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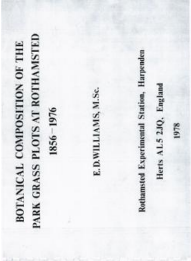
Botanical Composition of the Park Grass Plots at Rothamsted 1856-1976


BOTANICAL COMPOSITION OF THE
PARK GRASS PLOTS AT ROTHAMSTED
1856 1976

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Future Work

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and when a change be made in the method of analysing the vegetation, comparison be made with the traditional method of analysis if the results are to be compared with those in the past.

Since the large number of sub-plots now precludes hay analysis being used routinely to monitor the vegetation, a more worthwhile approach, as previously explained, is to use the method to try to answer specific questions for a limited number of plots and treatments. In the early years of the experiment and again following the liming scheme of 1903 when major changes were occurring on the plots it was clearly of greatest interest to quantify the changes in species composition of the plots and this remains so for plots when new treatments are imposed. However, the emphasis has now changed: whereas this aspect was of paramount importance at the outset, data on the distribution and contributions of the different species may now serve as a background to more detailed studies of individual species and factors affecting the distribution of groups of species.

The Park Grass plots provide within a small area of relatively constant soil-type, a range of discrete types of vegetation which receive similar weather and management. They give ample opportunity for work to ascertain why some species are confined to particular habitats whilst others occur on a wide range of plots. Species may be confined to particular habitats either because of a direct preference for or adaptation to particular conditions or because they are less adversely affected than other species and so are at a competitive advantage under such conditions. The wide distribution of other species might be the result of a wide tolerance within the species as a whole or because morphologically and physiologically different populations have evolved on the plots. Such intraspecific variation for many heritable characteristics has been shown to occur in *Anthoxanthum* by Snaydon and Davies (Davies, 1975; Davies and Snaydon, 1973a, 1973b, 1974, 1976; Snaydon, 1970; Snaydon and Davies, 1972, 1976) in a significant lead on this type of work on species with a wide distribution on the Park Grass plots. The species has increased its contribution on many plots in recent years : the facts that it produces viable seed before the first cut and is cross-pollinated must contribute to the speed of differentiation within the species. Similar studies of other species e.g. *Festuca rubra* would not only help to explain their distribution on the Park Grass plots but also add to the understanding of the mechanisms of adaptation and differentiation within plant species. Populations of *Holcus* from the different plots are also now being used by the Unit of Comparative Plant Ecology (Natural Environment Research Council) at Sheffield University in a study of the variation of response within the species to different nitrogen sources.

Apart from the autecology and ecological genetics of individual species, studies of the comparative ecology and competition between pairs of species should also help to elucidate their distribution on the plots. Some species e.g. *Alopecurus* and *Arrhenatherum* usually occur together and appear to have roughly similar requirements but *Arrhenatherum* tends to become dominant at the higher pH values. However, on some plots e.g. 11^1 and 11^2 the relative amount of the two species has fluctuated with time despite unchanging pH. *Holcus* and *Anthoxanthum* also have very similar ecological requirements and at different times have dominated the same plots : *Holcus* was dominant for 30 years on Plot 9 and also for a shorter length of time on Plot 10 before being replaced by *Anthoxanthum*. The rapidity of transition suggests that the species have fairly similar requirements since it is unlikely that there would be any large differences in nutrient status of the soil during the time of change-over of species.

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Studies of the comparative biology of related species which appear to have different ecological requirements would also be worthwhile. These would include comparisons of *Poa pratensis* with *Poa trivialis* and of *Taraxacum* with *Leontodon hispidus*. Lawes, Gilbert & Masters (1882) concluded that *Poa pratensis* benefitted from nitrogen in the form of ammonium sulphate but not as sodium nitrate, whereas *Poa trivialis* declined markedly on plots given ammonium sulphate, but remained prominent on plots given sodium nitrate. Although these differences have been generally true for much of the experiment, they are less clear-cut than in the past. For example, during 1947 and 1948 *Poa pratensis* was much more widespread on Plot 14 unlimed (nitrogen as sodium nitrate) than was *Poa trivialis* and during 1974 there was much more *Poa trivialis* than *Poa pratensis* on the limed half, especially the sub-plot receiving increased rates of lime, of plot 11^2 (nitrogen as ammonium sulphate). Fundamental studies of the response of the two species to different soil reactions and nitrogen sources should help in explaining their different distribution. Whilst *Taraxacum* and *Leontodon* are both absent from the most acid soils, *Taraxacum* is plentiful only on plots given potassium fertiliser whereas *Leontodon* is most abundant on plots lacking potassium. Experiments under controlled conditions should help explain to what extent differences in efficiency of uptake and utilisation of this cation can account for the different distribution of the two species and whether other factors such as competition with other species are also implicated.

It is possible that by now some of the changes that are occurring on the plots may be related to changes in supply and availability of minor elements. Since all the produce is removed every year and there is no replenishment, cumulative depletion of these elements must occur. Additionally, under the very acid conditions of plots given ammonium sulphate without lime, differential tolerance of species to such factors as aluminium toxicity (Hewitt, 1952; Rorison, 1975) must also be a factor in delineating the distribution of species and should be investigated.

The Park Grass plots now represent a range of sward types to be found in many areas of the British Isles. It would be of great interest to know what the likely outcome of ploughing and reseeding such areas would be in terms of regeneration from the previous vegetation. This would depend, in part, on the accumulation of seed of different species on the plots. Assessments of the number and type of viable seeds incorporated into the soil of the different plots would not only help in predicting this but would also contribute to an understanding of the role of buried seeds in regenerating and maintaining species under permanent pasture conditions. Only a very limited study of the buried weed seeds on Park Grass has previously been done (Brenchley, 1918).

In the early years of the experiment a measure of the value of the herbage on the different plots was obtained, at least of the aftermath, by the number of sheep the plots would support and the amount of liveweight gain made by them. Since then, although much work has been done on the botanical and chemical composition of the swards and yields have been estimated annually, no attempts have been made to determine the value of the vegetation, hay or individual species as animal feed although Brenchley (unpublished) applied the figures for individual species given by de Vries, Hart & Kruijne (1942) to estimate the quality of produce from the plots. This lack of information contrasts with the position for the Palace Leas field at Cockle Park at Newcastle (Elliott & Thomas, 1934; Thomas, Holmes & Clapperton, 1955a, 1955b), where less attention has been given to the botanical composition but more to the

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nutritive value of the herbage. Estimates of the nutritive value and digestibility of the material would greatly enhance the value of existing data. The value of a particular grassland species may, of course, depend upon where it is being grown and for what purpose and may also change with time. Although *Holcus* has been used in hill-land reclamation, it is nowadays considered undesirable in lowland pastures; Lawes & Gilbert (1859) state that "some consider it as almost a weed". Similarly, *Arrhenatherum* described by them as not growing abundantly except upon poor soil and being of "somewhat questionable value" is now abundant upon the high fertility plots of the experiment. It was, however, considered a useful hay grass by Smith (1924) and rated highly in de Vries' et al (1942) evaluation scores.

As far as can be foreseen it is likely that the botanical composition of many of the Park Grass plots will continue to change during the next 20-30 years, albeit at different rates for different plots, as a result of both natural succession and recent lime. If beyond that the flora became completely stable or the changes were of insufficient interest to continue recording, useful information would be obtained by changing the treatments on some plots, especially where there are two plots receiving almost the same treatment. For example, it would be of great interest to know what would be the effects on both yield and botanical composition of additions of nutrients to the now very impoverished Plot 2 (unmanured since 1863). This would not repeat the original investigation, because, as detailed previously, the vegetation at the outset differed in many respects from the present-day unmanured plots. Plots 3 and 12 (unmanured from the start) would continue as 'control' plots. As these plots are unique in not having any additions of nutrients for longer than 120 years, not only in the Park Grass but also in a wider context, it would seem desirable that they be maintained in such a state. The reverse situation where a plot given complete fertiliser e.g. N_3PK would be given no fertiliser would also be of interest. This could possibly be done on Plot 11^1 or 11^2 with the other plot continuing to receive N_3PK or alternatively by splitting Plot 9 ($N_2PKNaMg$) with one half continuing to receive the same fertiliser treatment as before and the other half none. However, soil acidity on the unlimed halves would be likely to limit the introduction of many species. Another possibility is that, where it is thought that a deficiency of a minor element is now influencing botanical composition and/or yield, judicious additions of such an element to a plot or part of it might reveal whether this is so. Plots 4^2 and 10 which receive similar treatment and have similar botanical compositions could also be used if any change of treatment were contemplated.

The fact that there are so many contrasting treatments in close proximity makes the experiment a rich source of plant material and this is likely to continue to be so.

Finally, it is clear that monitoring the botanical composition now serves a different purpose from that in the early years. In the past it provided new information of general application. However, as the experiment progressed, and with unchanged treatment, the contrasted processes of enrichment and depletion of nutrients on the different plots limited the applicability of much of the data to present-day agriculture. However, ecologically the data has become increasingly valuable and now serves as a source of information and ideas for more detailed studies of the behaviour of individual species. The usefulness of any future data on the botanical composition of the plots will be enhanced if steps are taken, as far as possible, to ensure that it not only describes the flora and changes in plant associations of a unique site but that it enables this data to be used to predict changes at other sites, and also attempts to describe the mechanisms of distribution and change within those associations.

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