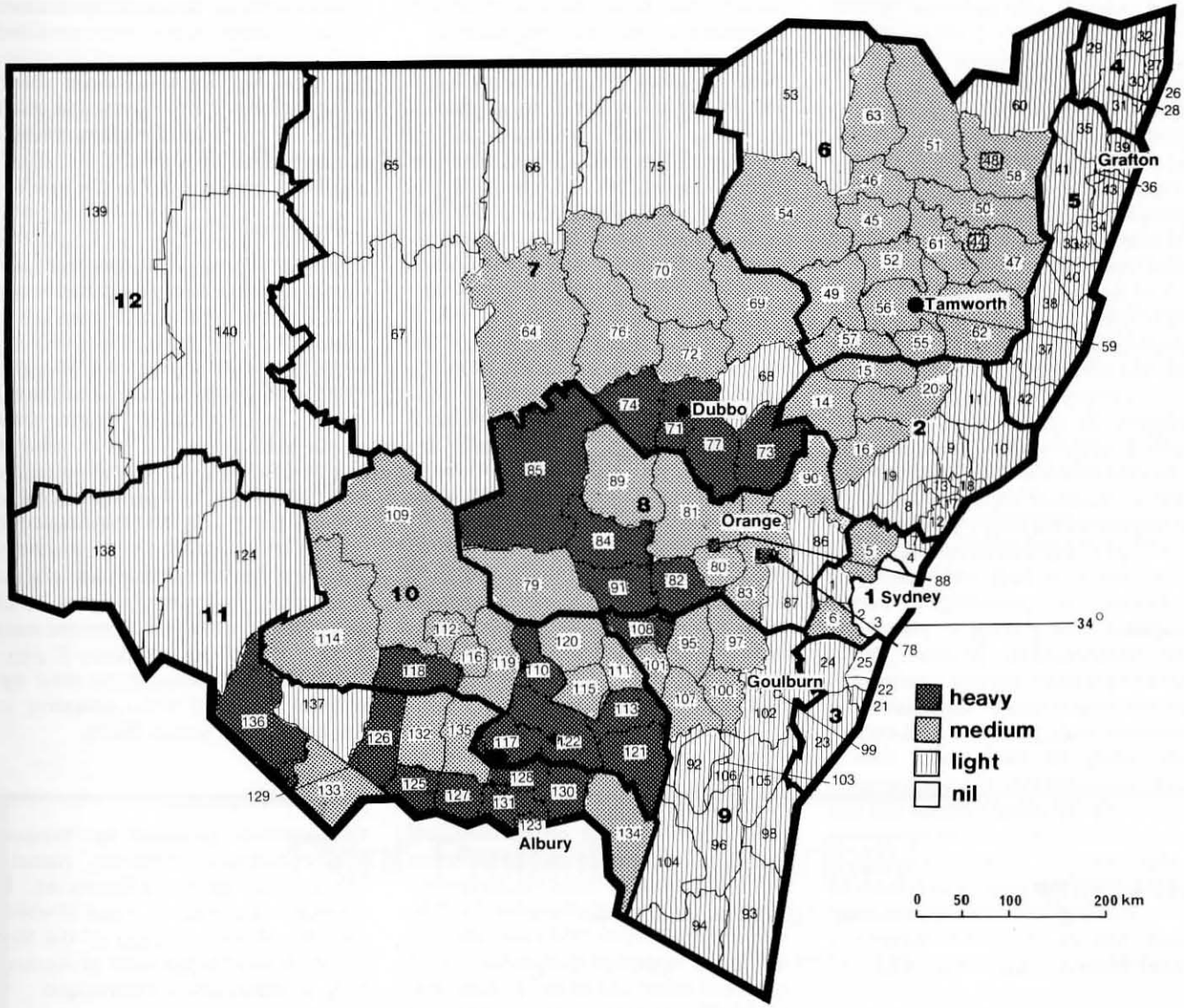

Figure 1 Distribution of *Echium plantagineum* in New South Wales on a local government area basis

Map Ref. No.	Local Government Area
	Category 1 (heavy)
71	Dubbo
73	Mudgee
74	Narromine
77	Wellington
78	Bathurst City
82	Cowra
84	Forbes
85	Lachlan
88	Orange City
91	Weddin
108	Young[A]
110	Coolamon[A]
113	Gundagai[A]
117	Lockhart[A]
118	Murrumbidgee
121	Tumut[A]
122	Wagga Wagga[A]
123	Albury City[A]
125	Berrigan[A]
126	Conargo
127	Corowa
128	Culcairn[A]
129	Deniliquin[A]
130	Holbrook[A]
131	Hume[A]
136	Wakool
	Category 2 (medium)
2	Camden City[A]
3	Campbelltown City[A]
5	Hawkesbury[A]
6	Wollondilly[A]
14	Merriwa[A]
15	Murrurundi[A]
16	Muswellbrook[A]
20	Scone[A]
44	Armidale City[A]
45	Barraba[A]
46	Bingara[A]
47	Dumaresq[A]
48	Glen Innes[A]
49	Gunnedah[A]
50	Guyra[A]
51	Inverell[A]
52	Manilla[A]
54	Narrabri[A]
55	Nundle[A]
56	Parry[A]
57	Quirindi[A]
58	Severn[A]
59	Tamworth City[A]
61	Uralla[A]
62	Walcha[A]
63	Yallaroi[A]
64	Bogan
69	Coonabarabran
70	Coonamble
72	Gilgandra
76	Warren
79	Bland
80	Blayney
81	Cabonne
83	Evans
89	Parkes
90	Rylstone
95	Boorowa[A]
97	Crookwell[A]
99	Goulburn City[A]
100	Gunning[A]
101	Harden
107	Yass[A]
109	Carrothool
111	Cootamundra[A]
112	Griffith
114	Hay
115	Junee[A]
116	Leeton
119	Narrandera
120	Temora[A]
132	Jerilderie
133	Murray[A]
134	Tumbarumba[A]
135	Urana
	Category 3 (light)
1	Blue Mountains
7	Wyong
8	Cessnock[A]
9	Dungog[A]
10	Great Lakes[A]
11	Gloucester[A]
12	Lake Macquarie
13	Maitland[A]
17	Newcastle[A]
18	Port Stephens[A]
19	Singleton[A]
21	Kiama
23	Shoalhaven
24	Wingecarribee[A]
26	Ballina
27	Byron
28	Casino
29	Kyogle
30	Lismore
31	Richmond River
32	Tweed
33	Bellingen
34	Coffs Harbour
35	Copmanhurst
37	Hastings[A]
38	Kempsey
39	Maclean
40	Nambucca
41	Nymboida
42	Taree[A]
43	Ulmarra
53	Moree Plains
60	Tenterfield[A]
65	Bourke
66	Brewarrina
67	Cobar
68	Coolah
75	Walgett
86	Lithgow
87	Oberon
92	A.C.T.
93	Bega Valley[A]
94	Bombala[A]
96	Cooma Monaro[A]
98	Eurobodalla[A]
102	Mulwaree[A]
103	Queanbeyan City[A]
104	Snowy River[A]
105	Tallaganda[A]
106	Yallowlumla[A]
124	Balranald[A]
136	Broken Hill City
137	Windouran[A]
138	Wentworth
140	Central Darling Shire
	Category 4 (Nil)
4	Gosford
22	Shellharbour
25	Wollongong[A]
36	Grafton City

Statistical Regions

1 Sydney
2 Hunter
3 Illawarra
4 Richmond–Tweed
5 Mid North Coast
6 Northern
7 North Western
8 Central West
9 South Eastern
10 Murrumbidgee
11 Murray
12 Far West

[A] Noxious declaration

have a heavy *E. plantagineum* density of the plant (category 1), except for the Evans and Cabonne shires which have a medium plant density (category 2). The Murrumbidgee region had the next highest number of cases (8 (19%)), with mortalities being confirmed from five of the six shires where *E. plantagineum* has a heavy density (category 1) in that region. In the North Western region one case was confirmed from each of the Dubbo and Mudgee shires which have a heavy plant density (category 1). In the Murray region one case was confirmed from the Albury City (category 1) and Jerilderie (category 2) shires while from the South Eastern region one case was confirmed from the A.C.T. (category 3).

On a statistical region basis, all of the regions with a heavy density (category 1) of *E. plantagineum* (regions 7 to 11; Table 1) had some cases of confirmed P.A. poisoning in horses associated with grazing *E. plantagineum*. Thirteen of the 26 shires (50%) with a heavy plant density (category 1) had confirmed cases of P.A. poisoning associated with grazing *E. plantagineum*, while in two shires (Young and Coolamon) P.A. disease was confirmed, but the plant species was not stated. The majority of the remaining 11 shires where *E. plantagineum* had a heavy density but from which cases of P.A. poisoning in horses were not diagnosed, are in the more extensively grazed Murray region (Figure 1).

Discussion

E. plantagineum is now more widespread in New South Wales than previously recorded (Piggin 1977*a*; Jacobs and Pickard 1981). Piggin (1977*a*) mapped *E. plantagineum* in Australia from plant specimens lodged at various herbaria and institutes throughout the country. He showed that in New South Wales there was a more intense record of specimens of *E. plantagineum* collected from the central and southern areas. Jacobs and Pickard (1981) indicated that *E. plantagineum* was present in all botanical subdivisions of mainland New South Wales with the exception of the Northern Tablelands and the Far South Western Plains. Their records indicate the plant either did not occur, or had not been collected, in these subdivisions.

Our survey provides an estimate of the distribution and abundance of the species in New South Wales in the 1983–84 season. Previous surveys and censes are historical records showing where *E. plantagineum* specimens had been collected over a usually long period. They did not indicate the extent or density of the plant population.

Noxious plant declarations have no relationship to the extent or intensity of infestation. In several local government areas where *E. plantagineum* had a heavy infestation, the plant is not declared noxious. We conclude that the weed control authorities considered that the extent of the problem is beyond the economics and practicability of control, and thus did not favour declaration. Other local government weed control authorities such as the Hunter and Northern regions, where *E. plantagineum* is not dense, may consider, by having the plant declared noxious, that they have the authority and capability under the Local Government Act, 1919 (Anon. 1919) to arrest the further spread of the species.

The review of laboratory records show *E. plantagineum* to be the most significant cause of pyrrolizidine alkaloid (P.A.) poisoning in horses in New South Wales over the 6-year period 1978–83. There is a strong and direct association between the distribution of the plant species and the number of confirmed cases of P.A. poisoning in horses.

The diagnosis of P.A. poisoning in this review is based on pathological examination of specimens submitted to the laboratory by field veterinarians. Typical changes attributable to P.A. poisoning (Hooper 1978) were demonstrated by histological examination of liver and other tissues in 74 cases. It is highly likely that more cases occurred but did not receive veterinary investigation and/or laboratory confirmation, and thus were not considered in this review.

Twenty-six of the 29 cases, where the grazing history was incomplete and the plant species was not stated, occurred in local government areas where *E. plantagineum* has either a heavy or medium density; probably the species contributed to the mortality in these areas. Of the 42 cases directly associated with *E. plantagineum*, 41 (98%) were reported from local government areas where the plant has either a heavy or medium density.

In the Central West region, the smaller farm size, larger number of pleasure horses, and greater number of horse stud farms would result in greater likelihood of horses poisoned with *E. plantagineum* receiving veterinary investigation. This can be compared to the more extensively grazed North Western and Murray regions, where there is a similar plant density, but where fewer confirmed cases of P.A. poisoning were recorded.

In this review the majority of cases of horse mortalities were associated with dense infestations of *E. plantagineum* on individual farms where horses were forced to graze the plant owing to the unavailability of alternative fodder.

Conclusion

In the 1983–84 season *E. plantagineum* was widespread throughout New South Wales. Only four local government areas (3%) out of a total of 140 surveyed had no *E. plantagineum* present. The heavy infestations occurred in the central and southern areas of New South Wales.

The survey also showed there was no correlation between the noxious status (Anon. 1919) of *E. plantagineum* and the extent and density of the plant distribution. However, there was a good relationship between the intensity of plant distribution and confirmed cases of P.A. poisoning of horses. *E. plantagineum* is considered the most significant cause of P.A. poisoning in horses in New South Wales.

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