An evaluatory study of the methods used in the reconstruction of historical vegetation and land-use, with reference to part of East Sussex, England.

by

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Abstract

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This thesis is directed towards an evaluation of the principal methods used in the reconstruction of historical vegetation and land use. It is argued here that previous reconstructions by many authors have employed only one or a very limited range of techniques, and that comparative evaluation of the resultant data and of the methods themselves has generally been lacking in such studies.

The present study draws on and evaluates a wide range of evidence from a strictly circumscribed study area on eastern Pevensey Levels, Sussex. The evidence principally includes lithostratigraphy, the analyses of pollen, plant macrofossils (supported by radiocarbon dating) and mineralogy, and primary and secondary documentary sources. The local archaeological record is also examined. Consideration is given to the extent to which the species and growth forms present, and their nature, abundance and distribution, can be assessed. The dynamics of change are reconstructed and discussed, and formations of historical vegetation are tentatively proposed.

The data from diverse sources are reciprocally tested. Correspondence is discussed, and present-day ecological data are drawn on in the explanation of anomalies. This enables critical reflections to be made on the contributory disciplines, as well as more general evaluation.

The main general conclusion is that any one method, were it used singly, would seriously mislead as to the nature of vegetation *sensu lato*. The data *en masse* yielded includes numerous incongruities, and ecological discussion and interpretation is offered on these. Particular, significant conclusions include - the awry representation in the pollen record of the majority of tree and shrub taxa as a consequence of sustained management practices; the gross under-representation of low-growing plants *en masse* ascribed to inhibited dispersion in a taller-growing general context; the under-representation in the recent pollen record of the hop, a locally common cultivar, due to specific management practices; the faulted, vague and ambiguous nomenclature of many types of vegetation and land-use in the documented record, as elucidated by *in situ* macrofossil and sedimentary records, together with the pollen record; the re-assertion of the status of the oak as the primary forest-forming tree in the study area, contrary to trends evident in other work on the forest history of south-east England. The documentation was found wanting in its singular slant-on the reclamation of the Levels, the nature of extractions from woodland and on the act of clearance. The means proposed for unifying the twin blocs of evidence, spatial analysis, was discussed and its rejection explained.

Declaration of originality

I declare, in the sense meant in such a context as this, that the content of this thesis is original and, unless signified otherwise, my own work.

Brian Moffat
15.6.84

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I - INTRODUCTION

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I - B. The study area: delimitation and description

I - A. The study: its purpose, and a discussion of previous cognate work

This work takes a multidisciplinary, reciprocally tested approach to the study of historical vegetation and land-use in order to evaluate the methods customarily used. To this end, the study incorporates the use of physical evidence, the analyses of pollen, plant macrofossils and mineralogy, and documentary evidence, the examination and evaluation of primary and secondary sources. It examines the local archaeological record. It moves on to consider the species and growth-forms present, and their nature and distribution. The dynamics of change are reconstructed and discussed. Formations of historic vegetation are tentatively proposed.

The entire study has been strictly executed within a circumscribed study area centred on eastern Pevensey Levels, Sussex, and within the absolute temporal limits of all data. As far as possible it was in the manner of modern ecological assay.

Using this data and under this last condition, reciprocal testing of derivative data has been achieved. Thus, the primary intent, the evaluation of methods, was attempted. Correspondence was discussed, and present-day ecological data together with historical land-management data was drawn on in explanation of anomalies. A review of previous work related to the methods separately, in vacuo, and in particular to the study area will appear in the body of the thesis (II and III). No analogous studies have been executed in south-east England. A general review of the contributory disciplines as recently practised is presented here. Stress is placed on the few attempts at inter-disciplinary work which have used diverse techniques.

There has been much preoccupation with the application of one or very few allied techniques and methods to any study area. Yet, appeals for the multidisciplinary approach have been numerous. They have permeated authoritative symposium volumes on "environmental archaeology" sensu lato (J.G. Evans, Limbrey and Cleere 1975; Limbrey and Evans 1978; M. Jones & Dimbleby 1981; Proudfoot 1983) and were explicit in recent reviews of pollen analysis

(Crabtree 1975; Faegri and Iversen 1975; Pears 1977; Bradley 1978;Moore and Webb 1978; K.J. Edwards 1979; Mannion 1980; Tooley 1981; J. Turner 1981) and most workaday pollen analyses. Yet thoroughgoing multidisciplinary work has been most exceptional. Work directed towards the end of environmental archaeology sensu lato has tended to be within the structure of discrete blocs of "traditional archaeology", "environmental archaeology" and "documentary history", and disunity in approach has been fossilised. Where several diverse techniques have been used, integration has been rare. Yet were a fully integrated science of historic vegetation and land-usage to be produced, it must originate in numerous local studies. These are to date absent. Edwards, for instance, has noted the practice of placing environmental data in undigested appendices, minimally integrated with the body of an archaeological report (K.J. Edwards 1979, 255-9).

It follows that the findings from one set of data have not been reciprocally tested against other sets, and corroboration of diverse data has been absent. "Regional" generalisations, synopses of our knowledge, have been pieced together from scarce local studies, each characteristically based on few allied methods. The upshot of this has tended to be an over-free use of analogy based on the "typical" nature and pattern of vegetation and land-usage.

Characteristically, pollen analytical work, which is considered the nexus of this study, has usually been complemented by some account of the cognate sedimentary stratigraphy and plant macrofossils, by radiocarbon dating and by some survey of present-day vegetation. Less commonly, a more thorough geosedimentary analysis on the basis of particle-size, chemical and mineral composition has been made. All these techniques have been brought into use in the present study. (Dealt with in II).

Some recent developments have been the augmentation of pollen analyses with the analysis of the assemblages of diatoms, molluscs and insects for the same site. Recent examples have included:- Mannion on the assemblages of pollen and diatoms obtained from the limnic deposits at Linton Loch, Roxburghshire, and Walker at Melynlynn, Snowdonia (Mannion 1978 a and b; R. Walker 1978); Kerney, Preece and Turner on the molluscan and plant biostratigraphy at Folkestone and Wateringbury, Kent (Kerney, Preece and Turner 1980); Girling and Greig on the pollen and beetle assemblages at Hampstead West Heath, London (Girling & Greig 1977). The impressive and plentiful work of the Somerset Levels Project (Somerset Levels Papers 1975 - 1982) has included analyses of pollen, plant macrofossils, and insects. It continues, yet lacks to date an integrated account of regional environmental archaeology where unsubservient to an archaeology preoccupied with 'material culture' (for instance, Coles 1981).

Diatom analysis does not elucidate the nature of the macrophytic vegetation other than reflect on the freshwater environment of the lake studied. Molluscan analysis has been especially developed on calcareous soils, as on "neutral and acid soils, shells are never preserved" (J.G. Evans 1972, 23; endorsed in Dimbleby and Evans 1974 & Moore 1982b). The soils of the study area are of the latter category. The analysis of assemblages of insects and, in particular, Coleoptera, may only be considered to be tentative in methodology: In recent authoritative reviews, the fundamental theoretical weakness of the technique has been repeatedly emphasised (Kenward 1975a & b & 1976; Coope 1977; Osborne 1978). Furthermore, the desideratum in such analysis would be where sets of taxa had ecological status soundly associated, from present-day ecological study, with diverse anthropogenic vegetational change. From the above reviews, this is not the case. A single paper noted the "loss" of a beetle species associated with anthropogenic vegetational change, the "decaying wood habitat" (Buckland and Kenward 1952). It has been argued that the 'new approach' to the interpretation of urban insect death-assemblages developed by Kenward (Kenward 1978) has not yet been applied to less immured, extensive rural conditions (D. Robinson 1981, 279).

The assemblages of both land mollusca and beetles of Pevensey Levels have been noted to be species-rich and of great interest (Ratcliffe 1977, II, 166); yet no methodological and interpretative procedures have been established for such a habitat over the period of the last, say, 5000 years.

Diatom analysis is considered for the present purposes, irrelevant. Analyses of molluscs and insects are judged to be of minimal use in this study. They would serve to dissipate the endeavours and argument of the rest of the study, being of no direct relevance. These three techniques are not further considered.

Numerous works have drawn on archaeological evidence in the interpretation of pollen analyses. The following published British works covering post-Neolith times were examined:- Atherden 1976a & b, & 1979; Bartley 1975; Bartley, Chambers and Hart-Jones 1976; Beckett 1981; Cundill 1976; Davies and Turner 1979; Donaldson and Turner 1977; Hicks 1971; R.L.Jones 1976, 1977, 1978; Merryfield and Moore 1974; Moore 1968; Moore and Chater 1969; Oldfield 1963; Roberts, Turner and Ward 1973; Simmons 1969a & b; Simmons & Cundill 1974a & B; Sims 1973 and 1978; Tallis and McGuire 1972; Thorley 1981; Tinsley 1975 and 1976; J. Turner 1964, 1965, 1975, 1979; M.F. Walker and Taylor 1976. All are considered reputable. Characteristically, they consist of a summary digest of regional archaeology from secondary and derivative sources. Major occupation sites, "monuments" and chance "finds" were identified and placed within their period of material culture. The archaeological evidence as it reflects the distribution, intensity and duration of human presence was appraised; it is in all the works examined emphatically subsidiary, undetailed and superficial. Particular criticisms may be made. None of these works drew on Ordnance Survey Archaeological Records. All made use of an implicit, regional model of zonation of prehistoric 'material culture'. All made scant or no account of the weighting of importance given to particular sites and imputed practices of land-usage. All made scant account of the duration of any site's occupation, and its presumed effects. All imported, without justification it is contended, a form of the long discredited "invasion hypothesis" (Addyman 1976), from traditional archaeology (Briefly discussed: App. 2).

Two individual works and two region-wide projects were located which thoroughly rated and used pollen analytical and archaeological evidence. These were K.J. Edwards working in the Howe of Cromar, Hawke-Smith in the Dove-Derwent interfluve of the North Midlands, the Somerset Levels Project and a co-operative group working on the North York Moors (K.J. Edwards 1978; Hawke-Smith 1979; Somerset Levels Papers 1975 - 82. Simmons & Cundill 1974a & b; Atherden 1976a & b, 1979; R.L. Jones 1976, 1977, 1978-the pollen analyses. Spratt & Simmons 1976; R.L. Jones, P.R. Cundill & I.G. Simmons 1979; Spratt 1982-the reviews). Edwards' work has scarcely been developed into publication form. His sites, excavated and pollen analytical, were chosen for nearness. His ancillary geosedimentological method was thorough yet slanted towards (here irrelevant) lake deposits. Radiocarbon dating was intensive. Ordnance Survey Archaeological Records were used. His excavations drew on several on-site assays. Pre-eminently and unprecedentedly reciprocal testing of methods and data was undertaken. Hawke-Smith depended on digests of other workers' pollen analyses, both from a scatter of archaeological sites and the two long-term deposits of Hicks (Hicks 1971), both of which were eccentric to his study area. The monumental work of the Somerset Levels Project is ongoing; there has been some incorporation of digests of environmental evidence in, albeit, provisional reports. The North York Moors study has a different form and emphasis. The nexus is an archaeological and environmental overview (Spratt 1982), covering prehistory period by period. Earlier reviews (Spratt & Simmons 1976; R.L. Jones, Cundill & Simmons 1979) were succeeded. The original pollen analyses (5) drew in regional archaeological work, particularly Elgee (1930), A. Fleming (1971) and, when available, Spratt & Simmons (1976). Particular archaeological sites are rarely cited (exceptions: R.L. Jones 1978; Atherden 1976a & b, 1979) and never evaluated. Fleming's (1971) conclusion, for instance, concerns a calculation on the duration of Bronze Age occupancy of the moors, and it like all archaeological data is simply not used. Spratt's section on the environment (1982; Various authors 33-99) used contributions from the pollen analysts (5). The work concluded that the region had yielded the acme in the level of synthesis in environmental and cultural aspects of the prehistoric past (op. cit. 35). Cover of the moors was generally good. Radiocarbon dates were moderately plentiful, apart from 'later prehistory' (op. cit. 33), and only one site produced a good set of dates for the Iron Age/Roman-British period (op. cit. 81). There was a dearth of settlements, located and excavated, and of field systems (op. cit. 218). The entire study is included here with reservations. No archaeological interpretation of any pollen record is site-based. The above shortcomings are felt to be crucial. The area of the moors is vast, and the low density of pollen analytical sites, and archaeological sites operative in land-use, permits only the delineation of sub-regional phases in land-use. In all four studies, extensive study areas were purported to be represented. Respectively these were:- 123 km²; 110 km²; 312 km²; 1800 km². (These last two are generalised estimates by the writer in the absence of formal delimitation in the works themselves.)

Accepting the general feasibility of integrating archaeological and pollen analytical evidence, the scanty archaeological record of the study area will now be briefly reviewed. Detailed discussion will be made in the body of the thesis.

The present research included no archaeological excavation and only localised examination of field evidence (II-B-i). Recent reviews of the prehistory of Britain and Sussex noted no excavations in the study area supported by radiocarbon dating (Curwen 1954; papers in C. Renfrew 1974, Drewett 1978a. All issues of 'Current Archaeology', 1967-1982). The only major excavated sites have been those at Saxon and medieval Pevensey (Salzman 1908 and 1909; Dulley 1967). Pevensey was the only known substantial local settlement in pre-modern times (Cunliffe 1978a; Rivet and Smith 1979; Money 1978, 39-40; Cleere 1978, 62-3; D. Hill 1978, 174-89) but has been judged to be "virtually unexplored" (Cunliffe 1978b, 222). One can contrast the paucity and typical superficiality of Wealden excavations with those on the circumjacent chalk downland. This paucity is well shown in distribution maps of sites of all archaeological periods in the county archaeological review (Drewett 1978a) and the superficiality, in contrast with the exemplary excavation reports of nearby Bishopstone, near Eastbourne. That site was occupied continuously for much of the time between the third millenium B.C. and the C6th A.D.; the excavations used the range of modern archaeological and ancillary techniques, and produced monumental reports (M. Bell 1972, 1975, 1976 and 1977).

Gazetteers on hillforts "and related structures", and prehistoric field systems, noted no such sites between Eastbourne and Hastings (Hogg 1979; Bowen and Fowler 1978). There were no soundly executed excavations of any gazetteered local "deserted medieval villages", (Beresford and Hurst 1971; Burleigh 1973 and 1976). Site reports although sketchy, were examined (Tatham 1890 & 1892; Beesley 1939; Lemmon 1963-7).

A map of the distribution of archaeological sites in the study area has been prepared (Fig. 3) from Ordnance Survey Archaeological Records ("record cards" and "record sheets") and index records of the Council for British Archaeology, augmented by reports published in local and national periodicals (listed in App. 1) and communication with active local workers. For ease of reference all basic maps appear at the end of Section I.

As can be seen, the abundance of field and archaeological data is associated with ironmaking and ironworking, especially in the medieval period. The history of the local iron industry is evaluated under appropriate heads (App. 9 - 1).

This constitutes the entire local archaeological record.

Far fewer works still have used documentary evidence in conjunction with pollen analytical evidence. Only five works were examined which attributed more than a most generalised and brief passage to documentary sources and, by implication, the historical period. This is considered a gross under-use of a vast corpus of transcribed and original documentary data.

It is difficult to generalise on the few lines usually accorded to the historical period. Historical events which have been frequently adduced in the interpretation of pollen analyses are:- the Norman Conquest and its aftermath, particularly in the "harrying of the North"; the establishment and expansion of monastic estates, and their purportedly distinctive land-use practices; incidences of plague; the secular deterioration in climate in the C14th; cross-border raids; the depredations of metal-smelting; expansion of agriculture, particularly arable, associated with the Napoleonic War and following years; expansion of the plantation of conifers. At a longer-term level, phases of clearance during the "Viking" and "medieval" periods have often been discerned (Atherden 1976a & b and 1979; Bartley 1975; Bartley, Chambers and Hart-Jones 1976; Cundill 1976; Davies and Turner 1979; Donaldson and Turner 1977; Hicks 1971; R.L. Jones 1976 & 1978; Moore 1968; Moore and Chater 1969; Oldfield 1963; Roberts, Turner and Ward 1973; Simmons 1969a & b; Simmons & Cundill 1974a; Sims 1973 & 1978; Tallis and McGuire 1972; M.F. Walker and Taylor 1976).

Prima facie, very few of these "events" have any prospect of being manifest in the pollen record in an unambiguous and distinct way. The crux of the problem is that such political, economic, social, military, and administrative upheavals have no demonstrably quantifiable manifestation in the landscape. The pollen record is a "series of distorting mirrors" (Crowder and Cuddy 1972, 61) in the way it represents vegetation of the past (fully discussed; II). Perhaps more important may be the fact that the duration of the nominate event, and its aftermath, have rarely been related to the duration of the change discerned in the pollen record. It would seem that, given the usual time-scales of preoccupation with the pollen record as being 10^2 year increments during 10^4 year periods (Solomon and Harrington 1979, 339), there is little prospect of a distinct dateable historical event being clearly manifest in the stratigraphic record.

The exceptions, prima facie, are when a new species has been introduced, and is manifest unambiguously in the documented and pollen records, and, above all, where there have been parallel, long-term comprehensive records. The typification, par excellence, of this last point is plainly the monastic estates records. It has been noted that there have been from 800 to 1000 religious houses in Britain (Knowles and Hadcock 1971, 45). While the completeness and quality of the records of these religious houses has not, and probably never will be evaluated in toto, the sheer mass of transcribed material contained in, for instance, the Camden Series of the Royal Historical Society, and the numerous county record and historical societies suggests a vast and scarcely tapped resource of information. There is in addition a valuable overview, a historical geography of the assiduously active Cistercian order (Donkin 1978).

Many of the activities of the monasteries (Hockey 1970, 1975 & 1976; Youings 1971; I. Kershaw 1973; Donkin 1978; D.M. Robinson 1980) were in regions with much pollen analytical work, for instance, North and West Yorkshire, the New Forest, Devon, Fenland and around the Somerset Levels. Several pollen analysts have adduced the presence and activities of monasteries in interpretation of the upper levels in the pollen record. For instance;- Atherden 1976a & b, 1979; Cundill 1976; R.L. Jones 1976 & 1978; Moore 1968; Moore and Chater 1969; Oldfield 1963; Tinsley 1976; Turner 1964; M.F. Walker and Taylor 1976. Yet none of them detailed the nature, time-scale and intensity of these types of monastic land-usage, and all relied on secondary sources. None made use of the nation-wide assessment of monastery property, carried out upon the Dissolution, the Valor Ecclesiasticus (Savine 1909; Youings 1971). In retrospect, Donkin noted that for almost a thousand years before the Dissolution, monastic communities were an integral part of the English economy (Donkin 1978,15).

The estate of Battle Abbey was part of the study area (Fig. 1) for about five centuries until the Dissolution. Its archives are extensive, and have been much studied; this is fully discussed later (III).

From the mid-sixteenth century, there was the establishment and proliferation of relatively competent map-making (Fully discussed: IIID), and an increased volume of often meticulously kept, continuous records of secular estates, with a plethora of surveys, maps, accounts and so on. From that time, there is, with careful selection of locale for study, a prospect of continuous documentation of land-usage for, say, six or seven centuries until the present day.

Only five works could be traced which countenanced the potentialities inherent in contemporaneous pollen and documentary records when used together, as a sound means of reconstructing historic vegetation and land-usage. These were based respectively on two small Weardale bogs in County Durham, on bogs in central Rossendale, in central Lancashire, on limnic deposits from the Broads, Norfolk, on four bogs distributed in Northumberland and on three sites, 'a rich valley fen' and two cores from a lochan, in Argyllshire (Roberts, Turner and Ward 1973; Tallis and McGuire 1972; Lambert et al. 1960; Davies and Turner 1979; Rymer 1974).

The first work, in Weardale, County Durham (Roberts, Turner and Ward 1973) had as its primary object the establishment of a relationship between physical and documentary evidence. Two long-term pollen analyses were made, supported by five radiocarbon dates. The vegetation of the bog surfaces was surveyed with brief comments on that of the "hillslopes around". Relevant documentation was extant from c. 1200 A.D. and took the form of occasional surveys, and more commonly, data on leases of farms and on accounts of metal-smelting as these were taken to reflect major local changes in vegetation. All data used was strictly local to the pollen analytical sites (unlike much of the cursory data of Atherden et seq., above). Great store was put in the status of land as park, common, reclaimed land, etc., and the associable vegetation was inferred. Interpretation incorporated political, economic, climatic and other explanations. The authors noted that the documented data is very imprecise as to spatial extent until the time of the Tithe Award Map (early C. 19th). A fairly satisfactory correlation was attained between data from the varied sources of data. Yet the pollen records of these very small peat bogs (60 x 15 m. and 40 x 25 m.) were reasonably taken to reflect only the immediate locality. The finely restricted spatial nature of the documentary record, and its consequent patchiness, manifest a particularly small-scale study.

The second work, the Rossendale study (Tallis and McGuire 1972) had as its declared aim the application of pollen analytical, archaeological and documentary evidence towards the central problem of a synthesised history of vegetation and land-usage. A single, major, long-term pollen analysis was supplemented by several analyses from archaeological sites. The vegetation of the study area was surveyed. There was no radiocarbon dating, and all dating was "tentative". The archaeological evidence was drawn from secondary, regional sources. The documentary evidence proceeded from an account of local place-name elements, through an evaluation of medieval court rolls, accounts, feets of fines, charters and wills (which may be at best indicative and at worst, anecdotal). From around the sixteenth century the cited documented evidence was minimal. The entire study based on the clearance of woodland was to be followed up; this has not, to the writer's knowledge, transpired.

The relatively large study area (23 km^2), it is judged, has been studied in only a preliminary manner. The pollen analytical evidence, were it reliably dated and replicated in the locale and the archaeological and documentary evidence, were it fully explored, may well produce a thoroughgoing study.

The Norfolk Broads work (Lambert et al. 1960) was a thoroughgoing study, drawing on evidence from sedimentary stratigraphy, basin morphology, historical documentation and cartography, archaeological excavation, pollen analysis and studies of relative sea-level, to determine, as its title declares, the origin of the Broads. The Broads had an aggregated total area of 1057 ha. (2611 acres) and, as the evidence strongly indicated, implied the removal of about 900 million cubic feet of peat. This is plainly a study which is spatially much restricted, and concerned with a peculiar, single issue.

The pollen analytical evidence originated from the limnic deposits of the Broads themselves. A sustained historic use as turbaries, amply demonstrated from an impressive array of documented records, explained the poor quality and truncated nature of the pollen record (described as "scanty"). No radiocarbon dating was used in the study, or in other pollen analyses cited (Godwin 1940 & 1943; Jennings 1952 & 1955).

The Northumberland study (Davies and Turner 1979) set out to correlate major changes in land-usage, as manifest in pollen analyses, with the archaeological and historical record. Four long-term pollen analyses were undertaken from sites well dispersed in the county; c. 9 radiocarbon dates covered the historical period at three of the sites. The archaeological evidence was taken from regional syntheses. Analogous clearance phases were adduced from sites throughout north-east and north-central England. A period of "political and economic stability" was conjectured locally in the post-Romano-British age. A succeeding period of extensive clearance was construed, by analogy and speculation, and deserving of the criticisms above, to be Scandinavian. A period of fourteenth century woodland regeneration was attributed to an amalgam of the Black Death, raids from Scotland and deterioration in climate. An expansion of arable farming was attributed to the early nineteenth century. A period of afforestation by conifers was inferred.

This "analysis" of the documentary record was brief (a half page), without explicit sources and any form of areal and temporal quantification. It selected events, and fitted them within a notional sequence of vegetational change. In contrast with the resumé made by the authors, this was felt to be markedly unsatisfactory.

The last of the five works set out to explore the records, palynological, archaeological and documentary, of a single, remote, highland parish, that of North Knapdale, Argyllshire, Scotland (Rymer 1974). 3 long-term pollen analyses were made supported by a series of radiocarbon dates yet to be completed. The vegetation of the parish was surveyed extensively ab initio, with intensified examination of critical hibitats. A high degree of floristic refinement was achieved. The archaeological record was particularly full for the Iron Age but lacked any formal excavation. Relevant documentation was extant from only the last two decades of the eighteenth century. Before that time, a most inconsistent array of political, administrative, and genealogical historiography was drawn on. Quantified data on land-usage, notably from Statistical Accounts (Scotland-wide digests on economy and land-use, dating from the late C18th and mid C19th), and estate records, ran for scarcely 150 years. Rymer was dissatisfied with the quality of the pollen analytical evidence, and its poor correlation with other records, ascribing this to failings inherent in the technique. Yet the parish (106.5 km^2) did not, in the main or derivative studies (Rymer 1976, 1977 & 1980), permit any thoroughgoing testing of the techniques and their data. The time-span of the documented record, its brevity and discontinuity, may have prima facie precluded this.

A number of pollen analyses from the North York Moors (Atherden 1976a & b, 1979; R.L. Jones 1976 & 1978; Simmons & Cundill 1974a) cite historical works on the local monastic economy, in particular, Waites (1967) and Wightman (1968); these are simply not used. [Waites' work on flock sizes and locations, and Wightman's on the distribution of landscape elements may well have been drawn on. Op. cit.] The two great multidisciplinary projects described above - those concerning Somerset Levels and North York Moors - do not properly extend into documented times. In addition, Rackham's "Ancient Woodlands" and Flower's work on the New Forest (Rackham 1980; Flower 1980) were based on documentary and field evidence, and cursorily drew on pollen analytical evidence from their study areas.

This concludes examination of studies broadly cognate to the present one. All may be seriously faulted, or have had emphases ascribed to them which are very different from this one, as has been discussed above.

Over the last twenty years, soundly executed pollen analyses with a substantial post-Neolithic pollen recordobtained from non-archaeological sites and supported by radiocarbon dating, have been produced in the British Isles at a rate of about twenty per annum. Yet a virtually insignificant proportion of these have been reconstructed from the basis of the present-day, and the documented past.

Were one to accept, as the writer does, the tenet put forward by Marc Bloch in his "The Historian's Craft" that "the natural progression of all research is from the best (or least badly) understood to the most obscure" (Bloch 1954, 45), then the main validity of pollen analytical investigation has been attenuated. The major, irreplaceable means which is useable to test and, potentially, to corroborate its data has been largely disregarded. This, it is argued here, has detracted from the usefulness of pollen analytical evidence in, for an instance chosen from many, Birks' study, "Past and present vegetation of the Isle of Skye; a palaeoecological study" (Birks 1973a). There, a single page and occasional, undetailed remarks on "anthropogenic" and "apparently anthropogenic" vegetation, covered the entire occupancy and influence of man on Skye (ibid. 319-20, 173-6, 180-1). Birks' research constituted two major blocs of evidence, intensive pollen analytical investigations and thorough present-day floristic and phytosociological study. These are polarised in time, discrete in methodology and in form of data, and, most important, without the means of establishing continuity as regards data on the nature (sensu lato) of vegetation. In a work which claimed that palaeoecology was greatly useful in illuminating the "causes and mechanisms of change within an ecosystem over time" (ibid. 3), this is hard to understand.

The raison d'être of this study is that the study area (described below I-B) allows a most rare opportunity for a thorough examination and integration (as against mere array in juxtaposition) of the major techniques used in the reconstruction of historic vegetation and land-usage, and their data. As contended above, this has not yet fully transpired elsewhere.

I - B. The Study Area: Delimitation and Description

At its broadest, the study area is part of south-east Sussex centred on eastern Pevensey Levels. More exactly, for all types of data apart from the pollen analyses, the study area is absolutely circumscribed. It is the twelve present-day civil parishes as delimited in Figures 1 and 2, and detailed in Figure 3. Within the study area such data was used as and where available:- documentary evidence from the archives of well-recorded estates, surveys of present-day vegetation from an area adjoining the Levels (all demarcated on Fig. 1); archaeological evidence from all excavations (Fig. 3); evidence as to sedimentary stratigraphy and plant macrofossils from a series of borings in the Levels (II-B-i, ii) as well as archaeological excavations (Fig. 3). Cartographic, and a diversity of supplementary documentary evidence was amassed for the entire twelve parishes.

The pollen analytical sites are marked on Fig. 1. The source of pollen accumulating on these sites cannot be established with any certainty. It is customary to accept that the range of pollen will be, for practical purposes of representation, at a maximum of 50 to 100 km. (after Faegri and Iversen 1975, 61-2); the study area as delimited above is wholly within 20 km. of the pollen analytical sites. It is reasonably accepted that the nearer the source of pollen to the site of accumulation, extraneous factors excluded, the greater the quantity of pollen deposited; this is discussed at length below (II-C).

It is possible to wholly exclude two distinctive vegetational formations of Sussex from this delimitation of the study area. First downland, and more particularly the eastern outlier of the South Downs to the east of River Cuckmere. This area has been demonstrated to have been substantially deforested by the Early Bronze Age in analyses of pollen at Lewes Brooks (Thorley 1971 & 1981), and mollusca at Bishopstone (T.P. O'Connor 1977, 267-73). The range of taxa characterising this development, its nature and date was not evident in the sites of the study area (Fig. 6F).

Second, are High Forest Ridges, and in particular Ashdown and St. Leonard's Forests, situated in the north of East Sussex. From documentary evidence, heathland, dominated by ericaceous species, was extensively established here (in terms of thousands of acres) by the time of a mid-C17th survey (Daniel-Tyssen 1871-3). There was no manifestation of this at that time in the sites of the study area. An "outer ring" may be proposed to exclude these vegetational formations, of proven history and distinctive taxa, from the study area represented in the pollen analytical evidence.

It is argued that the pollen analytical sites are central to "the twelve parishes", and may be expected to accumulate pollen predominantly from the circumjacent marshland and upland. The data from the diverse sources may be considered to be, for practical purposes, co-terminous in source.

The study area as it is today will now be briefly described. The topography of the Levels may be said to be low-lying marshland (below and seawards of the 15 m. contour. III-D-iii), composed of alluvium (Fig. 2), largely originating in the downwash of local streams (II-B-ii). Levels fields are interlaced by "land drainage channels", locally called sewers (Marshall, Wade and Clare 1978). They are largely in use as permanent grassland, particularly for pasture, although there has been some expansion in the area under arable in the last ten years. (Fig. 2; pers. comm. with local farmers).

The alluvial basin of eastern Pevensey Levels is central to the study area, and comprises about 25% of its area. To the west the study area is open and contiguous to the rest of Pevensey Levels. To the east, north-east and north it is surrounded by upland.

The study area, the twelve parishes, is a little over 212.0 km^2.

The circumjacent upland area may be described as of "moderately marked relief" (following the pioneering attempt of Fines to classify landscape in this part of East Sussex; Fines 1968) being hilly and deeply incised by small valleys. The altitudinal range is from the 15 m. contour to the minor local summit of 170 m. The drift geology is diverse and complex, but is overwhelmingly composed of Hastings Beds Series (over 98% of the non-alluvium surface area is Ashdown Sands, Tunbridge Wells Sand or Wadhurst Clay); a simplified account of the drift geology appears in Fig. 2 (based on Sheets 319 and 320 for Eastbourne and Hastings). There is no comprehensive modern local survey of local soils; neither is there a modern general survey for Sussex (McRae and Burnham 1975). The most useful studies of local soil concerned themselves with classificatory methods, and their usefulness in brickmaking (II-B-ii).

The present-day pattern of land-use, set out in Fig. 1, may be described as a complex interspersal of relatively low-grade agricultural land, and "land not in agricutural use" which is overwhelmingly woodland (>95% if the well-wooded parks are included). The scale of this land-use survey excludes representation of a local peculiarity, dense and broad hedgerows or "shaws"; these will gain attention in this study. It has been estimated that one-third of the woodland of the Weald is badly managed (Barrington 1968); this impressed the writer as an underestimate for the study area. The most recent Woodland Censuses conducted by the Forestry Commission (Locke 1970; Forestry Commission 1983) noted that, in general, coppicing had ceased on all but a small proportion of British woodland. This state of neglect has been subsequently endorsed in the case of Sussex, with the exception of the active management of u/c chestnut (Garthwaite 1976; A.H.F.Brown 1976 & 1977; Martyr 1977).

This study area, as regards its area, and <u>ab initio</u>, the potentialities of diverse sources of data, was felt to be well suited for a cross-disciplinary study such as this.

FIGURES 1, 2 & 3

Sources of Maps:-

Fig. 1 = O.S. 1:50,000 Series; Searle 1974; Steer 1958

Fig. 2 = O.S. Drift Geology Series

Fig. 3 = see map

fig. 1 The Study area :

Geographical extent of main sources of evidence and present day woodland

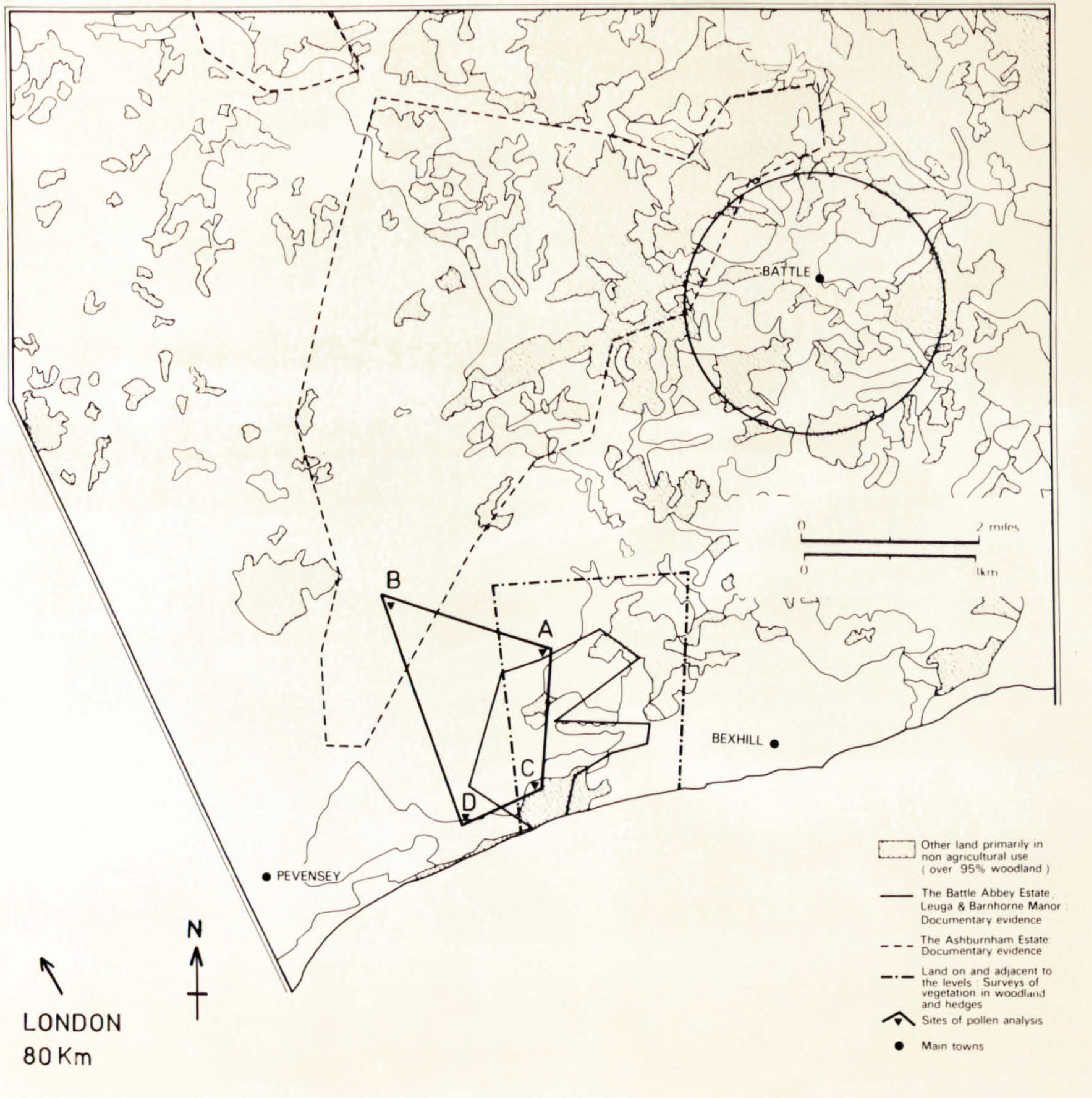

fig. 2 The Study area :

Simplified Drift Geology
and outline topography

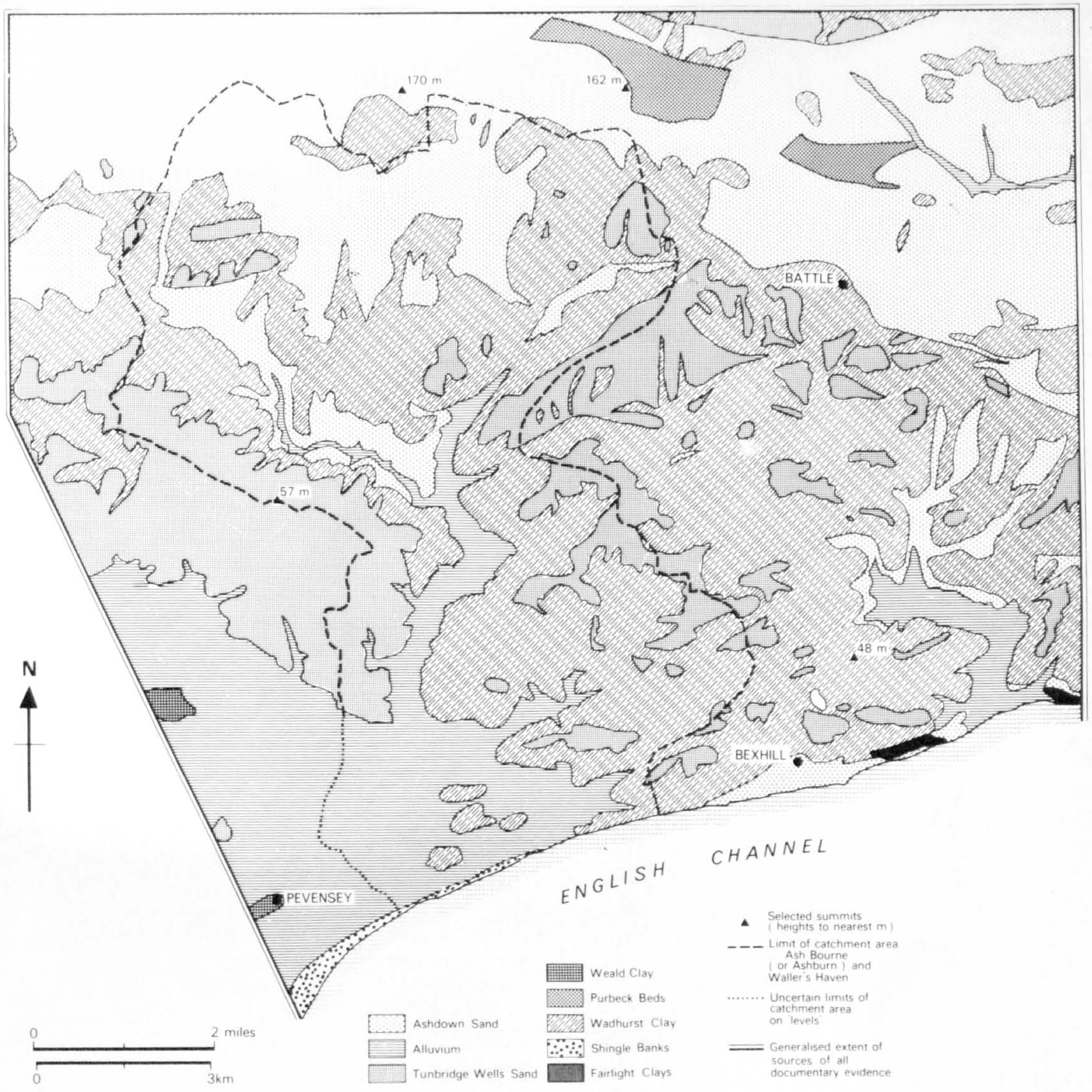

FIGURE 3: MAP OF PARISHES OF STUDY AREA & ARCHAEOLOGICAL SITES

EXCAVATED ARCHAEOLOGICAL SITES OF OTHER THAN MEDIEVAL DATE	A
EXCAVATED ARCHAEOLOGICAL SITES OF MEDIEVAL DATE	M
POLLEN ANALYTICAL SITES (SEE II)	P

ARCHAEOLOGICAL SITES NOT YET EXCAVATED -

BLOOMERY	B
FORGE	Fo
FURNACE	Fu
FURNACE WITH FORGE	FF

SOURCES:

ORDNANCE SURVEY (1979): ARCHAEOLOGICAL SURVEY

EXCAVATED SITES (in order, north to
south): BESWICK (1979 & pers. comm.)
BESWICK (1978, 1979 & pers. comm.)
CROSSLEY (1972)
BEDWIN (1980 a & b)
SEARLE (1974 & 1980b. A summary)
PEACOCK (1977) &
BRODRIBB (1979 & 1982)
BEESLEY (1939)
SALZMAN (1908 & 1909) &
DULLEY (1967) & DUNNING (1958)

THE NUMBER IN BRACKETS AFTER PARISH NAME IS THE PARISH TOTAL IN 1574 LIST OF IRONWORKS (CATTELL 1979)

SCALE in km.

0 1 2 3 4 5


A
A
Fu
Fu
Fo
Fu
Fu
WARBLETON
(3)
Fo
M
B
FF
FF
Fo
B
B
B
M
Fu
Fu
PENHURST
(1)
Fo
Fo
Fo
BATTLE
(1)
B
Fu
M
A
FF
ASHBURNHAM
(1)
FF
HERSTMONCEUX
(1)
B
CATSFIELD
(-)
B
B
B
B
B
B
Fo
B
NINFIELD
(-)
FF
CROWHURST
(1)
FF
B
Fo
WARTLING
(-)
HOOE
(-)
P
P
BEXHILL
(1)
B
M
P
P
PEVENSEY
(-)
A
M
ENGLISH CHANNEL

II DATA FROM PHYSICAL EVIDENCE

II - A. Outline of Section

This section (II) comprises:-

(i) a review of previous work on analyses of sedimentary stratigraphy and macrofossils in the study area (II - B - i), and on analyses of pollen in south-east England (II - C - i).

(ii) description of the techniques and methods of analysis applied to sediments and macrofossils (II - B - ii).

(iii) account of the selection of sites for pollen analysis, of field practice (II - C - ii) and of analytical procedures (II - C - iii).

(iv) a brief review of the pollen analysis technique as relevant to the study area (II - C - iv), and in particular to the general aims of this study (I).

(v) an account of the survey of present-day vegetation and a note on the local botanical record (II - D).

(vi) an account of the data obtained from physical evidence, which culminates in resolved pollen diagrams (II - E). These are then discussed under heads, 'Mire Vegetational History' and 'Regional Vegetational History' (II - F & G).

(vii) the chronology of vegetational change in the study area is then synthesised (II - H).

II - B. Analyses of sedimentary stratigraphy and macrofossils

(i) Review of previous work in the study area

In Figs. 1 & 2, the drift geology of the study area, based on the appropriate Geological Memoir and Ordnance Survey maps, is presented. The Quaternary geology, geomorphology and pedology of the study area has scarcely developed beyond this rudimentary data (see review of Shephard-Thorn, 1975). There have been brief, descriptive accounts of the physical, chemical and mineralogical composition of local economically important deposits, notably brickclays and ironstone (Butterworth and Honeyborne, 1951 - 2; Sweeting 1930, 1944 and 1950; Gallois 1965). Employing a simplified form of the soil classification scheme proposed for use in the Soil Survey of England and Wales (Avery 1973), Wealden soils have been reclassified (McRae and Burnham 1975). The authors noted that there was no recent general account of Sussex soils, and no detailed account for the study area. Their own work was preliminary and only incorporated 'limited (field) reconnaissance' on Pevensey Levels (op. cit., 607), and extensive and undetailed work in the rest of the study area.

No studies of post-glacial plant macrofossils in the study area off the Levels other than those of archaeological deposits (Fig. 22) have been traced.

There has been much work dealing with the stratigraphy of Pevensey Levels and the adjacent coastline (Topley 1875; C. Reid 1905 & 1913; Godwin 1943; J.A. Steers 1964; Akeroyd 1965 & 1972). Much was cursorily descriptive (op. cit.) or interim (II - F), except when concerned with 'submerged forests'. Outcrops on the foreshore, and sections in banks of Levels watercourses, have been frequently described:-

At the western extremity of Bexhill parish (TQ710062), there were the remains of 200 or more trees, mainly oak and birch ('E.J.C.' 1814), with - oak and yew intact, together with beech, ash, alder, hazel, etc. (Vidler 1892). Vidler noted these in the Levels too. Reid noted oak and hazel (Reid 1913, 71). Oak, birch, hazel and water plants were observed in sections within the Levels (Wolley-Dod 1937, xxvii).

One is obliged to remember Godwin's cautionary note on past misidentification of wood (Godwin 1975a, 8).

In addition most workers described the marked tripartite stratigraphy of the uppermost deposits of the Levels. However, their strategy of sampling and process of differentiation was never made explicit. Work on a single borehole at Cooden on the Levels added only measurement of the depth of horizons to previous work. A recent review of work on Wealden Quaternary deposits (Shephard-Thorn 1975) dated the periods in which peats and 'other organic horizons' were formed as:-

10000 to 8000 years B.P.;
6000 to 3000 years B.P.:
3000 to 1500 years B.P.

These were elicited from a catalogue of coastal Flandrian deposits in south-east England (op. cit., 543). None originated in the study area. Shephard-Thorn concluded that 'we remain in some ignorance of our (Wealden) Flandrian deposits, with few radiocarbon dates from suitably levelled and recorded horizons' (op. cit., 542). This work on regional 'biogenic phases' has been updated and amplified by Devoy (1982). In a general review of work on submerged forests around the British coastline (Heyworth 1978, 279-88), it was judged that the commonest age of such forests in the south-east (east of Devon, and south of Lincolnshire) was 5500 to 4000 b.p. (sic), and most recognisable trees were oak (ibid., 282).

These field observations of Levels and littoral deposits, and their chronological framework, make up all that has been established on recent local stratigraphic history.

(ii) Techniques, and methods of analysis applied to the study area

All analytical techniques described here were intended to supplement the pollen analyses. A series of *c*.50 borings was made throughout the eastern Pevensey Levels on a grid pattern (avoiding open water and levees). This was augmented by field walking of the entire length of the riparian levees of the study area. A ubiquitous tripartite stratigraphy was noted by eye; this was confirmed by laboratory analyses of physical, chemical, mineralogical and organic composition, and content of distinctive macrofossils. These stratigraphic distinctions are depicted in Fig. 7.

The lowest stratum of this tripartite stratigraphy was found to contain wholly inadequate counts of pollen (and macrofossils). Noting the subservience of these analyses to the pollen analyses, the study was confined to:-

particle-size analysis on samples (n = 10);
electron photomicrographic and optical examination of the deposits to establish the minerals present;
identification of the plants, and mollusca present.

All particles were clay and silt. The mineral, illite, was detected in abundance (M. Frost pers. comm.). Rootlets of *Phragmites communis* were found immediately below the zonal boundary (at Sites C and D). The shells were identified as *Scrobicularia plana* (M. Laverack pers. comm.).

The middle and uppermost strata of the tripartite stratigraphy were found to contain adequate counts of pollen, and so analyses of all types were intensified. The middle stratum was found to be entirely organic; no particle-size or mineralogical analyses were called for. *c*.50 pieces of wood were sampled at regular spaces for microscopic identification.

Using keys and type-photographs (Leney and Casteel 1975 and refs. therein; Miles 1978), the samples were found to be 46 of alder and 6 of birch. Smaller items were isolated by sieving and flotation. There was a superabundance of twigs, bark, cones and fruit of alder. In this stratum, at Site D, a skull fragment ascribed to a young male sheep was found (C. Grigson pers. comm.). The uppermost stratum was subjected to formal and intensive particle-size analysis. The results showed great heterogeneity (including clay, silt, sand; fragmentary and humified organic material had been floated off) and inconsistency.

The range was from 30% clay/70% silt to 63% clay/37% silt. Sand was characteristically present as small and dispersed sand lenses. These were common, especially as marked on Fig. 7. This generalised form of presenting results was adopted because of the remarkable heterogeneity and stratigraphic inconsistency evident in the results, with inclusions of organics and sand, and the small sample size. The particle-size classes followed the Soil Survey Field Handbook (J.M. Hodgson 1974).

The account of Wealden soils described above, albeit cursory for the study area, stressed that the soils to the north, north-east and east of eastern Pevensey Levels, reclassified as 'stagnogley soils' and 'stagnogley soils and brown earths', were a very complex spatial and stratigraphic pattern originating from varied lithology and patchy occurrence of drift. The Levels soils were reclassified as 'alluvial gley soils' (McRae and Burnham 1975).

A series of 12 samples (interspersed evenly through a single boring of the uppermost 'zone') and a further 8 from randomly chosen positions (in the 'zone', the stratigraphy and the Levels) was passed to E. Cox, Geochemistry Unit, Geology Department, University of St. Andrews, for a series of mineralogical analyses. As this set of techniques has not yet, to the writer's knowledge, been used in studies such as this, and as it was found crucial to the study (<u>infra</u>), laboratory and interpretive procedures are set out in full.

X-Ray Diffraction (XRD), Heavy Mineral Analysis (HMA) and Specific Gravity determinations were used. XRD is an established mineralogical technique for the identification and evaluation of clay minerals. All major clay minerals may be distinguished. The standard procedure for laboratory treatment was followed (Thorez 1975). Samples were ground and suspended in water, and the clay particles allowed to settle on a glass slide and dry at room temperature. Half of each sample was glycolated. Runs were made on the glycolated and dry samples. Both diffractograms (diffractometer trace diagrams) were read; each sample produced a diffractogram within a range of 5° to 65° as 2θ's determined by the 'd' spacings between the crystal lattice planes of its constituent minerals. Once the clays present were identified the relative intensities of each were recorded.

There was a consistent and marked predominance of kaolinite, with mica present as a mixture of biotite, muscovite and illite. There were minor amounts of chlorite. These clay minerals, and their relative importance were remarkably consistent in all samples. No carbonates or salts were present. The results, which Thorez (op. cit., 1) considered could only be 'semi-quantified', were partly endorsed by a descriptive account that the 'clays and the silts in the Tunbridge Wells Sands near Bexhill' 'generally contain disordered kaolinite, illite and a chloritic material' (Highley 1975, 561 - 2; Butterworth and Honeyborne 1952). The trace diagrams resulting from this and other techniques are held by the writer.

The heavy minerals (non-clay, and settling out in the flotation process preceding XRD) were then analysed. Those identified under a polarising microscope were tourmaline, rutile, glauconite and anatase. The Refractive Index Determinations carried out on selected grains of each identified mineral endorsed these findings. The remainder of the other material in the samples (i.e., that not settled out for HMA; unseparated, and post-TBE treatment, and so >2 to 7 specific gravity) was an aggregation of quartz and feldspar. Identification proceeded from the known and fixed position of quartz on the spectrum (c. 2.64). Linear correction was made to all peak positions related to deviation from the quartz peak. This allowed for operational and instrumental error at the St. Andrews Geochemistry Unit. In this way, a semi-quantitative estimate of the importance of each non-clay mineral was gained.

Comparing these results with the geological memoir (Gallois 1965 and Figs. 1 and 2) it was possible to interpret the origin of 'the alluvium'. It was first possible to discount, because of XRD, any contribution from the prevalent west-to-east longshore drift due to absence of carbonates and other salts. No deposition from calcareous downland deposits, which abut onto the westernmost limits of Pevensey Levels, was indicated. From HMA it was possible to discount contributions of and from Ashdown Sands (rare within the Ashburn catchment area) and Wadhurst Clay (which also has trace carbonate presence). The presence of glauconite and anatase allows the rejection of Ashdown Sands and no heavy minerals have been established in Wadhurst Clay. The alluvial deposits as sampled were inferred to consist of Tunbridge Wells Sand. The gross yield from HMA (~0.5 - 0.8%) endorsed this conclusion. It seems that in accordance with drift geology (op. cit.; Lake 1975), the origin of Levels alluvial deposits, as sampled, has been immediately local, and never >4 km. distant. This, considering the size, declivity and apparent potential transportational ability of the Ashburn, suggests substantial local translocation via surface wash and field-side ditches. No major watercourses on the Levels had any measurable flow (field measurements throughout 1975 and 1976). Deposition was inferred to be due to a progressive, sustained translocation of soil particles by surface flow. This is also indicated by the increased diminution of quartz particles with depth. (E. Cox, pers. comm.).

Of the c. 30 plant macrofossils sieved out, all were identified as common reed or sedge.

Finally, samples of organic origin coincident with key pollen and stratigraphic changes, were taken. These were dated by radiocarbon and reports as received from the laboratory, and as commented on by the writer upon submission to "Radiocarbon", appear below. The dates are annotated on the pollen diagrams (II - E), and their significance discussed (II - H).

The findings from this section are summarised in Fig. 7.

II - C. Analyses of pollen

(i) Review of analyses of pollen and macrofossils undertaken in south-east England

A thorough scrutiny has been made of all published, reputable work on vegetational history in the south-east, obtained by analysis of pollen and macrofossils. This was done using the authoritative list of 'recorded sites' in Sussex, Kent and Surrey (Godwin 1975a) updated as below. A breakdown of sites, based on type of data, association with an archaeological site, and location on or near a major formation of drift geology, provides the following data:-

FIGURE 4A: POLLEN ANALYTICAL AND MACROFOSSIL SITES : SUMMARY

	The 'recorded sites' of Godwin (1975a) (*1)	Sussex Archaeological Collections, 1968 - 82 (*4)	Thorley's sites (Thorley 1971 & 1981)	Barnes' and Bradshaw's site (Barnes 1974; Bradshaw 1978 & 1981a)
Pollen sites	6 (*2)	4 (*3)	4	2
Macrofossil sites	32 (*3)	6 (*5) (8)	-	-

*1 - Sites in Sussex, Kent and Surrey for Zones VIIb and VIII, or from archaeological excavations.

*2 - includes one archaeological site.

*3 - all archaeological sites.

*4 - The corresponding period of the Surrey Archaeological Collections yielded no relevant studies.

*5 - all archaeological sites. The bracketed figure refers to Fig. 22 which sets out macrofossil analyses at local ironworking sites.

FIGURE 4B: POLLEN ANALYTICAL SITES : ASSOCIATION WITH PARTICULAR GEOLOGICAL FORMATIONS:-

CHALKLANDS	- 4	N.B. this breakdown is based on workers' emphases in interpretation
LOWER GREENSAND SERIES	- 3	
OF STRICTLY LOCAL SIGNIFICANCE	- 9	
HASTINGS BEDS SERIES	- None	

Thorley's work (Thorley 1971 & 1981) was a 'preliminary, extensive regional study' of the vegetational history of south-east England (Thorley 1971, 11 - 15). It was largely based on pollen analyses at 4 sites (Fig. 4A). She discussed the significance of the south-east in post-glacial vegetational history, and the problems in establishing the history of regional vegetation, particularly forest trees. This was followed by reviews of 'regional woodland history' (an archaeological overview), of regional pollen analytical work, and of peat deposits suited for pollen analysis. The pollen diagrams were then presented and discussed.

The major conclusion, of critical importance to this and similar studies, was that it was virtually impossible to relate her results to the Godwinian scheme of pollen zonation. The key, expectable changes were asynchronous. This conclusion becomes axiomatic from the time when man had become the major agency of such change (see the review of data on radiocarbon dating of 'the onset' of the Neolithic; Whittle 1978). Major discrepancies, of pressing relevance to this study, were the Zone VIIb/VIII boundary at the Lewes II and Amberley Wild Brooks sites (op. cit., 173 - 7, 215 - 8). Thorley explained this and other discrepant horizons as due to differences in 'the local environment'. This could have easily, she argued, explained the extent to which this regional scheme diverged from the traditional scheme. Yet this local diversity was not analysed to any degree, other than by some "geological underpinning" of vegetational change, and imprecise "association" with nearby archaeological sites.

FIGURE 5: POLLEN ANALYTICAL SITES IN SOUTH-EAST ENGLAND; LOCATION, AGE AND SOURCE

	NAME OF SITE	COUNTY	PERIOD COVERED	REFERENCE: SEE BIBLIOGRAPHY
1.	ADDINGTON	K	VIIb	Burchell and Erdtman 1950
2.	AMBERLEY WILD BROOKS	Sx	both VIIb - VIII	Godwin 1943; Thorley 1971; Waton 1982
3.	ELSTEAD	Sy	VIIa - VIIb?	Carpenter and Woodcock 1981
4.	FROGHOLT	K	VIIb - VIII	Godwin 1962
5.	GASSONS FARM	Sx	entirely VIII?	Barnes 1974
6.	GIBBINS BROOK	K	VIIa	Thorley 1971
7.	GRAVENEY	K	MEDIEVAL	A.C.Evans and Fenwick 1971 D.G.Wilson & A.P.Conolly 1978 D.G. Wilson & A.P. Conolly 197
8.	HIGH ROCKS	K	IRON AGE	Dimbleby 1968
9.	LEWES I	Sx	VIIa - VIIb	Thorley 1971 and 1981
10.	LEWES II	Sx	VIIa - VIIb	Thorley 1971 and 1981
11.	MENS	Sx	VIII?	Bradshaw 1978 and pers. comm.
12.	MINSTED	Sx	EARLY BRONZE AGE	Dimbleby 1975
13.	NORTHFLEET	K	VIIa or VIIb	Burchell and Piggott 1939
14.	RACKHAM	Sx	"LATE NEOLITHIC"	Holden and Bradley 1975 Dimbleby and Bradley 1975
15.	WEST HEATH	Sx	"OF SECOND MILLENIUM B.C."	Baigent 1976
16.	WINGHAM	K	VIIb - VIII	Godwin 1962

VIIa, VIIb, VIII:P.A. Zones after Godwin 1975

Archaeological periods, after author

K -Kent
Sx -Sussex
Sy -Surrey

Thorley did, it is judged, achieve her aim of a "preliminary, extensive regional study". She was obliged in the end to provide some local and detailed explanation when a conspectus was attempted at the outset. This, it seems, is why her conclusions were so cautious (she eschewed zonation. She stopped short of full interpretation of the data from each site.).

Thorley's study was found to be of great usefulness in several other respects. She provided:-

- a bloc of data with long-term analysis and radiocarbon dating which remains unexcelled in south-east England.
- a detailed study of the nature of key "conventional" vegetational changes, such as the "primary elm decline" and the onset of "the Neolithic" (at Lewes I), and sustained deforestation in the Middle Bronze Age (at Lewes II), and so on, in the south-east.
- a framework from which to develop and evaluate this present study.

Barnes' work (Barnes 1974) was a single pollen analysis at Gasson's Farm in the far west of Pevensey Levels, about 5 km. from the nearest site examined in the present study. The pollen bearing deposits were dated from medieval pottery in the upper strata. There was no dating of the basal deposits. She considered that the base and top of the deposits were apparently truncated. This, together with the thinness of the pollen-bearing deposits made the study of limited usefulness. However, marked changes were noted within the spectra, and these had peculiarly local relevance. The assemblages of macrofossils and archaeological artefacts were also of interest. Waton's work (Waton 1982) was preoccupied with vegetational history on chalklands. One site, Amberley Brooks (cf. Fig. 5), was in the region of present interest. While a radiocarbon date of medieval age was obtained, all data presented was grouped in crude and undefined classes of pollen taxa. Little may be made of it in this discussion.

Much pollen data in Sussex has come from archaeological sites; most of this work has been 'soil pollen analysis' after Dimbleby (Dimbleby 1957 & 1961).

In such sites, downwash gives a 'depth distribution pattern' to the pollen record, and only broad conclusions are feasible. At its crudest this is undertaken - preceding, during and following - occupation. Another variable is thereby introduced.

These studies form the entire corpus of knowledge on vegetational history obtained by pollen analysis in the south-east, which were of relevance to this study. Other studies (Fig. 4B) had a pronounced and perhaps particular bias to geological formations, or an overwhelmingly local significance, and have been used warily. The work of Thorley has been accepted as basic, and used freely. Workers with local palynological work in progress were approached (pers. comm. with A. Thorley; A. Brookes; S. Jennings; R. Bradshaw). No pressingly useful data was obtained.

(ii) Selection of sites for pollen analysis. Field practice

The choice of sites for sampling for pollen analysis in eastern Pevensey Levels was most carefully undertaken. The primary consideration was the existence of undisturbed deposits bearing adequate amounts of pollen. Despite the examination of the local deposits and their rejection as unsuitable for pollen analysis (Godwin 1975a & Thorley 1971, 112 - 7), satisfactory amounts of pollen were found in particular conditions (infra). Pilot surveys (c. 50 borings) showed that pollen-bearing deposits were present throughout the study area. Yet, the uppermost strata rarely yielded adequate counts, and so exploration intensified.

The Levels are today predominantly pasture, as they have been for at least the last five centuries (discussed: III-D-iii), although there has been an increase in arable over the last ten years or so (Marshall, Wade & Clare 1978; pers. comm. with local farmers). Over the last ten years, much of the eastern Levels has seen a concerted programme of flood prevention and land 'improvement' mounted by the local water authority (Local newspapers: various issues), raising the general level of the land and thereby lowering the water table (Robson 1972). This has been done by raising the levees and enclosed land, by laying down vast quantities of topsoil. This topsoil, based on coarsely granular Tunbridge Wells Sand, is thick (up to 7 or 8 m) and compacted, and was found most difficult to bore. It is expected that this would, with the use of land-drains, lead to aeration in the uppermost strata and acceleration in pollen decomposition.

It was decided, therefore, to search the entire eastern Levels in an attempt to locate 'unimproved' marshland pasture. It was also a concern that any prospective site had not been deep-ploughed for water-drains, or truncated by the late medieval and early modern practice of 'paring and burning' where the turf was cut off, burnt and ploughed in (A brief examination of the treatments used to improve 'peat mosses', and their consequences is in App. 5). This was done by seeking grassland which was species-rich, waterlogged and unimproved, in areas of the Levels inaccessible to farm vehicles. The writer's judgement was endorsed by asking the local farmers.

Suitable field sites numbered only _c_. 12; at least 6 have since been deep-ploughed. The four sites finally selected are mapped in Figs. 1 and 3. Using surveying teams, heights of sites above sea level were established working from the nearest triangulation pillar. For sites A, B, C, and D these were respectively: 6.1 m; 6.2 m; 11.2 m including _c_. 7 m of levee; 4.2 m.

Boring was undertaken using a Hiller Borer or a Piston Corer. Samples were taken at 5 cm. spaces. There was little sign of oxidation in the upper 50 cm., and this was much concentrated in the unsampled 10 cm. There was no _in vivo_ root penetration beyond this depth. Great care was taken to ensure no in-chamber smear, or aerial contamination; samples were removed to the laboratory in air-tight glass tubes.

(iii) Analytical procedures

Samples for pollen analysis were prepared by standard concentration procedures (Faegri and Iversen 1964 & 1975) with:- maceration in boiling 10% NAOH and washing in distilled water to remove colloidal humic compounds; heating with hot 60% HF for up to 90 minutes to remove silicates; boiling with 10% HCl to remove colloidal silicates and silicofluorides; Erdtman's acetolysis (9 parts acetic anhydride to 1 part concentrated H_2SO_4) to remove celluloses; staining in safranin and glycerol and liquid mounting on unsealed slides.

Macroremains were sieved out (discussed in II-B-ii).

The sole variation on the standard procedure was that HF when hot, was found volatile and unmanageable; immersion in cold HF overnight was found to be satisfactory. This paralleled the work of Craig (Craig 1978).

Pollen counting was at x400 magnification. Whole numbers of slides with regularly spaced traverses across coverslip were counted for each sample, to avoid any errors linked with non-random distribution of pollen on the slide.

Counts were made to conform with four criteria:- a minimum of 150 grains of arboreal dry-land pollen; a minimum of 200 grains of all dry-land pollen; a minimum of 200 grains of local pollen; a minimum of 400 grains of total pollen.

These criteria were set for each sample at the four pollen analytical sites (Σ 163 samples). Such counts were found adequate to represent broad changes on a particular site; this judgement was founded on statistical validation, and on the view of the solitary worker on region-wide pollen anlayses in the south-east (Thorley 1971 & pers. comm.). The counts were effectively to a minimum of 600 - 700 when all criteria were satisfied.

The results of the pollen analyses are presented as percentages of all determinable types of pollen in Figs. 6.

The morphological categories followed the standard coded key (Faegri and Iversen 1975) augmented where possible by work done on the Northwest European Pollen Flora (NEPF: The 20 plant families covered in the Review of Palaeobotany and Palynology, vols. 17 - 29, 1974 - 80; Moore 1978a). Reference was made to the type-side collections at the Polytechnic of North London and University of St. Andrews (Geography Departments).

Analysis of pollen influx (the number of grains, falling on a unit area of land, over a unit of time) may complement and amplify analyses of percentage data. Its chief usefulness is that each value is independent of each other, and therefore not subsumed or given undue prominence. Recent examples include Craig (1978) and Pennington (1979). Such analysis was rejected for several reasons. First, pollen influx analysis has primarily been developed on lake deposits (op. cit.; the review of Birks & Birks 1980, 195 - 230), and only lately on peat deposits (Beckett 1979). The alluvium of Pevensey Levels falls into neither category, and the paths of influx are not as yet known. Furthermore, the stratigraphic record was not conducive to pollen influx analysis: the uppermost stratum was highly heterogeneous (II-B-ii) even over short distances, the middle stratum was a homogeneous entity, and the lowest stratum bore wholly inadequate counts of pollen. This stratigraphy could not be further refined; the desideratum of plentiful, clear, substantially and internally homogeneous units was not met. Considered together with the uncertainties inherent in radiocarbon dating, and the pioneering, tentative, 'time-compressed' nature of the work on documentary evidence, analysis of pollen influx would, in this case, be an onerous adjunct, of little prospective use.

(iv) Review of the pollen analysis technique as relevant to the study area

(a) Introduction. Studies of pollen production and transportation

Pollen analysis has been described as 'one of the most important auxiliary sciences for archaeology, adding to the picture given by human relics and macrofossils' (Faegri and Iversen 1975, 15). Its basic principles are well known yet, it is the writer's contention, that much in the rationale and practice has rested upon assumptions which require close examination and evaluation. A simple descriptive model conceals a much more complex reality as, say, the representational model of M.B. Davis shows, as recently reviewed (Solomon and Harrington 1979). Comments such as: pollen analysis represents past vegetation as 'a series of distorting mirrors' (Crowder & Cuddy 1973, 61) - and - the relationship between present-day pollen spectra and the vegetation which produced it showed 'highly distorted reflections' (Tauber 1977, 10). Aspects of palynology are based on assumptions, untested and scarcely tested.

It is here intended to comment on the more important of the shortcomings of the pollen analysis technique as they apply to the study area. Work on a supra-regional scale, and most work done outside North Europe will not be considered.

The basic problem in pollen analysis is ascertainment of differentials in the production, transportation and preservation of pollen. Differentials in pollen production between and within plant taxa contribute to under- and overrepresentation in pollen spectra. Explanation of these differentials has been undertaken in terms of the taxon, its life-form and status in the vegetational formation (Godwin 1975a; Faegri and Iversen 1975; Crabtree 1975; Moore 1976; Pears 1977; Mannion 1980). Long-term, methodical work on differential pollen production among forest tree species is scarce. This work will now be reviewed.

A study undertaken in Danish forests (Andersen 1970) established relative pollen production and representation of North European tree species. Establishing the species composition of the canopy layer(whence the great majority of pollen originates) and pollen assemblages preserved in ground-level samples, 'pollen productivity' and 'pollen representation' were calculated. From these, correction factors for each species were produced with which to 'weight' species pollen frequencies. These weightings were tested on Danish data and found to be satisfactory. Percentage area of species in the sample plots did not differ from the corrected pollen percentages by more than 5% (op. cit. 66). This study (op. cit.) was amplified into a six-year study (Andersen 1974a) where pollen deposition, classed by species, year and season, was recorded (species TP/cm^2/year/m^2 crown area). Wind conditions within the forest, pollen fall rates, and the 'fit' of these with canopy species and deposited species were monitored. There emerged an almost perfect correlation between the species deposited as pollen, and the species as part of the tree canopy within 20 m. (Andersen 1974a & b). Andersen had collated the results of previous similar studies (Andersen 1970, 78 - 81) and found them broadly comparable with his own; a major difference was, in his view, the repeated under-estimates of oak productivity.

Andersen's indices of productivity for the major tree taxa (Andersen 1967, 1970 & 1973) have been criticised as being of limited usefulness, because source areas over time cannot be known; they provide an inflexible 'index' which may not be verified (Birks 1973a 143 - 4 & 1973b). Birks' condemnation emanated from his experience in relating present-day patterns of vegetation to fossil pollen assemblages.

Bradshaw (1978, 1981a & b & pers. comm.) has developed the work of Andersen. Based on data (moss polsters) from 78 sites in southern England, which have had in historical terms, a continuously wooded status, he analysed (by Linear Regression Analysis) the relationship between the intensity of pollen deposition and tree basal area (between proportion of pollen by taxon, and area of the growing tree by taxon within 20 m of the polster. After Andersen). His results endorse Andersen's work, and as he presents them, in a ranked ordering of productivity by species, he produces a resolved synthesis of North European data, a general model. A single exception was an imputed underrepresentation of oak which he attributed in his Sussex sites to senescent, local oak populations. The 'Weighting factors' elicited were then applied to long-term pollen records from deposits in a Norfolk and a Suffolk wood, and found satisfactory.

While the counter-argument (of Birks and Tauber) is respected, Birks' statement - that the nature of deposition will alter over time corresponding to changes in 'environment, community structure, and pollen production and sedimentation' - need not render such studies void. Much difficulty of interpretation may be circumvented by a formal project comprising:- analysis of species composition; sampling at numerous sites; the employment of a set of reciprocally testing techniques. This is attempted in the present study.

Account has been made of the work of Andersen and Bradshaw; the 'weightings' for pollen production of forest tree species have been applied in an 'informal' way. The weightings have been taken into account in subsequent sections on the interpretation of the pollen diagrams (II-F & G) but not used as 'multipliers'. This was felt to be crude, inflexible and unrepresentative of ecological variation, both natural and anthropogenic. Detailed justification of this stance is made for key taxa below (IV-C-i).

For the same reasons, such treatments as stringent numerical processing and analyses (Gordon and Birks 1972 & 1974; Birks 1974; O'Sullivan 1973; Caseldine & Gordon 1978; D. Walker & Wilson 1978; Caseldine 1981. References therein) and the presentation of confidence limits to pollen data (Mosimann 1965; Maher 1972) have also been rejected.

Lower (sub-canopy) strata in forests have been noted to be strictly secondary and under-represented as pollen (Faegri and Ivesen 1975, 53).

Low wind velocity within the trunk space would, it has widely been suggested, lead to dispersal over substantially shorter distances for understorey than for tree pollen (Andersen 1970, 39; 1974a, 59 - 60). This has been endorsed by neutron activation analysis of the pollen dispersal of two sedge species in a woodland habitat (Handel 1976). Hazel flowering intensity was found to be low in the Danish forests even where the tree canopy was fairly open (Andersen 1970, 68); in general, it is accepted that hazel flowers more freely where there is no tree canopy (Jonassen 1950). Hazel, it seems, has to be present in a large quantity in the forest and in coherent growths before its pollen can effectively manifest itself. op. cit. 76. This reference has been widely accepted by, among others, Thorley (1971), Godwin (1975a) and Faegri and Iversen (1975). The species seemed most sensitive to soil variation (Andersen 1970, 68) and, has been widely used and managed. (Discussed: IV-C-i).

In vivo data on herbs within the forest complex is scanty. Andersen, Bradshaw and the writer noted the herbs in their 'forested' study areas; yet in all studies, herbs present a rare prominence, and merit scant debate (e.g. taller herbs were found to be better represented as deposited pollen. Andersen 1970, 69 - 70).

It has been implicit in the above account that pollen production depends not only on the source plant in isolation, but also the relationship of that source plant to the structure of the vegetational community. Similarly pollen dispersal is affected by community structure. One form of tree growth associated with free flowering is the isolated, freely growing individual; this has often been remarked on (for instance, Faegri & Iversen 1975, 53), but rarely quantified. In which case, greater canopy and flowering surfaces are exposed, and the "damping effect" of a closed vegetational formation is absent. (This is considered in the light of the documentary evidence, by what is called the "balance" of timber and various sizes of underwood.)

Long-term, methodical studies of pollen dispersion have been scarce, and localised in terms of geography and vegetational formation (Moore 1976). Such studies may monitor the dispersion of individual grains when "treated" with radioactive tracer labels (for instance, Colwell 1951; Chamberlain and Chadwick 1972), or neutron activation labels (Handel 1976). Some theoretical inquiry has been attempted, relating the complexities of airflow to trajectories of airborne pollens, and presenting these as equations of motion (Burrows 1975).

The most recent, authoritative study (Tauber 1977) expanded and extended his previous work (Tauber 1965 & 1967). All components of pollen transfer and deposition were monitored over five seasons. These components were: pollen in the trunk space, above the tree canopy, above and on the lake surface, and on the lake bed. The results allowed a "best estimate" of the contribution of these various components. Each component was found to have a distinctive pollen spectrum, and to have a particular and, in the main, broadly determinable range of origin. Tauber found that his model of pollen transfer, and its composite nature, was thus substantiated. He noted numerous difficulties in the interpretation of his data of which the most crucially pertinent to this study are:-

- the impossibility of any rigorous separation of components "because of the interrelated pollen spectra" (op. cit. 62).
- the great variability to be expected in influential conditions which were peculiarly local.
- the applicability of the data to only a forested area. He specifically disclaimed the applicability of the data where A. transfer was largely by water and B. where human influences, such as clearance, were present.

The conclusions he made were that, in general, there was no proportionality between the areal extent or pollen production of a stand, and the numbers of grains arriving from that stand, where areas of such a stand were positioned at different distances from the sampling point. This was a consequence of vertical and lateral dispersion, occurring during aerial transfer, and of losses by impaction and deposition. More generally, he noted that pollen spectra are "highly distorted reflections of the surrounding vegetation cover" and a "highly neglected field" (op. cit., 10 and 62 - 74). Similarly, in her seminal conceptual model of the palynological system, Davis stipulated that it and any analysis were valid, in particular, for natural plant communities (Solomon and Harrington 1979, 341 - 3).

It is plain that, when interpreting fossil pollen assemblages, this must be done in terms of present-day, pollen-producing vegetation. Palaeoecological data may only be obtained through, and subject to qualifications in ecological data. Repeatedly, the broad correlation between vegetation and pollen output has been accepted (for instance in reviews of Moore (Moore 1977; 1978a; 1979)). The satisfactory evaluation of this relationship provides the raison d'être for pollen analysis.

It is therefore necessary to consider the spatial origin of the pollen assemblage, fossil and present-day. A major cause of variation in spatial origin of pollen assemblages is the proportion contributed to any deposit by agencies of transportation. This has gained the attention of numerous workers. While Tauber (op. cit.) monitored "components" in dispersion in transitu, other workers have examined fossil pollen itself. The proportion of pollen classed as "deteriorated","indeterminable" and "unknown" has been taken as an index of this (following the definitions of Cushing 1967). The principle is that pollen thus damaged was latterly water-transported, derived from the erosion and transportation of soil that incorporated well-preserved pollen. The pollen would often be significantly, if indeterminably, older, and possibly different from the "fresh" spectra. It is customary to show the proportion of damaged grains on the pollen diagram (for instance, Pennington 1979). The resolution of the proportion of damaged pollen as an index of the proportion of water-borne pollen is by no means unequivocal. Damage to pollen grains may occur in sedimentation and may be overlooked in routine counting.

More recent work has separated the air- and water-borne components in contemporary pollen (Bonny 1978). Tubes, extending from lake bed to surface, excluded the water-borne component. Very different quantities and assemblages of pollen were ascertained in and out of tubes. With a similar end, two lakes, one with incoming streams and the other with an enclosed basin (Pennington 1979) had their pollen assemblages analysed. These fossil pollen assemblages differed fundamentally throughout the spectra. The proportion of water-borne pollen varied strikingly with the forest cover of the catchment: values of below 50%, when forest cover was at its fullest, rose to over 80% at the horizon of extensive forest clearance. Prior to local deforestation the stream-fed lake received only twice the quantity of pollen of the closed basin; after deforestation this rose to four times, with subsequent further erratic increase. One may elicit broad principles and caveats which are of relevance here:-

- that 'damaged' pollen grains may often represent reworked fossil pollen.
- that modern pollen studies manifest a substantial water-borne component in lake deposition.
- that the water-borne component would tend to increase with the extension of deforestation and agriculture.

It was considered properly cautious to note the number and, where possible, the taxon of "damaged" grains. The study area as it received pollen, both air-borne and water-borne as we distinguish them, has been discussed above. The coastal marshes of England are characteristically alluvial, and, by definition, receive material from their catchment. It is appreciated that Pevensey Levels have frequently been inundated (discussed below. III-D-iii) and water-borne pollen would be thereby dispersed. (No further discussion is made of pollen deposition in lakes as the work, notably by Pennington and co-workers, is not of direct relevance to this study.)

Finally, Oldfield made a crucial contribution to this debate when he considered "source strength" and "dispersal distance" on the fossil pollen spectra of a given site, and concluded that numerous combinations of pollen source strength and distance may, in theory, produce the same pollen input at the site of preservation. He found it necessary to formulate theoretical deductive models to determine the relative abundance of plant taxa and plant communities at one, and then between two points in time (Oldfield 1970). This entailed the consideration of ecologically restricted taxa, and ascription of these to particular habitats in the source area. A sound corpus of present-day ecological data is required, and a source area markedly heterogeneous in habitats. Edwards, for instance, noted similarly varied manifestations of phases of forest clearance (K.J. Edwards 1979, 258).

It is hoped that a multidisciplinary approach to the study of a restricted and thoroughly scrutinised locality would meet these valid requirements.

There have been relatively few studies of pollen production and transportation in vegetational formations other than forests. These have been mainly concerned with heathland, dominated by Ericaceae, (for instance, by O'Sullivan 1973; Tinsley & Smith 1974; Cundill 1971 & 1979) and mires (defined as wetland ecosystems where there is autochthonous peat development. Bellamy and Moore 1974, 84) (Janssen 1973; Caseldine & Gordon 1978). As neither vegetational formation was, from pilot pollen analyses, significantly evident in the fossil spectra nor in the survey of present-day vegetation (II - D) they are not further considered.

It is plain that very few vegetational formations, however defined, now 'present' in the study-area have had pollen production, transportation and reception studied. Very few studies monitoring dispersal of pollen from, for instance, the cultivated field could be traced (Vuorela 1973). (A field study is written up in App. 10.) The author of the single work which monitored all components of pollen transfer over the long-term (Tauber 1977. Reviewed II - C - iv - a) explicitly declared that his results were invalid where human influences, such as clearance, were present. Vuorela stressed that the results she gained were not of general validity, and deprecated their use as an analogy of the past (op. cit. 23). There have been several American studies on dispersion and deposition of pollen from in vitro monoculture plots. Though only one taxon, timothy grass, grew in historical Europe, all were low-growing, and of restricted dispersion range (Raynor et al. 1972. References therein).

There is an absence of fundamental, present-day data on the behaviour of pollen associated with human activities. This is deemed to be a critical flaw in the rationale of pollen analyses, and more particularly in their anthropogenic interpretation. Varied and subtile forms of anthropogenic interpretation are being practised in what is virtually a theoretical void. The currency of such interpretation may be assessed from a list of writers who have recently employed it. The works of (Atherden, Bartley et al., Cundill,Davies & Turner, Dimbleby,K.J. Edwards,* Godwin, Hicks, Moore et al., Oldfield, B.K. Roberts et al., I.G. Simmons, Sims, Tallis and McGuire, Thorley, Tinsley, J. Turner, M.F. Walker & Taylor and Whittington have given anthropogenic interpretation much prominence in vegetational history, and it may well be that, in post-glacial and archaeological contexts, it now constitutes the mainstream in palynological interpretation. Many of the above workers adduced highly selective archaeological and documentary evidence in a position most ancillary to pollen analytical evidence. Reviews of the technique (J.G. Evans 1975; Crabtree 1977; Pears 1977; K.J. Edwards 1979; Mannion 1980) and symposium volumes on "environmental archaeology" (J.G. Evans, Limbrey and Cleere 1975; Limbrey and Evans 1978; Jones & Dimbleby 1981; Proudfoot 1983) regretfully endorse this judgement of theoretical weakness. Only Edwards

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*Since completion of this thesis K.J.E. has been engaged on lines of theoretical research on this issue. K.J.E. pers. comm.

has clearly declared this timbre of judgement, as pollen analyses of indeterminate worth accumulate in the literature. He judged that the theoretical basis of them, and in particular in an anthropogenised context, is "weakly developed" and not a "discriminating judge of human activity." He found pollen analytical evidence to be frequently, in some degree, in conflict with other "depositional artefacts." (Edwards 1979, 256 - 9).

(b) A descriptive model of air motion as it would affect the catchment for pollen analysis

Tauber's model of the composite transfer of pollen within forests (discussed:II-C-iv-a) was found to be a useful basis for the study of local pollen transportation. However, such work is too onerous and time-consuming to support a workaday pollen analysis. One is faced with, for the past, an infinitely complex and quite irreconstructible "reality". It is necessary to accept a simplified model based on a broad classification of circulatory patterns. Thus, the pollen analytical site may have its "catchment area" broadly delimited.

It has been customary to classify British weather in terms of distinctive circulatory patterns (Lamb 1972, 33 - 35 & 1977). Lamb's climatic types, seven in all, with associated wind patterns, prevail over the British Isles, and have done throughout his period of study, 1868 to 1967. Should a wind of fairly constant direction prevail over a site of palynological study, during the flowering period, some idea of the range and direction of dispersal may be elicited: however in north-west Europe, there is a markedly changeable pattern of weather, with great variation in direction. (Lamb, supra provided 29-day averages for, say, August with c. 28%, of Westerly type, c. 5% of North-Westerly, and so on). The frequencies of, for instance, south-westerly winds for a longer period - 1340 onwards - Lamb 1972, 33) in south-east England varied from c. 15% to c. 30%. Though clearly dominant patterns of weather need to be considered, the imprecision of historical climatological records and the absence of any continuous local record, impels an acceptance of Faegri's statement, that short-term variations (in patterns of flowering, pollen release, air circulation) over time will be equalised over the surrounding surfaces of deposition (Faegri & Iversen 1975, 55).

The ideal would be a classification of numbers of grains of each taxon, by range of origin, over time. This, in any thoroughgoing way, would be quite impracticable. The approach taken is more empirical and the results more indicative than authoritative. The taxa present within the "region" are identified and their distribution outlined in surveys of vegetation. Indices of inter-specific pollen productivity and representation are drawn on. Broad patterns of air motion (Lamb 1972), especially during the flowering season, are appraised. The vagaries of local topography and vegetation (Tauber 1965, 33) acknowledged, and some attempt is made to break down a composite model of mode of dispersal and deposition (Tauber 1977; Andersen 1974, a and b). This is attempted here.

It is not customary to delimit a catchment other than as broad limits, such as 50 to 100 km. (Faegri & Iversen 1975, 61 - 2), usually related to the size of the receiving basin (Tauber 1977). However, it would be expected that most pollen would originate in the immediate vicinity, and the quantity would progressively diminish with distance. Wherever the catchment is delimited for generalised purposes, some grains would intrude. These, the over-representation of local pollen and intrusion of long-distance pollen, have been called the classical problems in discussion of palynological method, and potential sources of error (Faegri & Iversen 1975, 173 - 9). Fortunately the dominant marsh species of Sussex are, in the main, distinct from dry land species; this has been the case both historically as found (as pollen, macrofossils and sediments) in coastal peat beds of British Isles (Godwin 1943 & 1975a) and south-east England (Thorley 1971, 1.5), and at present as found in vegetational overviews of the British Isles (Tansley 1953), the south-east (Thorley 1971, 130 - 71) and local floras (F.C.S. Roper 1875; Wolley-Dod 1937; Hall 1980). Thus, local pollen taxa were prima facie distinguished from the regional taxa; this has been done for Alnus, Salix, Phragmites and Cyperaceae, none of which, it is judged, have ever occurred in any abundance away from the Levels in a free flowering state. (op. cit.)

Long-distance pollen is by definition a trace component of a pollen assemblage. It is only separable from the "regional" component where the taxa are exotic or where counts of a taxon are "unreasonably" high. Acts to exclude or modify the counts of a taxon are somewhat a convergence on expectations, whether or not justified. No reason for "adjustment" was found at the Sussex sites.

The form of the actual basin of deposition has barely been touched on in the literature. Material factors are the size and openness of the basin; this was referred to by Tauber (Tauber 1967, 1977) who found that the components of dispersal, and so distance of origin, varied with basin size. Jacobson and Bradshaw (1981) have proposed a general model with which it is possible to predict, for a basin of given area, the proportion of pollen which will originate from different distances outside it. The Levels are extensive (c. 65 km² or 25 sq. miles) and open to both sea and gentle slopes. Dispersal above the canopy would be expected to be dominant, and filtration inexceptional as there is now, at least, little peripheral shrub growth.

The catchment area of the eastern Pevensey Levels is taken to be an area, bounded to the east by the South Downs, to the north by the Forests of Dallington, St. Leonards and Ashdown, to the west by the Levels of Pett and Brede and to the south by the English Channel. These have been taken to be the outermost bounds of the study area, and "barriers" to the inward dispersal of pollen. Taxa and spectra characteristic of the downland pollen records nearest to the study area at Lewes, Frogholt and

Wingham (Fig.5&6F;Thorley 1971 & 1981; Godwin 1962) are present only intermittently and as traces in the present study. Where present in the study area they appear in c. 1400 AD, as compared with in the Bronze and Iron Age on the downland. Similarly, Ericaceae pollen characterises the long-established heath formations of the Forests of north Sussex (Discussed IV-A). It was not possible to discern any eastern boundary on the basis of any taxon.

The "descriptive model of regional air motion" for the study area may be summed up as an efficient and thorough mixing of the pollen of the eastern Levels and their immediate upland environs within an area broadly coincident with the formal delimitation of the study area (II - B).

(c) Recent work on pollen preservation

Methodical studies on the differential preservation of pollen meet the great, if not insuperable, difficulty of reconstructing the complex diversity of the depositional environment in the laboratory and monitoring any presumably lengthy process of deterioration. Faegri noted that data on sporopollenin as it related to pollen analysis was very sparse (Faegri 1971, 265). Sporopollenin has been defined as a"collective appellation for the resistant wall materials found in ... spores ... and ... pollen" (Heslop-Harrison 1971, 1). They were judged the most resistant organic materials of direct biological origin found in nature and in geological samples. The stability of sporopollenin is the raison d'être of palynology.

Pollen analysts, it has been said, live in "constant fear" of the "differential destruction" of pollen (Faegri 1971, 256). Workers on "differential destruction" have presented their results as a ranking of susceptibility to decay in soil environments over monitored periods of time. pH and permeability were measured. Groups of taxa commonly emerged at the top or bottom of the ranking (Andersen 1967 and 1970; Havinga 1967 and 1971); these have been noted.

A further complication has been noted, the selective destruction of pollen following ingestion by a ruminant (Harris 1971, 271); some pronounced destruction had been noted in preliminary work on pollen in the stomach contents of hare (the author, forthcoming).

One contributor was impelled to judge that pollen diagrams were unreliable, as it was rarely possible to account for all factors controlling the assemblage which would be fossilised (van Gijzel 1971, 272). The force of this is disputed; it is noted that particular environments are conducive to "good preservation" and these ought to be sought out.

These points all add much uncertainty to the reliable practice of pollen analysis.

II - D. Surveys of vegetation : in the present day and the past

(i) Present-day surveys of vegetation: methods and results

There are no detailed vegetational surveys of the study area. There was a clear need to slant this survey to vegetational formations and species* which were represented in the pollen record, and elements which persist, and may be expected to flower and to disperse pollen freely. Therefore the vegetation chosen for survey was:-

a) individual canopy trees (>0.7 m. in girth at 1 m. above the ground. Height exceeding 5 m.) in smaller areas of woodland (<100 ha.).

b) individual canopy trees (as defined above) around the perimeter of larger areas of woodland (>100 ha.).

c) the presence of woody species, trees, shrubs and climbers, in sampled 30 m. lengths of hedgerows.

d) the presence of species, with some judgement as to abundance (after Tansley 1953, I, 278 - 9, et seq.), on small areas of land known to have been recently burned or clear-felled.

e) the presence of trees and shrubs on 1 m. wide transects across named (Cooden and High) woods.

These habitats were surveyed in an area circumjacent to eastern Pevensey Levels, within 2 km. of the sites of pollen analysis, yet without the perimeter of the former Ashburnham estate (Fig. 1).

The results of surveys (a) and (b) are summarised in Fig. 8. The results of survey (c) are set out in App. 4. The hedgerows surveyed are mapped in Fig. 8, and the data summarised below. The results of (d) and (e) are summarised below. Fig. 8: see end of section.

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*NOTE: Nomenclature of plants follows that of Clapham, Tutin and Warburg 1962, after Kerrich, Hawksworth and Sims 1978.

It is possible to present these results succinctly:-

(a)

	PEARTREE W.	SMITHS W.	WET/KITES NEST W.	COODEN W.	COLLINGTON W.
OAKS	109	64	11	76	67
BEECH	26	-	2	-	7
PINE	-	-	-	-	25

(b)

OAKS	143	PERIMETER OF HIGH/FREEHOLD AND PEARTREE WOODS
BEECH	39	
ASH	6	
PINE	12	
CHESTNUT	(6)	

(c) In the 67 30 m. lengths of hedgerow sampled, 27 "woody" species were identified. Of these, only 8 were located in more than 20 hedgerows; these were bramble (in all 67), hawthorn (58), oak (46), ivy (43), sloe (40), hazel (39), dogrose (38) and holly (28). In all but five lengths, oak was present as a "canopy tree" as defined above.

(d) An area of about 1.6 ha. in three patches in High Woods, Bexhill, was felled and burned over in February, 1975, and was surveyed in June of 1975, 1976 and 1977. Of the species in abundance, bramble, bracken and common gorse were "locally dominant" throughout; holly and hazel (from stumps), stinging nettle, and ling "locally abundant"; birch and willow seedlings, rosebay willow-herb, wood sage, cross-leaved heather, docks, thistles and ivy "frequent.

(e) - from south to north in Cooden Wood (TQ706075) (1m. x 300m.) there were:-

Canopy trees	Understorey shrubs/trees
33 OAKS	24 HAZEL
4 ASH	12 HAWTHORN
	9 HOLLY
	6 SPANISH CHESTNUT
	3 WILLOWS

(ABUNDANT BRAMBLE THROUGHOUT)

- from west to east in High Woods (TQ714095) 1m. x 850m.) there were:-

Emergent trees	General canopy level	Understorey shrubs
8 OAKS	29 BIRCHES	12 HOLLY
1 BEECH	14 HORNBEAM	10 BIRCHES
1 PINE	12 OAKS	8 HORNBEAM
1 SYCAMORE	10 SYCAMORE	6 SYCAMORE
	7 SPANISH CHESTNUT	4 HAWTHORN
	7 HAZEL	3 HAZEL
	6 HOLLY	3 OAK
		1 SPANISH CHESTNUT
	(ALSO THICKETS OF COMMON GORSE, BRACKEN	("LOCALLY ABUNDANT" BRAMBLE)

This data signifies that the flora is species-rich (29 "Woody" species), diverse in habitat (woodlands of varied size, forms of management and "physical environment") and, to a great degree, a continuously present element in the environment. The high species counts in hedgerows (after Hooper 1970 and 1971; Pollard, Hooper and Moore 1974 & Pollard 1973; Hewlett 1973; Willmot 1980), and cursory note of herbs taken to signify assarting from woodland and soundly tested out in the south-east, endorse this. The mean count of species was 6.9, and the range 2 to 11. As at Otford (Hewlett 1973), whether the hedge was overgrown or laid, there was little difference in the species count. (Interestingly, several lengths of hedgerow with the highest counts complied with the boundaries of an early Saxon estate as traced and discussed by Brandon (Brandon 1974a, 80).)

Overall this study area may be summed up as:- densely wooded, dominated overwhelmingly by oak in the canopy layer, with an extremely diverse shrub and "scrub" layer.

(ii) Note on the botanical record of the study area

It is now intended to briefly review historical description of plants in the study area by field botanists. This has been based on the Sussex section of the 'Dictionary of British and Irish Botanists (and Horticulturalists)' (Desmond 1977), 'A bibliographical index of the British flora' (N.D. Simpson 1960), and a history of Sussex botanical inquiry (Wolley-Dod 1937). Works more specifically on the cultivation and management of timber and woodland (based on Henrey 1975) will be considered below (IV-C-i). Following from these, major county and local floras were examined. A recent "social history" of the aims and methods of much past botanical inquiry (D.E. Allen 1976), reported "blind piling-up of facts, the unquestioning seeking-out and garnering of data" as the norm (op.cit. 80). It was executed by - "brood after brood of natural lexicologists and list-makers, counters and comparers" (op.cit. 82). The outcome was a "surfeit of dubiously useful data" (op. cit. 192). These scathing judgements are endorsed following examination of all published works of these Sussex botanists. All were preoccupied with counts of species, and adding to these. All were inordinately slanted towards and seeking the new or local "variety" and "sub-species". All paid scant attention to notions of distribution, abundance, and "dominance" (as discussed by Krebs 1978, 497 - 502). All were for ecological purposes, sensu lato, of little use. Of some use, were the works of John Ray (1627 - 1705), Wm. Markwick (1739 - 1813); F.C.S. Roper (1819 - 96) and A.H. Wolley-Dod (1861 - 1948). The works of John Ray have been the subject of a biography (Raven 1942, 1950) and editions of his correspondence (Lankester 1848; Gunther 1928; R. Thompson 1974). He was well-travelled in Sussex with "constant visits to Danny and Cuckfield" and other places in east Sussex in the late c17th, "his wander-years" (Raven 1950, 140 - 3). His work relevant to Sussex was to produce county lists of species which were appended to Camden's "Britannia". This list comprised 7 species, all observed by him, but all were rare and local in incidence, yielding a quite inadequate flora (op. cit. 266 - 9). A single record useful to this study was his siting of rosebay willow-herb (Epilobium angustifolium L. (Chamaenerion angustifolium (L) Scop.)) "in a wood near Troiers in Mayfield parish" (Gunther 1928; Raven 1950, 204). This was the first Sussex observation of a species which has the repute of being indicative of post-fire wood clearance.

William Markwick resided for much of his life at Catsfield Place, Catsfield, in the study area. His work has been reviewed (Wolley-Dod 1937) and included "considerably over 300 early notices for the county of Sussex" for the period from 1768 to 1778. All the criticisms made above are due to Markwick. In addition, he rarely specified location. He did, however, in cooperation with Gilbert White, note the earliest and latest flowering time of numerous plants in the late c18th (White 1887). This is used below.

The works of Roper and Wolley-Dod (Roper 1875; Wolley-Dod 1937) represent the culmination of formal botanical inquiry in Sussex, floras of the Eastbourne area and Sussex. Both present "complete" lists of species with account taken of contemporary taxonomic refinement. Roper achieved a total of 700 species, and Wolley-Dod c. 1400 (op. cit. xxvii - xxxiii; Ii). Both offer a brief description of the abundance and distribution and habitat of the species. This data has been accepted (IV-A) as a generalised overview of documented botanising which will supplement the other documentary sources, and will eventually be related to data from physical sources.

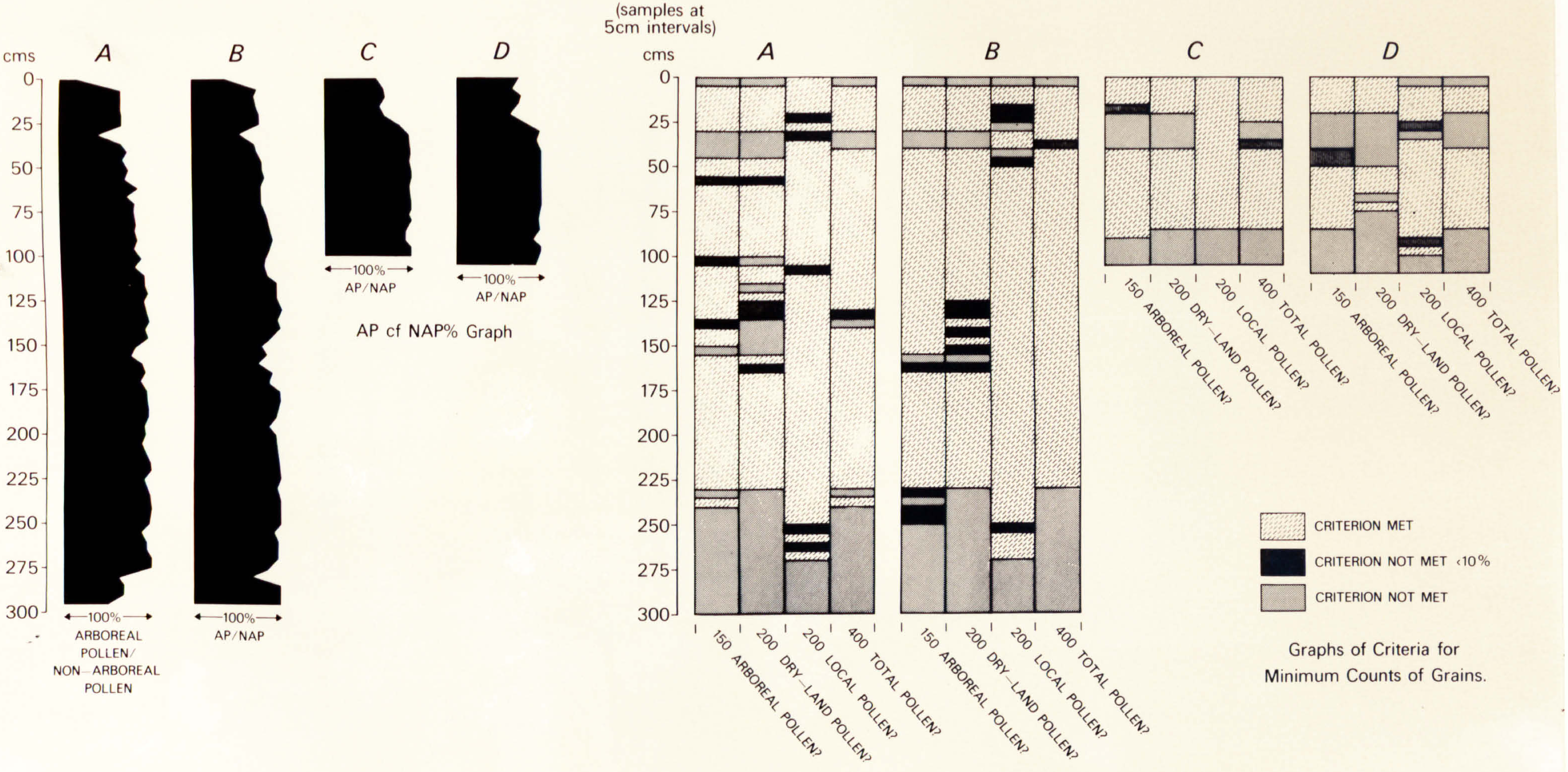
The high degree of generalisation in these judgements of abundance and distribution is fully noted. Habitat, similarly, was described in only the most cursory manner.

Botanical data for Sussex is lamentably poor. It lacks the particularly early and, for the time (1632), detailed flora such as that of Thomas Johnson from his "Journeys in Kent and Hampstead" (Gilmour 1972). It lacks a thoroughgoing review of floras, such as "The Historical Flora of Surrey", which uses material from 1548 onwards (D.H. Kent 1975). It lacks the up-to-date, intensively executed and methodically processed, present-day flora, such as that for Cambridgeshire (Perring, Sell and Walters 1964) or the computer-mapped flora as done for Warwickshire (Cadbury, Hawkes and Readett 1971).

However, the recently produced plant atlas for the county is fully used (Hall 1980). It is all that is available, and is necessarily considered, albeit with caution and reservation.

'Results from the physical data: Pollen Diagrams'

Fig 6A Eastern Pevensey Levels Summary Diagram



AP cf NAP% Graph

Graphs of Criteria for Minimum Counts of Grains.

Fig 6B **Eastern Pevensey Levels, A**

Fig6C **Eastern Pevensey Levels, B**

Fig 6D

Eastern Pevensey Levels, C-D

Fig. 6E: Sporiferous taxa [as % of Total Dry–land Pollen. Excluded from Pollen Sum]

FIG. 6-F: Notes on nomenclature of taxa &c. used in pollen diagrams

The nomenclature complies with the coded key of Faegri and Iversen (Faegri & Iversen 1964 & 1975) with the following exceptions:-

- Ranunculus, Rosaceae, Typha latifolia ought to be designated 'p.p.' on the pollen diagrams.
- Labiatae, Rumex, Salix and Potamogeton were not refined in identification to 'section', or 'type'.
- Plantago, was composed wholly of Plantago lanceolata grains.
- Following the footnote to the key (Faegri & Iversen 1975, 252), identification of all Ericaceae grains as Calluna vulgaris was secured.

\+ Note on taxa deemed to be essentially calcicolous in distribution and, for practical purposes, confined to downland beyond the substantive catchment of pollen in eastern Pevensey Levels: These were Taxus, Ligustrum, Juniperus, Helianthemum, Papilionaceae (including Lotus) Rhamnus, and tentatively, Tilia (following the 'Sussex Plant Atlas' and pollen analyses of Thorley at Lewes. P. C. Hall 1980; Thorley 1971 & 1981).

\+ Damaged pollen grains classified after Cushing (1967) were counted. In no sample did the proportion of all damaged grains exceed a trace value. There were no noteworthy classes of damaged grains associated with taxa of pollen. Such trace values clustered around c. 0.3 - 0.5 m depth at all sites, coincident with increased sand lenses; Cyperaceae pollen were not uncommonly 'crumpled' but the threshold definition presents problems.

\+ Trace values are signified by a '+' sign i.e. <2.25% value.

\+ Saw-blade diagrams are used in preference to histograms; although both are in current use (Birks & Birks 1980, 137. In the 'Journal of Biogeography' of 1981, Beckett employs the former and Thorley the latter), histograms, when the thickness of the bar represents the thickness of the sample, are accurate. Conversation with psychologists indicates that 'saw-blade' data is the more readily assimilated.

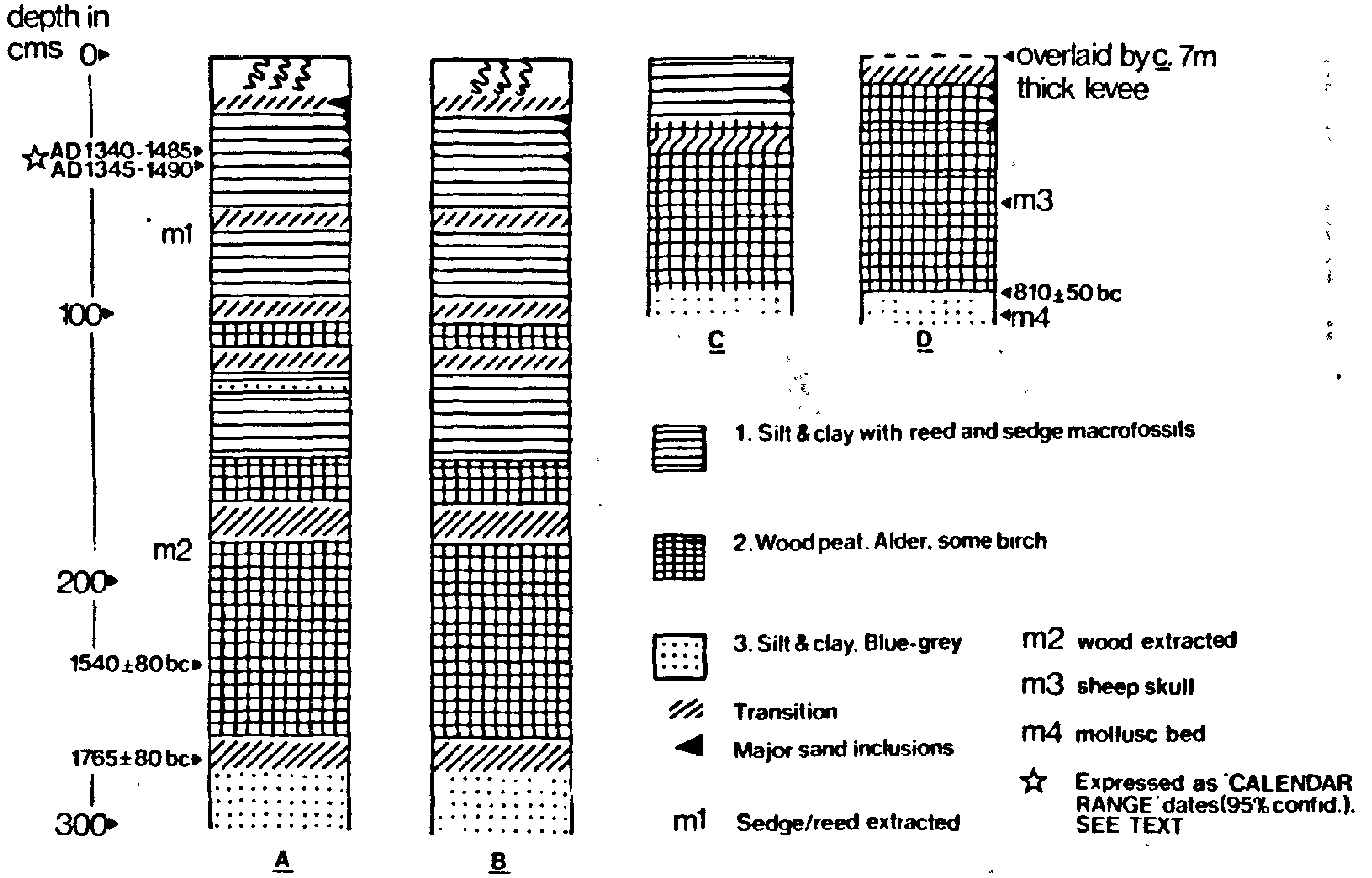


Fig 7 Summary of analyses of sedimentary stratigraphy and macrofossils (II - B - ii)

Fig 8 SURVEY OF PRESENT-DAY VEGETATION (see text)

II - F. Mire vegetational history

The taxa ascribable to 'the mire' or the Levels, and 'the region' or the land circumjacent to the Levels are reasonably distinct. This is judged on the basis of the county Plant Atlas (Hall 1980) and the pollen analyses conducted in south-east England (Fig. 5).

The pollen assemblage zones for the four pollen analytical sites are:-

	POLLEN ASSEMBLAGE ZONES (PAZ)
Site A: Court Lodge Bottom	
0.00 - 0.10 m	Growing *in situ* root mass
0.10 - 0.69 m	Cyperaceae - Phragmites - Salix - Alnus
0.69 - 1.18 m	Cyperaceae - Alnus - Phragmites - Salix
1.18 - 1.48 m	Cyperaceae - Alnus
1.48 - *c*. 2.80 m	Alnus - Cyperaceae
Site B: Puddledock Botton	
0.00 - 0.10 m	Growing *in situ* root mass
0.10 - 0.32 m	Cyperaceae - Phragmites - Salix - Alnus
0.32 - 0.75 m	Cyperaceae - Alnus - Salix
0.75 - 1.62 m	Cyperaceae - Alnus
1.62 - *c*. 2.80	Alnus alone
Site C: Cooden Beach Golf Course (west)	
0.00 - 0.27 m	Cyperaceae - Phragmites - Salix - Alnus
0.27 - 0.63 m	Cyperaceae - Salix - Alnus
0.63 - *c*. 1.00 m	Salix - Alnus - Cyperaceae
Site D: Norman's Bay Sluice	
0.00 - 7.10 m	Levee built up of sub-soil. No pollen.
7.10 - 7.40 m	Cyperaceae - Phragmites - Salix - Alnus
7.40 - 7.82 m	Cyperaceae - Alnus - Salix
7.82 - *c*. 8.40 m	Alnus - Salix

Site	Depth at which 'Wood peat' is succeeded by 'Silt with Clay' (from Fig. 7)	
	The major transformation	Minor transformation
A	1.56 m	1.0 m
B	1.58 m	1.0 m
C	0.36 m	
D	0.18 m ?	

With the exception of the uppermost PAZ at all four sites, Cyperaceae - Phragmites - Salix - Alnus, and the major 'character-taxon' - Cyperaceae - in 3 upper PAZ's at the 2 long-term, inland sites and 2 upper PAZ's at the 2 short-term, seaward sites, the PAZ's at the four sites are strikingly dissimilar. This indicates that the pollen records are particularly local to the pollen analytical sites. Depths of major stratigraphic transformations at these sites (above) do not coincide in depth with PAZ boundaries; this endorses the local nature of vegetational and environmental change. Elements in the flora may be reconstructed: alder carr; willow swamp; sedge and reed fen. Little is known of the pollen productivity of sedge and reed, and both alder and the willows have the repute of erratic pollen output. Therefore, although the progressive replacement of alder carr by sedge and reed fen is discernible at all sites, the loci and time-scale of the replacement is not ascertainable.

The nature of each stratum will be briefly described and the transformation from one to the other will be interpreted and discussed. (Results in full: II-B-ii). The lowest stratum (Stratum 1) bore only scarce macrofossils and microfossils and was taken as the lowest of interest. It was almost entirely mineral. The molluscs, part of a bed of about 50 individuals at Site D, were identified as Scrobicularia plana. This is a common bivalve inhabiting estuarine mudflats within the intertidal zone. It feeds on deposits and importantly it does not migrate to feed (Hughes 1969). There has been some suggestion that it tends towards the brackish and landward zone (Morton 1979, 128). The size of the bed and the habitual staticity of the species indicate that it is in situ, and lived and died where it was found. Plant macrofossils were absent except for several rootlets of Phragmites communis (common reed) directly below the zonal boundary at Sites C and D. A digest of part of the pollen record is presented to amplify the other scant records. An amalgamation of 16 samples (the lowest 4 5cm-spaced samples of 0.5 cm^3 volume at Sites A,B

C and D) is presented. The taxa represented fall into three classes:- trees and shrubs; grasses and sedges which may or may not be attributed to wetland; herbs which may be attributed to wetland. (see Fig.9).

The values of pollen present are low; a total of 636, and average per sample of <40. No great store is put in values of this order. Yet the presence of Triglochin (genus of arrow-grasses), Chenopodiaceae (the family including goosefoots, sea-blite, oraches) and Artemisia (genus of wormwoods and mugwort) en suite suggests some form of salt marsh habitat. Recent conspectuses of salt marsh (Ranwell 1972; Adam 1978 and 1981; Westhoff & Schouten 1979) have stressed the paucity of the species on salt marsh, and the emphatic physiographic zonation of species. The above pollen taxa incorporate many of the 'Character-taxa' of salt marsh and may not be reconstructed into any other form of vegetation. Such low values from taxa which are known to be prolific in their production of pollen - trees and shrubs, and grasses and sedges - allow them to be discounted as the vegetation on and near to these four sites.

Together, the presence of the mollusc bed, the reed fragments, the scanty though suggestive pollen record, and the mineral illite (characteristic of estuarine mudflats, though possibly illuviated. Frost pers. comm.) indicate the presence of salt marsh. More tentatively, this salt marsh may be placed in the supralittoral (sensu Westhoff and Schouten 1979) or landward zone.

The second stratum (Stratum 2) is wood peat. As sampled it was 100% organic, with abundant recognisable macrofossils, particularly of alder. Within this stratum, at Site D, there was a part of a skull attributed to a young, male sheep. At this time according to the documentary record (infra), Pevensey Levels had not yet been reclaimed by man. The pollen record (Fig. 6) endorses the plant macrofossil evidence, that there was alder carr fen, with some birch, over eastern Pevensey Levels at this period.

The uppermost stratum (Stratum 3) is highly heterogeneous with varied proportions of clay, silt and sand and macrofossils of reed and sedge.

Alnus	263		
Salix	22		
Quercus	38		
Fraxinus	6		
Betula	50		
Corylus	41		
Ulmus	8		
Pinus	21		
Ilex	1	Trees and Shrubs	350
Gramineae	68		
Phragmites	2		
Cyperaceae	48	Grasses and sedges	118
Artemisia	17		
Chenopodiaceae	38		
Triglochin#	13	Wetland herbs	68
		Total pollen	636

Triglochin (genus of arrow-grasses) is all but absent in the post-glacial pollen record of the British Isles. Fresh material of both species was obtained. Identification of plant and pollen was verified; the pollen reference collections of the Polytechnic of North London and University of St. Andrews (both, Departments of Geography) and Royal Botanic Gardens, Edinburgh were used.

Fig. 9. Digest of the pollen record: I-abstract from its base.

Relating the results of the mineralogical analyses to the regional geological memoir (Refer to Fig. 1), it was possible to determine that all deposits sampled were of Tunbridge Wells Sand. Because of the peculiar distribution of this formation as drift, it is argued that these deposits originated in the immediate locality, and never >4 km distant.

Discussion

The transformation from stratum 1 to stratum 2 and from stratum 2 to stratum 3 were, in stratigraphic terms, brief. Transitions are not protracted. Godwin has described the widespread establishment of peat-forming alder carr on the coastal alluvium of the British Isles in the mid-post-glacial (Godwin 1975a 263-4). He generalised this as being at around 7000 BP, and associated it with the concluding stages of the general eustatic rise in sea-level. He stressed the carr's extensiveness, and maintained that it was kept in existence by continuing or renewed marine transgressions. The establishment of such peat on Pevensey Levels is now dated. At its most inland (Site A) peat was initiated at 3715 ± 80 BP, and its most coastal (D) at 2760 ± 50 BP. Seaward of this last site is a shingle bank of indeterminable age. As all borings made manifest a single major peat stratum and there is no evidence of any stratigraphic discontinuity, a continuous process is inferred. It was a successional process which, to judge from the range in the habitats of alder today (McVean 1953; Tallantire 1974), is no longer observable. The Levels environment prior to the peat formation may only tentatively be reconstructed; following it, it is unambiguous. A reevaluation is prompted by this discussion. The dates for this initiation of a period of peat formation on the Levels straddle the boundaries of Shephard-Thorn's chronological groupings mentioned above (II-B-i). At 3000 BP (or around 1050 BC), Levels peat formation is still extending.

The transformation from stratum 2 to stratum 3 is not dated. There is no direct evidence for it, apart from the sheep skull. It is considered in terms of ecological factors which may contribute to the supplanting of the alder (Fig. 10).

Of the factors tabulated, a combination of numbers 1, 6a, and 6b are considered to be crucial. The substance of the Levels themselves argues weightily for this. An immense volume of sediments overlie the wood peat: in the catchment area delimited in Figure 1, an estimated 14 million m^3 lie. Its geographic origin has been established from mineralogical analyses. All the deposits sampled originated within 4 km of these Levels. Once alder fen had been precluded, the pressures from thegrazing of livestock may well have been the factor maintaining the marsh as largely treeless. The first of these transformations is judged to be a process of natural succession in a secular context. The second is considered to be due to a set of autecological factors acting to preclude alder: a greatly increased input of erosional materials into feeding streams and sewers of the Levels; a silting up of watercourses; ponding and a raising of the water-table; degeneration and a virtual local extinction of the alder population. The archaeological record tells us nothing of a protracted, continuous (and continuing) period of clearance accompanied by pronounced soil erosion.

Figure 10: The alder: ecological factors which would contribute to its reduction.

FACTOR	MANIFESTATIONS IN THE ENVIRONMENT
1. Increase in the water table	A ponding effect due to impeded drainage. At regional scale, may be caused by littoral shingle bar (now present but not dateable). At local scale, windthrow of trees on coast (there is a submerged forest *in situ*) or beavers. Both, with or without increased throughflow.
2. Decrease in water table	Peripheral draining of Levels. Impeded throughflow upstream.
3. Pressure of grazing	Sheep skull found *in situ* in upper wood peat. Anecdotal data on the palatibility of alder to herbivores suggests it is not much favoured (McVean 1953; Tallantire 1974). The fen may deter herds and herdsmen. Those there would puddle the ground.
4. Harvesting of wood	No evidence *in situ* and no excavation assemblages.
5. Increased salinity	No evidence as not succeeded by halophytes.
6a. Silted watercourses	The voluminous deposits from the surrounding upland which overlie the wood peat argue for this. Stream flow is scarcely measurable.
6b. Increased fertility	Coupled with 6a. Undetectable retrospectively. Some sedges, e.g. *Carex paniculata* may indicate this.
7. Fire	No evidence
8. Disease	No extinction - pollen persists after transformation. Fungal diseases accompany 1 and 2.

This summary is eclectic and general: Although alder has not, to the writer's knowledge, been the subject of monitored experimentation on its reaction to waterlogging, which when sustained, leads to anaerobiosis, and anoxia and eventual death in the plant. Moore (1982a) has reviewed knowledge on survival mechanisms in wetland plants, and Barclay and Crawford (1982) have monitored flood-intolerance in conditions of strict anaerobiosis. This together with field observations compiled by McVean (1953) and Tallantire (1974), indicates that sustained ponding is a plausible explanation.

Sources: McVean (1953); Tallantire (1974); M. Penny pers. comm.

II - G. Regional vegetational history

The pollen assemblage zones for the four pollen analytical sites are:-

	POLLEN ASSEMBLAGE ZONES (PAZ)
Site A: Court Lodge Bottom	
0.00 - 0.10 m	Growing in situ root mass
0.10 - 0.58 m	Gramineae - Quercus - Corylus - Betula
0.58 - 1.47 m	Quercus - Corylus - Gramineae - Betula
1.47 - 2.40 m	Quercus - Betula - Corylus - Ulmus - Gramineae
2.40 - 2.80 m	Quercus - Ulmus - Corylus - Betula
Below 2.80 m	Wholly inadequate counts of pollen
Site B: Puddledock Bottom	
0.00 - 0.10 m	Growing in situ root mass
0.10 - 0.58 m	Gramineae - Quercus - Corylus - Betula
0.58 - 1.46 m	Quercus - Gramineae - Corylus - Betula
1.46 - 2.38 m	Quercus - Betula - Corylus - Ulmus - Gramineae
2.38 - 2.80 m	Quercus - Ulmus - Corylus - Betula
Below 2.80 m	Wholly inadequate counts of pollen
Site C: Cooden Beach Golf Course (west)	
0.00 - 0.27 m	Various herbs - Gramineae - Quercus - Corylus - Betula
0.27 - 0.74 m	Quercus - Corylus - Betula - Ulmus
0.74 - 1.00 m	Quercus - Betula - Corylus - Gramineae
Below 1.00 m	Wholly inadequate counts of pollen
Site D: Norman's Bay Sluice	
0.00 - 7.23 m	Levee built up of sub-soil. No pollen
7.23 - 7.54 m	Various herbs - Gramineae - Quercus - Corylus - Betula
7.54 - 7.93 m	Quercus - Betula - Corylus - Ulmus
7.93 - 8.40 m	Quercus - Betula - Corylus - Gramineae
Below 8.40 m	Wholly inadequate counts of pollen

Because of the highly similar nature of these pollen assemblage zones and the entire pollen record, respectively at the two inland sites, A and B, and at the two seaward sites, C and D, the descriptions will be combined.

The inland sites: Court Lodge Bottom (Site A) and Puddledock Bottom (B). Quercus - Ulmus - Corylus - Betula PAZ. This PAZ is bounded by, at the base, deposits with wholly inadequate counts of pollen (discussed in II-F), and at the top, the commencement of a protracted phase of decline in Ulmus. Radiocarbon dates from Site A date these boundaries : 3715 ± 80 BP and

3490 ± 80 BP. Arboreal Pollen makes up >80% and more usually >90% of Total Dry Land Pollen throughout the PAZ. The 'character-taxa' of the PAZ (those in its title, in ranked order of importance) figure to the near exclusion of all others. Minor peaks in Fraxinus (at Site A), in Gramineae (asynchronous) and in lesser herbs (more noticeable at Site B) occur. The PAZ may only be interpreted as woodland with a major primary or forest-forming element and a substantial secondary, or scrub-forming, element. The slight and unsustained clearance phases, which are asynchronous and therefore highly localised, do not coincide with the decline in Ulmus.

Quercus - Betula - Corylus - Ulmus - Gramineae PAZ. This PAZ is bounded by, at the base, the commencement of a protracted phase of decline in Ulmus and, at the top, a rather ambiguous increase in Betula and Corylus values together with a decline in Quercus, and, particularly at Site B, in Gramineae. The lower boundary at Site A was dated by radiocarbon at 3490 ± 80 BP. Arboreal pollen makes up >80% and more usually >90% Total Dry Land Pollen throughout the PAZ (except for a value of c. 70% at around 1.60 m depth at both sites). The character-taxa remain the same as, and virtually as prominent as in the previous PAZ: Quercus, Betula and Corylus maintain high values throughout the PAZ. Gramineae values waver from trace values at the commencement, at around the middle, and at the end of the PAZ. A diversity of herb taxa appear as intermittent traces, but there is no clear trend to this nor relation with Gramineae values. There is a marked increase in Fraxinus values within, but not beyond the PAZ. A range of tree taxa appear as infrequent trace values; Pinus, Tilia, Fagus,* Ilex,* Taxus, Carpinus (those marked * for the first time). The PAZ manifests a gradual, progressive modification to woodland in the region. The Gramineae values manifest two distinct phases of clearance both of which were reversed; their coincidence in the stratigraphy suggests it to be a regional event. Sustained high values of Betula, Corylus

Fraxinus (which alone relates well with Gramineae values), and general increase in the number of woody taxa, manifest diversification in the structure and composition of woodland.

Quercus - Corylus - Gramineae - Betula PAZ. This PAZ is bounded by, at the base, an increase in Betula and Corylus values together with a decline in Quercus, and at the top, a general decline in woody taxa (but with increases in specific minor taxa) and increase in Gramineae and herb values. The upper boundary was dated by radiocarbon at Site A at 480 ± 50 BP (Calendar range, 95% Confidence : AD 1345 to 1490). Arboreal pollen declines progressively from c. 80% to c. 60% through this PAZ; this is complemented by a gradual continuous rise in Gramineae values, together with a suite of diverse herbs. The sustained high values of Corylus and Betula, and commensurately lower Quercus values in this PAZ is reversed towards its close when Quercus, and Ulmus re-establish themselves to some degree. The PAZ manifests the dominance of secondary forest for the first time: as it is not accompanied by any marked expansion in Gramineae pollen, it suggests a form of land-usage acting to maintain a secondary forest element - tentatively, extensive wood pasture.

Gramineae - Quercus - Corylus - Betula PAZ. This PAZ is bounded by, at the base, a marked increase in Gramineae and other herb values (together with increased frequency. Rumex values become continuous) and a complementary decline in woody taxa. Quercus values stabilise at an unprecedentedly low level, Corylus and Betula at their lowest level since a depth of c. 1.5 m. The appearance in the record of Acer, Castanea, Carpinus (Site A) for the first time, and a minor expansion in Pinus are notable. There is a case for making Pteridium a character-taxon in this 'PAZ'. This PAZ is clearly ascribed to the documented period. It is not appropriate to refine interpretation prior to using an array of potentially corroborative sources of evidence.

The seaward sites: Cooden Beach Golf Course (Site C) and Norman's Bay Sluice (Site D).

Quercus - Betula - Corylus - Gramineae PAZ. This PAZ is bounded by, at the base, deposits with wholly inadequate counts of pollen (described in II-F), and at the top, the temporary disappearance of Gramineae from the pollen record. A radiocarbon date - 2760 ± 50 BP - was obtained from the base of this PAZ at Site D. The character taxa made up the great majority of the pollen counted, and show great stability throughout the PAZ (except for the lowest strata where counts were scarcely adequate). Woodland with diverse primary and secondary elements, roughly on a par, is inferred. Pinus values at Site D would seem anomalously high. Gramineae values at both sites suggest a common, coincidental phase of clearance.

Quercus - Corylus - Betula - Ulmus/Quercus - Betula - Corylus - Ulmus PAZ. The PAZ's at these sites are contradictory, though not to any marked degree. The PAZ is bounded by, at the base, the temporary disappearance of Gramineae from the pollen record, and at the top, a massive expansion in herb and Gramineae values, and in a range of minor woody taxa. The 'character-taxa' apart from Ulmus (which maintains a minor presence) decline commensurately. The PAZ shows reasonable stability throughout (the inter-site differences at the upper boundary coincide with inadequate pollen counts). Woodland, similar in nature to the previous PAZ, is interpreted; the grassland element has however been succeeded.

Various herbs - Gramineae - Quercus - Corylus - Betula PAZ. This PAZ, as defined above, is confidently ascribed to the documented period, for reasons discussed below (II-H); full discussion is postponed until all sources of contemporary evidence are marshalled.

The vegetational history of 'the mire', eastern Pevensey Levels, and 'the region', the circumjacent upland, have been reconstructed from the deposits of a single continuous biogenic phase. In the context of local land/sea level change, only the events of the late medieval period, elicited from all sources of evidence, yield matter for discussion (IV-D-i). There is no substantive local evidence of any manifestation of climatic change in these pollen and ancillary records (following the authoritative compilations of Lamb (1977) and Godwin (1975a)).

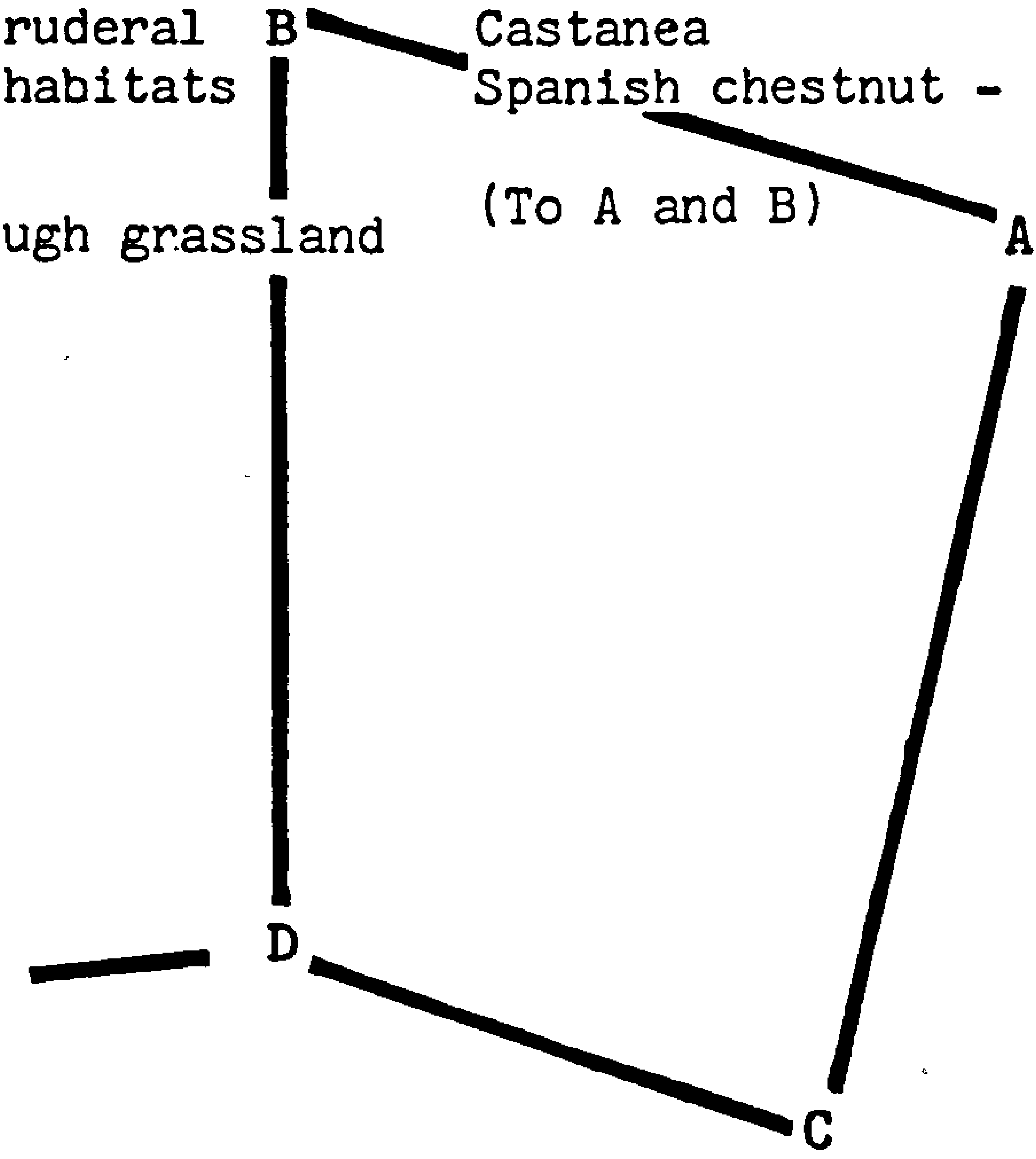
II - H. The chronology of vegetational change on and around eastern Pevensey Levels

It is now necessary to attempt a synthesis of the 14 Regional and 14 Local Pollen Assemblage Zones (PAZ's) and the 5 radiocarbon dates obtained from the 4 pollen analytical sites. The paired pollen analytical sites - inland and seaward - provide a remarkably precise 'mirroring' in PAZ boundaries (with 1 minor exception) and in stratigraphic contacts. At Sites A and B, the Arboreal Pollen/Non-Arboreal Pollen Ratio, and the percentage values of 'character-taxa' exceptionally differ by more than 5% at any level, other than where pollen counts were sparse (Fig. 6A). At Sites C and D, similar orders of comparability were achieved, although the overlain levee at D obscures data from the uppermost levels.

The contact common to all four sites (noting the previous point) is the present-day surface of the Levels. The uppermost Local PAZ of the 4 sites matches well. The uppermost Regional PAZ at the 4 sites is similar, apart from the herbs intrusive en masse at the 2 seaward sites. The more marked differences in percentage values of herbs, and certain woody taxa, among the four sites for the span of the uppermost Regional PAZ (EPLIV), appears in Fig. 11. This diagram summarises what are qualifications to a regional synthesis, and are explicable in terms of conditions local to 1, 2 or 3 sites. The criteria for the EPLIII/IV boundary stand up well at all sites and are taken to be contemporaneous, and dated as 480 ± BP at site A.

The entire mire vegetational history (II-F), with the exception of the uppermost PAZ already dealt with, was interpreted in terms of elements in vegetation local to particular sites. Similarly the regional vegetational history (II-G) was interpreted in terms of local variations in the major elements, primary and secondary woodland, and grassland, set against a regional background of progressive deforestation with generalised asynchronous phases of clearance (though two phases are clearly synchronous).

Figure 11: A synthesis of uppermost Pollen Assemblage Zones (PAZ's): taxa with divergent and indicator status.



Carpinus
hornbeam - canopy woodland
Ericaceae
- all ling - heathland
Rumex
- dock genus - ruderal habitats
Pteridium
- bracken - rough grassland

(To B)

Gramineae - grassland
grass family
Acer
maple family - canopy woodland
Castanea
Spanish chestnut - canopy woodland

(To A and B)

Plantago lanceolata
- ribwort - pasture and ruderal habitats

(To A,C,D)

For context see Fig. 1.

Umbelliferae
- parsley family - no habitats proposed
Chenopodiaceae
- goosefoot family - littoral habitats
Artemisia
- wormwood genus - littoral habitats
Fraxinus
- ash - littoral scrub growth?

Pinus
- pine - long-distance transportation?

(To C and D)

Great store has been put in the set of 5 radiocarbon dates which have been acquired to support the pollen and ancillary records. The rationale of radiocarbon dating, and the uncertainties inherent in methodology and interpretation are well discussed (Michels 1973; Aitken 1975; volumes of 'Radiocarbon') and have been usefully augmented by a discussion of the c. 200 dates obtained for the Somerset Levels (Orme 1982). No reflections critical of the dating technique are appropriate. The set of calibrated dates may only be evaluated in itself, and as it rates against other types of dating in the locality and, upon justification, analogous radiocarbon-dated sites in the region. The 4 dates obtained from Site A present an ordered sequence; neither these nor the single date from Site D are judged to be implausible. The earlier three - 3715 ± 80BP, 3490 ± 80 BP, 2760 ± 50 BP - (SRR - 918; SRR - 1445; SRR - 1442) may be placed in the framework of archaeological periods in Sussex, namely in the Beaker Period, in the Early Bronze Age and in the Middle/Late Bronze Age (Drewett 1978a. Various papers). Yet the archaeological record for the study area at this time is scanty in the extreme(I).There are no spatial - cum - temporal concentrations of radiocarbon dates in south-east England (after Devoy 1982) into which the present dates may be satisfactorily fitted. No other modes of dating may be brought to bear on the matter. The last two dates - AD 1340-1485 and AD 1345-1490 ('Calendar range' dates: SRR - 1444; SRR - 1443 D.D. Harkness pers. comm.) - place the associated developments in the later medieval period. The first and third radiocarbon dates date the onset of peat formation; thesecond the commencement of a protracted phase in the decline of elm; the fourth and fifth, a phase of expanded clearance inland and, difficult to distinguish, a marked expansion in a suite of herb and minor woody taxa. The entire dated biogenic phase represented by the Levels deposits examined was compared against the collation of similar dated biogenic phases in south-east England (Devoy 1982). No association with any temporal or spatial concentrations in the initiation of biogenic phases was discerned. The local event would seem to be a distinctive event.

III Data from Documentary Evidence

III - A. Introduction

The study area has been the subject of historical scholarship over the last, say, three centuries. Although little of this could be described as ecological history, sensu lato, much, especially economic and social history and what may be called 'evolution of the landscape', was found of critical relevance.

An ordered approach was attempted employing three major bibliographies on the history and geography of Sussex, published by the East Sussex Record Office (afterwards called E.S.R.O.) (C.E. Brent, Fletcher and McMann 1974; J. Farrant 1977; S. Farrant 1977). These were augmented by a comprehensive examination of the abstracts, periodicals, and series of publications listed in App. 1. Together with the Victoria County History for Sussex (VCH volumes I II III IX, referred to by volume), and the albeit incomplete series, 'The Cambridge Agrarian History of England and Wales' (Thirsk 1967; Finberg 1972; Whetham 1978; Piggott 1981), these formed the basis for the examination of all secondary material. A list of recent theses on Sussex was referred to (McCann 1974).

The following section outlines in chronological order the major sources of primary and secondary domcumentary evidence as they have been found useful in this study.

III - B. Major sources of primary and secondary documentary evidence used in this study

The catalogue of extant Anglo-Saxon charters was examined (Sawyer 1968). References to the study area (Barker 1947, 1948 & 1949) were few and of minimal use.

Scholarship directed towards the study of the Domesday Book has in Sussex, as elsewhere, been a cynosure. The authoritative accounts of the survey have been scrutinised (King 1971; Darby & Versey 1975; Darby 1977), as has a recent review of Domesday studies (S.P.J. Harvey 1980). Until early modern times, attention in the present and other studies has been focussed on the estates of Battle Abbey. Major secondary sources were consulted as they were concerned with local land-usage (Scargill - Bird 1887; Savine 1909; Brandon 1971; Searle 1980b. Primarily, Searle 1974) as well as transcriptions of original documents (Searle & Ross 1967; Searle 1980a). This was augmented by personal communication with Searle and Brandon. The catalogue of the Battle Abbey estate archives as lodged at the E.S.R.O. was examined (J.A. Brent 1973). No usable data, however, was obtained.

Studies of medieval Wealden history were consulted as relevant (most important were: Gulley 1960; Brandon 1963, 1969, 1971, 1972, 1974a, 1978b). These rarely referred to the study area directly or in detail.

Transcriptions of the Sidney Ironworks Accounts for Panningridge Furnace in the study area, of the Parliamentary Surveys of Sussex for the period 1649 to 1653, and the household accounts of Giles Moore of Horsted Keynes (30 km. w.n.w. of the study area), were examined in detail (Crossley 1972 and 1975b; Daniel-Tyssen 1871, 1872 & 1873; Bird 1971). A general study of the surveys of royal estates was used (Madge 1938).

Secondary sources, based on Herstmonceux estate archives, have been used in an ancillary manner.(mainly, E. Venables 1851; Lennard 1905).

Catalogues of local estate maps were consulted for the entire period of study (F.W. Steer 1962 & 1968) as was a major published collection of maps of Sussex (Margary 1970). The maps dated effectively from the late 16th until the twentieth century and all maps of part of the study area were viewed.

The Ashburnham estate archives, as catalogued (F.W. Steer 1958), were thoroughly examined as the major source of primary documentary evidence for this study. Estate maps and plans together with the meticulously kept accounts dated from the early C17th, but became particularly informative, full and abundant from the C18th. They were continuous until 1953, but it is for the period from the 1770's until 1914 that they were superb in reflecting in a thoroughgoing manner the diversity of local usage of land. The whole formed the basis and starting-point for the study of historical ecology. A calendar of a collection of manuscripts owned by a C18th Earl of Ashburnham (Historical Manuscripts Commission 1881) yielded no usable material. This data was supplemented by the surveys related to Tithe Awards (catalogued by F.W. Steer 1962, and reviewed by Kain 1974; Kain & Prince 1980). Studies in the local dynamics of major types of land-usage, as represented in maps and surveys from the late C18th onwards, were consulted (H.C.K Henderson 1935; Briault 1939 & 1942; H.B. Smith 1940). These were considered within the context of a review of the Ordnance Survey and its past surveys of land-use (Harley 1979).

In addition, the works of significant commentators on local agricultural, sylvicultural and general rural matters were scrutinised. This was based on Blanche Henrey's authoritative account of such literature (Henrey 1975). Most important were John Evelyn (Keynes 1968; deBeer 1955; Evelyn 1664, 1670, 1679, 1706 & 1729), William Marshall (Marshall 1798, I & II, & 1818). William Cobbett (various works), but above all, the Reverend Arthur Young (A. Young 1794 & 1813. Afterwards cited as 'A. Young'. His father is cited as 'A. Young snr.').

This was supplemented by examination of the works of numerous other writers of treatises on such matters (in particular, on woodmanship, the farming of livestock and hops, and management of game), writers of itineraries and diaries in and near the study area (listed in App. 14) and writers on local botanical matters (II-D-ii). These were amplified by examination of the entire series of the Annals of Agriculture and both series of the Journal of the Royal Agricultural Society of England.

Several works on local economic and social history were sparingly employed (J.H. Andrews 1954 & 1960; C.E. Brent 1973, 1975, 1976 & 1978; A.J. Fletcher 1975; J. Farrant 1976). Most were concerned with the 17th and 18th centuries.

The general cartographic context was considered, following accounts of the development of cartography (Harley in introduction to Margary 1970; Morgan 1979) and the appropriate edition of the Old Series Ordnance Survey Maps (Harley & O'Donoghue 1975). Works on the historical geography and cartography of land enclosures were consulted (Brewer 1972: Brandon 1963; Harley 1967; Yelling 1977; J. Chapman 1978; Butlin 1979); a single surveyed enclosure award, of small area, is catalogued for the study area (Tate 1949; F.W. Steer 1962).

General and local accounts of the measurement of land (A. Jones 1979; Nash 1978) and wood products (Apps. 7 & 8) were drawn on as necessary.

The sum, it is contended, constitutes as intensive scrutiny and treatment of primary and secondary documentary sources for the twelve parishes of, and circumjacent to, the eastern Pevensey Levels.

III - C. Major agencies of change in local vegetation and land-use as manifest in the documentary evidence

III - C - i Introduction

The section (III-C) deals with the major agencies of change in local vegetation and land-use, as manifest in documentary evidence. These are :-

- 'Archaeozoology': the grazing of livestock and game (III-C-ii).
- 'Extraction of fuel, and industries': the use of wood &c. as fuel and raw material (III-C-iii).
- 'Arable agriculture' (III-C-iv)

In Section III-C-ii, the emphasis is to obtain, collate and evaluate all available data. The major, pertinent species are identified, their duration of presence in the study area ascertained, their 'populations' estimated, their distribution established, and the effect on their environment assessed.

III-C-ii Archaeozoology

a. Introduction

A reconstruction of animal populations of the past is fraught with extreme uncertainties. In general, archaeozoological inquiry has taken several forms :-

1. - zoogeographic distributions based on the species composition of numerous assemblages of bones (e.g. E. Isaac 1970), or from presence as living animals (e.g. Corbet & Southern 1977 & H.R.Arnold 1978, on modern distributions of British mammals).

2. - detailed analysis of bone assemblages from one, usually archaeological, site. (e.g. Alcock 1963; Gebbels 1977).

3. - some reconstruction of habitat from bone assemblages (e.g. Harlan 1976).

Documentary evidence on archaeozoology has mainly been of four general types:-

4. - accounts of the livestock and game held, with study of techniques

for their management. This has beenconcerned particularly with the larger, well-documented, ecclesiastical and secular estates. Local examples have included the plentiful work on Battle Abbey estates (III-C-iii-c).

5. - accounts of the livestock held, as manifest in studies of probate inventories (e.g. C.E.Brent 1973 et seq., which included studies of East Sussex, for the period, 1540 to 1640).

6. - accounts of the livestock held, as manifest in studies of assessments for taxation (e.g. Postan 1973).

7. - collations of literary references to animals (e.g. Kirby 1974).

Such evidence, even when attempts at integration may be made, falls far short of the most desirable type of ecological data.

The data available for the study area has enabled only the broadest impression of presence to be gained (from few systematically excavated, minor archaeological sites, etc.), and some sketchy judgement of importance (from accounts of stock bought and sold, and killed for use in the household, together with rare inventories of stock) to be made.

In introduction, major and general biases in the data must be pointed out. Data was fuller and more dependable when:-

- the species was domesticated, where breeding, care, and feeding was more or less controlled by man.
- the species was prominent in the rural economy, and the subject of commerce.
- the species was kept predominantly for slaughter, rather than for usufruct or draught purposes.
- the species was the property of a large ecclesiastical or secular estate, or where 'peasant' livestock has been studied in detail (Postan 1973).

A major stricture is placed on this study. The study of animal populations is spatially incomplete; stock enclosed in fields is not considered.

In pollen analysis, the main species of pasture grasses are indistinguishable from allied species of numerous, diverse habitats. (Faegri & Iversen 1975). Pollen analytical data on pasture, therefore, may not here be tested. At the time that it is certain that livestock was mainly confined to fields, analysis is ended; this was c.1750 when Ashburnham estate records became more detailed. In the Woodcutting Books (III-C-iii-d), payment for hedging and ditching round the perimeter of all parcels of woodland was noted. This was the manifestation of good husbandry, to separate land-uses, and so minimise conflict between them.

In addition, there were no records of agistment, concessions to graze livestock, in estate woodlands (after F.W.Steer 1958). Indeed agreements to extract underwood discouraged incursions of draught oxen without muzzles, and laid stress on stockproof hedges and fences (III-C-iii-d). Young did not acknowledge the existence or advisability of the free forage of livestock locally (A. Young 1794 & 1813), and noted that ditches were maintained at 4 feet wide (A. Young 1794 259). It is from this time that pastureland was demonstrably and formally insulated from woodland. Herbivores in the woodlands are considered; pasture-bound stock is not. The extent of pastureland may best be ascertained from historical maps. This is summarised below (III-D).

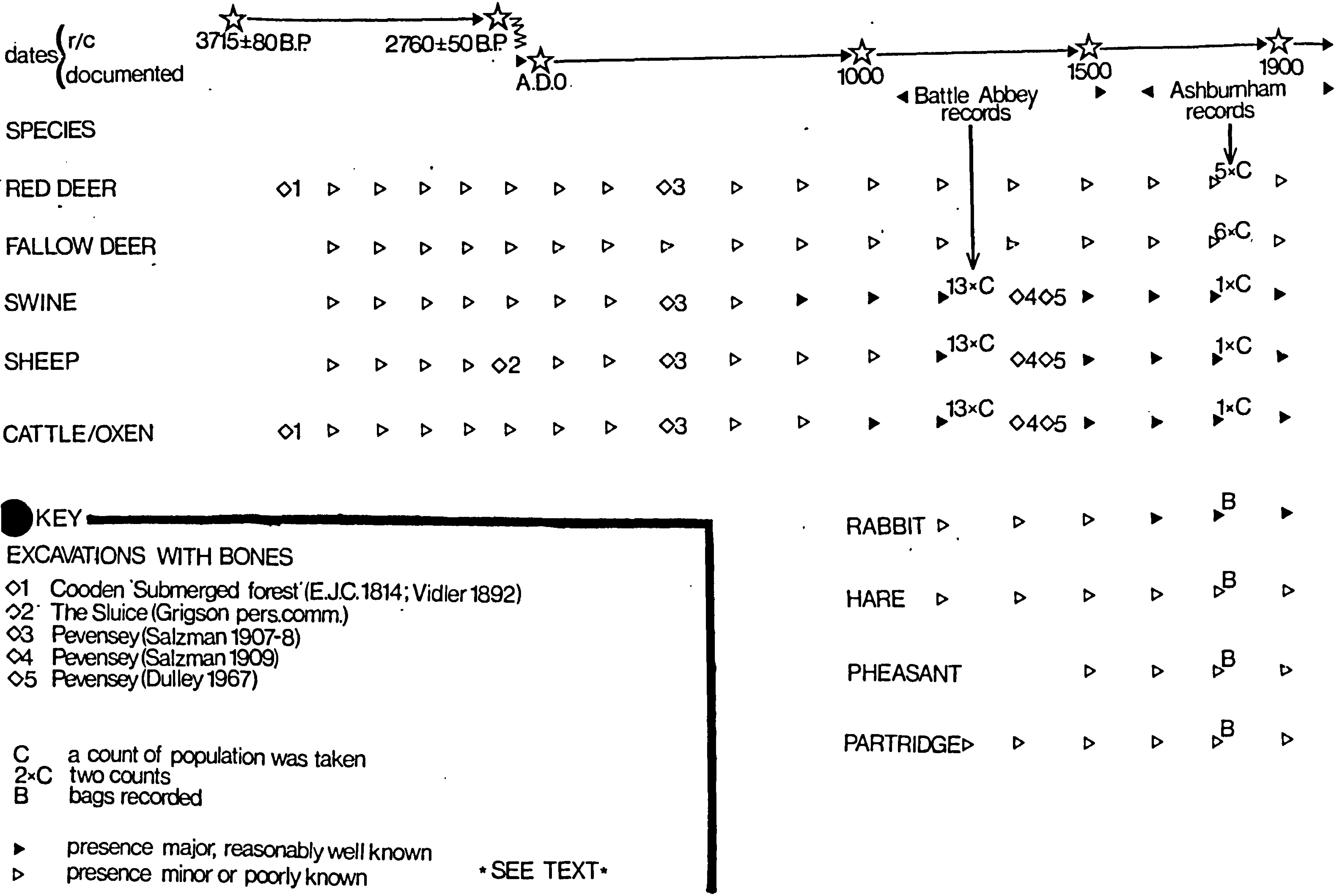
Taking the above points in turn:-

1. Zoogeographic distributions for the selected species have been determined. These comprised the study area for the entire time-span of this study, or otherwise as stated. This determination was made for 'wild' mammals (Butterfield 1905; Corbet & Southern 1977; H. Arnold 1978), 'wild' birds (Millais 1905; Cramp 1980) and livestock (Thirsk 1967; A. Young 1813; Jesse 1960; Spedding 1975).

The species selected for consideration were:-

- the red and fallow deer (The first is 'native', and on present-

fig.12 archaeozoology section~summary diagram



day distributions, the study area is at the periphery of a disjunct range. Fallow deer were most probably a Norman introduction. G.K. Whitehead 1964; op. cit.)

- the pig, sheep and cow (As domesticates all were 'introduced' before the time-span of this study. The 'extinct' status of the wild swine and wild cattle, the unknown time of their local extinction and the possibility of historic interbreeding with congeneric domesticates are noted).
- The brown hare, rabbit, pheasant and two species of partridge (the first is native; the second and third were introduced in, respectively, the late C12th and late C11th; the common partridge is native, and red-legged partridge an introduction in the C17th and C18th. Op. cit; Sheail 1971; Vesey-Fitzgerald 1946).

These make up all major livestock species, 4 of about 42 'wild' mammals, and 3 of about 300 'wild' birds which are established in Sussex (Butterfield 1905; Millais 1905).

2. The minor bone assemblages from the few archaeological excavations in the study area have been referred to. The species are annotated on Fig. 12.

3. Reconstructions of habitat form the crux of the study, and make up the summary. (III-C-ii-b).

4. to 7. primary and secondary evidence under these heads, highly disparate in quality, makes up App. 6.

b. Summary

Archaeozoological data for the study area has been amassed and assessed. (III-C-ii; App.6); it was most uneven in quality. It was more complete where the species had a key position in the local rural economy.

For the ten selected species, assessment was made of -

- population dynamics (numbers, in the study area, over time)
- population distribution (numbers, as the outcome of human partitioning

of species range)

- localisation to types of habitat, and to types of rural economy.
- impact on this habitat over time.

The 'population dynamics' of all species dealt with above is summarised in Fig. 12; it must be reiterated that this is approximate at best, and impressionistic. Even the solidity of Tubbs' conclusion that the vegetational history of the New Forest can be explained by 'wide fluctuation' in the populations of herbivores present (Tubbs, pers. comm.) is shunned for the study area.

The 'population distribution' of these key species will now be considered. This involves consideration of localisation of the population, as a consequence of species behaviour, and broad human partitioning of species ranges. It has been generally accepted that the major domesticates form, and always have formed herds, (varying by season according to sex and maturity); this has been the case with cattle, sheep and pigs (Various papers in Hafez 1975. Also Squires 1975), and with red deer and fallow deer (G.K.Whitehead 1970; Mitchell, Staines & Welch 1977, 19-22).

The broad partitioning of the range of particular species by man is as follows :-

Fig. 13 SUMMARY TABLE: PARTITIONED RANGE OF HERBIVORES

the partitioned areas	their bounds	species confined there:	
		major	minor
marshland (Levels) pastures	sewers, dykes, hedgerows	cattle sheep	horse hare wildfowl
pastures and meadows other than on the Levels (also fallow and stubble)	hedgerows, shaws	cattle sheep rabbit	horse swine hare
woodland, not imparked	hedgerows shaws	before, say, 1750 cattle swine	 horse hare
		after 1750 rabbit pheasant partridge	 hare
parks	shaws, palings walls	fallow deer rabbit	red deer swine

	red deer			roe			foraging cattle			fallow deer		
	a.	b.	c.	a.	b.	c.	a.	b.	c.	a.	b.	c.
1. What is the commonest size of groups?	5		very variable	3	2-3	3	20	15-20		8	14	very variable
2. What is the largest size of groups?	28	population	10	5	5	5	50-60	30		41	78	
3. Have these groups (setting aside that they may alter seasonally) predictable seasonal movements?	yes	insignificant	yes	no	yes	yes	yes	yes	rare 'in woods'	yes	yes	yes
– predictable daily movements?	yes		yes	yes	yes	yes	yes	yes		yes	yes	yes
4. Do groups aggregate in areas with predictable types of food? i.e. - glades/verges		'unrealistic			no	'unrealistic'	yes	'woodland	'unrealistic'		'ride	'unrealistic'
- open grassland	yes	question'		no	no		yes	edge		yes	edges	
- areas of browse					yes		minor	lawns'			& open grass'	
- closed canopy woods					no		no					
5. Do groups damage trees by fraying?	yes			yes	yes		no		no	yes	minor	no
by thrashing?	yes		yes	yes	yes	yes	no	no	no	yes	no	yes
by rubbing?	no			no	no	no	yes		yes	no	no	yes
by bark-stripping?	yes			no	yes	rare	rare		yes	yes	yes	no
by other means? (please specify)	browse		browse	browse	no	browse	yes	browse	–	browse	no	browse
(please annotate species very much affected or largely ignored)	'most species'		depends on type of damage	–	–	depends on type of damage	'most species'	–	depends on type of damage	'most species'	–	–
6. Could these actions (in 5.) lead to deaths of trees?												
- individuals, very locally	yes,		yes	yes	no	yes	yes	no	yes	yes	'doubt it'	yes
- several trees, very locally					no			yes				
- several trees, more extensively					yes			no				
7. Would you expect that such groups' behaviour if sustained over years, would give rise to, or enlarge glades and open areas?	yes		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Respondents: a. M. Clarke, Forestry Commission, Minstead
b. N. Flower, Nature Conservancy council, Lyndhurst
c. J.J. Rowe, Forest Research Stn., F.C., Wrecclesham

Fig 14 Summary of questionnaire : observations on grazing pressure in New Forest

The localisation of the species under consideration to types of habitat is greatly problematical. It is obligatory to call on present-day autecological studies as an analogy for historical study.

The crucial problem is that our knowledge of former animal habitats (contrasted with the transposition of 'analogy' in time) is inferior to, and largely derivative of our reconstruction of vegetation. It has been noted, for instance, that reconstructions of the habitat of red deer as being 'wooded' had been largely based on the assumption that all the land was 'then' wooded (P. Evans 1975, 44). This caveat, and the incorporation of a circular argument, is noted.

However, one is faced with the summary of the habitat of the red deer and roe deer as being 'mixed woodland associations' (Chaplin, 1975, 40-2; G. K.Whitehead 1970, xiv); knowledge of the autecology of deer has been summed up as being extremely incomplete (op. cit.). The absence or presence of red deer has been related to what are aptly called 'gross habitat features' such as marked relief and woodland cover (Mitchell, Staines & Welch 1977). For these reasons, it was decided to enlist the aid of people with experience of -

a. diverse species with moderately unconfined and extensive ranges.
b. diverse 'semi-natural' habitats (including closed- and open-canopy woodland, heath, grassland, bog).
c. a. and b. in lowland England.

All had experience of the New Forest. A questionnaire was designed to draw forth summary judgements based in prolonged and varied experience. The responses are set out in Fig. 14.

(Interestingly the size of groups of red, fallow and roe deer broadly match those noted in the mid-C15th treatise on hunting (Hands 1975, 170-1); little or 'common' herds were of 20 red or fallow ('great herds' of 80) while a bevy of roe consisted of 6. Sounders of swine numbered 12.) Critically, all respondents judged that, were the pressures of such groups of herbivores 'sustained over years', it 'would give rise to, or enlarge glades and open areas' (Fig. 14 q.7).

This information may usefully be supplemented by data collected in Polish state forests. Recent reviews of work on larger herbivores in forest habitats were examined. These had the advantage of a diverse and broadly analogous, native forest flora and fauna (all forest-forming, and most shrub genera were present in the Sussex study area as pollen and growing vegetation. II-D-i and ii. The large herbivore element in the fauna was made up of roe deer, wild boar and red deer in greatest numbers, together with fallow deer). A general model of the role of large herbivores in the functioning of forest ecosystems was set up, based on data from 8 extensive Polish wildwoods (Grodziński 1975). 3 detailed studies were of great relevance:-

1. On browse supply in various forest ecosystems (Bobek, Borowski & Dzięciotowski, 1975). Browse was found to be the main component in the diet of red and roe deer; very varied intake was noted according to age - classes (young plantations; thickets; pole-sized stands; timber stands) and various 'forest-types'. (Similar information has been compiled on red deer browse in Scotland: Mitchell, Staines & Welch 1977).
2. On food requirements of a wild boar populations. (Jezierski & Myrcha 1975). This led to the estimation of maximum carrying capacity; where feeding was exclusively in the forest, 17 individuals could be wintered on 1000 ha., and 80 during spring and summer.
3. On the debarking impact of red deer. (Fruziński, Kabudski & Wlazetko, 1975). In thickets and pole-sized stands, this was very variable, but most damaging in younger age-classes, and forest-forming ash and oak.

It is fortunate that there is such abundant high-quality data, and present-day observation. It must, however, be considered as simply analogous to the historic state of affairs. Today in Poland and the New Forest there are formal management programmes in operation, with control of herbivore population levels. Perhaps, a more realistic account, more pertinent to historic times, would be an authoritative late C19th treatise on forestry

'The Protection of Woodlands' by H. Fürst, The Director of Bavarian Forestry Institute. Here he unequivocally berated the serious, often irremediable damage done to growing trees by all major forest-dwelling herbivores (H. Fürst, 1893, 83-99).

A recent review of livestock grazing in forests noted that there was an absence of experimental evidence from British forests, little general evidence and that there had been a 'long history of uncontrolled grazing in European forests'. The practice of pannage had discontinued, and the grazing of lowland woods is now uncommon (S.N.Adams 1975; R.C.Steel 1974, 135-6). A recent review on herbivores as a major agent of vegetational change, and on the influence of animals on the pattern of vegetation, emphasises the paucity of data (Greig-Smith 1979).

Yet there is overwhelming data, albeit analogous in time and place, for the practicability of certain species of herbivores being agents of long-term vegetational change. It is from this summary judgement that this discussion may develop.

III-C-iii Extraction of fuel, and 'industries'

a. introduction

It is generally accepted that wood, in diverse species and forms, has continuously provided man with his most useful raw material and fuel throughout his past. This is attested to by archaeological evidence (Hodges 1976; Dimbleby 1978; Coles, Heal & Orme 1978), by documentary evidence (J.A.Evans 1970; Rackham 1971, 1975, 1976, 1977a & b, 1980), by an authoritative review of botanical literature from the C17th to the C19th (Henrey 1975), by recollections of the skills of woodmanship (op. cit.; Edlin 1973) and by current scientific assessment of the properties of wood (Desch 1973; Heal 1978). Woodland is patently the paramount source of these human requisites. Abstractions from woodlands, and modifications to them, are palpably a major agency of vegetational change.

It is now appropriate to examine the history of usage of woodland in the study area. This usage - its nature and duration, and the consequences for the ecosystem - is the crux of this section.

It has been noted that, compared with other vegetational formations, the historical ecology of British woodlands is under-recorded (Numerous mentions in Rackham 1976 & 1980). This appeared to the writer to be prima facie the case. It is further aggravated by there having been three centuries of 'misleading forestry propaganda' (Rackham 1980, 15).

In south and east England, study of woodland usage has comprised two types. First, a single wood has been thoroughly studied within its proper context of changing rural economy and ecology. Second, a regional or national amalgam has been produced; studies were framed on legislation, its antecedent justification and its consequences, on generalist reformative treatises and on local conditions, especially as evident in the manorial court records. Examples of the first type have included studies of Monks Wood and of Hayley Wood in Cambridgeshire, of Rockingham Forest and other east Midlands woods, of the woods of Great Bookham parish in Surrey, of the Mens 'woodland common' in West Sussex, and the New Forest (Steel & Welch 1973; Rackham 1975; Peterken & Welch 1975 & Peterken 1976; J.A.Evans 1970; Tittensor 1978; Flower 1980). Examples of the second type have included the Victoria County History piece on 'Forestry' in Sussex (among other counties), Roden's work on Chiltern Woodlands, and the works of Brandon, rooted in the study of manorial court records in selected parishes (Legge 1907; Roden 1968; Brandon 1963 & 1969). Logically in historical ecology, numerous local studies should precede, and form the basis and 'seedground' for grosser generalisation. This has not been the case: The sources arrayed in 'A history of English forestry' (James 1981) corroborate this.

Evans, in a pioneering attempt to juxtapose and critically compare these two types of study of woodlands as practised in southern England, noted numerous anomalies. Writers of reformative treatises and legislation need not have correctly perceived, and accounted for, any 'problem' in the state of woodlands. Entries in manorial court records although illustrative and picturesque, did not permit 'ecological monitoring' with any quantification (J.A.Evans 1970). This is endorsed by the view of Rackham on the near uselessness of manorial records in historical ecology (Rackham 1971, 569). An instance may elucidate this point. An infringement 'contrary to the custom of the manor' occurred (as enrolled) in 1686 in Herstmonceux. On named premises 'various' oak trees were topped (anon. 1940-1). Apart from the unknown scale of the offence, its typicality was indeterminate. The enforcement may signify an importunate local dearth of 'wood', or signal numerous or indeed few wasteful depredations.

Such manorial documents were available for the study area. On the Ashburnham estate the manors with documentation were few and small; sampling showed few and vague references to woodland (after Steer 1958, 57-66. Ashburnham MSS. 1-759, 2418). Any descriptions were scanty and recent, and inferior to other sources of evidence. Manorial records were therefore excluded from further consideration in this study.

b. the background to documented woodland history in the study area

Note: It is considered that 6 'industries' were of importance in this study as users of fuel and raw material from woods, etc. However, thorough scrutiny of their time-span, scale of operations and estimates of usage have allowed one conclusion; they were minor in terms of this study. For that reason, which is argued in detail, the account is presented in App. 9. A summary with diagram (Fig. 15) is at the end.

The documented history of local woodland will now be set out. In East Sussex documentation begins with the Domesday Book of 1086. The settlement pattern is not at all well known, and one gets the tenuous impression of 'islands of cultivation in a sea of forest'. Indeed all the islands cannot be located, due to the system of assigning places, and record of their economy, in accordance with administrative structure. This has led to grouping under certain heads, and, it must be owned, an irreconstructible distribution of settlement (King 1971; S.P.J.Harvey 1976, 195-9) and, it is inferred, woodland and its usage. It must also be said that the 'nature ' of this forest is too vague and homogeneous for easy acceptance. It has been surmised that, in 1086, the land surface of Britain was 20% forested (Holmes 1975, 69-70). Searle, writing on the establishment of Battle Abbey, ventured the term 'primeval forest' (Searle 1974, 44), and what seems to be sheer conjecture - 'The Wealden forest of the C11th was still largely uncleared' and was 'of oak, ash, beech and chestnut, withhazel and hornbeam underwood' (<u>ibid</u>., 45). This propensity to paint the Weald continuously green and impenetrable is common.

Three elements of woodland usage have to date been studied using documentary sources. These will be related now to East Sussex.

1. the exercise of customary rights in woodland within the manorial rural economy.
2. the management of land as forest, and chase
3. 'a coppiced system', with timber.

The post-Conquest manorial rural economy has been widely considered to be unprecedentedly destructive to woodlands in south-east England (all refs. of Brandon; J.A.Evans 1970, 13-16). Customary rights in land were established and exercised. These practices, in concert, were considered to have persisted, and effectively precluded 'normal' regeneration of trees. Under this set of continuous pressures, woodland was encroached upon and substantially replaced; here there is the implication of the existence of an 'original' closed-canopy forest. Also there has been an assumption that there was no shortage of forest products, and no need for and aptitude towards conservation. Measures towards conservation were taken to represent importunate shortages. This is a set of assumptions which is quite speculative and unsubstantiated, and unworthy of its protagonists, such as Evans (J.A. Evans 1970, 13-14). Manorial records have been discarded from an analytical study of this type, in this locale.

Lands with the status of Royal Forest have not featured significantly in the documented history of the study area. In recent reviews of the economic and social history of Royal Forests Sussex was not mentioned (C.R.Young 1979; Cantor 1982b); Sussex was formally and finally disforested by the late C13th. This was before the time of abundant, extant documentation. A single chase or 'private forest', Dallington Forest, is peripheral to the study area (Cantor 1982b, 71-2). Despite its incorporation in the Ashburnham estate, no documentation specific to it was traced.

The third element in the study of the usage of woodlands was that practice of silviculture known as 'coppicing'. The general historical background to coppicing is complex. James (1981, 305-14) has catalogued all statutes relevant to woodlands, and considered these to be 'corrective measures'. Particular statutes, for instance the Statute of Woods of 1543, were judged to be the most significant because of their far-reaching intent and, implicitly, their status as remedial to the parlous state of national woodlands. The critical and dominant status of coppice wood - its production, conservation, harvesting, preparation, measurement and sale - is most evident in these statutes *en masse*, and implicit in the repeated inroads of coppice production reported into timber production, and inroads into timber stands, and proposals for amends. Yet James (*op. cit.* 141-60) and Rackham (1980) have both observed, from their far-reaching studies, that the scale of prosecution subsequent to these statutes is imprecisely and incompletely known, and, in probability, was minor and ineffectual. No particularly local insight was gained.

In East Sussex, coppice provided smallwood especially for firewood and fuel, fence and hop poles, while the standards provided large timer: All these from the 50 to 70 native trees and shrubs, the widely naturalised Spanish chestnut and sycamore, and exotic species (Rackham 1976, 19-20). Thus, ideally, a continuous supply of a wide range of wooden end-products was ensured (Legge 1907; J. A. Evans 1970, 13-15; Rackham 1976, 15-85). This system prevailed in East Sussex until this century.

The established viewpoint has been that, from the C16th, timber resources became grossly depleted; this was manifested in shortages of timber suited to shipbuilding, and in a succession of Acts intended to remedy this. Alternating with these periods of concern and action, were, it is construed, times of neglect, abuse and waste; for instance, the wasteful sales upon the suppression of the monastic estates in 1538, and abuses of Early Stuart period and the Commonwealth. Depletion was also the keyword when fuel for iron-smelting, and to a lesser degree, for glassworks, was considered. In Sussex this notion has a not too respectable parentage. It would seem to spring from a comment made by Camden in his 'Britannia':- 'It (Sussex) has several veins of iron, and many furnaces for melting it, which consume great quantities of wood every year'. (Copley 1977, 29). This comment was made by someone whose interest in industry seems slight, and who journeyed only on or near the coast.

The Wealden iron industry, and its 'decline' have been well studied (treated in full in App. 9). Fuel shortages have been considered a major impetus for this, and woodland depletion an outcome. Flinn and, more particularly, Hammersley, on the other hand, working for the records of Wealden and other ironworks, argued that fuel needs were generally met and any shortages were local and organisational (Flinn 1958; Hammersley 1973). Hammersley perorated with reasonableness that continuing iron production required continuous charcoal (and, so, wood) supplies and self-interest and available management techniques would have ensured this. (Hammersley 1973). Brandon (pers. comm.) has pointed out that the Hammersley and contemporary views may be reconciled, if it is assumed that the former relates to privately enclosed woodland and the latter largely to commonland. The study area includes a minute area of commonland, (Tate 1949) and so for it, the Hammersley view is accepted.

The detailed chronology of this 'concern' and 'waste' has been set out by Evans, but it finds little reflection in strictly local documentation. The concern was most significantly expressed by John Evelyn in his treatise, 'Sylva', (Evelyn 1664 et seq.). It was the 'first important book to be published in this country on forest trees', (Henrey 1975, I, 101) and was perhaps the most informed. It was 'the subject of endless plagiarism' (Rackham 1976, 96-7).

Evelyn's experience took in Sussex, though he did not locate 'ravaged' woodlands 'on the ground'. He bemoaned the prevalent 'prodigious havoc' in the woods (ibid I, 1) and recommended 'nothing less than universal planting of all the sorts of trees....'. In the second and subsequent editions of 'Sylva', Evelyn prefaced that 'millions of timber trees, besides infinite others 'had been planted due to his treatise (Evelyn 1670, 1679, 1706 & 1729). Other early propagandists on this issue were Arthur Standish and Captain John Smith (Standish 1614, A3 & 2; J. Smith 1670, 1-22). Evans, among others, accepted this 'problem seen and diagnosed' and 'problem solved' version of woodland history. It may be politic here to append the conclusion of Defoe on his travels through Kent, Sussex and Hampshire. He saw 'one inexhaustible storehouse of timber never to be destroyed but by a general conflagration' (Defoe 1724-7 I, 125). Further periods of concern are recorded during the Restoration period, and in the early C18th, signalled by Batty Langley (B. Langley 1728) and following the Seven Years War of 1756-1763. In 1786, Parliament appointed Land Revenue Commissioners 'to enquire into the state and condition of the woods, forests and land reserves of the Crown' (J.A.Evans 1970, 20). The chairman of the Quarter Sessions, responsible in Sussex for the survey, noted that the quantity of large oak timber 'had diminished within memory'. Growing oak timber in hedgerows was not then encouraged, and grubbing up was common. It was suggested that the supply to dockyards may explain 'the general decrease'. Timber trees were being removed giving preference to underwood for charcoaling, and hop poles. Timber on commons and commonable waste was scarce, and subject to 'great depredation and waste' (ESRO: 'State of Timber' in 'Various Papers', dated 1807). Post-1790 interest was directed towards plantations especially of oak, pine and larch. Its primary object was the production of timber for building ships and houses, and fuel (Henrey 1975 II, 644-7). This augmented the existing 'coppice-with-standards' system (with a continuous supply of upgrowing 'tillers'). Developments were subject to the stimuli of war-time requirements, treatises and their ominous warnings (J.A.Evans 1970, 21-4; Holmes 1975, 69-80). Young noted such shortages in East Sussex (A. Young 1794, 26-2, 283).

This review has attempted to relate the national mainstream to the local conditions. Now material pertaining to actual usage of local woodlands will be considered.

c. Extractions from woodland - Battle Abbey estate

Records of extractions from woodland in the Cellarer's Accounts of Battle Abbey and the authoritative account of the Abbey rural economy and the ESRO archives have been used. (Searle and Ross 1967; Searle 1974, augmented by detailed personal communication; ESRO 1973). It is noted that, in the opinion of Searle, the leuga was largely forested throughout the monastic occupation (Searle, pers. comm.).

Timber, underwood and brushwood were brought to the Abbey household, and entered as such in the Cellarer's Accounts. Form, end-use and species may be named. Firstly and expectably, fuel, as faggots, firewood and 'kindling', was the most important item. The supplies, when quantified as thousands of faggots and wagonloads of firewood, are graphed in Fig. 16. (otherwise only value was stated). End-use for fuel was often given; most was for simple domestic and industrial operations. It seems that fuel was taken as needed, and was subject to no apparent shortages.

The second major product was timber. In terms of volume extracted this was decidedly minor and usually described as being for building. In most

Fig 16 BATTLE ABBEY : CELLARER'S ACCOUNTS - I Annual supply of cut firewood to household.

- II Annual supply of cut faggots to household.

years a little timber was felled, '1 tree' or a small amount paid for felling (characteristically under 10 % of that paid for preparing faggots and firewood). Single payments for working palings and stakes (in 1464-5) and for clearing timber from a meadow (in 1412-3) were recorded. In terms of the area of the leuga, timber was of minor importance, and cannot be traced to source. Sales of timber, and sales of rights in timber were a major source of income, apparently as and when money was required (Searle 1974, 64-5, 256-7, 448-51). Searle described this as 'dipping into capital'. The accounts for such sales are lodged in the Henry Huntington Library, California. Sales were often large, most irregular and almost always specified as oak. (Searle, pers. comm.) The Cellarer's Accounts noted odd large sales -

for felling '180 cartloads of beech and 500 of oak' (in 1275)

for felling '465 cartloads of beech and 700 of oak' (in 1278-9)

These are huge consignments for use outside the leuga, as no works great enough to require such volumes were then underway.

A third woodland product was charcoal. Coaling was paid for in most years up to mid-C14th. Again it was minor, being always valued at under 10 % of fuel in any year. Oakbark appeared in the accounts for 1278-9, but would seem not to be fully recorded as Searle considered that Battle, supplied by the neighbourhood, was a centre for tanning from the C12th (Searle 1974, 300-2).

Overall, the informativeness of these accounts was almost wholly related to form and end-use of the product, with made-up faggots and wagonloads of firewood of pre-eminent importance. Little was learnt of the species used or present, or management practices. Faggots may consist of branchwood, underwood, brushwood, or indeed, gorse, heath, broom, bracken and so on. Wood intended for use as hoops was specified as hazel and ash (in 1464-5, 1465-6, 1478-9), as were loads of both species in 1512-3. Management practices have not been ascertained; woodmanship was not the concern of such accounts, and tasks - labour services or piecework - were delegated _in toto_.

Apart from crops of field, garden and orchard, few references were made to the use of local vegetation. All were minor and infrequent; in 1407-8 payment was made for pulling up thorns, and in 1412-3 brambles, and in 1465-6, both. Nuts; osiers, wands and withies, for use as baskets or winnowing fans; rushes for and as mats; cut ash poles; broom and other thatch, complete the plant extractions recorded as being used by the Abbey household. (Searle 1974 & pers. comm.). Cutting and carrying away of heath was a service under the Rental of Barnhorne on the Battle Abbey estate (Scargill-Bird 1887, xv-xvii). A reed-cutter held a messuage in the town of Battle as set out in the Charter (Searle 1980a, 57).

d. Extractions from woodland - Ashburnham estate

A comprehensive search has been made of the Ashburnham estate Archives lodged at the East Sussex Record Office. The 'Estate Timber Accounts' were found most useful (Steer, 1958; ESRO: Ashburnham MSS. 1900-31). These were annual accounts of underwood and timber sold from, and used on the estate from the 1770's, with breaks, until the 1820's. There was a consistent four-way classification of those products which appeared in great volumes and most regularly. These were:- cordwood; house or domestic faggots; kiln faggots; hop poles. Minor items were diverse but never exceeded 5 % by volume of any major categories in any year examined. Definitions of all 'major' and 'minor' items, the units in which they were counted or measured and, where stated, species, have beenset out in Apps. 7 & 8. By way of comparison this has also been done using the household records of Giles Moore dating from the late C17th (Bird 1971).

All the major Ashburnham items were ascribed to their wood of origin.

Various aspects of the Ashburnham records render them crucial to this study. Firstly, great importance was placed on woodland products, their valuation and transfer. Wood at all stages of growth was surveyed and valued (Ashburnham MSS. 1944, 1967, 1969, 1972, 1973). This was the case upon termination of farm tenancies in the period, 1830 to 1850 (Short 1975, 164). Agreements to sell timber and plots of underwood, often standing, and licences to fell timber, also show this. (For instance, an 1801 agreement to sell and an 1813 licence to fell. Ashburnham MSS. 1943 & 66).

Species are recognised as such.

The principle of excluding grazing animals was evident in the great amount of labour used to hedge and ditch round the perimeter of all woods. The Estate Timber Accounts (Ashburnham MSS 1900-31) itemised annual piecework hedging and ditching measured by length. As the output of a wood was listed, the expense of hedging and ditching was accounted for. Indeed, as early as 1695, the first Lord Ashburnham showed specific practical concern on the matter in a letter to his agent (R.Gunnis 1949, 11). Young noted that a 4 foot wide ditch was usual in Sussex (A. Young 1813, 259).

A further canon of Ashburnham management ensured a diversity of species and growth-form. (see the product range in Apps. 7 & 8). _De facto_, this diversity was augmented by plantation. In the late C18th and early C19th, the usefulness of Scots Pine for rapid growth, for reclamation of heathland and as a nurse species was stressed. Pontey (1808) and Cobbett popularised this usefulness (Cobbet 1825). A survey of fir plantations on the Ashburnham estate made in the early C19th (Ashburnham MS 1971) recorded _c_. 49 ha (over 122 acres), much of this in established woodland; a function as nurse crop or shelter belt seems plausible. Plantation was strongly suggested by frequent reference to sale and use of 'runtwood' or stumps, and to payments made for grubbing up roots. 'Fir faggots' are rarely specified (Ashburnham MS. 1920). Young noted great variation in Sussex practices; even-aged stands were all felled followed by replanting, as were many-aged stands, when individual trees matured (A. Young 1813, 163-86). Runting was generally permissible, and was conceded to the purchaser in contracts (Ashburnham MS 1969). A simple model of 'coppice-with-standards' cannot suffice.

There was no unambiguous reference to the purchase of seeds or saplings for estate woodlands. In studies of gardening catalogues and nurserymen, covering the period from C16th to C19th (with data most plentiful from the C18th), all commoner tree species seem to have been held (J.H.Harvey 1972 a & b; 1974a & b). Harvey did not know of sales to the Ashburnham estate 'from the suppliers' end' (J.H.Harvey, pers. comm.). Oaks, particularly, seem not to have been sold in quantity. This confirms the views of observers as to its common, self-sown status locally (A.Young 1794, 309-83, & 1813, 164-9; Roberts 1909; Hall & Russell 1911, 49-50).

A further practice which ensured that a continuous supply of timber trees was 'coming through', was that of marking out 'tillows' or 'tillers' for preservation. These were saved under clauses in contracts to fell underwood (Ashburnham MS. 1969).

The labour paid for revealed the great efforts put into woodlands and their management. In any year, tasks were carried out: The perimeter of each wood was hedged and ditched; wood was felled and cut; some preliminary working was done, usually described as cleaving and shavering and bark-stripping; faggots and bavins were made from smallwood, and brushwood was bunched and bound; poles were cut to standard lengths; surveying and supervision was done, with men paid to do 'gaping round the woods' (they would, it seems, mark tellows, check boundaries and set work programmes). All tasks were under the supervision of a salaried woodreeve.
The major woodland products are considered. See Figs. 17-21 for output. (Source: Timber Accounts).

Cordwood is argued as having been, above all, oak, together with the range of standard and 'sub-standard' tree species. Species named for specialised end-uses indicate the importance of beech, ash, alder and chestnut (App. 7); these are judged to be anomalies and specialities. 'Cordwood' implied a range of size - from timber proper suited for structural purposes through smaller stuff for repairs, to runtwood, stocks and stumps used for charcoal manufacture.

The estate industries used cordwood in large, but most irregular quantities (an aggregated extraction of this and allmajor products is being worked towards. See Fig. 23). There is general and local evidence for oak being the building timber par excellence (App. 9). There is no little evidence of selectivity of species for charcoal manufacture. Evelyn noted oak made the best charcoal. (Evelyn 1664 et seq.). Young contrasted the 'smaller sort' of wood used for limeburning, with the great quantities of no specified size used in charcoal manufacture (A.Young 1813, 413) but he did not note any preferred species (ibid., 431-5) other than to state oak provided the 'strongest' charcoal (A.Young 1794, 212). In Fig. 22 there appears a collation of data on charcoal found in excavations of ironworks in Sussex. This suggested a preponderance, and an argument for the selective use, of oak for coaling.

Faggots were described by their end-use as kiln faggots or house faggots which, it is assumed, reflects different size and firing potential, and by source, bush, top, heath or spray faggots. It was rare for species to be stated. It cannot perhaps be expected for such a prosaic end-use. Several inferences may be made; that top and spray faggots consisted of the smaller branchwood of timber, tellow and coppice wood. Timber wood - pollarded or not - was usually specified as beech, and tellow wood as beech, ash or alder. Cordwood rarely had species named. One is obliged to infer the great importance of oak (from the accounts of Young & Roberts, and on the premise that anomalies were named) with a range of other standard species.

A second inference may be made concerning the size of this stuff. The definition of faggots, as opposed to bavins, was that the former is bound with two bands. Double binding, if for a practical purpose, suggests a length of at least 1m. for house faggots. To have a distinctly larger class, the kiln faggot, and a hybrid class, the mule faggot (as it is assumed), suggests a minimum length of, say, 1.5m. Heath faggots, alone were of known composition and a maximum length of 0.5m (the usual maximum height of ling growth) is expected. Bush faggots defy any determination as to their composition and size. The problems of the volumetry of faggots are discussed in App. 11).

Kiln faggots in the Timber Accounts were often detailed as 'for use' in the limeworks, brick kilns and ironworks of the estate. Fuel inputs - volumes, growth-form, species - to these three operations are discussed below (App. 9). Yet in all cases the intermittency and gross variability of such items indicates inconsistent entry.

Hop poles were simply straight poles cut to standard lengths - 10', 12', 14' and 16'. Species did not appear in the Timber Accounts. It has been necessary to examine treatises on hop cultivation, establish which species were recommended and which were locally present, and to gain some broad conclusion as to importance of any species.

Several products are, from contemporary accounts and recommendation in treatises, of known species. This may be said with most certainty of hop poles. Three species were described and prescribed in the literature as pre-eminent for use as hop poles. These were Spanish chestnut, ash and 'willow'. Evelyn in the first six editions of 'Sylva' proclaimed this, as did Bradley, Langley and Cobbett. More particularly, both Marshall and Reverend Arthur Young ranked species regarding the quality of poles yielded. They both went on to list hop poles as a major use for such poles. Young ranked: chestnut, ash, oak, willow, maple, red birch, beech, white birch, and hazel (this last was omitted from his second list). Marshall ranked chestnut, ash, and sallow as the best for poles. (Evelyn 1664, 1670, 1679, 1706, 1729; R. Bradley 1726 & 1736; Langley 1728; Cobbett 1825; W. Marshall 1798 I, 42-8 & 210-1; A. Young 1794, 261-2 & 1813, 186-8).

Broadly similar observations and recommendations were made by writers throughout the nineteenth century (Lance 1838, 128-9; Rutley 1848, 577-82; Stratton 1883, 18; Haggard 1902, 139, 153; Roberts 1909, 186-7). Parker's historical review came to similar conclusions (Parker 1934).

Three other 'strains' may be noted in the history of the species used and usable to pole hops. First, there was an early phase where no species was considered outstanding. Locally, this was represented in the works of Gervase Markham and Leonard Mascall. Mascall observed that any 'light and stiff wood' could be used. Markham advised that any species may be used, and listed ash, elm, withy, willow and sallow. In the household journal of Giles Moore of Horsted Keynes (near Haywards Heath, Sussex), hop poles were frequently recorded items in the period, 1657-8 to 1678-9. In only one of ten years when hop poles were entered was species named. Poles 'out of myne coppice' were 'all oke, ash and withy wood'. (Markham 1638, 139; Mascall 1652, 68; Bird 1971).

In parallel to this, was a phase when writers different to those above recommended alder poles (Scot 1574; Blith 1655; Worlidge 1697). These writers were experienced with Kent, Hampshire and Northamptonshire affairs. In general, however, alder represents habitats substantially distinct from most other pole-yielding taxa.

A last phase with local manifestation was an increase in the use of larch. Rutley noted, in 1848, that in Sussex this had happened 'lately'. (Rutley 1848, 577-82).

Considering now species which were second-class as hop poles, the treatises cited above declared that maple (presumably sycamore) and hazel were such. Yew, although costly and uncommon has been recommended (Lance 1838, 128-9) as latterly was spruce (Haggard 1902, 153).

It is concluded that hop poles produced in the study area have been above all Spanish chestnut and ash, and secondarily various willows, sycamore and hazel. All these species have been present in abundance as evident in the Ashburnham records together with the surveys of present-day vegetation (II-D).

A paper based on the last two pages is in press (Moffat 1984c). Hop cultivation is dealt with below (IV-C-iii).

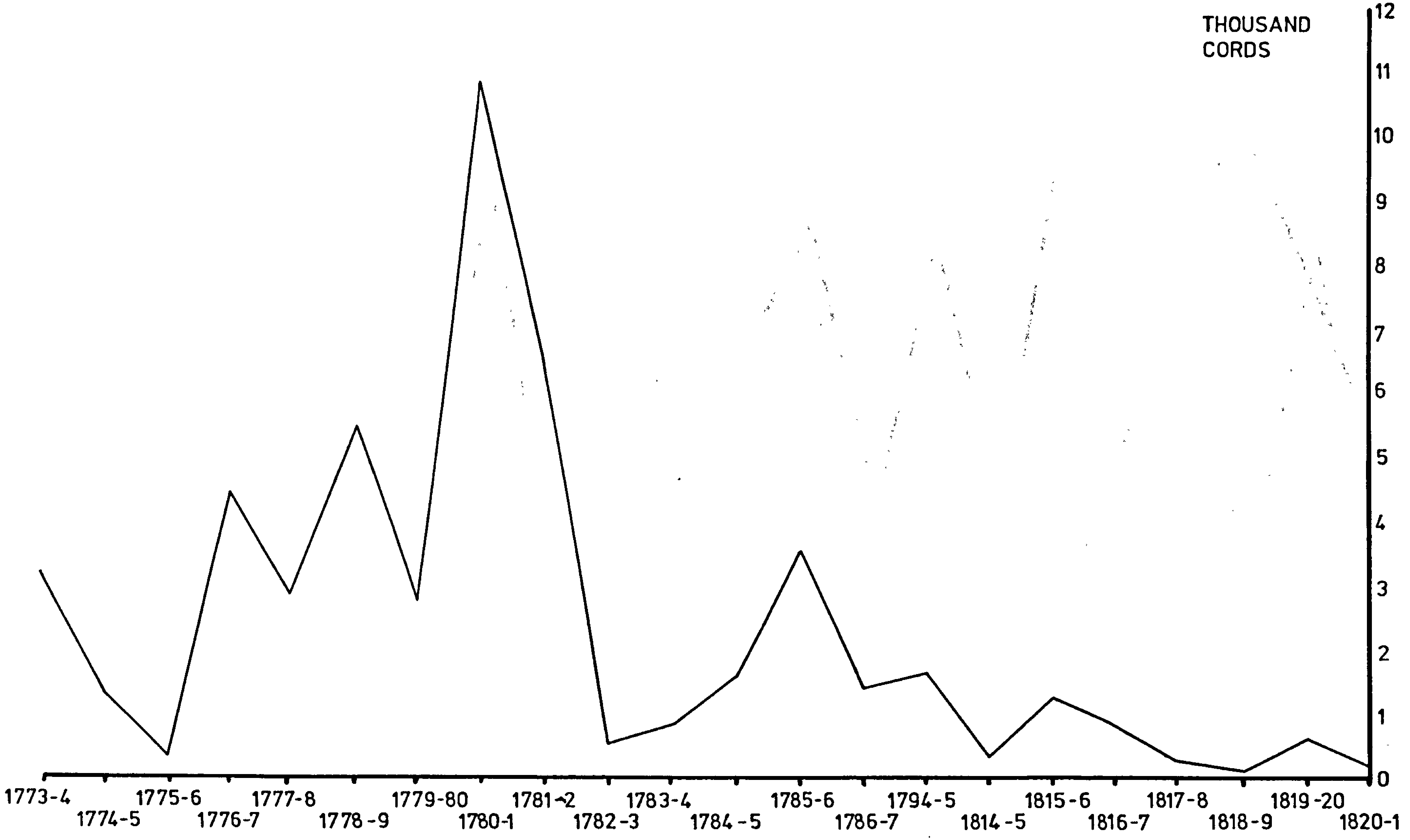


Fig 17 ASHBURNHAM ESTATE: ANNUAL PRODUCTION OF CORDWOOD

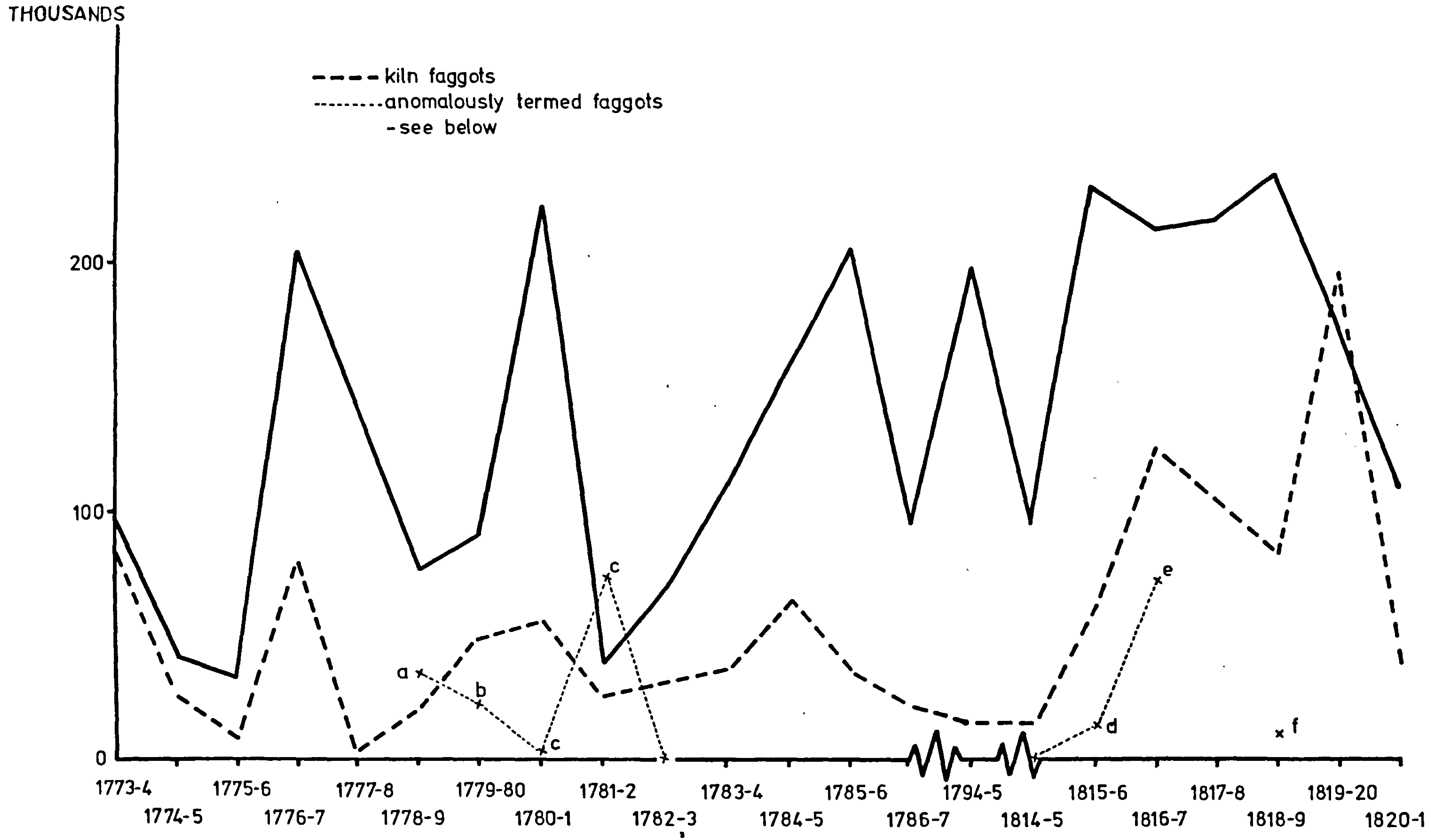


Fig 18 ASHBURNHAM ESTATE: ANNUAL PRODUCTION OF FAGGOTS

a. mainly spray faggots (31.0)
b. mainly heath faggots (23.3)
c. all spray faggots
d. mainly heath faggots (12.5)
e. mainly bush faggots (60.4)
f. mainly top faggots (7.6)
g. mainly heath faggots (39.8)

Fig 19 ASHBURNHAM ESTATE: ANNUAL PRODUCTION OF HOP POLES

(with estimated acreage of hop-gardens which could be fitted out, as annotation.)

Fig 20 ASHBURNHAM ESTATE : KILN FAGGOTS ENTERED IN "TIMBER ACCOUNTS" AS HAVING BEEN SENT FOR INDUSTRIAL USE . ANNUAL TOTALS.

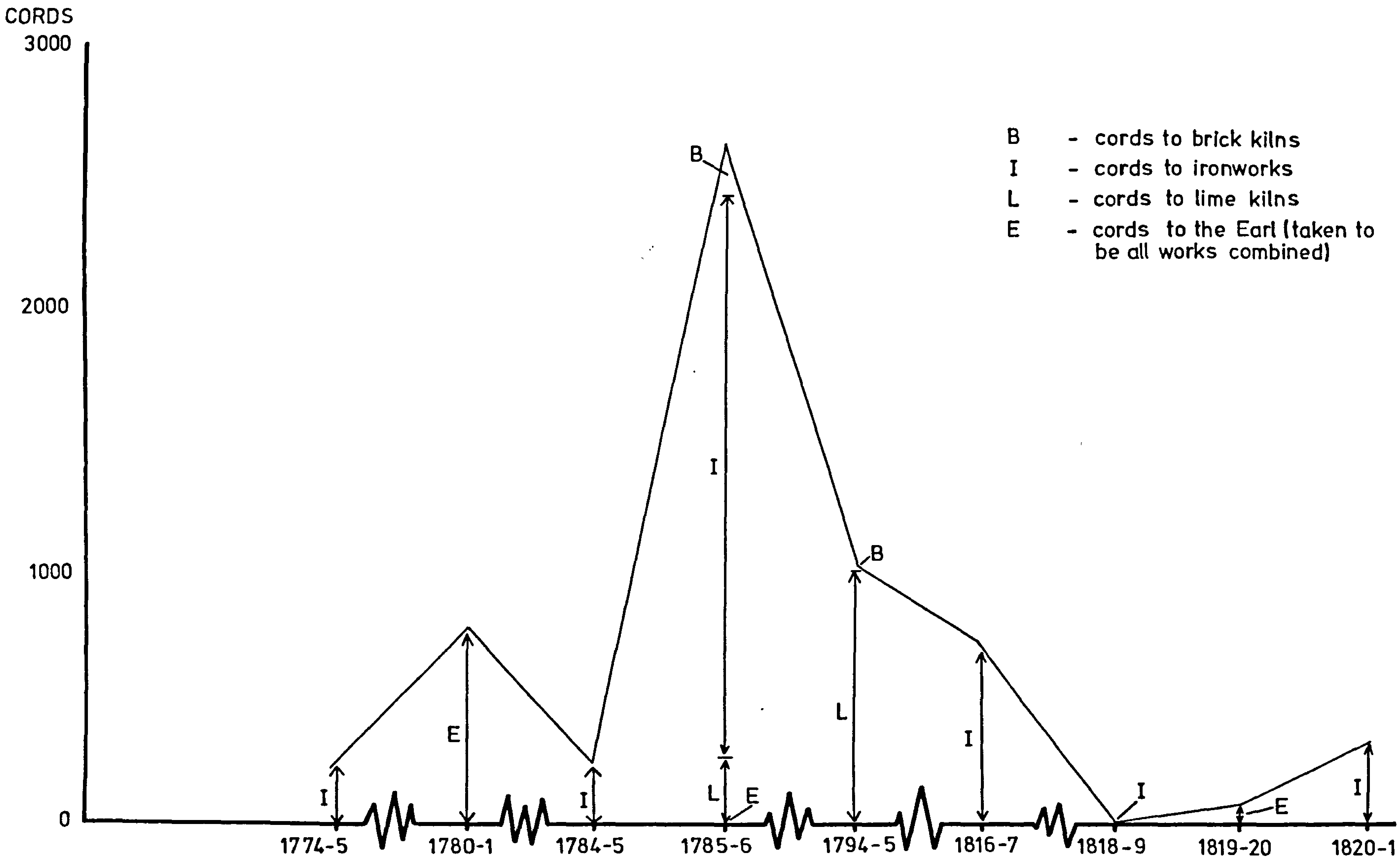


Fig 21 ASHBURNHAM ESTATE: CORDWOOD ENTERED IN "TIMBER ACCOUNTS" AS HAVING BEEN SENT FOR INDUSTRIAL USE, ANNUAL TOTALS

Fig. 22: Major excavations of south-east Sussex ironworks : classification of charcoal by species

NAME OF IRONWORKS	•Alder	•Birch	Hornbeam	Sp.Chestnut	Dogwood	•Hazel	Beech	•Ash	•Poplar	•Oak	•Willow	Lime	DATE	AUTHOR'S REMARKS ON SAMPLING
1. CROWHURST PARK	□					□		□		□			C 2nd	"abundant"
2. HIGH ROCKS	△						△			■			C 1st & 2nd	"from both periods" and "original surface".
3. MAYNARD'S GATE		△		△	□	△	▲	△			□	□	C 16/17th	28 fragments "collected unselectively"
4. MINEPIT WOOD	△	□				△	□	△	△	▲			C 14/15th	?
5. PANNINGRIDGE		△	▲					△		△			C 16th	"recognisable pieces" and "a sample"
6. PIPPINGFORD		△	□							▲			prob. C 1st A.D.	"a sample"
7. PIPPINGFORD										▲			early C 18th	?
8. TURNER'S GREEN										■			C 1st/2nd	"a number of samples"
9. NOT NAMED						▲							C 5/6th	three pieces
	-	9	3	-	-	3	7	2	1	7	-	-		

Sources: App. 9-1

■ dominant
▲ major
□ substantial
△ minor

Those marked • are 7 of the 9 commonest kinds from English archaeological finds (Keepax 1977)

c. Summary

In the preceding sections (III-C-iii, a-d), documentary evidence on the extraction of woodland products has been introduced and evaluated. Data on extractions, expressed as species, growth-form, end-use and volume, has been presented and discussed.

A map which represents the aggregated extraction of woodland products on the Ashburnham estate over a period of *c.* 30 years is presented (Fig.23). The explanation of this map appears on it. It forms the basis for the 'Collation of results from documentary evidence' (III-D).

III-C-iv. Arable agriculture

a. introduction

Arable agriculture is not considered in detail here. This has been because the data from physical and documentary sources are palpably not compatible. The relatively few crop taxa of the past are well known (Neustupny 1952; Gill & Vear 1969; Dittmer 1972; J.M.Renfrew 1973; Dimbleby 1978). No major crop has been brought into cultivation in the last five thousand years (Dimbleby 1978, 72), the approximate time-span of this study. The major crop taxon the cereals, only rarely appears in the present pollen record as traces. The legumes (Leguminosae), the family including cabbages, turnips, mustards, etc. (Cruciferae) and the family including onion, leek and garlic (Liliaceae) were absent. All these taxa, but particularly Cerealia and Leguminosae, are accepted as commonly and extensively grown crops. Reviews of assemblages of plant remains and impressions, in particular seeds, from archaeological sites in southern England have demonstrated their cultivation (Helbaek 1952; Dennell 1972, 1974 & 1976). Seed assemblages from the intensive and multi-period Bishopstone excavations (Arthur, 1977, 273-5) and Pevensey (Salzman 1908 & 1909; Dulley 1967) endorsed this. It has been judged that from the seed assemblages from Roman Pevensey, Romanised agriculture prevailed locally with distinctive 'exotic' taxa. (Piggot 1981, 120).

Documentary evidence from Battle Abbey estate, including Barnhorne (a manor holding arable land adjacent to, and on Pevensey Levels), has amply demonstrated the staple 'field crops' (Brandon 1971, 71-8; Brandon 1972, 404-10; Searle & Ross 1967; Searle 1974, 286-91). Cruciferae and Liliaceae had some status of 'garden crops' on the abbey lands at Battle. (Searle & Ross 1967 & 1974, 286-91). The status of this range of crop taxa remained the same from the C16th to the C20th (Cornwall 1955; Thirsk 1967, 163-79; C. Brent 1973, 35-114; A. Young 1794; A. Young 1813, 79-145; Hall & Russell 1911, 19-26, 43-8). During the C16th and C17th a further complication arises. This was the systematic cultivation of the grazing unit, with the introduction of clovers (Lane 1980); this was carried out at Herstmonceux in the C17th where clovers were purchased (Lennard 1905). Young noted and recommended the use of 'artificial grasses' in Sussex (A. Young 1813, 149-53).

The extent of arable fields has been evident in periodic surveys; for instance, in 1115 A.D. there were c. 560 acres of demesne arable on the Battle Abbey estate (Searle 1974, 58); at Barnhorne there were c. 800 acres of frequently cropped land (Brandon 1971, 69). Such surveys were frequent (reviewed in III-D). However, they provide data which cannot be related to, and tested against, the physical data. The introduction of cartographic surveys of land-usage, including arable agriculture, in the late C18th in Sussex, has been well studied and evaluated (H.C.K. Henderson 1935; Briault 1939 & 1942; H.B.Smith 1940). It is not intended to duplicate these studies, nor indeed can anything of significance be added to the historical ecology of arable agriculture. Two courses have been developed in order to relieve this difficulty:-

1. The serious under-representation of crop taxa in the pollen record may be explained, in part, by the smallamounts of pollen produced and dispersed by cultivars (Godwin, 1975a, 405-15). The necessity for insect pollination of the commoner crops of Leguminosae, Cruciferae and Liliaceae is well known (Free 1970, 135-55, 198-277, 426-9). It is

accepted that taxa which are habitually insect-pollinated tend to produce relatively small amounts of pollen compared with wind-pollinated taxa. These 'relatively small amounts' are released at near ground level. This it is argued, together with the generally wooded state of the study area has led to the 'filtering out' of cultivar pollen. The substantiation of the 'generally wooded state' and some attempt to test this hypothesis appears in App. 10. It was found acceptable. Shaw-enclosed small fields have been demonstrated to obstruct the outward dispersal from fields of low-growing and sparse cultivar pollen. The removal of shaws especially in the C19th and C20th succeeded the major period of oat-growing (oats being the only cereal which freely disperses pollen); this obscures the representation in the pollen record. The arable status of large areas of Pevensey Levels, notably in the C13th and C14th, requires comment. It has been noted that the value of corn produced in parishes of Pevensey Levels in 1340 was among the highest in Sussex. (Dulley 1966, 36-7). The Barnhorne manor of Battle Abbey gave over large areas of its c. 800 acres to arable, on and adjacent to the eastern Pevensey Levels in the late C14th and early C15th (Brandon 1972, 404-10). The establishment of arable on Pevensey Levels may be dated to the late C12th and early C13th, paralleling the progress of reclamation or "inning" (Salzman 1910); its end has been firmly dated to the early C15th, when "devastating floods" terminated the substantially arable land-usage at Barnhorne. There was a pronounced trend to pastoral farming over the first half of the C15th; this inaugurated an era of overwhelmingly pastoral land-use on Pevensey Levels which has continued to this day. (Brandon 1971, 82-5; C.E. Brent 1976, 43). The continued status of the "Levels" as pasture is demonstrated by the livestock present (App. 6). The sole explanation which satisfies the writer as to absence of cereal pollen is that of the relatively brief (in stratigraphic terms) arable phase. This is not felt to be fully satisfactory.

2. It is hoped to partly remedy the inadequacy of physical data on cultivars by the examination of a locally distinctive crop plant, the hop. There is _prima facie_ abundant physical and documentary evidence for hop cultivation, and therefore the prospect of reciprocated testing. This is attempted below (IV-C-iii). The area of hop gardens is set out at the close of this section (Figs. 24 & 25).

III.D Collation and evaluation of results from documentary evidence

i. introduction

This collation is presented within the framework of historical cartography. The work of the cartographer, Saxton, in the 1570's marked a new level of cartographic achievement in England (R.A.Skelton 1970; V. Morgan 1979) including Sussex (Kingsley 1982). It was from the time of Saxton that the data becomes full and reliable.

The relevant data on maps of the study area is confined to broad categories of land-usage.

Fig. 26 Map of study area on which demarcated category of land-usage first appeared.

Park	Saxton (lin.= c.5 miles)	1575
Marshland Few of larger woodlands (Symbol as 'stipple')	Budgen (lin.= 1 mile)	1724
Marshland Woodland Arable Pasture	Yeakell & Gardner's (2 in. = 1 mile) 'Great Survey'	1780
Hopgardens	Tithe Award Maps for parishes of Bexhill, Herstmonceux, Warbleton & Wartling. (Bexhill 26.6 in. = 1 mile; others 13.3 in. = 1 mile)	c.1840

Sources: Margary 1970; Steer 1962 .

The documentary evidence for each of these categories of land-usage will now be summarised and evaluated under three heads -

A. surveys and maps

B. extractions (namely, timber, underwood, stock, game and crops)

C. narrative accounts (namely, topographic and vegetational description in itineraries and diaries)

ii. The 'Park' Category of Land-Usage

A. Surveys and maps. A definition of the 'park' suited to a study of land-usage is 'a place specially enclosed for beasts of venery' (Whitehead 1964, 471-82). Five such parks have been identified within the study area. Their time of establishment is not known but particularly early reference to the parks at Wilting in the Domesday Book, at Battle Abbey and Herstmonceux have been noted in the C13th (Darby 1977, 202-3; Searle 1974, 353; Venables 1851, 134). The mapping of Ashburnham Park and Crowhurst Park were, in 1575 and 1795, the earliest records which have been traced.

No subsequent record of the park at Wilting has been traced; the Domesday Gazetteer (Darby and Versey 1975, 48-9) has it mapped in Crowhurst near what are now Lower Wilting and Upper Wilting Farms, and so peripheral to the study area. It is not further considered.

Fig. 27: Historical Mapping of Parks in the Study Area

	mapped by Saxton (1575)?	mapped by Norden (1595)?	mapped by Budgen (1724)?	mapped by Gardner & Gream (1795)?	O.S. 1st Series lin.Shee (1813)
Ashburnham Park	No	No	Yes	Yes	Yes
Battle Abbey - Great & Little Parks	Yes	Yes	No	No	Yes
Crowhurst Park	No	No	No	Yes	Yes
Herstmonceux Park	Yes	Yes	Yes	Yes	Yes

Source: Margary 1970

The three parks which are to be considered further had relatively small but remarkably constant areas (Crowhurst Park was peripheral to the study area, and lacked a substantial, long-term, documented history. It is not further considered). Areas and boundaries have been remarkably constant to the succession of maps above, and 'on the ground' where they have still substantial boundary banks and ditches.

Fig. 28: Parks of Study Area: Area and Remarks on Boundaries

	Area	Outline
Ashburnham Park	c. 500 acres	apparently constant from time of Budgen's 1724 map.
Battle Abbey - - Great Park	c. 300 acres	much contracted from rough mapping of C16th and extents listed upon Dissolution of abbey in 1538. (Vidler 1841?)
- Little Park	c. 100 acres	Little Park lost in 1813 map.
Herstmonceux Park	c. 600 acres (enlarged to this in 1440. Ellis 1885,127)	apparently constant from time of Budgen's 1724 map.
% Area of study area	c. 3%	

These acreages were confirmed by C19th accounts of Ashburnham and Herstmonceux deer parks (Shirley 1867, 64-8; Ellis 1885, 127; Whitaker 1892, 151) and by 'Digitizer' (ascertaining the areas enclosed on map; (App. 13)).

Little has been learnt of the vegetational cover of the parks from these maps. An unusually early survey, dating from the Elizabethan period, described Herstmonceux Park as 'hills and woods', with two-thirds 'great timber trees, most of beech, and partly oak, of fair timber' and one-third of 'lawns (E. Venables 1851, 198-201). The broad distribution of clumps and lines of trees, and complementarily, lawns and glades may be elicited. This was especially the case at Ashburnham Park, subsequent to its landscaping by Lancelot 'Capability' Brown (cf. the plan for intended alterations. ESRO: Ashburnham MS.4458 & Stroud 1975, 176-7, & O.S.Old Series, Sheet 5).

B. Extractions

Extractions from the three parks show great similarity; where records were made as 'from the park' as distinct from 'from the estate' the extractions were entirely livestock and game of few species, together with timber and underwood. This and subsequent sections summarise the sections on agencies of vegetational change (III-C). The livestock in the parks was of few species; cattle predominated in the leuga, and in particular, on the parks of Battle Abbey. Searle put this succinctly - 'much of the leuga had been given over, in the C13th, to hunting park, timber and to Marley's (a manor of the estate) herds' (Searle 1974, 353). Cattle were the main stay of Battle Abbey stockfarming, largely succeeding peasant mixed agriculture by the late C13th (Searle 1974, 294-9); horses were subsidiary. The sizes of herds have not been established although these would seem to have been great. It was usual for payments to be taken for the agistment of tenant's cattle. Such stockfarming formed the basis of an important tanning industry in the town of Battle (Searle pers. comm.). The 'hunting park' of the Abbey, the Great Park, was not known to contain deer (Searle pers. comm.). The species established and worthy of the hunt have been set out (App. 6); it would seem that wild swine, rabbit, hare, and, possibly, deer were present. Mentions of these in, for instance, the Cellarer's Accounts were most unusual.

The maintenance of these species on the park signifies the presence of herbage and browse; this, plainly, means extensive grassland and secondary or scrub forest.

Timber extractions were most irregular and frequently voluminous. It was the judgement of Searle that the abbey used their timber trees when they needed to 'dip into capital'. The most valued and most frequently specified species was oak with only beech timber otherwise mentioned (Searle, pers. comm.).

Wood other than timber was brought to the Abbey household in the form of faggots, firewood and 'kindling'; volumes have been set out in Fig. 16 for this prosaic end-use. One may infer a range of growth-forms (timber from tree species; faggots from underwood and scrub and loppings from timber and a variety of woody and herbaceous 'brush') and species (as named or deduced). One must be wary, however, not to 'populate' the parks with species which were named in accounts because of economic utility or working properties.

In the published work on Herstmonceux Park (E. Venables 1851; Shirley 1867; Ellis 1885; Whitaker 1892; Lennard 1905) the extractions of livestock and game have been evident. Surveys of the numbers in a herd of deer, occasionally specified as fallow deer, survive for Elizabethan times but mainly for the late C18th and C19th. The numbers were usually in the range of 150 to 200 (App. 6); deer carcases featured in household books of Herstmonceux Castle. A 'fair warren of conies' was present (E. Venables 1851). Extractions of timber and underwood reveal a state of affairs almost identical to that of Battle Abbey; the range of end-products, and of explicitly named species was analogous.

Original work on Ashburnham estate and its voluminous archives have been central to this study (III). The park was, like Herstmonceux, stocked with a large herd of fallow deer and a small herd of red deer, and surveyed in the C19th. A range of game was shot around the park; from the late C18th, this was intensively managed; partridges and pheasants were shot in great numbers but the rabbits shot and trapped far exceeded these in number (App. 6).

Extraction of timber and underwood from Ashburnham Park along with all other woodlands, is depicted inFig. 23. The product-mix for the park, including the Old Park(that unaltered by 'Capability' Brown) and adjacent woodlands, displayed disproportionately great volumes of cordwood. This suggested, according to the definitions and discussion above (App. 7; III-C-iii-d), substantial-sized canopy trees of a size and quality inferior to timber used for structural purposes, and mainly of oak ('The Old Park' was rarely used. The adjacent Buridge Wood was more typical of the rest of the estate, regarding product-mix). Higher proportions of faggots and hop-poles signify the abundance of underwood and brushwood.

C. Narrative accounts

These are a miscellany of comments and descriptions (App. 14). A feature noted by almost all travellers was the densely wooded parks;

this was the case throughout the time-span of these visits, from the C16th to the C20th. Ashburnham and Herstmonceux parks were frequently visited by such gentlemanly travellers. Of descriptions which were informative on vegetation :-

Ashburnham was:-

to Dr Pococke, in 1754, 'a wood with ridings cut through it'

to Wm. Gilpin in 1774, it was 'surrounded with woods and lawns'

to 'L', in 1786, 'a beautiful park, well wooded and watered'.

to the Hon. John Byng, in 1788, 'a lofty extent of ground, of much gaiety, and prettily interspers'd by plantations'

to Gideon Mantell, in 1821, 'through woods and coppices ... thickly beset with cordwood'

to the Duchess of Cleveland, in 1877 'a green repose of woods and coppices' with 'few really fine trees and underwood major'

to W. S. Ellis, in 1885, 'splendid masses of timber'

to J. Whitaker, in 1892, 'fine old timber' especially oak, beech, pine and Spanish chestnut.

(J. A. Cartwright 1889 II, 101; Gilpin 1804, 49-50; 'L' 1786 II, 852-3; C.B.Andrews 1934 I, 363-5; Curwen 1940, 40; Cleveland 1877, 319-20; Ellis 1885, 13; Whitaker 1892, 151).

And Herstmonceux was :-

to Horace Walpole, in 1752, 'at the end of a large vale ... with wings of blue hills covered with wood'

to Vine, in 1772, 'well stocked with beech'

to the Hon. John Byng, in 1788 'abundant of lofty timber' but then became 'a waste' and 'wilderness' save for some Spanish chestnut near the house.

to Venables in 1851, Spanish chestnut remained after a great felling.

(Hadley 1959, 117; Vine 1773, 63; C.B.Andrews 1934 I, 363-5; E. Venables 1851, 169)

(iii) The 'Marshland' Category of Land-Usage

A. Surveys and Maps

Marshland in the study area corresponded areally with the 'Levels'. The 'Levels' are coastal alluvial marshes with a long history of reclamation. They are largely in use in pasture, and are leveed, and surrounded by sewers (drainage ditches usually of open water). They are wholly in the south and south-west of the study area, in the parishes of Pevensey, Herstmonceux, Wartling, Hooe and Bexhill. The boundary of the 'Levels' is quite clear; it has shown great verisimilitude over 3 to 400 years of proficient map-making (Lower 1870b; Margary 1970; ESRO:- TD/E141, E89, E93, E83, E88). The progress of Levels reclamation has been reconstructed from documentary evidence (Salzman 1910; Brandon 1971 & 1972), and documentary together with field evidence (Dulley 1966). Characteristically, newly reclaimed and named lands have been noted as they appeared in the documentation; this has been supplemented by mapping of features associated with old shorelines (op. cit.). The present-day shoreline seems to have been established by the time of Saxton's 1575 map (a major difference would be what seems to have been a lagoon in Bexhill parish. This persisted until the 1780 map of Yeakell & Gardner). The landward boundary may be demarcated as complying with the 15 m. contour; within this boundary, map-makers differentiated between the Levels with fields bounded by permanently water-filled ditches or sewers (op. cit.; ESRO - Ashburnham MSS. L2312, L2458 & 4388). Map-makers depicted Levels fields as bounded in double lines, sometimes shaded blue; local surveyors have differentiated in map legends between symbols for the boundaries of fields in the marsh and on the upland (ESRO - Ashburnham MSS. L2312 & 4388). The 15 m has here been accepted although field inspection suggested 8 to 10 m as more realistic; the formally surveyed boundary has, however, been accepted. Thus, for the entire documented period, the 'marshland' category of land-usage, the Levels, have made up c. 25% of the study area.

Maps of the 'Levels' have provided little explicit information on vegetation and land-usage. They provided the 'Levels' boundary, seaward and landward, and the bounds of individual fields and watercourses. Surveys of land on the 'Levels' have been few. Local Domesday Book evidence is absent; there were no 'marshland' entries adjoining the 'Levels' (Darby 1977, 159-62). In the Rental or Custumal of Barnhorne in the reign of Edward I the demesne comprised :-

c. 465 acres of arable land made up of -

terra maritima, or land near the sea-shore - c 168 acres;

- terra brocalis, or woody or marshy ground c. 101 acres;

- terra susana et campestres, or unsound or uncultivated lands or flats. 196 acres

c. 13 acres of meadow;

12 acres of wood (Scargill-Bird 1887), xv-xvii). Brandon's work on the same estate, concerning farming practices in the late C14th and early C15th, yielded a classification of land. On the 800 acre estate, the infields (strictly upland) were continuously given over to arable, and the other 95% or so, either high-quality arable land (being arable for 3 to 5 years, and left to fallow for a similar period) or pasture (being only occasionally tilled). (Brandon 1971, 71-8).

In the Parliamentary Surveys of 1649-53, Crown lands in the Manor of Pevensey were surveyed (Daniel-Tyssen 1871-3). An area 'by estimacon' 1250 acres, was made up of over 60 parcels of land surveyed in the parish of Pevensey. Almost all of this (with land under burgage tenure, 'urban plots', excluded) was described as 'mersh lands', 'marsh' or could be clearly located on 'the Levels' by phrases suchas 'in Horsy', 'in Mancksey Level', 'att Chilley', (all administrative subdivisions of Pevensey Levels). Lands called 'salts, were recorded in Pevensey and Bexhill (op. cit.180, 182); these are interpreted as shoreland natural grass pasture, with the latter 'overflowen by the sea'.

Such information confirms that the levels were pastoral, but tells little of their nature (other than the treeless state. Timber and underwood were carefully valued on this Survey. None were itemised). Such information is analogous to the voluminous corpus of reports and surveys carried under local Commissions of Sewers.

Numerous commissions were made to view, and repair the banks, ditches and sewers of Pevensey and the otherLevels, and the sea defences which protected them. Where the locality was specified, and today recognisable, these date from the C13th (Dugdale 1772, 87-102) until this century (ESRO 1954, & pers. comm.). Floods seem to have frequently prompted the setting up of commissions; in the reign of Elizabeth I, at Pevensey Haven, there was 'apparent drowning of their lands, by the frequent overflowing of the said fresh water' (Dugdale 1772, 87). Unusually the acreage flooded is given, as when 3783 acres around the Ashburn were in 1402, and 1072 acres along the Haven in 1455 (ibid., 97-8). Little detail as to the state or vegetation of 'the marsh' is usually given, other than an occasional reference to the blockage of the 'common watercourse', Ashburn, by 'sand, mud, grass and other filth' (ibid., 97). In these reports reference to livestock lost and at risk and losses of grazing land (ibid; also Salzman 1910; Dulley 1966 & 1967) confirm the state of the Levels as 'marshland pasture' as do occasional references to 'salts', 'salt marsh' and 'shingle'. The report of the Royal Commission on Coast Erosion and Afforestation (Vols. I-III, 1907-11) followed this pattern in being of little use.

B. Extractions from the marshland category of land usage have been of few types, overwhelmingly livestock and, in particular, cattle. Arable agriculture was transitory on the 'Levels'. There have been no records of extractions of wood which may be ascribed to marshland although one may only speculate on the source of 'wands and withis' and 'osiers' which frequently appear in the Cellarer's Accounts of Battle Abbey (Searle & Ross 1967). No woodland was mentioned in the Parliamentary Surveys of 1649-53 in Pevensey parish (Daniel-Tyssen 1871-3); about 1250 acres were surveyed outside the town. This is perhaps unsurprising in view of a succession of accounts of the treeless Levels (III-D-iii-c). There have been few and minor extractions of game on the Ashburnham estate; some birds which could be attributed to a wetland habitat.

The marshland category of land-usage has been continuously and overwhelmingly bound up with stockfarming. This has been noted as the prevalent type of Levels land-usage since the 1420's (Brandon 1971, 82-5). Examination of primary and secondary evidence endorses this.

c. narrative accounts.

Of the works set out in App. 14, many endorse two of the above arguments, that the Levels were treeless (and being flat and lowlying could have been seen to be so) and were overwhelmingly given over to pasturage. This was noted by contemporary reporters (Vine 1773, 63; A. Young 1794, 233-5, 243; A. Young 1813, 156, 235-45; 'T.H.' 1829, 334-6; Horsfield 1824, 7; Lower 1870a,2, II, 89; Roper 1875, xiv; C. Patmore 1886, 55-6; Haggard 1902, I-104; Ingram 1907, 278; Hall & Russell 1911, 15-16, 54-68; Jesse 1960, 22-3). All apart from Young noted the preponderance of cattle. He noted a recent rise in the numbers of sheep (A. Young 1794, 243; A. Young 1813, 156).

(iv) The 'Woodland' Category of Land-Usage

Woodlands other than parks and forests will now be dealt with.

Data on woodland in the Domesday Book has been of little use in this study. It was in the form of swine renders, which have been much debated (with varied views on the area of woodland which would render so many swine). Darby's classification of Domesday woodland noted that in the study area almost all identified places had small swine renders, with 'small amounts of woodland'. (King 1971; Darby & Versey 1975, 48-9; Darby 1977, 171-94).

The archives of Battle Abbey estate have yielded several extents of woodland, mainly for the demesne lands and the Manor of Barnhorne (Searle 1974; also Scargill-Bird 1887 & Brandon 1971). These were minor; one for 1306 listed only 12 acres of demesne woodland compared with 450 acres of arable land. It was, however, Searle's judgement that the leuga was largely forested throughout the monastic occupation (Searle, pers. comm.) and the extensiveness of the leuga (around 7 sq. miles) signifies incomplete recording of woodland.

This was certainly shown by the extractions and the extents set out in a grant of the abbey lands upon the Dissolution of 1538. Parcels of land were itemised withnames, areas and, frequently, the use to which they were put. Summarised, there were :

c. 400 acres of parks (III-D-ii), a total of 355½ acres of grazing lands and 315½ acres for which no use was specified, totalling 1071 acres. (after a grant under Letters Patent; cited by vidler 1841?).

This was an inventory of all abbey lands (op. cit. 120), yet made up less than 2 sq. miles of the leuga 7 sq. miles. The woodlands at Battle were not valued separately in the Valor Ecclesiasticus upon Dissolution as was done elsewhere (Savine 1909, 144-6). Description of Sussex woodland in the Valor Ecclesiasticus was undetailed (ibid. 206).

When reliably surveyed maps and surveys were issued from the late C18th (Margary 1970) woodland may be seen to be thoroughly interspersed with pasture and arable over the majority of the study area (the main exceptions being the 'marshland' land-usage taking up much of the 'Levels', and the parks). Conversions among these three types of land-usage will be dealt with in the resumé.

The woodlands of the Ashburnham estate, as mapped from 1780 to the present day show great constancy in outline and area (Compare Figs. 2 & 23). On the 1" scale, losses calculated by 'Digitizer' have been <5%. This, of course, ignores the smaller woods and shaws, as discussed in App. 10. Losses in these classes are considered substantial. The characteristically stable, sinuous outline of woods has been considered indicative of 'primary woodland' (Rackham 1975, 20-1); this, with reservations discussed below (IV-C-i), is endorsed.

B. extractions

Extractions from the woodlands of Battle Abbey were very similar to those from the abbey parks (III-D-ii), with changes in emphasis; faggots and firewood were rarely specified as from the park (Searle and Ross 1967). This may be an artefact of undetailed accounting for such prosaic items. Yet parks and 'other forests' were the chief sources of great timber and main location of the hunt. (Searle pers. comm.) Details of origin for woodland products are rare, and one is obliged to agree with Searle's judgement that the leuga was largely forested throughout the duration of its ownership of the abbey and in use as 'woodland-pasture' (Searle 1974, 67, 353, 368-75 & pers. comm.). There were occasional late intimations that underwood was 'barred to livestock; in the 'deed of surrender' upon the Dissolution, the abbey's seized property included 'woods', 'underwoods' as distinct from 'pastures', 'feedings' and 'meadows' (Vidler 1841?, 90-110). The main types of livestock seem, in the main, much the same in the leuga as in the 'other forests' with cattle predominating (Searle, pers. comm.).

Extractions from the woodlands of the Ashburnham estate showed a wide range of woodland products. By volume, these were predominantly in three categories - cordwood, faggots and hop poles (Figs. 17-19; III-C-iii-d). This product-mix, its growth-form and species composition, may in the great majority of cases be ascribed to particular woodland areas (Fig. 23; App.12). The use of this data is fully discussed in App. 13. Interestingly, such a product-mix appeared also in the household accounts of Giles Moore of Horsted Keynes (30 km w.n.w. of study area) in the late C17th (Bird 1971).

There was remarkably little variation in the product-mix among the woodlands of the Ashburnham estate and almost all woods fell into category (i) -

(i) where the volume of faggots exceeded double that of cordwood and hop poles combined.

(ii) where the volume of faggots exceeded that of cordwood and hop poles combined but was less than class (i).

(iii) where the volume of cordwood and hop poles combined exceeded that of faggots.

51 of the 56 'named woodland areas' in Fig. 23 were in class (i). These comprised over 95% of the area of woodland on the estate.

There were 3 class (ii) and 2 class (iii) woodlands (respectively, Cushman's, Lakehurst and Wilding Woods, numbered 26, 45 & 64; and Burnt Oak and Duckreed Woods, 18 & 28. App. 12).

The growth-form and species composition have been discussed at length above (III-C-iii-d); the main conclusions were :-

a. Cordwood. From trees which were 'sub-standard' and standard (with larger and better timber excepted). A range of tree species but predominantly oak.

b. Faggots. Spray and top (smaller branchwood): from timber cordwood and coppiced underwood. Scrub, heath, and perhaps, bracken, gorse, broom. Great range of species, and most difficult to ascertain their relative importance.

c. Hop poles. Straight poles from coppiced underwood cut to lengths of 10' to 16'. Species were, above all, Spanish chestnut and ash, and also willows, sycamore and hazel.

Fig. 23 shows all this data. Moffat (1983 & 1984a) uses the data.

C. narrative accounts

Travellers customarily noted little of interest about Wealden woodlands. A representative selection includes: in the late C16th, Camden noted 'extensive woods and forests'; in 1724-6, Defoe noted 'one inexhaustible storehouse of timber never to be destroyed but by a general conflagration'; in 1774, Gilpin saw Battle as surrounded by 'woody swells'; in the late 18th, Pennant commented that the country round Battle was 'very beautiful, full of gentle risings, and fertile bottoms well wooded'; in the early C19th, Horsfield, visited Windmill Hill (in Herstmonceux) and saw it 'surrounded by lofty plantations'.

All these, and others agree on the wooded and hilly terrain, especially as contrasted with the Levels. There is little detail and few seem to have strayed from the Battle to Ashburnham road, and its celebrated piles and parks. (Copley 1977, 66; Defoe 1724-7, 124; Gilpin 1804, 45; Pennant 1801, 44; Horsfield 1824, xxi).

(v) The 'Arable' Category of Land-Usage & The 'Pasture' Category of Land-Usage

Arable agriculture has not been considered in detail. The reasons for this have been fully discussed above (III-C-iv). They may be summarised as :-

a. the physical evidence is all but absent.

b. the documentary evidence has already been used for both the medieval and modern periods.

Thus no contribution may be made in what is a multidisciplinary piece of research. The 'pasture' category of land-usage has been considered under several heads :-

a. The 'marshland' category of land-usage, pasture on Pevensey Levels, for the entire period of study has been considered above. (III-D-iii).

b. 'woodland-pasture' This has been dealt with under the 'woodland' and 'park' categories. As a practice it had ceased in the study area by the late C18th and the inception of the plentiful and detailed Ashburnham estate archives (c. below manifested this).

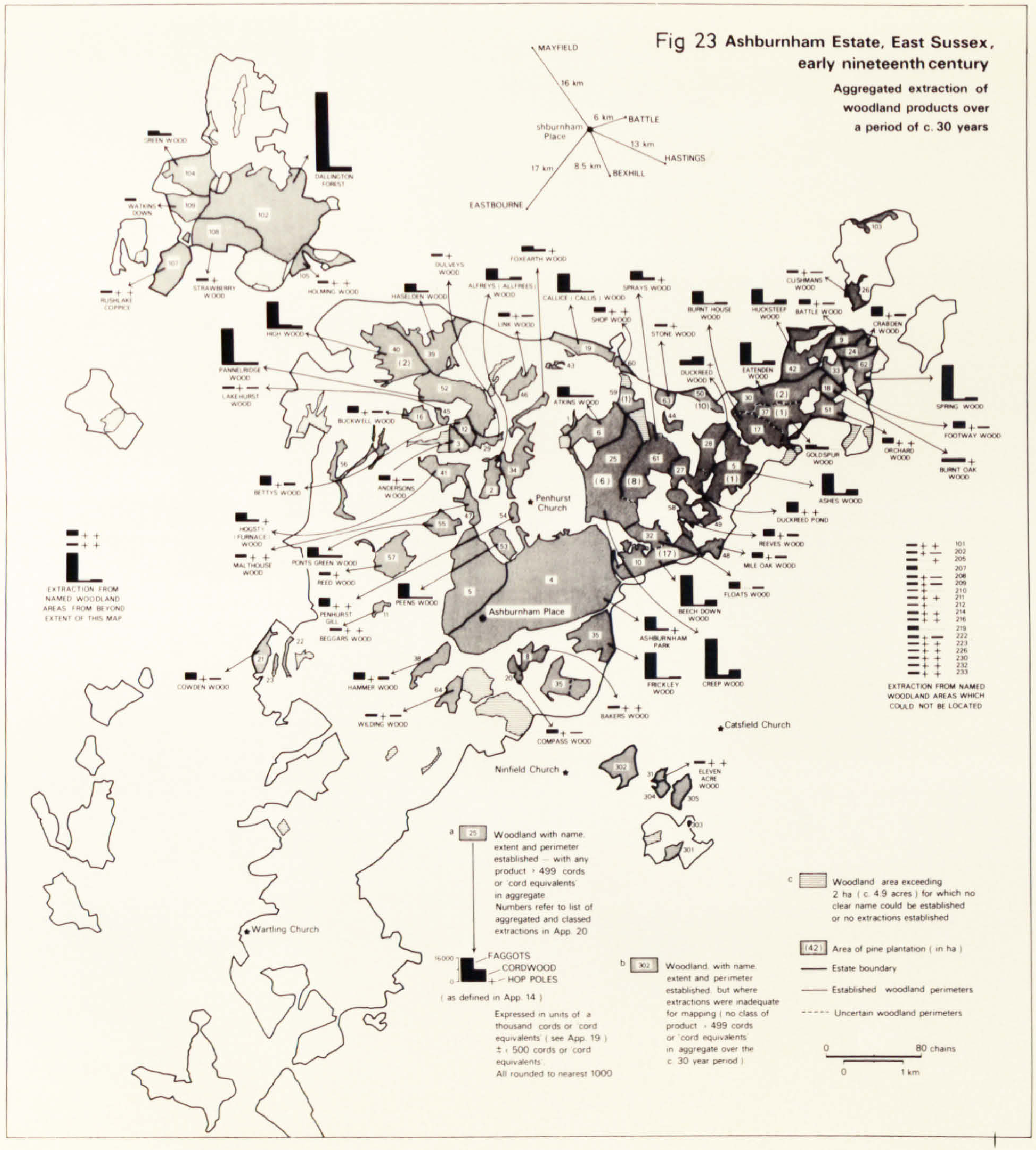
c. pastures away from the 'Levels', where forage was barred from the woodlands, have not been considered. This was because such pasture has been convertible to arable either by systematic cultivation of the grazing unit, or by ploughing and sowing, in the short-term. Such vacillation and indistinctiveness of the taxa of this and 'similar' habitats has been fully studied for the modern period from cartographic and other surveys. (Lane 1980; H.C.K.Henderson 1935). Such vacillation - systems of 'convertible husbandry' - have been demonstrated to exist on the leuga from the mid-C14th, and possibly earlier (Searle 1974, 274).

Summary diagrams and tables based on aggregated extractions of woodland products over a c. 30 year period in the late C18th and early C19th

(Fig. 23), on area of hop gardens (Figs. 24 & 25) and on classification of land-usage originating in the Tithe Award Surveys (Fig. 29) follow. These as base-data will be developed and evaluated against the data from physical sources (II-E) in Section IV, "The Consolidation and Evaluation of Evidence".

Fig 23 Ashburnham Estate, East Sussex, early nineteenth century

Aggregated extraction of woodland products over a period of c. 30 years



NAME OF PARISH	LANCE'S ESTIMATED AREA OF HOPGARDENS IN 1838 (ACRES)	AREA OF HOPGARDENS IN TITHE AWARD SURVEYS (ACRES) E - ESTIMATED	DATE OF SURVEY (OR AWARD)
Ashburnham	75	70 E	1839
Battle	204	200 E	1859
Bexhill	61	67 (& 5 perches)	1839
Catsfield	49½	50 E	1839
Crowhurst	54¼	55 E	(Award 1841)
Herstmonceux	83	60 E	(Award 1839)
Hooe	40	40 E	1839
Ninfield	82	50	(Award 1841)
Penhurst	109	30 E	(Award 1840)
Warbleton	152	150	1846
Wartling	76	75	(Award 1839)

(ESRO: TD/E13, E50, E68, E88, E89, E93, E107, E109, E141, E158)

Fig 24 Area of hopgardens in study area

YEAR	AREA OF HOPS PLANTED ('000 acres)
1729 - 32 period	2.6
1850	8
1878	11
1900	7 (Treasury Board Papers cited by J.H. Andrews 1954, 22)

Fig 25 Area of hopgardens in Sussex

Fig 29 Area assigned to land-usage categories, based on tithe award surveys (expressed in ha.; acreages in brackets)

INLAND PARISHES (Ashburnham; Battle; Catsfield; Crowhurst; Ninfield; Penhurst; Warbleton)

Total area	Arable land	Meadow and pasture land	Woodlands[*1]
11234	3051 - 35%	3617 - 32%	2699 - 24%
(27759)	(9765)	(8937)	(6669)

PARISHES WITH MARSHLAND (Bexhill; Herstmonceux; Hooe; Pevensey; Wartling)

Total area	Arable land	Marshland pasture	Other meadow & pasture land	Woodlands[*2]
9978	3277 - 32%	3966 - 40%	1423 - 14%	935 - 9%
(24657)	(8097)	(9800)	(3517)	(2312)

Notes.

1. All areas based on modern surveys with differences apportioned out.
2. Marshland pasture ascertained by "Digitizer" programme. All "Levels" lands below 15m. contour level taken to be marshland pasture except 3.
3. Shortfall due to minor categories, such as hopgardens, glebe land, common land, waste, etc.

*1 Includes two parks of 303 ha. (750 a.) (2.7%).

*2 Includes one park of 243 ha. (600 a.) (2.4%).

IV - Consolidation and Evaluation of Evidence

IV. A Consolidation and evaluation of evidence : the taxa

(i) introduction

The physical and documentary records have been separately described above (IIE-H;IIID). It is now necessary to test the records each against the other, and to evaluate the soundness of the results, and make some explanation of any disparity.

The basic data is 'the record' of the existence abundance and distribution of the plant taxon. It is therefore appropriate to set out all taxa which were identified as pollen, and the degree of correspondence with documented taxa (In general, the translated or transcribed name was accepted although detailed supplementary questions were put, notably to Searle and Harvey).

The taxa which merited further detailed consideration were : oak and beech; hazel and birches; Scots pine - hornbeam - Spanish chestnut - maples; willows; alders; the grasses, the common reed, and the sedges; the hop; ling and bracken. This total of 16 taxa may be compared with the c. 1400 species named in the county flora (Wolley-Dod 1937, li).

(ii) the relationship of taxa in the physical and documentary records: a cross-disciplinary account of vegetation from the late medieval period until c. 1900.

The pollen (and spores) of all 16 taxa (with the exception of the genus Acer which may not be further refined. G.C.S. Clarke & M.R.Jones 1978) is distinctive and identification is either unambiguous or discussed below. The pollen record of the 16 taxa seriatim will be rated against the documented record.

The pollen record of oaks in zones EPLIV and III/IV is, when 'weighted' (II-C-iv-a), continuous and major; that of beech, near-continuous and minor. Oak, despite some debate (Andersen 1970; Bradshaw 1981a), is a stable, predictable producer of pollen. Diminution in oak values, complemented by increases in the values of other taxa, is the basis of the present zonation schemes. The oak pollen spectrum represents the state of a major (locally,the major) element in primary and many secondary forests. The medieval archaeological record manifests oak charcoal at 14 and beech at10 of 25 local ironworking sites (Fig. 22) and oak is the _in situ_ local medieval building timber _par excellence_ (D. Martin pers. comm.).

The documentary evidence on these genera is abundant, though complex to interpret. The estate records of Battle Abbey occasionally specified large extractions of oak and, secondarily, beech timber (III-C-iii-c) for for sale from the park and woodlands. No other timber species was specified.

The Ashburnham estate archives yielded abundant data on products of these genera; of the more important, cleft timber, timber, tillow, pollarded timber were usually named as beech. Apart from minor items oak was never specified. This has been discussed at length above; it was argued there that oak was the commonest and the customarily used timber. This was judged so on the basis of contemporary accounts of its use and usefulness and analogous more general accounts, on the basis of its abundance in macrofossil assemblages and its recommendation in ironmaking treatises and occasional mention in ironmakers' accounts (App. 9; III-C-iii-d). From these same sources beech was judged emphatically subsidiary; no other timber-bearing tree species featured apart from very occasional mentions of ash, alder and Spanish chestnut. It was not, however, possible to quantify extractions of oak and beech, nor to attribute these to specific areas of woodland. Much cordwood and faggots is considered to have been oak (especially top faggots). This, however, may not be quantified.

Noting the reputation of oaks as common, and dependable where manifest as physical evidence, and the frequent mentions in documentary evidence, some discussion will be made of their status locally. In Sussex it has been unanimously regarded as the commonest and most prominent forest tree, the 'dominant'.

The oak is a member of most British woodland vegetational associations (Tansley 1953, 265-357), being found in association with almost every native tree and shrub species (R.C.Steele 1974, 130). It has been argued that as it is present in most woods, as it is a common dominant of unmanaged shrub and has been abundantly present (since well-preserved) in the 'primeval forest', it has come to be regarded as in some sense the past 'climax dominant' tree of most of England. It has become a convention that semi-natural woods have been treated as variants of oak woodland. The presence of oak has thereby spuriously subsumed great ecological variation (Rackham 1974, 74-7). Rackham has further noted that the oak is distinctive and prominent, often growing outside woodland. In historical documentation, it has had numerous specific uses, for which it has been highly valued, and being the landlord's proprty, entered in detail in accounts. There has been an 'almost embarrassing wealth' of historical information about oak (Rackham 1980, 16-18 and 283). The local evidence allows some re-examination of the debate as to the authenticity of the data:-

a) oak is continuously and abundantly present in the 'weighted' pollen record.

b) it is repeatedly and prominently present in the macrofossil record.

c) in the documentary record, where it is infrequently named, it has been argued above (III-C-iii) that oak was the species, <u>par excellence</u> and predominant, in yielding the major product, cordwood, probably made substantial contribution to faggot production, and predominated in timber and charcoal production.

d) it has often been remarked on, for its profusion and massive growth, by authorities on woodmanship and by travellers to Sussex.

e) it was by far the commonest local 'standard' and 'timber' species as evident in the historical botanical record, and the present-day surveys of vegetation.

Evidence on oaks is superior to that of any other species in its diversity, longevity and irrefutability. It has been the major, continuously present element in the most constant vegetational and broadly equivalent land-usage category, woodlands. It is peculiar to them (oaks do not flower until they are virtually of timber status). Its history may be summed up as one of continuous though moderate, decline throughout the time-span of this study.

The other forest tree species have been established for Sussex by Thorley (Thorley, 1971. Reviewed by Sheldon, 1978). No evidence from any source parallels, and presents in such diversity, a reconstruction of such prolificity as that for oak. Mentions of beech in quantity, for instance, do not extend beyond the late C13th (III-C-iii-c). Lime is absent from the documentary record.

The pollen records of hazel and birches in zones EPLIV and III/IV is, when 'weighted' (II-C-iv-a), continuous and substantial.

The medieval archaeological record manifests hazel charcoal at 6 and birch at 12 of 25 local ironworking sites (Fig. 22).

Birch was not mentioned in the Battle Abbey estate records, while hazel was frequently brought in for hoop-making, by the 'load' or 'wagon load' (Searle & Ross 1967 139, 144, 150, 158).

Neither species was named in the vast array of products obtained from the woodlands of Ashburnham Estate (Apps. 7 & 8).

Hazel and birches have had, it seems, similar histories :-
great abundance; a canopy status when they would be expected to be succeeded and overgrown by forest-forming tree species (Kinnaird 1968), 181; Forestry Commission 1956 3-4); presence on the 'Levels' but, particularly, in a range of underwood, scrubland and pioneer habitats. They have been confined in the 'woodland category of land usage', shaws and hedgerows.

Four genera may be considered together :- Scots pine - hornbeam - Spanish chestnut - maples. The pollen record for all (EPLIV and EPLIII/IV) was near continuous, and substantial or minor. They appear in the pollen record (or, in the case of pine, became prominent) at almost coincident levels (Figs. 6B - 6D). These levels, when slightly generalised, form the distinctive zonal boundary (Zone EPLIII/IV) and were dated at 480 ± 50 years B.P. (SRR - 1444) obtained from wood at pollen analytical site A.

Charcoal of hornbeam was found in 5 local medieval ironworking sites of the C15th and C16th and maple and Spanish chestnut on one site each (Fig.22). Documentary evidence on these genera was sparse with no specific mention in the records of Battle Abbey estate (Searle & Ross 1967; Searle 1974 & pers. comm) and on the Ashburnham estate, only rare mentions of 'fir', and a single mention of chestnut faggots (Apps. 7 & 8).

An undated list of 'fir', i.e. pine, plantations, probably of the early C19th listed c. 300 ha (122 acres) on the Ashburnham estate. All were located within established areas of woodland (Fig. 22). Pine and Spanish chestnut were noted in narratives on local parks (III-D-ii).

In the vegetational surveys, plats (single-age, single-species areas of woodlands) of about 1 ha were noted in the larger woods; these were, in 1976-7, 'bolted' coppices especially of sycamore, birch, hornbeam and Spanish chestnut. Full-grown Spanish chestnuts were 'occasional' in local woods, and sycamores in local hedgerows, while full-grown pines were common as 'standards' in the less well-managed woods, and on the minute area of local heathland (II-D).

These taxa, adventitious in the main, may be considered as :- species introduced to the area; species de novo allowed to pollinate and disperse pollen freely; some combination of the above. Study of planting of forest trees has been obscured by confused nomenclature, the reliance of few records of unproven typicality and the late evidence for any commercial supply (c. 1660)(J.H.Harvey, pers. comm.). From

documentary evidence - the lists of nurserymen, herbals, gardening treatises and estate records - Harvey concluded that the species were cultivated as follows :-
Scots Pine, occasionally from about 1350; Sycamore, from about 1570; Hornbeam - not brought effectively into cultivation until after 1600; Spanish Chestnut, from about1200. All four species 'would be planted a lot' from c. 1670 onwards (J. H. Harvey 1972, 1974, 1978 pers. comm.). Further reviews (Jarvis, 1979a & b) on times at which species were introduced had Spanish chestnut as 'Roman' and sycamore as early sixteenth century.

There is little specific evidence on the introduction of these taxa to the study area; this is based on records of trade in trees, but cannot preclude unrecorded importations.

The second possible explanation suggests changes in the usage and management of woodland whereby trees pollinated freely, the structure and composition of woodland was altered, and species (the ones considered and perhaps others) increased their pollen representation. This, in effect, means a widespread and coeval cessation in the growing of standards and pollards, and the establishment of the taxa under discussion in the uppermost stratum in woodland with ensuing free dispersal of pollen. This would mean Scots pine becoming a canopy species, Spanish chestnut and maples becoming de novo a standard species or canopy coppicewood, and hornbeam a canopy coppicewood. In the case of sycamore and hornbeam the pollen evidence pre-dated the earliest documented evidence and in the case of Scots pine it was broadly contemporary. From the pollen and documentary records, a common status in woodlands with modified and intensified management, is accepted.

The pollen record for willows (EPLIV &III/IV) is continuous and substantial and willow charcoal was uncommon in excavations of local ironworks (Fig.22).

Documentary evidence of willows was scanty. The accounts of Battle Abbey recorded the purchase of small quantities of osiers (S. viminalis), withies (OED: a willow of any species, or a branch of one) and wands (usually grouped with withies) (Searle & Ross 1967, 63, 75, 95, 93, 102, 106, 129).

The Ashburnham estate Timber accounts (App. 8) included only a rare item of relevance 'willow batts'. The major products of the estate woodlands did not preclude the use of the willow, or its usual growth-forms. Willow is feasibly usable as hop poles and faggots. Young noted that willow was widely recommended and used for hop poles and all purposes to which underwood was then put (A.Young 1813, 167-8). No trace was found of osier beds.

The status of willow species in the ecological community - generally in wetland - is well established, on the basis of present-day and historical ecology. (Thorley 1971, 204-6). A major status is interpreted in local "carr and flush vegetational formation" on the basis of the physical evidence.

The alder pollen record (EPLIV & III/IV) is continous and substantial. Alder charcoal was found occasionally and in small traces in excavations of local ironworks (Fig. 22).

Documentary evidence on alder was deficient. There was no mention of it in the archives of Battle Abbey estate (Searle & Ross 1967; Searle 1974 and pers. comm.). In the Ashburnham estate archives it occurred frequently as the species from which several specialist products were made (App. 8). Much originated in woods away from the Levels. It was not, however, recommended locally as underwood, or for any of its derivative uses (A. Young 1813, 166-8).

The status of alder was most unclear. It would seem to be localised to the 'marshland', and, to a lesser degree, the 'woodland' categories. Most extractions however seem to have been from woodlands near the park and away from the Levels.

Grasses, sedges and the common reed comprise major character-taxa in the pollen record (EPLIV & EPLIII/IV) on and off the Levels.

Documentary evidence of these taxa exceptionally distinguished 'the species' fromthe land-usage. The extent and duration of the marshland, paralleled the progress of reclamation or 'inning'.

The autecology of *Phragmites communis* is well known. (Haslam 1972a & b, 1978). 'In the British Isles *P. communis* is the most important reedswamp species, being an initiator of, and a stage in, hydroseres, and is a plant of very wide habitat range ...' (Haslam 1972a, 588). It is important to distinguish the habitat of *P. communis* from the salt marsh formation; this 'normally begins at a level subject to salt water tidal inundation twice daily. The upper level of tidal influence, where salt marsh is replaced by fresh-water marsh, is subject to tidal inundation only a few times a year at the spring and autumn equinoxes, and then by almost fresh water'. (Ranwell 1972 , 63). In contrast *P. communis* in temperate zones is restricted to estuarine marshes where chlorinity in the soil does not rise much above 1%, namely the 'brackish zone'; it is a frequent successor to salt marsh species, and has a salinity control to growth (Ranwell 1972, 75, 108, 116-7). In addition, *P. communis* has been regularly cropped on much marshland in historical times; the cut, lately every two years in winter, often with firing (Haslam 1972b), may lead to erratic flowering.

The documentary evidence for the reclamation of Pevensey Levels has been reviewed(III-D-iii). All workers used salt marsh or closely, if precisely, allied terms; Salzman had it thus :- it 'must have been for centuries one great lagoon'. Dulley referred to the 'pre-reclamation' Levels as 'salt marsh', 'tidal flats', a 'lagoon' and 'mud-flats'; Brandon had it as 'sea marshes'. (Salzman 1910, 32; Dulley 1966, 26-30; Brandon 1971, 78). All these workers traced the progress of this reclamation through the medieval period, and stressed the frequency and disastrousness of inundations by the sea. Perhaps the most recent mention of 'salt marsh' was on a map surveyed in anticipation of invasion by the Spanish Armada in 1587 (Lower 1870b).

The documentary evidence was clearly at odds with the physical evidence. The presence of Phragmites communis (albeit in small amounts) and sedge pollen (in abundance) throughout the uppermost strata at all four sites merits scrutiny. P. communis macrofossils were abundant, and sedge occasional in c. 50 Levels sites at levels corresponding to the pollen evidence. This was also the case at Barnes' site in the western Levels (Barnes 1974).The close of the documented record of reclamation (III-D-iii) has been dated by radiocarbon (SRR-1443; 490 ± 50 years B.P.). It has been argued from stratigraphic, macrofossil, mineralogic and pollen analyses that estuarine, i.e. salt-marsh, conditions were manifest locally in the lowermost strata; there were brief phases of these conditions subsequently, but these were most improbably within the documented timespan (II-B-ii).

The significance of the physical evidence is most difficult to refute. The faultiness of the documentary evidence may be explained by its vague terminology, subsequently imbued with over-exact or deviant meaning by historians. The salt-working sites, so critical to the historians' argument, were described as on creeks; creek-side locations, with estuarine status, need not influence the state of the entire 'marsh' (App. 9). The proper, anthropocentric concern of historians with subsistence, and its assurance in the short-term, is accepted; however, the succession of disastrous floods in the local documentary evidence left no marked and no extraneous stratigraphic trace, but for minute sand lenses (no calcareous deposits, resulting from the prevalent eastward longshore drift, could be proven).

The physical evidence is taken to be infinitely the superior; it is disquieting that the documentary evidence, when so detailed, should be refuted so thoroughly.

Hop/hemp pollen, judged to be hop, was present only as 2 trace values. The documentation is amplified into a study of hop husbandry (IV-C-iii).

Ling and bracken present a minor local expansion in the pollen/spore record.

Documentary evidence was slight; a single mention, a payment made 'for cutting heath' in 1351 - 2 occurred in the Cellarer's Acounts (Searle and Ross 1967, 57), a single small extent of heathland at Barnhorne (Brandon 1971, 70) and a single product, heath faggots, occasionally turned up in the Ashburnham Timber Accounts (App. 8). In the 18 tetrads of the study area, bracken was represented in 25 and ling in 2. This last omits at least 3 sites of ling in 1976. In the surveys of vegetation a minute area of ling-dominated heathland with abundant bracken was noted. Bracken grew also in waste and cleared ground and in hedgerows.

On a more generalised scale it has been commented that, apparently, many of the land-use changes especially clearance in woodlands, cessation of cutting of the last 200 years, have favoured the autecology of bracken (R.T.Smith 1977, I 1-7; 1977 III; Rymer 1974, 1976 and 1977). The high levels of spore production, particularly in man-opened habitats, has been noted in a review of bracken phytogeography (C.N. Page 1976, 21-4). The end of pasturing cattle in woodland and the decline in bracken-cropping industries (App. 9) are local manifestations in this development from <u>c</u>. 1700.

IV - B. Rating of the evidence on stands of vegetation; the standpoints of physical evidence (the 'vegetational formations') and documentary evidence (the 'categories of land usage').

The evidence from the physical (II) and documentary records (III) has been dealt with and discussed separately. Yet before detailed discussion may be usefully begun, an aide memoire on the nature of the data is given:-

	Documentary data		Physical data
1A.	Anthropocentric in nature. A contemporary perception of actual or potential land-usage.	1B.	Palaeoautecological in nature The above schema purports to be palaeosynecological on the basis of analogous modern ecologic data.
2A.	Intermittent, but increasing in frequence towards the present-day. Tends to isolate unitary 'periods' in history.	2B.	Continuous, being closely and evenly sampled. In general, consistent in quality.
3A.	In the main, may be attributed to precise locations or extents 'on the ground'.	3B.	Requires complex weighting (which is probably of indeterminate validity, and certainly highly artificial) to compensate for differentials in pollen productivity, transportation and preservation. 'Strength of source' to be accounted for.
4A.	Accurately and comprehensively dated in terms of calendar years.	4B.	Periodically dated in terms of radiocarbon years. Dating imports a technique with highly debated accuracy, and qualifications as to reliability. Assumption made as to a constant rate of sedimentation between dated points.
5A.	Marked bias regarding taxa towards those which were usable and used as crops, timber and (for specialised end-uses) underwood. Also livestock and game. (About 30 named, cf. c. 1400 named in the county flora).	5B.	Clear bias regarding taxa; to those which were prominent due to (or despite) the above differentials. Favours recording of anemogamous trees, shrubs and herbs. (51 taxa identified, cf. c. 1400 named in the county flora).
6A	Bias largely to large well-organised estates where records are extant.	6B.	No such bias.

The two corpuses of data are disparate in their intrinsic nature (discussed above), in extent of land represented and its determinability, in time-span covered and its determinability and, in most cases, the ethos and purpose of any inquiry.

Plants grow in stands of vegetation, with varied degrees of heterogeneity. Although a reconstruction of vegetation attenuates the interpretative processes in pollen analysis, it is attempted here. Six distinct vegetational formations are discerned in this pollen record (Fig. 30-A). A status, major or minor, is proposed in these formations for all taxa in the pollen record (Fig. 30-B), using ecological source-material (Fig. 30-C). Developing this, a master schema is presented (Fig. 31) where the status of all taxa present in physical and documentary records is proposed and evaluated. This master schema forms the basis of the following section where accordances and discordances in the evidence are debated.

IV - C. Accordances and discordances in the evidence: Questions asked of the Pollen Record

Ab initio, it would seem that the pollen record, in the light of all other records *in toto*, faultily represents the vegetation growing in the historic past (Pollen Zones EPL III/IV & IV Figs. 6). This is the case even when the corpus of data on inter-specific differentials in pollen productivity and dispersion is applied. Sound *prima facie* evidence of this faultedness exists for three categories of plants:-

i. woody plants. Trees and shrubs under management.
ii. low-growing plants *en masse*.
iii. cultivars.

This will now be discussed.

IV - C - i. Woody plants. Trees and shrubs under management

The authoritative modern works on present-day British vegetational associations and British Flandrian palaeobotony (Tansley 1953; Godwin 1975a) gave the matter scant attention. Rackham's monumental work on ancient woodlands, their natural history, historic usage and management (Rackham 1980), may have been expected to yield sound pertinent data. Yet, despite using digests of pollen analyses from the region of his predominant interest, East Anglia and adjoining counties, and touching on this issue (*op. cit.* 106, 243, 329-30), it was not fully countenanced. The physical and documentary sources of evidence were arrayed in juxtaposition, and yet not recriprocally tested in any detail. His points, that there has been little account taken of woodland management in the interpretation of pollen analytical evidence, and that the short rotations of the Middle Ages would inhibit flowering (*ibid.*) are accepted.

The standard text on pollen analysis allots a sentence to the matter: 'Many forest practices tend to reduce drastically the flowering of forest trees (*Niederwald*, *palina*, etc.)' (Faegri & Iversen 1975, 53). These last terms mean 'coppice' respectively in German and Italian (N.A. Furness & C.P. Bond, pers. comm.), but having eluded the specialist translator, may connote more than this.

Practically all of the corpus of data on in vivo inter-specific differentials in pollen productivity and dispersion in northern Europe is concerned with woody plants, particularly 'forest trees'. The data is in the form of weightings of and ranked orderings in productivity (Andersen 1970 & Bradshaw 1981a; references therein). When they were used to modify the present pollen record (IV-A), the fit with all other data on present-day and recent vegetation was poor. The values of some few woody taxa in the pollen record married well with 'values' in other records; this may be said of oaks, birches, hazel, and Scots pine. In 'relative pollen diagrams' such as these (Figs. 6), all values are dependant one upon the other, and therefore generic underrepresentation leads to a general overrepresentation, and vice-versa. The work of Andersen and Bradshaw (op. cit.) countenances the problems of 'natural' differentials in pollen productivity and dispersion, yet ignores a gamut of influential (infra) management practices. Both workers have in fact cited accounts of historical usage of their study area woods. For instance, 21 of Bradshaw's 78 sites were in the Mens and the Cut, a woodland common near Arundel, West Sussex (62 km. west of the writer's study area), which is well-documented and studied and where pollarded oaks and beeches are common (Tittensor & Tittensor 1977; Tittensor 1978). Many of his other sites were in the New Forest where, perhaps, the managed history of living trees has been uniquely well studied (Peterken & Tubbs 1965; Tubbs 1968; Flower 1980. Also transcriptions of historical documents: Stagg 1983 et seq.): Here visible and historical evidence of management is profuse. Indeed in the most general terms, M.B. Davis and Tauber have declared that the prevalence of human influences invalidates the theoretical and methodological basis of pollen analysis (Discussed: II-C-iv-a). The whole matter will now be fully researched and discussed.

The crux of the whole matter is the quality of the data, in vivo observations on the impact of management techniques on patterns of flowering (and free release of pollen) and on responsiveness of the pollen record to past management. Plainly the effects of cutting and flowering cycles on the release of pollen are the key variables. The optimum quality of data on this would be:-

a intensive surveys of the composition of species and growth - forms of present-day vegetation.

b an account of management practices as they were and are applied to the various species, growth-forms and locations of wood.

c an account of concurrent practices intended to modify a and b namely plantation, 'weeding-out' and 'filling-in'.

d a corpus of sound data on the inception of a mature flowering rhythm for all species and growth forms under management. This would need to be qualified for diverse environmental gradients and biogeographical regions.

As this last desideratum would provide the ecological data essential for the interpretation of the pollen record, an intensive search of the literature was undertaken. The time at which traditional systems of woodland management ceased in south-east England has been exactly recorded. The conversion to 'high forest', free-standing timber trees with little secondary stratum, was widely recorded and promoted at the end of the C19th and beginning of the C20th (Nisbet 1893; Brown & Nisbet 1894; Nisbet 1905; 'Quarterly Journal of Forestry', 1907-1920). In submission to the Royal Commission on Coastal Erosion and Afforestation, a Sussex woodman, described such conversion in Sussex, as did various contributors to the 'Quarterly Journal of Forestry' (T. Roberts 1909; L.S. Wood 1907; Somerville 1908; J.P. Robertson 1910). This last writer noted a prevalent policy of 'clear, cut and plant'.

Coppicing as a formal practice of woodland management has now, in the main, ceased in southern England. A major exception to this has been the coppicing of Spanish chestnut to produce stakes, &c. (Locke 1970, 48; Garthwaite 1976, 13; Martyr 1977; Forestry Commission 1983).

Thus for the period from *c.* 1650 up to *c.* 1920 all relevant works in the holdings of selected libraries were examined. All works on field botany, and practical woodmanship and sylviculture, at the National Library of Scotland, and the libraries of the universities of St. Andrews and Edinburgh* were vetted for contemporary observations. Little of use was found; this endorsed the view of contemporary ecologists on the dearth of work on managed woods (Adamson 1921; Christy 1924; Salisbury 1924). What there was was mainly concerned with recording the age at which the major forest -, and plantation - forming species normally began to flower and attain 'maturity and reproductive capacity', for instance - alder and larch began to flower aged 20 to 30 years; both birches at 25 to30; Spanish chestnut at *c.* 25 and elms and hornbeam at *c.* 30; Scots pine, ash and sycamore at 40 and 50; and beech and oaks at *c.* 50 to *c.* 70 (Nisbet 1893).

Of more direct relevance were the observations of an experienced turn-of-the-century field botanist, (and Professor) from Cambridge University (H.M. Ward 1905, III, 5-7). His observations on 'the approximate age of flowering in certain of our common trees' were:-

> 'Alder, 12 to 20, up to 35, or even 40 years
> Ash, 20 to 25, or even 40 years
> Beech, 40 to 50, or even 60 to 80 years
> Birch, 8 to 10, up to 20, or even 30 years
> Chestnut, 6 to 10, up to 20 or 30, or even 40 to 60 years
> Hazel, 5 to 10 years, or even earlier
> Hornbeam, 15 to 20 years
> Oak, 20 to 50 or 60, or even 80 to 100 years
> Sycamore, 10 to 25, or even 30 years
> Some Willows will bear flowers when 2-3 years old.'

* All 3 were Copyright Deposit Libraries up to *c.* 1920.

He noted further that -

'Individual trees occasionally bear flowers much earlier than the normal age, especially .... from coppice.'

Further scraps of information were gleaned: on the first flowering of beech and sycamore (Loudon 1838).

Yet there was little account taken of variation in growth-form and habitat. A solitary exception was the Boulger account of the beech (Boulger 1907) 'Coppice-shoots flower when 30 or 35 years of age'; 'isolated trees do not as a rule flower until they are 40 or 50'; 'trees in close order not until they are from 60 to 80 years of age'.

In general, all this data was highly generalised and made scant account of traditionally managed woodlands. The ubiquitousness of such woodland underlines this dearth of ecological knowledge. In illustration, one may take the hornbeam. A thorough survey of hornbeam woods in south and east England was made at the close of the period of interest (Christy 1924, 84-90). It was noted that practically all hornbeam has been 'mutilated', by coppicing and pollarding. This signifies that processes in the pollination ecology of the hornbeam, at least, are scarcely known.

Dissatisfied with the quality of this data, it was felt necessary to approach the Arboricultural Advisory and Information Service of the Forestry Commission, and draw on its collective expertise and long-term observation (Patch pers. comm.).

A digest of these communications is:- Setting aside the production of pollen by immature trees which tends to be very erratic and sparse, the time at which a 'flowering rhythm' commences is the nub of the present discussion. At this time flowering becomes abundant and cyclical, and potentially discernible in the pollen record.

Although there is probably no specific age at which trees develop a flowering cycle, for the major species the 'possible time scales' would be:-

Willows	2 years
Poplars	3-4 years
Hazel	3-5 years
Alders, Birch and Hornbeam	10-15 years
Maples	20-30 years
Sweet chestnut, Beech and Oak	30 years plus

With the exception of willows, poplars, hazel, birch and alder it is suspected that coppiced trees would not be allowed to remain sufficiently long to develop a flowering rhythm. However, provided these five taxa are cut at sufficiently long intervals there should be copious production of pollen. The other slower growing species would probably be cut on a 15-20 year cycle in the majority of localities with the result that 'there would be absolutely no chance of any quantity of pollen being produced even if some flowering did occur'.

It may take a further several years for what may be categorised as 'liberal' dispersion of pollen to develop.

It is suggested that no distinction would be evident as regards the pollen produced under a clear-felled and a draw-felled coppicing system.

With regards to pollarded trees there is even less information available. Possibly the nearest parallel would be a hedge and yet not even a neglected beech hedge, for example, has been observed producing flowers. This may reflect a retention of a physiologically juvenile condition within the plants. The general inference is that cutting cycles generally would have been too short to permit many species to flower, but we are generally not fully aware of the relationship between tree maturity, the effects of cutting and flowering rhythms.

Coppicing and pollarding of trees which have achieved a flowering rhythm manifestly curtails pollen production although the data is imprecise and much qualified. (All the above: Patch pers. comm.)

Furthermore, there seems to be a serious shortage of data on the usual age up to which species have a capacity to coppice. All that was discovered was: Spanish chestnut, oaks and elms have the capacity up to about 85 years; alder, ash, field maple and sycamore coppice 'well'; beech and birches lose reproductive vigour after several coppicings (Nisbet, 1905 I, 332). This contradicts Peterken's contention that, if coppicing is maintained, the stools are 'almost immortal' (Peterken 1981, 20).

None of the above conflicts with the writer's observations, and the data and its qualifications are accepted. It is now appropriate to review the data for the study area. Relating this to the other desiderata set out,a–c ––a.using the Ashburnham estate woodland composite (Fig. 23) as base-data, it is plain that in the late C18th and early C19th, the area and output of estate woodland was at least 95% underwood. This was certainly its continuous state from c. 1750 to c. 1920. The species composition at this time was: named as underwood for specialist end-uses were Spanish chestnut, ash, willows and less important, alder, holly and dogwood; underwood (yet unnamed) for non-specialist end-use, were birches, hazel, hornbeam, sycamore, field maple, thorns and those listed above; timber was predominantly oak, to lesser degree, beech and less important, ash and alder. Underwood for specialist end-uses was mainly in the form of erect stems of 10 to 16 ft. in length; other underwood was up to these maximum sizes but included much shorter and more straggly growth; timber of substantial cordage came mainly from full-grown trees.

b there is no direct data on the time and rotations at which underwood was cut on the Ashburnham estate. The Woodcutting Books though naming the woodland from which major products were obtained did not specify age at which underwood was cut, or name and unequivocally delimit a plat so that periodicity in extraction may indicate age. Yet the frequency at which extractions were recorded from named woods, allowed the inference that the majority (the notable exception being Dallington Forest) were cut at a minimum of 10 to 13 years. This accorded well with the observation of A. Young jnr. that underwood was cut at 14 years old at Ashburnham (for full account, see Fig. 34).

There were only two surveyed maps of estate woodland which detailed the age of underwood. One dated 1770 was of 77 acres; the other 1850, of 55 acres. Both had a fairly even age-distribution from aged 9 to 20, and from newly cut to 10 years (Ashburnham MSS. 4398 & L2526).

As this data is low-quality, a thorough review was made of the works of reputable informed writers on rural matters with experience of woodland management in south-east England. This is set out in Fig. 34. Setting aside particular cuts for specialist (and minority) species and end-products, a remarkable uniformity in the time of cut is manifest. This was recorded and recommended as being within the range, 8 to 16 years, over a period from the early C17th to early C20th. This data is inferior to the impressive collection of estimates presented by Rackham with *c*. 300 cuts from the C13th to the C20th. (Rackham 1980, 141). Yet it is the best locally available: It does not manifest the reduction in rotation length noted by Rackham over the period of his study.

No evidence was found to bear on different methods of management being used for different woods. Product-mix and time of cut (see Fig. 23) seemed uniform.

c Regarding the final desideratum, some account of plantation, 'weeding-out' and 'filling-in', this is set out in columns 6 to 8 of Fig. 34. The sole evidence 'on the ground' was a survey of 122 ha. of pine plantation within established woodland. Although the planting of coppice wood has been considered a rarity (Nisbet 1905 I, 417-8), runtwood (from stumps and roots) was a commonly accounted minor item, and noting the great constancy in the extent of the woodlands, 'filling-in' is clearly implied. Its nature is not known. The general notion of a self-maintaining species composition in coppiced underwoods is accepted, with the well-known exception of beech (Watt 1924).

The pollen record for woody taxa may be summed up as:-

Taxa interpreted as being 'dryland'

	Presence (IV-A)		Plant Atlas Record (Hall 1980)	
CONTINUOUS & MAJOR	oaks		pedunculate oak	- U
			sessile oak	- 1
CONTINUOUS & SUBSTANTIAL	birches		silver birch	-15
	hazel		downy birch	- 6
			hazel	- U
NEAR CONTINUOUS & SUBSTANTIAL	elms	Site A only	ash	- U
	maples		beech	-15
	Spanish chestnut		elms	- U (agg.)
			field maple	- U
NEAR CONTINUOUS & MINOR	maples	Site B only	hornbeam	-15
	hornbeam		ivy	- U
	Spanish chestnut		Spanish chestnut	-12
	elms		sycamore	-17
	limes	A	thorns, roses etc.	- U (agg.)
	ash			
	ivy			
	beech			
	Scots pine			

Taxa interpreted as being 'wetland', and predominantly from the Levels

CONTINUOUS & SUBSTANTIAL	alder	alder	-16
	willows	willows	- U (agg.)

[1 to 18 = presence/absence in 15 full/3 part 2 x 2 km tetrads. U = 'ubiquitous'.]

Fig. 23: Digest of the pollen record - II. Woody taxa (Zone EPLIV; Sites A & B).

Much recent ecological work on lowland English coppice woods has been on post-coppice production, the closure of the canopy and associated floristic, energetic and ecological changes (Salisbury 1916, I & II; and 1924: Adamson 1921; Christy 1924; Begley 1955; Ford & Newbould 1970, 1971 & 1977; J.M. Anderson 1973; Ash & Barkham 1976; A.H.F. Brown 1976 & 1977).

Coppicing practices would be expected to manifest themselves in the pollen record in several ways:-

a. pollen taxa representing characteristic open-habitat 'woodland' herbs would persist (the rotation with, say 10% of woodland was coppiced for each of ten years would ensure this. Such rotations have been proven locally).

b. the pollen record would selectively represent those shrub taxa present, and capable of flowering within the coppice cycle.

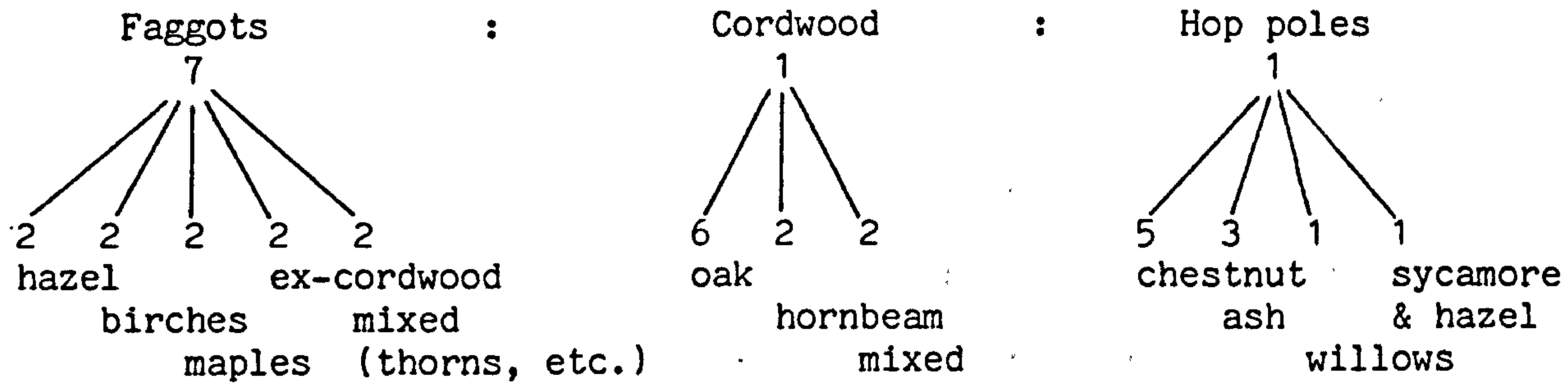
c. the pollen record would test suppositions made on the tree and coppiced shrub status of certain taxa, following from b.

Taking these points in turn:-

a. coppiced plats of several hectares have been demonstrated to carry a distinctive and varied flora in the 8 to 12 years it takes for the restoration of a closed canopy (op. cit.). The taxa are well-known; from the above analogous studies, from the local surveys of vegetation and from the pollen record, occupants of such habitats may be discerned. Bracken and ling are two such. The absence from the pollen record of two taxa, which were abundant in the surveys of vegetation, release pollen freely and may be identified as pollen, wood sage (Teucrium scorodonia) (Discussed in Moffat 1984b) and rosebay willowherb (Epilobium angustifolium), (But, see IV-D-iii), was puzzling.

b & c. at the time of cuts noted for the study area, within the range, 10 to 16 years, and drawing on the ecological data of the A.A.I.S., several taxa could not be expected to present dependably in the pollen record, namely, Spanish chestnut, field maple, sycamore, beech and oak. There is no direct evidence for coppicing of the last two in the study area. The flowering of coppiced alder and birches must be considered uncertain. Of the coppiced species abundant in the study area, only the willows and hazel may be expected to dependably figure in the pollen record. Both willows and hazel have been judged to be erratic and 'swamping' producers of pollen. The notion is proffered that no species coppiced for underwood in the study area may be expected to produce pollen in, for the purposes of a pollen record, predictable and stable quantities.

It may assist visualisation of the species composition of the major Ashburnham woodland products to produce a tentative breakdown by volume*:-



The species documented as being felled as timber are listed above. The A.A.I.S. data and the pollen record corroborated the documentary evidence. The predominant status of oak timber is accepted as proven. The discontinuous, minor values for beech suggest felling while flowering is inhibited and, as suggested by abundant bolled beeches encountered in surveys, a history of pollarding. Other timber species were of minor local significance.

The significance of these points is critical. Were coppicing a widespread and long-lived practice as, for instance, the Somerset Levels Project (Somerset Levels Papers 1974-1982) suggests, the pollen record grossly misrepresents the growing vegetation. On the Somerset Levels, the assemblage of wood indicated active selection of species, diameter and growth-form, and the setting aside of woodland with exclusion of herbivores (Rackham 1977). Hurdle manufacture has been demonstrated to be a simple and rapid process (Coles and Darrah 1977). Similarly, as early as 852 A.D., large quantities of faggots, a common underwood product and commonplace output from coppicing, were recorded in the Anglo-Saxon Chronicle (Garmonsway 1953, 65).

In the study area, inhibited flowering due to coppicing was the case for all but two taxa which were locally coppiced and more tentatively, for all but oak as timber. Only hazel, and some willows may reliably flower within

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* Growth form is not known. Spacing of stocks or stubs and, from observation, height of cut above ground, affect crown area, a component in calculations of pollen productivity and dispersal.

the period before cutting, and these have a reputation for erratic pollen production. Local evidence strongly suggested a rather rude form of coppicing on the Battle Abbey estate, judging from volume and nature of woodland products, and endorsed by the description of abbey woods upon Dissolution, as coppices. Intensive cyclical coppicing has been inferred to supply the Panningridge Furnace (on the Ashburnham estate) in the C16th and C17th (Crossley 1972, 61). There can be no doubt that, on the Ashburnham estate, coppiced woods made up the great majority of the estate woodlands (Fig. 23) from at least the mid-C18th, until this century. All this is, of course, properly tentative, yet the duration, extent and nature of coppicing practices add another 'unknown' to interpretation of the pollen record. With the aid of documented history some hazy insight may be gained; in prehistory this would be most improbable. Rackham nicely described 'the quiet usually unremarked regrowth of the young shoots, known as spring, automatically replacing the woods every time they were cut down, decade after decade, century after century' (Rackham 1980, ix). Such spring, following the cut or wind-throw &c., is plainly and generally observable; its promotion is accepted to be a tradition and to be readily and empirically feasible.

IV - C - ii Low-growing plants en masse

Low-growing plants are, for this discussion, those under 1 m. in height. Maps of the study area, beginning with the earliest (c. 1570 A.D.) (Margary 1970), show that the greater part of its area is open and without extensive continuous woodland; much of this land would carry low-growing plants. Yet, grass, in all certainty the commonest and most extensive component of such open land, only rarely exceeds 15% of total dry-land pollen in Zone EPLIV. This is roughly matched by herbs of dry land in the zone, apart from at the minor seaward sites (II-F). No data on the in vivo productivity of grass pollen has been traced (II-C-iv-a). Yet it is implicit in the interpretation of most pollen records, certainly those examined (4-6), that increases in grass pollen values complement decreases in tree pollen values in a way in which the processes are understandable and interpretabilit is dependable. Grass pollen values, despite representing diverse species and habitats, have a reasonably sound status in pollen analysis. For this reason, the low values of grass pollen immediately beneath the zone EPLIII/IV boundary prompted concern. A small field experiment was set up (App. 10) to test the hypothesis that the pollen of low-growing plants would be filtered out by taller-growing plants and this would shorten the normal range of dispersion, and make appearance in pollen records more improbable. With reservations (op. cit), the hypothesis was found acceptable.

Setting aside 'aquatic plants' and 'mire plants' (sensu: Godwin 1975a; Beckett & Hibbert 1979), the interpretation of the record of 'herbs of dry land' is problematical. Taxa are numerous and are often large aggregates of species representing many, varied habitats. It has been conventional to interpret increases in these taxa en suite as due to expanded farming practices. Farming which ranges between fully pastoral and fully arable has been discerned in 'weed' and grass spectra (J. Turner 1965; Hicks 1971; Atherden 1976a & b); this is debated (K.J. Edwards 1979, 256-7). A variant on this is to name 'clearance herbs', 'those which definitely reflect human clearance activity' (Beckett & Hibbert 1979, 579). A number of distinctive prehistoric types of land-usage with distinctive herb components have been reviewed (Groenman-van Waateringe 1978); none were discernible in this pollen record. All the above are qualitative observations.

All four of the present pollen analyses show a marked increase in the presence and continuity of pollen attributed to herbs of dry-land. The increases have been dated to 480 ± 50 years B.P. (SRR-1444), and form the boundary of zones EPLIII/IV (Figs. 6B & 6C). 17 pollen taxa were represented, excluding cultivars: 6 taxa may be described as aggregates of numerous species representing most diverse habitats (Caryophyllaceae; Chenopodiaceae; the two types of Compositae; Labiatae; Umbelliferae); 4 as taxa representing genera where the species which contributed most pollen may be reasonably determined (Artemisia; Plantago; Rumex; Ranunculus) though the last two have common species representing semi-aquatic habitats; and Rosaceae, which it is judged, largely represents woody shrubs. Other taxa are represented only as traces.

No common non-aquatic herb characterised habitats on or off 'the Levels'. (T.J. Turner pers. comm.; personal observations).

The herb spectra in zone EPLIV may be interpreted as representative of expansions in several habitats:- cleared woodland on or off the Levels (III-D-iv; IV-D-iii); levees and aggraded banks (A.R. Hill (1976) and T.O. Robson (1972) describe the habitat, and Beeftink (1975) the vegetation); the littoral (II-F); laid down pasture; fallow (Thirsk 1967, 161-99; A. Young 1813, 67-75); weed-infested arable fields (W.H. Long 1979). These are, it is thought, in decreasing order of importance and feasibility, but a full reconstruction is inextricable.

The only documented insight came from agricultural writers; several specified the most troublesome weeds of farmland. In 'Markham's farewell to husbandry' there were itemised moss, heath, ling, broom, bracken, fern, gorse, twitch, whins, briar and sweet briar, and 'morish stinking grass' (Markham 1638, 3 & 18-20). According to Arthur Young, Sussex pastures were covered with 'rushes, thistles, fern, broom, brambles, &c. &c.' and Sussex 'natural meadows and pastures' included docks, buttercups, ribwort plantain (A. Young 1794, 205-6 & 1813, 146-8). Hall and Russell named spurrey (probably sand-spurrey), groundsel, knotgrass, among other 'troublesome weeds' (Hall and Russell 1911, 137-9). This is of minimal assistance.

IV - C - iii Cultivars

Cultivars are plainly low-growing plants. Yet they differ in being sown as species in monoculture, for fixed periods, with well-documented practices of husbandry. The preposterously low values of undifferentiated cereal and flax pollen show gross underrepresentation (Figs. 6); in the Tithe Award Surveys of 1825-35 (Fig. 29), arable made up 35% of the total area of the 7 inland parishes and 32% of the marshland parishes (Fig. 3). Hopgardens made up c. 850 ha at the same time. The hop is a climbing perennial plant. Its natural habitat is marshy, wet depressions in fen carr, and moist alder-oak woodland (Tansley 1953). It has also been grown as a cultivar, mainly for use as a flavouring and preservative in beer. Recently this has been in enclosed, hedged small fields, called hopgardens in Sussex (Parish 1875). It also occurs in hedgerows and thickets - wild, as an escape from cultivation, and deliberately planted.

The hop was selected for intensive study for several reasons - its 'wild' habitat within the study area is localised to Levels and riparian sites (Roper 1875; Wolley-Dod 1937).

- it has been used as a cultivar in the study area for a determinable period of time (infra).

- it has been grown in ascertainable acreages for at least the last three centuries. As the subject of taxation, its production has been continuously supervised (Lance 1838, 1-9; Mathias 1959, xiii).

- it has been considered as a distinctive, and interesting type of horticulture in East Sussex. It is usually commented upon in detail by writers of treatises and travellers (infra).

- it has had fairly well known methods of cultivation. It requires well-manured, heaped-up soils, and the support of specially grown poles. The poles were required in standard numbers, and so provide endorsement of the acreage under hops.

- evidence from documentary and physical sources would seem compatible. Hop pollen is abundantly produced and dispersed; this is discussed at length below.

In all, a study of hops would seem unique in that as a cultivar (perhaps with the exception of hemp and flax), it potentially allows reciprocated testing of methods of inquiry, and of data.

Of the four pollen analytical sites only one (B) yielded pollen which was formally identified as 'Humulus/Cannabis' ('hop/hemp'). Of c. 110,000 pollen grains which were identified from these 4 closely grouped sites only 25 grains were of 'Humulus/Cannabis'. All were from 2 levels, contributing 13 and 12 grains respectively at 15 and 25 cms. depth.

The earliest botanical record of hops in Sussex was in 1666 (Wolley-Dod 1937, 402). The local and county floras respectively noted it to be 'rather rare' and 'rather frequent' in the 'wild' state (Roper 1875; Wolley-Dod 1937). It was found in 9 of the 18 tetrads of the study area as set out in the Sussex Plant Atlas (Hall 1980).

There is evidence for the use of hops other than for brewing in the past (D.G. Wilson, 1975, 634-48; D.G. Wilson & Conolly 1978). Yet its abundance, in what has been considered to be the cargo of a C10th boat excavated at Graveney, Kent, strongly suggested its use in brewing. This was an unusually early example of hops being used in quantity. Conventionally, the use and cultivation of hops in south-east England commenced only in the late C16th and early C17th.

Local evidence was not plentiful; work on the Battle Abbey estates (Searle & Ross 1967; Searle 1974 & pers. comm.) yielded no evidence on the use of hops. The earliest indisputable record of the cultivation of hops was on the estate of Herstmonceux Castle for the period, 1643 to 1649. Hops, measured by weight or bags, were brought into the household (Lennard 1905). The earliest records of hopgardens were in 1622, 1635 and 1689; these were respectively in the Hooe area, in Ashburnham and in Ninfield (ESRO: Suss. Arch. Soc. C/34 & Ashburnham MSS. 4373 & 4379).

A comprehensive search for data on hop production has been made of the Ashburnham estate Records at East Sussex Record Office (F.W. Steer 1958). Only odd chits and bills of sale were extant. The underwoods of Ashburnham estate, however, continuously yielded huge quantities of hop poles. The yields of particular named woods were set out in the Woodcutting Books (Figs. 19 & 23). Acreages of hopgardens were first stated in the estimates of the treatise - writer, Lance (Lance 1838, 189-99) and the Tithe Award Surveys and Maps for the parishes of the study area. Both sets of data recorded c. 850 ha(2100 acres). (Figs. 24 & 25). The number of hop poles required per acre at the time was 3-4000, and from 12.5% to 20.0% of all poles were replaced annually (Parker 1934, 64). Thus it seemed valid to calculate the acreage of hopgardens which could be fitted out with the estate production of hop poles; using the higher density (4000) which seems the local practice (after A. Young-jnr.-1794 & 1813), and the range in replacement rates some corroboration of the area under hops may be made. The total hop acreage supportable by the pole production is annotated on Fig. 19.

The calculation made several assumptions:-

- that the rate of replacement was in the above range. Rotting was rapid in the well-manured soils required for hops. Before the introduction of creosoting, to preserve poles, in the last quarter of the nineteenth century, this seems plausible.
- that poling used standardised numbers. Before c. 1870 when wiring systems and espaliers were introduced this seems to have been the case; their adoption in East Sussex is precisely dated. Creosoting, and training on 'string and wire' were being taken up locally in 1870; by 1878, creosoting was 'almost universal' and by the-turn-of-the-century wiring systems were the norm (C. Whitehead 1870, 344-7, & 1878, 727; Haggard 1906, I, 108-10, 139, 153; Macdonald 1908, 379).
- that the end-use of poles was not convertible. This is accepted, as value was substantially lost by, say, cutting down for fence poles. Periodic checks on the value of various products itemised in the above accounts confirmed this, as did an account of sale prices of underwood products from Easebourne in 1880. Hop poles were valued at 15s. per hundred, and no other product was valued at over 9s. per hundred (Tallant 1880).
- that there was little long-distance trade in poles, and local underwoods supplied local hopgardens. With such a high-bulk, widely available item this seems reasonable.

Extreme fluctuations in the acreages of estate, and by inference, local hopgardens are apparent in the period covered. While total acreages for most parishes changed little (<5 acres) over a period ranging from 4 to 24 years, those for Herstmonceux, Ninfield and in particular Penhurst fell dramatically. Hop cultivation in the study area had virtually ceased by the turn of the C20th (Hall & Russell 1911, Fig. 50. Perhaps 50 acres remained) and had ceased by the time of the Land Utilisation Survey in 1940 (Briault 1942).

Plainly there are serious disparities in the evidence which merit discussion. First, the nomenclature of the hop must be established. The documentary record presents no problem. The poverty of climbing plants in the British flora together with a succession of detailed accounts on the habit, autecology and uses of the hop argues for this. But in pollen analysis, workers have had difficulty in distinguishing the pollen of hop from hemp. This has been resolved to the writer's satisfaction. Though the critical features of the exine could be said to gradate from one taxon to the other (Godwin 1967b) no problem was encountered in this study. Using the standard method of oil-immersion microscopy, reasonably sound identification was secured (Godwin 1975a, 242-3). The identification of 'hop/hemp' as hop is endorsed by its late appearance in the pollen record, and the absence of late records of local hemp cultivation.

The history of hemp cultivation as apparent in the pollen record has been well studied (Godwin 1967a and b; Godwin 1975a, 242-3; Bartley 1976; Bartley et al. 1976; Davies & Turner 1979; R. Bradshaw et al. 1981). It has been characterised by the substantial presence of pollen and frequent mention of hemp cultivation and hemp in trade. It was frequently referred to in local purchases of hemp, canvas, rope, cord, at Battle Abbey, and in 1382-3, payment was made for rope to be made from the monks' 'own hemp' (Searle & Ross 1967); preparation of hempen yarn was widespread in the 1540 to 1640 period in East Sussex (Brent 1978, 41); it was mentioned also in accounts of local ironworks in the C16th (Crossley 1975b). In Sussex, it was grown along the rivers in the C16th and C17th (Thirsk 1967, 177).

Interestingly, in the diary of Giles Moore of Horsted Keynes, (30 km. w.n.w. of the study area), he described that in 1658-9 he experimented with growing hemp. He noted that pamphleteers had remarked that it was much grown in living memory but added that very little was grown 'at present' (Bird 1971, 110-5). He had to send up to London for seed, and found the experiment unprofitable. This seems to plainly mark a clear end to any substantial hemp-growing. In 1767, Parliament established bounties for growing hemp and flax. There were records of claimants' names, with details of farm and parish, and acreage grown. No hemp seems to have been grown in Sussex as no claims were registered (ESRO: 1954, 51). This is endorsed by published county summaries for 1783 to 1785 (AA9, 473-7). The meticulous Arthur Young did not mention hemp even among those crops 'not commonly cultivated' in Sussex (A. Young 1813, 77-145). It is evident that hemp was rarely grown in early modern times in Sussex. However, examination of C19th encyclopaedias of agriculture has shown that where hemp was grown for its fibre, as was evidently the case in the study area (rather than for fibre and seed) the plant was uprooted as soon as it flowered; where it was grown for fibre and seed the male of this easily sexed species was uprooted when seed was set (Loudon 1835, 851-2; C.W. Johnson 1842, 626; H. Stephens 1851 II, 33-5, 326-8; J.C. Morton 1855, II, 24-8). Yet several experienced practical writers noted that both sexes were 'pulled' at the same time (AA9, 376-81; AA10, 377-89) in the 1780's. More particularly in a 'Prize Essay', specifically 'On Hemp', addressed to the Royal Agricultural Society of England (Rowlandson 1849), these observations were fully borne out. All these works were descriptive of what occurred, and prescriptive.

No records of hemp were made in the local and county floras, or the Sussex Plant Atlas (Roper 1875; Wolley-Dod 1937; Hall 1980).

For these reasons:- formal pollen identification; the absence of any continuous substantial pollen record; the absence of any clear local documentation of hemp cultivation in the last three centuries; the ambiguity of hemp-growing practices - the pollen of 'hop/hemp' type was judged to be hop.

Second, the habitats of the hop need to be evaluated. There is no documented record of hop as a 'wild' plant or an escapee from cultivation. As a cultivar the hop is recorded in detail as regards acreage and distribution over time. There is no distinction yet established between the pollen of wild and cultivated hops in the historical period. The concern is that the hop habitat, fen carr, may be over-represented in the pollen record. There is little evidence for any such habitats locally. The outcome of c. 400 years of proficient local map-making (the compilation of Margary 1970), including the Tithe Award Surveys (ESRO: TD/E83; E88; E89; E93; E141) and several large-scale local maps (ESRO: Ashburnham MSS. L2312 & 4388) showed no considerable wooded areas on the Levels. Neither were there osier, sallow or alder beds. The Parliamentary Surveys of 1649-53 covered an area of 'by estimacon' of 1250 acres in the parish of Pevensey; this bore no timber or underwood (Daniel-Tyssen 1871-3). A succession of travellers' accounts, from the C16th to C20th, endorsed the treeless state of the Levels (III-D-iii-c). No considerable extent of woodland capable of supporting the wild hop could be established, and the pollen record is taken to represent cultivation.

Third, incompatibility in dating the evidence presents problems. The documented evidence may be faulted simply on its intermittency. The physical evidence may be faulted on the basis of the fallibility and latitude inherent in radiocarbon dating. The two dates obtained are, however, broadly corroborated by the appearance or increased presence of a suite of woody taxa in the pollen record (II-G), interpreted as a local manifestation of underwood management and plantation.

Fourth is the consideration that the deposits of the Levels may be truncated by agricultural practices, and, in particular, the much recommended if imprecisely recorded 'pare and burn'. This is known in general terms to have been much practised in Sussex from at least the C17th to C19th (Fully discussed in App. 5). No records of 'pare and burn' were traced to the study area, the nearest being Sandwich, Kent and Petworth, Sussex (AA: 5, 112-9 & 24, 521-2).

The probable consequences of the practice are: disturbance; mixing; aeration; consolidation; accelerated decomposition of pollen grains; and destruction of a valid pollen record.

Fifth, there is clear evidence from numerous descriptive accounts and treatises that prevalent practices of husbandry actually inhibited the production of hop pollen. The plant is dioecious. The first record of this being scientifically recognised was in the early C18th by the Rev. J.K. Lawrence (Parker 1934, 26-7), although the sexes are prima facie easily distinguished regardless of any attribute of sexual function. Writers of several treatises felt the necessity to prompt hop-growers to make a point of planting the male plant near the females and so promote pollination.

This strongly suggests that such an elementary act of husbandry was commonly omitted, and would, in addition to leading to crop failure, lead to poor representation in the pollen record. The scale of this under-representation cannot even be conjectured, but a substantial acreage was under hops in the study area in the C19th; for instance in the Tithe Award Surveys of around 1840 there was an estimated 850 ha (2100 acres).

Lance in 'The Hop Farmer' and MacDonald in 'Stephens' Book of the Farm' noted this omission as prevalent (Lance 1838, 60-6; MacDonald 1908, 377). Parker noted that it went on, but did not specify sources (Parker 1934). Gilbert White noted it in his letters in the late C18th, and it was even then a debate in 'The Naturalists' Journal' (Holt-White 1901, II, 169-70).

White recommended growing the male plant (White 1887, 356). In several treatises the proper number of male plants to be planted was specified (Lance 1838, 103-5; Rutley 1848, 546-7; Hall & Russell 1911, 32), presumably to remedy malpractice. Yet a practical farmer, Mr. Ruggles of Finchingfield (Essex), could note *ab initio* that crops were 'visibly better' near a scattering of male plants in his hopgarden and also that it was common to leave them in or near hedges. This was as late as 1804 (AA *42*, 289-90).

Summarising most writers in the words of Rutley's prize essay, the fertilisation of hops seemed ineffective even where 'well impregnated with male farina' (Rutley 1848, 545-7). He also noted a 'difference of opinion' as to the 'utility' of the male plants. Parker noted that it was a common practice 'to mark them' and 'root them out' (Parker 1934, 31).

This strongly suggests a failure to grow male plants, and their active extirpation. It must be stressed that all the above treatises described and prescribed that 'propagation was by division of the plant' (Loudon 1850) (unlike hemp which was grown from seed) and from a cutting of presumably known sex.

Sixth and last, there is strong indication that whatever pollen was produced would be susceptible to filtration. This would be the case because hop was characteristically grown in small, enclosed and hedged gardens, and although a climbing plant and trained onto frameworks of poles, filtration would, it is expected, be the norm. The mean acreage of local hopgardens in the Tithe Award Surveys was 2.1 acres. Most writers of treatises, and also Belcher (AA*7*, 97) were preoccupied with the necessity for windbreaks and shelter belts. In 1673, Giles Moore recorded that he had completed quick-setting his 'hop-garden' (Bird 1971, 200). Generalising from modern data on such barriers, the leewards inside such minute fields would be most probably in permanent calm (Caborn 1965) and there would seem little chance of hop pollen entering 'the pollen rain'.

This effect would be aggravated in an area which was most densely wooded and interlaced with dense hedgerows (App. 10). The actual, precise location of most hopgardens cannot be ascertained, as on the Tithe Award Surveys for the parishes nearest to the pollen analytical sites, Hooe, Ashburnham and Ninfield, they are not marked, Peculiarly local conditions may not be reconstructed.

The history of the hop has been dealt with at this great length because it presented numerous questions and complexities.

IV - D - i Accordances and discordances in the evidence : Questions asked of the Documentary Record. The Levels in late medieval times

The stratigraphic record of the eastern Levels indicates that there has been a single biogenic or terrestrial phase continuing until the present day. At the most inland pollen site (A) peat growth was initiated at 3715 ± 80 BP and at the most seaward site (D), 2760 ± 50 BP. Subsequent to this, there is no evidence of any marine incursion or prolonged state of inundation. In the upper 0.6 m. of deposits (roughly corresponding to zone EPLIV) the plant macrofossils and sediments indicate continuous terrestrial status (Fully discussed: II-F).

Much work on the documented history of these Levels has been done (Salzman 1910; Dulley 1966; Brandon 1971). All vaunt the idea of a reclamation from the sea, or 'inning' as it is locally called, during the medieval period from c. 1100 A.D. to c. 1500 A.D. (actual calendar dates). The first date may only signal the commencement of documentation now extant. All accounts take the form of a staged history of reclamation where new fields are named and measured and, it is inferred, newly reclaimed. Brandon has succeeded in a precise mapping of the medieval Levels. This conforms well with the topography of the present-day Levels, leveed and interlaced with ditches and sewers (Brandon pers. comm.). There are repeated references to inundation and livestock drowning. Beyond this all three writers describe the pre-inning Levels as a salt marsh or similar: lagoon; salt marsh, tidal flats, lagoon, mud flats; sea marshes

(Salzman 1910, 32; Dulley 1966, 26-30; Brandon 1971, 78). All these workers state that the presence of salt pans signifies tidal influxes to fill them. The requisites of the industry (App. 9-F), the documentation related to the Levels (III-D-iii) and the littoral status of pans (Akeroyd 1972) have been studied. From these sources, a prime site for a salt pan would be on an estuarine creek-side and not on the edge of marshes inundated in toto. The 'salt pan argument' for the Levels being inundated in their entirety is dismissed. In turn, the workers write of reclamation from the sea, which implies protracted inundation to some depth. No method employed in this work endorses this at all. This may be explained by unclear terminology in the original documents subsequently being imbued with over-precise or incorrect meaning by historians.

The latest two radiocarbon dates at AD 1345 to 1490, and AD 1340 to 1485 (Calendar range: 95% confidence. Rendered thus to make dating compatible. Harkness pers. comm.) coincide almost perfectly with the date Brandon gave (op. cit.) for the completion of inning on the Levels, at AD 1420. From then onwards, the Levels were under pasture. The dates were acquired to mark a major phase of clearance inland, and an increase in lenses of sand, originating inland. There is no form of stratigraphic evidence for the conclusion of this comprehensive reclamation (supra).

IV - D - ii Accordances and discordances in the evidence : Questions asked of the Documentary Record. Extractions from, and the composition of woodland

Data on extractions comprises the most voluminous, continuous and dependable source of documentary evidence in this study (III-D), at the very least. In the documented record of Battle Abbey estate, large volumes of the growth-forms - faggots and firewood - and of the timber species - oak and beech, were extracted from the leuga. In the documented record for the Ashburnham estate, over 95% of the volume of output (originating in woods totalling over 95% of the area of estate woodland), was smallwood. Faggots, cordwood and hop poles were cut in the ratio of volume - 7:1:1.

Timber, usually specified as beech, made up the main minor item. Ascription of extractions may not be made to specific woods of Battle Abbey, nor to specific plats within woods at Ashburnham. There is strong prima facie evidence of selectivity in species and growth-forms; this may well be manifest in the pollen record.

A digest of data on woody taxa in the pollen record, with views on the relative significance of individual taxa, has been presented (Fig. 32). This clearly shows continuity and inter-relatedness in the spectra of woody taxa. The essence of this discussion is the continuity of the entity and species composition of woodland. Management (Thoroughly discussed above: IV-C-i) by pollarding and coppicing rejuvenates the stool, and promotes the repeated growth of 'spring'. This capacity to be rejuvenated has been stated to be finite, but modern observers have rejoined that this regrowth may recur almost indefinitely (Peterken 1981, 20). The prevalence of the tradition of coppicing is critical to these considerations but is, until last century, indeterminate in scale.

There are local intimations of large-scale, selective or draw-felling:- the vast consumption of the Roman ironsmelting industry (Cleere 1978); the vast sales of oak, together with beech, from Battle Abbey (Searle pers. comm.); Tudor and Stuart ironmaking (App.9-1); and the retrospective surveys of wasteful fellings (III-C-ii). Examining the pollen spectra of oaks and beech, the zone EPLIII/IV boundary area fortuitously coincides with the last two centuries of abbey occupancy. In all the other cases, scale and duration and aftermath are not known; all these *will* be pertinent. An instance, is Cleere's (1978) account of Roman fueling of ironworks. The fuel was branchwood, especially oak and beech; of itself, this amounts to selectivity of species at least, and the uncertainty of pollarding. The critical fault in Cleere's and other works is to equate the cutting and felling of wood, in all inevitability, with consummate clearance. The act of clearance will be discussed below (IV-D-iii).

Essentially, the problem is that there are no surveys of composition (species and growth-form) of woodlands until late last century. There are repeated, albeit intermittent, records of voluminous extractions, of most particular species and growth-form, in the documented record from the C12th until the C20th. Depletion in these particular species and growth-forms, outstandingly oak and beech timber, and the impoverishment of regional woodland in general have been repeatedly inferred in the most general terms. Yet, the pollen spectra of oak and beech, considered to be stable and dependable in their behaviour (IV-A), respectively show, in zone EPLIII/IV and IV, a generalised progressive decline and a substantial, though discontinuous presence. Explanations of the awry, conventional historical accounts may be:- regrowth of trees which have been felled or cut, has figured inadequately in historical accounts (IV-C-i; supra); natural seeding and man-sponsored plantation or 'in-filling' within established woods (Actively promoted from at least the early C17th onwards: Fig. 34) have been scarcely considered; the scale of felling operations, often imprecisely known, has been taken to be widespread and characteristic; the propagandist pessimistic element in contemporary writings has misled (III-C-ii).

IV-D-iii Accordances and discordances in the evidence: Questions asked of the Documentary Record. The nature of the act of clearance

Clearance in the pollen record is discerned from a phased inter-relationship of particular taxa on the increase and decrease; in the stratigraphic record from increased inputs of distinctive soil-based sediments. In contrast, the documentary record presents clearance as a single-stage, undetailed act; it is consummate and requires no maintenance. Cleared and uncleared lands are described as quite distinct. A piece of cleared land appears in the documented record : it is named, measured and cropped. The end of such mentions probably signifies abandonment. For instance, on the Battle Abbey estate there were distinct phases of assarting, especially in the C11th and C12th (Searle 1974, 22, 46-8, 51, 57-60, 63-4, 66, 144, 171 282). The net total clearance on Abbey lands was 639 acres of fields at the Dissolution (III-E-iv). This was accomplished in 100-150 years of the monastic occupancy of almost five centuries.

The desiderata on these clearances would be :- the means by which clearance was accomplished, by means of herbivores, tools and fire; knowledge of the species which precede, accompany and succeed clearance; knowledge of the erosional effects; the means of maintaining cleared land. The documented record has little to say on these matters: at Battle, only exceptionally are piecework fees paid to cut and clear scrub, dredge and mow (Swift 1936; Searle & Ross 1967).

There is no record of the use of fire in the estate records of Battle Abbey and Ashburnham. A locally experienced woodman judged that there was no risk of firing locally (T.Roberts 1909, 392), although a present-day felling contractor found little difficulty burning branchwood, brush and underwood (A. Peterson, pers. comm.). The continuously sodden litter layer may deprecate the use of fire. Contradicting this is the expansion of rosebay willowherb a common post-fire pioneer from a curiosity observed by John Ray, locally in Mayfield in the late C17th, to its present ubiquitous local status.

Much economic history and studies on 'evolution of the landscape' naturally dwell on clearance; it is considered as a consummate act, but should more properly be considered as a varied ecological process.

IV-D-iv Accordances and discordances in the evidence: Questions asked of the Documentary Record. Little known medieval pig-grazing practices elucidated using present-day ecological parallels.

Two specific ways of grazing swine, which are known to have prevailed in historical times in Sussex, will be briefly considered: Pannage, the seasona feeding of swine on the mast in oak and beechwoods, and the free forage of swine. Both are based on the diversivore nature of swine; Grigson (1982) reviews the practice, and Kidder and Manners (1978), the digestive facility of the pig. Because of late maturation of oak and beech, with mast produced inquantity only from ages, 80-120 years, (Penistan 1974, 103; Watt 1923; Hyde 1965), and intermittent mast years (Rackham 1974, 73; Nisbet 1908 I, 57; Penistan 1974, 103), the practices may have been complementary. Much has been made from the abundant charter and place-name evidence on pannage, particularly from Kent (DuBoulay 1962 & 1966; Witney 1976). Yet in the contiguous Sussex Weald, charter evidence is all but absent (Stenton 1971, 283). In Anglo-Saxon charters for the locality (Sawyer 1968; Barker 1947-9) mention of pannage is absent; in Domesday, in the Battle Abbey estate records, in the Parliamentary Surveys of 1649-53, and in the Ashburnham estate records, evidence is slight in the extreme (King 1971; Darby 1977, 149-54 & S.P.J.Harvey 1976, 195-9; Searle 1974, 57-8 & pers. comm. ; Daniel-Tyssen 1871-3; F.W.Steer 1958). There are c. 6 'den' placename elements in the study area (Fig. 1: O.S.1:50000 scale), including one, Cooden and its wood, 1-4 km. from the pollen analytical sites; Brandon's work on Wealden place-name elements yielded a preponderance of 'pig' elements (Brandon 1978c, 145-6).

Witney has declared that pannage was a 'primary and prolonged use' of Wealden forests (lasting up to 8 centuries), with a density of 1 swine per acre or so (Witney 1976, 13, 97-8, 162). It is now an established traditio in regions of Spain(Parsons 1962, 211-35). This discussion is at a remove from precise source data. The capacity of swine to modify vegetation is widely reported :- wild swine introduced to the Gray Beech Forest (U.S.A.) rapidly eliminated many elements in the herb and ground layers (Bratton 1975), and herds of wild swine in Polish forests affected sapling growth (Jezierski & Myrcha 1975). These are swine in free forage. This practice is not well recorded as it has not been the subject of custom and charter. Yet as early as the Seneschaucy, a C13th treatise on land management, the swineherd was to loose his swine on 'forest, wood, marsh and waste' (Oschinsky 1971, 285); in the Parliamentary Surveys of 1649-53 pannage (sic) was available for 6 swine in Northeye marsh, central to the eastern Levels. The direct equation of 'pannage' and 'forest' so often made (King 1971; Darby 1977; Searle 1974) is refuted. It is not easy to extricate the two practices, but in Sussex a debate on the proper place for swine, the pigfold or the waste, recurs (Markham 1637, 126-36; anon.-'The Complete Grazier' 1767, 166; A. Young 1813, 381-90). Swine are plainly an extremely potent agent in vegetational change, yet in Sussex their prolonged presence in numbers large enough to be influential has not been proven, though is here suggested. A prolonged and sustained diet of mast &c. may feasibly lead to eventual local extinction of the parent plant.

Documented mention of pig-grazing in the study area is highly fragmentary and scanty. It often has a nebulous significance ascribed to it. Using presnt-day analogy, a perspective on the potential ecological impact of swine in medieval times is gained.

IV-E. Accordances and discordances in the evidence: Questions asked of the entire record. Spatial analysis, its potentialities and problems.

The context for this discussion appears in Fig. 33. It has been argued throughout this thesis that the various methods used in the reconstruction of historical vegetation are, in terms of the present study at the very least, seriously flawed. This has been well shown by the gross disparitie and incongruities in the data assembled (IVA-D). Yet throughout the evolution of this thesis, methods and approaches were being examined and developed with a view to implementation, were the data tested and found amenable. These are termed in toto spatial analysis.

As the present programme of study was conducted by a geographer, and as spatial analysis is the end of much modern geographical research, the spatial analysis which was proposed will now be outlined. The stages were to be:-

1 a clear, primary circumscription of the area for study. This has been accomplished (I-B).

2 the preparation of distribution maps of "centres" of types of land-usage at key times in the past.

3 the formulation of models of site territory and, drawing on data on the dynamics of vegetational change, the site catchment was to be analysed. The documentary record, supplemented by the contemporary archaeological record, was to be used. Notional catchments were to be delimited, with intensified treatment for the Battle Abbey and Ashburnham estates.

4 hierarchical weighting of the influence of all identified sites related to distance from the pollen analytical sites within the framework of formal distance-decay modelling (after P.J.Taylor 1975).

5 testing of the distance-decay models by multivariate analysis until a satisfactory representation of reality was achieved.

The two blocs of data may only have been rated each against the other through the nexus of dating key points or phases. Key points in the physical record were:- i) the uppermost strata taken to represent, say, the last centuries or so, and the radiocarbon dates at ii) 490 ± 50 B.P. and iii) 480 ± 50 B.P. Key phases precede and separate these key points. Key points in the documentary record were:- a) the Ordnance Survey mapping of this century and the latter half of last century (in particular the mapping of land-use. Harley 1979) (Because of close similarities, these are grouped together) b) the Tithe Award mapping for the 12 parishes of the study area dated c. 1839-59 (see Figs. 29 & 24) c) the composite mapping of extractions from the woodlands of the Ashburnham date c. 1800 (Fig. 23) d) an amalgam of the Parliamentary Surveys of 1649-53, the Valor Ecclesiasticus and a succession of maps of progressively improving detail and accuracy dating from the late C16th to the early C18th (See Fig.26. Increasingly detailed depiction of land-usage is paralleled by increasingly detailed notation of settlement). This last was to be augmented by the uniquely complete list of ironworks dated 1574 (Cattell 1979. The 9 works annotated on Fig. 3). e) the Domesday Book data, together with the loci of settlement suggested by the distribution of churches at the close of the Anglo-Saxon period (Darby 1977; Darby & Campbell 1971; Darby & Versey 1975. H.M.Taylor & J. Taylor 1965; E.A. Fisher 1970; Aldsworth 1978; Kirby 1978). An exemplary study was that on the spatial pattern of land-usage in the Vale of Pickering, c. 1300 A.D. (Wightman 1968. Its dependence on place-name evidence is however to be regretted.)

It was intended that all these individually dated records, related to the state of vegetation and land-usage at the time, may be intercalated, with temporally adjacent records rated one against the other. A synthesised history of local ecology may then have been produced.

The distribution patterns of "centres" of types of land-usage at the dates set out above (a-e) would then be taken forward and weighted for impact. Models of site territory and site catchment analysis were held in mind (after Higgs & Vita-Finzi 1972 & Higgs 1975, recently applied by Parkington 1981; reviewed - G.Isaac 1981), and, in particular, the "model of an Iron Age society and its settlement", strictly a site catchment analysis of a part of the Somerset Levels based on archaeological data (D.L.Clarke 1972. This is considered to be an area of marshland similar in nature to Pevensey Levels.). Tentatively, it was felt that this last model may be adapted for use on documentary data from the Pevensey Levels area.

These projects were rejected for many reasons. The rationale for this rejection will now be discussed. The progressive encroachment of man upon woodland is central to the interpretation of most post-Mesolithic pollen diagrams. A recent seminal review (K.J.Edwards 1982) has noted that "there have been few examples of an explicit acknowledgement of the importance of space in anthropogenically-orientated palynology", with clearance phases only vaguely described. There is a paucity of studies on pollen dispersal in analogous sites (op. cit.5). The process of clearance is scarcely known. Locally phases of clearance are not clearly manifest in the pollen record until after the latest radiocarbon date (480 ± 50 B.P.). Accounts of the area cleared in toto and, it is postulated, at least as significant, the area of units produced and the nature of the intervening barriers (see App.10), are characteristically absent. (Edwards' concept of the "woodland edge" clearly implies a "frontier". Such a marked contradistinction is not substantiated.) The uppermost pollen spectra indicate a near dominant woodland component, yet the maps of the C19th evidence an interspersal of numerous small units of land-usage (usually <10 ha. with the exception of woodland, and the Levels. The pattern of the woodland with shaws and hedgerows "in the field" is incompletely depicted in Ordnance Survey maps. Cleared land is to a substantial degree inapparent in the pollen record.

The poor correlation between the taxa and growth-forms present in the woodlands and those manifest in the pollen record from c. 1400 to c.

1900 has been fully discussed (IV-C-i). The "faggot" category exceeds all in volume; its composition as regards species and growth-form is scarcely determinable. The detailed distribution of woody vegetation in minute pockets and belts is not known; even if from named woods, these may not often be located (Fig.23), and if not, tend to be entered in accounts *en masse*. Such sites free of the 'damping effect' are likely to contribute disproportionately high values of pollen (II-C-iv-a; App. 10)

Thus, the most stable and enduring formation of vegetation, and category of land-usage, comprising few major taxa - "woodland" - may, when surveye on the ground or as extracted, scarcely correspond to the pollen record. Much has already been made of this (IV-C-i). For various reasons, all the other formations of vegetation and categories of land-usage have, considered separately, a faulted representation in the pollen record (IV-C A pattern of interspersed types of land-usage, each with faulted representation, it follows, comprehensively distorts the pollen record. This problem is the polar opposite in time to that of the "woodland edge" (perhaps better called the "frontier of clearance") discussed by Edwards (K.J.Edwards 1982). Where he attempts to model the effects of discrete settlements in a forested *terra incognita* employing present-day studies of pollen dispersion, the attempt is here made to relate the recent pollen record to landscapes that have been documented in detail by means of retrospective studies.

The reasons set out above, it is judged, invalidate the rating of the documented and physical records in any throughgoing, quantified manner. Spatial analysis was felt not to be feasible.

Particular instances may assist; attention has been given in this and other works (App. 9-1; Reviews: Hammersley 1973 & Tebbutt 1981) to the supposedly cataclysmic effect of fuel usage by the iron-smelting industry on Wealden woodlands, including the study area. A brief note will be made on the likelihood of such phases of iron-smelting being manifest in the pollen record. The distribution and nature of the industry in the C16th and C17th is fairly well known. The nearest ironworks to the pollen analytical sites is Panningridge in Penhurst, *c.* 6 km. away. Its duration of operations there was at a maximum of *c.* 50-60 years (Crossley 1972). Its fuel uptake of coppicewood shown in the furnace accounts (Crossley 1975b. The actual figures are abstracted; App. 9-1), at the usual coppicing frequency, permits us to discount this ironworks as a heavy depredatory imposition on woodlands likely to be evident in the pollen record. Other more distant, small yet less well known, ironworks would seem unlikely to be evident also; most of the 9 works of the study area (Cattell 1979; Fig. 3) are at a distance of 8-12 km.

An earlier phase of iron-smelting in Romano-British times is represented by two excavated sites, at Beauport Park, by Battle, and Crowhurst Park, in Crowhurst (Straker 1931a; Peacock 1977; Cleere 1978; Brodribb 1979 & 1982). Despite their peripheral position in the study area (at 10.5 km. and 9 km. distance from the pollen analytical sites; Fig. 3) the waste on-site was substantial; the former had "upwards of 100,000 tons of slag" which made up the biggest Roman slag heap in England (Brodribb 1982, 177). This slag has largely been removed for road-mending. The dating of long-removed slag is questionable and the duration of operations is not known, yet such a volume suggests great usage of wood (speculatively over a million tons.). Yet (any) woodland management, and wood consumption, both volume and rates, are unknown. Such ironworking is not evident in the pollen record; this may reflect delimitation of an over-extensive "working" pollen catchment and study area.

Iron-smelting, and other industries (App. 9), have been discounted from consideration in the above issues.

In all, the desiderata necessary for a staged spatial analysis (2-5 above) were absent: Full analysis was therefore reluctantly discounted.

IV-F. Summary evaluation of techniques used in the study, and suggestions for their development.

The crux of this study has been to obtain, interpret and evaluate data on vegetational history from diverse physical and documented sources. Such a range of sources has exceptionally been treated with stringency, for a locationally circumscribed study area. Developing this, the techniques used were evaluated in their application to the study area, in the usefulness of the resultant data and, primarily, in themselves. Proceeding from this, it is hoped, in a sceptical and cautious manner, the evidence *in toto* was consolidated and evaluated.

Major themes in local ecological history were drawn out, and particular critical reflections were made on the techniques used (IV-C,D,E). Yet a thoroughgoing synthesis of local ecological history was precluded. This would have taken the form of a reasoned and reciprocated evaluation of evidence from all sources used. A multi-stage spatial analysis was necessitated. This was not feasible for reasons detailed in IV-E. Similarly, a single narrative history was not felt permissible; this would entail the suppression of much necessary qualification and discussion.

Yet this research, in the light of all these considerations, prompted reservations in the author's mind. It is now proposed that the author's major reservations as to techniques and methods used, and the quality of the resultant data - as it elucidated the history of vegetation and land-usage - be made explicit. All reservations have been fully discussed in the appropriate sections above, and evidenced in the reciprocated testing of method against method, and results against results.

(i) Pollen analysis

a. there is a serious shortage of long-term studies of pollen production and transportation *in vivo*. In characteristically anthropogenised vegetational formations, which have made up the greater part of the English lowlands over the past *c*. 5000 years, this is considered highly regrettable.

b. there is a serious shortage of work on differential preservation, in the medium- and long-term, related to diverse taxa and diverse environments.

c. there are serious problems with unrefined identification of pollen taxa, most particularly "herbs of dry land". A vast range of habitats is represented in these agglomerates, and many workers have interpreted these as representing crudely engrossed, anthropogenised habitats. This underlines point a.

d. there is an absence of dependable weightings for the pollen productivity of prolific non-forest-forming taxa, and for all taxa, taking account of environment - physical, biotic and (yet again) anthropogenic. Low growing plants <u>en masse</u> (IV-C-ii) and cultivars (IV-C-iii) are particularly poorly served in this respect, and problems of their dispersal and representation are, upon scrutiny, more intricate than it was supposed.

e. The speculativeness of the act of reconstruction of historical vegetational formations is acknowledged. Godwin's tenet that this technique permits only palaeoautecological interpretation is well known and spoken of; yet as an issue it is skirted by pollen analysts at least to some degree. Here the evidence vindicates the speculation; all other reservations proposed here, however, confuse a confident judgement.

f. the ignorance (in the corpus of methodology, and in the customary procedure of interpreting pollen diagrams) of provenly extensive and long-enduring management techniques, in particular coppicing but also pollarding. Arguments, that coppicing sustainedly inhibits flowering in extensive tracts of particular species, have been put forward (IV-C-i). Inter-specific differentials in pollen representation under coppicing cycles are proposed and discussed.

This last has been a major contribution of this work, in its reflection and elucidation of a critical shortcoming, a quite literal stunting, in the technique, practice and value of pollen analysis in historic and prehistoric England. All other points (apart from b) have had some measure of elucidation made by this work.

There have been three particularly local difficulties :-

g. the erstwhile shortage of base-data for lowland England, and in particular the south-east, and also for particular geological formations of a reputedly distinct ecological history.

h. the problem of filtration out of herb pollen by shaws and dense hedgerows. There is little data on the number, location and impassability of shaws in the past. The extent of such filtration can never be ascertained though a small field experiment suggests it to be most significant. The County Report to the Board of Agriculture for Sussex noted shaws as common; this and other County Reports strongly intimate that such filtration of pollen in the past may have been common and widespread.

i. the impossibility, within the time strictures of postgraduate research, to obtain a number of radiocarbon dates, then being conducive to Pollen Influx Analyses. The values of P.I.A. are fully appreciated, yet the heterogeneous nature of upper Levels deposits and the very different emphases in this investigation would have served only to dissipate (<u>sensu</u>, waste and disperse) efforts.

(ii) Macrofossil analysis.

Shortcomings of this technique, highlighted in this study were :-

a. biases to wood of the Levels, and to wood and charcoal on archaeological excavations. There are imponderable differentials in preservation.

b. inexplicit and unsystematic sampling techniques used in the past. The present "sampling strategy" was somewhat invalidated by the occasional and accessible nature of the "finds".

(iii) Surveys of present-day vegetation. Shortcomings were :-

a. that of necessity, it was a cursory and preliminary study.

b. that there was not necessarily any continuity in many species and vegetational formations over a period when formal management of woodlands has locally ceased, and agricultural practices have greatly changed. The vegetation surveyed was spatially and temporally incontiguous with the consolidated pollen-bearing deposits.

(iv) The Botanical Record

This was preoccupied with catalogues of species, rarities and local varieties, and only superficially withabundance, and geographical and ecological distribution.

(v) Sedimentary Stratigraphy

A suite of techniques was used to supplement other physical data. The techniques applied, while usefully establishing particle-size composition, the clay and non-clay minerals present and, broadly, their relative importance, and their geological and geographical sources, did not allow precise quantification; neither would this be of great use in this study. The qualifications and approximations inherent in these techniques were noted, but no particular difficulties were encountered. Reservations are held as to the translocation within the stratigraphy (potentially affecting radiocarbon dating, pollen spectra and the distribution of finer inorganic particles) and the truncation of the deposits (by excavation of the uppermost marsh deposits for turf, deep ploughing and "pare and burn") and their contamination by treatment with sleech, fresh-water mud.

Turning to the documentary evidence:-

(vi) the crude equation of type of vegetation and land-usage pervaded all sources of documentary evidence. The utilitarian, engrossed and anthropocentric description of vegetation (in nomenclature of plants and vegetational formations) prevailed paramount. This is seen as a most serious fault, greatly obscuring diversity in species and growth-forms, in vague and aggregated terms. A gross instance of this was noted in historical descriptions and reconstructions of the state of the Levels in medieval times (IV-D-i).

(vii) Considering "extents, maps and surveys", these were characteristically discontinuous in time and incomplete in space; yet they progressively improved in accuracy, quality and detail up to the present day (subject to point vi).

(viii) Considering "extractions", these were almost always classed by end-use, which allows inference as to growth-form, but mainly mere surmise as to species. This, above all, was the case for the major end-use for the entire period of study, fuel in the form of faggots and firewood. However, much reasoned argument as to species present was made from treatises, narrative accounts, and surveys of present-day vegetation.

(ix) In addition, it was not until the last two centuries of the study that any "extraction" could be ascribed to a clearly delimited, refined area of land "on the ground": After that, it was possible, but rarely to a plat or panel within a wood. At this time it was feasible to equate, retrospectively, extractions from, and the composition of, woodland (IV-D-ii) and consider the act of clearance (IV-D-iii). The topics which the documentation introduced, it rarely gave full account of (See also IV-D-iv).

(x) There was a bias towards extant archives of great aristocratic and ecclesiastical estates, which need not represent the land, land-usage and rural economy of the study area as a whole.

(xi) The secondary sources consulted were never directly concerned with vegetational and ecological history; they may be summed up as the short-term and location-diffuse histories of subsistence gained from the fields, within the societal milieu.

The gist of these shortcomings may be summed up: Spatial and temporal incompleteness and a questionable representativeness of sampling, and of quality in inference and conjecture.

In resumé, both sets of sources suffer from being unidisciplinary (and introspective and anti-integrative by nature); while the end result of one has typically been "a pollen diagram from....", with <u>in vitro</u> "analysis" of spectral changes (and supplementary "broad-brush" archaeological bolstering), the other has taken the form of broad, generalised chronologies of "advances in" and "retreats from" cultivation, where the nature of plant life "everyone knows" (the author's quotes).

All the techniques when used separately were found wanting, and the results if used singularly, would seriously mislead as to the vegetation present, its species composition, growth-form, extent, distribution, abundance, and usage by prehistoric and historic "societies". With the data integrated, however, a rounded, "near-quantified" local study of historical ecology has been expounded, considering ecosystem dynamics (biotic and anthropogenic factors present over time). It is hoped the study forms a "seed-ground" for regional synthesis, longitudinal extrapolation, and above all methodological development. The methodological development which the author proposes to concentrate upon entails intensification in the scale of preoccupation, over space and time. The work of Bradshaw has been a model for this (Bradshaw 1981a & b; Bradshaw et al. 1981) where intensification of all aspects of studies of pollen representation bore fruit. It is intended to amplify aspects of the present study, particularly those related to sustained and prolonged management of woodland. A proposed study area is a farm, Catsfield Place, Catsfield parish; it has been surveyed frequently at dates in the C18th, C19th and C20th. Shaws, hedgerows and woodland were mapped in detail. The number of years since the last cut is always stated. Pits of varied ages, dug for clay, are marked; these presumably collect pollen from the immediate vicinity and directly manifest particular woodland management practices. These practices may be ascertained, and amplified from the writings of the naturalist, William Markwick, who lived at Catsfield Place (Steer 1962 & 1968; in White 1887; catalogue of Markwick's papers lodged at Hastings Museum.). It is hoped that such a study would nest within and further test, validate and develop the present study.

KEY: STATUS INTERPRETED FOR EACH TAXON

1 CLOSED CANOPY FOREST (by far greatest contribution from canopy tree layer. Other layers minor)

2 OPEN CANOPY AND SUCCESSIONAL FOREST (contributions esp. from canopy tree, smaller tree and shrub layers)

3 "HEATHLAND" (contributions esp. from low shrub layers)

4 "LAWN VEGETATION" (contributions esp. from field layer, whether or not continuous)

5 CARR AND FLUSH VEGETATION

6 "OPEN MARSHLAND" (contributions esp. from field layer)

Fig.30A Vegetational status proposed for the taxa in the pollen record

Fig. 30B

STATUS PROPOSED FOR EACH TAXON (proven as pollinating, freely dispersing, individuals) IN VEGETATIONAL FORMATIONS RECONSTRUCTED FOR STUDY AREA (sources : below)

DRY-LAND TAXA

AP	MAJOR	MINOR
QUERCUS	1	2
BETULA	2	134
CORYLUS	2	13
ULMUS		12
FRAXINUS	2	14
PINUS	2	13
TILIA	1	2
FAGUS	1	2
ILEX	2	1
TAXUS		12
CARPINUS	2	1
HEDERA	2	14
JUNIPERUS		23
CASTANEA	2	1
ACER	2	1

NAP	MAJOR	MINOR	
GRAMINEAE	34		
CARYOPHYLLACEAE	4		
CHENOPODIACEAE	4		
HELIANTHEMUM		4	
ARTEMISIA	4		PRESENT IN
COMPOSITAE TUB.	4		ALL FORMATIONS
COMPOSITAE LIG.	4		ESP. 2,3,6
LABIATAE	4		
PLANTAGO	4		
RUMEX	4		
RANUNCULUS	4		
THALICTRUM		46	
FILIPENDULA		46	
ROSACEAE	24	36	
UMBELLIFERAE	4	236	
ERICACEAE	3	24	
TRIGLOCHIN		6	
CEREALIA		4	
LINACEAE		4	
CANNABIS/HUMULUS		246	

LOCAL (LEVELS) TAXA

AP	MAJOR	MINOR
ALNUS	5	16
SALIX	5	236

NAP	MAJOR	MINOR
CYPERACEAE	6	45
GRAMINEAE-PHRAGMITES	6	45
LESSER AQUATIC TAXA	6	5

SPORIFEROUS TAXA

PTERIDIUM	3	24
POLYPODIUM		124
FILICALES		145
OSMUNDA		15

MAIN KEY: ON NEXT SHEET

TAXA LISTED IN SAME ORDER AS ON POLLEN DIAGRAMS

SOURCES: ON NEXT SHEET

Fig. 30C

SOURCES FOR PROPOSALS AS TO THE STATUS OF EACH POLLEN TAXON

DRY-LAND TAXA

AP

QUERCUS	1 - 4, 5(59),6
BETULA	1 - 4, 7
CORYLUS	1 - 4
ULMUS	1 - 4
FRAXINUS	1 - 4,5(61)
PINUS	1,2,4,5(68)
TILIA	1 - 4,8
FAGUS	1 - 4
ILEX	1 - 4
TAXUS	1,2
CARPINUS	1,2,4,9
HEDERA	1 - 4
JUNIPERUS	1,2,10
CASTANEA	1 - 4
ACER	1 - 4,5(44)

NAP

GRAMINEAE	1 - 4
CARYOPHYLLACEAE	1 - 4
CHENOPODIACEAE	1 - 4
HELIANTHEMUM	1,2,5(56)
ARTEMISIA	1 - 4
COMPOSITAE TUB.	1 - 4
COMPOSITAE LIG.	1 - 4
LABIATAE	1 - 4
PLANTAGO	1 - 4,5(64)
RUMEX	1 - 4
RANUNCULUS	1 - 4
THALICTRUM	1 - 4
FILIPENDULA	1 - 4
ROSACEAE	1 - 4
UMBELLIFERAE	1 - 4
ERICACEAE	1 - 4,5(60),11
TRIGLOCHIN	1 - 4
CEREALIA	1 - 4
LINACEAE	1 - 4
CANNABIS/HUMULUS	1 - 4

LOCAL (LEVELS) TAXA

AP

ALNUS	1 - 4,5(53),12
SALIX	1 - 4

NAP

CYPERACEAE	1 - 4
GRAMINEAE-PHRAGMITES	1 - 4,5(72)
LESSER AQUATIC TAXA	1 - 4

SPORIFEROUS TAXA

PTERIDIUM	1 - 4,13
POLYPODIUM	1 - 4
FILICALES	1 - 4
OSMUNDA	1 - 4

GENERAL WORKS

1 – Tansley 1953
2 – Clapham, Tutin & Warburg, 1962, Local Floras
3 – Roper 1875
4 – Wolley-Dod 1937
5 – "Biological Flora of the British Isles" (1944 – 1980:year bracketed)
6 – Morris & Perring 1974
7 – Kinnaird 1974
8 – Moore 1977
9 – Christy 1924; Salisbury 1916
10 – Ward 1973
11 – Gimingham 1972
12 – Tallantire 1974
13 – Watt 1940, 1972, 1976. Page 1976. Rymer 1976

Fig. 31A: MASTER SCHEMA FOR THE EVALUATION OF ALL DATA ON VEGETATIONAL FORMATIONS

NAME OF VEGETATIONAL FORMATION RECONSTRUCTED FROM PHYSICAL DATA	CONSTITUENT SPECIES: - OF MAJOR IMPORTANCE	- OF INTERMEDIATE IMPORTANCE	- OF MINOR IMPORTANCE	NAME OF COMPARABLE 'LAND-USAGE CATEGORY' RECOGNISED IN DOCUMENTED DATA	CONSTITUENT SPECIES: - OF MAJOR IMPORTANCE	- OF INTERMEDIATE IMPORTANCE	- OF MINOR IMPORTANCE
1. 'closed canopy forest'	oaks (PR.M.VS.BR)	beech (PR?M.VS)	ash (PR.VS) elms (PR) limes (PR) Scots pine (PR.VS) Spanish chestnut (PR.VS) sycamore (PR.VS)	1. woodland	oaks (BAER. IA! AER!WRM) beech (BAER.IA! AER) hazel (BAER!AER! WRM) thorns (BAER? AER?)	ash (BAER!AER! WRM) Spanish chestnut (AER!WRM) Scots pine (AER. WRM)	willows (BAER.AER!WRM) holly (AER) dogwood (AER) alder (AER.WRM) birch (AER.WRM)
2. 'open canopy and successional forest' (or 'scrub')	birches (PR. M.VS.BR) hazel (PR.M. VS.BR) thorns (PR? VS)	ash (PR.VS) hornbeam (PR.VS) Scots pine (PR.VS) Spanish chestnut (PR.VS) sycamore (PR.VS)	oaks (PR?M? VS)				
3. 'heathland'	ling (PR.VS) bracken (PR. VS)	birches (PR?VS) Scots pine (PR?VS)		no comparable category of land-usage	- species quite without representation in the documentary record apart from rare mentions of heath (BAER. AER)		
4. 'lawn vegetation' (or 'sward')	grasses (PR. VS) a diversity of herbs (PR.VS)			2. marshland	rarely more exact or detailed than such terms as 'grazing', 'pasture' or 'herbage'. Presumably of grasses and a range of herbs. WRM confirm this.		willows (BAER?)
				3. pasture			
				4. arable	above all cereals and legumes		

Fig.31B: MASTER SCHEMA FOR THE EVALUATION OF ALL DATA ON VEGETATIONAL FORMATIONS (continued)

NAME OF VEGETATIONAL FORMATION RECONSTRUCTED FROM PHYSICAL DATA	CONSTITUENT SPECIES: - OF MAJOR IMPORTANCE	CONSTITUENT SPECIES: - OF INTERMEDIATE IMPORTANCE	CONSTITUENT SPECIES: - OF MINOR IMPORTANCE	NAME OF COMPARABLE 'LAND-USAGE CATEGORY' RECOGNISED IN DOCUMENTED DATA	CONSTITUENT SPECIES: - OF MAJOR IMPORTANCE	CONSTITUENT SPECIES: - OF INTERMEDIATE IMPORTANCE	CONSTITUENT SPECIES: - OF MINOR IMPORTANCE
5. 'carr and vegetation'	alder (PR.M) willow(PR.VS)	a diversity of aquatic plants (PR) birches (PR?M)					
6. 'open marshland'	common reed (PR.M.) sedges (PR.M.) grasses (PR!)	a diversity of aquatic plants (PR) and much the same taxa as 'pasture' and 'arable' apart from cultivars (PR!VS)		2. marshland	rarely more exact or detailed than such terms as 'marshland grazing' or 'pasture'. Presumably of grasses, including the common reed, and sedges. WRM confirm this.		
7. hop gardens	hop (PR)			5. hop gardens	hop (AER. WRM)		
8. hedgerow/shaw	thorns and other Rosaceae (PR?VS) hazel (PR?VS); other taxa considered indistinguishable from those of 1 & 2 above	Ivy (PR?VS)		1. park/wood-pasture	a combination of woodland and lawn vegetation. Probably only distinctive taxa would be unusually numerous mature timber trees (especially oaks, beech, Spanish chestnut) (AER. WRM)		

KEY

Sources of physical evidence

PR	Pollen record
M	Macrofossil record
VS	Survey of present-day vegetation
BR	Botanical record

Sources of documented evidence

BAER	Battle Abbey Estate Records
IA	Ironworks Accounts
AER	Ashburnham Estate Records
WRM	Writers on rural matters

Data from each source of evidence may be qualified thus:-

'!' Argued, to the writer's satisfaction as being the case. Discussion in text.

'?' Proposed status is doubtful or uncertain.

Fig.33 Time-scale of major sources of evidence; summary

Arthur Standish fl. 1611 - 5	Treatise - writer on shortage of timber and its remedy	Declared himself well-travelled and informed. Lived in Cambridgeshire or South Lincolnshire	The Commons' complaint (1611) New directions of experience to the Commons' complaint ... for the planting of timber and fire-wood (1614).
Gervase Markham 1568?-1637	A writer of treatises on agricultural and other rural matters	Apparently based mainly on London .	Farewell to husbandry 4th and 7th eds. (1638 & 1676) The inrichment of the Weald of Kent (1660)
John Smith fl. 1633-1673	Treatise-writer who dealt with forestry slightly.	Declared himself to have 30 years experience of forestry. Apparently London - based.	England's improvement reviv'd (1670)
Giles Moore 1617?-1679	A journal-writer, recording in detail the management and output of woods and shaws he owned.	Resident owner of woodland at Horsted Keynes (by Haywards Heath,(Sussex).	The journal of Giles Moore, for years, 1657/8 to 1678/9, edited by R.Bird (1971)
William Blith fl.1649-1653	Writer and propagandist on agricultural affairs	Apparently Midlands - based. Most examples given from Northants.	The English improver improved (1652. 1655 reprint)
John Evelyn 1620-1706	Informed writer & propagandist. Author of 'first important book to be published in this country on forest trees'(Henrey I,101)	Based at Wooton (Surrey) and Deptford(now in London) for much of life.	Sylva, or a discourse on forest trees, and the propagation of timber in his majesties dominions 1st to 5th. eds. (1664; 1670; 1679; 1706; 1729)
John Worlidge fl.1669-1698	Author of 'first systematic treatise on husbandry on a large and comprehensive scale' (DNB) Practical farmer.	Long residence in Petersfield (Hants.)	Systema agriculturae, being the mystery of husbandry discovered and laid open by I.W. (1697 & 1781).

Promotes oak, ash, elm for timber, in response to perceived dearth	Promotes plantation of fuel-bearing wood	Cut of timber - at 20 years; of underwood at 10; of willows and sallow, 3 or 4.	
Dearth of timber	Promotes plantation of oak, ash, elm, beech, chestnut	Cut of timber from the age of 10; by implication smallwood would be, and was cut at younger age without fixed rules.	
Once more, dearth of timber.	Promotes oak, ash, elm as timber.	Cut for timber trees at about 40 years; for underwood (for fuel in particular) 10 years was usual. Willows and sallows lopped every 3 or 4 years (3-7).	
17 or. 18 timber trees counted in his Bromfield Wood. 42 young trees from shaws No species given Small footage of ash, elm.	Steady, substantial output of faggots (No species,'spray', 'bush','billet' and 'hedge'), cordwood and hop poles (the item names oak, ash, withy).	Cut of 'Bromfield Wood' and shaws at 9-10 year intervals. The plots seem all to have been clear-felled and grubbed up.	
Promotes planting of oak and elm. (155-6)	Promotes planting of poplar, willows, aspen, sycamore, maples, ash, 'witchazel'; of quickset for hedges; of ash & willow for in-fill (152-73)	Cut: annually for osiers; at 3,5 or 7 years for willows; at 4 or 5 for hurdle-wood; at 5 or 6 for small poles for hops; etc. (159)	
Promotes oak as timber. Claimed in second and subsequent editions that 'millions of timber trees' and ' infinite others' planted by 'sole discretion' of 'Sylva'.	'Our ordinary coppices' mainly of hazel or birch. Recommends in-fill with ash, sallow (1664,71-3) and these with chestnut and sycamore(1679,146-50. Et seq.).	Cut: at 12 or 15 years if 'of competent growth' but better if older (1664,71-3) but markets, kind of wood, and emergent uses would dictate (1679, 147. Also later ed.)	John Evelyn. A study in bibliophily with a bibliography of his works by G. Keynes (1968). The diary of John Evelyn, by E.S. de Beer (ed.) Vols. 6 (1955).
Promotes oak	Promotes ash, Spanish chestnut, alder for poles	Cut: young coppices at 1, 2 or 3 years; at 12 or 15 years where of 'competent growth' (or 17, or even 20). Depends on nature of ground & market. Timber at 'their perfect age, full growth or best state'. (1781,86-110)	

★B

Moses Cook or Cooke fl.1676-1724?	Gardener to Earl of Essex. Nurseryman	Based at Cassiobury by Watford (Herts). Briefly owned with others a nursery garden at Brompton (Middlesex)	The manner of raising, ordering and improving forest-trees. 1st and 3rd eds. (1676 & 1724).
John Mortimer 1656?-1736	Estate owner and improver. Tree planter.	Long residence on Hatfield Peverel (Essex) estate.	The whole art of husbandry : or the way of managing and improving of land. Vols. 2. 4th ed. (1716)
Batty Langley 1696-1751	Estate improver (theoretical and practical) and landscape gardener	Long residence at Twickenham (Middlesex). Examples given, are mainly from south-east	A sure method of improving estates by plantations of oak, elm, ash, beech & other timber-trees, coppice-woods &c., (1728).
Nathaniel Kent 1737-1810	Land valuer and agriculturist. Wrote and worked on practical estate management	Much of work in and around Norfolk. Briefly bailiff of farm in the Great Park, Windsor. Lived latterly at Fulham.	Hints to gentlemen of landed property. 2nd. ed. (1776)
Arthur Young senior 1741-1820	Prolific writer on agriculture and rural economy. Wrote several 'General Views' of the agriculture of counties	Practical farmer and land improver with mixed success at Bradfield (Suffolk), Samford Hall (Essex), North Mimms (Herts). Well travelled. Secretary to the Board of Agriculture	Rural economy, or essays on the practical parts of husbandry (1770). Editor of and contributor to 'Annals of Agriculture' (1790-1808). The Farmer's Calendar. 8th. ed. (1809)
William Marshall 1745-1818	Authoritative commentator on agricultural matters Great stress on thorough observation and proper practice. A life-long involvement	Exceptionally well travelled in southern England. Managed a Surrey farm, and agent on a Norfolk estate. Ran his own Yorkshire estate.	The rural economy of the southern counties. Vols. 2. (1798). The review and abstracts of the County Reports to the Board of Agriculture. Vol. 5 - Southern & peninsular departments. (1818).

★C

Promotes oak and elm, above all	In-fill as suits the ground. Elm, cherry, poplar, service, sallows recommended (1724,123 & 169)	Cut at 10 or 12 on shallow ground & 12 or 14 on better soil. Oftener, the better (1724,170)	
Promotes a range of timber-bearing species, particularly oak and firs(i.e. pines).	Promotes chestnut, above all for poles. Also ash and willow. For in-fill, any species wished (62-8)	Cut of copplewood observed at from 8 to 20 or 30 years, depending on end-use and in-mix of timber (62-8).	
'Our woods nearly exhausted' of timber. Promotes plantation of all timber species Ornamental bias.	Promotes for underwood only hazel, sycamore, 'withys', 'salleys', willows and 'oziers'	Cut: entirely to depend on 'computations on gain' (26), but 20 years usual for oak, elm, ash, chestnut, 25 to 30 for pine, 35-40 lime. Hazel at 6 or 7. Sycamore similar. Copses at 7 or 8%	
Accepts a dearth of timber,-particularly oak (cites House of Commons committee) (184-7)	Promotes ash, 'long-leaved withe', and on boggyland, black poplar, ash, all sorts of withe for poles; ash, beech, sycamore, maple, hazel for fuel (184-96) . Deprecates pollarding (210)	No time of cut stated.	
Sussex 'custom' of shaws, 2 to 4 rods wide., ubiquitous in Weald .. 'spread with small timber oak' (A. of A. 1789, 179-80, 192-5)	Recommends chestnut, ash, oak, sallow, maple for poles, and oak for timber (A. of A. 1792, 52-8, 451-5).	Cut for poles: at 14 years if from wood, at 11 if from plantation (A. of A. 1792, 451-5). Cut at 12 or 14 years (1809, 33-6).	The life of Arthur Young, 1741-1820, by J.G. Gazley (1973). Arthur Young and his times by G.E.Mingay(1975)
No oak timber in Weald of Sussex suited to shipbuilding, except on large estates (II, 121-2)	Species: oak, birch, alder, willows, hazel, dogwood, ash, rowan, cherry, whiteleaf, chestnut. Ranks: chestnut, ash, sallow, redwillow, birch, maple oak, hornbeam & beech - for poles (I, 210-1)	Cut: to fit out Kentish hopgardens etc., at 12 up to 18 years, and the much increased plantations at 10. (I, 42-8). At Farnham etc., at 8 to 12 years (II, 108-31)	

★D

Arthur Young, jnr b. 1769	Son & protégé of A. Young snr. Was allocated 'Sussex': Researched and produced 'General View ' of its agriculture etc.	A Tour through Sussex, 1793 (1794) General view of the agriculture of the County of Sussex (1813)	Travelled intensively in Sussex over c. 20 years.
William Cobbett 1762-1835	Writer on agriculture & rural economy. Preoccupied with smaller land holdings.	The woodlands (1825)	Based & farmed in Farnham, Surrey. Extensively travelled in Southern England.
John Claudius Loudon 1783-1843	Writer on arboriculture, Horticulture and landscape gardening. Compiler of encylopaedias	Arboretum et Fruticetum Britannicum (1838) Hortus Britannicus(1850) Trees & Shrubs (1883)	Based mainly in and around London.
F. Tallant Not known	Practical grower of underwood at Easebourne Sussex.	Underwood: The planting growth, conversion and sale, thereof (1880)	Lived on small Easebourne Estate. Sound knowledge of Sussex.
Coventry Patmore 1823-1896	Owner & improver of estate with underwood at Uckfield, Sussex.	How I Managed & Improved my Estate (1886)	400 acre Uckfield estate with 170 acres of woodland.
T. Roberts Not known	Practical woodman somewhere in Sussex Weald	In evidence to Royal Commission on coast erosion, the reclamation of tidal lands & afforestation (1909)	A member of the Royal Forestry Society, Sussex Branch. Long-time Sussex resident & woodman.
John Nisbet 1853-1914	Writer on 'scientific & systematic' forestry. Forest scientist	British forest trees & their sylvicultural characteristics & treatment (1893). The forester: A practical treatise .. (with J. Brown, 1894) (1905)	Considered as culmination of 19th century forest science No known local connection.

★E

'Inconsiderable quantity' of oak then standing. On Ashburnham Estate 4000 acres of cõppiced underwood. Full grown Scots pines at Battle Abbey		Ranks underwood for poles: Spanish chestnut, ash, oak willows, maple, red birch beech, white birch, hazel (1794) Same list, without hazel (1813)	At 13 to 17 years; at 14 years in Ashburnham - Battle area; heath broom & newly planted woods at 7 or 8 years. In general, at 11 to 16 years to 10 to 18 depending on soil. Other than this 'no fixed rules' (1794, 261-2;1813, 186-8). Slightly contradictory.	
The range of underwood species set out & dealt with in only general terms		Ash, Spanish Chestnut & hazel, especially promoted.	In species by species account, only rotations for ash (12,15 or 16 years), hazel (10 to 12) and osier (annual) given.	William Cobbett, by J.Sambrook (1973) William Cobbett: A hibliographical account of his life & times by M.O.Pearl (1953)
The range of underwood species set out and dealt with. Uses & applications fully described. Stress on gamut of specialised end uses			At 4 or 5 years if to be used in hoopwork. At 7 or 8 years for hurdles, poles. For oak, 12 to 15 years. For willows 1 or 2 years (1838)	
Only chestnut, ash, alder & willow mentioned as usable & used.		He plants & fills in with chestnut & ash alternatively, and alder in swampy places, in Weald	At 8, 9 or 10 years	
Spanish Chestnut Ash Birch	Oak(scarce: 2 or 3 per acre. 'Comparatively very few well well-timbered woods in Sussex) (29-30)	Filled gàps with: larch, ash, Spanish chestnut, and excluded: willows, dogwood, birch. Planted single pines & cedars in 60 acre park	First cut after 2 years on new plantation;no period of 'normal cut' given (all, 17-26).	The life & times of Coventry Patmore by D. Patmore (1949)
Overview of profitable species: chestnut, oak ash. Also willow and larch. Grows & mainly promotes these.		Noted little woodland in his area converted to high forest.	At 8 to 12 years for all underwood (indirectly). Oak timber at 60, 90 or 120.	
		Rare to plant coppices except for osier holts, game coverts, alder & ash groves (1905 I, 417-8)	Cut depends on the local market but usually from 7 to 12 years for mixed coppice, from 12 to 16 for oak-bark, annually for osiers, from 20 to 30 for alder (1905 I, 339-42)(also noted by Ramaiengar 1907). For coppice woods at 12 to 20 years (1894,179)	'The Duke's Osier bed by the River Thames ....(1907)

★F

1.Writer & 2.Dates	3 Sources: The works themselves (col. 4. & 10.); Henrey's Botanical and Horticultural Literature; Dictionary of National Biography; Who was Who	4 Works consulted: (Full references in Bibliography)	5. Local knowledge connection & experience.
A.D.Hall & E.J.Russell Not known	Agricultural and soil scientists	A report of agriculture & soils of Kent, Surrey & Sussex (1911)	Extensive knowledge of Southern England Based at Rothamsted Experimental Station & Wye, Kent
W.R.Fisher 1846-1910	Forest scientist	Princes Covert,Oxshott, Surrey (1907)	A single study of a Surrey wood.
A.D Webster Not known	Writer on the evaluation of wood as fuel. Forest scientist	Firewoods: their production & fuel values (1919)	No local connection except some experience of an unnamed Kentish estate

Underwood market defunct Ash, chestnut, birch, hornbeam, hazel grow. Ash, chestnut & larch as plantations	Oak 'leading tree' in High Weald. Little regular trade	8 to 16 year rotation (48-52)	
Ash, hazel, Spanish chestnut, thorns, etc.	Promotes ash, hazel & Spanish chestnut; this was in operation		
	Notes oak, ash & beech 'generally preferred' for charcoal (60). Ranks all species on 'heating power' (see text)	10 year rotation for all underwood (19-22)	
Comments on 6. underwood and 7. timber species present. 8. Species promoted and deprecated.		9. Underwood Rotations as described and prescribed (see text)	10. Further References

★H