ADAPTATION OF A LEAD-TOLERANT POPULATION OF *AGROSTIS TENUIS* TO LOW SOIL FERTILITY

By D. JOWETT
University College of North Wales, Bangor

ATTENTION has recently been directed[1] to populations within *Festuca ovina* and *Trifolium repens* adapted to different levels of soil calcium. In the same publication the authors reported failure to find similar differentiation within *Agrostis tenuis*. However, further work indicates that such differentiation does exist within this species.

A population of *A. tenuis* growing on lead-ore grindings at Goginan (Cards.) has already been shown to be tolerant of lead[2,3]. However, in addition to being rich in lead the soil is of very low fertility. Soil analysis by extracting with $N/2$ acetic acid gives the following values per 100 gm. soil:

Lead 7·1 m.equiv., calcium 0·15 m.equiv., phosphorus pentoxide 1·2 mgm.

The growth of this population in relation to different mineral levels has therefore been investigated in sand culture, by a technique previously described[4]. It was compared with a non-tolerant population from a nearby pasture. The results of one such experiment are shown in Tables 1 and 2. This was designed as a factorial experiment with four levels of calcium and three of phosphate, but there was no significant interaction between the two nutrients.

It is apparent that the pasture population responds to calcium and phosphate within these limits, whereas the lead mine population shows no response to calcium and a lesser response to phosphate. However, in both cases the major part of the response is shown between the two lowest levels. Therefore two further experiments were set up, the results of which are shown in Tables 3 and 4.

Despite the rather erratic results for the lead mine population the general trends are the same as before. The major response to calcium in the lead mine population occurs up to 4 p.p.m., whereas the pasture population increases in yield up to 10 p.p.m. In the case of phosphate, the populations yield similarly at 2 and 4 p.p.m. but diverge thereafter. Calculation of linear regressions of yield on log. nutrient concentration gives a good fit and high significance (0·01 per cent) for both nutrients in the case of the pasture population, but no significance and very poor fit for the lead mine population. The differences between the two coefficients are not significant largely owing to the high error variance of the lead mine population. This high variance may be explained if the population consists of a diverse collection of genotypes, the major unifying feature being the possession of lead tolerance. Greater replication is desirable.

Table 1. CALCIUM (DRY WEIGHT YIELD, GM.)

Population	Calcium p.p.m.			
	5	15	50	200
Lead mine	53·21	50·51	50·24	47·45
Pasture	53·42	77·65	70·43	58·94

$S.E. = 7·75$

Table 2. PHOSPHATE (DRY WEIGHT YIELD, GM.)

Population	Phosphorus p.p.m.		
	5	25	125
Lead mine	52·89	74·74	73·78
Pasture	66·80	93·22	100·42

$S.E. = 9·02$

Table 3. CALCIUM (DRY WEIGHT YIELD, GM.)

Population	Calcium p.p.m.				
	2	3	4	6	10
Lead mine	10·48	13·31	22·67	12·41	18·03
Pasture	13·35	15·79	16·01	19·52	27·91

$S.E. = 3·90$

Table 4. PHOSPHATE (DRY WEIGHT YIELD, GM.)

Population	Phosphorus p.p.m.				
	2	4	8	16	32
Lead mine	10·28	15·54	11·09	18·03	16·13
Pasture	10·99	16·66	21·87	20·99	26·87

$S.E. = 3·70$

The results indicate that the lead mine population is adapted to low levels of calcium and phosphate. Walker *et al.*[5] found similar adaptation in serpentine endemic species; but in their case high magnesium accompanied low calcium-levels. The situation on lead mines is in many ways similar to that on serpentine, except that magnesium is not present in quantity. However, here the differentiation is within a single species and not between species.

Previous failure to find such differentiation within *A. tenuis* may have been due to failure to find sufficiently severe habitats. In more normal habitats *A. tenuis* tends to be replaced by *A. canina* at low fertility-levels, but in lead mine habitats this is not so. As a result, *A. tenuis* is here subject to the most extreme conditions of low fertility.

A considerable range of adaptation to soil mineral-levels has now been found in this species. It has populations tolerant of lead, copper and nickel poisoning, and of low levels of calcium and phosphate. Either it is remarkable in this respect, or such variation is much commoner than previously reported. The fact that both species previously examined in this Department showed similar variation suggests the latter to be the case.

[1] Bradshaw, A. D., and Snaydon, R. W., *Nature*, **183**, 129 (1959).
[2] Bradshaw, A. D., *Nature*, **169**, 1098 (1952).
[3] Jowett, D., *Nature*, **182**, 816 (1958).
[4] Bradshaw, A. D., Lodge, R. W., Jowett, D., and Chadwick, M. J., *J. Ecol.*, **46**, 749 (1958).
[5] Walker, R. B., Walker, H. M., and Ashworth, P. R., *Plant Physiol.*, **30**, 214 (1955).