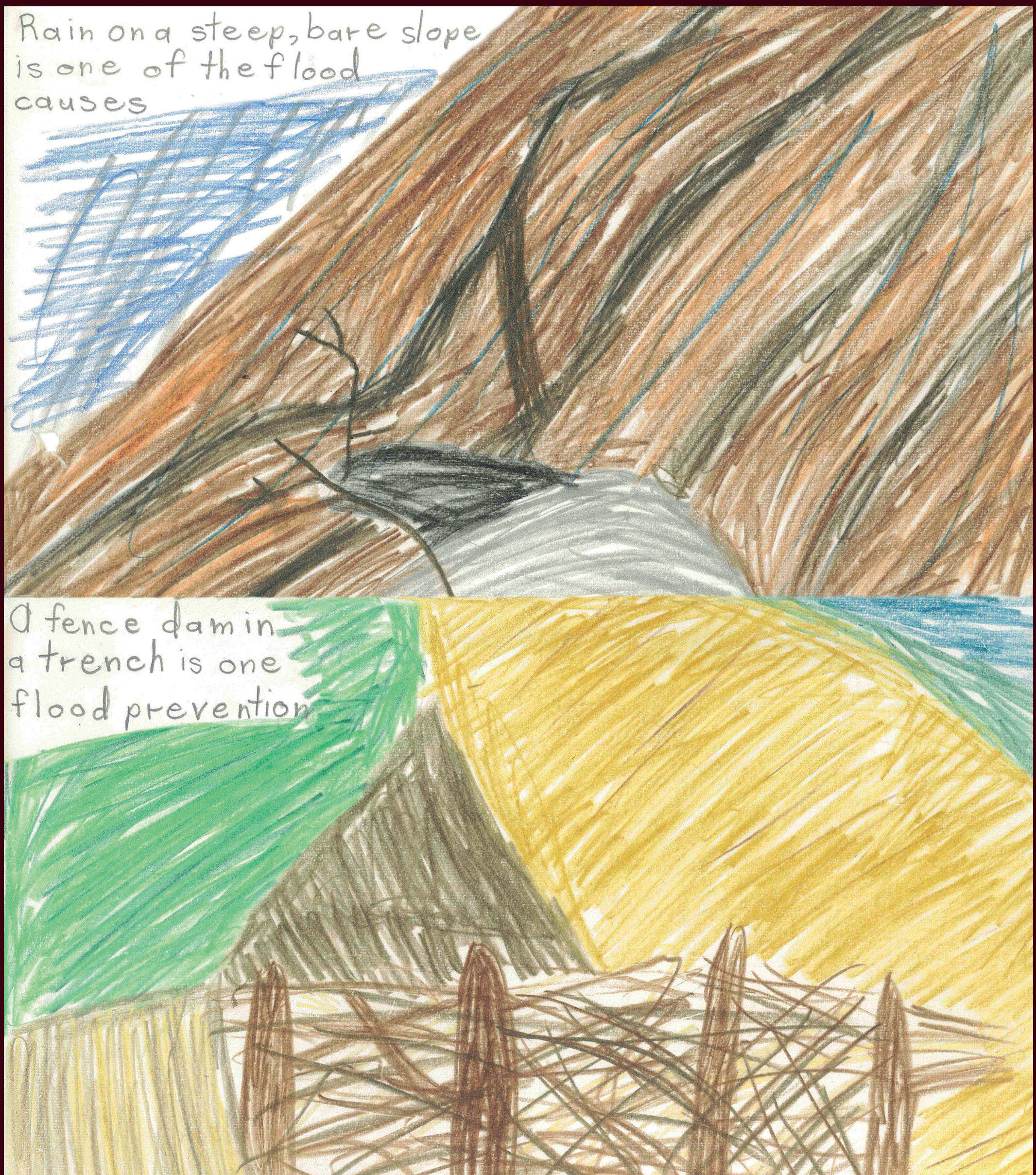
McDONALD INSTITUTE CONVERSATIONS

Inspired geoarchaeologies: past landscapes and social change

Essays in honour of Professor Charles A. I. French

Edited by Federica Sulas, Helen Lewis & Manuel Arroyo-Kalin



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Essays in honour of Professor Charles A. I. French

Edited by Federica Sulas, Helen Lewis & Manuel Arroyo-Kalin

with contributions from
Michael J. Allen, Andrea L. Balbo, Martin Bell, Nicole Boivin, Christopher Evans, David Friesem, Kasia Gdaniec, Lars Erik Gjerpe, Michael Gill, Martin Green, Ann-Maria Hart, Robyn Inglis, Martin Jones, Gabriella Kovács, Helen Lewis, Johan Linderholm, Roy Loveday, Richard I. Macphail, Caroline Malone, Wendy Matthews, Cristiano Nicosia, Bongumenzi Nxumalo, Innocent Pikirayi, Tonko Rajkovaca, Rob Scaife, Simon Stoddart, Fraser Stuart, Federica Sulas & Magdolna Vicze

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On the cover: *Hand drawn illustration by Charly French, aged around 10 years old. Courtesy of Kasia Gdaniec.*

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Martin began a fieldwalking survey as a lad on Cranborne Chase in the latter 1960s. Following experience gained on a number of field projects, he began excavating independently in the region in 1976. He joined Richard Bradley's and John Barrett's Cranborne Chase Project the following year, contributing four site excavations to *Landscape, Monuments and Society* in 1991. He continued independent fieldwork in the early 1990s in collaboration with Mike Allen, in particular on the Fir Tree Field shaft which revealed a remarkable sequence of deposits dating from the late Mesolithic to the Beaker period, and worked with Charly French on the Upper Allen Valley Project 1998–2003, contributing four further site excavations to *Prehistoric Landscape Development and Human Impact in the Upper Allen Valley, Cranborne Chase, Dorset* (2007). Since that time, he has continued independent research, also in collaboration with Josh Pollard and Southampton University, on the Dorset Cursus, on Down Farm and in the Knowlton environs whilst continuing to increase the biodiversity on his small farm. He was made an FSA (Fellow of the Society of Antiquaries) in 2004 and received an honorary Doctor of Science degree from Reading University in 2006.

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Francis has studied the archaeology of the Fens since 1971. His major excavations in the region took place near Peterborough at Fengate, Maxey and Etton. In 1982 his team's survey of fenland drainage dykes revealed the timbers of a waterlogged Bronze Age timber platform and causeway at Flag Fen, which was opened to the public in 1989. He was a member of Channel 4's long-running series *Time Team*. He has written many popular books including *Seahenge* (2001), *Britain* BC (2003), *Britain* AD (2004), *The Making of the British Landscape* (2010), *Home* (2014), *Stonehenge* (2016) and *The Fens* (2019). His most recent book is *Scenes from Prehistoric Life* (Head of Zeus 2021).

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Rob is a visiting professor of palaeoecology and environmental archaeology at the University of Southampton, and an honorary research associate of the McDonald Institute for Archaeological Research at the University of Cambridge. His first degree was in geography with geology, and an interest in the Pleistocene led him into palynology. He investigated the Late and Post-glacial vegetation changes of the Isle of Wight for his PhD (King's College London). Subsequently, he worked at the Institute of Archaeology, London, and the Ancient Monuments Laboratory at English Heritage. As a freelance palaeoecologist, he has continued to work across southern and eastern England, along with international studies in Italy, Turkey, Peru and Chile.

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Figures

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Chapter 6

Soil pollen analysis: a waning science?

Rob Scaife

The period of greatest use of soil pollen analysis as a means of determining local vegetation and environments, especially in relation to archaeological sites, came with the establishment of archaeological science as a discipline during the 1960–70s. Recent decades, however, have seen the demise of this technique such that where soil pollen analysis is undertaken, many of the factors needed for interpretation are not realized. Of very substantial importance to the understanding of soil pollen profiles has been the continuing development of soil micromorphological studies. Where the two disciplines are undertaken in conjunction, the data obtained greatly complement each other, providing a better understanding of the soil and the past vegetation and environment of archaeological sites. This contribution examines briefly the history and techniques of soil pollen analysis and its value to archaeology.

Introduction: a background to soil pollen analysis

Pollen analysis has traditionally been carried out on peat and lacustrine sediments providing vegetation and environmental histories, often with substantial time spans and a wide geographical range. Soil pollen analysis contrasts in providing localized vegetation records from non-wetland sites. From the 1950s, this relatively new discipline was expounded in the UK by Dimbleby (1950; 1952a; 1955; 1957a,b; 1961a,b; 1962), and by Waterbolk (1953; 1957; 1958) and Groenman-van Waateringe (1978) in the Netherlands, both having a particular interest in archaeological buried soils and old land surfaces, especially sub-barrow profiles (Andersen 1995). In France, pioneer work on pollen in acidic soils was carried out by Guillet (1970; 1971a,b). The value of examining deep woodland mor humus was recognized in Draved Forest, Denmark, by Iversen (1964) and Andersen (1979), producing long woodland histories, back to 6300 BP (*c.* 4280 BC); Stockmarr (1975) similarly examined deep mor humus profiles at Mantingerbos, the Netherlands, also stressing the value of their stratification and for establishing past local woodland and environments.

Although Dimbleby's soil pollen analysis is largely known from his analyses of archaeologically related features, especially palaeosols, he pioneered the research and development of soil pollen analysis as part of his work for the Forestry Commission at Oxford. It was because of his need to understand the past vegetation and soils of largely heathland zones that he turned to the evidence which could be obtained from buried soils, especially those underlying prehistoric monuments (Dimbleby 1952b; 1953; 1957b). Dimbleby's (1950) doctoral dissertation, 'The ecology of some British podzol formations', examined soil formation in relation to vegetation history. This work pioneered the study of pollen preserved in soils under Bronze Age barrows and field boundary banks of North East Yorkshire and the New Forest, England. His examinations of pollen profiles in acid, podzolic soils demonstrated the establishment of heathland after woodland clearance which caused soil degeneration, and that podzolic soils are ideal for pollen preservation. This early research work was encapsulated in *The Development of British Heathlands and Their Soils* (Dimbleby 1962), establishing the long-term history of these environments (Dimbleby 1976b). As a corollary to this work he also examined the mechanics of pollen in soils (Dimbleby 1961a,b) and the possibility of soil regeneration of podzolic soils (Dimbleby 1962). This aspect of palynology at the time contrasted markedly with the traditional approach of studying past vegetation through the analysis of stratified peat and lacustrine sediment and, as such, was not without criticism from the 'established' school and especially by Godwin (1958). However, data obtained from such prehistoric contexts established Dimbleby within the newly developing field of environmental archaeology, embodied in Brothwell and Higgs' (1963 (1969)) textbook *Science in Archaeology* (Dimbleby 1969; Ucko & Dimbleby 1969). His specific techniques were adopted by a number of analysts throughout the U.K. (e.g. Bayley 1975; Baigent 1976; Balaam 1984), largely by students from the Institute of Archaeology, University College London. Dimbleby's methodology and characteristic pollen diagrams are not frequently mentioned in current research literature, but they deserve to be highlighted and are described below.

Although not carried out with such intensity as Dimbleby's research, which produced some hundreds of analyses, important pioneering work was carried out in Europe by Waterbolk (1950; 1954; 1956; 1957), who adopted different and more standard techniques to examine palaeosols and determine past environment and environmental change. His work on palaeosols and old land surfaces underlying Neolithic monuments on heathland in the Netherlands (Waterbolk 1956) demonstrated that heathland formed in the wake of human impact on woodland and subsequent soil deterioration. Early archaeological analyses of ditch fills and funerary barrows on similar pedologies were carried out in the Netherlands by Groenman-van Waateringe (1978; 2012), Groenman-van Waateringe and Spek (2015/2016) and Casparie and Groenman-van Waateringe (1980), including studies of multiple sub-barrow soils and old land surfaces, as well as in Denmark (Andersen 1995). Such works not only established characteristics of the overall environments but were able to document change from woodland to heath associated with pedological changes. Other investigations of soil character and development were undertaken using pollen by Iversen (1969) in his seminal work on pedological change through interglacial cycles, and by Stockmarr (1975) on the character of (copro- and myco-) mor humus. Subsequent studies tended to address particular sites, and issues such as past land use (Vuorela 1970; 1976; 1982; Sergerstrom 1991).

More recently, a number of critical appraisals of soil pollen and its interpretation have been forthcoming. These are examined below through a review of studies that question the taphonomy of soil pollen, shedding light particularly on how pollen becomes incorporated throughout a profile and how this may vary in differing soil types and geographical zones.

Taphonomy of pollen in soil

Dimbleby's premise was that pollen, liberated by flowers and by spores from non-flowering plants, contributes to the atmospheric pollen rain. After settling on the land surface, most is destroyed through oxidation and/or microbial and microfaunal activity. In fortuitous circumstances, however, pollen may be preserved in certain types of soil where such processes are inhibited, especially in acidic podzols, and can be extracted to provide data on past vegetation and environments. Importantly, this contrasts with lacustrine sediments and peat accumulation under anaerobic conditions, where the upward accumulation of sediments provides a vertical stratigraphic record of changing vegetation and habitats at a local and more regional scale.

There is a general downward movement in soils and sediments of pollen aided primarily by water flow, largely rain. Pollen and spores, however, do not move downwards as individual grains but are locked in humic colloids, and the downward movement is, therefore, slow, and the breakdown and release of grains from the colloids depends on various pedological conditions. The humus complexes tend to keep pollen in broad layers in which they were originally deposited. This results in a crude stratification of pollen within the soil profile with the oldest, irrespective of grain size, at the base of the profile. A soil pollen profile is, however, not truly stratified, as while the youngest pollen is largely at the top and oldest lower down, at any particular level there may be pollen of various ages (Dimbleby 1985). Longer residence in soils, and the effects of bacterial action and physical and chemical decay reduce the number of pollen grains present, resulting in differential preservation in favour of the most robust types. In Britain, these are often Lactucoideae (dandelion types) and fern spores. In acidic soils with no faunal mixing, the highest absolute pollen numbers are in the upper levels, especially the humic Ah horizon, and decrease with depth. Thus, calculation of absolute pollen frequencies is an important tool in interpreting soil pollen data/assemblages, coupled with knowledge of the differential preservation/resilience of various pollen types in varying soil and sediment types (Havinga 1964; 1967; 1971). Long-term study of taphonomic processes has been carried out to aid interpretation of palaeo-pollen spectra (e.g. Sangster & Dale 1961; Jewell & Dimbleby 1966; Dimbleby 1974b; Havinga 1974; 1984).

Other aspects affecting pollen preservation include microbial attack, oxidation, corrosion, temperature and the physical composition and thickness of the pollen wall. The preservation of pollen in soils and, in most cases, the differential preservation noted, is clearly fundamental to the interpretation of soil pollen data. Havinga's (1964; 1967; 1971; 1974; 1984) seminal studies remain the most authoritative research on the susceptibility to different forms of deterioration in varying types of soil profile and the resulting consequences in interpreting pollen data. Havinga (1963) initially examined the arguments of downwash of pollen as promoted by Dimbleby (1985, 50–5), as opposed to mixing through biological activity, and stressed that preservation may be a function of a number of taphonomic factors: namely microbial attack, oxidation, corrosion, mechanical forces, sporopollenin (pollen wall) robustness and composition, and temperature. Typically, pollen of taxa such as the Lactucoideae (fenestrate pollen of dandelion types) are robust and may have long residence time in soil compared to thin-walled taxa, thus leading to significant over-representation and skewing of pollen assemblage data.

Interpretation of such stratified soil pollen requires a different approach to that of peat and lacustrine sediments. However, the only principal contradiction to this is if they come from soils where there is a build-up of a surface humus horizon, as in a podzolic heathland soil (Ah) or woodland mor humus. There may be a stratigraphical accretion of pollen upwards as humus continues to accumulate and may produce long vegetational histories as documented in Draved Forest, Jutland, Denmark (Iversen 1964; Andersen 1979). Here, a remarkably thick and pollen-rich mor humus developed on earlier mull under climax woodland. There occurred a retrogressive change from *Tilia* forest with *Quercus* and *Corylus* to *Quercus*, *Betula* and *Fraxinus* and finally *Quercus*, *Fagus* and *Ilex*. High biological activity and breakdown of plant cellulose is carried out by microorganisms and fungal activity. With the former, ingested pollen is excreted to form *copromor*, and with the latter *mycomor* (Stockmarr 1975). Changes in woodland structure through human activity may result in a change from mull to mor humus, rate of accumulation and, with increasing acidity, better pollen preservation (Iversen 1964; Aaby 1983). In such mor humus, pollen may be remarkably abundant with many millions of pollen grains per cubic centimetre. For example, a Bronze Age woodland humic podzol underlying a bank at Hengistbury Head, Dorset, England, produced in excess of twenty million grains per cc (Scaife 1992).

Advancing podzolization implies the soil is becoming degraded, and with this is a reduction of faunal, especially earthworm, bioturbation, better pollen preservation and a degree of stratification. As noted, this process is best observed with change from forest brown earth soil, which has been degraded through clearance and cultivation, with soil depletion providing a suitable habitat for heathland vegetation. There are, however, clear differences between this typical situation and other soil types. In complete contrast to such pollen-rich mor humus noted, calcareous rendzina type soils, such as found on the chalklands of southern England, have proven problematic for pollen preservation, with all of the factors suited to ideal preservation being absent (high pH, oxidation, faunal mixing). Analyses of often well-defined palaeosols underlying field monuments have been summarily discounted for palynological analysis in spite of the fact that the past/prehistoric ecology of the chalk and other limestone lithologies has remained enigmatic. However, pollen may indeed be obtained from such contexts using larger sample volume and more specialized extraction techniques. Occasional analyses showed that useful information can be obtained, such as a late-glacial (Windermere) interstadial dated profile at Brook on the Kentish Downs (Lambert 1964), later recalibrated by Preece (1994).

It was Dimbleby and Evans (1974) who demonstrated the real value of examining soil pollen combined with molluscan analysis in calcareous palaeosols underlying Neolithic barrows, enclosures and henge structures on the chalk of southern England, for instance at Beckhampton Hill, South Street, Avebury, Windmill Hill, Durrington Walls, and Knap Hill. This has proven valuable for the Downs of Kent and Sussex and Wiltshire (Salisbury Plain) that have had a paucity of palaeo-vegetation data and an enigmatic palaeo-vegetation record due to the absence of suitable peat and lacustrine sediments for 'normal' analysis in other environments (Turner 1970; Allen & Scaife 2007). Soil pollen studies of calcareous rendzina soils at important pollen sites, such as Silbury Hill (Dimbleby 1997; Robinson 2002; 2003), came to complement palaeoenvironmental records from the study of mollusca in colluvial profiles, showing that attempts to study pollen even in these environments are worthwhile. The processes affecting pollen distribution in such biologically active, calcareous soils were examined by Dimbleby and Evans (1974; Dimbleby 1974b) and through the long-term experimental earthwork studies at Overton Down, Wiltshire (Dimbleby 1966) and subsequent staged analyses (Crabtree 1996; Crowther *et al.* 1996; Kelley & Wiltshire 1996).

Whilst the majority of soil pollen studies relate to archaeologically buried soils, or indirectly to them as through colluviation, for example (Riezebos & Slotboom 1974), it should be noted that analyses of non-buried mineral soils have also been undertaken. Such studies are again largely attributed to Dimbleby, who showed heathland development through soil deterioration in his early work on forestry in the North York Moors, and documented woodland regeneration in podzols at the New Forest, Hampshire (Dimbleby & Gill 1955; Dimbleby 1962).

There are now numerous pollen studies which show that *Tilia cordata* was the dominant woodland tree across much of southern and eastern England during the middle and later Holocene. Tauber (1967) observed the abundance of pollen trapped in the bark of trees and there is the possibility of this pollen being flushed from the tree bark and into adjacent soil. Keatinge (1982; 1983), in an important but not widely known study, examined the mode of transfer and problems of representivity of this robust (*Tilia*) pollen type in soils and sediment at Iping Common, West Sussex. This suggested that discrete pollen assemblage zones arise from the incorporation of pollen into the soil by successively shallower burrowing earthworm populations. As the soils changed from mull to mor type, there is typical pollen evidence of change from mixed deciduous woodland of *Quercus, Tilia* and *Corylus* with fern rich understorey, to scrub woodland with *Betula* and *Corylus* and *Pteridium* understorey, to *Calluna* heath on podzolic soils, as exists today.

Given these factors, it is clear that each soil profile must be considered in terms of a range of factors and not as one would consider the pollen assemblages from lacustrine and peat sequences. Here soil micromorphology plays a fundamental role in understanding the taphonomy of the pollen, placing the pollen and, thus, the reconstructed vegetation and environment in relation to previous land use, on-site archaeology and also, for an understanding of the environment, to pedogenesis. In addition, micromorphological analysis has aided understanding and debate as to the processes of pollen translocation in soil.

Discussion of Dimbleby's interpretation of pollen incorporation into soil has been evaluated by a number of researchers, some incorporating observations from soil micromorphological studies, but there has been little recent research on this. Whilst Dimbleby considered that downwash of clumped pollen in humic colloids was the principal mechanism of incorporation, others have considered movement as individual pollen grains through void spaces (Kelso 1974), or the movement and distribution of pollen as the result of bioturbation. Walch *et al.* (1970) and Andersen (1979) consider pollen distribution to be due to bioturbation by invertebrates rather than downwash of humic material. Similarly, Davidson *et al.* (1999; Tipping *et al*. 1995; 1997), using fluorescence microscopy of pollen in conjunction with soil micromorphology, showed that soil organisms are responsible for the distribution of pollen in soil. In acidic podzols, however, this may not always be the case as only the surface organic mor humus (Ah) may have a stratigraphical build-up of humic material through lack of earthworm activity. Where human activity has resulted in past soil degradation, pollen evidence of past land use in lower soil horizons of neutral or higher pH will be bioturbated, especially through earthworm activity, and homogeneously distributed throughout. If subsequent acidification and humic downwash later occurred, a broad pollen stratigraphy may be found as described by Dimbleby. In the upper Ah, a more detailed stratigraphy may also be present even though microfaunal activity may have caused some mixing.

In reality, it is probable that a range of these factors should be taken into account, depending on the nature of the soil in question. Van Mourik (1999) emphasizes that soil micromorphological studies are important to the investigation of pollen in soils and soil processes resulting in infiltration and the differential preservation of pollen. His studies of colluvial deposits with intercalated Pleistocene cambisols in Galicia, Spain, demonstrated phases of ecological development during the deposition of soliflucted layers (van Mourik 1999). Tipping *et al.* (1995; 1997) further elaborate on the need to understand the stratigraphical integrity of pollen data in relation to soil formation and character. Tipping *et al.*'s (1994) investigations of palaeosols on Biggar Common, Scotland, produced positive results in relation to archaeology, and in Sweden, Florin (1975) similarly attested to stratification of pollen in the upper A-horizon soil, essentially mirroring Dimbleby's view that the upper part of buried soils and old land surfaces has more integrity, whilst differential preservation of robust types typically occurred in the lower soil profile. In spite of these factors, it is clear that soils buried beneath earthen structures such as funerary monuments or field boundary banks may provide pollen data which are representative of the vegetation and environment immediately prior to soil burial, if that soil has not been truncated in the process of site construction.

As noted above, Dimbleby pioneered the pollen analysis of palaeosols underlying Bronze Age prehistoric mounds and other earthen structures such as field boundary banks and ramparts (e.g. Dimbleby 1971), and there have been many subsequent studies (e.g. Tubbs & Dimbleby 1965; Eide 1981; Catt *et al.* 1987). There have been numerous studies in Britain and Europe which have demonstrated (as noted above), the change from woodland (climax vegetation) to heathland, with change from mull to podzolic soils with mor humus caused by human activity and consequent soil degradation. This is shown in Dimbleby's classic work at Iping Common, which showed the establishment of heathland due to prehistoric woodland clearance and subsequent soil degradation (Dimbleby in Keefe *et al*. 1965). Other examples include Minsted, Sussex (Dimbleby 1974a) and West End Hampshire (Dimbleby 1976a), classic Dimbleby analyses of Bronze Age barrows constructed using inverted turves cut from the surrounding landscape to form the central core. The former shows an acid podzol with good pollen preservation, typically showing pre-barrow woodland comprising *Quercus*, *Corylus* and *Alnus.* Increasing *Calluna* at this time also suggests that some soil deterioration had occurred prior to construction of the barrow, probably the result of woodland clearance. The latter site is also a good example of the presence of *Hedera helix* (ivy) pollen in a lower soil. This phenomenon, described as seemingly inexplicable, was later discussed by Simmons and Dimbleby (1974) and suggested as coming from the collection of ivy for feeding deer during winter months. There are many other pollen analyses from English lowland heath illustrating the creation of heathland from dominant woodland, often with an intervening phase of scrub (hazel) colonization (Rankine *et al.* 1960; Simmons & Dimbleby 1974; Baigent 1976; Dimbleby 1976a,b; 1985; Palmer & Dimbleby 1979; Scaife & Macphail 1983; Scaife 1985).

The pollen method

Preparation techniques are generally standard (Faegri & Iversen 1964 and later editions; Guillet & Planchais 1969; Moore & Webb 1978; Moore *et al.* 1991), although samples larger than the typical 1 ml/1 cc of peat or lake sediment are frequently used in soil palynology. Certainly, in the case of calcareous/rendzina soils, samples as large as 10 ml or more may be necessary to recover sufficient pollen for reasonable counts to be made. Extraction is now aided by use of micromesh sieving and elutriation and/or decanting in large volumes of water to remove much of the clay/fine silt extraneous mineral material prior to hydrofluoric acid (HF) treatment. The introduction of known quantities of 'exotic' pollen or spores to a known volume of sediment is used in the analysis of peat and lake sediment, where radiocarbon dating allows the construction of age-depth models and pollen influx data (calibrated aliquots as used by Dimbleby may also be used). The measurement of absolute pollen frequency in soil takes on a different role. As noted, there is in general a reduction of pollen numbers down a soil profile. In many cases an old land surface and palaeosol under a monument may not always be visible due to the effects of later pedogenesis. Recording absolute pollen and fern spore frequencies throughout such a profile may show the position of the old land surface, and in some cases the position of structural turves (and whether they are inverted). Once identified, multiple turves taken from the surrounding area may produce a number of mini pollen profiles revealing past on- and near-site vegetation.

The possibility of changing differential preservation was illustrated by Dimbleby's diagnostic technique of representing pollen data. For each taxon, percentages are given on the right of the vertical (Y) axis and the measured APF on the left (Fig. 6.1). This illustrates the value of APF calculations in interpreting soil pollen assemblages in terms of differential preservation of individual taxa down a profile. The much-published pollen diagrams of Iping Common (Dimbleby in Keefe *et al.* 1965) and Rackham in Sussex (Dimbleby & Bradley 1975) demonstrate his technique, and were also used by Dimbleby to explain the incongruity of pollen in relation to archaeology and artefact distribution in certain soil pollen profiles, due to soil faunal mixing. This technique of pollen data depiction is now rarely, if ever, used with more normal presentation with overall rather than individual APF values plotted, thus relying on knowledge of specific preservation characteristics of pollen taxa.

From recent enquiries to the writer for pollen analysis of archaeologically related soils, there often seems to be a lack of understanding of the relationship of artefacts in a soil profile. There is the expectation that pollen recovered from the same levels as artefacts may provide data on past vegetation concurrent with the human activity represented. This is clearly not the case, especially on 'open sites'. Darwin's (1881) pioneer studies demonstrated earthworm processes, and in more recent times Atkinson (1957) and Canti (2003) (papers well worth reading), discussed the displacement and incorporation of small objects into soil profiles through faunal (largely earthworm) activity. Atkinson suggested this occurred at a rate of two inches in a decade and lasted for thirty years. This is clearly significant to the stratigraphical distribution of archaeological artefacts in contemporary and ancient soil profiles. The concept of archaeological artefacts recovered from soils of a different type to that on which they were originally deposited, was examined by Dimbleby in his often-quoted classic studies of the distribution of Mesolithic artefacts in now acid soils at Iping Common, Sussex (Dimbleby in Keefe *et al.* 1965) and of the distribution of Neolithic artefacts in relation to pollen horizonation at Rackham, Sussex (Dimbleby & Bradley 1975). At the former (see Fig. 6.1), Dimbleby also demonstrated the establishment of heathland due to prehistoric woodland clearance and subsequent soil degradation. Whilst initially soils were brown earth mull, subsequent deforestation, soil depletion and development of *Calluna* heath would have led to extinction of earthworms and the development of the podzolic soil in which the artefacts are now found. Both sites have artefacts incorporated into the soil through earthworm activity, and these are not associated with the buried soil.

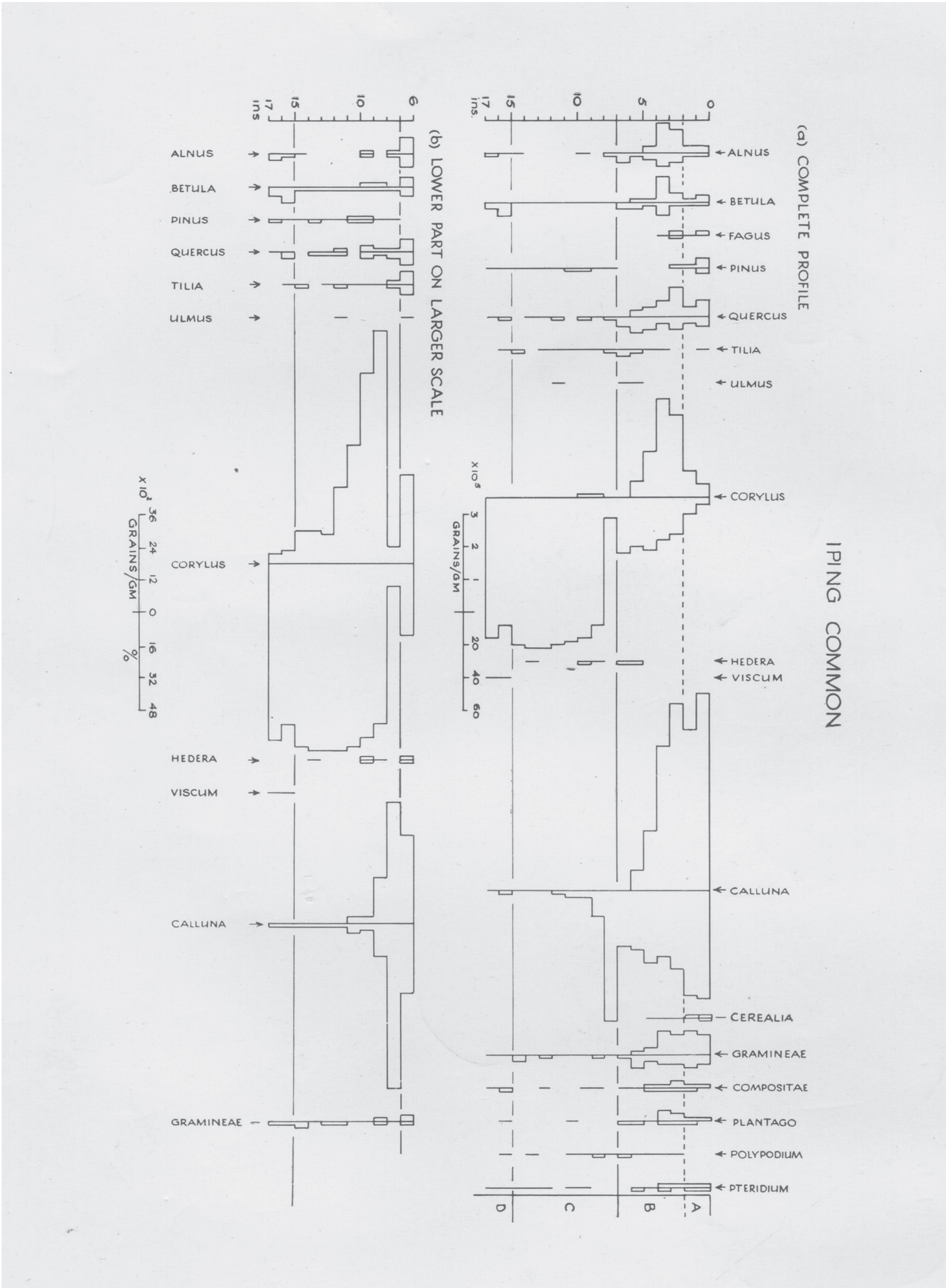

Figure 6.1. *Dimbleby's much-published soil pollen diagram from Iping Common, Sussex, illustrating his style, and used in discussion of the differential movement of pollen and artefacts in a soil profile. Image: Rob Scaife.*

Research archaeological and experimental studies

The trend towards experimental archaeology arose out of the development of archaeological science as a discipline. Pollen taphonomic studies were carried out at Overton Down, Wiltshire (Jewell & Dimbleby 1966; Crowther *et al.* 1996) and Wareham Heath, Dorset (Dimbleby 1974b; Macphail *et al.* 2003), the former on calcareous lithology and the latter on acid substrate. These sought to examine questions such as movement of biological remains in these contrasting soil types, and represent, perhaps, the most ambitious research because of their long-term aims. Initially, Dimbleby (Jewell & Dimbleby 1966; Dimbleby 1974b) was responsible for establishing studies of pollen and spore movement in soils, using *Lycopodium* spores sprinkled over the surface prior to establishment of the earthwork.

Whilst pollen preservation is usually marginal in calcareous soils such as Overton Down, this was not the case at this experimental site and previous analysis of a nearby, sub-Bronze Age barrow soil was able to establish the earlier presence of prehistoric woodland. With increased interest in soil micromorphology, these sites offered a unique opportunity to further relate microfossil movement and taphonomic processes at Overton Down (Crabtree 1996) and Wareham (Macphail *et al.* 2003). Old floors and land surfaces are commonly encountered and examined to determine local activities, and sampling, both spatially for determining areas of activity as well as vertically/stratigraphically for temporal changes, may be undertaken, as in the Late Bronze Age hut floors at Must Farm, Cambridgeshire (Scaife forthcoming). At Butser Ancient Farm, Macphail *et al*. (2004; 2006) demonstrate observable differences between experimental domestic floor and stable deposits using soil, chemical and palynological studies. Here, unusual pollen preservation in otherwise unsuitable, calcareous material is explained as an outcome of organic and phosphate-rich deposits, which also resulted in homogeneous soil and micromorphological characteristics.

The taphonomy of pollen may be complex in such circumstances, with the possibilities of trampling and disturbance, and the inclusion of secondary/derived pollen from domestic refuse, floor covering, food waste, and human and animal faecal material, all of which may contain secondary pollen (Macphail *et al.* 2004; Cruise & Macphail 2000). Combined soil micromorphology with pollen helps to determine such aspects, and the complicated taphonomy (Macphail *et al.* 2004). Sageidet (2005) provides a further, continental example (Norway), of the analysis of prehistoric/Bronze Age podzolic soil and comparison with an adjacent/nearby clearance cairn. Pollen and pedological/micromorphological data demonstrate correlation between cultivation and the stone clearance cairns. As with many other sites, there is clear evidence of bioturbated brown earth soil which, subject to agriculture, became degraded, and the development of an acid podzol.

Cultivation history is obviously of significance to archaeologists. Traditionally, observation of past field boundaries and subsoil plough marks are some of the best indicators. Palynological studies of agricultural development have been forthcoming by Vuorela (1970; 1976; 1982) in Finland, demonstrating slash-and-burn agriculture with clearance, cultivation, grazing and forest regeneration in the late nineteenth century. In Jutland, Denmark, Sergstrom (1991) studied thin mor humus layers to identify arable clearance phases dating from the Iron Age to more recent times. Ropke *et al.* (2011) similarly studied Bronze Age to Middle Ages land-use systems and environmental change spanning the last 3,500 years. Environmental analyses including pollen analysis of both peat profiles and colluvial sediments demonstrated pastoral phases relating to climate, especially to the Little Ice Age, economic, social and cultural changes. Odgaard & Rostholm (1987) analysed Bronze Age sub-barrow soils (2600 BC) in Jutland, showing a transition from deciduous woodland to heathland podzol instigated by forest clearance and subsequent soil degradation. Similar examples come from Norway (Sageidet 2005) and the Netherlands (van Mourik *et al.* 2012). Dijkstra and van Mourik (1996) combined soil micromorphology and pollen analysis of young acidic mor humus soils in the Netherlands, and studied forest dynamics in terms of plant litter production and decomposition in relation to soil development. Contrasting with many studies of prehistoric sites, which show change from woodland on brown earth soils, soil degradation through human activity and consequent podzolization, this study showed local change from acidic soil under open heath to (pine) forest. As well as Dimbleby's premise of pollen being broadly stratified and of different ages, this study also demonstrated the importance of pollen in micro-faunal (non-earthworm) excrement.

Even palaeoscatological studies may play a part in understanding the pollen make-up of soils, with the possibility that pollen within faecal material disposed of in gardens, as waste or in manuring of horticultural plots, in rivers on floodplains and in many other archaeological features, may contribute to the diversity of pollen assemblages recovered from archaeological contexts. It is well understood that pollen from the cereal inflorescences may remain with the harvested crop during crop processing, and become incorporated into farinaceous food products (Robinson & Hubbard 1977) and, once eaten by humans or animals, pass through the digestive system. Where such faecal material is present, past agriculture and diet can be ascertained (Greig 1981; Scaife 1986). Such factors need to be taken into account when examining archaeologically based soil and sediment. Where faecal debris is present, soil micromorphology has assisted in determining the possibility of such secondary pollen sources.

Evidence of the value of combined soil micromorphology and palynological studies has been forthcoming from interdisciplinary studies from excavated sites, some from appendices to monographs of developer-funded excavations and not often quoted in mainstream publications. These date back from the 1980s on, with combined micromorphological/pollen analyses of sub-barrow palaeosols, for example, at West Heath, Sussex (Macphail 1985; Scaife 1985) and Deeping St. Nicholas, Lincolnshire, (French 1994; Scaife 1994), both on acid substrates. More extensive landscape histories based on combined pollen studies of nearby peat and soil pollen with soil micromorphological and other pedological studies have been forthcoming (e.g. Whittington & Edwards 1999). The chalklands of Cranborne Chase (French *et al.* 2007), as noted above, are problematic for pollen analysis, but have provided long-term landscape history from soil micromorphology, pollen and mollusca. From the palynologically 'easier' heathland environment of Poole Harbour, Dorset (Branch & Scaife 1991; Scaife 1991) and Exmoor (Carey *et al.* 2020; 2021) similar landscape histories have been obtained.

Such integrated studies also come from further afield. Soil pollen studies attempted in the tropics have been less successful because of the high biological activity and other climatic conditions, ranging from high rainfall and humidity to intense dry conditions. Horn *et al.* (1998), working in Costa Rica, demonstrated that high pollen values were present in well-preserved soil, showing episodes of forest clearance and secondary woodland succession. However, this study showed that in such biologically active systems and climatic regimes, rapid downwash occurred in soil through high rainfall and with strong bioturbation, resulting in a lack of coherent stratigraphy and pollen only representing a few decades of vegetation and a very local environment. In Columbia, however, Herrera *et al.* (1992), in order to establish modern, efficient agriculture, have studied past soil and agricultural changes spanning 800 years in the Aracuan region of the Columbian Amazon. Also in South America, Branch *et al.* (2007) have examined terrace palaeosols dated between *c.* AD 615–1400 (Middle Horizon and Late Intermediate periods) in the Peruvian Andes. Sedimentological analysis of palaeosols coupled with pollen obtained from adjacent sediments demonstrated terrace construction for cultivation of maize.

Extensive field survey on Easter Island (Rapa Nui), by Prof. S. D. Hamilton (Armstrong *et al*. 2017) identified palaeosols associated with a number of monuments (*moai*) which are being severely eroded in the Poike region. Sampling for recovery of palaeoenvironmental data pertinent to the well-documented deforestation of the island was carried out. The monument Ahu Hati te Kohe is suffering severe erosion and degradation and before the loss of this monument and its associated palaeoenvironmental contexts, the palaeosols were sampled by the writer in 2017. An integrated soil micromorphology and pollen study was carried out on profiles from under the construction and from closely adjacent palaeosols (Scaife & French 2018). Pollen analysis suggests that palm forest was present at the time of moai construction. However, soil micromorphology shows some truncation of the 'A' horizon, and thus a possible time period when clearance prior to construction of the monument may have taken place. Analysis of an adjacent palaeosol indicates the former, but final resolution of this awaits further examination of buried soils from under the monuments; nevertheless, this illustrates the value and often necessity of adopting an integrated pollen and soil micromorphology approach.

Conclusion

This contribution seeks to provide a background to the development and study of soil pollen analysis and its value, especially to archaeology. After what might be regarded as the pinnacle of this discipline during the latter part of the twentieth century (1970–80s), associated with the rising awareness of environmental archaeology as a discipline, environmental analyses were frequently required, where appropriate, as part of developer-funded site investigations. Such analyses have become much scarcer in the past two decades, such that the techniques and understanding of soil palynology have become obscure. There is an evident value of interdisciplinary studies (van Mourik 1999; Macphail & Cruise 2001; French 2003; 2015; van Mourik *et al.* 2012) and especially liaison between soil micromorphology and palynology. Whilst the majority of soil pollen analyses are site-specific and end up as appendices to the archaeology, attempts to understand soil pollen taphonomy have important implications for interpreting site formation processes. The advancement of studies in soil micromorphology has helped in understanding the processes of past soil formation, and thereby, the long-debated processes of pollen incorporation into a soil profile. In many cases, this may be vital to the interpretation of pollen assemblages obtained in relation to archaeological remains, and for the correct interpretations of the past, archaeologically contemporaneous vegetation and environment. This is especially pertinent in relation to ascertaining such aspects as soil truncation prior to burial and subsequent modifications by later pedogenesis of archaeologically important horizons. Such integration may not be apparent in many publications, but background dialogue between pollen and micromorphological analysts regularly occurs to ascertain such factors, and thus the contemporaneity of pollen with the matrix and the archaeology. There is, however, a paucity of expertise in both disciplines of soil palynology and soil micromorphology, such that there are relatively few published, integrated methodological studies and site data, compared to the increasing wealth of environmental and archaeological science analyses. It is clear that further research is required on the taphonomic processes of pollen in soil and many research projects remain. Subsequent to his retirement, this view was strongly expressed by professor G.W. Dimbleby (pers. comm.).

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Inspired geoarchaeologies

Geoarchaeological research captures dimensions of the past at an unprecedented level of detail and multiple spatial and temporal scales. The record of the past held by soils and sediments is an archive for past environments, climate change, resource use, settlement lifeways, and societal development and resilience over time. When the McDonald Institute was established at Cambridge, geoarchaeology was one of the priority fields for a new research and teaching environment. An opportunity to develop the legacy of Charles McBurney was bestowed upon Charles French, whose 'geoarchaeology in action' approach has had an enormous impact in advancing knowledge, principles and practices across academic, teaching and professional sectors. Many journeys that began at Cambridge have since proliferated into dozens of inspired geoarchaeologies worldwide. This volume presents research and reflection from across the globe by colleagues in tribute to Charly, under whose leadership the Charles McBurney Laboratory became a beacon of geoarchaeology.

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