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# Distinguishing cereal from wild grass pollen: some limitations

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## Summary

The criteria used to distinguish pollen grains of cereals from those of wild grasses are tabulated and discussed. The importance of accurate annulus measurements and the resolution of surface sculpturing using phase contrast microscopy are shown. The problem of distinguishing *Hordeum* (barley) pollen from that of certain wild grasses is emphasised. Caution is needed in separating pollen of *Avena* (oats) from that of *Triticum* (wheat). *Secale* (rye) grains may be more confidently identified.

## Introduction

Problems in distinguishing pollen of cereals from those of wild grasses have led to the adoption of varying criteria by different workers. This paper is an attempt to summarize the non-British literature on cereal pollen identification and also to suggest a more standardised form in which results can be presented. The state of preservation varies according to local conditions and whether mires, ditches, soils, pits, 'cess', coprolites, potsherds or even bog bodies are pollen-analysed and therefore the degree of certainty which can be attached to the identification is not constant.

## Size and surface sculpturing

Andersen (1979) divides Poaceae (Gramineae) pollen into four groups:

(1) Wild grass group: mean annulus diameters smaller than 8 µm, mean pollen size less than 37 µm, surface sculpturing scabrate or verrucate. This group includes most *Bromus* spp. which usually have a slightly smaller mean annulus diameter, although the mean grain size is within the range of group 2 (Andersen 1979, table 1).

(2) *Hordeum* group: mean annulus diameters 8-10 µm, mean pollen size 32-45 µm, scabrate. This group comprises wild grasses and cultivated species.

(3) *Avena-Triticum* group: mean annulus diameters larger than 10 µm, mean pollen size larger than 40 µm, verrucate. This group comprises cultivated species and one wild grass, *Avena fatua*.

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4) Secale cereale: the grains are scabrate and only separated from group 2 by Andersen on account of their larger pollen index (ibid, table 3). They are here included in group 2. The grains are usually prolate and therefore the only cereal pollen which can be identified solely on shape.

The species listed in Andersen's groups 2, 3 and 4 are here given in Table 7.

The scabrate patterning of the Hordeum group is shown as isolated dark dots (spinules, punctae) with phase contrast (Fig. 5(a)). Scanning electron micrographs of some of the species in this group (Andersen and Bertelsen 1972) show that the sculpturing differs slightly between some genera. Faegri and Iversen (1975) note differences in the pore and annulus structure. Vorren (1986) has suggested that distinctions in the sculpturing of certain species can be seen with the light microscope.

The verrucate patterning of the Avena-Triticum group is seen as irregular dark spots (maculae) in phase contrast (Fig. 5(b)). These spots are composed of spinules grouped on small islands together with single spinules and shown in scanning electrom micrographs by Andersen and Bertelsen (1972). However Andersen (1979) points out that this may not always be distinguishable from scabrate sculpturing. On the other hand Beug (1961, figs. 12 and 13), using phase contrast, separates Avena-type from Triticum-type on differences in the grouping of the dark spots. Faegri and Iversen (1975) also note sculpturing differences within the group.

## Chemical treatment and mounting medium

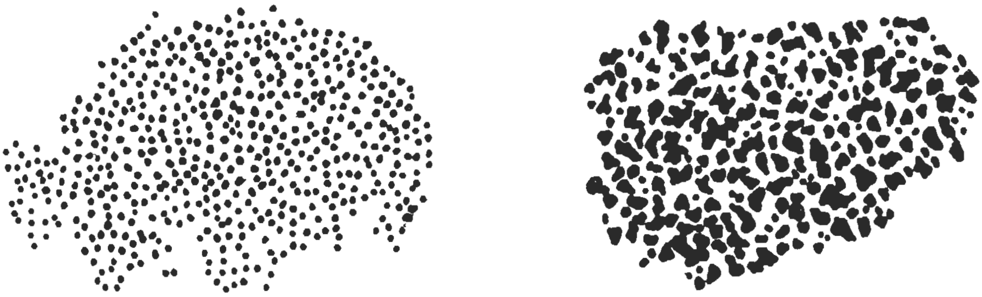
The preparation of reference grass pollen for measurements of size and annulus diameter have usually consisted of treatment with potassium hydroxide (KOH) and acetolysis followed by mounting in silicone oil. However various workers have noted that grains swell after acetolysis and so Corylus at c. 25 µm, has been used to standardise the results (Faegri and Iversen 1975; Andersen 1979). Corylus and grass pollen swell by a similar proportion if mounted in glycerol (Faegri and Iversen 1975, table 2). The type of deposit may further affect the size (op. cit., table 12) which tends to be more constant if mounted in silicone oil. KOH treatment without acetolysis appears not to affect the size of the grains. It may be advantageous in some circumstances also to prepare the sample without acetolysis so as to be able to measure the annulus diameter and size, especially if Corylus is not present in the sample as a standard. The swollen grains which frequently result from acetolysis may show the surface sculpturing more clearly than those treated with KOH alone.

## Identifying fossil grains

### Hordeum group

As is shown in Table 7, grains of Hordeum group can be separated from those of Avena-Triticum group by the smaller annulus diameter, used in combination with the scabrate sculpturing. Pollen size may be helpful but the larger fossil grass grains are frequently crumpled. Andersen (1979, fig. 6) has used the annulus diameters to separate crumpled grains of Glyceria from those of Hordeum vulgare and Elymus (Agropyron) repens. Obviously this is only possible when a number of grains can be very carefully measured. Vorren (1986) has distinguished Hordeum from Elymus repens using the thicker Hordeum annulus with steep peripheral margin (which E. repens lacks), together with the tendency for the punctae of E. repens to be dispersed in groups. Andersen and Bertelsen (1972) note that in phase contrast irregular dots may be seen in some grains of E. repens.

Ditch deposits are particularly likely to contain pollen of Glyceria, and Glyceria spp. may also be found in shallow damp hollows in pasture (J. H. Dickson pers. comm.). Elymus repens is very common in waste places such as field margins. Inland locations will probably exclude the three maritime grasses in this group and known geographical ranges may exclude Triticum monococcum and Hordeum murinum from consideration; the latter has a rather southern and eastern distribution in the British Isles (Perring and Walters 1976).



a b

Figure 5. Surface sculpturing of (a) Hordeum-type (H. distichon); (b) Avena-type (A. sativa) pollen grains. Redrawn from Beug (1961), and based on phase contrast photographs (x 2200).

Avena-Triticum group

The only wild grass in this group is Avena fatua but its ubiquitous presence in barley and other cereal crops, from the Iron Age onwards in Britain, is a serious problem in the interpretation of post-Bronze Age Avena-Triticum pollen. The smaller mean annulus size of A. sativa has enabled Andersen (1979, fig. 9) to identify crumpled grains, using the annulus and surface sculpturing as criteria. It must be noted that the size range of annulus diameters of A. sativa overlaps in particular with that for Triticum aestivum and so small numbers of grains are not necessarily distinguishable. Pollen analysts have distinguished Triticum pollen, and those grains with a particularly large annulus seem separable from those of Avena spp.

## Conclusion

If large grass pollen is present only as occasional grains, Secale may be the only cereal identifiable to the generic level with certainty. Grains frequently become swollen by acetolysis and by mounting in glycerol, and both annulus diameter and grain size must be corrected against Corylus as a standard. Pollen of Hordeum group (including wild grasses) may be distinguished by its smaller annulus size and scabrate sculpturing from that of Avena (including A. fatua) and Triticum with verrucate grains. It may be possible to distinguish Hordeum pollen from that of wild grasses by very accurate measurement of the annulus diameter combined with observation of well-preserved surface sculpturing using phase contrast. Pollen of Avena sativa has been distinguished when similarly very accurate measurements of annulus diameters have been made on a number of grains. Some species of Triticum appear separable on their larger annulus diameters.

It is highly desirable that the criteria used for identification are stated in both published and unpublished reports together with a list of wild grasses which may be contributing.

## References


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Table 7 (opposite). Measurements of Poaceae (Gramineae) pollen grains from the available literature (all given in um). Measurements from Andersen (1979) and Faegri and Iversen (1975) are for grains mounted in silicone oil and standardized against Corylus = 24.5 and 25 µm respectively. The measurements from Beug (1961) are from grains mounted in glycerol and therefore larger; use of a correction factor of 0.78 to both annulus diameter and size range will give results comparable with those from the other authors.

| | |
|---|---|
| Anl D | mean diameter of annulus |
| $\frac{M+ + M-}{2}$ | mean of greatest diameter (M+) and diameter at a right angle to M+ (M-) |
| G D | greatest diameter of grain |
| * | average of more than one collection |
| + | tentative identification of the genus by Beug |

| | Andersen, 1979 | | Faegri & Iversen, 1975 | | Beug, 1961 | |
|---|---|---|---|---|---|---|
| | Anl D | $\frac{M+ + M-}{2}$ | Anl D | G D | Anl D | G D |
| **HORDEUM GROUP** | | | | | | |
| Ammophila arenaria (L.) Link | 8.44 | 32.0 | | | 10.9 | 31.9–43.8 |
| Bromus inermis Leysser | | | | | 11.3 | 39.8–55.7 |
| Elymus farctus (Agropyron junceiforme) (Viv.) Run. ex Meld. | 8.89 | 39.72 | 8–10.5 | 39–47 | 12.2 | 38.5–55.1 |
| Elymus (Agropyron) repens (L.) Gould | 8.80* | 37.72* | 7–10.5 | 38–47 | 8.7+ | 37.2–49.1+ |
| Glyceria fluitans (L.) R. Br. | 9.55* | 34.47* | | < 40 | 11.3 | 30.5–43.8 |
| G. plicata Fr. | 9.66 | 34.99 | | < 40 | 11.3 | 29.9–42.5 |
| Hordeum murinum L. | 8.77 | 39.10 | | | 11.2 | 37.2–53.7 |
| H. vulgare L. | 8.23* | 37.29* | 8–10.5 | 39–47 | 10.7 | 35.2–53.7 |
| Leymus (Elymus) arenarius (L.) Hochst. | 8.88* | 43.86* | < 12 | | 10.6 | 37.8–57.7 |
| Secale cereale L. | 8.93* | 40.10* | < 12 | 49–58 | 10.7 | 31.9–65.0 |
| Triticum monococcum L. | 9.19* | 37.63* | 9–11.5 | 39–47 | 11.3 | 32.5–59.1 |
| **AVENA-TRITICUM GROUP** | | | | | | |
| Avena fatua L. | 11.93 | 44.24 | 11–13 | 47–54 | 13.0 | 43.8 |
| A. nuda Höjer | 11.60 | 40.67 | | | 10.8 | 34.5–47.8 |
| A. sativa L. | 10.72* | 40.92* | 8–12 | 38–55 | 12.0 | 49.1–55.0 |
| A. strigosa Schreb. | | | | | 10.0 | 37.8–66.4 |
| Triticum aestivum L. | 11.81* | 45.03* | 11.5–16 | | 16.6 | 39.8–69.0 |
| T. compactum Host. | 14.18 | 47.19 | 11.5–16 | | 16.3 | 44.5–66.4 |
| T. dicoccum Schrank | 13.51 | 45.77 | 11.5–16 | | 14.6 | 38.5–71.0 |
| T. polonicum L. | 10.98 | 39.57 | | | | |
| T. spelta L. | 12.59 | 45.99 | 11.5–16 | | 15.9 | 41.8–72.3 |