AML Report 3382,

(207)

POLLEN ANALYSIS OF THE LLOYDS BANK SEDIMENTS, YORK J.R.A. Greig

1.1

The organic material from Lloyds Bank, in addition to the studies of the bones, insects and plant macrofossils, was subjected to pollen analysis. This was a somewhat unusual step at the time, for this approach had been rejected by Godwin & Bachem (1962) when dealing with similar deposits from York. A few spectra were examined from this type of material by Cundill in Radley (1972). The excavations of this Lloyds Bank site and the pollen content of some of the sediments was briefly reported in Buckland and others (1974), and at that stage a description was all that proved possible with the pollen results. Further work (e.g. Greig, [illegible] 1978) attempted characterisation of the pollen spectra obtained from a series of pollen analyses. A wide range of data was used in addition to that from the pollen, in an attempt to improve the resolution of interpretation possible (Greig 1981a). Pollen analysis of some other deposits in and around York has provided further data which can be of use in the interpretation of this Lloyds Bank material (e.g. Greig in Kenward et al, 1978).

1.2

The first pollen preparations, made in 1973, were not very good, but when more suitable techniques had been developed for dealing with such archaeological deposits (rather than natural sediments), the pollen was found to be fairly abundant and well-preserved in all the samples examined. Success in pollen analysis of archaeological material depends upon the care and thoroughness with which basically standard methods of preparation are applied, with a few detail improvements. It was discovered that parasite ova (Trichuris, Ascaris) show up well in pollen preparations, especially when they have not been exposed to acetolysis. Latterly it has been the practice to sub-sample preparations before the acetolysis stage if it is suspected that parasite ova may be present, to make sure that they are detected.

1.3

Monolith samples of about $1m^2$ were taken from the LB III excavation and sub-sampled for the early counts, which are numbered according to their relative position on one of those successions; it had been hoped to link these back to the archaeological sections. The samples from LB II were collected according to the distinguishable layers seen during excavation. Plant macrofossils and insects have been studied from the same basic samples, although the layer samples may not necessarily be homogeneous. Some samples were not analysed for pollen. The sediments are not described in detail; they were generally of a humic nature, but with a range of minerals ranging from clay to sand size. Samples 17, 18, 20 and 31 were blacker, with leather offcuts but otherwise there was very little visible difference between them. Sediment description and sampling would have been easier if small monolith samples of about 25 x 10 x 10 cm had been collected so that the sections could be re-assembled and thoroughly studied under laboratory conditions rather than on site in the gloom of the basement.

2.1.

The results are presented in histogram form (Figs 1,2) as a "pollen diagram" to facilitate comparison of the results from sample to samplé. This is not a pollen diagram in the true sense because the samples do not come from a stratigraphic succession but rather from a series of archaeologically more or less distinct layers.

The pollen records have been arranged in ecological groups as far as possible, for the sake of clarity. Some pollen records could represent plants from a range of habitats, and although the macrofossil records sometimes help decide which plants are most likely to have been the source of a particular pollen record, there are inevitable some clashes and misfits. A phytosociological approach has not been employed, partly because the pollen records cannot yet be matched with such finely resolved plant communities as can macrofossils (Willerding 1978).

The forest tree group on the pollen diagram (Quercus, Tilia, Ulmus includes what are believed to have been the main constituents of lowland forest in eastern and central England before clearance, and to a large extent afterwards (Rackham 1981). The forest tree pollen records do not necessarily show extent and proximity to York of such forest, because these trees also grow in woodland relict hedgerows and other places, but it provides a guide which can be compared with the results of conventional pollen diagrams from around York.

The next group, consisting of trees of open woodland and scrub covers a wide range of possible habitats. Some of these trees more often grow on acid heathland, like Pinus and Betula, others on wet land (Alnus and Salix) or as weed shrubs on land richened by human activity, like Sambucus nigra. Rosaceous trees like Crataegus and Prunus are likely to have been seriously under-represented. Pollen records are especially important in detecting signs of trees because they are not well represented in the seed record.

The wetland plant group has Polygonum persicaria included with P. bistorta in order to save space. The Umbelliferae records are here, although this family has members which grow in most kinds of vegetation, including wetland. Ericales, suggestive of heathland have no heading, like parasite ova (not included in the pollen sum) which are indicative of excrement.

Figure 2 starts with a group of records from probable grassland plants such as grasses, hawkweeds, dandelions, plantains, clover and knapweed which can be seen commonly on grassy banks and roadsid The Leguminosae pollen records, although all combined to save space (except Vicia faba) are largely comprised of Trifolium repens and Trifolium pratense, with a small amount of Lotus type.

The group of records from crops and weeds of cultivated land starts with Cerealia. It was often difficult to identify these grains in their crumpled state, and attempts to obtain a consistent separatio between wheat, oats and barley proved unsuccessful. Cannabiaceae records probably represent both hops, which may have been gathered from the wild, and hemp which was cultivated. Compositae (Tubulifl is a large group. Much of the pollen was of Anthemis type and this, together with the abundant seed records of Anthemis cotula justifie the placing of this pollen group among the weed records.
A few grains of Vicia faba were found, and these are practically the only evidence of an important food plant.
Other weed records include Artemisia, Chenopodiaceae, Caryophyllace (Stellaria seeds were common), Cruciferae (Rhaphanus rhaphanistrum seeds were found) Rumex and Urtica. Finally, an indication of the diversity or otherwise of the insect fauna is given, after Kenward (1978) and in this volume.

2.2

Before considering interpretation, and inevitably all the other data from Lloyds Bank, it is instructive to examine the pollen records alone, starting with the tree pollen. The most abundant tree pollen here is Alnus, Corylus, Betula, Quercus and Sambucus in decreasing order of abundance. Although this will not necessarily reflect the relative abundance of those trees and shrubs, it does provide a means of comparing the other pollen records. The pollen diagram from the organic deposits at the site of the Ebor brewery in Aldwark shows a similar pattern, as do the results from analyses of Roman soils from Skeldergate and Coney Street (AY 14/3, AY 14/2). These predominant taxa are among the most pollen productive (Andersen 1970) so they will tend to overshadow the records of less productive trees like Tilia and Ulmus which are surprisingly abundant when this is taken into consideration. Ilex, Crataegus and Fraxinus are probably also more important than their pollen records would suggest. It is not possible to estimate how many trees were in or near Viking York from these records. Betula, Corylus, Alnus, Salix and Sambucus nigra are commonly found in towns now, mainly because of their ability to colonise waste ground rapidly, and so these records are the most likely to represent local scrub, together with Ilex, Crataegus and Fraxinus. The large record of Sambucus nigra pollen in sample LB II 29 is exceptional; perhaps that part of the deposit contained some remains of elder flowers.

The records of wetland plants are fairly small in importance and variety compared with peatland pollen analysis sites. Since this is a dry land occupation site these plants were probably brought in, together with their pollen. The Ericales pollen could also have been brought in on heathland vegetation, but the consistent appearance of small amounts of Ericales pollen in most of the pollen results from York suggests that at least some probably came from heathland around York. The uniform Ericales pollen record from Lloyds Bank can be compared with that from the Ebor site where the amount appears to have greatly increased with time, probably coming from heathery material brought into York.

The parasite ova Trichuris and Ascaris were probably present in small amounts throughout the deposit, but they were destroyed by acetolysis in some samples, giving an incomplete record of their past presence. These worms infest a range of animals including mankind and the presence of ova is an almost certain sign of the remains of excrement in a deposit. The numbers of ova are much smaller than were found in a latrine (Greig 1981b) where they outnumbered the pollen. If the infestation of human and animal populations has remained nearly constant, these York deposits do not contain much excrement.

The grassland plants group contains some interesting pollen record Centaurea scabiosa (greater knapweed), of which 3 pollen grains we found, grows on dry grassland,

, and the plant is not recorded from

the Ouse and Foss region of Yorkshire (Baker 1906). Gentiana ?pneumonanthe, (marsh gentian), of which 3 pollen grains were also found, does grow in this part of Yorkshire, on Stockton and Strensall Common (Baker 1906). The flowers are very attractive, so it is possible that they arrived in York as a result of deliberat gathering, rather than having been collected with a mass of other plant material.

Among the crop plant records, Vicia faba (broad bean) is very under-represented, for a bean pod contains only about 200 pollen grains compared with around 40,000 for an ear of wheat (Greig 1981a) The 5 pollen records probably come either from beans or bean straw, demonstrating the presence of an important crop plant whose remains do not otherwise survive unless charred, and this is a rare chance, although charred remains were found at Hedeby (Behre1969).

A range of weed taxa are represented, although some of these appear to be very under-represented in the pollen record. This is partly compensated by pollen records of weeds like Artemisia the seeds of which do not appear to survive. The presence of Solanum nigrum pollen draws attention to the need for an extensive pollen reference collection when dealing with archaeological material, which can contain pollen types that would not normally be encountered in naturally deposited sediments. It is interesting to note that Centaurea cyanus (cornflower) pollen was not encountered among the 6,397 pollen grains counted from Lloyds Bank. It does appear in the upper part of the Ebor pollen diagram (Greig, unpublished), and that from Askham Bog, and would therefore appear to have been introduced to the York regio at some stage of the medieval period.

The pollen record is very good at showing up some aspects of the nature of the deposits, such as the trees, grasses and cereals. This, however, a biased picture of the remains and incomplete without consideration of a range of further evidence.

3.0

There are several drawbacks to the use of pollen results on their own. There are uncertainties because of the level of identificatior possible in pollen analysis so that, for example, the exact identities and hence ecological affinities of groups like the grasses are largely unknown but for occasional macrofossil records. There are also uncertainties because the pollen could have arrived in the deposits in so many different ways, such as from the atmosphe or contained in vegetation.

There are three main ways of overcoming these problems. One is to assess the likely nature of the archaeological deposits, and then to test these ideas against the data obtained, both from pollen analyses of the deposits and also of modern materials. Another approach is to employ additional data from the deposits such as that obtained from plant macrofossils and insect remains, as well as paying careful attention to anything relevant in the way of archaeological data relating to the deposits. This can help to amplify and confirm findings from the pollen record, and provide information on aspects of the deposit that are not evident from the pollan data. A third approach is to compare Lloyds Bank data with that from other sites, and so see which features are commonplace and which are unusual. It is also useful to compare the data with that from sites where the evidence for the nature of the deposit may be clearer.

3.1.

The first approach, that of considering which materials are most likely to have to have contributed to the remains at Lloyds Bank is summarised in Fig 3. Such a list will have to be modified in the light of experience, but it provides a starting point. Since there are no longer any sites like these Viking cities in occupation now, it is necessary toconsider farms in remote places and folk history records to find out how people lived before the availability of good building materials became widespread. Records from Ireland (Estyn Evans, 1957) and the Orkney and Shetla Isles (Fenton 1978) are very informative: it is interesting to not for example, that thatch roofs were often renewed annually, made with turf, straw and heather (all pollen-containing materials).

The study of the pollen content of materials like thatch, so vital to this work, is dogged by the problem of trying to find out what materials like hay consisted of in the past. In this respect archaeologists in the nineteenth century had an advantage over workers of the present generation because the countryside had not changed as much as it has since the introduction of mechanisation and chemicals. Presents day archaeological botanists have to rese details of weed communities and crops as well as trying to identi their remains in archaeological deposits.

Results so far show that there are sometimes clues to the source of pollen, such as cryptogam spores which are often common in soil pollen spectra, or parasite ova where pollen may have come from faeces. It is hoped that new results will permit a refinement in the "pollen evidence" column of Figure 3. At present there are problems, such as the identification of the range of materials which would contain the pollen of grassland vegetation. Grass occurs in a great range of vegetation types, and its remains could occur in materials as diverse as turf and a animal dung, so it is a long-term project to investigate various kinds of grass products and their pollen spectra. Hay meadows today often have a sown sward which is probably very different from those which were current in the past. Pollen analyses of modern hay are therefore being concentrated on samples from more "natural" fields which might approximate to past hay meadows.

The remains of cereals seem to be identifiable from pollen as rhachis fragments (Robinson & Hubbard 1977, faeces (Krzywinski 1979a and a number of other products (Greig 1981a).

Heathery matter seems to leave a clear record, but some other materials likely to have been used, like brushwood (perhaps in wattle and daub construction) are potential sources of pollen as shown by modern pollen dispersal studies (Krzywinski 1977). Industrial waste is of great potential interest, for the remains from processes involving plant materials would probably leave some trace in the pollen record, but so far there seems to be littl sign of this.

3.2

Additional biological evidence is very useful for the understanding of pollen results such as these. The various studies on organic archaeological material usually have to be carried out by different specialists because of the demands of the different disciplines involved, such as botany, entomology, vertebrate zoology etc. The final results, on the other hand, can be compared with one another very usefully to give a more balanced picture of what has gone on, compared with the results of the various studies considered in isolation. The results from the studies of plant macrofossils (D.W., A.R.H. `) have been used to provide extra information for interpretation of these spectra. Entomologi evidence (H.K.) is also useful, providing data on aspects such as the "indoor" or "outdoor" nature of a deposit.

3.3

There are only a a few other organic archaeological deposits with data comparable to that from York, from pollen, plant macrofossils and insects. Material from a Welsh March castle at Hen Domen (Greig (is useful because is appears to have been sealed in a pit and may be less disturbed than the York deposits. A medieval latrine deposit has also provided evidence of what may be expected from faecal material (Greig 1981b) .

4.1 Interpretation

Figure 4 summarises the data considered most significant for the interpretation (insofar as possible) of these layers. The main characteristics used have been discussed (Greig 1981a) and are briefly as fdllows:

Characteristics of naturally dispersed pollen (in situ or otherwise)
high tree and shrub pollen, abundant outdoor insects and diverse fauna, high Compositae (L) pollen but few seeds, high Plantago lanceolata, Leguminosae and Gramineae pollen.

Characteristics of human dispersed pollen
Compositae (L) pollen and seeds, high Cerealia pollen, Compositae (
pollen and weed seeds, superabundant insect fauna, low diversity.

Samples 8, 9, 10 and 12 form a group with similar characteristics, suggestive of naturally-dispersed pollen. The high tree and shrub pollen values would appear to represent the natural pollen rain in and near York, for similar values were obtained from buried soils albeit of Roman date, at Coney Street (AY 14/2) and at Skeldergate (AY 14/3). These samples also have signs of the "Gramineae local" type of spectrum with high Compositae (L) pollen but very few seeds, although the amount of tree and shrub pollen masks the abundance of Gramineae pollen. This type of pollen spectrum is a peculiar feature of some archaeological deposits, and it must be emphasised that it is not the result of the differential destruction of fragile pollen leaving the robust Compositae (L). This spectrum is thought to arise from vegetation growing very close to the forming deposit with grasses, composites, plantains and other plants of short grassland. An extensive flora of weeds of disturbed ground, such as Chenopodium, Urtica and Polygonum was evident from the macrofossil records, but not obvious from the pollen.

This evidence is difficult to interpret, because it is surprising that an organic archaeological deposit should have such "outdoor" characteristics and only a trace of signs of "indoors". This would suggest that large amounts of decaying organic matter were probably not present here. Moss, turf and brushwood can all contain large amounts of pollen that has been deposited on them by natural means, and such materials could also perhaps account for some of the outdoor beetle fauna as well. Turf seems to be a likely original constituent of these deposits, although moss, brushwood and various other materials such as wetland vegetation may also have been presen Turf was widely used as a building material until the advent of corrugated iron and slate, in Scandinavia and places such as Orkney and Shetland, and it seems to have required frequent replacement when used for roofing (Fenton 1978). The pollen and insect content of these layers could easily be explained if they had come from turf, for the most part. The weed seeds could represent a disuse phase, and they may tend to give a somewhat exaggerated impression of the weediness of the surroundings because these plants are so productive of seeds (weeds like Stellaria media can produce 15,000 seeds per plant, Sobey, 1981). It is possible that these deposits received some pollen from such weedy vegetation and other nearby plants.

Sample 14 stands by itself, with the unusual characteristics of a very large amount of tree pollen which might be suggestive of an outdoor type of deposit, yet the fauna is of low diversity. It is possible that tree pollen could have arrived in a rich source like moss, or some could have washed down from the layers above. Anomalies like this are best studied in the light of the results from a large series of samples, as have been used here. If only a few layers had been studied, it would have been less feasible to try to detect characteristics with less confirmation from comparing samples.

Samples 15 - 33 form a second distinct group of samples with general similar characteristics. They have large amounts of Cerealia pollen, and pollen and seeds from Compositae (T) such as Anthemis cotula, a cornfield weed of the past. This characteristic has been called "Cerealia - human" because it would be hard to imagine circumstances in which such a deposit could form naturally. It would seem to be the result of straw having decayed to form part of the archaeologica layer, acquiring a superabundant insect fauna as it rotted.
In addition to the signs of straw, some samples (18, 20 and 30) have several signs of grassy vegetation which could come from hay or other grassy matter (although weed grasses could also have occurred in the straw). Grassy vegetation and its remains are a problem to interpret; the pollen can be deposited naturally from short grasslan be transported as a naturally-formed spectrum in turf, it can also come from hay (and probably dung) and perhaps from other kinds of grassy matter that might have been gathered in the past for various

purposes. In the case of thses particular samples, the tree pollen values are around the average, and Liguliflorae pollen values are not particularly high, so the evidence for an accumulation of naturally-deposited pollen is not strong. On the other hand, the signs of straw from high Cerealia pollen, and a fauna with high superabundants in two cases (18, 20) together with high Gramineae pollen, and Compositae (L) pollen together with seeds, provides strong evidence of the past presence of hay or other grassy plant material.

The samples from LBIII lack the additional evidence from seeds and insects, thus limiting the interpretation. One sample (4-6) with high Cerealia pollen appears to represent mainly straw, while the others have very large amounts of grass pollen suggesting that they mainly consisted of grass. The tree pollen values were lower than was the case of LBII, so the turf or other sources of the tree pollen and other "outdoor" features of most of the LBII deposits seem to be largely absent here.

4.2

The findings from Lloyd's Bank cannot be compared very directly with the pollen diagram from Askham Bog, which is a few miles outside York (Kenward et al 1978) although it is interesting to try to see points of similarity. The Askham results show something of the state of the landscape around York when the Lloyds Bank site was occupied, butthe flora which grew on and around the bog is so strongly represented in the pollen diagram that the state of the dry land vegetation of the area is hard to tell, and the dating of the levels of the pollen diagram is not very accurate. Work is in progress on a detailed profile in an attempt to solve some of these problems and the uncertainties which come from a bog where peat cutting has taken place. The greater signs of tree pollen at Askham Bog are as expected, although much of this woodland may have been growing on or close to the Bog as it does today, leaving the countryside largely deforested apart from hedges and small wood: The arrival of Centaurea cyanus can be seen to occur, and the part of the diagram contemporary with Lloyds Bank is probably just beneat this horizon, where Cannabiaceae pollen also increases, correspondi with the finds of hemp and hop macrofossils at Lloyds Bank. A grain of Centaurea scabiosa pollen shows that the grains from Lloyds Bank may have been of local origin, although the greater knapweed now does not grow near York (Baker 1906).

Viking remains at Hedeby yielded moss polsters which had been gathered outside the settlement. The pollen analyses (Behre 1969) show something of the vegetation around Hedeby and hardly surprisingly, show little sign of the human-transported pollen so abunda in the samples from Lloyds Bank, with Cerealia , always less than 8% total pollen. Mosses were not readily visible in the York deposits but it is possible that such material, mixed with the othe organic matter, could have given rise to the high tree pollen value noted, as in the case of sample 14.

Some other organic deposits have extremely low tree pollen values, as if almost all the pollen had come from the plant material like hay or straw, rather than from other sources. At Hen Domen (Greig, unpublished) the motte and bailey castle had a pit full of organic matter which had very little tree and shrub pollen (less than 6%) nor much sign of an outdoor insect component. A find like this may show what can be expected from the remains of fairly pure organic material, in this case apparently used in stables, judging from th finds of horse-shoe nails. Deposits such as this seem to be crucia to the understanding of organic materials used in the past, for where there is fairly clear evidence as to origin and content of a limited range of plant remains the interpretation is straightfor and these findings can be usefully applied to complex mixtures, su as those from Lloyds Bank. A latrine, which apparently contained the remains of plant material used in domestic flooring (Greig 19 is also interesting to compare with the Lloyds Bank results. It also has very little tree pollen or "outdoor" signs, and very lar numbers of parasite ova which may be a sign that at York faecal material was only a small proportion of what was there.
Only a few samples (LBII 30, LBIII 4-6) seem to have similarly slight signs of tree pollen.

Organic deposits of the York type seem to be fairly common in post-Roman urban remains such as London (Scaife 1979), Bergen (Krzywinski & Faegri 19 and Cracow (Koperowa in Wasylikova 1978) but these examples seem to be some of the few cases where pollen analysis has been reported. High cerealia pollen appears to be a common feature of these, but lack of other botanical and entomological data makes it hard to make a comparison. It is not known why these organic deposits accumulated. Restricted drainage and flooding may not explain the occurrence of such remains at so many different places. A possible explanation lies in the extensive use of organic material for building. New buildings may have been erected on the debris from their predecessors, and material like flooring and roofing may have been discarded in heaps in the town. Such a mass of organic matter may have been preserved thereafter not by waterlogging, but by exclusion of air from lower layers by those above together with quite a high water content resulting from drainage from above and the water retaining properties of organic matter. Organic deposition would seem to have ceased when brick and tile construction succeeded that with timber and thatching, which was encouraged by the more fire resistant properties of inorganic building materials.

5.0
In summary, it can be said that the pollen results provide useful information about the nature of the deposits, and some botanical records not well represented from the macrofossils. The tree pollen values provide parallel data to that obtained from the insects on the "indoor" nature of layers, or otherwise. The pollen results show up signs of grassland plants like Gramineae, Plantago and Legumino: very well, signs of crops such as Cerealia and Vicia faba and animal remains such as the parasite ova which are indicative of excrement. Comparison with pollen spectra from material of known origin provides a means of identifying those obtained from archaeological samples, although a large amount of research needs to be done to explore this subject. The Lloyds Bank layers appear to represent a great mixture of materials, making the interpretation more difficult than has been the case with other sites. The upper layers have signs of possible turf or soil, while all the samples have signs of grassy material, straw, and slighter signs of sedge with wetland vegetation, and faeces. Heathery material does not appear to have been present apart from trace

BIBLIOGRAPHY

Andersen, S. Th (1970) The relative pollen productivity and pollen representation of North European trees, and correction factors for tree pollen spectra determined by surface pollen analyses from forests Danmarks geologiske Undersøgelse, II Raekke, 1-99.

Baker, J.G. (1906) North Yorkshire: studies of its botany, geology climate, and physical geography. Brown, London

Behre, K-E. (1969) Untersuchungen des botanischen Materials der frühmittelalterlichen Siedlung Haithabu. In: Schietzel, K. (Ed.) Berichte über die Ausgrabungen in Haithabu 2, Wachholz, Neumünster.

Buckland, P.C., Greig, J.R.A. & Kenward, H.K. (1974) York: an early medieval site. Antiquity 48 25-33.

Estyn Evans, E. (1957) Irish Folk Ways Routledge, London

Fenton, A. (1978) The Northern Isles: Orkney and Shetland Donald, Edinburgh.

Godwin, H. & Bachem, K. (1962) Plant material. appendix 3 in: Richardson, K.M., Excavations in Hungate, York. Archaeological Journal 116 109-113

Greig, J.R.A. (1978) A preliminary report on the pollen from Lloyds Bank site, York, and its possible origins. Ancient Monuments Laboratory Reports, Nr2578.

Greig, J.R.A. (1981a) The interpretation of pollen spectra from urban archaeological deposits. In:Hall, R.A. & Kenward, H.K. (Eds.) Environmental archaeology i the urban context. Council for British Archaeolo research reports, London.

Greig, J.R.A. (1981b) The investigation of a medieval barrel-latr from Worcester. Journal of Archaeological Scienc

Greig, J.R.A., Girling, M.A. and Skidmore, P. (1978) A report on the plant, beetle and fly remains from the pit (F 1/27) Hen Domen. Ancient Monuments Laboratory Reports Nr. 2530.

Hall, A.R., Kenward, H.K. & Williams, D. (1980) Environmental evidence from Roman deposits in Skeldergate in: Addyman, P.V. (Ed.) The Archaeology of York 14 (Council for British Archaeology, London.

Kenward, H.K. (1978) The analysis of archaeological insect assemblages: a new approach. In: Addyman, P.V. (E The Archaeology of York 19 (1), Council for Briti Archaeology, London.

Kenward, H.K., Williams, D., Spencer, P.J., Greig, J.R.A., Rackham,]
& Brinklow, D.A. (1978) The environment of Anglo-Scandinavian York. In: Hall, R.A.(Ed.) Viking Age York and the North, 58-70. Council for British Archaeolog Research Report 27, London.

Kenward, H.K. & Williams, D. (1979) Biologicalevidence from the Roman warehouses in Coney Street. In: Addyman, P. (Ed.) The Archaeology of York 14 (2), Council fo British Archaeology, London.

Krzywinski, K. (1977) Different pollen deposition mechanisms in forest: a simple model. Grana 16 199-202.

Krzywinski, K. (1979) Preliminær undersøkelse av planterester i latrine. Arkeo 1979 31-2.

Krzywinski, K. & Faegri, K. (1979) Etnobotanisk bidrag til funksjonsanalyse. Eksempler fra middelalder-undersøkelser i Bergen. Arkeo 1979 33-39.

Rachkam, O. (1981) Ancient Woodland Arnold, London.

Radley, J. (1971) Economic aspects of Anglo-Danish York . Medieval Archaeology 15 37-57.

Robinson, M. & Hubbard, R.N.L.B. (1977) The transport of pollen in the bracts of hulled cereals. Journal of Archaeological Science 4 197-200.

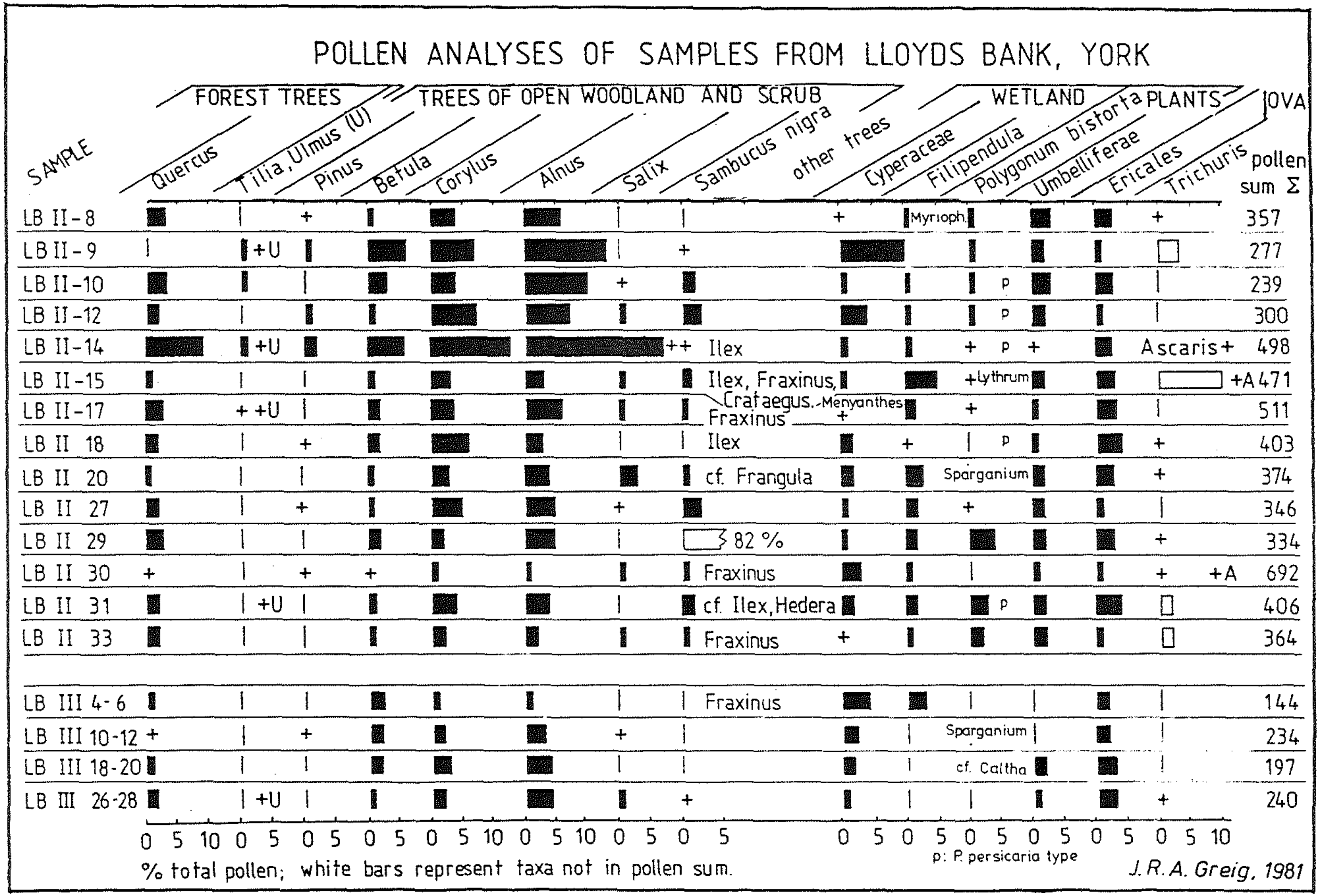
Scaife, R.G. (1979) Pollen analyses of some dark earth samples. Ancient Monuments Laboratory Reports Series Nr.30

Sobey, D.G. (1981) Biological flora of the British Isles Nr. 150, Stellaria media (L.) Vill. Journal of Ecology 69 311-335.

Wasilikowa, K. (1978) Early and Late Medieval plant remains from Wawel Hill in Cracow. Berichte der Deutschen Botanischen Gesellschaft 91 (1) 107-120.

Willerding, U. (1978) Die Paläo-Ethnobotanik und ihre Stellung im System der Wissenschaften. Berichte der Deutsche Botanischen Gesellschaft 91 (1) 3-30.

Figure 1


POLLEN ANALYSES OF SAMPLES FROM LLOYDS BANK, YORK
FOREST TREES
TREES OF OPEN WOODLAND AND SCRUB
WETLAND PLANTS
OVA
SAMPLE
Quercus
Tilia, Ulmus (U)
Pinus
Betula
Corylus
Alnus
Salix
Sambucus nigra
other trees
Cyperaceae
Filipendula
Polygonum bistorta
Umbelliferae
Ericales
Trichuris
pollen sum Σ
LB II-8 357
LB II-9 277
LB II-10 239
LB II-12 300
LB II-14 498
LB II-15 471
LB II-17 511
LB II 18 403
LB II 20 374
LB II 27 346
LB II 29 334
LB II 30 692
LB II 31 406
LB II 33 364
LB III 4-6 144
LB III 10-12 234
LB III 18-20 197
LB III 26-28 240
+U
Ilex
Ilex, Fraxinus, Crataegus,
Fraxinus
cf. Frangula
82 %
cf. Ilex, Hedera
Myrioph.
Lythrum
Menyanthes
Sparganium
cf. Caltha
p
Ascaris
+A
% total pollen; white bars represent taxa not in pollen sum.
p: P. persicaria type
J. R. A. Greig, 1981

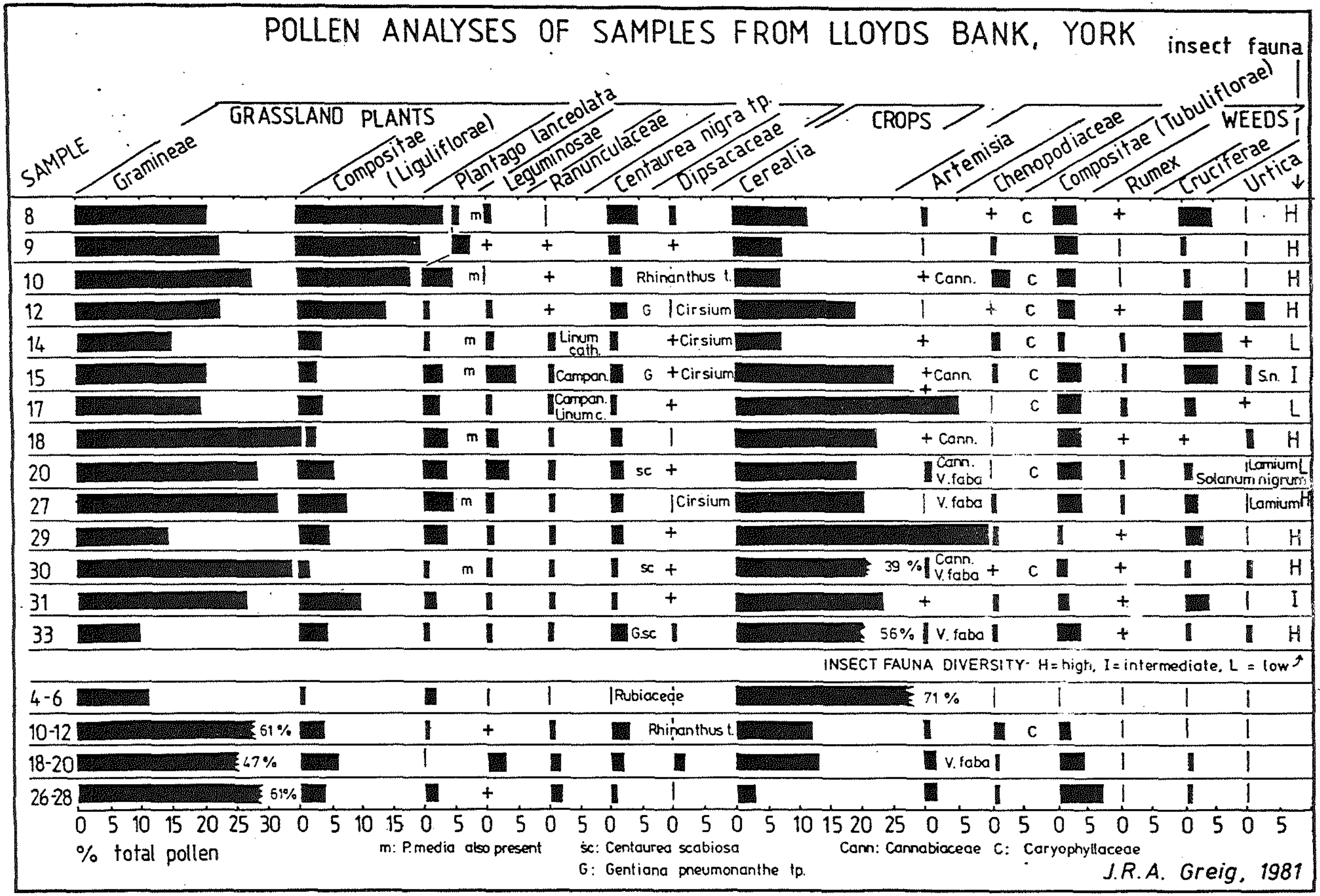

POLLEN ANALYSES OF SAMPLES FROM LLOYDS BANK, YORK
insect fauna
GRASSLAND PLANTS
CROPS
WEEDS
SAMPLE
Gramineae
Compositae (Liguliflorae)
Plantago lanceolata
Leguminosae
Ranunculaceae
Centaurea nigra tp.
Dipsacaceae
Cerealia
Artemisia
Chenopodiaceae
Compositae (Tubuliflorae)
Rumex
Cruciferae
Urtica
INSECT FAUNA DIVERSITY- H=high, I=intermediate, L = low
% total pollen
m: P. media also present
sc: Centaurea scabiosa
G: Gentiana pneumonanthe tp.
Cann: Cannabiaceae C: Caryophyllaceae
J.R.A. Greig, 1981

Figure 2

Material	uses	pollen evidence	macrofossils	insects	examples (most of these are discussed in Greig 1981a).
Peat	fuel	matches other peatland spectra	peatland taxa	peatland taxa	AY 14/3 (insects, seeds) AY 14/1 (? pollen)
Moss	various	high tree pollen from woodland mosses	moss fragments	?	Barton Court Hedeby
outdoor deposit	muckheap	Gramineae-local ?	weed seeds	outdoor fauna	Lloyds Bank
Turf, buried soil	building	matches other soil pollen spectra; spores	weed seeds when present	outdoor fauna when present	AY 14/3 Lloyds Bank
GRASSY MATERIAL					
"fodder hay"	fodder	Gramineae-local, low tree pollen	very few seeds	?	? somewhat like modern hay, roadside vegetation.
chalkland	hay	ditto, with Calcicole records	very few seeds	?	somewhat like modern examples from chalk grassland
"rough hay"	general	Gramineae-local, low tree pollen	wayside plants	superabundant when decayed	Lloyds Bank
sedge etc	general	unclear; Cyperaceae pollen usually present	some taxa abundant, e.g. Ran. scel.	wetland taxa	Lloyds Bank
bracken	general	-	some frond fragments?		Hen Domen?
Herbivore dung		?Gramineae	? seed fragments	dung beetles	
STRAW ETC					
Straw	general, fodder	Cerealia, C. cyanus after introduction.	cornfield weed seeds	?	Lloyds Bank, Worcester
grain, flour	food	Cerealia	bran	weevils	Worcester, Greig 1981b
excrement	food residue	Cerealia parasite ova	bran, seeds of edible plants	characteristic see Osborne in press	Worcester Greig 1981b
Heather	general	Ericales	heathland taxa	heathland taxa	Ebor
Brushwood	general	high tree	?	?	

(note:"general use" represents building, roofing, flooring etc.).

Figure 4

SUMMARY DIAGRAM OF DATA FROM LLOYDS BANK

sample	Tree and shrub pollen	outdoor insects	Compositae L pollen	Compositae L seeds	Plantago lanceolata pollen	Leguminosae pollen	Gramineae pollen	Cerealia pollen	Compositae T pollen	Compositae T seeds	superabundant insects	INTERPRETATION	
LB II - 8	15	I	24	+	1	1	21	12	4	-	I	local	
LB II - 9	28	36	20	-	3	+	23	8	4	-	11	local	
LB II - 10	24	11	18	I	5	-	28	7	3	I	12	local	
LB II - 12	21	16	14	-	1	1	23	19	3	+	21	local	(straw)
LB II - 14	55	8	4	+	1	1	15	7	1	3	62	?	straw
LB II - 15	11	18	3	+	3	6	21	25	4	1	43		straw
LB II - 17	16	5	4	3	3	1	20	35	4	9	37	local	straw
LB II - 18	14	13	3	3	4	2	36	22	4	17	41	hay	straw
LB II - 20	13	6	6	1	4	4	29	19	4	26	44	hay	straw
LB II - 27	16	7	8	+	5	1	32	20	4	4	11	local	straw
LB II - 29	11	5	5	+	4	1	15	39	1	3	17		straw
LB II - 30	5	19	2	7	1	1	34	39	2	17	10	hay	straw
LB II - 31	13	12	10	1	2	1	27	23	2	10	27	local	straw
LB II - 33	9	14	5	-	1	1	10	56	4	8	-		straw
LB III 4-6	6	I	1	I	2	-	12	71	-	I	I		straw
LB III 10-12	8	I	4	I	1	+	61	12	2	I	I	hay	
LB III 18-20	9	I	6	I	-	3	47	13	4	I	I	hay	
LB III 26-28	10	I	4	I	2	+	61	3	7	I	I	hay	

probable pollen source: Naturally-dispersed pollen (Tree and shrub pollen to Gramineae pollen); Human-dispersed pollen (Leguminosae pollen to superabundant insects)

THE FIGURES GIVEN ARE % TOTAL POLLEN, % TOTAL SEEDS, % TOTAL INSECTS RESPECTIVELY.
THE FIGURES CONSIDERED MOST SIGNIFICANT ARE BOXED IN.
LOCAL: GRAMINEAE-LOCAL TYPE POLLEN ASSEMBLAGE

J.R.A. Greig 1981