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A comparison of results from two designs of sedimentation pollen trap

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Two different types of sedimentation pollen traps (Tauber and Cundill designs) were tested together in a grassy glade within a pine forest in east Fife, Scotland over the period 1992–1995. The results from 1992 and 1993 are presented and demonstrate close similarities between the quantities of pollen of the major taxa captured by the two traps. Differences between the pollen values of Poaceae from the two traps may be attributed to localised release of pollen although variations in *Pinus* pollen are less easy to explain. Problems were encountered in the use of the Tauber trap because it acted as a pitfall trap for insects, amphibians and small mammals and this led to some samples from 1994 and 1995 being discarded. In general both the traps operated with the same level of efficiency although the Tauber trap requires the addition of a mesh or bactericide/preservative to counteract its tendency to act as a pitfall trap.

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A range of designs of pollen traps have been used for modern pollen studies over the past 50 years. There are two main types of trap; volumetric traps designed to capture pollen and other particles present in the atmosphere and sedimentation traps which collect pollen which lands on the ground. The present paper deals with two examples of the latter type of trap. Several types of sedimentation traps have been used to study the relationship between vegetation and its resultant pollen deposition, with the ultimate aim of applying knowledge of this relationship to fossil pollen records in order to provide a more accurate picture of fossil vegetation. Amongst the earliest type of sedimentation trap was the microscope slide smeared with a sticky substance which captured pollen impacting upon its surface. This trap had a number of disadvantages and in the late 1960s a new design of pollen trap was devised by Tauber (1974). The Tauber trap with various modifications has become the standard design for modern pollen deposition studies although some researchers continue to introduce other designs based around the use of acetate wool as a collection surface for pollen (e.g. Flenley 1973, Cundill 1986). The present paper concentrates on comparing data obtained from two different types of sedimentation trap; the Tauber and Cundill designs in order to assess, for example, their relative efficiency, ease of use and representativity.

MATERIAL AND METHODS

Since 1980 Cundill design pollen traps have been sampled at monthly intervals from a site in a coastal sand dune area at Morton Lochs in north east Fife, Scotland (Fig. 1). The pollen traps were set up in a glade (dominated by grass and herbaceous vegetation) within a planted woodland of pine (*Pinus contorta*, *P. sylvestris*), willow (*Salix* spp.) and occasional beech (*Fagus sylvatica*). In January 1992 a Tauber design pollen trap was located alongside (within 20 cm) one

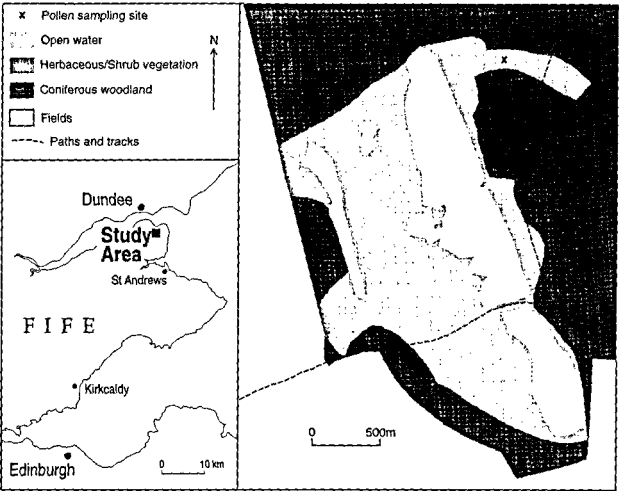


Fig. 1. The location of the pollen traps within the Morton Lochs N.N.R. and eastern Scotland.

of the Cundill traps. The two traps were close to one another in order to minimise variations such as those that might be introduced by wind eddies in the woodland glade. The Tauber trap was positioned so that it was sitting with its base flat on the ground and this resulted in the opening of the trap being elevated about 11 cm above the Cundill trap (Fig. 2). This may have influenced the wind flow around and over the trap surfaces and potentially could have led to differences in results between the two traps. Although the surface sampling area of the two traps is identical because the diameters of the two circular openings are the same, the design of the traps is completely different. The Tauber trap consists of a cylinder sitting on a flat base. An aerodynamically shaped collar sits on the top of the cylinder and, in the case of the trap used in the present study, this collar has a 7.5 cm diameter opening in the middle (Fig. 2). The whole trap is constructed from perspex. Pollen

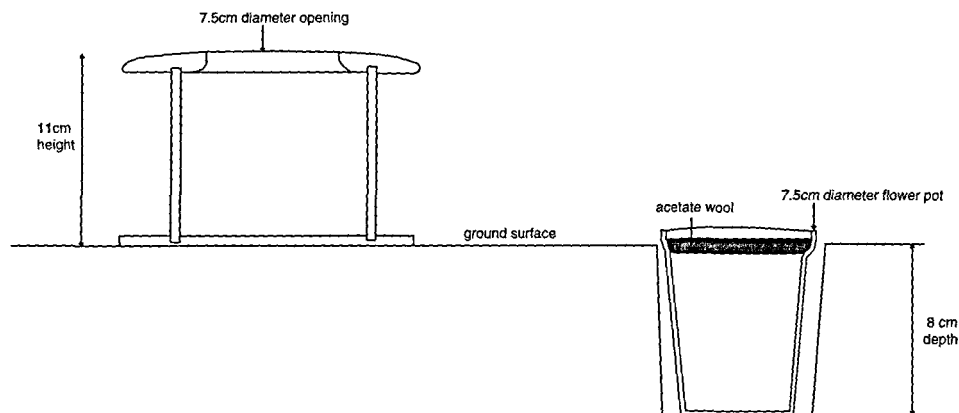


Fig. 2. A sketch diagram (not to scale) of the position of the Tauber and Cundill pollen traps in relation to ground surface.

is transported under wet and dry weather conditions through the opening and deposited on the inside surfaces of the cylinder (Tauber 1974). The Cundill trap is a standard 7.5 cm diameter plastic flower pot into the top of which is inserted a layer of acetate wool, held in place by wire mesh (Cundill 1986). Deposition of pollen takes place on the surface of the acetate wool but excess rainwater filters through the wool and drains away through the hole in the bottom of the flower pot (Fig. 2). Although the monthly sampling of the two traps has been continuous since January 1992, a comparison of the two years 1992 and 1993 only are considered in this paper because of problems of sampling the Tauber trap in 1994 and 1995.

The acetate wool material sampled from the Cundill trap was dissolved in acetone and subjected to standard pollen analysis treatment (Cundill 1986). The water samples from the Tauber trap were centrifuged when quantities were excessive and then treated with KOH and acetolysis (Moore et al. 1991). A *Lycopodium* tablet (Stockmarr 1972) was added to each of the samples at the beginning of the chemical treatments so that absolute pollen totals could be calculated. At the end of the chemical processing the samples were dehydrated with alcohol and mounted in silicone fluid. Counting was carried out on a Nikon Labophot microscope at $\times 600$ magnification and continued until a total of 100 introduced *Lycopodium* spores (1% of the total sample) had been recorded.

RESULTS

The pollen totals recorded for each month from the counting of samples ranged widely from 5 to 749 (equivalent to $0.1\text{--}16$ pollen cm^{-2}) in the Cundill trap, and 0 to 1832 (equivalent to $0\text{--}40$ pollen cm^{-2}) in the Tauber trap. A total of 38 different taxa were identified in the Tauber trap samples and 35 in the Cundill trap samples. The range of taxa from the two traps is almost identical. Many of the taxa are recorded at low values throughout the two years and it would be unproductive to attempt to display all these in graphical form. For this reason only three major taxa (*Betula*, *Pinus* and *Poaceae*) and the total pollen values are illustrated (Fig. 3). Because the samples were collected on the same occasion each month and the surface openings of the two traps are identical the two sets of data are displayed together on the same histograms so that they may be directly compared.

The results from the three individual taxa do not show exactly the same pattern. The *Pinus sylvestris* data shows that the peak in values from the Cundill trap occurs in June 1992 and May 1993 whereas the Tauber trap has a peak in

July in both 1992 and 1993. In terms of values the Cundill trap appears to be less efficient in capturing *Pinus* pollen than the Tauber trap which records considerably higher peaks in each of the two years. The *Poaceae* values show much closer agreement with the peak in 1993 in both traps occurring in the same month, July, although in 1992 there was a difference between the two traps, with the highest value recorded in July in the Cundill trap and August in the Tauber trap. However, there is also a very high value in July for the Tauber trap. The values for *Betula* are the closest of the three with no peak of pollen recorded in either trap in 1992 and a single main peak in May 1993 in both traps. If the total pollen values are considered the differences between the two traps are less obvious apart for the double peak (July and August) in the Tauber trap in 1992 compared with the single peak (July) in the Cundill trap. Other than this the close agreement in the pattern of results from the two traps is perhaps best illustrated by the rise-fall-rise pattern observed in the May, June and July values for 1993. It is difficult to observe significant variations in the winter month values between the two traps, although frequently the Cundill trap records higher values than the Tauber trap a feature that may reflect differences in the secondary deposition of pollen from the surface of leaves in autumn and winter.

DISCUSSION

From the data available in this study it would appear that there are no substantial differences in the way that the two pollen traps operate in the field. There are, however, differences in detail between the results recorded from the two traps and some of these may be attributed to the differences in the design of the two traps. For example, the difference in the height of the trap openings above the ground surface may influence the capture of pollen. In the case of *Pinus* pollen, peak values occur at different times and while this may be due to the differences in the height of the pollen traps, it may be due equally to the shape of *Pinus* pollen and the way that it enters the traps. Whatever mechanisms are involved, the differences that are produced may pose difficulties if the results are being used in a detailed study of *Pinus* pollen emission and transportation. Variations in the *Poaceae* values recorded by the two traps may be easier to

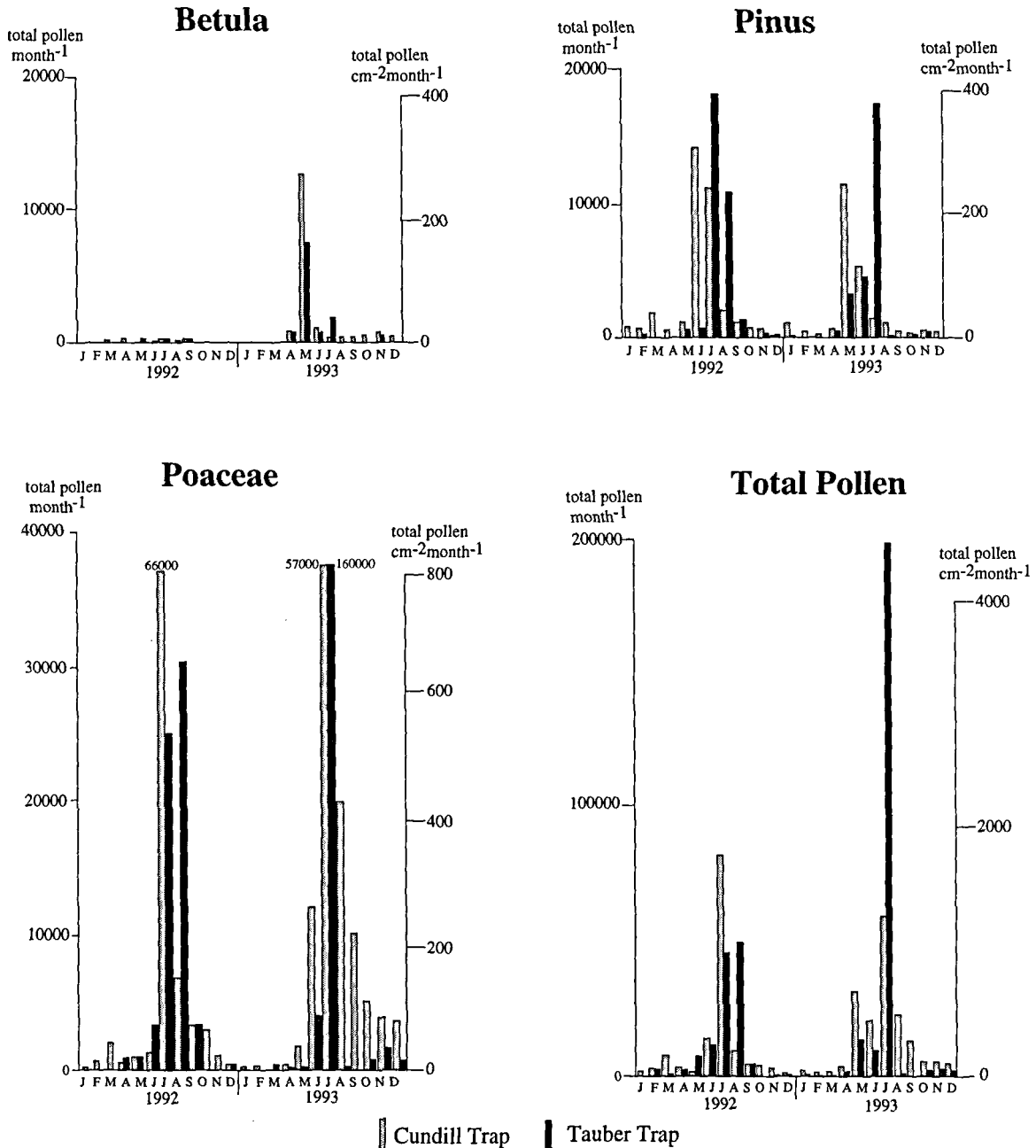


Fig. 3. Histograms of the monthly values of *Betula*, *Pinus*, *Poaceae* and total pollen for 1992 and 1993 at Morton Lochs, Fife. Values on the left hand axis of each histogram show the total monthly quantities of pollen sedimenting onto the acetate wool surface of the Cundill trap or dropping through the orifice of the Tauber trap while the right hand axis shows monthly pollen quantities expressed as numbers of pollen cm⁻² of the pollen trap surface/opening.

explain because there could be localised differences in the flowering of overhanging grasses which may have affected the timing and the quantity of pollen received by each trap. In other words individual flowering grass stems might provide variations on a highly localised scale. In addition there is more than one species of *Poaceae* in the area adjacent to the traps and this may result in different emission and deposition rates. The close similarity in the *Betula* values between the two traps is interesting because it demonstrates that both traps can collect this type of pollen in the same manner. One

explanation for the similarity in values of *Betula* may be found in the source of this pollen which is more distant than either *Pinus* or *Poaceae*. Many of the other pollen taxa (e.g. *Brassicaceae*, *Potentilla*), although they are recorded at low values, often tend to show similar trends in both traps. This may indicate that the variations seen in the values of *Pinus* and *Poaceae* in this study are the result of particular factors at the Morton Lochs site which affect the emission, sedimentation and entrapment of these two taxa. There may not be the same problem in the operation of either of the two

traps at other sites. However, this study may have shown that highly localised variations can occur in the trapping of modern pollen and that those carrying out research in this field should be careful in the interpretation of values derived from locally produced pollen.

Although the Tauber trap is the more complex to construct, it is the simplest to operate in the field. However, it has one major drawback. If it is placed on the ground, even though the pollen collecting orifice is elevated above the ground surface, it acts as a pitfall trap for insects, mammals and amphibians. This was a feature also noted by Hicks and Hyvarinen (1986), and pollen adhering to the bodies of these living creatures may in part help to explain variations in the pollen record. During the two year sampling period, a live frog was found in the trap in the July 1993 sample, numerous dead insects and a bee in the August 1993 sample and a dead mouse in the September 1993 sample. The latter sample was discarded and does not appear in the records. In 1994 three months of samples had to be discarded because of dead animal remains and in 1995 four months of samples were not collected for the same reason. As all these samples were from crucial summer months the value of the trap for modern pollen sampling is therefore diminished unless the trap contains preservatives and other materials to prevent bacterial decomposition (Hicks & Hyvarinen 1986). The acetate wool in the Cundill traps can be contaminated by passing insects and other animals but they are not trapped by the design of the pollen trap.

CONCLUSIONS

The work described here demonstrates that although there are differences in total pollen values recorded by the two sedimentation traps, the pattern of deposition is very similar. The variation in total values between the traps is significant only in terms of the two major pollen taxa, and in the case of Poaceae these differences may be explained by local factors. Therefore if sedimentation traps are being operated

in order to demonstrate general patterns of pollen emission and deposition during the year there is a good level of agreement between the two trap types. It is when attempting to use annual pollen totals that significant differences are observed and clearly this could be important when comparing modern and fossil influx values. However, in the present study the use of a two year period of sedimentation trapping is inadequate to allow comparisons with most fossil situations. In practical terms the Cundill trap does not act as a pitfall for animals and is easier to construct, but the Tauber trap is highly successful as long as chemicals such as formalin are added to the trap to prevent the growth of bacteria and kill animals which fall into it (Hicks and Hyvarinen 1986). Overall this study demonstrates that both designs of sedimentation trap provide efficient methods for monitoring modern pollen deposition.

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