Effect of a non-ionic surfactant on the uptake and translocation of ^{14}C-asulam in bracken under field conditions

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Correct application of 'Asulox' by helicopter to mature bracken fronds generally results in good control of new frond growth the following season. It has been noted that the uptake of asulam by the sprayed fronds can be relatively slow. Addition of a non-ionic surfactant ('Agral') to the spray at a concentration of 0·1% does not increase the amount of 'Asulox' spray retained by the fronds but generally may increase greatly the rate of uptake of asulam by the fronds. Use of ^{14}C-asulam has shown that there is no change in the efficiency of translocation of asulam out of fronds and into the rhizome system associated with the addition of surfactant to the applied asulam solution. The translocation of ^{14}C-asulam out of treated pinnae amounted to 60–80% of the uptake into the pinnae.

^{14}C was detected in frond buds up to 2 m away from fronds treated with ^{14}C-asulam. The concentration of ^{14}C in frond buds on a rhizome attached to a frond treated with ^{14}C-asulam was much lower where they were adjacent to a frond not treated with ^{14}C-asulam. This emphasises the importance of good spray coverage on the fronds in achieving good control of bracken.

Polymorphism for cyanogenesis in British bracken (*Pteridium aquilinum*, subsp. *aquilinum* var. *aquilinum*)

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Cyanogenesis, the release of cyanide from damaged tissue, occurs in many plants (Conn 1980) and in some the character is polymorphic because, on the basis of a simple field test, some individuals are apparently acyanogenic. Bracken is a cyanogenic species (Greshoff 1908) and limited studies at two locations in England have recently revealed it to be polymorphic (Cooper-Driver and Swain 1976; Lawton 1976). Our investigation has been initiated to study the occurrence of cyanogenesis in bracken throughout Britain and to determine the basis for the polymorphism.

In 9 locations throughout mainland Britain, well-grown bracken stands were selected in 3 different habitats: woodland, open field or heath and, where available, coastal sites. At each location, the chosen sites were as close as possible to minimise the effects of other factors. At each site, an 18 m × 18 m grid was marked out and 50 or 100 fronds sampled at regular intervals. The terminal 4 cm of the lowermost pinna of each frond sampled was tested in a 50 × 12 mm stoppered tube by the modified sodium picrate test for HCN (Jones 1966). The bright yellow test paper changes colour in the presence of cyanide, becoming pale orange to chocolate brown

depending on the cyanide concentration. Previous experiments, using known amounts of HCN liberated from KCN solutions by concentrated HC1, had shown that the colour change can be used as a semi-quantitative test.

Most sites were sampled once during 1983, but at one location in SE Scotland, samples were taken at intervals throughout the growing season (Table 1) and at one location in SW Scotland, 4 additional sites were tested annually in July from 1978 to 1982 (Table 2). The picrate test and the more specific Fiegl–Anger test (Fiegl and Anger 1966) gave similar results for these sites.

Table 1. Percentage of cyanogenic fronds in samples from the two sites in SE Scotland tested throughout the summer of 1983. Sample size in brackets; from the original sample of 100 at both sites, several fronds had died or could not be found on subsequent occasions

Site	Date			
	Early June	Mid-July	Mid-August	Early September
Coastal	68 (100)	39 (94)	8 (83)	3 (77)
Open	18 (100)	17 (95)	12 (68)	9 (55)

Table 2. Percentage of cyanogenic fronds in samples from 4 sites in SW Scotland tested in July each year for 5 years. (From 1978 to 1980, the grids were located within about 10 m of the previous year's site. From 1980 to 1982, the sample areas coincided within about 1 m.)

Site	Year					
	1978	1979	1980	1981	1982	Mean
Coastal (exposed dune)	4	3	7	2	4	4
Coastal (partially sheltered)	59	73	79	53	54	64
Open (upland pasture)	34	80	67	62	68	62
Woodland (lowland deciduous)	35	38	51	27	33	37

The results showed bracken to be polymorphic for cyanogenesis throughout Britain. The percentage of cyanogenic fronds in samples from different sites varied from 0 to 100%. Most sites contained both cyanogenic and acyanogenic fronds with a mosaic distribution on the grid. The two phenotypes were otherwise indistinguishable.

At most localities, fronds from woodland sites produced high levels of cyanide, although not always the largest percentage of cyanogenic fronds. The percentage of cyanogenic fronds, and the amount of cyanide they produced, was low at most coastal sites. For woodland sites, samples from the south and east of Britain had a higher percentage of cyanogenic fronds than those from the north and west.

Sites at the location sampled at monthly intervals during the growing season showed a decrease as the season progressed in the percentage of cyanogenic fronds in a sample (Table 1). However, some fronds were acyanogenic from the time of emergence.

The four sites sampled annually showed little change in the percentage of cyanogenic fronds over a period of 5 years (Table 2).

These observations show many parallels with those for *Trifolium repens* (Daday 1954a, b) and *Lotus corniculatus* (Jones 1977), where the existence of a genetically determined polymorphism, sometimes modified by developmental and environmental factors, has been proposed. The stable polymorphic mosaics in bracken are most easily explained in the same way. However, a genetic basis for the polymorphism in bracken has not yet been confirmed, and additional, preliminary, results include the observations that (i) rhizomes producing acyanogenic fronds in the field produced cyanogenic fronds the following season when transplanted into garden plots, and (ii) spores collected from acyanogenic fronds in the field produced cyanogenic sporelings in laboratory cultures. These turned acyanogenic when they became pot bound, as did sporelings raised from spores produced by cyanogenic fronds.

These suggest that the physiological state of the rhizomes or individual frond buds may be important in influencing the expression of the cyanogenic genotype in the fronds which develop from them. Thus, local variations in light, nutrient or water availability may influence the cyanogenic phenotype. It may even be that acyanogenic genotypes do not exist in bracken. The causes of the polymorphism are currently being investigated. An understanding of the underlying mechanism is needed in order to assess the ecological role, if any, of cyanogenesis, and the possibilities of using cyanogenesis as a genetic marker for the study of bracken population structure. This in turn has important implications for strategies of bracken control.

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Effect of G418 on spore germination and growth of *Pteridium aquilinum*

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G418 is an antibiotic produced by *Micromonospora rhodorangea*. It has been found to have an inhibitory effect on a wide variety of prokaryotic and eukaryotic organisms but has not previously been tested on pteridophytes. The structure and chemical