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SOIL AND BOTANICAL STUDIES OF THE "DARK EARTH"

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Summary

The "Dark Earth" is a dark coloured mixture of anthropogenic debris and soil material, which was thought to represent Saxon and Viking urban occupation. Rather, it has now been shown that it can date to the late Roman and marks a radical change in the land use of once built-up areas of London. Here, excavations, together with these present soil and botanical studies, seem to confirm that a mixture of local and imported soil material combined with anthropogenic waste was purposely dumped to produce "artificial soils" for possible cultivation in once built-up areas during the 4th Century and earlier, and these were probably in use until the 9th-11th Centuries when urban settlement re-established itself. At York, however, the "Dark Earth" examined appears to relate more to continued urban accumulation of anthropogenic and organic waste, during probable Anglo-Saxon and Viking times. There also seems to be strong evidence of cess material being included in this "Dark Earth" from York, and as such is comparable with later Medieval urban environments.

It may be suggested that "Dark Earth" from other Roman towns should be excavated and examined in ways similar to those used here, to try and reveal whether activities archaeologically significant to understanding late Roman London were at all widespread in other English towns. This would also widen our understanding of the general urban environment during the later post Roman period. Lastly, the better preserved nature of deposits from York indicates that waterlogged sites yield more environmental information than that gleaned from the "dry" "Dark Earth" sites so far excavated in London, and thus such wet sites should be given priority in any rescue strategy as far as investigating the environment of the "Dark Earth" is concerned.

SOIL AND BOTANICAL STUDIES OF THE "DARK EARTH"

By R. I. Macphail

INTRODUCTION

The "Dark Earth", which is a dark coloured anthropogenic deposit, is commonly present on urban archaeological sites between Roman and Medieval levels. It is usually poorly stratified and features are difficult to identify as they are commonly of a similar dark colour (Roskams, 1980, personal communication). It may be 0.5 to 1.5 metres thick, and often contains reworked Roman pottery and merges with, or is contaminated by, Medieval or post Medieval debris and features. Unfortunately opinions differ as to what this material represents, and therefore this enigmatic deposit is difficult, and some might say unproductive, to excavate. Nevertheless, careful examination of the "Dark Earth" and its relationships to the underlying and overlying levels and environmental studies in general, have begun to show how urban land use, in the period in question, varied both in time and space, and that information which is archaeologically pertinent is available if sought.

The importance of fully excavating the "Dark Earth" was realised relatively recently, mainly as a result of "Rescue's" survey of London in 1973 (Biddle et al.) which highlighted the dearth of urban archaeological information in the period 5th to 11th centuries A.D. In London Saxon remains were elusive, firstly because of their destruction by Medieval activity, and secondly because of the insubstantial nature of their structures. However, it was considered that these factors did not fully account for the lack of Saxon archaeology in the City of London - much may have been missed by poor excavation technique. In fact many of the pre Medieval and post Roman deposits were not excavated but removed in bulk to reveal the Roman levels.

Such deposits of "Dark Earth" can be identified from sections drawn of excavations of Roman London at the beginning of this century (Norman and Reader, 1912) as "Made Earth" or "Dark Made Earth" burying Roman surfaces and abutting Roman walls. In the nineteen sixties, the "Dark Earth" was certainly well known from excavations in London but was given little attention apart from the Saxon structures it contained (Merrifield, 1965; Grimes, 1968). Yet more recently, the London and Middlesex Archaeological Society's Special Paper (1976) on current problems of the archaeology of London appeared to ignore the whole question of the "Dark Earth".

However, the "Dark Earth" is an important deposit, commonly representing accumulation of material over seven centuries, and is not exclusively restricted to London or the United Kingdom. Archaeologically, it is significant because its occurrence between Roman and Medieval structures represents a marked break in the continuity of normal urban land use. Moreover, the "Dark Earth" is not related solely to the Anglo-Saxon period, for it may be 3rd century Roman (Roskams and Schofield, 1978) or Viking (Addyman, et al., 1976), or merge with the Medieval levels. Consequently, a deposit known to archaeologists since the early excavations of Roman London has been generally neglected because of difficulties in interpreting its amorphous unstratified nature and long deposition period.

In the past, there was some doubt that the "Dark Earth" was an anthropogenic deposit - Kenyon (1959) working at Southwark believed it to be a flood sediment. Subsequently this view has been rejected after consideration of the nature of the material it contains (Sheldon, p40, 1978) and Southwark "Dark Earth" is believed to have been brought in for use as a growing medium for a form of market gardening (Sheldon, 1978). Contrary to expectations for an agriculturally used soil, no increased organic matter content was found in the upper part of the "Dark Earth" during detailed excavations at Milk Street, London (Roskams, unpublished report B); neither was there enough humus in "Dark Earth" from Southwark to suggest it had been cultivated (Taylor, 1978).

If the material had been imported and dumped, such events might be illustrated by particle size analyses of sequences through the "Dark Earth", but Taylor (1978) reported little or no variation through columns of the "Dark Earth" at Chaucer Street Southwark. Thus, earlier views on the nature of the "Dark Earth" seemed contradictory to the evidence. It was therefore reasoned that these questions could only be resolved by investigating "Dark Earth" from a number of sites in London and other localities in the United Kingdom.

SOIL AND POLLEN STUDY

During 1979 and early 1980 samples of "Dark Earth" were examined from four sites in London, and one each from York and Carlisle (Macphail, 1980). Also one rural Roman/post Roman site provided a contrast (Macphail, 1980). In order to check uniformity of identification and character, samples were studied for colour, pH, extractable phosphate content, loss on ignition and alkali soluble humus. Grain size and coarse inclusion analyses were also carried out on samples from selected sites. Thin sections were manufactured of "Dark Earth" from GPO 75 (London) as a comparison for thin sections from Southwark already produced by Mr. T. P. Taylor, and to enable past and present pedogenic processes to be identified more clearly. Complementary botanical studies were carried out, i.e. phytolith (opalised plant remains) analysis of samples from GPO 75, St. Bartholomews Hospital (both London) and the Bedern (York) as pollen had been reported to be scarce. Nevertheless, an attempt was made to extract soil pollen from one level at GPO 75 (Scaife 1980a), but this was only partially successful so a second attempt was made on wetter samples from the Bedern, to provide a comparable source of data.

Methods

Soil colour, both wet and dry, was determined using a Munsell Chart. pH, loss on ignition and grain size analyses followed standard procedures; the test for alkali soluble humus is based on Cornwall's method (1958). Coarse inclusions (larger than 2mm) were washed, identified and calculated as percentages, and extractable phosphorus content was estimated by the method of Schwartz (1967). Thin section manufacture was also based on standard methods. Soil pollen analysis followed standard concentration procedures (Faegri and Iversen, 1974; Moore and Webb, 1978).

Phytolith analysis was carried out on fine soil (less than 1mm) after pre-treatment with HCl., and the combustion of non-opalised organic material. Three samples from each level were mounted on glass slides using Naphrax (Refractive Index 1.74). Phytoliths were counted under the microscope using three or more transects on each slide under phase contrast, and total counts per level varied from 460 to 680. Phytoliths themselves are constructed of biogenic silica or opal (Smithson, 1958; Geiss, 1973) as strengthening to cell walls, and although there are a large number of problems relating to their use in palaeobotanical studies, as listed by Twiss et al. (1969), selected identification and grouping allows the differentiation of particular phytolith suites. These not only permit the grouping and comparison of the general Gramineae per level, but also occasionally individual types may be recognised.

Phytoliths from the "Dark Earth" were counted in broad categories with descriptive names as follows: Plain Rod, Rectangular Rod, Crooked Rod, Fine Rod, Ornamental Rod, Fine Wavy-Rod, Coarse Wavy-Rod, Fine Spiny-Rod, Coarse Spiny-Rod, Spiny Shape, Hat and Dumbell, as these were types both common to the soil samples and to the 30 grass and cereal species examined at the Institute of Archaeology, London.

The Archaeological Sites

The rural site at Lechlade comprises small (generally less than 10 metres across) dark soil zones associated with Roman occupation areas (Miles, 1979, personal communication). Samples were taken from the present day brown Ap horizon and the laterally merging dark Ap horizon (Table 1). Samples were also taken from "Dark Earth" above the Watling Street at Southwark (Dean, 1979, personal communicatio from "Dark Earth" above a Roman floor at Bar 79 (Bentley, 1979, personal communication); from "Dark Earth" above Antonine levels at POM 79 and GPO 75 (Norton, 1979, personal communication; Roskams, 1979, personal communication); and from "Dark Earth" overlying a 2nd century wooden and 3rd century stone building at Keays Lane (Macarthy, 1979, personal communication). Lastly, "Dark Earth" lying between Roman walls and Medieval deposits at the Bedern was received from Andrew Jones of the York Environmental Archaeological Unit.

RESULTS

Before discussing the laboratory results it is useful to consider a typical site description of the "Dark Earth" from GPO 75, as follows:-

"black humic silt, frequent flakes of shell, moderate flecks of burnt daub and charcoal, moderate cobbles-pebbles, occasional flecks of brickearth". (Roskams, unpublished report A).

A similar description of the "Dark Earth" is available from the Milk Street publication:-

"a dark grey silt with inclusions of cultural material such as pottery, tile, and oyster shell, most of which is severely abraided" (Roskams and Schofield, 1978).

In this present study the "Dark Earth" has been found to vary from wet to dry in its modern state and can sometimes be characterised by earthworm casts, yet the descriptions above are typical and show how basically "Dark Earths" have comparable attributes:-

1. "Dark Earth" has a strongly uniform colour throughout the sites (Table 2) especially when wet. However, much of the London "Dark Earth" had dried out to similar greyish browns. Brickearth and the Clayden Pike Ap horizon obviously differ.

2. pH is remarkably consistent, at neutral to alkaline, but this is not unexpected in deposits which are commonly rich in preserved bone and shell.

3. Extractable phosphorus levels vary greatly from Trace to Strong (see Table 2). Both the dark coloured and brown coloured areas of the soil at Clayden Pike have equal amounts, presumably from contemporary agricultural practices. However, as "Dark Earth" from London (i.e. samples 3-15) is often completely dried out, and as phosphorus is known to be irreversibly absorbed on drying (Peter Loveland of the Soil Survey of England and Wales, personal communication), the wetter deposits from Carlisle and York may give a better indication of original phosphorus levels. Variations may relate to the known inhumation at Bar 79 (samples 5 and 6), or be associated with leaching and earthworm activity from an overlying Medieval cemetery as at GPO 75 (sample 12), or reflect "Dark Earth" containing fragmented bone or cess material.

4. Loss on ignition and alkali soluble humus are discussed together as the latter indicates amounts of organic carbon in the "Dark Earth", while slow ignition (at less than 400°C) includes carbonised material in its estimate of organic matter. Knowledge of organic carbon status is useful in ascertaining the agricultural potential of the deposit; loss of ignition is an additional parameter for comparing homogeneity of levels in the "Dark Earth" - it measures immobile material as well as

the mobile organic carbon. The samples from Clayden Pike are interesting because they show amounts of alkali soluble humus in a modern cultivated soil, and reveal little difference in loss on ignition between the dark Ap horizon and the brown Ap horizon, suggesting homogenisation of the surface soil during cultivation.

In London generally, the alkali soluble humus content of the "Dark Earth" is lower than in contemporary soils at Clayden Pike, and tends to be similar at each individual site. Loss on ignition may vary to a much greater extent than, and apparently independent of, the alkali soluble humus content. Organic carbon is more easily disseminated throughout the "Dark Earth" due to pedologic, faunal and floral activity, while loss on ignition tends to reflect the original heterogeneity of the deposit which may result from additions of dumped material.

Samples from Carlisle and York exhibit a similar pattern, but contain far more alkali soluble humus than found in London "Dark Earth" or reported by Taylor (1978) from Chaucer Street, Southwark. In the latter case these low amounts coincided with the small quantities of alkali soluble humus measured from the overlying post Medieval and immediately underlying Roman levels. The wetter nature of the "Dark Earth" from Carlisle and York apparently provides good evidence that lower alkali soluble humus contents of London result from severe oxidation of the organic matter content, because as noted previously, in London the "Dark Earth" is often completely dried out and contains evidence of previous intense biological activity demonstrated by soil micromorphology and soil pollen studies described later. Thus, the London "Dark Earth" may have originally contained similar amounts of organic matter as at Clayden Pike, i.e. levels equivalent to that of an agricultural soil.

5. Particle size analysis shows the "Dark Earth" at GPO 75 to be very poorly sorted, varying between a sand and a loamy sand, and is moderately stony (Table 3). Clay content is relatively low; variations in silt content may depend upon how much of the local "silty" brickearth has been admixed, as shown in thin sections. The "Dark Earth" shows only small variation in texture with depth as noted by Taylor (1978) at Chaucer Street, Southwark.

Much of the coarse material (i.e. larger than 2mm in diameter) at GPO 75 consists of anthropogenic debris (Table 4), such as bone, "tile", mortar, pottery, charcoal and, in some cases, shell (mussel). At York, a similar suite of inclusions is present, so much of the "Dark Earth" is made up of finely fragmented anthropogenic debris, mixed with soil material and organic matter. At GPO 75 stones, and the mainly sandy matrix, must be regarded as exotic in an area dominated by a silty parent material; some coarse grains may derive from abraided pottery. The physical composition of the "Dark Earth" was examined in more detail in thin sections.

6. Three large slides of the central horizon of the "Dark Earth" at the GPO were examined under the microscope (see Micromorphology). Generally, the "Dark Earth" has a dark brown to opaque (Plane Polarised Light, PPL) agglomeroplasmic (after Brewer, 1964) fabric with areas which are more porhyroskelic in nature. Cursory point counting showed the material to be quite dense with good channel structures. Skeletal material comprises much sand and silt, but also inclusions of ceramics and calcite/aragonite shell occur. In addition, recognisable charcoal fragments are present, and it seems likely that more finely comminuted material may be attached to the intimately mixed iron-clay complexes in such a way as to make them opaque. Indeed, evidence of earthworm activity which would account for this dense agglomeroplasmic fabric is common-place. For example, the thin sections contain pedotubles (after Brewer, 1964) comprised of silts without any dark colouration showing how earthworms have burrowed through the "Dark Earth" into the "brickearth" beneath, probably to aestivate. This evidence indicates areas where the "Dark Earth" has yet not been intimately mixed with the "fines" in the natural. Such mixing was apparent in the textural analysis of the site.

In addition, two slides manufactured by T. P. Taylor of "Dark Earth" from Chaucer Street, Southwark were examined in detail and showed the same kind of dark brown to opaque (PPL) agglomeroplasmic fabric. They also exhibit pedotubles relating to fauna importing "non-Dark Earth" material within the matrix of the "Dark Earth" proper. Consequently it appears that the materials are similar and that faunal activity, especially of earthworms, has been important in both. The base-richness of the "Dark Earth" and obviously active faunal population may account for the apparent losses of organic matter.

7. Summary. Soil studies indicate that the "Dark Earth" is a neutral to alkaline deposit originally relatively rich in organic matter, made up of local and exotic mineral material, mixed with a variety of cultural debris (which in the case of charcoal has become intimately associated with the soil fabric) and therefore apparently mainly imported. In London, at least, it would have provided a useful growing medium, containing quantities of phosphorus, bone, organic matter, and, in some cases, cess, in a freely draining environment. It is difficult using soil studies alone to differentiate between material which may be Medieval in origin and "Dark Earth" which is late Roman to pre-Medieval.

BOTANICAL STUDIES

As stated earlier, phytolith and soil pollen analyses were carried out, the latter by R. G. Scaife (1980a). Sample 13 from GPO 75 was examined; pollen was found to be notably sparse and a diminutive total of 35 pollen grains were identified. These are listed in Table 5 and show a predominance of grains with thick exines - Taraxacum type, (Liguliflorae) and Sinapis type. Where grains with thinner exines were identified such as Gramineae, a high degree of degradation was apparent. Crumpling, heavy oxidation and microbial attack resulted in poorly preserved pollen. Consequently differential pollen preservation may be an important feature of this spectra creating a total biased in favour of more robust pollen types.

In view of the above, it can be said that types represented are of predominantly ruderal nature. Pollen of Cerealia type and Sinapis type (4 grains) are most likely to have been introduced onto the site from urban waste rather than from on site cereal production. Differential pollen preservation has almost certainly caused the under-representation of other weeds such as Urtica and Gramineae identified in later deposits at Broad Sanctuary, Westminster (Scaife, 1980b), where a marked species diversity exists.

The poor pollen preservation further supports the hypothesis that the organic matter content of the "Dark Earth" in London may originally have been greater. Cerealia type and Sinapis type pollen could be secondary and associated with a cess input.

Calculation of percentage types of phytoliths from samples 6, 7 and 8 from

Bar 79 and samples 12, 13 and 14 from GPO 75, showed these London "Dark Earths" to be dominated by Festucoid grass types (Twiss et al., 1969; Rovner, 1971), which are represented by Fine Wavy-Rods, Coarse Wavy-Rods and by many of the Spiny and Hat types (Figs. 1 and 2). There are only minor quantities of the diagnostic Dumbell phytoliths (Table 6) which relate to small additions from Panicoid grass types. The pollen data clearly suggested a waste-ground environment, and the phytolith suite present conforms to this.

At GPO 75 the three levels sampled show minor variations in their respective phytolith suites and thus, despite disturbance by earthworms, seem to reflect slight change in flora (either local or imported). At Bar 79 the two lower levels (i.e. samples 6 and 7) are far more alike than the Saxon level above (i.e. sample 8; see Table 1). The latter also differs from the suites present at GPO 75 (see Fig. 2) being characterised by many Coarse Wavy-Rods typical of grass genera such as Cynosurus and Poa, which could indicate a sharp change in usage of or input into the "Dark Earth" at this time.

The two samples from York were examined for pollen by R. G. Scaife and the results were encouraging - absolute pollen frequencies were higher than at GPO 75 enabling a basic count of 100 grains to be made of sample 18 (see Table 1) and 200 grains were counted from sample 19 (the lower level of the Bedern "Dark Earth"). Pollen preservation was also notably better, although a divergence was found in the pollen spectrum of the upper level.

On one hand a number of types including Taraxacum and Anthemis type with thicker exines, showed a degree of degredation seen at GPO 75. The remaining bulk of the pollen was in a moderate to good preservation state including Gramineae, Cerealia type and Centaurea cyanus (Table 7).

The pollen taxa are dominated by ruderal and pastoral pollen types of which Gramineae is the most important. In addition to these, however, are Cerealia type, Centaurea cyanus and Sinapis type which are usually indicative of arable agriculture. These pollen types are likely to be of secondary-derived origin in such urban contexts. Analyses of medieval cess material show that high concentrations of cereal pollen and macro remains are present (Scaife, 1980b). It seems likely, therefore, that arable pollen types are derived from human faecal waste deposited on or in the soils. Further evidence of this comes from the presence, albeit in low numbers, of parasite eggs (Trichuris spp.) and these have been reported elsewhere from urban deposits (Pike and Biddle, 1966). Whilst these may be from animal sources (especially pigs) a human origin is likely.

The dual nature of the preservation noted, suggests that two phases of pollen influx are present:-

a) The degraded pollen of robust exine types may represent autochthonous growth of these plant types. These may therefore pre-date the well-preserved pollen.
b) Well preserved pollen may have been contemporaneous and in material dumped on the site including the ruderal and arable pollen types discussed above.

Phytolith analysis of the York samples again showed a basically Festucoid suite, but with far greater quantities of Panicoid grass types than found in London. Interestingly, sample 18 contains a high proportion (19%) of Coarse Spiny-Rods (see Fig. 2) many of which were very large indeed (approximately 140 microns by 20 microns). Study of the Institute of Archaeology (University of London) phytolith collection indicated that many grass types could not be represented by these particular phytoliths. Even genera with Coarse Spiny-Rods such as Cyperacae spp. and Nardus spp., seemed unlikely candidates because they lack the multiple elements present on the species of these Coarse Spiny phytoliths. However, reference phytoliths of Triticum aestivum, both from the collection and from archaeological material, are clearly similar to the Coarse Spiny types identified from York (Hubbard, personal communication). As shown by the soil pollen, there may have been increments of secondary cereal pollen into this deposit, together with arable indicators, further supporting the contention that cereal material was included in the "Dark Earth". Armitage (1975) found well preserved phytoliths on the teeth of ungulates at Baynards Castle, and this argues that phytoliths at York could be of secondary origin. On the other hand, they may relate to waste from, for example, threshing.

In the lower level at York pollen preservation was good, possibly due to a higher moisture content. The dominant types are Calluna (46% TP), Taraxacum type

(9% TP), Gramineae (22% TP) and Cerealia type (7% TP), (Table 8). These occur in association with a diverse ruderal assemblage similar to that of York Sample 18. Calluna is the notable exception to this and poses the question of its origin. Natural transportation cannot be the case because although Calluna produces large quantities of pollen, its dispersion is poor due to the high specific gravity of its pollen tetrads. Calluna must have been collected and utilised for one or more reasons of floor cover, animal bedding, fodder or brushwood. Indeed, evidence of Calluna and specific beetle remains has been similarly interpreted for an Anglo-Danish site elsewhere in York (Buckland, 1974). The presence of high Gramineae totals may also be noted in this respect. Such material may have been dumped onto the soils of waste ground. The presence of cereal pollen as in preceding samples may similarly result from kitchen waste or human faecal material being dumped.

Phytoliths included 16% Dumbells (see Fig. 2), revealing a relatively high composition of Panicoid grass types. Two typical Panicoid grasses are Sieglingia sp. and Molinia sp., and a review of the reference slides, together with Smithson's (1958) findings from North Wales, suggested that both of these may have contributed towards the Panicoid grass types represented in sample 19. It is likely that the Calluna was collected from local moorland areas and Sieglingia and Molinia may have easily become incorporated in the same way, whether by design or accident it is difficult to say; or alternatively these particular phytoliths may have been brought in by stock which had been grazing on the moor.

Summary

Urban areas are highly complex depositional environments, which causes problems when interpreting both phytolith and pollen data because the majority of pollen and phytoliths found result directly or autogenically from human activity. This is illustrated by the relatively low pollen frequencies of arboreal types transported naturally from rural areas. The assemblages therefore appear to reflect:-

a) The growth of ruderals on waste ground in urban areas, e.g. Plantago lanceolata, Compositae spp., Rumex spp.

b) Plants introduced/brought in from rural areas for various uses, e.g. Calluna sp. and Gramineae.

c) Refuse material discarded onto waste or open areas, with which are associated the arable pollen types and related weeds, derived from domestic waste, and possibly parasite eggs.

It must be remembered however, that some of the secondary material may have been imported with the "Dark Earth" which is not directly related with its use.

DISCUSSION

Soil and botanical studies showed the "Dark Earth" as apparently fulfilling varying but similar roles and comprising mainly rubbish material. As Grimes (1968) pointed out for the Medieval period, in urban areas there was probably a general accretion of waste matter, not easily disposed of and likely to have been spread over open ground in gardens and elsewhere. Evidence of such additions of material is provided by the pollen, phytolith, loss on ignition and inclusions data. The uniformity of grain size described by Taylor from Chaucer Street, Southwark (1978), which was also noted at GPO 75, does not in fact preclude successive dumping as a means of accumulating "Dark Earth", especially if it all comes from a similar source. Particle size analysis, with the micromorphology, also revealed how extraneous material has been mixed in with the local parent materials. There is also clear indication of dumping, from West to East at GPO 75, in the form of tip lines, zones with much higher proportions of inclusions, or layers of building material (Roskams, unpublished report A). In contrast, "Dark Earth" from Milk Street, London appeared homogenous throughout, because it is thought (Roskams, unpublished report B) to be more intensively used, and evidence of dumping therefore obscured. This intensive cultivation perhaps accounts for the severe abrasion of pottery, and the position of a 9th century sherd 60 cms down into the "Dark Earth" (Roskams and Schofield, 1978). Yet "Dark Earth" was apparently tipped onto an undisturbed mosaic at Milk Street (Roskams and Schofield, 1978), in the same way as "Dark Earth" seems to have been dumped onto an opus signinum floor at St. Bartholomews Hospital.

"Dark Earth" may have also included "street sweepings" (Sheldon, 1978) which were deposited in market gardens in the early 17th century and would tend to produce layers of uniform texture, mixed with anthropogenic debris. Both Orton (1978) and Wilson, et al. (1979), looking at the distribution of cultural debris in "Dark Earth" from Southwark and Abingdon respectively, have found the progressive introduction of later pottery up through the deposit, together with mixing of relic pottery from earlier periods. This suggests successive accumulation and reworking of "Dark Earth"

The inclusion of anthropogenic debris would increase fertility and produce freely draining, neutral to alkaline "soils", in some cases phosphorus rich, effectively base rich brown earths. The soil pollen may suggest a cultivated soil, although a more organic upper soil, expected from agriculture, has been obscured by the general oxidation of the "Dark Earth" and by earthworm activity, as well as by continued reworking as described above.

At York, increments of material to the "Dark Earth" seem to be similar to other areas, although at the Bedern more evidence is preserved of botanical additions other than the local ruderal flora. Here, elements of waste occur, similar to that from later crowded Medieval cities when it was common to use any spare ground as an open sewer (Ziegler, 1969), as illustrated by the 15th to 17th century stream-fill from Broad Sanctuary, Westminster. At this site Scaife (1980) has shown very large urban ruderal pollen input into a narrow riverine deposit which was probably rich in cess; this assessment agrees with findings from pre-Norman York (Addyman et al., 1976).

CONCLUSIONS

Study of samples of "Dark Earth" has revealed the numerous components which produce this deposit, which may result purely from rubbish dumping or was purposely used for market gardening. "Dark Earth" is important to the history of the sites and cities where it occurs, because the simple model of Roman abandonment and Dark Ages decay may not be wholly correct.

London was thought to have been occupied as a city almost to the end of the 5th century; after an unspecified time, walls collapsed and ruins were deliberately demolished and subsequently overlain by material representing the Dark Ages (Merrifield, 1976). However, evidence from Staines indicates a decline in the 4th century (Crouch, 1976), and nearer the City, at Southwark, mid 2nd century buildings at the Borough High Street were destroyed and overlain by "Dark Earth" containing 3rd to 4th century pottery (Southwark and Lambeth Archaeological Excavation Committee, 1978). General findings from Southwark show earlier buildings being buried by "Dark Earth" by the mid 4th century and the "spreading process" continuing as late as the end of the 4th century (Sheldon, 1978). Previously built-up areas were given over to market gardening towards the end of the Roman period, presumably to meet local requirements, and the "Dark Earth" continued to accumulate into the Medieval and post Medieval when much of the sites in question were known to be gardens (Sheldon, 1978). At Staines, the "dark soil" was used for agriculture during the 9th - 12th centuries as evidenced by relic ridge and furrow (Crouch, 1976).

Evidence therefore exists of a dramatic change from an urban existence to cultivation of artificial soils burying these previously built-up areas in the "suburbs". At the end of the 4th century, London was still the seat of the Provincial Treasury (Biddle, et al., 1973) and the City's bastions had only been recently completed (Grimes, 1968). Even so, at St. Bartholomews Hospital the opus signinum floor is buried by "Dark Earth" of between 2nd - 4th century in age (Bentley, 1979, personal communication), while the lowest "Dark Earth" at GPO 75 dates from the 4th century (Roskams, unpublished report A). At GPO 75, the late Roman had been cut away at different levels, sometimes removing the underlying Antonine completely, while much residual building material had been loosely deposited before the "Dark Earth" accumulated (Roskams, unpublished report A). Further, at Milk Street an absence of destruction debris seems to show systematic dismantling of the Roman at the end of the 2nd century, whilst the actual deposition of the "Dark Earth" commenced in the early 3rd century (Roskams and Schofield, 1978). Again, as at Southwark, there seems to have been a radical change in land use, with a lack of 4th century finds at Milk Street indicating a non-domestic occupation of the area (Roskams, unpublished report B).

The inferred implications of this are that late Roman London probably had a sparser population, with possible farming within the walls, and that there had been a dramatic change from the early commercial expanding town with its entrepreneurial class (Roskams and Schofield, 1978). Seemingly, built-up areas had been dismantled and now were possibly used for agriculture based on dumped "Dark Earth", while the legal, government and military functions of the city continued.

Therefore, the "Dark Earth" here, seems to represent the changing nature of the City during the late Roman period rather than its sudden abandonment and decay relating to Roman withdrawal and the arrival of the Dark Ages. This then is relevant to questions of urban continuity during the late Roman and Saxon periods as posed by Biddle (1976).

In the case of York, the Anglo-Saxons inherited buildings, while later the walled town was also utilised by the Danes, giving the city a continuity of use up to the Normans, and this intensive occupation produced in many cases dark deposits which are commonly organic in nature (Addyman et al., 1976). This better preserved type of "Dark Earth" as analysed earlier and here described in the literature, cannot be directly compared with the more oxidised deposits associated with the changing urban environment of late Roman London, yet in contrast seem to suggest continued accumulation of domestic waste in restricted areas over many centuries.

We may then have two types of "Dark Earth". One perhaps relating to a sparser urban population in London, as an initially purposely dumped artificial garden soil, and the other, being a deposit concomitant with continued urban refuse disposal in a more densely occupied environment as at York. The next step now is to examine a wet "Dark Earth" site from London so that it can be more accurately compared with material from York. In addition, it would be worthwhile looking at "Dark Earth" from other towns to see if there are other instances of supposed late Roman "Dark Earth".

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SAMPLES

1-2, Clayden Pike, Lechlade, Oxfordshire Archaeological Unit.

3-4, Arcadia Buildings, Southwark, Southwark Archaeological Unit.

5-9, St. Bartholomews Hospital, London, Department of Urban Archaeology.

10-11, GPO (Middle), London, Department of Urban Archaeology.

12-15, GPO (South), London, Department of Urban Archaeology.

16-17, Keays Lane, Carlisle, Planning Department, Carlisle City Council

18-19, Bedern, York, York Archaeological Trust.

TABLE 1

Site	Sample	
Clayden Pike, Lechlade, Oxon.	1	Contemporary brown Ap
	2	Contemporary black Ap
Arcadia Buildings, Southwark	3	Above Watling St; "Dark Earth"
	4	to Medieval.
St. Bartholomews, London (Bar 79)	5	Late 2nd C. to 4th C.; resting
	6	on opus signinum floor.
	7	Late Roman or Saxon
	8	Probable Saxon
	9	Approx. 11th C.
GPO Middle (POM 79), London	10	Medieval
	11	Possible "Dark Earth"
GPO 75, London	12	"Dark Earth"
	13	" "
	14	" " , approx. 4th C.
	15	Brickearth
Keays Lane, Carlisle	16	"Dark Earth" to Medieval
	17	" " " "
The Bedern, York	18	"Dark Earth"
	19	" "

(See Samples)

TABLE 2 - ANALYTICAL DATA

Sample	Site	pH	P. spot test	Alk. Sol. Humus	% loss on ignition	Colour Moist	Colour Dry
1	Clayden Pike, Oxon	7.5	Pos-W	108.0	10.3	10YR3/4	5YR3/4
2	" "	7.5	Pos-W	109.0	9.9	10YR3/1	10YR3/2
3	Arcadia Buildings,	7.0	W	56.0	3.96	10YR3/1	10YR6/2
4	Southwark	7.0	Tr	56.0	4.49	10YR3/1	10YR6/2
5	Bar 79, London	7.4	Pos	24.0	2.34	10YR3/1	10YR4/2
6	" "	7.4	Pos	27.4	2.04	10YR3/1	10YR5/2
7	" "	7.4	W	25.0	2.26	10YR3/2	10YR4/2
8	" "	7.4	Pos	31.0	2.60	10YR3/1	10YR4/2
9	" "	7.5	W	54.0	2.04	10YR3/1	10YR4/2
10	POM 79, London	7.6	Pos	92.0	6.81	10YR3/1	10YR4/2
11	" "	7.1	Pos	86.0	5.37	10YR3/1	10YR4/2
12	GPO 75, London	7.3	Pos	54.0	2.70	10YR3/1	10YR4/2
13	" "	7.5	W-Pos	58.0	15.01	10YR3/1	10YR4/2
14	" "	7.6	Tr	59.0	2.70	10YR3/1	10YR4/2
15	" "	8.4	W-Pos	5.9	1.49	10YR5/4	10YR7/4
16	Keays Lane, Carlisle	6.9	Pos	118.0	5.16	10YR3/1	10YR4/2
17	" "	6.7	Pos	144.0	5.53	7.5YR2/0	10YR4/1
18	The Bedern, York	7.2	W	200.0	12.33	10YR3/0	10YR5/1
19	" "	7.0	Str	212.0	10.30	10YR3/1	10YR5/1

N.B. i) Alk. Ext. Humus, mgms. per 100 gms. dry soil

ii) Phosphate: Tr, Trace, approx. 0.08 - 0.15% P_2O_3

W, Weak, approx. 0.15 - 0.4% P_2O_3

Pos, Positive, approx. 0.4 - 0.8% P_2O_3

Str, Strong, approx. 0.8% or more P_2O_3

After Schwartz (1967)

TABLE 3

% PARTICLE SIZE - GPO 75

Sample	Cl.	F.Z.	M.Z.	C.Z.	F.S.	M.S.	C.S.	(Gravel)
12	12	5	3	2	27	39	12	(19)
13	13	4	4	7	29	32	11	(20)
14	12	3	8	2	32	34	9	(17)

TABLE 4

% INCLUSIONS, LARGER THAN 2MM

Sample	Site	Bone	"Tile"	Mortar	Stones	Pottery	Charcoal	Mussel Shell
12	GPO 75	1.2	24.0	43.0	13.0	3.7	0.09	-
13	"	18.0	17.0	3.5	45.0	7.0	0.06	-
14	"	12.0	10.0	3.4	70.0	0.2	0.64	3.8
18	The Bedern	1.4	8.0	31.0	33.0	26.0	0.5	-
19	"	2.4	10.5	36.0	33.6	5.7	11.6	-

TABLE ~~4~~ 5

London G.P.O. ~~Boston~~ 75, Sample (13)

	Pollen
Sinapis type	4
Chenopodium type	2
Papilionaceae indiff.	2
Centaurea cf scabiosa type	1
Taraxacum type	29
Gramineae	2
Cerealia type	1
Dryopteris type	1
Pteridium aquilinum	1

Total pollen count = 35 grains

[illegible]

PERCENTAGE PHYTOLITH TYPES FROM ST. BARTHOLOMEWS HOSPITAL, GPO 75 AND THE BEDERN

Sample	Plain	Plain-Rods Rect.	Plain-Rods Crook.	Fine	Total Rods Pl. Rods	Total Rods Orn.	Wavy-Rods Fine	Wavy-Rods Coarse	Spiny-Rods Fine	Spiny-Rods Coarse	Spiny Shape	Hats	Dumbells	Total Count
St. Bartholomews Hospital (London)														
6	10.7	3.5	2.4	1.6	18.2	19.8	22.5	31.8	4.8	1.4	-	2.3	0.4	541
7	26.8	3.5	3.5	-	33.8	13.1	23.5	10.7	5.6	2.9	-	3.7	0.7	571
8	30.6	2.1	1.5	-	33.2	14.0	28.5	6.1	6.1	4.6	-	5.4	0.2	477
GPO 75 (London)														
12	20.2	0.3	1.0	1.6	22.9	14.1	30.0	6.3	12.1	6.3	1.6	4.1	1.6	569
13	19.6	0.4	1.5	1.7	24.2	23.3	33.9	1.7	8.7	3.9	0.6	3.3	0.8	460
14	12.7	-	0.9	0.8	14.4	21.7	40.4	4.6	8.6	4.6	1.5	2.6	1.7	544
The Bedern (York)														
18	12.2	-	0.7	3.9	16.8	14.3	24.4	4.4	9.8	18.9	4.7	1.4	4.5	680
19	13.4	-	1.3	1.9	16.6	14.4	25.6	5.0	7.9	9.7	3.6	0.9	16.2	617

TABLE 7

York, Bedern, Sample (18)

	Pollen
Alnus	4
Calluna	2
Sinapis type	2
Chenopodium type	1
Plantago lanceolata	2
Taraxacum type	7
Anthemis type	5
Bidens type	1
Centaurea cyanus	3
C. nigra type	1
Gramineae	58
Cerealia type	7
Cyperaceae	5
Unidentified pollen	2
Dryopteris type	1
Parasite eggs (Trichuris spp.)	5

Total pollen count = 100 grains

TABLE ~~4~~ 5

York, Bedern, Sample (4) (19)

		% TP
Betula	2	1
Alnus	3	1.5
Corylus	9	4.5
Calluna	71	35.5
Ranunculus	1	0.5
Silene type	2	1.0
Chenopodium type	2	1.0
Trifolium type	1	0.5
Papilionaceae indiff.	1	0.5
Umbelliferae	1	0.5
Polygonum convolvulus	2	1.0
Rumex	2	1.0
Scabiosa	1	0.5
Bidens type	1	0.5
Anthemis type	1	0.5
Taraxacum type	17	8.5
Centaurea nigra type	1	0.5
Gramineae	43	21.5
Cerealia type	14	7.0
Cyperaceae	4	2.0
Unidentified pollen	1	0.5
Sphagnum	1	0.5
Pteridium aquilinum	3	1.5

A.P.F. = 14000 grains per gramme

Micromorphology, "Dark Earth" level B at G.P.O. 75

An undisturbed sample of the "dark earth" was air-dried and impregnated with an Araldite mixture, and thin sections (3mm x 1.5mm) were examined under the petrological microscope.

The "dark earth" is heterogenous; black (opaque) to dark brown (P.P.L. - Plane Polarised Light), and black with a medium lustre under reflected light (R.L.). It comprises fine rounded accomodated primary peds forming in most areas more coarse, rounded blocky secondary peds. Total voids equal 20-25%, with mostly compound packing voids which are mainly metavughs or well formed channels both within and between larger peds.

There is approximately 18% skeletal material comprising sub-rounded medium sized (0.2-0.6mm) sand grains and gravel sized (2-6mm) grey shell, and dark red brown (PPL) ceramic material. The "dark earth" contains nearly 20% silt. The shell fragments, which are most probably oyster, exhibit extreme birefringence colours concomitant with a calcite/aragonite composition.

Varying quantities of silt and fine sand sized (0.06-0.2mm) charcoal fragments are present. Reflected light suggests both soil humus and finely divided charcoal are intimately mixed with the iron and clay complexes forming the matrix.

Both manganic and ferric glaebules can occur. Generally, fabric is silasepic; agglomeroplasmic-porphyroskelic.

Pedological features include pedotubles; one of which is 5mm in diameter and has three zones. The outer edge is a greenish colour, most probably due to gleying and demarcates the non opaque soil of the pedotuble from the black, carbon-rich "dark earth". The outer zone is orange-brown (PPL) and silasepic. The inner zone is grey-brown and asepic (free of silt or sand), whilst the centre is void space. It seems likely that this is a faunal burrow (earthworm) which has brought "natural material" (brickearth-silasepic) into "dark earth". The grey-brown iron-clay material in the centre is likely to be fines which have been washed into the burrow through some soil disturbance.

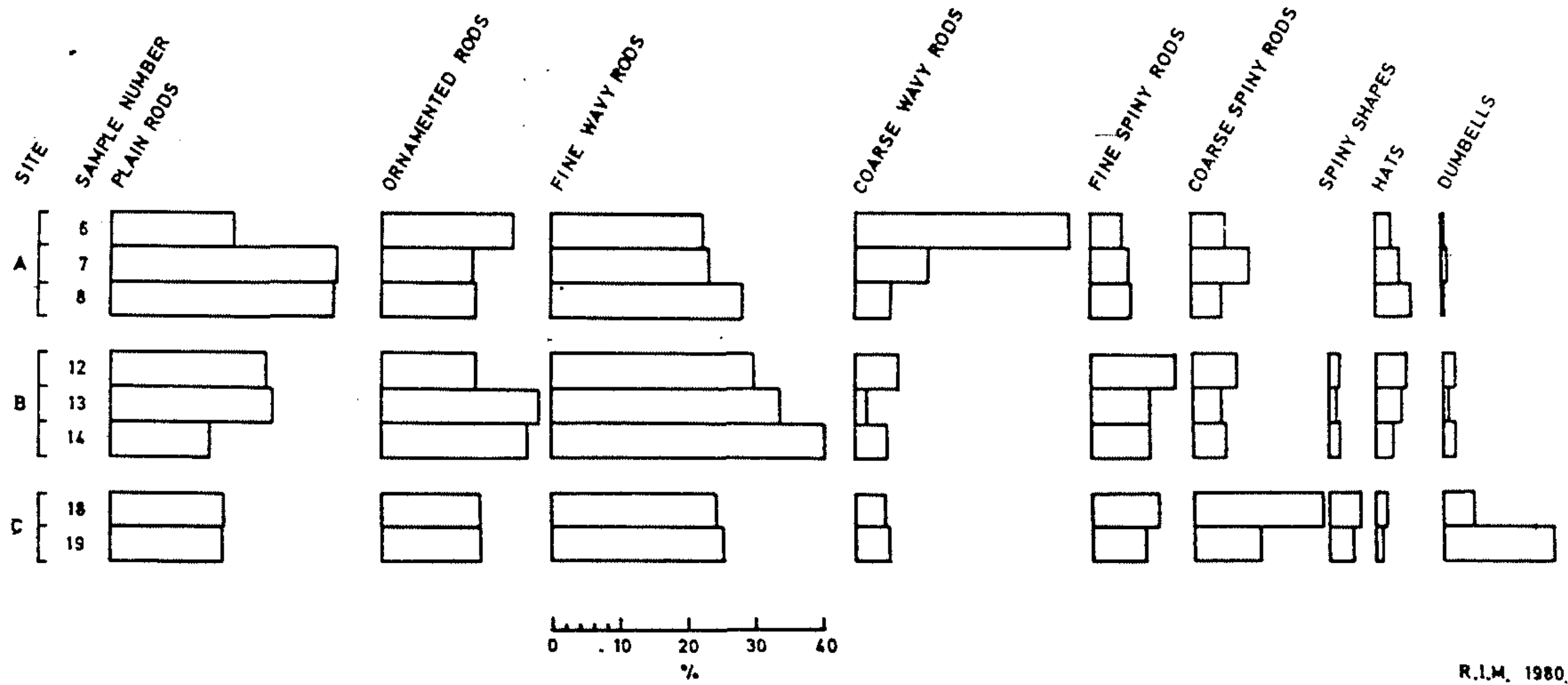
Elsewhere in the "dark earth" there are plasmic separations both in the form of non-birefringent iron-clay channel linings and rare grain and channel argillans indicating some movement of material through disturbance other than faunal.

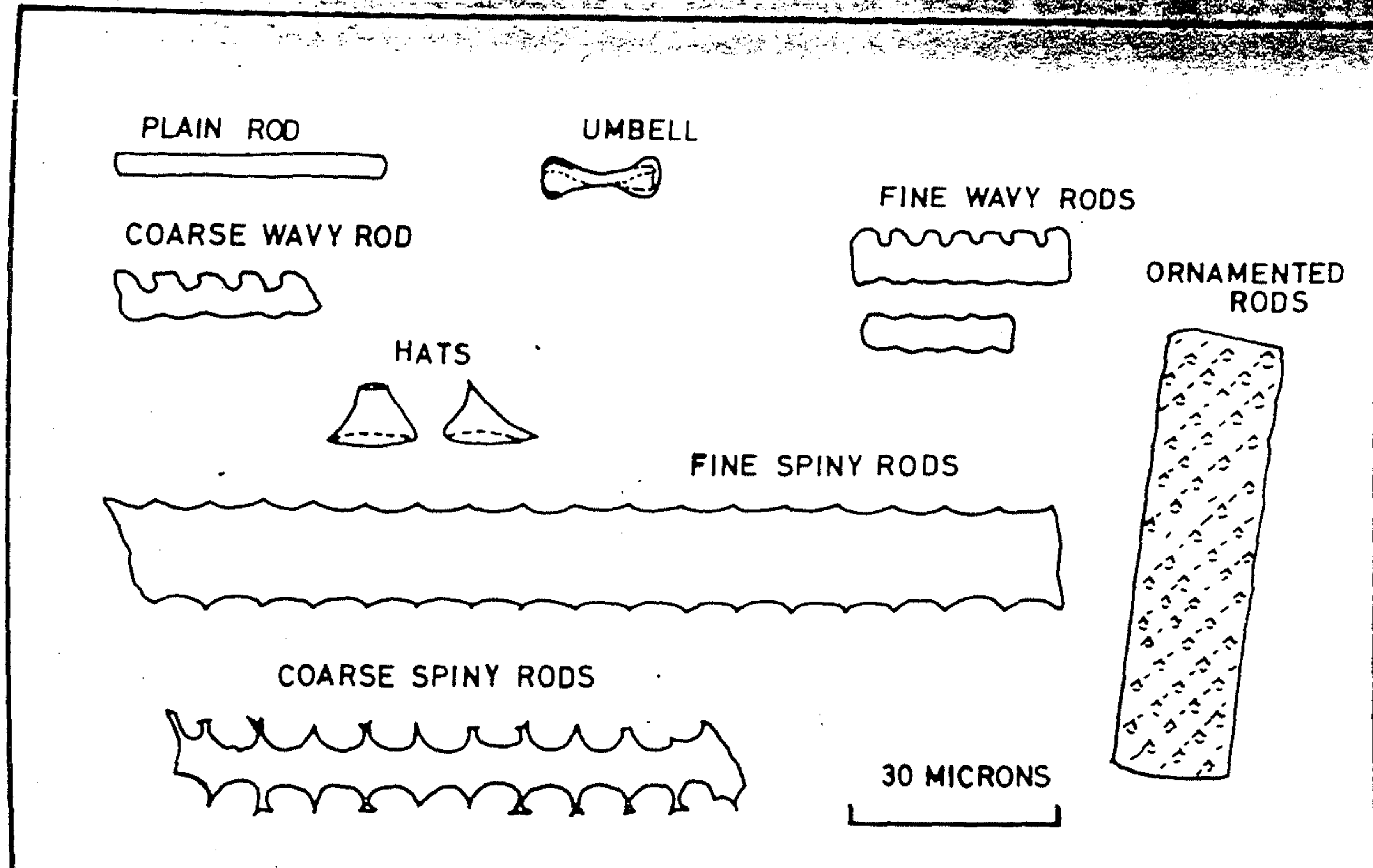
Thus we have a soil environment where wetting and drying are important processes. In addition, faunal activity is evident through obvious pedotubles and the nature of the soil aggregates or peds, which tend to occur in high base status brown earths. Therefore it is likely that the intimate mixing of charcoal and organic matter with the soil mineral content is liable to have occurred through faunal as well as wetting and drying activity.

It is likely that soil material that has been mobilised and redeposited has originated from the underlying natural brickearth, for these "fines" tend to have no "dark earth" content and thus were most probably not flocculated and thus more readily moved.

Overall, the micromorphology of GPO "dark earth" is similar to that of Southwark "dark earth" except for perhaps there being more large charcoal fragments at Southwark which notwithstanding is characterised by an agglomeroplasmic fabric and pedotubles.

FIG. 2 PERCENTAGE PHYTOLITHS FROM (a) GPO 75 (b) St. Bartholomews Hospital and (c) The Bedern




PLAIN ROD
UMBELL
FINE WAVY RODS
COARSE WAVY ROD
ORNAMENTED RODS
HATS
FINE SPINY RODS
COARSE SPINY RODS
30 MICRONS