

A comparison of grass foliage, moss polsters and soil surfaces as pollen traps in modern pollen studies

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Summary

Modern pollen studies are usually performed using moss polsters or artificial pollen traps. As neither of these methods were suitable at the site under investigation, grass foliage was chosen as the trapping surface. A comparison was made with soil surfaces and moss polsters to evaluate the suitability of grass foliage for modern pollen studies.

Introduction

In the interpretation of fossil pollen assemblages, much use has been made of information derived from the study of modern pollen rain produced by various types of vegetation. Those studies carried out by Andersen (1970) on forests, and by Vuorela (1973) on the extent to which agriculture is reflected in pollen rain, have done much to increase the understanding of the many processes affecting the production and transport of pollen under these conditions.

Little work has been done on the identification of pollen spectra associated with local variations in agriculture, however, especially with regard to the recent past. The information derived from modern pollen studies in an agricultural context should be useful in the identification and interpretation of fossil pollen assemblages (Hall 1989).

A modern pollen study of a farm typical of those common in late eighteenth and early nineteenth century Ireland was therefore performed at the Ulster Folk and Transport Museum, Cultra, Co. Down. The farm was established approximately ten years ago, and is being managed according to the practices of the early nineteenth century. The fields are enclosed by walls and by hedges of hawthorn and blackthorn, and rye, wheat, potatoes and flax are all grown.

Farming practices in late eighteenth and early nineteenth century Ireland

During the eighteenth century a number of changes took place in farming practices throughout Great Britain. During the closing years of that century in Ireland, changes in arable cultivation, such as the application of lime, typified the new, 'improved'¹ system of agriculture.

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Enclosure by ditch and bank became increasingly common. The bank was usually planted with hedges composed, primarily, of hawthorn (*Crataegus*) with blackthorn (*Prunus spinosa*) to a lesser extent. Documentary evidence from the period states that crops such as oats, barley, rye, flax and potatoes were grown in the newly-created enclosed fields. Many of the farms also included land used for grazing.

There is little documentary evidence about the inception or rate of spread of enclosure, and the agricultural changes which accompanied it, anywhere in Ireland. Palaeobotanical studies of deposits from this period may therefore be the only method of identifying and tracing some aspects of the development of the enclosed agricultural landscape.

The choice of sampling method

Traditionally, modern pollen studies have made use either of artificial pollen traps (e.g. Lewis and Ogden 1965; Tauber 1974; Cundill 1986) or of moss polsters (e.g. Carroll 1943; Jonassen 1950; King and Knapp 1963; Andersen 1970; Vuorela 1973; Caseldine 1981).

In this study, neither of the traditional methods could be applied. Regular cultivation of the fields under study meant that small moss polsters were present only sparsely, on the walls separating the fields and never beneath the crops. The placement of artificial pollen traps would have been difficult, as they would have been disturbed by mechanised cultivation or by grazing animals. The paths which run through the museum are in regular use by the public and this increased the likelihood of disturbance (interference with traps can be a significant problem, according to Vuorela (1973)). It was for these reasons that it was decided to attempt the study using green grass foliage as the trapping surface. Grasses grew throughout the study area, both as a component of the weed understorey of the crops and as the major constituent of the flora of the grazed areas.

Grass leaves are not an ideal impaction and preservation surface for pollen grains. Unlike many mosses, they are not constantly damp and do not provide a pH which facilitates preservation. Repeated wetting and drying of the trapped pollen on grass foliage may therefore result in some degree of chemical or physical damage. On the other hand, grass foliage has the advantage of being relatively uniform in surface texture and thus might be thought to vary little in its ability to act as a trap.

To evaluate the usefulness of grass foliage as a pollen trap, a comparison was made with moss polsters from the field walls and exposed soil surfaces.

Sampling and sample pre-treatment

Some 60 samples of green grass foliage were obtained during the autumn of 1985. They were taken mostly at 5 metre intervals along three transects passing through the major arable, pastoral and enclosure features on the site. The sampling intervals were shorter where there were distinct vegetational changes, for example at a crop/hedge boundary.

The soil surfaces of the fields used for pasture were the only ones to have been exposed and undisturbed for long enough for them to have captured the pollen spectrum produced over a full yearly cycle, the soils beneath the crops having been disturbed during preparation for sowing and harvesting. About 20 surface soil samples were taken from the same points on the transects in the grazed fields in early spring 1986.

There were only five places on the site where mosses grew and, with the exception of one, and none was closer than 15 m to a transect. The mosses were of different height and growth forms and thus may not provide directly comparable trapping surfaces (Boyd 1986). All five samples taken were from mosses growing on or near the base of walls.

As the samples were small, it was not thought practicable to remove the green parts from the mosses in order to provide the surface most comparable with that of the grass leaves. Moreover, the use of the whole moss plant may provide a composite pollen spectrum for a number of years (Bradshaw 1981). This has the disadvantage of masking annual variations in the pollen rain and reduces the degree to which a valid comparison can be made with the pollen rain of only one season in the spectrum trapped by grass foliage.

The samples were stored until required in a refrigerator at 4° C. Standard pre-treatment (Faegri and Iversen 1975) was performed using potassium hydroxide, sieving through 250 and 10 micron polyester meshes, and acetolysis. After washing twice in distilled water, the samples were dehydrated in alcohol, stained with safranin and mounted in silicone fluid.

A pollen sum of 500 grains was used for the moss and grass samples. Where possible, the same sum was used for the soil samples, but in some cases sums of 100 grains were all that could be reasonably counted.

Results

(i) Grass samples

Results from the grass samples clearly demonstrated that much of the pollen trapped on them was of very local origin and, in all cases, grass pollen was present at varying concentrations. In these samples, the state of preservation was variable.

As might be expected, the concentrations of all pollen-types was highest in the vicinity of the plant producing it. Between 9 and 22% cereal pollen was present in samples beneath the crop, but consistently low values of 1-2/J were recorded at distances of more than 1.5 m from the edge of the crop.

Linum pollen was present at levels of 45? beneath the crop, but was rarely detected other than as single grains outside the area where the flax was growing.

At no point in this, and a previous study by the author, was potato pollen detected in any sample.

The pollen of taxa growing in the hedge was present in samples close to the hedge and to a belt of trees surrounding the site. These were single grain occurrences in some instances.

Pollen from the perennial and (many) annual weed taxa was present at varying levels throughout the site. Tree taxa were represented by very low pollen levels in the grass foliage traps. Many of the herbaceous species present on the site also made contributions to the pollen sum.

(ii) Moss polsters

The moss polsters contained fewer pollen taxa than the grass foliage, but the state

of preservation was good. The values of 3% cereal pollen were similar to those from grass samples taken beyond the area of the crop. Values for perennial weeds were higher than the average of 5% for this category in the grass traps. Levels for other taxa varied to some extent from those recorded in the grass foliage samples.

(iii) Soil samples

The soil surface samples contained the least number of taxa, in general, but on the other hand the highest values for tree pollen taxa occurred in these samples. Although the values for tree pollen were high, the state of preservation was, as throughout these samples, poor. This was especially true for Alnus, where the grains were badly corroded.

The results obtained from these analyses are summarised in Table 3, where the figures are expressed as mean percentages of the total pollen sums (including standard deviations).

Table 3. Mean percentages (with standard deviations) for three categories of pollen from mosses, grass foliage and soil surfaces

	%tree pollen	%grass pollen	%herb and cereal pollen
samples from mosses (n=5)	11.0+3.7	60.0+5.5	26.0+7.2
samples from grasses (n = 56)	4.5+3.8	70.0+14.8	23.0+25.8
samples from soils (n = 17)	14.0+5.9	70.0+11.1	10.0+13.8

Discussion

A comparison of this type can only be made at a general level. The moss and soil samples came from areas that were used primarily for grazing, and therefore neither contained the range of taxa trapped by the grass sample, which had been collected from many different parts of the site. Moreover, the environment reflected in the moss and soil samples was more uniform than that in the grass samples. Nevertheless it is believed that grass and soil samples containing at least part of one year's pollen rain can still be fairly compared with the small number of moss samples containing the pollen rain of several seasons.

The poor state of the pollen trapped on the soil surface samples and, to a lesser extent, on the grass foliage (compared with that on the mosses) demonstrates that the pollen trapping surface is a factor in determining the final state of pollen preservation.

There was an element of difference between the percentage of tree pollen in the assemblage trapped by the grasses and those trapped by the mosses and soils. During the winter and early spring, the only areas on the site that had green grass foliage present on them were the fields used for grazing, and their surrounding banks. Samples from these areas were the only ones likely to have trapped the pollen rain produced at this period of the year. Such material would have comprised only a small proportion of the grasses sampled throughout the site during the autumn, by contrast.

The low percentages of pollen produced during the winter and spring are more likely to reflect this shortcoming in the sampling strategy rather some inherent inability of grass foliage (present during winter and early spring) to trap pollen grains. For this reason, it is probable that tree pollen, and possibly all pollen produced during winter and early spring, may be poorly represented in the pollen spectrum from the grass traps.

Grasses produce copious amounts of pollen and this was present at high values throughout the site in the various sample types. Some degree of over-representation of grass pollen might therefore be expected in the grass foliage traps. The similar values for percentage grass pollen for all three types may reflect the extremely local nature of all the trapped pollen, as both the mosses and the soils were surrounded by large expanses of flowering grasses.

Herb and cereal pollen

A study of modern pollen rain associated with agriculture in Ireland has been performed by O'Connell (1986), who used soil surface samples and Sphagnum polsters. In general, his results for cereal pollen percentages from analyses of these samples are similar to those obtained in the present study.

The similarities between the figures for percentages of herb and cereal pollen from the grass and moss samples (Table 3) are notable, even though the number of moss samples was small. A wider range of taxa was trapped by the grass foliage, but this is probably a function of the greater number of sites from which grasses were taken. All the taxa typical of the system of agriculture were detected in the grass traps: Cerealia, Linum, taegus, Prunus spinosa and perennial and annual weed taxa. Corylus and Alnus, which flower in late winter/early spring, were also present, but in very small amounts.

The slightly higher values for herb and cereal pollen in the moss samples was mostly a result of values of over 50/K Plantago pollen in one sample taken from a wall, with a number of Plantago plants growing nearby. Variations in data are almost inevitable when averages from a small number of samples are all that are available.

Conclusions

As most of the grass foliage sampled was produced during the late spring and summer, there was an increased chance of sampling pollen produced during this period. The same might be said of the soils, which trapped pollen produced by winter- and spring-flowering trees. As the composite pollen spectra from mosses and, to a lesser extent, from the soil

surface samples, mask the annual variation in pollen rain, it is necessary to take a number of grass samples from all vegetation types on the site to provide data as a basis for comparisons of this kind.

Although grass foliage sampled during the autumn contained only a small proportion of material that was present during the early part of the year, the pollen spectrum typical of the system could be identified from the results obtained,

A bias in favour of summer-produced pollen is built into this sampling method where samples are taken during or soon after this part of the year. This is not necessarily a disadvantage when trying to evaluate pollen productivity and dispersal from agricultural systems, however, since these are intrinsically spring and summer phenomena.

With adaptation, especially with regard to the time at which sampling takes place, the method might be used to carry out modern pollen studies of other systems of land-use, where aspects of local variation in a pollen spectrum may be identified in a fossil pollen assemblage.

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