UNIVERSITY OF READING

THE ENVIRONMENTAL IMPLICATIONS OF ROMANO-BRITISH IRON PRODUCTION IN THE WEALD

A Thesis presented to the Department
of Archaeology in partial fulfilment of
the degree of Doctor of Philosophy

Jaime Kaminski

January 1995

CONTENTS

FIGURES

CHAPTER 1

CHAPTER 2

CHAPTER 6

Figure

CHAPTER 8

Figure

APPENDIX 1

Figure

APPENDIX 3

Figure

ABBREVIATIONS

2 ser.	Second Series
acc. no.	Accession Number
B.A.	Bronze Age
bc	Uncalibrated Radiocarbon date
Brit. ser.	British Series
C.B.A.	Council for British Archaeology
C.I.L.	Corpus Inscriptionum Latinarum
D.O.E.	Department of the Environment
ed(s).	Editor(s)
ESx.S.M.R.	East Sussex Sites and Monuments Record
F.A.O.	Food and Agriculture Organisation
H.B.M.C.E.	Historic Buildings and Monuments Commission for England
H.M.S.O.	Her Majesty's Stationary Office
I.A.	Iron Age
int. ser.	International Series
K.A.R.	Kent Archaeological Rescue
Kt.S.M.R.	Kent Sites and Monuments Record
MS(S)	Manuscript(s)
N.A.R.	National Archaeological Record
new ser.	New series
occ. paper	Occasional Paper
O.D.	Ordnance Datum
O.S.	Ordnance Survey
P.C.B.	Plano-convex bottom
R.B.	Romano-British
R.C.H.M.E.	Royal Commission of Historical Monuments for England
res. rep.	Research Report
R.I.B.	Roman Inscriptions of Britain
S.A.M.	Scheduled Ancient Monument
S.E.I.	Surrey Excavations Index
soc. antiq.	Society of Antiquaries
V.C.H.	Victoria County Histories
S.M.R.	Sites and Monuments Record
W.I.R.G.	Wealden Iron Research Group
WSx.S.M.R.	West Sussex Sites and Monuments Record

ACKNOWLEDGEMENTS

A great number of individuals and institutions have provided considerable help, resources and encouragement during the production of this thesis, not all of whom can be mentioned by name. From the University of Reading special thanks are due to Prof. M. G. Fulford, Dr. R. W Chapman, Dr. G. Astill, Professor R. J. Bradley, Dr. S. Mithen, Dr. T. Durden, Dr. D. Sim, Dr. J. Harding, Ms. R. Morse, Ms. J. Stevens, Ms. N. Finley, Ms. P. Woodman, Ms. K. Mew and Dr. N. Spencer. Considerable help was provided by Dr. M. Keith-Lucas from the Department of Plant Sciences, University of Reading. Without his unfailing assistance the nucleus of environmental research which comprises this thesis would not have been possible. The financial help of the British Academy and the University of Reading is gratefully acknowledged, as is the contribution of the Tebbutt Research Award.

All members of the Wealden Iron Research Group have been unstinting in their help. Their contribution through past excavations and helpful discussion is gratefully acknowledged. Special mention must go to Dr. H. F. Cleere, Mr. J. Hodgkinson, Mrs. M. Tebbutt, Mr. B. K. Herbert, Mrs. S. Broomfield, and Mrs. D. Meades. Other field researchers and landowners have also provided extensive help and advice these include Mrs. G. Jones (HAARG), Dr. A. Woodcock (East Sussex County Council), Dr. E. Okafor (University of Sheffield), Dr. M. Taylor (West Sussex County Council), Major-General G. W. R. Monckton, Mr. W. R. Beswick and Mrs. M. Beswick, Mrs. G. W. Parkes, Mr and Mrs Slynne, Mr Reading, Mr B. Ansty, Professor J. E. Tunbridge, Mrs. M. E. Tunbridge and family. Thanks are also due to Claire, for helping me through it all whilst writing her own thesis. A final acknowledgement must be made to my parents who have provided both financial and moral support throughout the production of this thesis.

ABSTRACT

Re-evaluation of archaeological research in the Weald has significantly altered the distribution of known iron production sites, suggesting that all regions of the Weald were exploited for ore during the Romano-British era. Evidence for Roman bloomery production has been recovered from the Low Weald and the Scarp Foot regions, although the High Weald is still considered the dominant iron production region.

Identification of the charcoal derived from Roman slag deposits in the High Weald suggests that the arboreal environment was heavily dominated by oak; with birch, hazel, and *Pomoideae*-type taxa probably colonising clearings and woodland margins. The exact ratio of taxa is dependent on the local juxtaposition of sub-surface geology, soils, and hydrological regimes. A new methodology, developed by the author to study palynological data from slag deposits, corroborates this.

The acquisition of pollen from such sites represents a new methodology in the study of industrial landscapes. The correlation of this evidence with macrobotanical data suggests that little selection of wood was undertaken, although there is some indication of the exclusion of taxa of the *Salicaceae* family, and to a lesser extent alder. In the context of the Weald, selectivity is seen primarily as a function of species availability in the local environment, and, additionally, the subjective awareness of the properties of the woody materials.

The majority of the charcoal examined was consistent with the use of branch-sized wood, as suggested by age, size, and annual ring structure. The exact meaning of this remains insoluble. Widespread exploitation of smaller diameter wood could have been the product of deliberate management policies on industrial type operations, or possibly the *ad hoc* utilisation of woody regrowth. However, the static nature of many of the large-scale fuel-consumptive industries both in the Weald and around the Roman countryside suggests that management techniques were practised, as opposed to a random utilisation of the woodlands.

The evidence from the Weald does not support the conclusion that the Weald was an impenetrable forest either during, or prior to the Roman era. Such hypotheses are considered to be a function of the nature of the Wealden literature and the inherent perceptions which derived from such sources.

CHAPTER ONE

INTRODUCTION

INTRODUCTION

THE HISTORY OF PREVIOUS RESEARCH

1844-1899

The accepted origin of the study of the Roman iron industry in the Weald came in 1844 with the discovery of the extensive industrial site at Old Land Farm, now called Oldlands, East Sussex. The discovery was prompted by the realisation of the Reverend Edward Turner (1794-1872), of Maresfield, that ceramics associated with iron slag being utilised for road metalling in his parish were of Roman origin (Bell-Irving 1903: 166-7, Dalton 1983). Tracing the iron slag to its source, at Old Land Farm, revealed extensive evidence of Romano-British occupation in conjunction with industrial activity. The dominant feature was a horizon of bloomery slag, representing the waste product of iron production, extending for approximately "six or seven acres" and varying in depth between "two to ten feet." In addition evidence was recovered for stone built structures, inhumation burials and a coin sequence extending from Nero to Diocletian (Lower 1849b: 170-174, Lower and Chapman 1866: 62, 67, Turner, E. 1862b: 158).

The discovery of the industrial complex was brought to the attention of Mark Anthony Lower (1813-1876), of Lewes, the founder and first president of the Sussex Archaeological Society (Campkin 1877: 141-2, Salzman 1946: 5-6). Lower first communicated the news of these discoveries at Old Land Farm at the annual general meeting of the Sussex Archaeological Society in Lewes, on 10

August 1848. A week later, he provided a similar paper at the fifth annual general meeting of the British Archaeological Association in Worcester. The first published material appeared in the British Archaeological Association's volume for the following year (Lower 1849a). This paper, containing additional archaeological and documentary evidence relating to post-Roman iron production sites in the Weald, was subsequently published in the second volume of the Sussex Archaeological Society's collections[†] (Lower 1849b: 170-4, 214). Through these publications, the Roman exploitation of the Weald was brought to the attention of the wider public and antiquarian arenas, and themselves generated significant interest (cf. Yates 1858: 32). The discovery of industrial activity represented a significant development in antiquarian perception of the Weald during the Romano-British era. Prior to this discovery, the apparent absence of Romano-British remains within the geographical confines of the High and Low Weald had led antiquarians to postulate a virtually uninhabited, densely forested region (see Fig 1.1).

"Stretching from the edge of Romney Marsh to the border of Hampshire, the Andredswald, or the Forest of Anderida, occupied nearly the whole space between the North and South Downs, covering about a third of Kent, nearly the whole of Sussex except the seaboard and a considerable slice of Surrey. So

[†] The Old Land farm site continued to attract considerable attention after the publication of this article. A case of antiquities from the site, lent to the Sussex Archaeological Society museum in Lewes, contained additional finds to those recorded by Lower in 1849; these included a coin of Aurelian (A.D. 270-275), a bronze head, and an iron scale beam (Lower and Chapman 1866: 67).

densely wooded was this district, that the Roman roads avoided it; the way from Chichester to London, for instance, passing through Southampton ... it remained for centuries after the adjoining parts had become subject to Roman civilisation, a *terra incognita* to both rulers and ruled" (Browne 1884: 126, quoting *The Spectator* of 15 February 1879).

The concept of the primeval Weald has remained until recently a recurrent theme in literature about the Weald, even with the accumulation of discoveries of and evidence for Roman industrial activity in the area. This provided a marked contrast to the Victorian perceptions of the nature of woodland exploitation in the other known region of Roman iron production in the Forest of Dean. From an early date, this area was known to be an area of significant ferric exploitation (Nicholls 1860: 236-7, Wright, T. 1852: 37).

By the time Andrew Yarranton wrote of the Forest of Dean in 1677, the extent of the Roman industrial activity was widely known. He noted that "in the Forest of Dean and there abouts the iron is made to this day of cinders, being the rough and offal thrown by the Romans ... there are great and infinite quantities of these cinders, some in vast mounds above the ground, some under the ground, which will supply the iron works some hundreds of years" (Nicholls 1860: 236-7). This prompted some authors to consider that the Romans used the forests "only for the purposes of utility" (Browne 1884: 9 quoting an anonymous paper of 1853, *English forests and forest trees*).

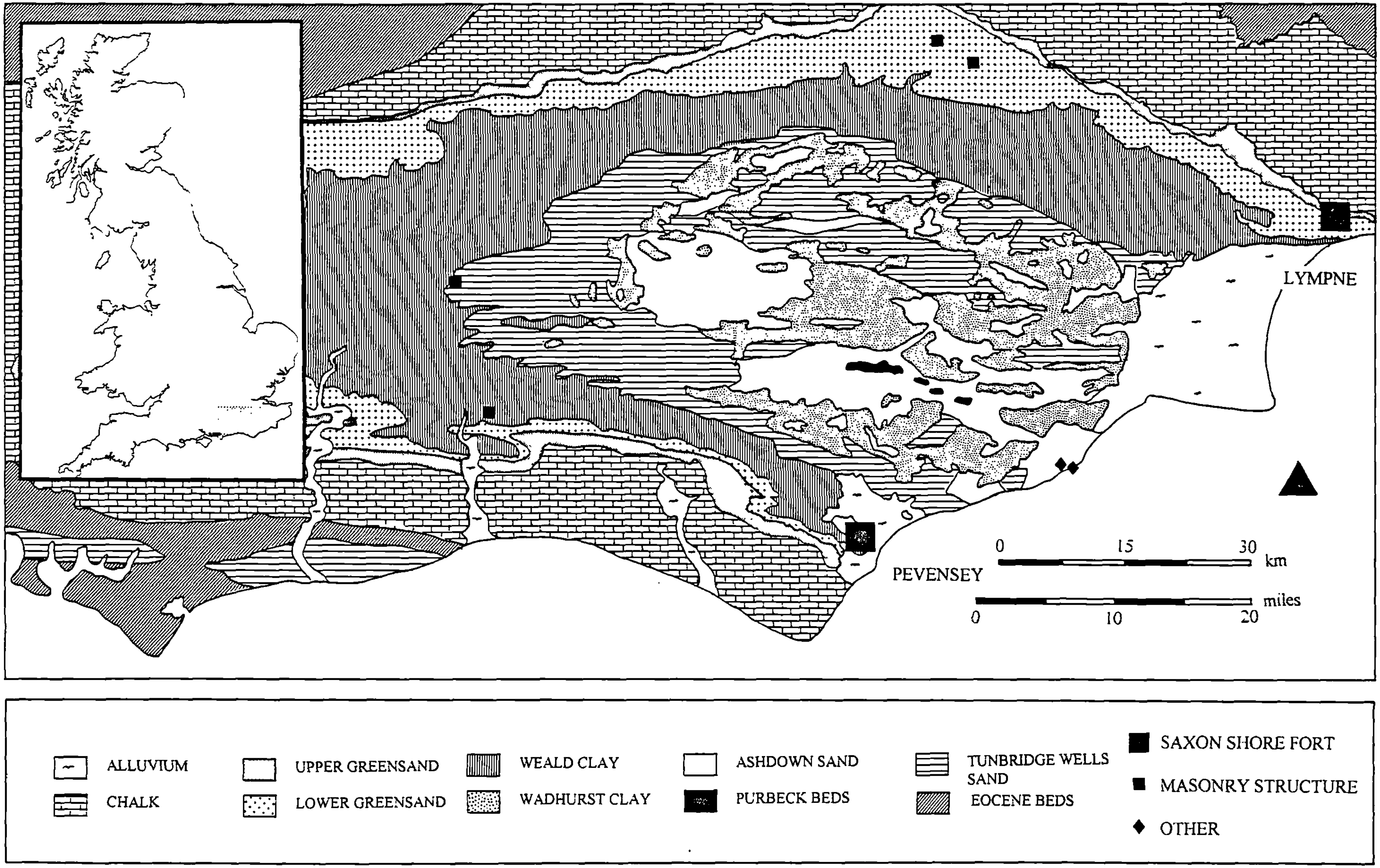


Fig 1.1 The distribution of Roman sites discovered in the Wealden region prior to 1899

Although Old Land Farm was the first Roman iron production site from the Weald to be extensively published it was not the first *industrial class site*[†] to be discovered. Lower alluded to another extensive industrial iron production site, approximately 35 km to the east at Oaklands Park, near Sedlescombe, although the only information he provided related to the discovery of "many Roman coins in a cinder-bed" which were "greatly corroded and some ... burnt" (Lower 1849b: 174). Straker however, records that four years before the discovery of Roman activity at Old Land Farm, a slag bank at Oaklands Farm "thirty feet high" and of unknown extent was destroyed during the removal of road metalling for the construction of the Harrow Inn to Watlington road. Finds collected by Mr. Byner, of Sedlescombe, the County Highways Surveyor, included "six coins of Hadrian and also pottery". In addition brick and tile fragments were recovered from the matrix of the slag deposit, which suggested the presence of masonry buildings (Straker 1931: 329). Romano-British occupation was later confirmed by Combe (1877: 228) who recorded his discovery "among the iron *scoriae* and cinders," at Oaklands, of "Roman copper coins".

In addition to the sites at Oldlands Farm and Oaklands Park, Lower (1849b: 209) also provided a vague reference to a Roman industrial site in the parish of

[†] Industrial-class facilities are those which are considered to have produced in excess of 1,000 tonnes of bloom iron during their operational life. Semi-industrial sites are defined as those which are estimated to have produced between 100 and 999 tonnes of bloom iron during the era of production. Small-scale or non-industrial sites are considered to have produced up to 99 tonnes of bloom iron. These definitions differ to those proposed for industrial and semi-industrial sites by Cleere (1980).

Chiddingly where "*great quantities* of cinders occur in the northern part of the parish, among them pottery, presumed to be Roman has been discovered" [my italics]. This is later elaborated by Lower (1862) in his history of Chiddingly parish. He noted that towards the northern boundaries of the parish, "among the scoriae or cinders of the long extinct iron works, fragments of samian and other Roman pottery have been found" (Lower 1862: 208). Lower also provided another unspecific reference to Roman finds recovered from an un-named slag deposit in Westfield, noting that "Roman coins have been found among cinders in this parish" (Lower 1849b: 174-5, 219). The exact locations of both iron production sites are now lost. As Straker (1931: 383, 329-39) does not record their presence it is possible that they were destroyed in the later nineteenth century. However, it is conceivable that Lower's Westfield site could represent an early reference to the extensive slag deposits at Beauport Park, which were certainly large enough, with prolific Romano-British material culture to come to the attention of local antiquaries, although no further information is available to corroborate this.

The publication of Lower's articles (1849a, 1849b) attracted considerable attention. This enticed antiquarians such as T. Wright to study the newly discovered industrial sites. Wright (1854: 331) extensively recorded the finds from Oaklands Park after the construction of a driveway to Oaklands Park House in 1850, at a time when seven metre high slag banks still remained, even after the depredations of Mr. Byner. Unfortunately the publication of Wright's *Wanderings* *of an Antiquary*, in 1854, did not come to the attention of the Sussex antiquarian community and as a result has not influenced later research.

Although Lower used the *Sussex Archaeological Collections* as a vehicle for the publication of newly discovered iron production sites, his later works (1850, 1866) dealt predominantly with evidence of ferric exploitation from the second major period of Wealden iron production, which resulted from the introduction of blast furnace technology from the Low Countries in the last decade of the fifteenth century. Lower recorded no further Romano-British bloomery sites from the Weald during his lifetime, although his work on previously discovered sites did continue (Lower and Chapman 1866: 62).

Prompted by the work of Lower, James Rock, a historian and antiquarian from Hastings, in Sussex, published an account of two additional industrial class iron production sites at Beauport Park and Chitcombe (see Fig 1.2). The presence of industrial activity at Beauport Park was first documented in 1862 by the Reverend S. Arnott of Hollington (Arnott 1869: 138) who noted the presence of "a large cinder bank, on which grow firs, with ash and oak," although, as the bank was relatively undisturbed at this stage, no dating evidence was recovered. This notoriety was possibly responsible for its subsequent utilisation for the provision of road metalling by Mr. Byner and the county highways department, whose interest in slag deposits began three decades earlier, at Oaklands Park. The extraction began in 1870 and continued for at least a decade (Brodribb 1972: 4, Straker 1931:

330). Prior to its denudation, the Beauport Park complex represented the largest known Romano-British industrial site in the Weald (Cleere 1976a: Table 1, 238). The archaeological evidence from the central site took the form of a large mound of iron slag which extended for "two or more acres" with an elevation of "fifty feet above the surrounding land" at its highest point (Rock 1879: 169). The slag mound yielded coins of Trajan and Hadrian in conjunction with examples of black and red samian ware, and "many fragments of large vessels, of a rough character, of light colour and unglazed," which could possibly be indicative of locally produced East Sussex Wealden wares. No masonry structures were recorded at the time. As with Oldlands Farm, inhumation burials were recovered from the base of the slag deposit (Read 1893: 359). Excavations for metalling in 1877 also apparently produced a cast iron statuette, described as being of Roman origin, found "at a depth of twenty seven feet" (*ibid.*). The debate concerning the authenticity of the statuette (*ibid.*: 360-1; Straker 1931: 336-7, Davies, O. 1935: 58) was not conducive to its alleged Roman origins; however, the onus of blame rested with the labours who allegedly recovered the statuette, and who were thought to have supplemented their income from selling artefacts to collectors with forgeries such as this statuette (Straker 1931: 337)[†].

[†] In view of Dawson's apparent role in the Piltdown forgery (Weiner 1955: *passim*), the forgery of the "HON AUG ANDRIA" tiles at Pevensey Castle (Dawson 1907, Peacock 1973) and the forgery of a map of Maresfield Forge in 1724 (Crake 1912: 279, Andrews 1974: 166), the association between the statuette and Charles Dawson could be significant. Aside from Dawson's propensity for forgery, James Rock (1879: 168-75) does not chronicle the recovery of the statuette from Beauport Park, despite extensive recording of other small finds, including the coin of Hadrian apparently found in association with the statuette (Weiner 1955: 183; See Appendix 1).

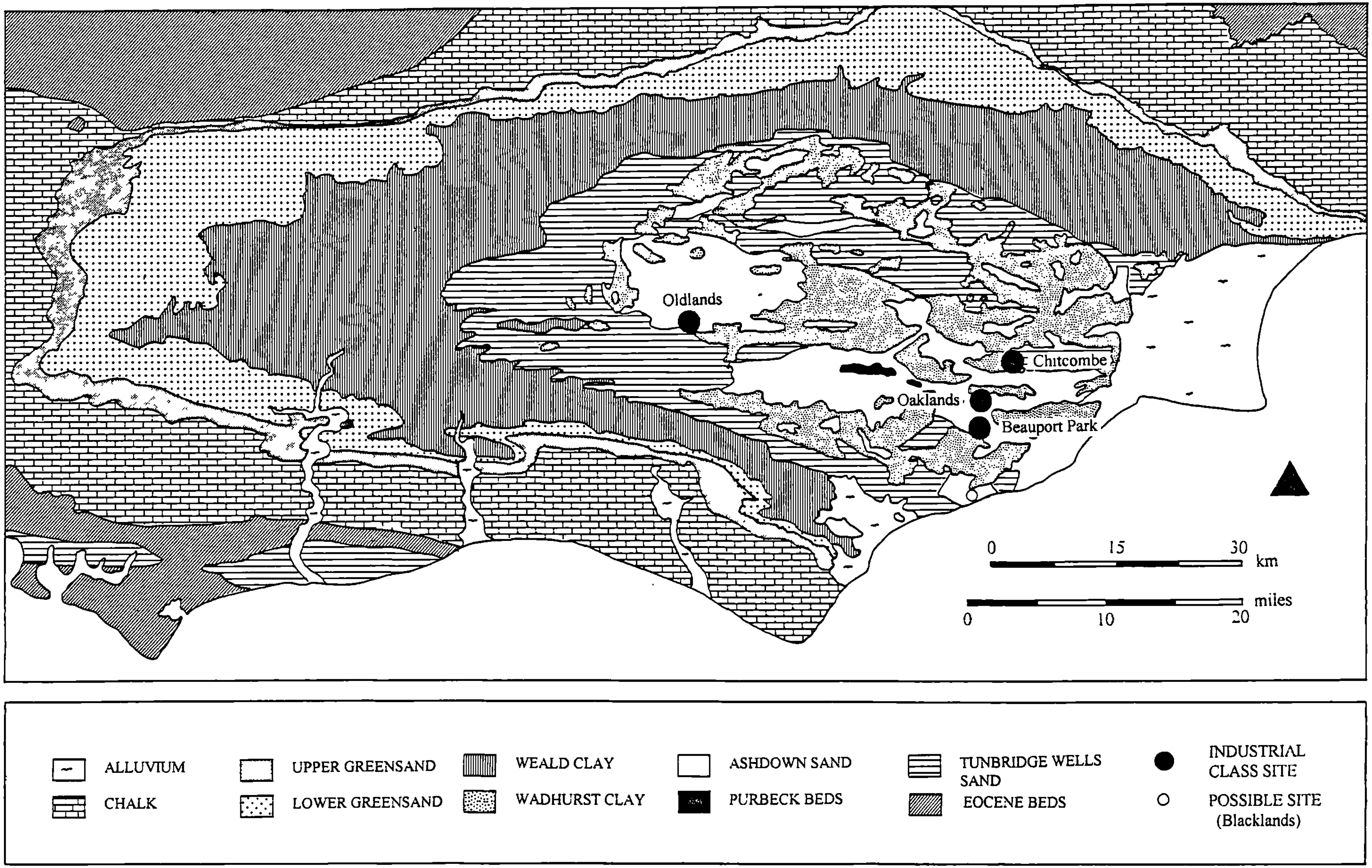


Fig 1.2 The distribution of Roman iron production sites discovered between 1840-1899

The other iron production site, recorded by James Rock at Chitcombe, approximately 6.5 km north-east of Beauport Park, represented the only Hastings or eastern Wealden industrial class site which were not discovered and destroyed by the county highways surveyors as a result of the extraction of road metalling during this early phase of nineteenth century antiquarian study. Although as with all the industrial class slag deposits, small-scale attrition occurred as a result of the removal of slag for metalling and hardcore for local projects such as the construction of the driveway to Chitcombe House (Rock 1879: 175). The slag deposit comprised five principal spoil banks which extended for "about a quarter of a mile," along the banks of the River Tillingham, and rose to a height of "fifty feet above the level of the stream" (Rock 1879: 177). Finds included substantial quantities of brick and tile, a slag-metalled road and an extant wall foundation which was traced for "five or six feet" under a hedge. The ceramic assemblage was dominated by East Sussex Wealden wares, which, compounded by the absence of diagnostic Roman fine wares and coin finds, allowed only the tentative suggestion of a Roman date (Rock 1879: 179). The amalgamation of these discoveries with Lower's previous work contributed to the development of an overall interpretation of the Hastings hinterland as a focus of metalliferrous exploitation and industrial activity in the Roman period. In addition, Rock (1879: 167) made the first intuitive correlation between iron production sites in this coastal region and the utilisation of river and sea-borne transport to move products and raw materials. This point was later reiterated by Tatham, (1890: 148) who considered that the products of Roman iron production sites in the Weald were transported either "beyond sea, or to the large towns of the interior."

The majority of the discoveries of iron production sites in the mid- to late-nineteenth century were a consequence of the need to provide suitable material for metalling to repair roads throughout the Weald. The increased volume of road traffic in the later part of the nineteenth century, between the rapidly growing south-coast towns and both London and the interior, necessitated the resurfacing of roads which, with the exception of some turnpikes, had changed little since the Tudor era (Straker 1931: 84-8). The ubiquitous slag deposits of the Weald provided an ideal source of metalling which was dense, highly resistant to abrasion and available in substantial quantities from discrete locations. However, the resulting diminution of the archaeological record was extensive. This is evident not only as a result of the large-scale extraction of slag such as the work of Mr. Byner, but numerous smaller-scale extractions for local projects which occurred throughout the Weald (Wright, T., 1850: 231, Rock 1879: 175, Straker 1931: 237).

The post-depositional attrition of Romano-British industrial-class slag deposits was relatively high. Slag deposits of Roman origin were preferentially exploited to a greater degree than those of later eras, although blast furnace slag was apparently utilised for local projects (Straker 1931: 237). In addition, blast furnace slag does not tend to be found in the discrete mounds and banks which characterised the Romano-British industrial and semi-industrial class slag deposits, but is often found widely scattered around furnace sites. This could be a function of the use of blast furnace slag in the post-medieval periods for fertiliser on fields. Certainly the sale of "woodashes" and "cole duste" were recorded at Panningridge Furnace in 1548 and 1551 (Tebbutt 1977b: 403). Possibly the vitrified nature of blast furnace slag and its propensity to produce conchoidal fractures and sharp edges under stress was not considered conducive to the production of a good metalled surface, compared to the heavier, denser bloomery slag. Although tap slag is not an ideal material for the metalling of roads due to the difficulty of creating an interlocking surface after tamping down (Herbert 1973), bloomery sites tend to have an amalgam of tap slag and cinder in association with other debris. It is the combination of tap slag and cinder that produces a hard-wearing interlocking surface after tamping down. Certainly the removal of slag from Oldlands, Oaklands and Beauport Park, and the domestic utilisation of other slag deposits (cf. Rock 1879: 175) was apparently not matched by a corresponding utilisation of blast furnace slag.

It is estimated that in excess of 50,000 tonnes of bloomery slag were removed in the course of extraction for both local and regional road metalling during the nineteenth century. Extremely little in the way of documented excavation was recorded, no plans were made, and less than fifty portable finds were recovered and subsequently published, many of which are now lost. These losses of slag and associated socio-economic evidence represented a significant depredation of a finite archaeological resource†. This is comparable to the devastation of Romano-British iron production sites in the Forest of Dean, as a result of re-smelting of bloomery slag in the Tudor blast furnaces (Lower 1850: 248, Nicholls 1860: 236-7, Wright, T. 1852: 40-1). Although it has been suggested by Sweeting (1944: 7) that re-smelting was also prevalent in the Weald, no evidence for such activity has been recorded in a Wealden context (Butler 1973, Straker 1931: 94). Prior to their destruction in the ninteenth century, the major Roman industrial sites remained essentially intact, although heavily pitted by local slag extraction. However, as the original size of the slag deposits remains unknown, this cannot be validated with any degree of certainty. In addition, the large number of furnace and forge sites recorded throughout the Wealden region has resulted in a certain degree of correlation between the distribution of Roman industrial-class sites and later furnaces, such as Cansiron forge and furnace,

† At Beauport Park the County Highways Surveyor estimated removing "from 2,000 to 3,000 cubic yards per annum" over a period exceeding a decade (Straker 1931: 330). Assuming an average of 2,500 cubic yards this would equate to 25-30,000 tonnes of material or 30% of the deposit At Oaklands Park a deposit, estimated by Cleere (1976a: Table 1, 238) to have contained 60,000 tonnes of iron slag, was exploited between 1838 and 1840. Based on the Beauport figures this would equate to a maximum of 9,000 tonnes of material which would explain why Wright (1854: 331) recovered slag banks that were seven metres deep. At Oldlands exploited by Byner after Oaklands Park, exploitation carried on for an indeterminate number of years but possibly in excess of half a decade resulting in the extraction of 10-15,000 tonnes of material. When this is considered in conjunction with other local extractions probably amounting to 2,000 tonnes, a possible total of 56,000 tonnes of slag were removed.

Oldlands furnace in the western High Weald, Crowhurst furnace and forge, and Brede furnace and Westfield forge in the Hastings hinterland, although there is no archaeological or documentary evidence for the exploitation of earlier deposits for smelting at these sites. Bloomery slag was used in construction projects such as dams, such as Batsford furnace (Straker 1931: 360).

THE BIASES OF VICTORIAN EXCAVATION

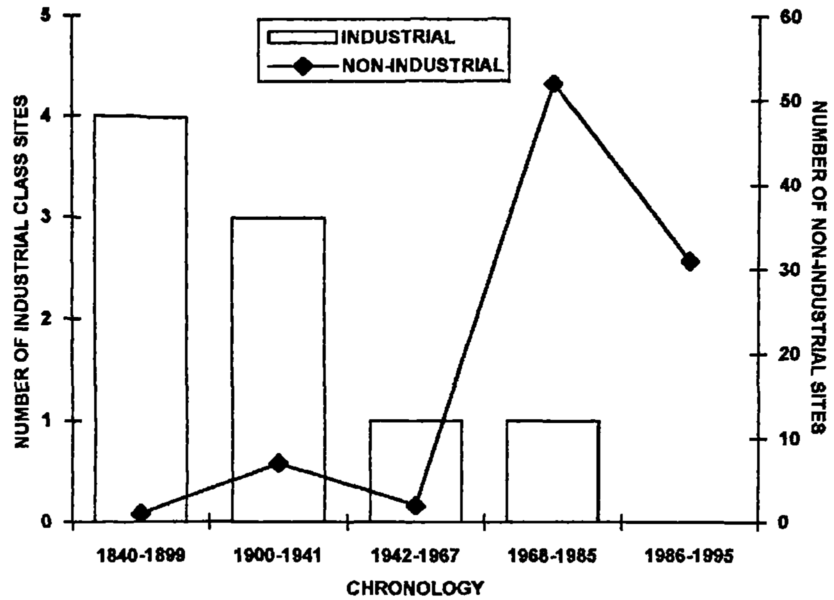


Fig 1. 3 The differential recovery of Roman iron production sites of different classes since 1840.

The elucidation and description of the larger industrial sites formed the primary focus of nineteenth century research. With the exception of the possible Romano-British small-scale/domestic bloomery found at Blacklands, in Hastings (Anon. 1862, Straker 1931: 350), the recording of smaller bloomery sites was a rare occurrence (see Fig. 1.3). This trend was witnessed throughout the excavations of nineteenth century Britain; in the context of the study of the Wealden iron industry this appears to have been a function of several factors. Initially, antiquarian research tended to focus on sites which would provide a wealth of material culture that might then form the basis for private or museum collections (cf. MacLeod 1933, Straker 1931: 337). Smaller sites are less likely to produce ceramics which are diagnostic to distinct chronological eras. The predominant ceramic forms found on sites of all sizes are the local, coarse East Sussex Wealden wares. These have caused problems with dating. It is difficult to distinguish between local Romano-British assemblages and those of the LPRIA (Cleere and Crossley 1995: 298, Rock 1879: 179). Diagnostic Romano-British material such as coins and ceramic fine wares which could provide dating for iron production sites tended to be found more regularly on larger industrial or semi-industrial sites. In addition, smaller sites tend to be poor in both quantity and quality of material culture. By their very nature, these smaller sites tend to have a lower archaeological visibility, which was further decreased by the large percentage of land within the Weald which was under permanent pasture during the Victorian era[†].

[†] This was predominantly the result of the state of peace the country had been under since the cessation of the Napoleonic and Revolutionary Wars. The large numbers of troops who had been stationed on the Sussex and Kent coasts to counter the threat of a French invasion at the beginning of the nineteenth century (Holden 1970, Hudson 1986), were no longer required and as a consequence a major stimulus to the Wealden economy was lost. As a result the Wealden region witnessed a steady growth in the area of land that was under permanent pasture since the cessation of the Napoleonic wars in 1815. This was in conjunction with the simultaneous collapse of corn prices after 1815 which caused the conversion of more arable to pasture (Briault 1942: 498, Dudley-Stamp 1962: 59). This was subsequently aggravated by the repeal of the Corn Laws in 1846. The resultant free trade caused a further decline in arable cultivation in the heavy clay soils characteristic of significant areas of the Weald, which could no longer compete with cheaper foreign grain imports (Briault 1942: 506).

While the study of the distribution of Roman iron production sites remained in its infancy, significant numbers of post-medieval blast furnaces and forges were recorded. Several reasons are evident for this state of affairs. Unlike the majority of non-industrial Romano-British bloomery sites, these sites exhibited a high archaeological visibility. This was a consequence of the extensive manipulation of the landscape which resulted from the construction of dams, hammer ponds, and other earthworks, which were essential for the retention of water necessary for the provision of hydraulic power to run hammers and bellows. As a result the average area occupied by water-powered sites tends to be larger than non-industrial bloomery sites. The need for water power predicated that these operations were carried out in the vicinity of rivers and streams, which has acted as a convenient focus for fieldwork in these areas. The infrastructure of these later sites required buildings of some sort to contain the workings. In many cases these were of masonry construction; this, in conjunction with the more recent period of use, also meant that upstanding stone remains were visible in some cases (Straker 1931: plates on pages 71, 73, 215, 427, 449, 453). By contrast, even Roman industrial-class sites rarely have upstanding, above-ground, remains. The only exception is the wall footing from Chitcombe (Rock 1879: 178-9). This is largely a function of the greater antiquity of Roman remains, in addition to the relative rarity of sources of building stone in the Weald which have made them more prone to robbing. There would probably have been fewer stone buildings as a result of the greater use of timber for construction, even on industrial-class production facilities (cf. Cleere 1970: *passim*). Other evidence for Romano-British industrial activity, such as slag banks and mounds, are usually an integral part of the landscape, which without significant ground penetration remain concealed.

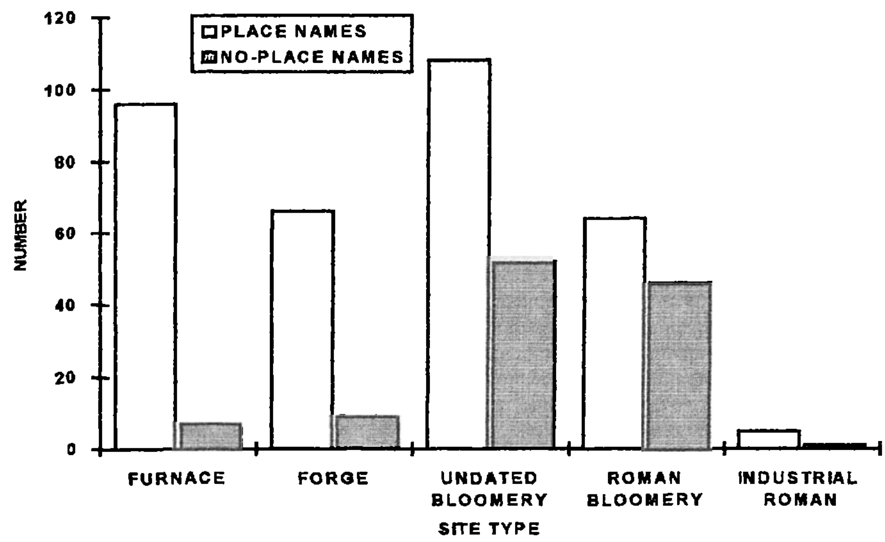


Fig 1. 4 The differential association of place name evidence between post-medieval and bloomery sites.

The impact of industrial activity on the landscape often resulted in place-name evidence found in association with such sites relating to all stages of production (i.e. Minepit Wood, Furnace Field, Forge Pond, Hammer Farm and Cinderbank Shaw). In a post-medieval context such names either derive from the period of use or were introduced after site closure to describe these phenomena in the landscape (see Fig 1.4). This is in contrast to place name evidence for Romano-British bloomery sites, which only tends to be associated with sites of industrial or semi-industrial class where charcoal-impregnated soil, slag banks and possibly mine pits provide the only evidence of previous working. No greater perception of the nature and antiquity of the processes that produced these phenomena are in evidence (i.e. Minepit Field, Blacklands, Cinderills, Cinder Mead, Cinderbank Shaw, Cinderbank, Cinderfield). The presence of bloomery slag from smaller non-industrial class sites rarely justifies the provision of a name. During the four hundred years when iron was produced by the indirect method, significant quantities of documentary evidence were generated, including wills, contracts, deeds, writs, lawsuits and lists (Chaplin 1970: 82-3, Parsons 1882: 21-3). Such evidence has served to locate many sites (Lower 1850: 245). The range of evidence used for the recovery of post-medieval sites is significantly diminished for the elucidation of Roman sites. As a result of these various circumstances, the second half of the nineteenth century witnessed an explosion in the number of known iron production sites of all periods in the Weald, but was dominated by post-medieval indirect activity, rather than Romano-British bloomery production (see Fig 1.5).

The knowledge available to Lower, Rock, and other early antiquarians did not allow them to comprehend fully the process of bloomery iron production (cf. Rock 1879: 171). Some assumed from analogy with the indirect process that water power was utilised. In recording the Roman deposits at Beauport Park, Rock (1879: 171) considered it unusual that there was no "dam across the bed of the small stream, which runs by the side of the mound." From this he concluded that "no forge existed at this spot", but he did consider it possible that "a dam may exist in the woods lower down", blurring the distinction between bloomery and blast

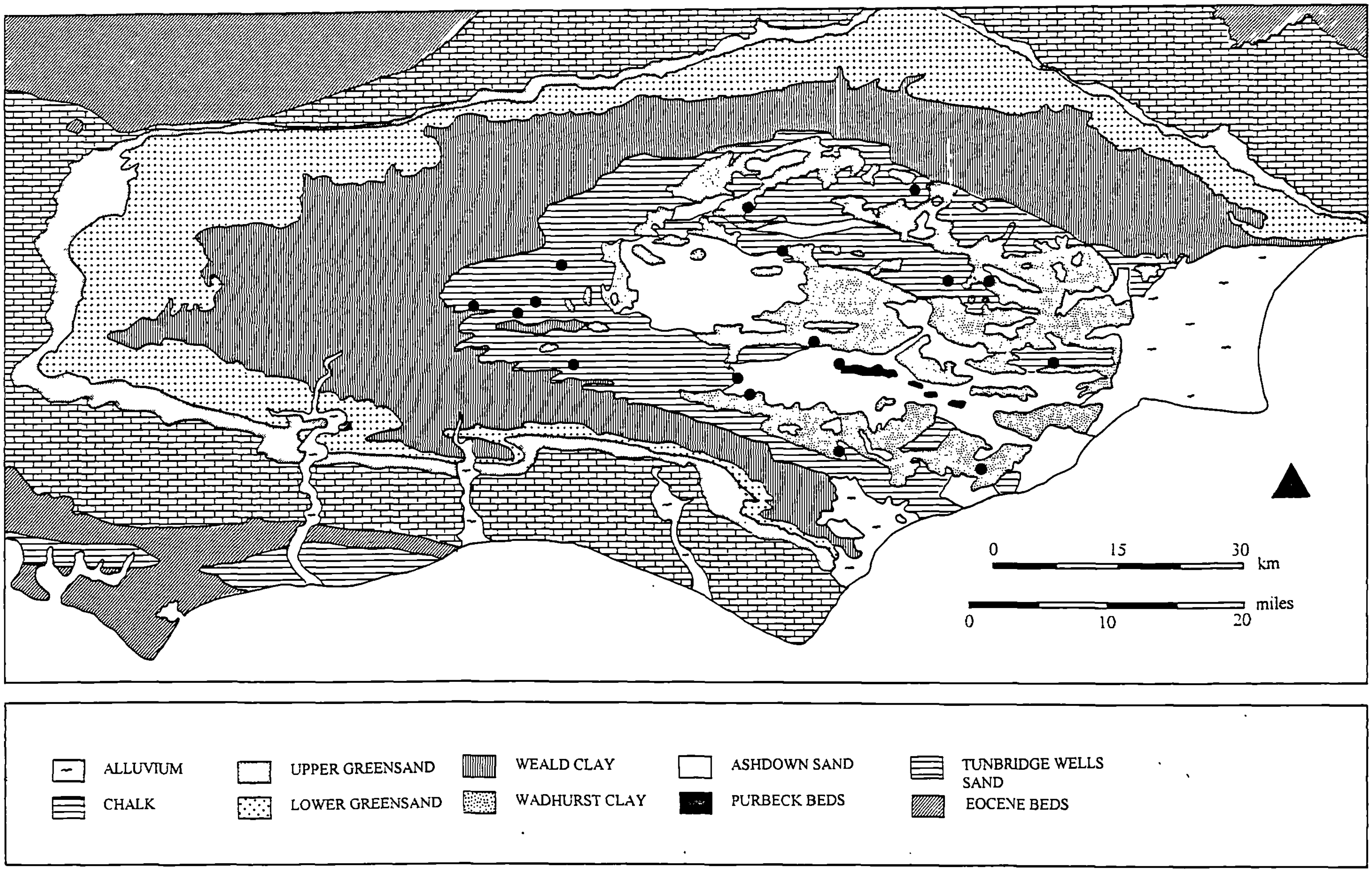


Fig. 1.5 The discovery of post-medieval blast furnace and forge sites between 1840-1899

furnace production methods. Understandably, the detailed processes of bloomery smelting were also not fully understood. Rock also considered, erroneously, that the apparent evidence for cyclical stratification found within the slag deposit at Beauport Park was indicative of actual smelting within the body of the waste deposit. "The process of smelting seems to have been simply to form a mound of earth, then to cover it with charcoal; upon this to place the ironstone or ore, and to cover the whole with clay, probably with some arrangement for the passage of air, to secure combustion of the charcoal when ignited; the molten iron running off from the ore to the bottom of the mound" (Rock 1879: 171, Page 1907: 241). Based on European analogy, Savery (1868: 338) considered that, "earlier furnaces were constructed on top of hills, so that a perpetual draught could be obtained independently of the direction of the wind." There was, and still is, no definitive evidence for such furnaces in the Roman Weald.

Rock (1879: 176) did however integrate place-name evidence, which was the precursor to a technique that was to be successfully employed by Straker to elucidate the location of iron production sites (1931: *passim*). The combined contribution of these early antiquarians to the study of the Roman iron industry in the Weald was significant, considering the limitations of transportation, the accessibility of sites in the era, and that large-scale maps of the region were not available. The work of Lower, Rock, and Wright resulted in the recovery of evidence that would otherwise have been lost; they provided a body of data upon which later researchers could work. In addition they generated, for the first time, both public and antiquarian interest in the Wealden iron industry during the Romano-British era as a discrete entity, and established the Weald as a centre for major industry prior to the Industrial Revolution.

1900-1941

The twentieth century opened with the exhibition, in 1903, of Sussex ironwork and pottery, as produced by Charles Dawson, at the Castle Lodge, Lewes, for the Sussex Archaeological Society (Dawson 1903). A paper based on the exhibition was published in 1903, in the Sussex Archaeological Societies Collections, by Dawson, now considered a leading authority on the Wealden iron industry (Weiner 1955: 181). However, Dawson had undertaken no fieldwork on iron production sites in the Weald, and his article was merely an amalgamation of work previously published by Topley (1875) and Gardner (1898), with little reference to their contribution.

The first industrial-class iron production site to be recorded in the twentieth century was at Bardown on the banks of the River Limden, discovered by Mrs. Odell and Mr. Eden Dickson, in February 1909 (Hodson and Odell 1925: 27). Bardown was a large industrial site of the type frequently discovered and recorded during the late nineteenth century, with contemporary estimates of 13,500 tonnes of iron slag (Cleere 1976a: Table 1, 238). Excavations of unknown extent within the slag deposit by Mrs. Odell revealed extensive evidence of Romano-British material culture. This included both decorated and undecorated samian, Upchurch and Castor ware, the inscribed base of an earthenware dish, and a coin of Faustina the Younger, which suggested intensified activity in the later half of the second century (Haverfield 1916: 195). In addition to these finds, excavations apparently revealed evidence for *La Tène* II and III ceramics, which were dated by Reginald Smith.

This was followed in July 1924 by Ernest Straker's discovery of substantial slag deposits on either side of a tributary of the River Brede at the head of the Durhamford Valley, near Footlands Farm. Along with Chitcombe, this represented a site which had not been extensively denuded for road metalling during the later nineteenth century, although extensive agricultural activity had levelled the slag mounds on both sides of the river. A trench dug in September 1925 by the Sussex Archaeological Society, under the direction of Mr. John E. Ray, the local secretary of the Hastings branch of the Society, revealed quantities of Belgic wares, and East Sussex Wealden wares, in conjunction with samian which were dated by Thomas May as extending to the closing years of Roman occupation. The excavations remain unpublished as a result of the disposal of the detailed records kept by Mr. John Ray after his death (Hodgkinson 1987b: 25). As with many of the industrial class sites, a significant number of excavations and explorations have been undertaken over time, but few have been adequately recorded.

The most fundamental contribution to the early study of the Wealden iron industry was made by Ernest Straker, of Reigate, in a career spanning forty years (see Fig 1.6). Although Straker was a bookbinder by profession and had no special knowledge or qualifications in metallurgy, his interest evolved from his devotion to the region in which he lived (Margary 1972: 3). The ubiquitous nature of iron production sites in the Weald meant that Straker was not alone in his interest in Wealden iron production during the first quarter of the twentieth century. Colonel D. MacLeod, a contemporary and friend of Straker's (Straker 1937: 206), instigated his own local survey of archaeo-metallurgical sites around the parishes of Heathfield and Warbleton, resulting in the recovery of ten bloomery sites, which were subsequently integrated into Straker's work (Straker 1931: 26, 212, 360-2). Straker's work was also aided by the efforts of other active fieldworkers, and members of the Sussex Archaeological Society, such as Herbert Blackman, John E. Ray and Barry H. Lucas. Based in the Battle-Hastings region, these researchers were involved with the excavations at Peppering-Eye, Chitcombe, Beauport Park, Footlands and Crowhurst Park during the early half of the twentieth century (Straker 1931: 351, 347, 335-7, 327). Straker acted both as a focus and an impetus for the study of the Roman iron industry in the Weald. His ultimate achievement was the integration of the work of these essentially local field workers into a single monograph.

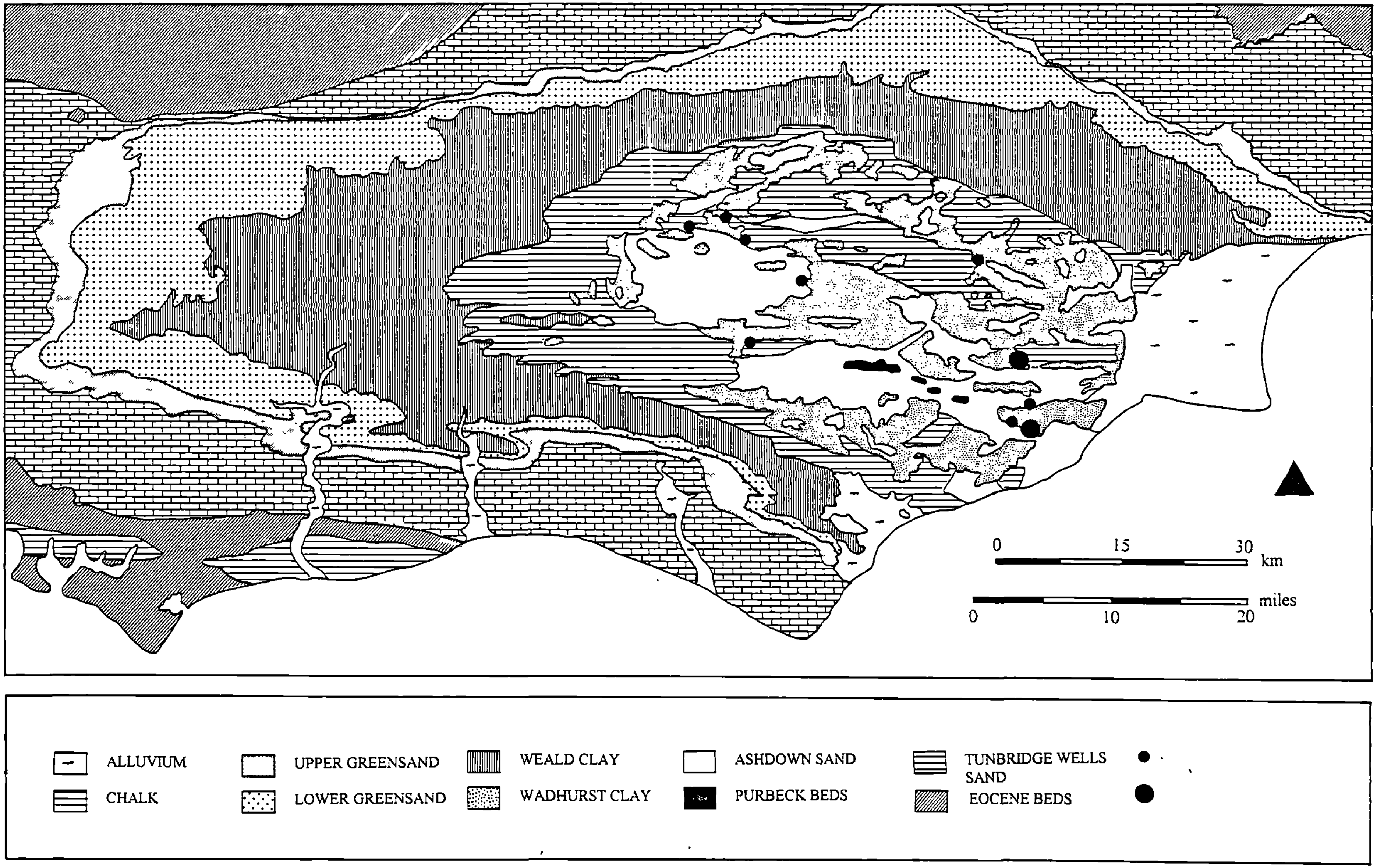


Fig 1.6 The distribution of Roman iron production sites discovered between 1899-1942

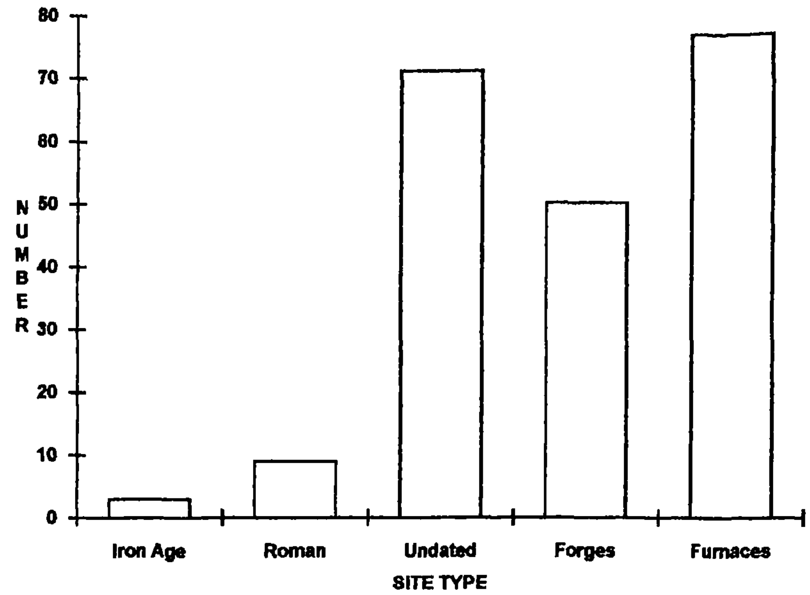


Fig 1. 7 Straker's discoveries of iron production sites in the Weald.

The dominant method of site exposure during the Victorian era was a consequence of the utilisation of slag deposits for road metalling; this, however, tended to focus attention on the industrial-class sites of the Weald. The exhaustion of the known slag deposits (Rock 1879: 178), in conjunction with the utilisation of different raw materials for road building, decreased the demand placed on slag deposits as a source of material. The cessation of one of the primary methods of elucidating iron production sites in the archaeological record necessitated a more rigorous and methodical method of locating sites. As a result, Straker employed a new methodology to focus fieldwork in areas which were likely to yield evidence of metalliferrous exploitation. He based this on the elucidation of place and field name evidence derived from tithe apportionment lists and maps, in conjunction with information from local inhabitants. This highly active research provided sharp contrast to the essentially passive investigations of the nineteenth century antiquarians, and resulted in a massive increase in the number of recorded iron production sites of all periods in the High Wealden region (see Fig 1.7).

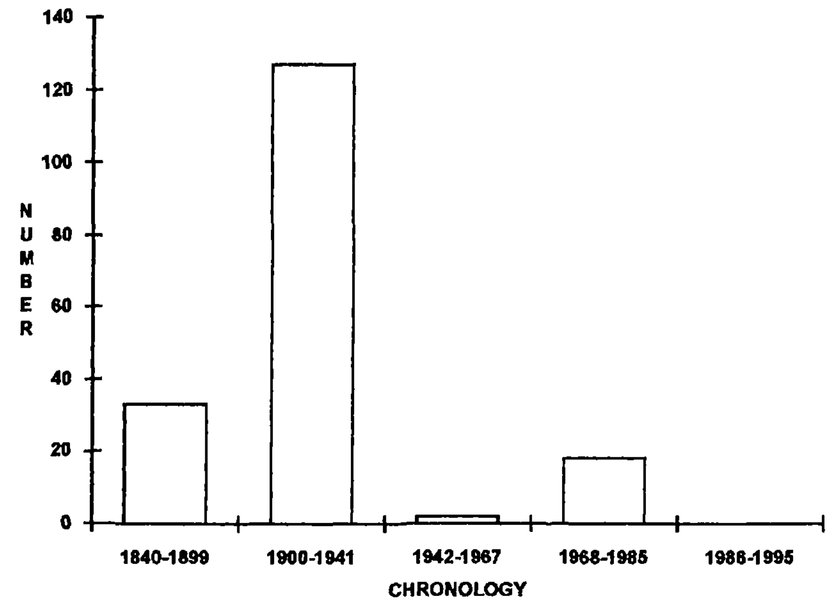


Fig 1. 8 Straker's contribution to the discovery of post-medieval iron production sites in the Weald.

Straker's work culminated with the private publication of the seminal *Wealden Iron* in 1931. Straker's contribution to the study of the iron industry, in the Wealden region, was considerable. He produced the first radical alteration to perceptions of the Wealden iron industry during the Romano-British era since study of the region had begun. The extensive pro-active fieldwork carried out during his research significantly altered the distribution map of known Roman sites in the Weald. This resulted in the northward extension of the boundaries of the Roman iron industry from Oldlands, in Maresfield, to Ridge Hill, south of East Grinstead. His research revealed the complex array of sites, ranging from the small non-industrial/domestic bloomery to the semi-industrial and classic industrial class sites. This provided a correlate with the Antiquarian research which focused on larger-scale exploitation to the detriment of other sites. In addition, he discovered significant numbers of undated bloomeries for which later fieldwork would provide a Roman date. Straker's research also provided the first identification of charcoalified wood from Roman slag deposits and fuel contexts in the Weald. In addition, charcoal was examined from Tudor, Stuart, and eighteenth century contexts (Straker 1931: 110). This work represented some of the earliest palaeo-botanical research in the Wealden region. Such systematic analysis of charcoal from iron production contexts in a discrete region was revolutionary for the time. Straker was also responsible for the discovery and recording of significant numbers of post-medieval blast-furnaces and forges. It was this research which essentially produced the distribution of these later sites that is known today (see Fig 1.8 and Fig 1.9).

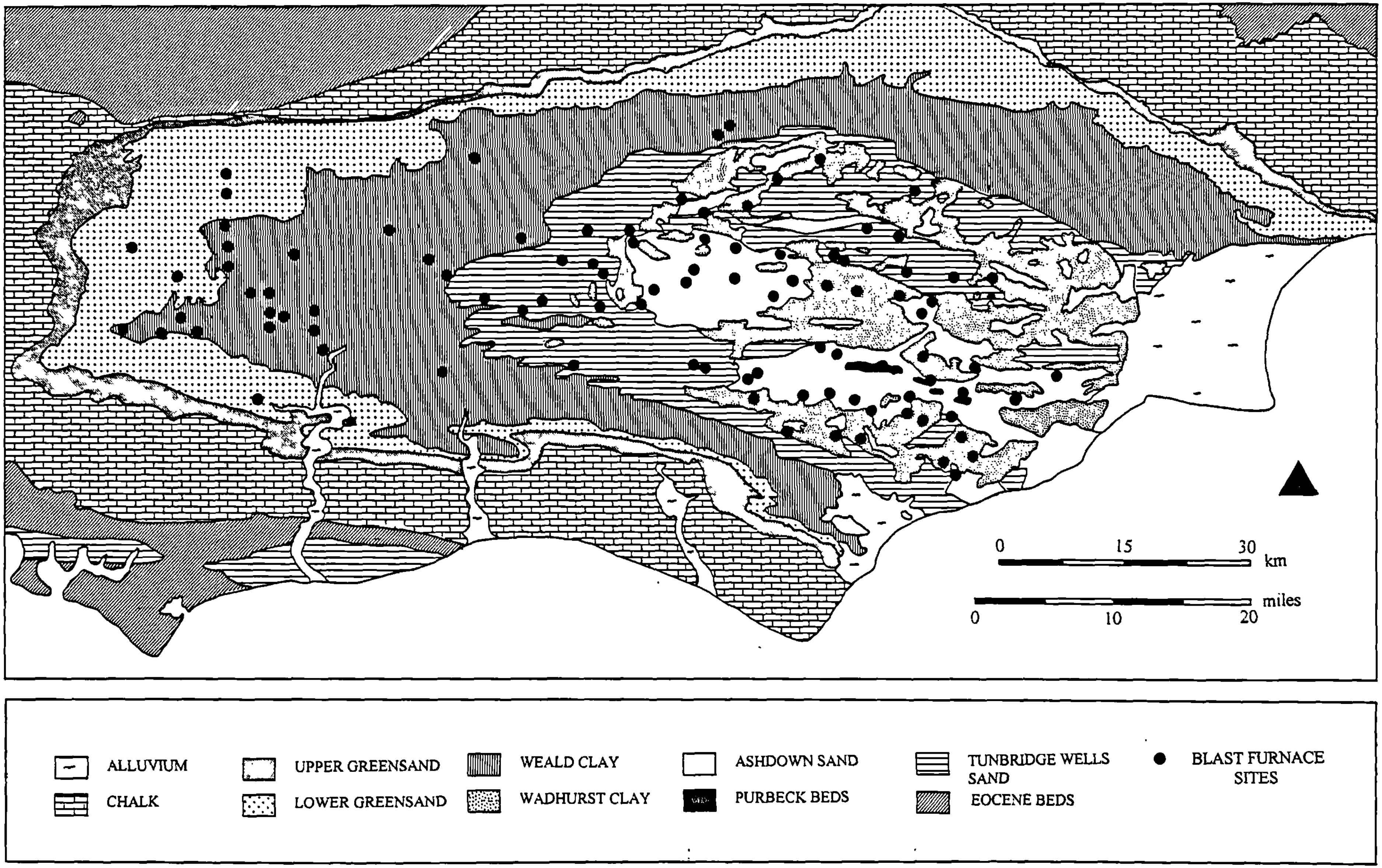


Fig 1.9 The distribution of post-medieval iron production sites discovered by 1941

This achievement was even more considerable when seen in the light of Straker's short-sightedness (Shelley 1973: 10), deafness and asthma (Margary 1972: 2). Although a subjective element was occasionally incorporated in his work with statements such as "a bloomery of ancient type" (Straker 1931: 218), "of early, perhaps Roman type" (*ibid.* 357) and "very ancient type cinder" (*ibid.* 393), the majority of his material was highly factual in nature, and has become the basis for modern research (Cleere and Crossley 1995: *passim*, Salzman 1946: 106).

This publication elevated the iron industry of the Weald from regional to national importance, and also represented the first true synthesis of data from a Roman metal-producing region in the country. However, Straker's work was not rapidly incorporated into the wider steam of academic research and did not receive the recognition it deserved on anything other than a local scale. The private publication of *Wealden Iron* did not allow for a high, country-wide, circulation. In consequence, there was a relative lack of awareness of Straker's work on much more than a regional level. Straker's research was incorporated into the wider stream of academic study when Oliver Davies (1935) published *Roman Mines in Europe*. This major work integrated literary and archaeological evidence for Roman metalliferrous exploitation throughout Europe, and placed the Romano-British exploitation of ferric and other metalliferrous resources in a wider European perspective. However, Davies devoted only 13 lines to the iron industry of the Weald (1935: 151-152), and provided only one reference to Straker's contribution. His map of the region (map IV a), does not include all of Straker's discoveries, but includes some additional Iron Age and Saxon sites. As a result, much of mainstream academic awareness of the Roman contribution to iron production in the Wealden region was limited to the comparatively well-known Victorian and early-twentieth century discoveries of industrial and semi-industrial class sites. This factor could have contributed to the hiatus of activity in the study of Wealden iron production in the 25 years after Straker's death.

The last excavation of a Romano-British bloomery site recorded by Straker was at Crowhurst Park in 1936 (Straker 1931: 353; Straker and Lucas 1938; Straker: unpublished). This was the last major industrial-class site to be discovered in the Hastings hinterland of the eastern High Weald. The later years of Straker's life witnessed a cessation of fieldwork as a result of deteriorating health and the transportation difficulties that the onset of the Second World War generated. However, these difficulties did not prevent Straker from publishing details of post-medieval iron production sites (1939, 1941) until his death in 1941 (Anon 1941). This marked a brief hiatus in study relating to the Roman iron industry of the Weald.

This first phase of study, from the pioneering work of Lower to the death of Straker, represents over ninety years of research, and encompasses the recording of 11 bloomery sites of Romano-British date in conjunction with an additional 73 undated sites. During this era the emphasis on the discovery of, and research into, larger, more conspicuous sites gradually evolved under Straker to the elucidation of all sites, irrespective of age and size, in the form of topographical survey. The extensive topographical survey adopted by Straker was a unique approach for the era. It was only during the 1950s in Eastern Europe that this form of extensive area survey relating to metallurgical industries was utilised in Bohemia by Radomir Pleiner, and in the Holy Cross mountains of southern Poland by Kazimersz Bielenin (Cleere 1993: 177).

1942-1967

Little recorded excavation was carried out on Wealden iron production sites during the course of the Second World War. However, limited trenching was carried out at Footlands (Lucey 1978: 24); the pottery recovered was noted by Chown (1947) as being of Iron Age appearance.

The immediate post-war years saw no significant discoveries of Romano-British iron production sites in the Weald. However, important work relating to Roman roads and their relationship with the now well-established industrial class iron production sites of the Eastern Weald was carried out (Margary 1947). This was followed by the consideration of the wider relationship between transportation networks in the province and the Weald (Margary 1946b, 1946c, 1953, 1965). In addition, the Roman harbour facilities at Bodiam were discovered and limited excavation carried out (Lemmon 1952, Lemmon and Hill 1966), although within the limited confines of the key-hole trenching at the time no evidence of iron production was recorded.

1968-1985

It was not until the late 1960s that research into Roman iron production in the Weald began to take the form it has today. The discoveries in the Weald could be perceived in relation to changes that were taking place in both Britain and in the wider sphere of Europe. Many factors contributed to this, including changes in national agricultural policy, the growth of experimental archaeology and archaeometallurgy, and the formation of local archaeological and historical societies.

Government agricultural policy was greatly affected by Britain's participation in the two World Wars. As with the agricultural policy of the Great War, the government encouraged the conversion of pasture to arable land in the interests of self sufficiency, with the provision of grants as an incentive for the ploughing of fields (Anon 1952). In addition, increasingly powerful farm machinery facilitated the rapid cultivation of heavier clay soils. This increased activity in areas untouched within living memory, or marginal regions, which resulted in significant numbers of bloomery sites being revealed. As with many areas of archaeology, the agricultural utilisation of the landscape has been a significant element in the elucidation of iron-production sites in the Weald. Unlike many archaeological features which can be obliterated by ploughing, iron production sites generally have a higher archaeological visibility as a result of the carbon-rich soil, which shows up as heavily-stained dark areas after disruption of the topsoil by cultivation, while the indestructible slag remains on the surface as an additional indicator of bloomery iron production. However, although the archaeological visibility of the site may be enhanced, the effect over time is one of sustained degradation resulting in obliteration of site structure and, in many cases, dating evidence. Certainly some pre-Roman ceramic forms have a reduced ability to resist attrition and surface weathering compared to Roman ceramics, which is possibly a function of the poorer, more variable firing in many instances, compared to the standardised production of the Romano-British era. In addition, the earthy and dark colours of some of the East Sussex Wealden wares can significantly reduce the archaeological visibility of such sherds both in the soil and in slag deposits.

This is a broad generalisation, although the matrix of bloomery sites is often carbon-rich, resulting in the characteristic exposure of black soil when disturbed, there is immense variety in the nature and density of various materials in slag beds. In some cases, especially on the smallest class of sites, very little charcoal is evident in the plough soil, which can decrease the archaeological visibility, although bloomery slag still remains as an indicator.

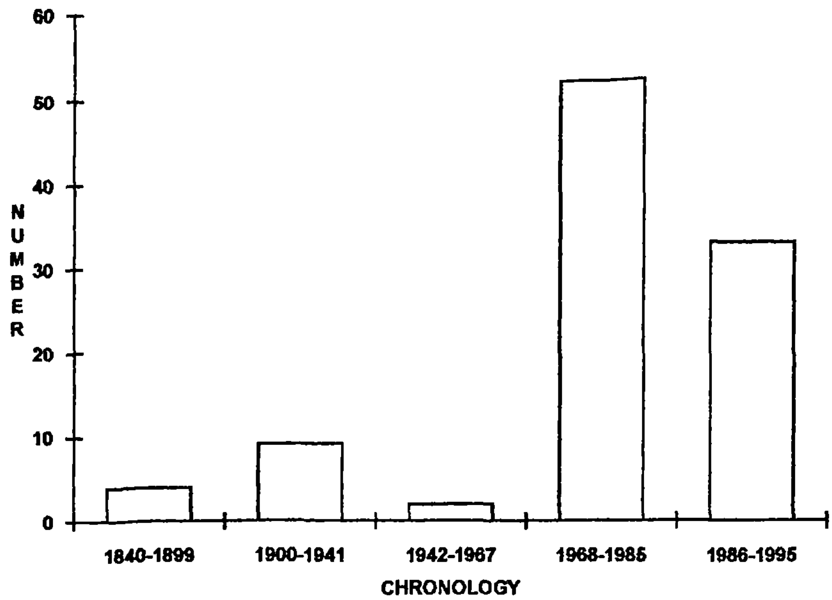


Fig 1. 10 The contribution of the WIRG to the discovery of Roman iron production sites between 1969-1985.

The increase in the number of iron production sites being recorded in the Wealden area precipitated the formation of the Wealden Iron Research Group in 1968, under the aegis of Henry Cleere and David Crossley. The WIRG was dedicated to the promotion of "further research into the iron industry of the Weald of Kent and Sussex," with "the ultimate intention ... to publish a survey and history of the industry" (Anon. 1982: 2, Cleere and Crossley 1969: 19). Straker's techniques of extensive area survey, published forty years previously, provided the methodology for the WIRG to examine complete landscape units. This represented a fundamental change in the nature of research in the Weald, providing a platform for significant numbers of multi-disciplinary researchers. The post-war era saw a shift in emphasis, from individual researchers cataloguing sites to the advent of institutional and group research, focusing on all aspects of iron production.

The Wealden region incorporates the research areas of many local, semi-professional, and professional archaeological groups. Although fieldwork relating to iron production sites is dominated by the Wealden Iron Research Group, other bodies have contributed significant numbers of bloomery sites to the database of known sites. These groups include the Hastings and District Archaeological Research Group, the Kent Archaeological Rescue Unit, and the Battle and District Archaeological Research Group; additional research has been undertaken by the field archaeology unit of the Institute of Archaeology.

The formation of the Kent Archaeological Rescue unit stemmed from the need to combat the rising number of archaeological sites which were destroyed as a result of urban development and agricultural practices. Substantial numbers of rescue and training excavations have occurred on Romano-British bloomery sites in the area around Lenham since the 1970s (Philp 1980), almost all of which remain unpublished.

The formation of the Hastings and District Archaeological Group in 1972 resulted in the most intensive and detailed area coverage of archaeological and historical sites of all periods in the Wealden region. This approach provided both a contrast and a correlate to the results of the WIRG, whose study area is significantly larger and whose *raison d'être* differs considerably. The work of the WIRG has concentrated on extensive site location, whilst the Hastings Group has undertaken intensive field survey in a geographically confined region.

The clear geographical demarcation of the Weald has been conducive to self-contained studies of the iron industry within its boundaries. This phenomenon is also seen in the Forest of Dean with its clear boundaries, although in this context research has been considerably more haphazard than work in the Weald. As yet there has been no coherent monograph devoted to the bloomery iron industry in the Forest of Dean, in the fashion of those from the Weald. In addition, the number of publications relating to Roman bloomery iron production is considerably less that those in the Weald, with activity and resources concentrating on the major production centres such as Ariconium. Much of this can be attributed to the absence of iron-specific research groups in the Forest region.

Unfortunately, this state of knowledge is not evident in the studies of the other Roman iron production centres in Northamptonshire, where the industry is concentrated in the hinterland of Water Newton and Irchester (Jones and Mattingly 1990: 195, Map 6:14). This region has been prone to depredation from modern open-cast mining which may have destroyed many previous production sites (*ibid.*). In addition, this iron production region covers several counties in the Midlands and eastern England, which has severely disarticulated coherent fieldwork. A comparison can be provided by the state of research in the periphery of the Weald, which encompasses five counties.

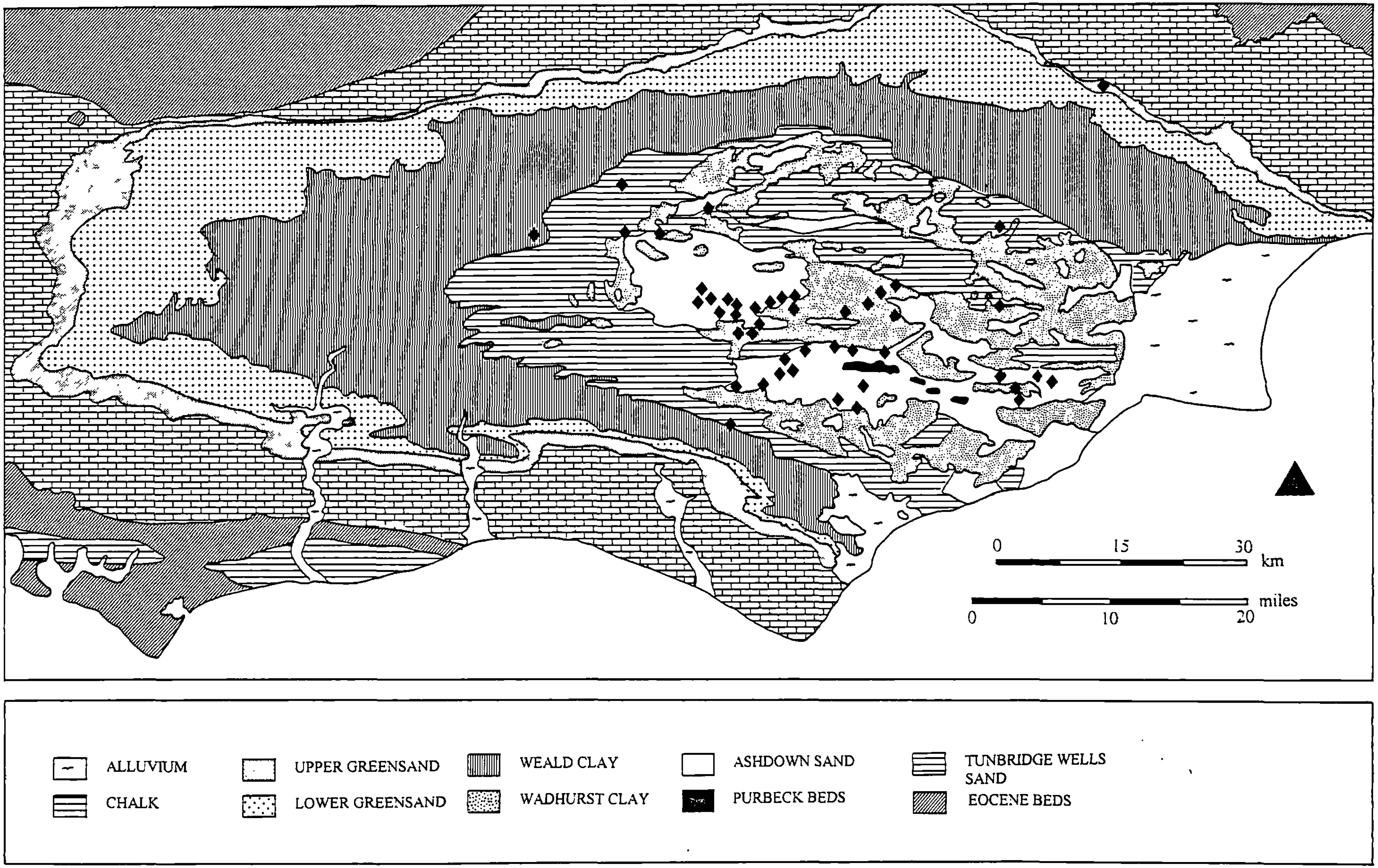


Fig 1.10 The distribution of Roman iron production sites discovered between 1968-1985

The late 1960s and early 1970s witnessed a profusion of excavation on iron production sites in the Wealden region. This includes independent fieldwork by Charles Cattell in the Lower Rother Valley, in East Sussex, which determined the location of non-industrial bloomery sites as a function of the location of geological faults. Based on the premise that these faults would provide an easily accessible source of ore, these areas provided *foci* for fieldwork (Cattell 1969, 1970, 1971, 1972).

The first large-scale excavation and recording, by contemporary standards, of an industrial-class iron production site occurred at Bardown, on the River Limden. Four seasons of excavation provided the first definitive socio-economic data from an industrial-class Wealden iron production site (Cleere 1968a, 1969b, 1970). The discovery of stamped tiles of the *Classis Britannica* began the process by which the wider implications of iron production in both the provincial and continental European economies were realised (Cleere 1975: *passim*).

Simultaneous excavation at Holbeanwood 1.5 km to the north of Bardown revealed the presence of an outlier, or work place utilised for industrial purposes, while the main site was used as a residential centre (1968b). Until this era the small-scale excavations which took place were often poorly published or unpublished. Widespread excavation allowed for an accumulation of dating evidence which provided a chronological framework in which to fit the previously disparate dates from Romano-British iron production sites.

Excavations were carried out by James Money (1918-1991) on the Romano-British and medieval bloomery sites at Minepit Wood, Withyham (1971, 1974). Excavations over four years revealed three roasting hearths and two smelting furnaces. The excavations at Minepit Wood were followed by annual excavations between 1973 and 1982 at Garden Hill, a hilltop site first occupied in the Neolithic and Late Bronze Age. This provided evidence for LPRIA occupation continuing into the Roman era, at which point the Iron Age round houses were replaced by rectangular buildings with a bathhouse. A certain amount of industrial activity was associated with iron working (Tebbutt 1970, Money 1973, 1977, Money and Streeten 1979).

The expansion of Crawley New Town during the mid 1960s resulted in the discovery and excavation of a substantial series of industrial class sites at Broadfield by Gibbson-Hill. The earliest discovery was of substantial quantities of iron slag found in association with evidence of an agricultural settlement dating from the second century B.C. at Goffs Park, Southgate West (Slater 1970). Further building construction in the Broadfield area resulted in the discovery of more industrial activity associated with iron production dating from the first century A.D., with expansion during the mid-first century. This necessitated the formation of the now defunct Crawley Excavation Group, which was essentially concerned with the rescue excavation of the remains discovered during construction. The importance of the Broadfield complex was evident from its length of occupation, the variety of furnace types in operation simultaneously, and its close association with an agricultural settlement. Difficulties with publication, and the subsequent death of the author which necessitated the re-analysis of the fragmentary excavation archives, delayed publication until 1992 (Cartwright 1992, Davies, G. 1993: 5).

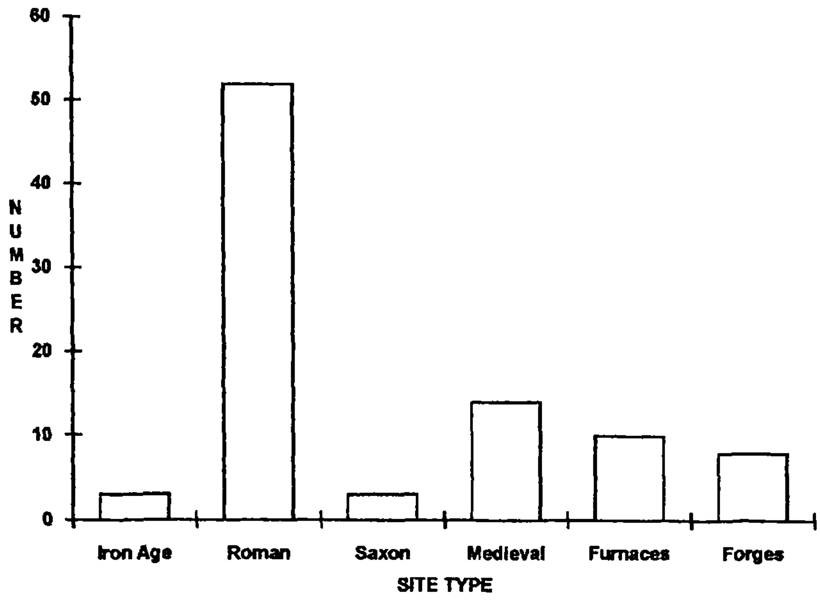


Fig 1. 12 The contribution of the WIRG to the discovery of iron production sites of all eras in the Weald between 1967-1985.

This research radically altered the geographical biases in the study Roman sites of the south-east, of which the Wealden region is central. The rich villa sites of the North and South Downs, the Sussex coastal plain and the Vale of Kent, have acted as a focus for archaeological activity (Gardiner, M. 1990), to the detriment of sites in the Weald, which was traditionally thought to be archaeologically less productive than the surrounding downland. In addition, a broad spectrum of bloomery and post-medieval sites have been recovered to supplement the research undertaken by Straker (see Fig 1.12).

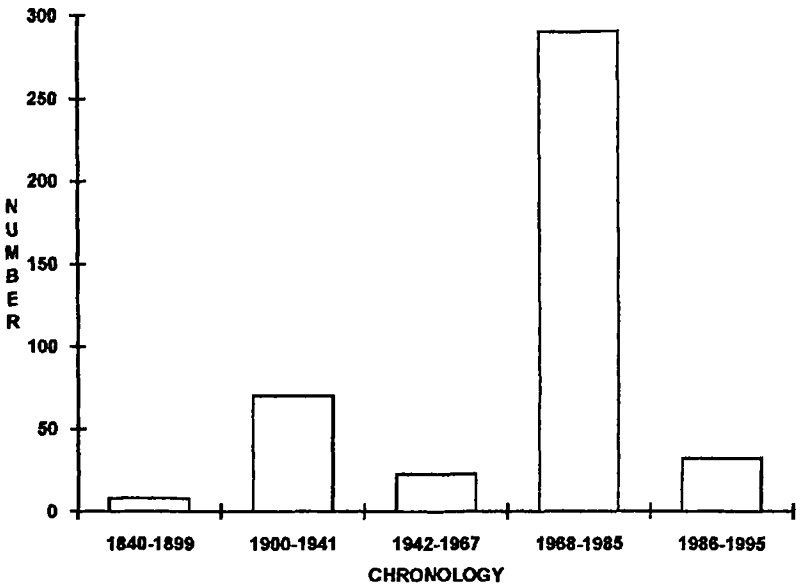


Fig 1. 13 The discovery of undated bloomery sites between 1840-1995 showing the contribution of the WIRG.

The dominant area of discovery of the WIRG related to the location of non-industrial/small-scale bloomery sites (see Fig 1.13). This is partly a function of the discovery of the majority of the larger industrial-class sites during the nineteenth and early twentieth centuries, and is partly related to the numerical superiority of the non-industrial type bloomery site. The instigation of a project designed to significantly enhance understanding of a 180 km^2 unit of land in the central Weald revealed an intensity of 1.6 predominantly undated, non-industrial sites per km^2 (Tebbutt 1981a, Cleere and Crossley 1985: 279-83, Goodburn, R. 1978: 467, Hodgkinson and Tebbutt 1985). In 1985, the "survey of the industry" proposed by Cleere and Crossley, 16 years earlier, was published in the form of the *Iron Industry of the Weald.* This represented the most complex and detailed assessment of the industrial history of the iron industry of the Weald of all eras, since the publication of *Wealden Iron,* fifty-four years earlier.

1985-1994

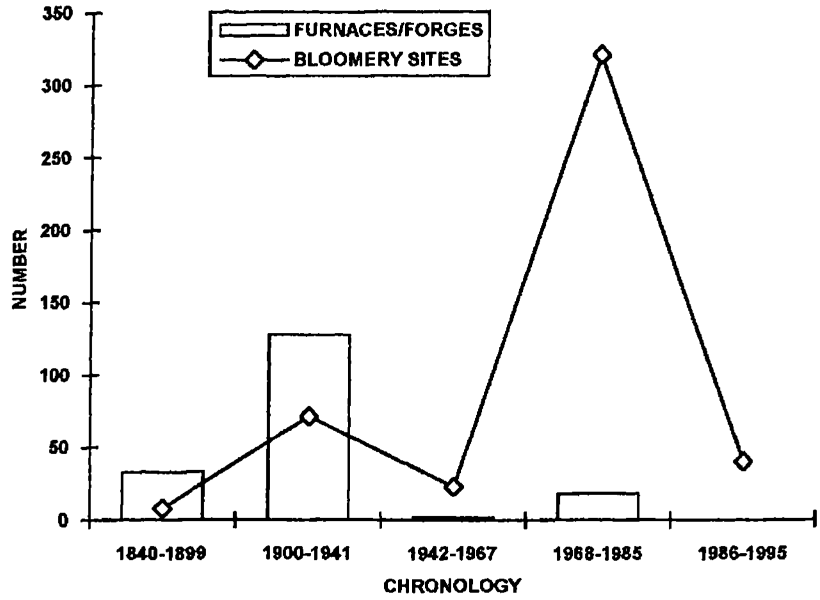


Fig 1. 14 The differential periods of discovery for post-medieval and Roman iron production/working sites.

The results of research during the last decade have emphasised that the study of bloomery iron production during the Romano-British era has evolved along significantly different lines to that of the study of the indirect era of exploitation during the post-medieval era (see Fig 1.14). The discovery of new additions to the list of the later blast furnaces and forges is reaching its conclusion (cf. Cleere and Crossley 1985: 308-67, 1995: 306-67). It is probable that few more blast furnace and forge sites remain to be discovered, and as a result the research tends to concentrate on the interpretation of the available data. The estimated original number of blast furnaces and forges in the Wealden region can be measured in terms of hundreds of sites, while the number of bloomery sites is better expressed in the thousands. As such, the discovery of new bloomery sites from the Wealden region is still in its infancy. The effects of such widespread bloomery activity over time would have resulted in significantly different implications for the Wealden environment, than those which resulted from focused blast furnace and forge activity.

Extrapolation of the data relating to the discovery of sites suggests that the distribution of the industrial-class iron production sites will remain essentially unaltered, as the vast majority have already been discovered. The semi-industrial class sites remain enigmatic, and many still remain to be discovered. The area which will undergo the greatest degree of revision is the distribution of the non-industrial class sites. These small-scale units of production have formed the nucleus of the discoveries during the twentieth century. It is the distribution of these non-industrial, small-scale sites in the ore-bearing geologies of the Weald which dictate the dominant method of anthropogenic interaction with the landscape, rather than the highly-focused industrial and semi-industrial class operations, which have attracted so much attention.

BIASES IN THE ARCHAEOLOGY OF THE WEALD

The archaeology of the Weald could be considered to be *the archaeology of bias*. This is evident not only in the Romano-British era but in all periods of study. In both the High Weald and the Low Weald, the evidence for Romano-British occupation is dominated by evidence for bloomery activity to the detriment of settlement evidence. On the geologies peripheral to the High Weald, the evidence for settlement far outweighs that for iron production. This is an amalgam of bias and a representation of the original settlement pattern.

The High Weald was undoubtedly the centre for bloomery iron production during the Roman occupation. The contemporary discovery of this activity is enhanced by the location of field research groups such as the Wealden Iron Research Group and the Hastings and District Archaeological Research Group, which between them have been responsible for the discovery of approximately 70% of the known Roman bloomery sites in the Weald in the last 25 years. This contrasts with the peripheral geologies, which have witnessed few concerted examples of archaeological research, although exceptions include the East Hampshire survey, which impinged on the extreme westerly tip of the Weald (Shennan 1985), and the Cuckmere Valley fieldwalking project (Gardiner, G. 1990: 36-7). By contrast, evidence for settlement, associated with iron production and other sites, is dominant on the Greensand geologies. Here consistent sources of building stone are available, resulting in archaeologically visible remains, while in the High and Low Weald, timber was probably the major material used in construction. Much evidence for activity comes in the form of coin finds and ceramic scatters. What is evident is that while there is undoubtedly a nucleation of bloomery activity in the High Weald, there is a corresponding dearth of settlement activity; as iron producers would have had to live somewhere, it is evident that bloomery activity is being picked up to the detriment of evidence for occupation.

An additional reason for the focus of activity in the High Weald is the dominance of research by the Sussex Archaeological Society, since the publication of Lower's work in 1849, and the presence of the Wealden Iron Research Group since 1969. However, modern socio-political boundaries have no relevance to the study of the Roman landscape, and the firm adherence to these through the two major field research groups has enhanced the significant biases inherent in the Wealden region.

The discovery of evidence for bloomery activity is not comparable between the major physiographic zones of the Weald. The elucidation of a Roman date for bloomery activity is a two-stage process. First, evidence for generic bloomery activity has to be recovered. Usually, this a result of ploughing or deliberate field research. The evidence for bloomery activity is further enhanced by the awareness of local communities of their industrial past. While this is evident in the High and Low Weald, perceptions decline towards the periphery. In addition, the large number of easily assessable sites on the North and South Downs have acted as a focus for archaeological resources from an early date, to the detriment of the Weald. The lighter soil, generally diminished ground cover, and the higher visibility of sites all create an environment which is more attractive archaeologically than the Weald.

Where surface material is not evident, which is the case in over 90% of sites, further work has to be undertaken. The location of field researchers is the obvious bias which would result in the greater number of excavations leading to confirmed dates. The trial-trenching of a bloomery site does not guarantee the recovery of diagnostic chronological indicators. There do appear to be biases in the nature of the archaeological record at bloomery sites of different chronological eras. The heavy under-representation of Saxon and medieval bloomery sites could be a result of the use of perishable material culture on these sites to a greater extent than on sites of a Roman date.

AIMS AND OBJECTIVES

The utilisation and exploitation of environmental resources underpinned society in Roman Britain, as it does today. The relationship between environment and society is especially prevalent in the study of the Roman iron industry, which as its most basic requirement needed substantial quantities of wood for conversion to charcoal, necessary to sustain the smelting operations and any secondary or tertiary working where this was applicable. Other woodland exploitation arose from the continual requirements of domestic fuel for the iron works, and constructional wood and timber. The study of the Roman iron industry in Britain has been dominated by the study of technological innovation and change. The consideration of a metal-production region from an environmental perspective is a relatively recent phenomenon, with little work focused on the environmental basis for the industry. Exceptions include Cleere (1976a), Mighall and Chambers (1989) and

Mighall *et al.* (1990). The following research represents the first attempt to consider a complete iron production region in the country from an environmental perspective, allowing the integration of archaeological data with palaeo-environmental evidence in a region which has been traditionally devoid of palaeo-botanical investigations.

The objective of the study is the elucidation of the relationship between iron production and environment, which includes ascertaining the nature of the environment, and in some instances the impact of iron production on that environment. Emphasis is placed on the elucidation and interpretation of environmental conditions, within the confines of the taphonomy of the palaeo-botanical assemblages studied and the fuelwood strategies needed for the smelting processes. The value of the botanical remains are, therefore, discussed in relation to the processes of formation, deposition, degradation, and retrieval of the material.

The Weald forms a distinct physical environment which was visible and definable to past populations on the basis of topography, vegetation and landuse, certain components of which appear to have acted as an distinct economic region in the Roman era. With documented research extending back as far as 1844 and with continuing research by the Wealden Iron Research Group and the Hastings and District Archaeological Group, an extensive database of sites and publications exist from a spatially-defined region over the whole of the Roman era, with the majority of working occurring during the first three centuries A.D. This compares favourably to the study of Roman iron exploitation in the Forest of Dean where research has been highly fragmented, despite its nucleated geographical confines and the earlier origins of research. The Weald compares still more favourably with the other Roman iron exploitation regions around Northamptonshire, Lincolnshire and Norfolk, where until recently research into the iron industry has been disarticulated and rarely considered as a coherent unit. As with the Wealden periphery, the study of the Northamptonshire hinterland has been hindered by the distribution of sites across county boundaries, enhancing the problems of research. The archaeological evidence for the Weald is apparently dominated by sites of iron exploitation and production to the detriment of other settlement evidence, and therefore provides an ideal opportunity to examine the relationship between iron production and the environment.

The study of the Wealden iron industry in the Romano-British era has advanced considerably since its early origins with the studies of Lower (1849, 1850). The pace of discovery and research has witnessed an acceleration over time, under the *aegis* of Straker (1931) and Cleere (Cleere and Crossley 1985, 1995). The ability to cultivate marginal land has resulted in the discovery of more sites. Therefore, any attempt to assess the environmental impact and other implications of iron production on the environment of a specific time, must assess the validity of the current number and distribution of sites iron production, which will have implications for the extent of the activity and its subsequent impact on the environment.

Since the publication the *Iron Industry of the Weald* in 1985 and its revision in 1995, significant developments have occurred in the elucidation of Romano-British iron production sites in the Weald. Consequently, this has resulted in additions to the distribution map of iron production sites proposed by Cleere (Cleere and Crossley 1985: 58-9), which both confirm hypotheses of these authors and add new areas of exploitation. In the light of these advances, a fuller picture is available of the distribution of sites in the Weald. By 1995, one hundred and ten Romano-British iron production sites had been recorded within the Weald, yet little attention has been devoted to their environmental and landscape context. The nature of research has placed emphasis on the nature of the sites themselves and the industrial processes - little is known about the nature and context of the environment in which they were situated. In the absence of literary and epigraphic evidence, archaeology has provided the primary source of information relating to the nature of exploitation of the Weald. However, much of the surrounding environment is difficult to detect using archaeological methods alone. With the exception of slag, the dominant archaeological material recovered from iron production sites is charcoal, which, in conjunction with the known fuel needs of the industry, has tended to focus the emphasis on the surrounding woodland to the detriment of other components of the wider environment such as agriculture.

Interpretations of the Wealden woodlands have either taken the form of the "primeval Anderida" and its subsequent destruction as a consequence of deforestation, or of extensive coppice or managed woodland. Few elements between this dichotomy have been considered.

Previously, bloomery sites were considered as discrete entities, not as *foci* for the wider environment. It is essential to integrate the evidence of iron production sites with other contemporaneous settlement evidence, to assess the variety of land uses that were needed to sustain the different components of the socio-economic structure of the Weald during the Romano-British era.

Traditionally the consideration of environmental impact in relation to bloomery iron production has been synonymous with the fuel requirements of the industrial processes. Little consideration has been devoted to the other forms of primary, secondary, and tertiary impacts which occur as a function of the development of transportation networks, domestic fuel consumption, food production, and constructional requirements. These considerations have important implications for the study of the of the exploitation of environmental resources throughout Roman Britain.

The provision of comparable environmental samples from securely-dated Romano-British deposits across a single region would allow for the creation of an environmental database for a region not traditionally rich in such information. The study aims to provide a detailed regional survey which will allow for an inter-site comparison of the patterns of exploitation within the geographical confines of the Weald and its borders. The information that the environmental evidence provides has considerable implications for the study of the exploitation of woodland resources during the Romano-British era. The results are viewed in the broader socio-economic context of Roman Britain. This is in keeping with Straker's assertion that "the story of the extinct Wealden iron industry has a far greater significance than a mere study in local archaeology" (Straker 1931: vi).

An attempt to assess the effect of the environment has led to an examination of the socio-economic development of the Wealden region and how the region has been modified as a result (cf. Cleere 1985: 718). Endeavours to measure the output of furnaces in the Wealden region have been attempted for the Roman era (Cleere 1976a) and for the charcoal blast furnace era between 1540-1750 (Hammersley 1973, Riden 1977). This data has then been utilised to determine the quantity of wood fuel required to sustain the industry at particular periods and under different technological constraints. However, detailed research by Hammersley (*ibid.*) for blast furnace charcoal iron production suggests that this industry was never threatened by a lack of wood fuel. Using comparable Romano-British data it is hoped to assess if the classic decline of iron industries in the High and Low Weald was a direct result of the inability of the environment to support production or if other economic factors were responsible.

CHAPTER TWO

GEOLOGY, TOPOGRAPHY AND LANDUSE

No tender-hearted garden crowns,
No bosomed woods adorn
Our blunt, bow-headed, whale-backed Downs,
But gnarled and writhen thorn-
Bare slopes where chasing shadows skim,
And, through the gaps revealed,
Belt upon belt, the wooded, dim,
Blue goodness of the Weald.

Rudyard Kipling
Sussex (1902)

GEOLOGY, TOPOGRAPHY AND LANDUSE

REGIONAL BOUNDARIES

The Weald is a geologically and geographically distinct region in the south-east of England. The accepted contemporary definition of the Wealden region comprises the unit of land which is bounded by the Upper Cretaceous Chalk of the North and South Downs and the intermediate Butzer Hills (Gallois 1965: 1, Worssam 1985: 1). The South Downs extend from Beachy Head and the Seven Sisters, where the Chalk is truncated by the Eastern Channel, through to Steyning and Lewes and north-west to the Butzer Hills near Alton and Petersfield, delimiting the western edge of the Weald. The Butzer Hills constitute a crescent of Chalk which serves to link the North and South Downs. This outcrop expands westwards into the Hampshire Downs (Whittow 1992: 76). The North Downs extend from Farnham in Hampshire, to Guildford, through Wrotham and Wye, and on to the section of coast between Folkestone and Deal, where the Straits of Dover truncate the formation.

Although the geological definition of the Weald encompasses the region bounded by the Chalk Downs, other historical boundaries do exist (Topley 1875: 1). In Surrey, where the Lower Greensand rises to form an escarpment running approximately parallel to the North Downs, the southern scarp foot allows for a clear limit to the Weald, which was essential in determining which lands were subject to tithes (Straker 1931: 6). To the east of Surrey, the Greensand escarpment diminishes, so no such geological boundary exists to the south of the Downs. For the purposes of the appropriation of tithes, the scarp foot of the Downs, as expressed by the location of the Pilgrims Way, a trackway of probable prehistoric origin, formed the boundary. Interpretation of the Wealden region and the area exploited for ferric resources during the Romano-British era varies considerably. Lower (1849b: 169) considered that only the High Wealden region contained suitable ore deposits, a point which was later elaborated by Topley (1875: 334, 337), who felt that the High and Low Wealden regions contained sufficient ore. Straker (1931) reiterated this in his seminal work *Wealden Iron*, where he interpreted the Weald as the region of the Hastings Beds and the Weald Clay, bounded by, but excluding, the later Greensand formations.

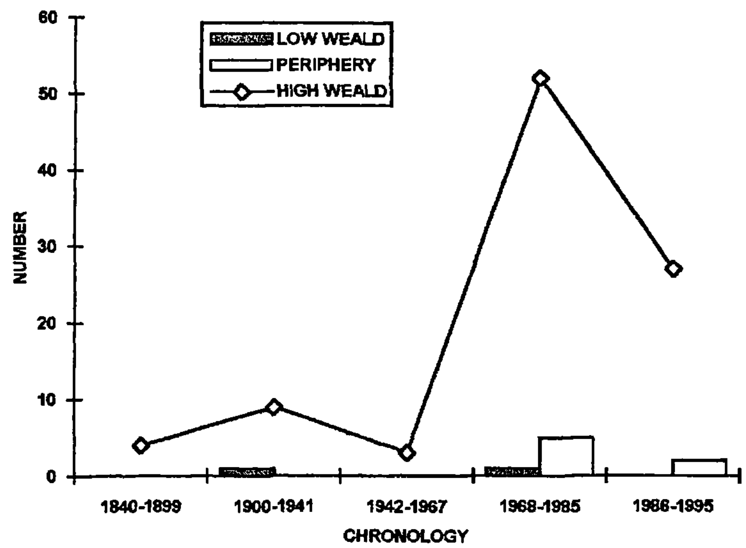


Fig 2. 1 The bias for the recovery of Roman bloomery sites in the High Wealden region.

This interpretation focused Straker's work on the dominant iron-bearing strata where the bulk of the Roman and post-medieval iron industries were concentrated. This equated principally to the High and Low Weald, to the exclusion of the younger strata of the scarp foot region. "From the earliest of times this forest region, with its abundance of fuel and easily won ore, was the seat of the iron industry, which was mainly confined to the Wealden Beds, or High Weald" (Straker 1931: 14). Straker further refines the known distribution of bloomery sites as being "most frequent in East Sussex on the Wadhurst Clay, and ... scarce on the Weald Clay" (Straker 1931: 27).

Based on the information available to Straker in the first quarter of the twentieth century, this was an acceptable hypothesis. However, the substantial number of excavations which have occurred since the publication of *Wealden Iron* have revealed that localised exploitation of ferric resources did occur beyond the bounds of the Weald Clay, both on the Greensands, and in some cases the later Chalk formations. In consequence, any contemporary interpretation of the Romano-British iron industry in the Weald must include the wider geographical region bounded by the Chalk Downs. For the purposes of this research, where exploitation of ferric resources occurred on the immediate boundaries of the Weald *strictu sensu,* these sites were included to allow a holistic framework for the Wealden industries.

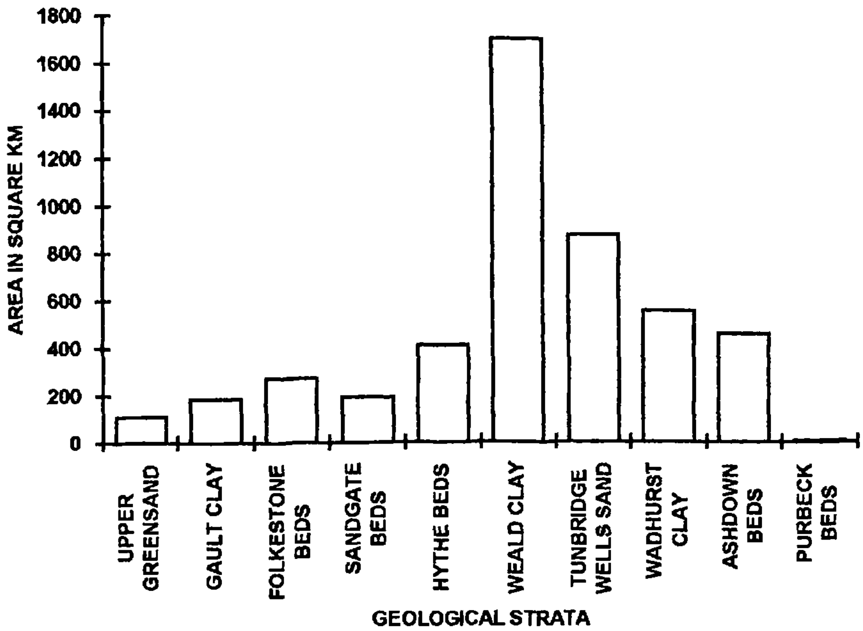


Fig 2. 2 The area covered by various geological strata in the Weald.

The Wealden region extends for 4720 km^2 and occupies half the land area of the contemporary Sussex counties, in addition to elements of Hampshire, Surrey and Kent. The area contains 10 major geological formations (see Fig 2.2), in three integral physiographical zones - the High Weald, the Low Weald, and the Scarp Foot, or periphery. The terminology is broadly expressive of the lithological differences. The Hastings Beds of the High Weald are surrounded by concentric bands of more recent strata, with the Weald Clay and the Gault Clay forming the low ground, while the more resistant Lower Greensand and Chalk, outside the Weald, remain as escarpments (see Fig 2.2).

Sedimentological analyses of the major formations of the Wealden region have been produced by Mellars and Reinhardt (1978: 251), using the earlier data

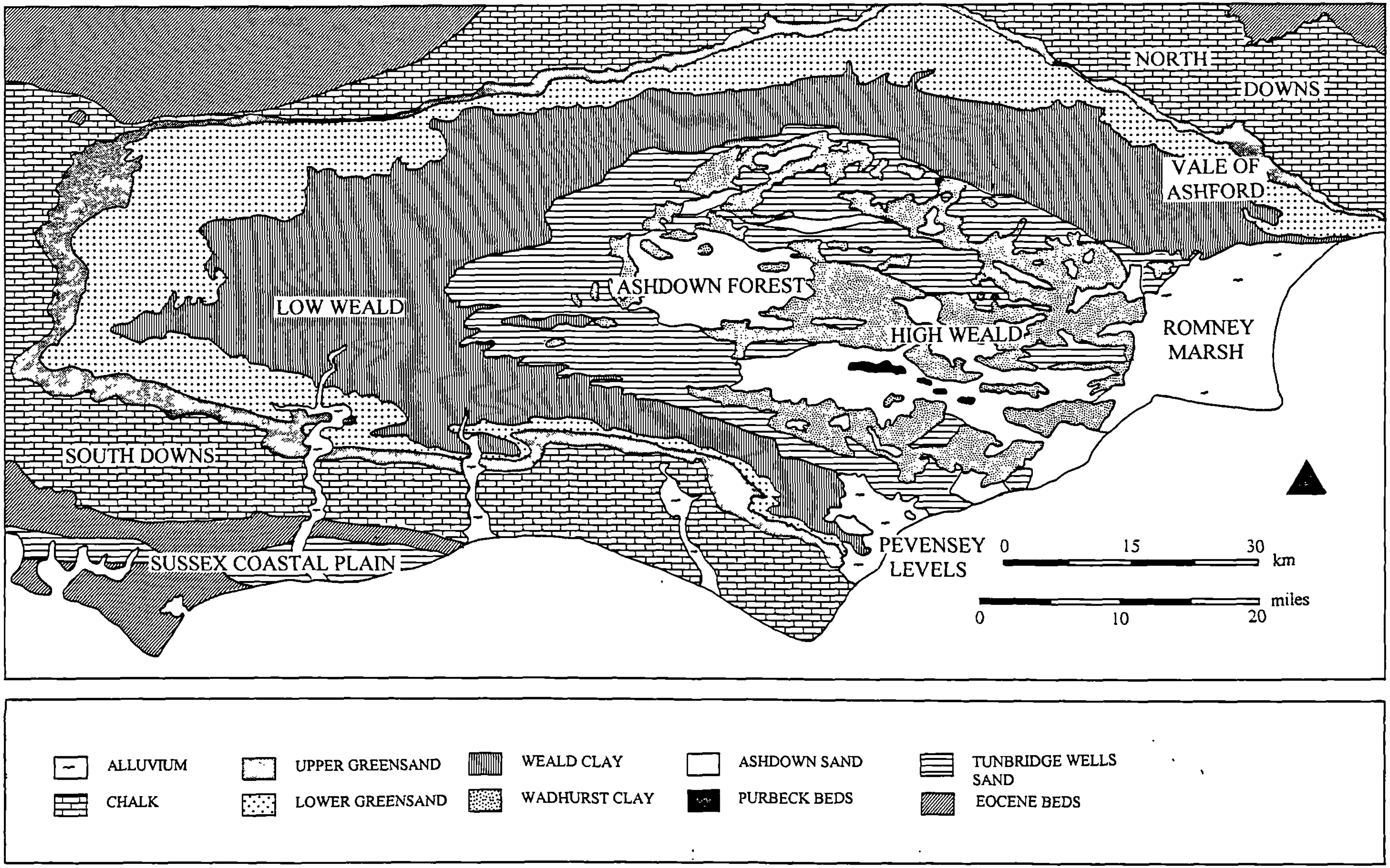


Fig 2.3 The major physiographic zones of the Weald

of Hall and Russell (1911). These data reveal a dominance of coarse-grained sand in the Folkestone Beds of the Lower Greensand, which is followed by the other divisions, the Hythe and Sandgate Beds, with 10-30% less coarse sand than in the Folkestone Beds. In the sandstone formations of the High Weald and the Upper Greensand, there is a consistent drop in the percentage of coarse sand, and the total sand element only achieves 40% of the total composition. The clay formations which include the Weald, Wadhurst, and Gault Clays, have sand comprising only 20-25% of the total along with the dominant sediments of the clay and silt grades (see Fig 2.4).

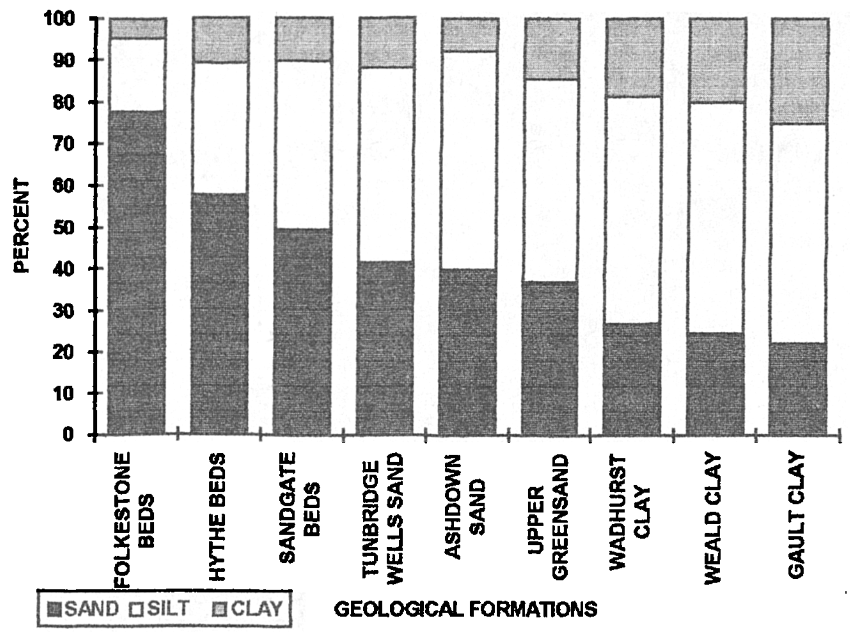


Fig 2. 4 Granulometric composition of soils developed on different geological formations of the Weald (Data: Mellars and Reinhardt 1978: Table 3).

The relationship between Wealden soils and parent materials, such as solid geology and superficial drift, was first considered by William Topley (1841-1894) in 1872, while writing on the Agricultural Geology of the Weald. This was later amalgamated to form the *Geology of the Weald* (Topley 1875). In most cases there is a strong correlation between the solid geology and the soil types, however, some blurring of these boundaries does occur, especially on the Wealden periphery, where surface modification has occurred as a result of the mobilisation of surface material through colluvial or fluvial action.

Detailed surface mapping of the soils of the Weald has only occurred in two areas, incorporating approximately 250 km^2 of Romney Marsh (Green, R. D. 1968) and approximately 100 km^2 in the vicinity of Ashford in Kent (Fordham and Green 1980). A more generalised regional classification of the soils of the Weald has been undertaken by McRae and Burnham (1975). This has resulted in the classification of thirteen soil associations labelled A-N, which extend from calcareous rendzinas (A), to raw sands and alluvium (N).

THE HIGH WEALD

The High Weald denotes an area of 1870 km^2 extending from Hastings on the Channel coast to Horsham in the north-west, and represents 39.6% of the total Wealden land surface. The broken upland attains heights of 240 m in the Ashdown Forest and 216 m at Brightling Obelisk.

The erosion of the anticlinal structure has resulted in the exposure of older strata as they are traced inwards towards the geographic centre of the upfold, with the oldest strata of the Upper Jurassic Purbeck Beds and Lower Cretaceous

Ashdown Beds exhibited in the Central or High Weald (Whittow 1992: 73). Three small Upper Jurassic inliers of the Purbeck Beds, comprising a total of approximately 5 km^2, are exposed between Battle and Heathfield, at Archer Wood, Darwell Wood and at Brightling-Broadoak. Although the primary source of iron ore in the High Weald derives from the lower beds of the Wadhurst Clay, (Straker 1931: 14) localised deposits were probably obtained from older formations such as the Purbeck Beds. Some clay ironstone can be found on the upper parts of this limestone formation (Worssam 1985: 8).

The primary geological formations of the High Weald are the Hastings Beds, comprising the Wadhurst Clay (545 km^2), the Ashdown Sand (455 km^2) and the Tunbridge Wells Sand (865 km^2). The junction between the High Weald and the Low Weald is essentially formed by the various divisions of the Tunbridge Wells Sand and the Weald Clay, with the exception of three small exposures of Wadhurst Clay between Tonbridge and Tenterden on the eastern boundary. The Tunbridge Wells Sandstone displays three sub-divisions - the Lower Tunbridge Wells Sand, Grinstead Clay and the Upper Tunbridge Wells Sand. The Lower Tunbridge Wells Sand includes the Ardingly Stone, a major source of building stone for the central Weald. To the east of Horsham, where the Upper Tunbridge Wells Sand outcrops, alternate beds of sandstone and clay are exhibited. The region now supports the development of St. Leonard's Forest. Geological research by Worssam (1972), which elucidated the distribution of minepits and other

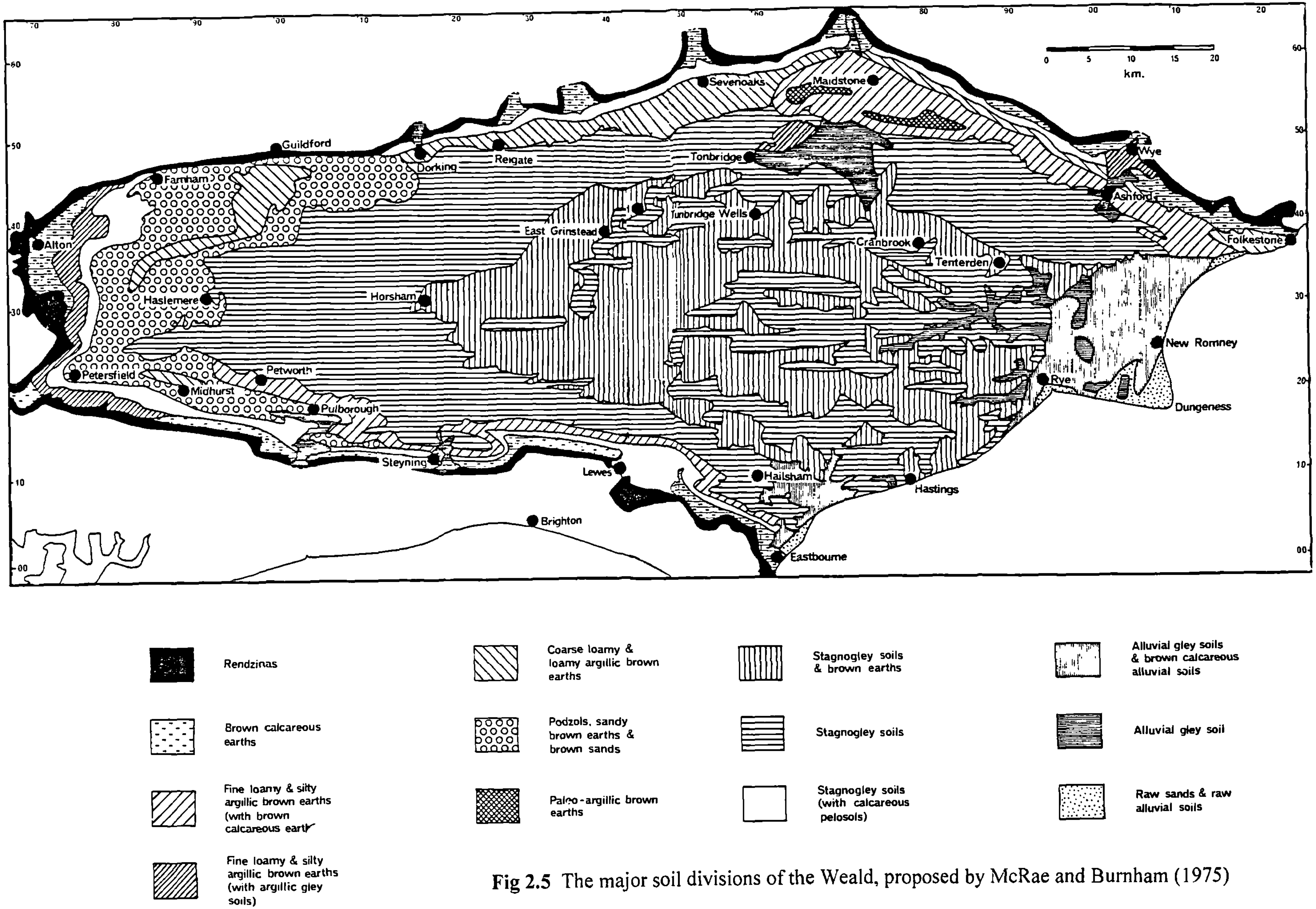


Fig 2.5 The major soil divisions of the Weald, proposed by McRae and Burnham (1975)

evidence of iron production in this region of the Upper Tunbridge Wells Sand, revealed that these formations could sustain extensive mining operations.

The Ashdown Sands are expressed in the south of the High Weald in the extensive tract of heathland, known as the Ashdown Forest. The ore sources in the Ashdown Beds are considerably less productive than the other constituent formations of the High Weald - the Wadhurst Clay and Tunbridge Wells Sand. However, ore is not absent; some derived sources do exist. This was sufficient to influence the location of 9 post-medieval blast furnaces and forges in the Ashdown Forest region. Of the formations which constitute the Hastings Beds, the Wadhurst Clay represents the most prolific source of iron ore, in the form of clay ironstone. It was this clay formation which sustained much of the Wealden iron industry of all eras.

The characteristic compact subsoil of these geologies results in the development of *stagnogley* soils, which McRae and Burnham (1975: 601) consign to two different associations, both characterised by conditions of impeded drainage. The sandstone-dominated lithologies are overlain by stagnogley soils and brown earths (McRae and Burnham's association H); these have a tendency to support both woodland and permanent pasture, although the poorer tracts of land, such as the association J podzolic soils of the Ashdown Forest, are under heath.

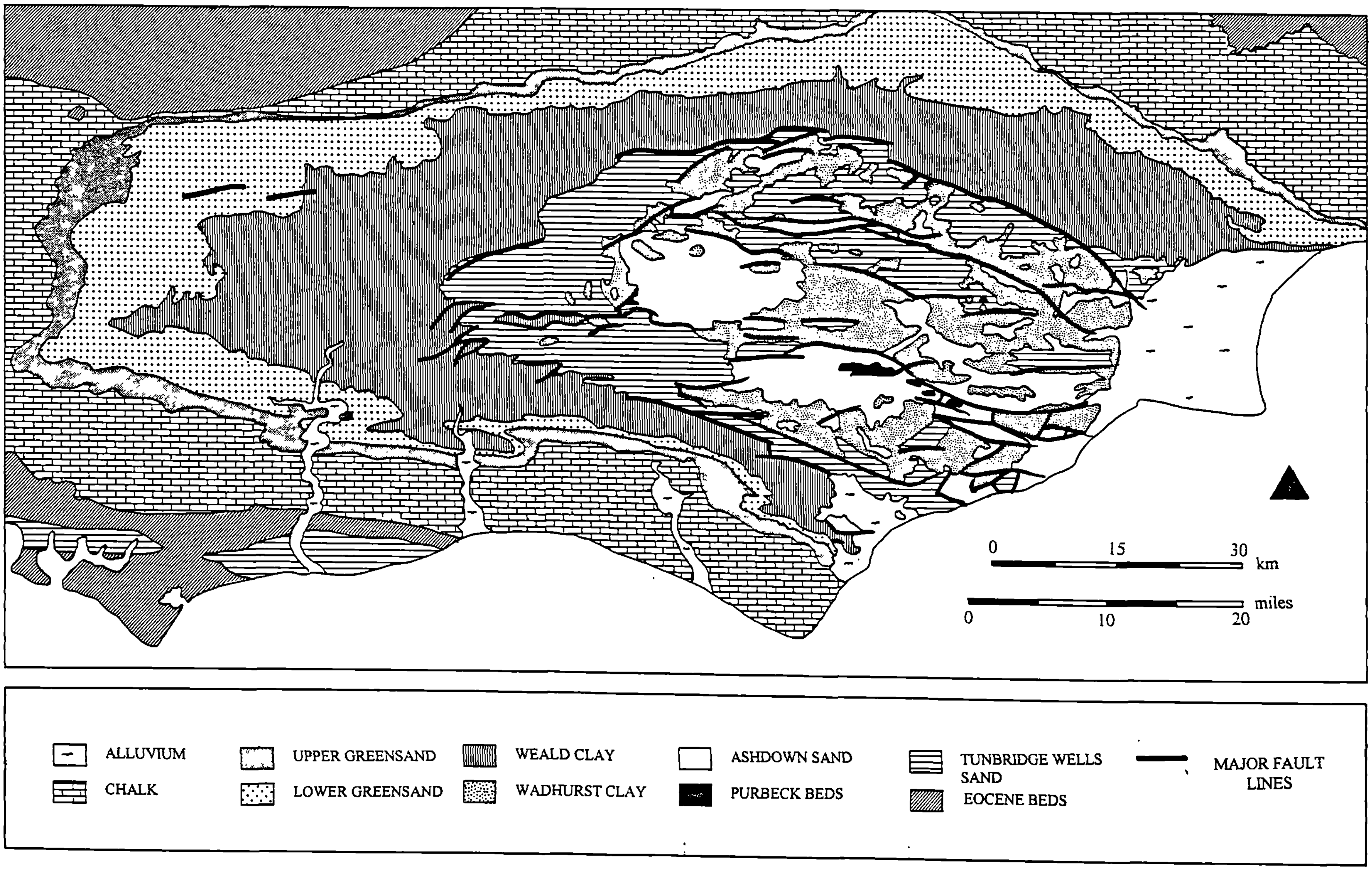


Fig 2.6 The major fault lines of the Weald

The denuded clay outcrops of the High Weald which form the Grinstead Clay, Wadhurst Clay, and Fairlight Clays are composed entirely of stagnogley soils of association J. By contemporary standards, the High Weald is characterised by poorly drained, acid, infertile soils in an extensively undulating topography. This encompasses a wide disparity of complex ecologies.

The intricate geology of the High Weald is further complicated by numerous faults running principally east-west (Trueman 1971: 92, see Fig 2.6). This complex faulting and erosional sequence has resulted in the retention of two exposures of Weald Clay - in the western High Weald to the north of Cuckfield, and in the eastern High Weald to the north of Appledore. In addition, much of the boundary of the High Weald results from the expression of fault lines in the contemporary landscape. The extensive faulting, in conjunction with the denudation of the Hastings Beds, has resulted in the tendency to the formation of parallel east-west ridges, giving rise to the local name of the "forest ridges". The formation of this topography is often detrimental to communication, which, when considered in conjunction with the heavily wooded nature of much of the terrain, results in the insularity of the central Weald evident even in contemporary society.

A highly characteristic feature of the High Wealden region is the heavy incision caused by the erosion of tributary streams through overlying sands into the basal clays. The resulting steep-sided valleys, known colloquially as ghylls, are often extremely damp and densely wooded, being highly marginal with little or no agricultural use. Such erosional features may have allowed Roman metallurgists to view exposed iron-bearing strata in the stream sections, and therefore acted as a focus for iron production.

The junction between the High and Low Weald is not as clearly defined in all regions as the name might suggest. In the north and east of the High Weald, in the vicinity of Tenterden and Tonbridge, the dichotomy with the low-lying Weald Clay is well expressed. However, on the western boundary of the High Weald in the Horsham Crawley region, this boundary is less evident.

THE LOW WEALD

The Low Weald, which includes the Vale of Sussex and the Vale of Kent, is a U-shaped corridor of denuded Weald Clay, expressed in the contemporary landscape as a low-lying, relatively featureless region in relation to the High Weald and the surrounding Greensand and Chalk escarpments (Trueman 1971: 95). Covering approximately 1690 km^2, this region represents 35.8% of the land surface of the Weald. Although the Purbeck and Hastings Beds of the High Weald are heavily faulted, little faulting or folding affects the Weald Clay, due to its inherent plasticity. Therefore, although moderate undulations are extant in the Weald Clay, the extensive denudation on the softer clay has meant that these rarely exceed 130m O.D. The U-shaped clay corridor is truncated at its terminals by the coast of the eastern Channel, to form the two marshlands of the Weald, at Pevensey and

Romney. The selective erosion of these clay strata compared to the High Wealden geologies has given rise to these marshland environments. The clay substratum is relatively narrow in the hinterland of Pevensey; however, wider tracts are exposed to the west of Horsham, where it broadens to a maximum width of 24 km. On the northern edge of the High Weald the clay belt decreases to 6-8 km, which gradually extends south-eastwards as it approaches Tenterden. The greater thickness of the Weald Clay in the vicinity of the Channel coast in this section of the eastern Low Weald, explains the greater size of Romney Marsh compared to the considerably smaller Pevensey marshlands.

The soil has been characterised by McRae and Burnham (1975: 601, 606, Fig. 1) as stagnogley of association J, although the dark grey Weald Clay can weather to form brown clays and loams. The Clay Vales are characterised by heavy waterlogged soils which historically supported permanent pasture in conjunction with oak, ash, and hazel woodland. Cobbett recorded that the "bottomless Clay would only grow three things well, oak trees, wheat and grass." Even though the impermeable nature of the Weald Clay results in impeded drainage, making it difficult to work and cultivate prior to modern cultivation methods, its high fertility has resulted in a large percentage of its surface being utilised for contemporary arable agriculture. Consequently, the present Weald Clay region actually contains the lowest density of woodland in the south-east. The Weald Clay is not a completely homogenous deposit but comprises 457m of strata whose major formations include the Upper Weald Clay, Horsham Stone and Lower Weald Clay (Reeves 1968). Where exposed beds of shelly limestone and sandstone occur, soils are light enough for cultivation with little manipulation. The shelly limestone, known as Paludina Limestone, is composed predominantly of fresh- to brackish-water snail shells. It is beneath the hard flaggy sandstone, or Horsham Stone, near the base of the Weald Clay that the primary deposits of clay ironstone occur. This sandstone is not exposed throughout the Weald Clay region.

The Weald Clay also contains localised bands and nodules of ferruginous material. In addition, the stagnogley soils encourage the deposition of iron pan which has been recorded as an ore source at some sites. These deposits were extensively exploited for metalliferrous resources during the post-medieval era, but comparatively little Romano-British exploitation has been recorded within the confines of the region, compared to the High Weald and the peripheral geologies.

THE WEALDEN PERIPHERY

The Scarp Foot region or periphery is located below the northern scarp edge of the South Downs and to the south of the Wealden Vale. This is composed of three concentric bands of geological formations - the Upper Greensand (110 km^2), the Gault Clay (185 km^2), and the Lower Greensand (865 km^2). The Lower Greensand is further sub-divided into three component geologies - the Folkestone Beds (270 km^2), the Sandgate Beds (190 km^2), and the Hythe Beds (405 km^2). The total scarp foot region covers approximately 1,110 km^2, and comprises approximately 24.6% of the total land surface of the Weald. The escarpment of the Lower Greensand formations achieves its greatest height at Leith Hill (294 m), to the west of the Mole Valley, and at Black Down (280 m), to the north of the Vale of Fernhurst. The formation gradually thins between the Adur Valley and the coast at Eastbourne. The Upper Greensand is poorly expressed in the eastern and northern Weald, but thickens considerably to the west of Reigate. It forms a prominent escarpment at Selborne (174 m), to the north of Petersfield.

As with the Weald Clay, extensive denudation of the Gault Clay forms a narrow clay vale, known as the Vale of Holmesdale in the north of the Weald, which is contained within the escarpments of the Downs and the Lower Greensand. The soils are similar in nature to those of the Wealden Vale, however, in certain locations on the Upper Greensand and in Combe deposits on the Gault, extensive modifications have occurred as a result of the influx of calcareous material of colluvial origin from the adjacent Downs. These brown earths of association B (McRae and Burnham 1975: 598), in conjunction with the fine loamy and silty argillic brown earths and subsidiary argillic gley soils of association D, facilitate better drainage and enhanced fertility. This, in conjunction with the emergence of the spring line at the scarp foot of the Downs, has resulted in extensive settlement and cultivation. Only in the western Wealden periphery, between Dorking and Steyning, does the Lower Greensand support acid, infertile and coarse-textured podzols of association F (McRae and Burnham 1975: 599-600). This has a tendency to support both woodland and expanses of heath.

CHAPTER THREE

THE ENVIRONMENT AND ARCHAEOLOGY OF THE PRE-ROMAN WEALD

THE ENVIRONMENT AND ARCHAEOLOGY OF THE PRE-ROMAN WEALD

THE NATURE OF THE EVIDENCE

Prior to the utilisation of inorganic alluvial sequences for the acquisition of palynological data in the Wealden region, the primary method of determining environmental change in the prehistoric era has been through the analysis of soil pollen sequences; a technique developed by Dimbleby (1954, 1957, 1961a, 1969b). The presence of significant numbers of surviving archaeological monuments in the south-eastern region has resulted in a relatively high number of palynological analyses of palaeosols from terrestrial archaeological contexts (Scaife 1987: 125). However, notable biases do occur in the geographical and geological distribution of monuments likely to preserve palaeosols. The deleterious effect of calcareous soils on the survival of pollen, in conjunction with the concentration of archaeological resources into rescue contexts, emanating from sand and gravel extraction on the Greensands, has resulted in the production over time of a nucleated group of soil pollen profiles from the leached acid podzols beneath Bronze Age funerary monuments on the Folkestone Beds of the western Lower Greensand[†]. The preservation of pollen in mineral soil profiles is

† Pollen evidence from palaeosols has been recovered from beneath Bronze Age barrows, in the western Wealden periphery, at Iping Common (Dimbleby 1965a), Oakhanger Warren VII and VIII (Rankine *et. al.* 1960,), West Heath I, II, III, IV (Baigent 1976), West Heath barrows V, VIII, IX (Scaife 1985), and Rackham (Dimbleby and Bradley 1975). In addition, Iron Age ramparts at High Rocks in the High Weald have also provided palaeoenvironmental evidence (Dimbleby 1960).

dependent on enhanced levels of acidity which, by circularity, can often be the result of human interaction. These monuments are, however, essentially peripheral to both the High and Low Wealden lithologies and to the calcareous chalk downland.

The superficial nature of many Wealden excavations (Moffatt 1984: 7), and biases caused by the distribution of individual fieldworkers and research groups (Gardiner, M. 1990), in conjunction with both a decrease in the density of sites (*ibid.*: Fig. 1) and the ephemeral nature of much of the archaeological evidence, has significant implications for the acquisition of palaeo-environmental evidence. The apparent absence of large numbers of earthworks from the High and Low Weald has resulted in a deficiency of stratified and securely dated deposits when compared to other areas of southern Britain. In addition, the study of prehistoric sites in the High Weald region has not received the attention that has been devoted to Romano-British and later sites (Sheldon 1978: 6).

The analysis of pollen from terrestrial peat in the Wealden region is extremely rare. Although a significant nucleus of organic peat deposits from non-alluvial contexts does exist in the Ashdown Forest area of the High Weald region, these have never been utilised for palaeo-environmental studies. This is primarily a function of their utilisation as a fuel source during the historic era, and the corresponding truncation of environmental sequences that this entails.

The problems in the creation of organic peat deposits suitable for pollen extraction in the south-eastern region have been noted by Scaife (1987: 26-7). These include the deficit in summer rainfall, which is detrimental to the formation of ombrotrophic bogs; the absence of suitable glacial incised topography; and anthropogenic truncation or destruction of existing bogs during the later historic periods. The dominance of pollen data from palaeosols in the western Greensand belt has resulted in the inception of several university-based research projects designed to overcome this bias in environmental data from the Wealden periphery (cf. Thorley 1971, Jennings 1985, Moffat 1984, Burrin 1983, and Scaife 1987: 153). In these cases non-archaeological palynological data was obtained from both coastal peat deposits and from predominantly inorganic alluvial sequences. This research has resulted in a significant increase in the quantity of radiocarbon-dated pollen sequences from the south-eastern region. The greatest increase in palynological knowledge has occurred in the coastal region of the Weald, where both the High and Low Wealden geologies are truncated by the eastern English Channel[†].

The major sources of environmental evidence from the Wealden region include the use of palynological data from palaeosols from archaeological contexts

[†] Sediments for extended alluvial sequences, and organic deposits which allow for radiometric determinations, have been analysed by Jennings (1985) on Willington levels; Smythe and Jennings at Combe Haven, near Hastings (1988); Burrin and Scaife at Sharpesbridge in the Ouse valley (1984); Scaife and Burrin at Stream Farm in the Cuckmere Valley (1985); Burrin at Robertsbridge (1988).

which provide evidence for site-specific, local environmental change. The alluvial sequences from non-archaeological contexts provide evidence for the nature of the local and regional environment, although extrapolation of data has been suggestive of anthropogenic impacts upon the ecosystem. Palynological evidence has often been used in conjunction with soil and sediment analysis. These can be either quantification of the volume of alluvial sediment deposited in river basins, such as those studies undertaken in the valleys of the coastal Weald (Burrin 1988, Scaife and Burrin 1983, 1985), or the determination of leaching, podzolisation and enhanced acidity in mineral profiles.

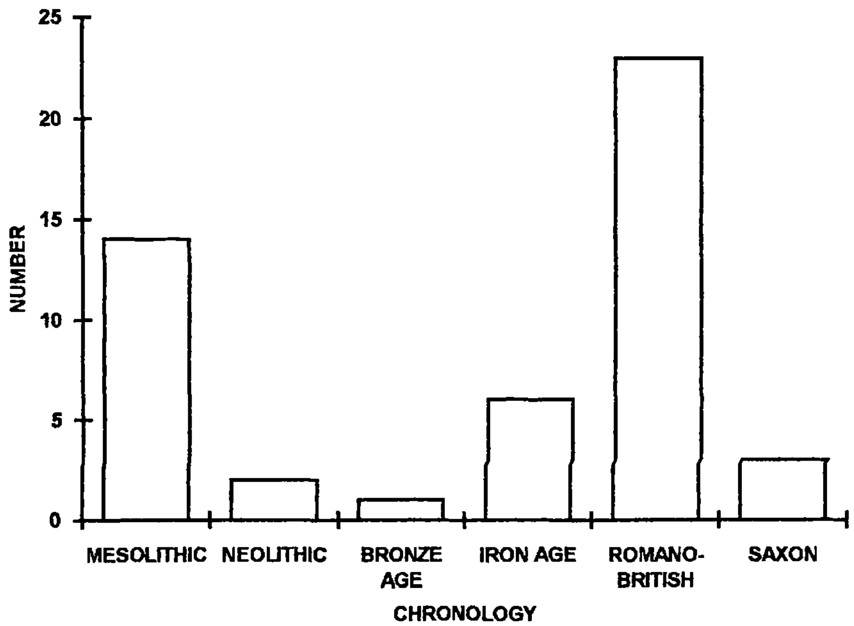


Fig 3. 1 The comparison of the number of archaeological charcoal analyses between sites of various eras.

In addition to palynology, the analysis of macrobotanical remains from archaeological contexts can provide direct evidence of anthropogenic exploitative behaviour, which can, in most cases, be related directly to a spatial and temporal zone. No concerted attempts have been made to recover macrofossils from archaeological contexts in the Weald. Recovery, and analysis, have taken place on an *ad hoc* basis, and are temporally biased in favour of the Romano-British era, when the major fuel consumptive industries came to prominence.

In general, environmental data from the Weald, especially the High Weald, are sparse (Sheldon 1978: 6). This is primarily a function of the absence of concerted archaeological research within the confines of the High and Low Weald, especially on pre-Roman sites. The deficiency of archaeological research and the absence of secondary environmental evidence has enhanced hypotheses of the impenetrable "primeval Weald," which, through circular argument, is detrimental to further research. However, in a geographical region encapsulating 4720 km^2, regional generalisations based on sources geologically biased to the south-western extremities of the Greensand periphery, the coastal alluvial and marshland sequences, interspersed with rare local studies, do have limitations. The almost total absence of any palynological data from the central High Weald does create problems, as the concerted analysis of complementary macrobotanical remains from prehistoric contexts is also rare.

THE PALAEOLITHIC (TO 8000 B.C.)

The distribution of Lower and Middle Palaeolithic sites in the Wealden region has been recorded by Roe (1968: 295-305), and Woodcock (1981). However, the vast majority of these sites are represented by isolated artefacts and not *in situ* deposits and, as such, have yielded an extremely low frequency of environmental data covering a vast temporal span. The major Palaeolithic occupation sites are located at Swanscombe in Kent and Boxgrove in West Sussex to the north and south of the Weald.

The harsh periglacial conditions of the Late Devensian resulted in extensive pedological instability resulting from cryoturbation and solifluction (Macphail and Scaife 1987: 31). Such extensive pedological disturbance and disruption resulted in the removal of many superficial deposits and their associated palaeo-environmental data (Sheldon 1978: 5). The vast majority of the corpus of environmental data begins at the Late Devensian / Flandrian transition.

THE EARLY MESOLITHIC (8000-5000 B.C.)

The inception of the Early Mesolithic corresponds to a period of rapid climatic warming after the colder, wetter conditions of the final Late-glacial, or Younger Dryas. This phase is analogous to Godwin's pollen Zone IV or the Flandrian I chronozone. Archaeologically the Early Mesolithic, extending between c.8,000 and 5,000 b.c., witnessed the development of typological variations from the lithic technology of the Upper Palaeolithic. These are exhibited by a decrease in the size of scrapers and blades which eventually became microliths, in addition to the emergence of new tool types such as the flaked *tranchet axe*. The introduction of the 'tranchet axe' to the lithic assemblages of the early Flandrian, apparently for wood cutting, amongst other uses, could be indicative of the need for clearing the new closed forest communities, which were not a component of the environment of the Late Devensian (Simmons *et al.* 1981: 103). The economic strategy of gathering, hunting, and fishing was essentially the same as that of the Palaeolithic, although the increase in temperature beginning during the Procratic phase of the Holocene allowed for the procurement of a more extensive diet of fauna and flora than could have been obtained during the harsh conditions of the Late Devensian.

The Procratic witnessed the rapid amelioration of temperatures as indicated by climatic data from Coleoptera (Osborne 1974), pollen sequences (Pennington 1969: 41), and oxygen isotope levels from sea floor cores (Simmons *et al.* 1981: 89). The *combination* of climatic amelioration and the development of stable pedological changes after the periglacial instability of the Late Devensian (Wymer 1981: 50) allowed for the expansion of arboreal species at the expense of the established herbaceous communities. These factors, in conjunction with the open nature of the vegetation communities present in Zone III, allowed for the rapid increase of the pioneer arboreal taxa (Macphail and Scaife 1987: 39).

Environmental evidence for the Early Flandrian is generally sparse (Simmons *et al* 1981: 82), although some pollen sequences from the Wealden region and its immediate borders provide environmental evidence for the Early Flandrian. A characteristic element of the Late Devensian - Flandrian (Zone III / IV) transition is the expansion of juniper. A radiometrically-dated pollen sequence from the coastal Weald at Willmington levels revealed the presence of stands of *Juniperus* by 10,000 B.P. (Jennings 1985: 218). This extension of juniper during the early Flandrian succession is normally explained as either an increase in the actual number of trees or their ability to flower in the warmer conditions of the Pre-Boreal (Caseldine 1990: 33, Pennington 1969: 42). This juniper maximum is characteristically followed by an expansion in the values of birch pollen which relatively quickly extinguish the shade-intolerant Juniper.

Although *local* variations in vegetation composition do occur, dependent on changes in topography, lithology and water regimes, the general nature of the post-glacial succession remains. The rapid influx of juniper was quickly followed by pioneer colonisation of birch and hazel, which was closely followed by the expansion of pine in the Wealden region This succession is characteristic of all geological zones in the south-east, including the chalklands, the Greensands and the Wealden lithologies.

The extreme southerly nature of the Weald in relation to the retreating ice sheets allowed for a more rapid rise in temperatures than could be achieved north of the Thames Valley. Once the mean temperature in the later Pre-Boreal and Early Boreal (Zone VIc) Weald allowed for the expansion of oak and elm, their longer life span, in conjunction with their taller canopies, allowed for the progressive elimination of the light-demanding birch and hazel communities. This

Fig 3. 2 The location of Mesolithic archaeological sites in the Weald.

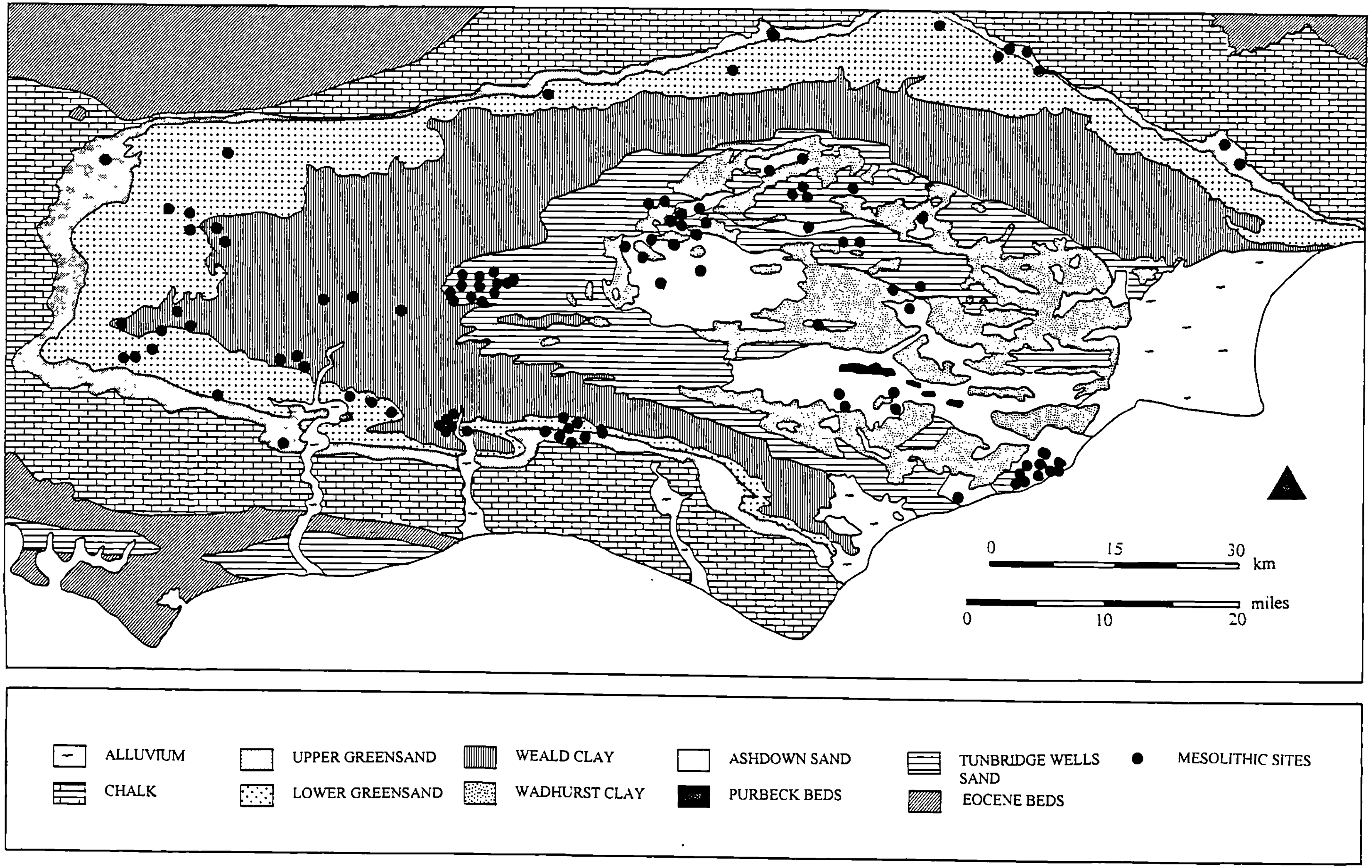


Fig 3.2 The distribution of Mesolithic archaeological sites in the Weald

resulted in the eventual dominance of oak, elm, ash and lime in the *'climax forest'*. Isochrone (isopollen) maps extrapolated from a limited number of samples from the south-eastern region demonstrate a general advance of both oak and elm into the Weald by 9000 B.P. (Birks 1989). The appearance and expansion of lime, the most thermophilous of British trees, in the pollen record of Zone VIc, is an index of the ameliorating climate. A classic example of these climax communities has been recovered from the Vale of the Brooks, near Lewes; a well-established elm and lime woodland existed during the Early Flandrian, and damp valley bottoms supported alder, while on the surrounding chalk, oak and hazel communities existed (Thorley 1971, 1981).

ANTHROPOGENIC IMPACT

This early phase of the Mesolithic revealed what has been interpreted as one of the earliest recorded impacts attributable to Mesolithic communities on the local environment. Pollen analysis of a soil sample, from the palaeosol preserved beneath a Bronze Age round barrow at Iping Common, revealed what appeared to be a rapid transition from hazel-dominated woodland to ericaceous-dominated heathland. This has been tentatively attributed to Manglemosian environmental impact as a result of *in situ* flint knapping on the site. The earliest phase of this activity was dated on botanical grounds to the early Boreal (Keef *et al.* 1965: 88). The correlation between archaeological evidence of intensive occupation and the replacement of hazel woodland implied an anthropogenic origin. Dimbleby (*ibid.*) suggested that a major biotic influence could have been the anthropogenic utilisation of fire, as intensive grazing was likely to have favoured grasses which did not show a significant percentage increase. After the initial rapid decline the hazel woodland witnessed a temporary regeneration; although total recovery was never achieved during the Mesolithic or subsequent prehistoric eras. In addition to the palynological data, soil degradation was manifested in the burial of the Mesolithic occupation horizons by wind- and water-deposited sediment, of possible Atlantic date.

The permanence of the change suggested by the palaeo-environmental and pedological evidence from Iping Common is summed up by Evans (1975: 99), who notes that "here is evidence for the destruction of hazel woodland leading to a heath environment, accompanied by soil deterioration and, later, by wind erosion - all being brought about by hunting communities in the sixth millennium b.c."

THE LATER MESOLITHIC (5000-3500 B.C.)

The later Mesolithic, corresponding to the Flandrian chronozone II and Godwin's pollen Zone VIIa, represented the climatic optimum of the post-glacial, with an increase in mean annual temperatures of 2-3°C greater than those of today (Evans 1975: 71). This would have encouraged relatively stable environmental conditions compared to the rapid ecological change of the Pre-Boreal and Boreal.

Archaeologically, this phase was characterised by differences in lithic technology; however, the ability to recognise these has been questioned.

Two Bronze Age round barrows excavated under rescue conditions at Oakhanger Warren (sites VII and VIII), in Hampshire, revealed evidence for a gradual depletion of the forest cover which was characteristically manifested by a percentage increase in the pollen of heather and grasses. The overall composition of the pollen spectra was indicative of the Later Mesolithic or Godwin pollen Zone VIIa (Rankine, Rankine and Dimbleby 1960: 255-62). At Oakhanger VIII, erosion occurred in the Atlantic period.

Rescue excavation, in advance of sand extraction, at the nucleated barrow complex at West Heath, revealed evidence of utilisation between 2100 – 1450 B.C. (Drewett 1975a, b, c, 1976a, b, 1981, 1985). Palynological analysis of the preserved palaeosols beneath barrows I, II, III, IV (Baigent 1976) and V, VIII, IX (Scaife 1985), revealed evidence of anthropogenic manipulation of the local environment beginning in the Mesolithic.

Scaife (1985: 58) suggested that the lowest horizon of sandy brown earths would have sustained a deciduous forest cover during the Atlantic period; however, this was not represented in the pollen diagrams, as both the nature and low acidity of the soil profile at this time would have been detrimental the preservation of pollen. The presence of Mesolithic lithic assemblages in conjunction with a hearth radiometrically dated to the Later Mesolithic, was considered by Scaife (*ibid.*) to be indicative of the earliest phases of forest manipulation. This was manifested in the palaeosol by enhanced soil acidity. Palynological evidence of these early clearance phases revealed the presence of a background forest cover of mixed oak forest, dominated by oak, lime, elm and ash. The anthropogenic or naturally-induced clearings appear to have been dominated by pioneer hazel and birch scrub.

Rescue excavation in advance of sand extraction, by the Sussex Archaeological Field Unit, at Minsted (Drewett 1975b, 1975c) revealed evidence for a palaeosol which was utilised for palynological analysis (Dimbleby 1975). Minsted was one of two outliers to the south-east of the Iping Common barrow group (the West Heath), similarly located on the Folkestone Beds of the Lower Greensand. A small scatter of Mesolithic material was recovered from beneath the barrow (Drewett 1975c: 56), in conjunction with a concentration of lithics, found prior to excavation to the north-west of the site, which suggested considerable Mesolithic activity in the locality. This is complemented in the palynological record by evidence for arboreal depletion, and in the soil profile by acidification and podzolisation.

At Coombe Haven Valley, peat formation, interspersed with inputs of peaty clay and clay, occurred between 6020 ± 70 b.p. (SRR 2683), and 5900 ± 50 b.p. (SRR 2685). The organic conditions preserved palynological evidence for a canopy forest dominated by oak, elm, lime, and some hazel, possibly on the valley sides. The high percentages of alder pollen, in conjunction with macrofossil evidence, suggested that alder dominated the environment of the damp valley floor (Smyth 1986, Smyth and Jennings 1988: 7). The interbedded clay horizons corresponded with a decline in arboreal pollen and a rise in the pollen of *Chenopodiaceae*, grasses and sedge, which allowed for the postulation of intermittent esturine conditions (Smyth and Jennings 1988: 8). There was however, no palynological evidence which could be attributed directly to anthropogenic impact.

Similarly at Sharpesbridge on the River Ouse, substantial quantities of material of derived loessic nature have been recorded (Burrin 1981, 1983, Scaife 1983, Burrin and Scaife 1984, Scaife and Burrin 1983). This has been interpreted as the manifestation of accelerated erosion resulting from anthropogenic disturbance in the ecosystem. However, with the absence of direct archaeological evidence at these sites, the separation of natural and anthropogenic phenomena is highly problematical. Questions relating to the stability of early soils have prompted field experimentation in the loess regions of the Netherlands and Luxembourg, which have demonstrated the natural susceptibility of loess to erosion (Macphail 1987: 338-9).

Mellars and Reinhardt (1978: 265) suggest that the pine dominated assemblages, found on sandy lithologies and characteristic of Godwin zones IV-VIa, would have been vulnerable to anthropogenic impacts, as a result of anthropogenic and natural fires leading to soil degradation. This was predominantly the result of the nutrient-poor soil conditions which would have been enhanced by the free leaching of the essential elements in the highly porous sandy soil. The correlation between archaeological evidence for extensive Mesolithic activity and environmental evidence for environmental degradation associated with several examples of Mesolithic horizons, suggests that these less stable environments on the periphery of the Weald were subject to anthropogenic manipulation at an early stage of the Mesolithic. Mellars and Reinhardt (*ibid.*), consider that the tenuous environmental impacts ascribed to the later Mesolithic of the Lower Greensand related not to the utilisation of an "essentially virgin deciduous forest, but ... the exploitation and perhaps even deliberate management of an environment that had been to a large extent 'pre-adapted' for human settlement by a 1,000 years or more by humanly-induced disturbance in both vegetation and soils."

The extrapolation of this data to the lithologies of the High and Low Weald is problematical. The ecological effects of both natural and anthropogenic impacts on the peripheral belt of sandy Wealden soils would have resulted in accelerated and prolonged environmental degradation which might have had a different effect compared to the deciduous woodland of the clay and silt-dominated soils of the central Weald. However, the Wealden lithologies exhibit a dichotomy between clay- and silt-based perant materials, such as the Weald Clay (1,690 km^2) and

Wadhurst Clay (545 km^2), and the acidic lithologies of the Hastings series characterised by the Ashdown Sand (455 km^2), and the Tunbridge Wells Sand (865 km^2). In the High and Low Weald, sand-dominated lithologies constitute 37% of the total land surface. In the High Weald these lithologies represent 71% of the exposed strata. The acidic sands and gravels of the Hastings series have a propensity to degradation and podzolisation as exhibited in the extensive heathlands of the Ashdown Forest.

Extensive archaeological evidence has been recovered for Mesolithic activity in the central Weald, manifested by extensive lithic scatters both in the Ashdown Forest region (Tebbutt 1975) and the surrounding Weald clay (Standing 1964). Three radiocarbon determinations have been obtained from Mesolithic rock shelters in the High Weald. At Hermitage Rock, near High Hurstwood, a determination of 4850 b.c. ± 100 (Q 1312) was established (Tebbutt 1975: 41), while the rock shelter at High Rocks (site F) produced two determinations (Money 1960: 212) of 3700 b.c. ± 150 (BM 40), and 3780 ± 150 (BM 91), from a dubious context (Jacobi 1978a: 15). Radiocarbon determination at the Stonewall shelter, near Tunbridge Wells, suggests occupancy before 6000 b.c.

The only palynological analysis from the High Weald originated from the rock shelter at High Rocks, on an extensive outcrop of Tunbridge Wells Sand. The profile recovered suggested continuous woodland cover in the vicinity of the site during its occupation. The samples indicated a dominance of hazel scrub, in conjunction with beech, oak, birch and yew (Money 1960). However, it was considered that the occupation of the site was highly intermittent, possibly insufficient to instigate significant interaction with the environment. It has been suggested that the occupation of such central Wealden sites was seasonal, relating to hunting and foraging in this region, with permanent base-camps on the surrounding Greensands. It does have to be noted that analysis of the alluvial sediment from near the site produced extensive evidence for influx of inorganic sediment at some point during the prehistoric era. It is possible that activity in this locality was not always so negligible (Harding and Ostoga-Zagórski 1987).

The Mesolithic witnessed significant changes in the environment, including vegetational, climatic and geomorphological alterations. However, the most significant new element recorded in palaeo-environmental evidence was the widespread effects of human communities on the ecosystem. Perceptions of the Mesolithic interaction in the Weald have altered considerably over time. Curwen (1954: 54) suggested that "the claylands of the Weald would also (as the downs) be useless to him, not only because they are cold and damp for habitation but because in a state of nature, they would have been covered with dense impenetrable forest not worth clearing with 'tranchet' axes". The presence of Mesolithic lithics from the Weald was thought to be a result of hunting expeditions (Curwen 1954: 57). The research of Tebbutt in the Ashdown Forest, during the early 1970s, prompted his assertion that, "one cannot escape the supposition that a great deal of forest clearance took place, even in Mesolithic times, perhaps by fire or ring barking, and perhaps to increase the feeding grounds for wild animals" (Tebbutt 1975: 36). The evidence for Mesolithic flints in the High Weald is now considerable, with the discoveries of Tebbutt (1975) and Gardiner (1988); however, the low density of the flint scatters has prompted Drewett *et. al.* (1988: 22) to suggest that these could represent specialised activity centres such as hunting stops, although the presence of some tranchet axe finds in the Ashdown Forest could be indicative of forest clearance.

THE NEOLITHIC (3500-2000 B.C.)

Traditional interpretations of the Mesolithic/Neolithic transition and the Early Neolithic (cf. Case 1969) have undergone radical revision on both archaeological and environmental grounds. Palaeo-environmental evidence for the occurrence of cereal pollen in pre-elm decline deposits from sites in the British Isles has led to the suggestion that, in certain instances, cereals could have been a component of the Mesolithic economic strategy (Edwards and Hirons 1984). In addition, the elm decline and the apparently synchronous introduction of Neolithic material culture into the archaeological record is traditionally considered to be evidence for selective anthropogenic deforestation. The recovery of the bark beetle *Scolytus scolytus*, in pre-elm decline deposits has been heralded as an indicator of a possible

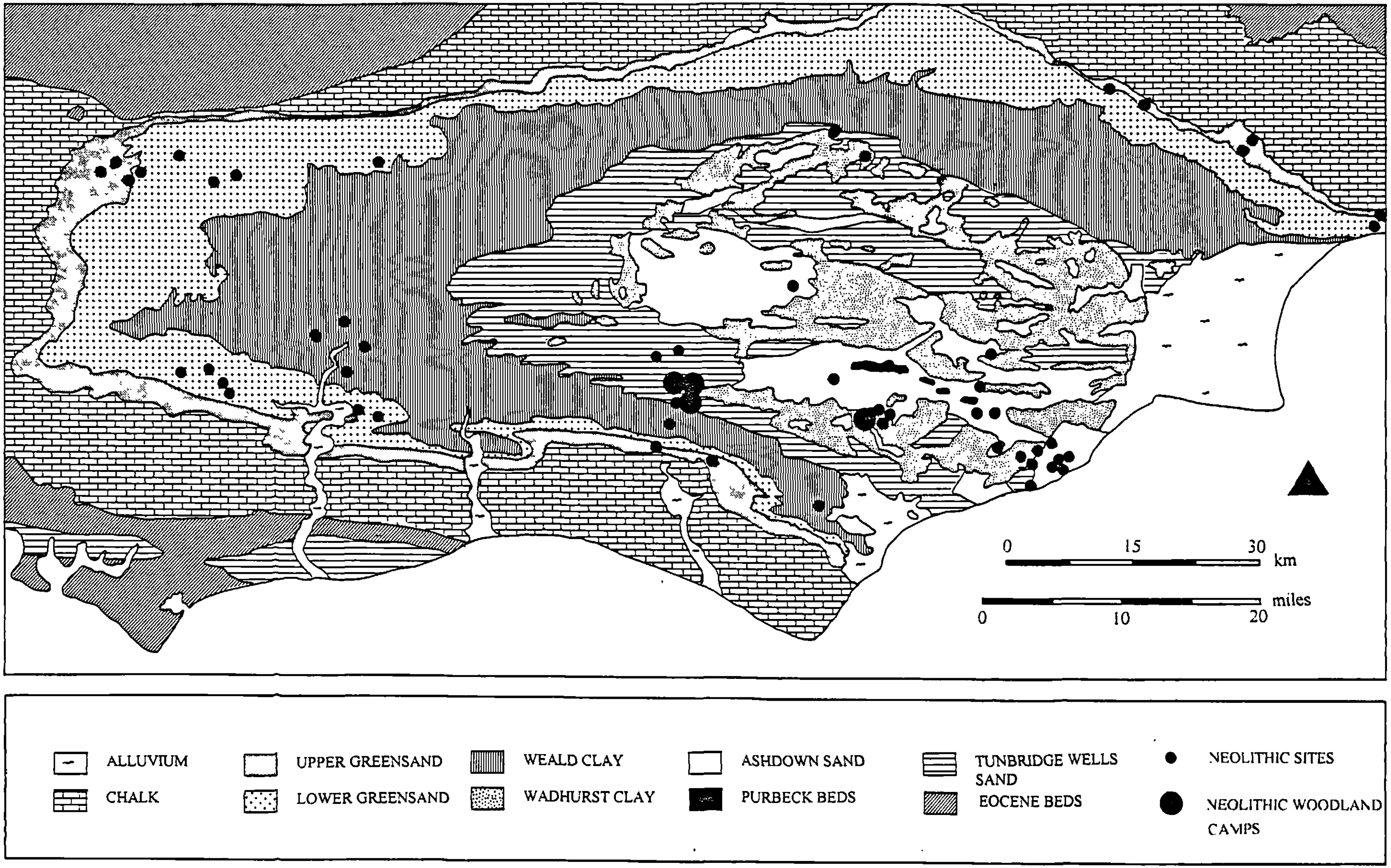


Fig 3.3 The distribution of Neolithic archaeological sites in the Weald

pathogenic origin for the elm decline rather than a purely anthropogenic process (Girling and Greig 1977).

The division between the Late Mesolithic and Early Neolithic is essentially an artificial construct. In the Wealden region of the fourth millennium b.c., as with elsewhere, there may have been no clear distinction, either archaeologically or environmentally, between Mesolithic and Neolithic communities. The mixed assemblages of Mesolithic and Neolithic flints suggests that there was some similarity in the use of the environment.

The distribution of Neolithic enclosure sites closely follow the line of the Downs surrounding the Weald (Drewett 1978: 23, Fig. 9). It is these, non-Wealden, calcareous lithologies and the coastal plain which provide the majority of the environmental evidence for the south-eastern region. Palynological analysis by Thorley (1981) in the Vale of the Brooks, 1 km from the chalk of the South Downs, revealed that the local environment was still wooded during the Neolithic; however a small temporary clearance was evident in the profile. Molluscan evidence from Bishopstone (O'Connor 197: 267-73) suggests that some form of anthropogenic woodland clearance might have occurred during the early Neolithic. This provides a contrast to molluscan evidence obtained from Neolithic sites at Offham and Alfriston (Drewett 1978: 23). Molluscan analysis of the palaeosol beneath the causewayed enclosure at Offham suggested that the site was constructed within an earlier woodland clearing; the surrounding woodland persisted through to the construction of a second bank and ditch at a later date. The species composition from the land surface beneath the barrow at Alfriston (2360 b.c.) suggested open grassland with some shrubs was established prior to the construction of the barrow.

Molluscan analysis from five causewayed enclosures on the South Downs by Thomas (1982) has revealed localised deforestation prior to construction followed by rapid regeneration of deciduous woodland. These disparate palaeo-ecological samples have been interpreted by Drewett (1978: 23) as the manifestation of a lightly-wooded landscape on the Downs, which existed in conjunction with clearances for settlement and other purposes.

As with all the prehistoric eras prior to the latter half of the first millennium b.c., the only definitive non-alluvial palynological evidence derives from the Greensand belt surrounding the Weald Clay. Possibly the most significant environmental evidence of Neolithic date comes from Rackham, West Sussex. Palynological analysis of the pre-barrow soil at Rackham revealed evidence for a wooded landscape dominated by oak, alder, birch and hazel during the sub-Boreal. However, by the end of the sub-Boreal, the pollen assemblage was dominated by *Calluna*. Late Neolithic flints were recovered from midway down the profile, although these could not be attributed to a recognisable land surface. It has been suggested that the flints were buried in the profile by earthworm activity and that the leached acid podzol was originally a brown earth with sufficient pH for the survival of worms (Sheldon 1978: 6). However, subsequent deforestation and the emergence of *Calluna* heathland resulted in base leaching and podzol formation (Dimbleby and Bradley 1975).

The projection of this environmental data to the central Weald, with its different ecological setting, is problematical. The presence of leaf-shaped arrowheads from the Weald Clay region does suggest that Neolithic communities were utilising the Weald; however, the absence of structures likely to produce surviving earthworks evidence negates the possibility of retrieving securely dated environmental evidence of Neolithic date, therefore, it is from this era onwards that environmental evidence for vegetational communities in the Weald becomes infrequent. Gardiner (1990: 42) has suggested that, Neolithic communities were making greater impact on the environment than their predecessors, although there is only limited corroborative environmental evidence to support this hypothesis. An alluvial pollen sequence derived from the High Weald, at Mayfield, suggests that during the Neolithic or immediate post-Neolithic there was extensive valley-side erosion, which was complimented in the pollen sequence by the pollen of *Gramineae* and *Plantago lanceolata* (Scaife and Burrin 1987). However, evidence from the pollen sequence at Coombe Haven Farm, suggests that there was little evidence of Neolithic impact with considerably more evidence of Bronze Age and Iron Age activity (Jennings and Smyth 1987).

THE BRONZE AGE (2000-600 B.C.)

Extremely little Bronze Age material has been recovered from the central Wealden region (Ellison 1978: 31, Fig. 14). Until recently, with the exception of the outlying Bronze Age round barrows on the peripheral Greensands, little settlement evidence or funerary monuments had been recovered from the High Weald or its surrounding Weald Clay. With only stray finds of MBA Bronzes, the possibility for recovery of securely dated palaeosols for palynological or macrobotanical analysis is minimal. However, tentative evidence exists for the presence of Bronze Age funerary monuments in the Ashdown Forest, postulated by Tebbutt (1975: 42), near Gills Lap, Nutley and two at Duddleswell, in addition to six centred at TQ 444291 and a possible site at Ewhurst (Jones, G. 1980). These sites have possible correlates at Mockbeggars, which has been interpreted as a ploughed-out round barrow (Cleal 1982) in conjunction with the surrounding Playden environs, which features circular crop marks possibly indicating further ploughed-out round barrows (Dickinson 1981). The apparent absence of activity in the central Wealden region is, therefore, significantly dominated by taphonomic factors (cf. Tebbutt 1975: 34). Bronze Age ceramics are highly prone to degradation in the plough soil, in addition to being relatively rare. The other known Bronze Age sites, on the Greensands, appear to concentrate around the entrances to the Weald across the Downs. This could be a taphonomic factor, or it could indicate an interest in the control of movement between different resource centres.

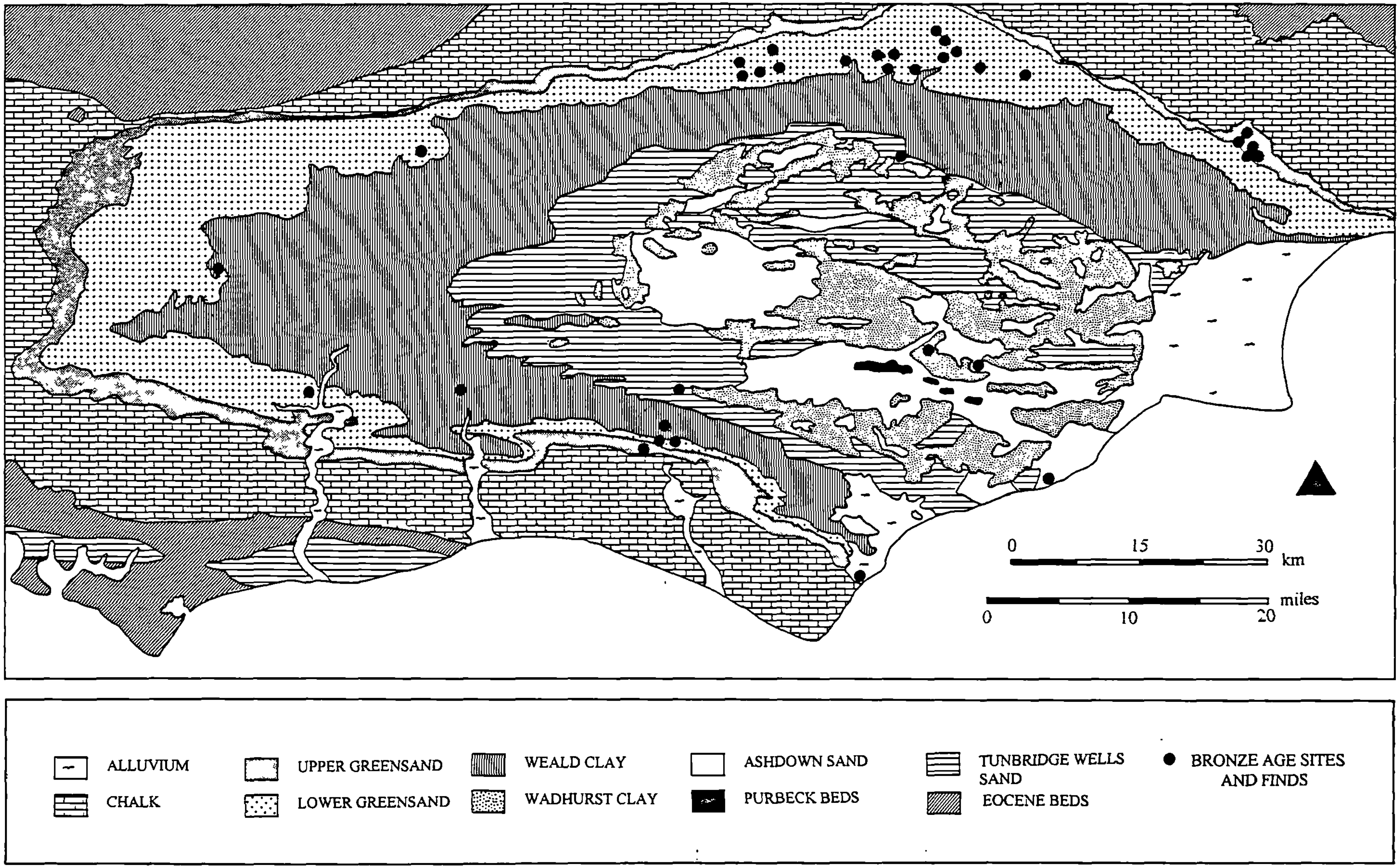


Fig 3.4 The distribution of Bronze Age archaeological sites in the Weald

Substantial deforestation on the South Downs to the east of the River Cuckmere had already occurred by the Early Bronze Age, as attested in the palynological data from the Vale of the Brooks, Lewes (Thorley 1971, 1981), and molluscan evidence from Bishopstone (O'Connor 197: 267-73). More extensive and permanent deforestation was to occur in the Vale of the Brooks during the M.B.A., radiometrically dated to c. 1240 ± 125 b.c. (Thorley 1981). Palynological data from Wingham near Canterbury suggests that the region was deforested as early as 1600 B.C. (Godwin 1962: 97). Palynological data from the palaeosols from the nucleated barrow cemeteries at West Heath, Minsted and Iping Common suggest that the Greensand belt had never recovered from the earlier impacts initiated during the Mesolithic. Evidence such as this has prompted Allen (1988: 83-4) to suggest that the "major permanent clearance in the south-east seems to have occurred in the Early Bronze Age (Beaker period) or Middle Bronze Age."

Palynological evidence derived from two cores taken at Lottbridge in the Willington Levels suggest that during a period of peat growth extending between 3,750 ± 40 B.P. and 3,390 ± 40 B.P., the drier elements of the levels and their surroundings supported a deciduous forest cover. In two of the pollen diagrams a decline was evident in the arboreal pollen levels, particularly those of oak. This was considered by Jennings (1985: 175) to be indicative of a phase of Bronze Age anthropogenic clearance. This was further correlated with the simultaneous presence of cereal pollen in the pollen record for Lottbridge site B. However, the origin of the pollen is not certain; several contrasting environments are located in the vicinity of the Willmington Levels, including the Chalk 5 km to the west, and the Gault and Upper Greensand ridges to the north (*ibid.*).

Godwin (1975: 263-4) suggested that the establishment of peat-forming alder carr occurred on the coasts of the British Isles around 7000 B.P. Moffat (1984: 73) has dated the establishment of peat on Pevensey Level as between 3715 ± 80 B.P. (SRR-918) on the inland levels, and 2760 ± 50 B.P. (SRR-1442) near the coast. The stratigraphic sequence obtained by Moffat suggested that the wood peat was submerged by an immense volume of sediment, which mineralogical analysis suggests derived from within 4 km of the levels. The increased input of erosional materials was responsible for extensive siltation and raising of the water table, resulting in the virtual extinction of the alder carr. An anthropogenic origin has been forwarded for the prevention of regeneration of the alder carr, as a result of the recovery of a sheep/goat cranium from this stratigraphic horizon, which has been linked to increased grazing pressure at this time (*ibid.*). The early radiocarbon determinations from this sequence relate to the Beaker period of the Early Bronze Age, possibly extending to the Middle and Later Bronze Age; however, as with the wider Wealden region, comparative archaeological evidence from the surrounding locality is sparse (Moffat 1984: 83).

Palaeoenvironmental evidence from Coombe Haven suggests that the first recognisable clearance episode in the pollen sequence occurs in the upper peat and silt clay which post-date the elm decline. This is considered by Smythe (1985) to be indicative of anthropogenic disturbance in the Bronze Age. Lime declined to extinction after these clearances. How far this data can be applied to the Wealden clay regions is questionable. The ability of clay-based soils in the more central Weald to retain nutrients when subjected to environmental stress is significantly higher than the easily leached Mesozoic Greensands. However, the lack of Bronze Age archaeological sites from the central Weald prevents the corroboration of these data.

Some idea of the flora and fauna of the Wealden forest during the Bronze Age can be elucidated from the records of Vidler (1892: 199), who recovered 5 bronze celts from the submerged forest on the Hooe Levels. From the same depositionary horizon he recorded, "the bones and skulls of deer with antlers, skull and bones of *Bos Longifrons*, wolves, squirrels ... huge trees of oak and trees of yew, these are the only kinds of timber that have remained sound ... the beech, ash, alder, hazel and other woods are so soft that they can be squeezed by the hand. Nuts and acorns used to be plentiful here, and very perfect leaves." The trunks of oak are described as being "fifteen or eighteen inches in diameter" (*ibid.*).

THE IRON AGE (600 B.C.- A.D. 43)

Evidence for Iron Age activity in the Wealden region is extremely limited. Little fieldwork has been undertaken in the central Weald with the intention of locating

Iron Age sites (Money 1978: 38). The resulting evidence is extremely biased towards sites with a high archaeological visibility such as hillforts and iron production sites, which have attracted significant interest for reasons other than the study of the distribution of Iron Age culture. The remaining sites which do not fit into these categories, at Gills Lap, Kings Standing and possibly Horstead Keynes, are ephemeral in nature with little detailed excavation.

The evidence for hillforts in the Wealden region appears to be divided into two major groups on the basis of geological distribution. The peripheral Lower Greensands, which form a distinct escarpment in many regions as a result of the differential erosion of the surrounding clays, support fortified enclosures such as Torberry Hill, Hammer Wood, Pipers Copse, Holmbury, Squerryes Wood, Oldbury and Quarry Wood. This contrasts to the northern and central High Wealden region, which has hilltop sites at Castle Hill, Dry Hill, High Rocks, Garden Hill, Saxonbury and Philpots.

The only significant hillfort for which palynological evidence has been obtained is High Rocks, 1.5 km south west of Tunbridge Wells. Excavations by Money (1941, 1960, 1968) revealed evidence of two phases of occupation, utilising the natural defences of the promontory of Tunbridge Wells Sand. The first hillfort consisted of univallate defences (phase 1), enclosing 9.71 ha. Palynological analysis of the palaeosol preserved beneath these defences revealed evidence of cereal pollen and "weeds of cultivation", which suggested arable

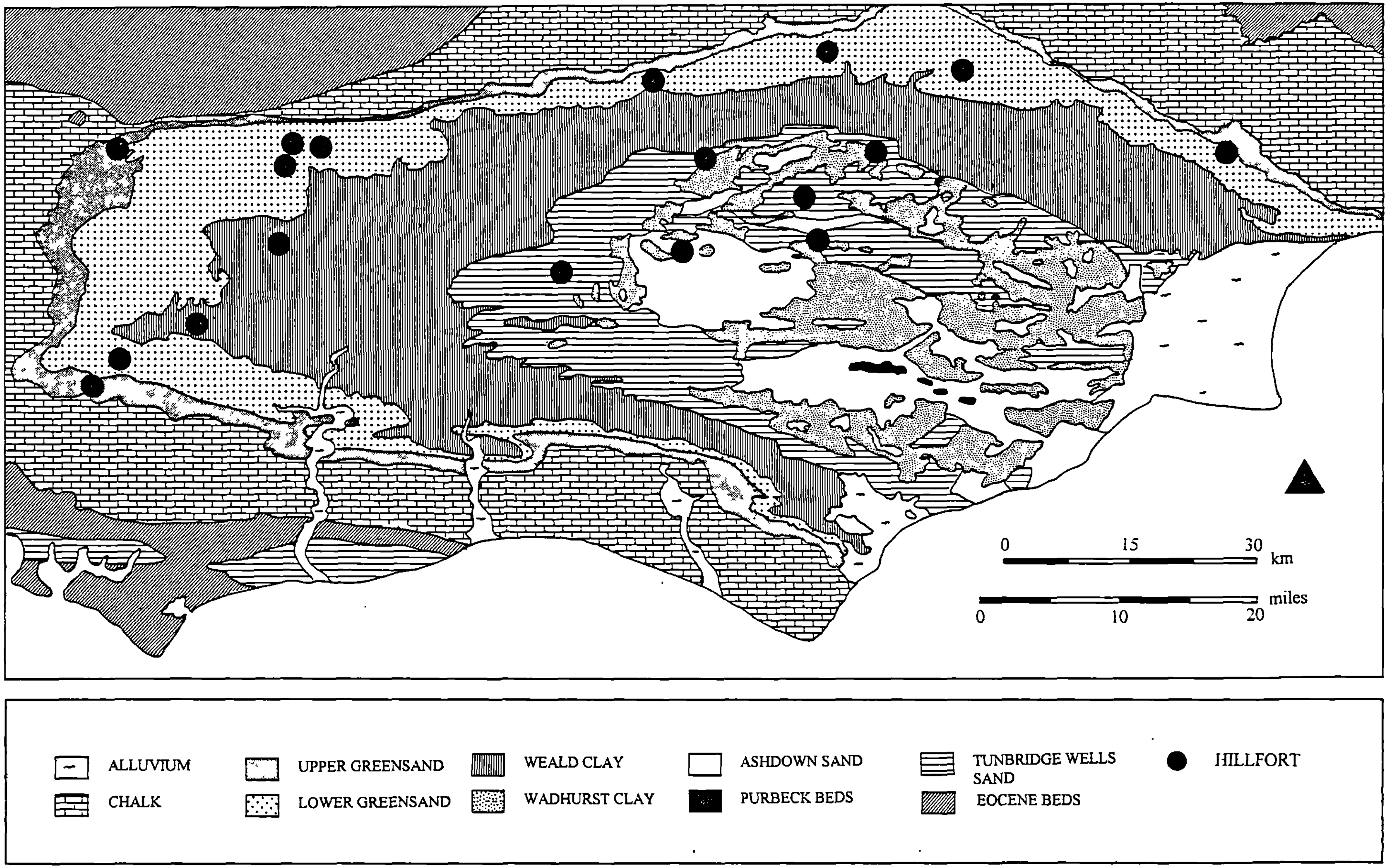


Fig 3.5 The distribution of Iron Age archaeological sites in the Weald

cultivation on the site. Significantly this was considered to have occurred at some time before the construction of the ramparts (Dimbleby 1960). These defences were apparently rapidly abandoned, with further evidence of cultivation and limited iron production in the locality between the periods of construction. In common with many hillforts in the south-eastern region, refortification (phase 2) occurred during the late Iron Age, with double banks and ditches added (Money 1978: 39). The absence of beech pollen from Iron Age contexts at High Rocks, after its prominence during the Neolithic, has led to the suggestion that the inception of iron production in the late centuries B.C. resulted in the "main exploitation of the wildwood" (Sheldon 1978: 6). Possibly the larger population size in the later Iron Age of the High Weald would have resulted in enhanced interaction with the environment as a result of the need for food production, construction, and industry. However, insufficient archaeological information exists in the Wealden region to postulate population size.

The High Rocks pollen sample provides a correlate with the palynological analysis of the palaeosol preserved beneath the rampart of Caesar's Camp, to the north of the Wealden region at Keston, in Kent. Here palynological evidence suggested the presence of dense oak-dominated woodland, with hazel, birch and holly (Dimbleby 1969a) as the primary local vegetation type during the construction of the inner rampart. Pollen evidence suggests that the construction of the hillfort resulted in opening of the woodland in conjunction with limited cultivation (Scaife 1987: 157, Armitage *et. al.* 1987: 260).

The intensification of activity which is evident in the Late Iron Age is expressed in the landscape of the Ashdown Forest. Aerial photographic evidence provided by Margary in the 1920s revealed extensive evidence for an archaeological landscape of enclosures and field boundaries. Where archaeological research has been directed at these enclosures (Margary 1930a, Margary 1930b, Wickenden 1986), evidence for a Late Iron Age occupation date has been provided. It is highly probable that the associated field banks are contemporaneous with these enclosure (Gardiner, M. 1990: 43). The implication of this activity is significant; the extensive clearance required for agricultural activity would have either stimulated soil degradation on the brittle environment of the Ashdown Forest, or could have been a result of earlier manipulation of the environment causing a reduction in tree cover.

CONCLUSIONS

The environmental and archaeological evidence available for the Wealden region suggests that the by the onset of the Romano-British era, the vegetational environment of the Weald had witnessed significant anthropogenic modifications to the climax woodland which was evident during the Mesolithic. By the cessation of the Mesolithic, human communities had undertaken widespread small-scale manipulations of the local vegetation over a temporal span equivalent to all of the subsequent Holocene. Anthropogenic modification of the environment favouring the extension of pioneer species such as hazel, birch and heather is a recurrent factor in the pollen record of the Mesolithic. Those impacts on the "fragile environments" characterised by the sand-based lithologies were more likely to be recorded as localised environmental degradation, as attested by the palaeosol from Iping Common. Many of the clearances, especially on the clay-dominated lithologies, would have produced few or no long-term effects. The re-use of some Mesolithic flint sites for Neolithic activity suggests that some sites could have remained open, possibly as a result of soil degradation, allowing later communities to exploit the sample area (Gardiner, J. P. 1984: 36). It is possible that increasing population towards the cessation of the Mesolithic might have led to a more intense and controlled utilisation of the landscape (Jacobi 1973).

The evidence for activity in the Weald in the Early to Mid-Neolithic suggests that human/environment interaction was little different to that of the Mesolithic. Archaeological evidence for these eras in the Wealden region is generally sparse; however, comparable environmental evidence suggests a certain degree of interaction and limited local clearance of some elements of the woodlands. The pollen of *Gramineae* and other anthropogenic indicator taxa make a significant appearance in the pollen record at this time, suggesting some degree of activity. This can be correlated with the discovery of polished axes also clustering in the coastal Weald, although it is possible that these represented prestige goods rather than instruments for forest clearance.

Archaeologically, the Bronze Age of the Weald is the most sparsely represented of the prehistoric eras; the major sites appear to concentrate around the peripheral geologies. It is a distinct possibility that the rarity and friability of Bronze Age ceramic forms could account for this bias. This period represents the first use of the Wealden forest for the purposes of metallurgy, with metal production attested by the recovery of a bronze casting header at Framfield, on a tributary of the Cuckmere (Tebbutt 1979b). The presence of possible ship wrecks to the east and west of the Weald, at Langdon Cliff, east of Dover harbour, and Seaford Head, suggest that external trade was increasing in importance during this period.

The Iron Age of the Weald witnesses the first development of highly visible archaeological activity as manifested by the presence of hillforts. The possibility that population stress on the Wealden borders caused a general movement into the Greensand periphery and the northern High Weald has been forwarded by Cunliffe (1978). The apparent absence of activity on the Weald Clay is primarily a function of the low lying nature of the region rather than any wider archaeological implications. By the onset of the Late Iron Age, the Wealden environment was beginning to be heavily used by fuel-consumptive industries such as iron production and ceramic manufacture, in conjunction with agricultural activity in some of the more open regions, such as the Ashdown Forest.

By the beginning of the Romano-British era, the environment of the Weald had witnessed eight millennia of interaction with prehistoric communities. Some sandy lithologies would have been considerably more open than their early Flandrian counterparts, while clay-dominated lithologies would have still sustained the dense boreal woodlands. The general perception of the High and Low Wealden regions would have been of a heavily-wooded area, interspersed with small-scale clearance. What is certain is that by the time Roman iron production was undertaken in the Weald, the region was not a primeval forest but an actively utilised landscape which had been pre-adapted for woodland exploitation by eight millennia of prehistoric communities.

CHAPTER FOUR

METHODOLOGY AND TAPHONOMY

Increased interest in the reconstruction of environmental and economic patterns from past societies has enhanced the importance of the study of plant macro-remains. With the exception of iron slag and cinder, charcoal is the most common find in Wealden slag deposits of all periods. The preservation of charcoalified remains within slag deposits provides an ideal context for the determination of the nature of the raw materials used, in addition to the possibility of determining how arboreal resources were exploited, and to quantify differences between sites.

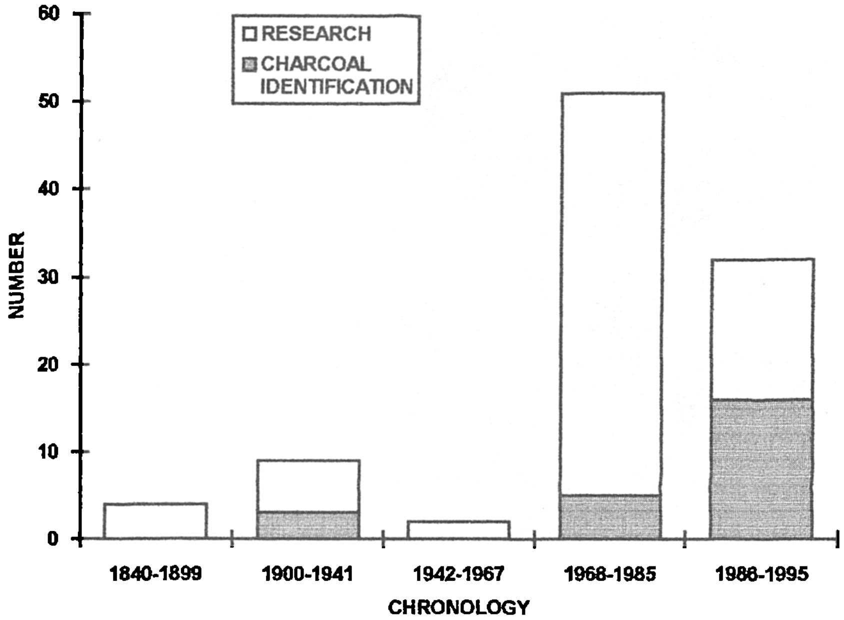


Fig 4. 1 The analysis of charcoal from Roman iron production sites in the Weald since 1840.

The collection of archaeological charcoal during the process of excavation has not, however, been a standard component of archaeological investigation of iron production sites in the Weald. The analysis of charcoalified macrobotanical remains from iron production facilities has only occurred on 11% of sites; however the disparate nature of the studies does not allow for adequate quantification of the results other than at the individual site level. This is a function of several factors. The inherent emphasis of Victorian excavations was related to the acquisition of material culture. In the nineteenth century, archaeobotany was a relatively recent discipline; this negated the possibility of including any form of palaeo-environmental data. Straker (1931: 110) was the first to produce identifications of charcoalified materials from the slag deposits at Footlands, Ridge Hill, and Crowhurst Park. The need for specialists, from the Royal Botanical Gardens at Kew and the Forest Products Research Laboratory, to analyse the material precluded the identification of a statistically viable sample from these sites. The majority of the field research carried out by the Wealden Iron Research Group has been in the form of trial-trenching designed to ascertain a date for bloomery sites. As a result, excavation focused on the acquisition of ceramic and other dating evidence rather than macro-botanical material. However, research excavations at Bardown (Cleere 1970), Minepit Wood (Money 1974), Pippingford Park (Tebbutt and Cleere 1973) and Smytheford (Hodgkinson 1985) did allow for the identification of charcoalified remains.

The slag/refuse deposits are the most common and easily determined archaeological feature of Wealden iron production sites. The acquisition of palaeo-environmental data from these deposits was therefore undertaken to consolidate the previous research. In addition, these areas represent the least archaeologically sensitive components of a site, representing the waste products of iron smelting in a secondary archaeological context; the actual working areas are normally found some distance away. Keyhole trenches and test-pits were used to cause minimum disturbance to the sites. However, where slag faces were previously exposed, such as through earlier excavation, trial trenching, or streamside erosion, these sites were examined in preference to the creation of further trenches. This was based on the principle that exposed slag faces tend to erode over time and their integral charcoal would degrade as a result of weathering; cutting back these faces allowed access to undisturbed charcoal.

TAPHONOMY

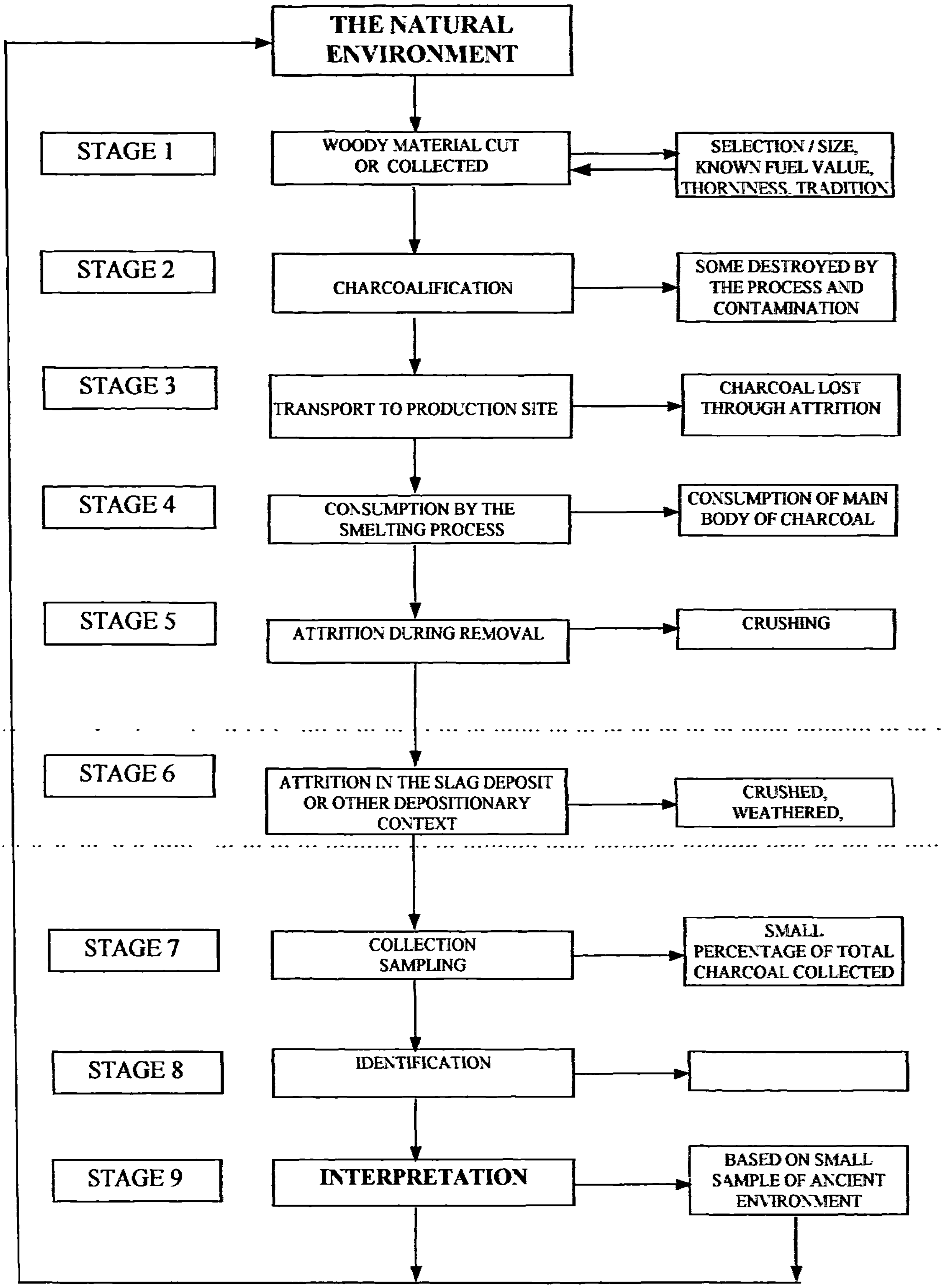
The methodology is determined by the pre- and post-depositional processes which have affected the assemblages. Any assessment of excavated charcoal must, therefore, appraise the taphonomic biases which determine the different methods by which wood reached sites and the method by which it was subsequently incorporated into the archaeological strata. The translation of quantitative numerical data from excavated material to a reconstruction of the environment is, therefore, problematic.

Under normal archaeological conditions, organic vegetable matter decays as a result of microbial action. In temperate climatic regions, wood can be preserved by water-logging (Western 1969: 178), incorporation in anaerobic deposits (Levy

1969: 188), mineralisation (Dimbleby 1977: 109-10) and replacement by corrosion products (Keepax 1975), examples of all of which have been recorded on Wealden iron production sites of the Romano-British era. However, the most common method for the incorporation of wood into the archaeological record is in the form of charcoal, which predicates its exposure to fire. Accordingly material used as fuel for industrial or domestic processes would have a significantly higher chance of preservation than material utilised for building construction and other elements of site infra-structure.

The taxa recorded represent woody material which has been selected and actively transported for utilisation on the site. Irreducible needs such as fuel and the provision of constructional material would have been the primary reasons for the introduction of wood to the sites. The macroscopic carbonised remains from the matrix of a slag deposit cannot be expected to represent a random sample of the woody vegetation growing around the site of deposition. The macroscopic remains will exhibit a bias towards the exploitative behaviour of the local populace. The large industrial nature of some iron production sites suggests that the fuel requirements were provided by an extensive *territorium*; Cleere (1976a: 241) estimates that an area of 15 km^2 was exploited for Bardown, while the Beauport Park complex might have required 100 km^2. This implies that woody material for fuel from larger sites could have been obtained at considerable distances from the site of iron production, possibly from localities with diverse ecological

Fig 4.2 Taphonomic factors affecting charcoal in slag deposits



constituents. The taxa represented by excavated material do not necessarily represent a picture of a single woodland community. Wood could have been brought from some distance to the site, a factor enhanced by the relatively efficient transport and communications of the Roman era. The larger the size of the exploitation site, the more likely that the overall composition of the taxa reflects an amalgam of material derived from the local and wider environment. The environmental data, therefore, have different implications depending on the nature of the site of origin.

Small-scale localised exploitation, as characterised by the sites of the western Weald and periphery, would, in many cases, result in the exploitation of woody material from the immediate locality. Spatial and temporal limitations on the extent of the workings do not predicate the exploitation of large areas of woodland. In contrast, the iron workings of industrial size would have required a constant source of raw materials to supply the fuel requirements of both the industrial processes and the associated domestic settlements which were an integral part of the sites. The sampling of palaeo-botanical remains was required to span sites of different size and function to determine if quantifiable assemblage differences occur.

BIOLOGICAL SAMPLING

Charcoal was collected from the matrix of the slag/refuse deposits manually. To eliminate any biases which might be introduced by utilising size as a criterion for collection, all visible charcoal was collected, irrespective of size. Where charcoal fragments derived from differential stratigraphic horizons or lenses, this was noted and the charcoal was analysed separately.

Individual specimens of charcoal were placed in cotton wool in individual compartments of a rigid plastic container to prevent further attrition during transport. If any fragmentation of the highly friable material occurred during the extraction process, the individual elements of the same specimen would be collated as a single element, to prevent alteration of the total numbers for individual species.

Samples of the carbon-rich soil matrix, which were a characteristic feature of the slag deposits explored, were also taken and sieved using a coarse mesh grade (5 mm) to provide a correlate to the manual extraction of charcoal. This would provide quantifiable evidence for any selection processes introduced by the use of size as a primary criterion for the collection of macrobotanical remains. Unless otherwise stated, these were three litre samples of which one litre was sampled for carbonised remains.

PREPARATION TECHNIQUES

Each charcoal fragment was manually pressure-fractured to allow observation of the tangential, transverse, and radial planes under a Wild M3Z stereo-microscope, utilising magnifications of up to x 400. For stability, the samples were mounted in Plasticine on a microscope slide. To prevent the destruction of the diagnostic anatomical structure as a result of rapid heat transmission through the carbon, obliquely angled top lighting from two flexible fibre optic sources was used in preference to a direct light source. The material was identified using comparable anatomical information from atlases of wood anatomy (Schweingruber 1978, 1990), in conjunction with comparisons with contemporary charred specimens. This facilitated the rapid identification of a considerable number of fragments in a relatively short period of time when compared with older methodologies requiring chemical impregnation and thin sectioning (Leney and Casteel 1975, Western 1969: 181-2).

In addition to identification of the taxa present, the maximum tangential length and the maximum radial width were measured on all non-sieved fragments prior to fracturing, to quantify the size of the individual elements of the sample and to allow for comparison between sites on the state of preservation.

TAXA IDENTIFICATION

The tracheids and vascular tissue of the tracheary system are essential for the movement of water and dissolved minerals from the roots to the leaves during transpiration. The dissolved minerals and water can also be stored in the undifferentiated parenchyma cells. In the inner heartwood core of the tree, the parenchyma is dead and acts a depository for polyphenols, resins, gums and other waste products of photosynthesis (Shackley 1981: 93). In addition to this, both trees and shrubs require mechanical support, which is facilitated by the fibre cells (February 1992: 347-8). The distinctive organisation and distribution of these tissues and cells in the transverse, radial, and tangential planes is diagnostic to the genus level of identification.

The term wood refers to the secondary xylem of the tree (Shackley 1981: 93), in which the component carbohydrates, cellulose and hemicellulose are bonded with lignin (Sjöstrom 1981: 12). Charcoal constitutes the remnant solid residue which is produced as a result of the carbonisation or pyrolysation of the wood ultrastructure, either under controlled conditions in an enclosed space in the absence of oxygen (Olson 1991: 411) or after incomplete combustion in oxidative conditions. The conversion of organic wood to charcoal with a high inorganic carbon content results in a chemically and biologically inert material which is resistant to microbial attack and can attain indefinite preservation unless it is subjected to very wet conditions or distorted by pressure, although this is dependent on the cellular integrity of the wood prior to carbonisation. This allows for the retention of the diagnostic anatomical structure even after charcoalification.

Charcoal analysis is defined by Heinz (1991: 299) as "the taxonomic and quantitative study of carbonised wood found in an archaeological context." There are, however, limitations in the analysis of archaeological carbonised material which must be quantified. It is not usually possible to identify material to *species* level when dealing exclusively with charcoal. The specific name given to the generic identification is that of the indigenous species. It is assumed that material from secure Romano-British contexts will not produce later introductions.

This poses problems if there is more than one native species, such as with deciduous oak. In the text, deciduous oak is referred to by its generic name *Quercus* spp., which comprises two indigenous species: *Quercus robor*, the Common or Pedunculate oak; and *Quercus petraea*, the Sessile or Durmast oak. The damp clays and acid sands of the Weald suit the ecological requirements of both *Quercus robor* and the other native species *Quercus petraea*. The close juxtaposition of clay and sand geologies in the High Weald implies that the two species would have been considerably mixed.

In some instances morphological precision between different genera is impossible. In most cases, this relates to the poor state of specimen preservation and the consequent obliteration of diagnostic anatomical features. Some species, such as hazel (*Corylus avellana*) and alder (*Alnus glutinosa*), are anatomically similar. Where distinction was impossible, this is indicated in the text by the use of the two generic names, i.e. alder/hazel (*Alnus / Corylus*).

Some groups are normally only identifiable to the level of subfamily, such as the *Pomoideae, Prunoideae* and *Rosoideae* subfamilies of *Rosaceae*. Where confirmed identifications to genus level were recorded, this is noted in the text. The species included in the subfamily *Pomoideae*, and likely to be represented in the archaeological material, are *Crataegus monogyna* jacq. (Hawthorn) and *Crataegus laevigata* (Poiret) DC. (Hawthorn); *Malus sylvestris* Mill., (Crab apple) and *Pyrus communis* L. (Wild pear); *Sorbus aria* (L.) Crantz., (Whitebeam); *Sorbus acuparia* L. (Rowan); *Sorbus torminalis* (L.) Crantz (Wild service tree). Other problematic subfamilies in the *Rosaceae* family include the *Prunoideae*, which include *Prunus avium* L. (Wild cherry); *Prunus padus* L. (Bird cherry) and *Prunus spinosa* L. (Blackthorn); and the *Rosoideae* subfamily which includes two similar genera - *Rosa canina* L. (Rose) and *Rubus fruticosus* L. (Blackberry).

The cellular morphology of the *Salicaceae* family is similar between the *Salix* and *Populus* genera, which include *Populus alba* L. (White poplar); *Populus nigra* L. (Black poplar); *Populus Tremula* L. (Aspen) *Salix alba* L. (White willow) and *Salix fragilis* L. (Crack willow).

The removal of integral water during the process of charring results in shrinkage of between 40-45% by volume. Extensive distortion is caused by the differential shrinkage between tissue types and planes of the wood. The charring of oak in a contemporary commercial kiln resulted in an average shrinkage of 25.68% in the tangential dimension, 15.45% in the radial dimension and 11.43% longitudinally (McGinnes 1971, Pearsall 1989: 161-2). This differential shrinkage results in morphological changes to the anatomical structure. The most distinctive change found in all contexts examined by the author was severe splitting and distortion along the radial plane. In addition to this, folding of cell walls and the distortion of pore shape was also recorded in some samples. This distortion is not a diagnostic element of the conditions of charcoalification, as the moisture content of the wood prior to charcoalification and the temperature of the charcoal kiln are both unknown and unequal between specimens (Pearsall 1989: 162). Identification can also be hampered by the natural variability between wood of the same genus which can occur as a result of both ecological and physiological factors

BARK

The outer dead bark, or rhytidome, serves to protect the woody tissues from mechanical damage, in addition to regulating humidity and temperature changes. It is composed of periderm and cork cells which die at an early stage, and are cemented together to prevent the passage of water and gases (Sjöstrom 1981: 100). As the outer bark is a dead tissue, it can not expand to accommodate radial stem growth, resulting in a characteristic split appearance. Although the gross morphology of this varies between species as a result of differential elasticity and structure of the rhytidome, post-depositional fragmentation of the bark negates the use of the gross bark morphology as a technique for identification.

Tree bark represents the layer external to the cambium which surrounds the stem. It has two major components: the phloem, which is an inner living tissue; and the rhytidome, which is an outer dead bark. The outer tissue is highly friable. This, in conjunction with the rigidity imparted by the carbonisation process, means that the outer bark is likely to detach from the surface of the wood.

The anatomical morphology of the bark of the majority of British trees is undiagnostic to species. If the fragments of bark examined were unassociated with wood (the secondary xylem), identifications were not possible. The analysis of diagnostic calcium oxalate and calcium carbonate crystals in the bark structure is not practical in archaeological samples (Gale 1991a: 227).

The preservation and quantity of charcoal evident between different slag deposits was highly variable. This could be a function of micro-environmental phenomena such as the impregnation of charcoal with mineral crystals, fungal hyphae and, rarely, precipitated corrosion products from iron in the slag deposits. All of these can obscure or degrade anatomical features necessary for identification.

Alternatively, phenomena from the depositional environment can have an important effect on the formation processes. In the smallest slag deposits, the absence of the protective slag matrix resulted in exposure to the elements which gave rise to very low numbers of taxa and high fragmentation. Slag deposits of a larger nature normally contained a greater percentage per unit of deposit, of charcoalified remains. This is partly a function of the higher quantity originally present, the larger size of the site, and the insulating nature of the surrounding slag.

CESSATION OF GROWTH

In the temperate zone, trees lay down secondary xylem throughout spring and summer until cessation of growth in the autumn and winter. This is manifested anatomically by narrow bands of thick walled trachids with small cavities, which comprise the annual or growth rings (Western 1969: 180). As a result of the growth by the cambium, each annual increment is produced in the shape of a hollow cone, which, when viewed in transverse section, appears as concentric rings (Pashin and de Zeeuw 1970: 397). Where applicable, the annual rings were counted; however, the establishment of the age of the fragment can only be accomplished if a transverse section from the core to the vascular cambium remains. In most cases, mechanical abrasion and fragmentation both prior to deposition and within the matrix of the slag deposit negated the possibility of statistically establishing an age profile of the taxa represented. The methodology developed by Gale (1991a: 226-7) to produce age statistics on waterlogged wood was adopted. A series of three categories was utilised to incorporate age data from charcoal fragments in various stages of preservation. The categories were slightly modified to account for charcoalified wood and defined as follows.

a) A complete transverse section of wood exists from the core to the vascular cambium. The phloem and cortical region which comprises the bark could be present or absent.

b) The occurrence of mechanical attrition was noted but little material had been removed.

c) Certain ring loss as a result of abrasion or fragmentation, no information available on the completeness of the sample.

If branch material has been split longitudinally, resulting in the preservation of the vascular cambium, but the core material was absent, then the diameter could be determined. In addition to age data, the retention of the vascular cambium can be used to determine the season of growth cessation. If a tree is cut, or otherwise ceases growing through death or disease while it is still laying down xylem in the spring and summer, the last annual ring will be truncated, resulting in an absence of the diagnostic tracheids. The seasonality data produced does not necessarily indicate deliberate cutting in all cases. The data actually indicates when the tree or element of a tree ceased growing. Factors such as disease and natural breakage could account for some of the results, although this would probably account for a negligible component of the samples analysed. Such natural causes of growth suspension would tend to occur out of the growing season, when the trees are more brittle, and are vulnerable to cold and winter gales. The same restrictions of preservation which affect the determination of age data apply to the elucidation of seasonality of cutting. As such, significantly less data is available.

The major limitation to the analysis of charcoalified remains in relation to other branches of environmental archaeology is the absence of a quantitative methodology for the elucidation of actual or relative numbers of individuals. In the analysis of charcoalified wood of the same species, there is no method of determining the minimum number of individuals (MNI), which causes intrinsic problems in the determination of the relationship between the fragments represented and the past environment. This is an irrepressible function of the nature of the evidence. The most obvious method of comparing charcoal fragments of the same taxa relates to the comparison of the annual rings. However, these can vary within a single branch as result of differing environmental stresses (Dimbleby 1977: 102, 110). Unless a direct analogy can be made between annual rings from two or more different fragments, there is minimal chance of relating fragments to the same branch, let alone the same tree, by anatomical methods. If a direct correlation between fragments could be determined, then these fragments were treated as a single individual.

POLLEN ANALYSIS

The provision of data concerning the taxa composition of samples derived from the charcoal recovered from slag deposits is biased towards the arboreal environment. Pollen analysis could provide a correlate for the charcoal data., which could be used to compare the taxa composition of the charcoal recovered and provide information concerning the herbaceous communities which would have co-existed with tress and populated the environs of the production sites.

Soil pollen analysis was utilised as it would provide a highly focused, insight into the Roman environment of a specific locality, as a result of its high representation of pollen from the immediate vicinity of the site of deposition. This also could allow for the assessment of selection processes in operation on certain sites, by the comparison of the local environment as elucidated by pollen analysis and the taxa composition of the charcoal from the slag deposits.

The soil pollen was utilised. This could be used to provide a picture of the environs of the sites examined, unlike alluvial pollen sequences which would provide a general picture of a considerably larger pollen catchment area. In the context of alluvial pollen considerable time and resources would have had to have been devoted to the analysis of a larger sequence. Considerable problems would have been encountered in the elucidation of elements of the sequence of Romano-British date, and the connection of these to the impacts of the bloomery iron industry. In addition, several alluvial pollen sequences exist for the coastal Weald (see above).

A monolith of soil was extracted from the sample site, and sealed in a plastic container until extraction of the soil samples. The method of pollen extraction from the soil was as follows.

1) Approximately 1 cm^3 of sediment was placed in a boiling tube, to which 10 ml of 10% sodium hydroxide (NaOH) was added, to facilitate the disaggregation of the sediment. This was placed in a water bath for 5 minutes at 100°C to speed up the reaction, until the organic matter was dispersed.

2) The contents of the boiling tube were passed through a 180 µm mesh sieve, sitting on a funnel to allow the supernatant to flow into a 15 ml PVC labelled centrifuge tube. Extraneous sediment was washed through with distilled water.

3) To allow for the examination of macroscopic remains the sieve was inverted into a labelled petri-dish, while the excess was washed out with distilled water.

4) The sediment was then centrifuged for three minutes at 3000 r.p.m. and the supernatant liquid decanted.

5) Distilled water was added and stirred thoroughly to neutralise any remaining caustic chemicals; this was then centrifuged and decanted. For added safety this operation was undertaken twice.

6) To aid the removal of siliceous material such as silts and clays, 8 ml of hydrofluoric acid was added to the pellet and placed in a boiling water-bath for 2 hours, and stirred occasionally to aid breakdown.

7) The pellet was resuspended in 10% hydrochloric acid which was warmed in a water-bath, and then centrifuged.

8) 8 ml of acetolysis mixture (acetic anhydride, concentrated sulphuric acid) were added to the pellet. This was stirred and placed in a boiling water-bath for 60 seconds then immediately centrifuged.

9) The pellet was resuspended in 8 ml of glacial acetic acid, then centrifuged.

10) The pellet was added to distilled water and 3 drops of 100% potassium hydroxide. This was then centrifuged.

11) The remaining pellet was thoroughly mixed with 2 ml of melted glycerol jelly.

12) The mixture was spread onto a warmed microscope slide and covered with a large coverslip. In view of the poor pollen preservation at least 4 slides were produced for each sample.

The material was identified using contemporary reference material from the School of Plant Sciences, University of Reading in conjunction with reference work (Moore and Webb 1978, Moore, Webb and Collinson 1991).

SAMPLING STRATEGIES

The large number of Roman iron production sites recovered from the Wealden region necessitated some form of sampling strategy for the acquisition of data at the regional level. Unfortunately, the Scarp Foot and Low Weald, which have undergone the most drastic revision in site distribution, are least suitable for sampling of macrobotanical remains (see Fig 5.2). The High Wealden region, which has received the most previous archaeological research, was therefore the source of the sample sites. Small study areas were selected, which could be sampled in depth, and for which the results would complement each other. This was preferential to the utilisation of a random site sample, which would provide greater coverage, but the disarticulation of sites across the 1870 km^2 of the High Weald would decrease the validity of the results obtained. Of the three study areas chosen, one was in the eastern High Weald, which was used as a correlate to the previous charcoal analyses undertaken by Straker. In the western High Weald, two study areas were chosen: the newly discovered Stumletts Pit Wood environs which are located on the boundary of the Wadhurst Clay; and the trio of sites at Walesbeach, Ridge Hill and Standen, which have received previous attention, and are located for comparison on the Tunbridge Wells Sand.

NON-BIOLOGICAL ANALYSIS:

VOLUMETRIC ANALYSIS

The utilisation of volumetric analysis as a methodology for the determination of the original volume of slag deposits was first proposed by Cleere (1976a: 234-7). This methodology was used to provide a gauge for the environmental requirements of iron production however; such analyses were only undertaken on sites of the industrial-class in the eastern High Weald (*ibid.*: Table 1). For the purposes of this research, it must be assumed that bloomery slag is indestructible in the natural environment. Chemical and mechanical attrition do not significantly reduce its volume over time. The very resilience of slag increases its value as a material for hard-core and road metalling, which has significant implications for taphonomy in the archaeological record. In addition to this, it has been suggested that crushed slag could be used as a flux during the smelting process (W. R. Beswick *pers. comm.*). The estimation of the volume of the slag deposits does not necessarily represent the original quantity of material deposited.

The removal of slag from Roman deposits tends to be a factor which affects industrial sites to a greater extent than non-industrial deposits, despite their more extensive distribution. This is a function of several factors: larger industrial waste deposits have a significantly higher archaeological visibility than smaller sites, and with larger quantities of material in one location, the removal of slag is more economically viable, compared to the extraction of small quantities of slag from disparate locations. This generalisation does not apply in all contexts, as can be seen by the removal of slag from the Smytheford site for road metalling (Hodgkinson 1985). It is also more likely that if slag were removed from a small deposit, then its archaeological visibility would be significantly reduced. The volume and weight of slag at the sites visited were estimated to provide a general figure, which could be used to extrapolate the production output of small-scale iron production sites in the Weald, which have not received the attention of the industrial-class operations.

CHRONOLOGY

The bloomery period in the Weald extends from the Early Iron Age until its gradual cessation after the introduction of blast furnace technology, utilising the indirect process, during the last decade of the fourteenth century. However, even while iron was produced commercially utilising the blast furnace, local non-industrial needs could still have been sustained with the aid of bloomery technology. As late as 1640, William Yalden, of Blackdown, was pardoned for infringing the Wood Acts by running an illegal bloomery at Lurgashall (Straker 1931: 431). As the Romano-British era represents only 20% of the possible chronological span of bloomery production, there are a large number of undated sites in the Weald which could emanate from eras other than the Romano-British. The difficulty involved in obtaining dating evidence, meant that as a general rule, only previously dated Romano-British sites were studied to prevent the diversion of time and resources into sites which might not yield a Romano-British date. Fieldwork was, therefore, not designed to elucidate new sites, although several dated and undated sites were discovered in the process of research. The aim was to work on previously dated sites to supplement and consolidate the known database with the provision of palaeoenvironmental data. However, the inception of such a methodology to sample sites is reliant on previous archaeological research. By circularity the sites of the High Weald will be studied to a greater extent than those of the periphery, which are less numerous and have a greater percentage which have been excavated or destroyed (see Fig 5.2). The results of such work, therefore, have to be viewed within the framework of bias proposed in the first chapter.

A significant problem with smaller bloomery sites is that their dating tends to rely on locally-made East Sussex Wealden wares, which have a poor chronological resolution. The assemblages produced from trial excavations of the sites tend to reveal a paucity of fine wares, coins and other chronologically diagnostic material. The absence of tight chronological control negates the study of the dynamics of ecological change in the environment and landscape evolution.

CHAPTER FIVE

THE DISTRIBUTION OF IRON PRODUCTION ON THE WEALDEN PERIPHERY

THE DISTRIBUTION OF IRON PRODUCTION ON THE PERIPHERY OF THE HIGH WEALD

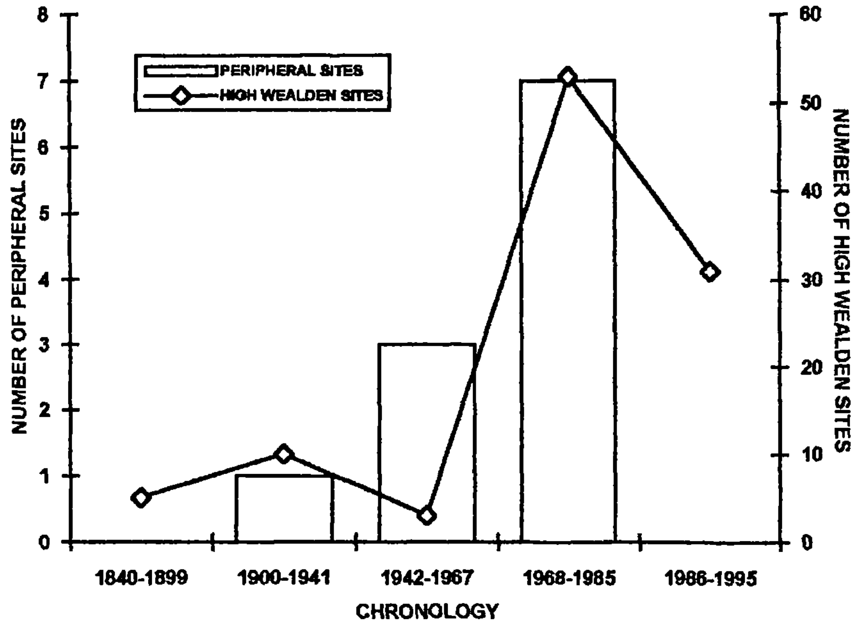


Fig 5. 1 The comparison of research undertaken on Roman iron production sites in the periphery and the High Weald since 1840

In the context of this chapter, the periphery of the High Weald is defined as all geological strata now in the Weald, deposited later than the Hastings Beds of the High Weald. This differs from the purely geological definition of the periphery or scarp foot, which only encompasses the Greensands and Gault Clay. The archaeological periphery of this chapter is considered as two distinct geological and physiographic elements. the Low Weald, and the scarp foot. The region defined covers approximately 2850 km^2, or 60% of the total Wealden land surface. The low density of sites recovered from these geologies, which cover a greater area than the High Weald, does not allow for further geological subdivision into the Weald Clay, Lower Greensand,

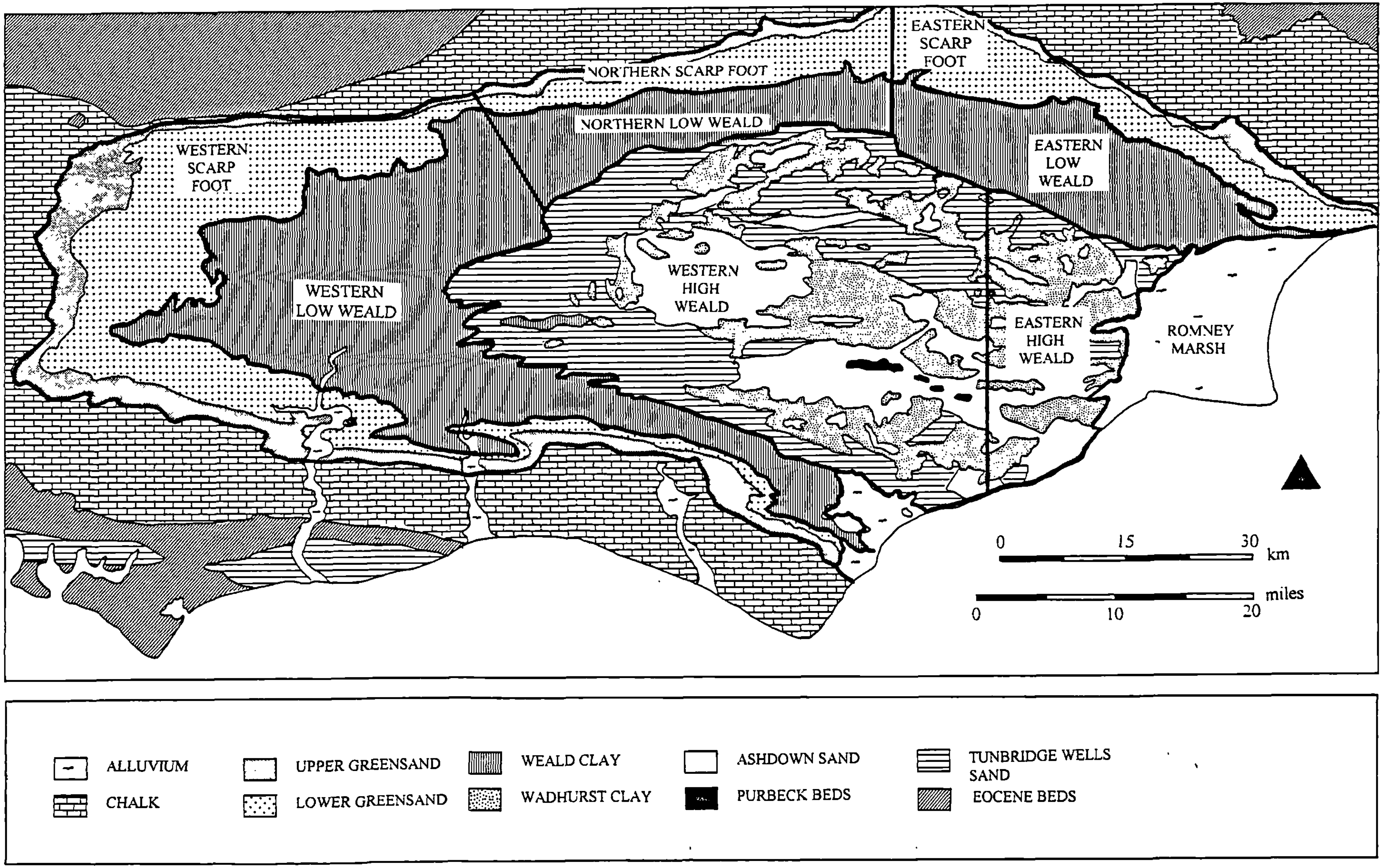


Fig 5.2 Subdivisions of the wealden periphery

Gault Clay and Upper Greensand. However, the different economic influences which would have stimulated iron production on the periphery necessitated the instigation of arbitrary subdivisions based on the probable markets for iron produced (see Fig 5.2). The study of the iron industry in the periphery has advanced in an extremely *ad hoc* fashion (see Fig. 5.1), and has not been considered as a discrete entity, as a result of the distribution of the sites across five counties, and the apparent disarticulation of sites from the main body of activity in the High Weald.

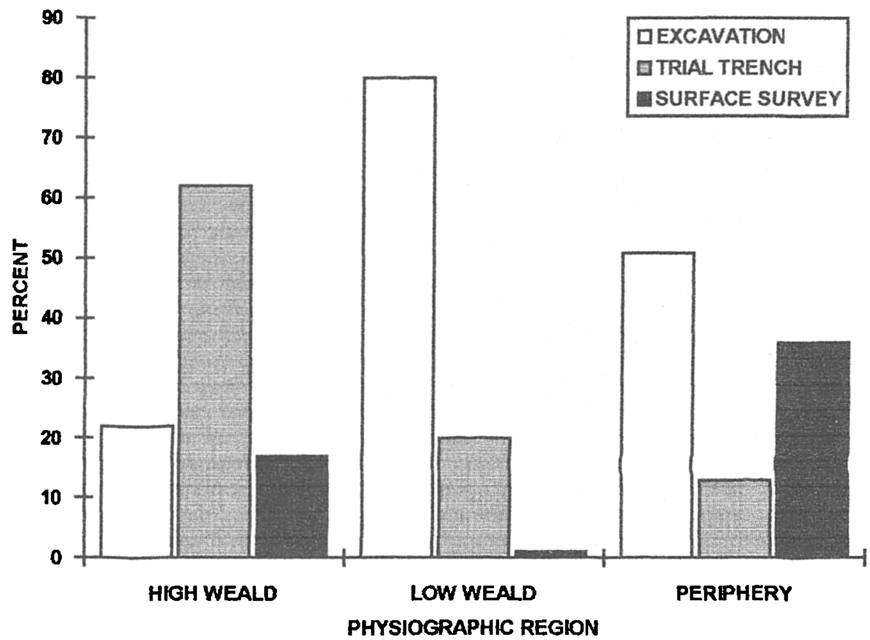


Fig 5. 3 The differences between site exploration in the High Weald, and the periphery

Contemporary research on the sites of the periphery is hampered by several factors. There are far fewer sites on the periphery, comprising only 9% of the known sample of Roman iron production sites in the Weald, at a density of one site per 237.5 km^2 (0.42/100 km^2), predominantly as a result of the lack of research.

The enhanced agricultural activity which is evident in the eastern periphery, and now on the Low Weald, has resulted in the disarticulation of many sites as a result of ploughing, in conjunction with the reduction in the accessibility of the land for research. A greater percentage of sites in the periphery have iron production as a subsidiary element of the economy of a larger site, which confuses surface indications of iron production, in addition to encouraging excavation which results, in many cases, in the destruction of suitable deposits for palaeo-environmental investigations (see Fig 5.3).

THE LOW WEALD

COLDHARBOUR FARM

Evidence for iron production at Coldharbour Farm (TQ 884466) is located on Weald Clay, approximately 200 m north of the farm building from which it derives its name. Roman activity was first recorded in 1961, when a cremation group was recovered during the recutting of a drainage ditch, at TQ 8829 4684. The assemblage included part of an abraded samian dish (form 18/31) with no surviving glaze, and a globular jar, composed of a gritty grey ware, containing calcined bone fragments. These are indicative of a date in the second century.

This discovery prompted further exploration of the recut ditch, which resulted in the discovery of Romano-British ceramics and bloomery slag in the spoil at TQ 8849 6554. Another small deposit of bloomery slag which had been scattered by ploughing was also found 150 m to the NW, centred at TQ 8835 4670, although no dating evidence was found in association with this site (NAR TQ 84 NE 7).

The chance nature of the discoveries does not allow for speculation as to the size of the exploitation, but it does appear to represent a smaller-scale site, possibly with others in the vicinity. The location of large numbers of ponds in the immediate area could be indicative of minepits, although this is impossible to corroborate. The presence of a cremation burial could imply the presence of a settlement in the immediate locality.

ROMDEN PLACE

Extensive evidence for iron production at Romden (TQ 895420) is located immediately to the SE of Romden Castle. This site represents another example of a recorded Romano-British iron production site on the Weald Clay. Exploration was prompted by the recovery of a coin of Faustina in the late nineteenth or early twentieth century. No record is made of whether this was a coin of Faustina I Senior (A.D. 138-161) or Faustina II Junior (who issued coins under Antoninus Pius A.D. 139-161 and Marcus Aurelius A.D. 161-180). However, this certainly represents a coin produced in the second century, between 138-180. Evidence for Romano-British industrial occupation at Romden was first recorded in August

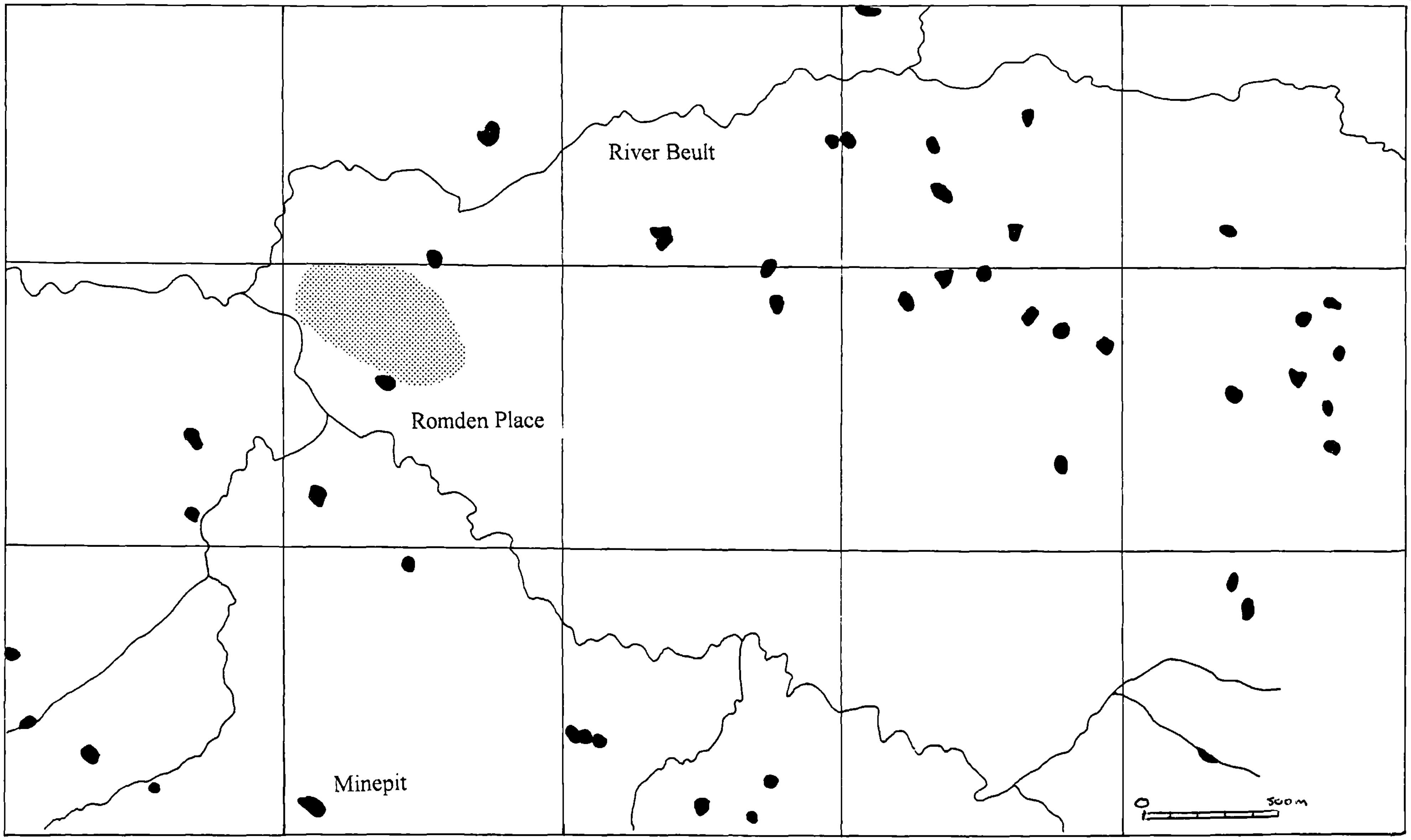


Fig 5.4 The distribution of minepits in the vicinity of Romden place

1912 by W. Basil Worsfold and Mr. Paley Baildon, who recovered both slag and Romano-British ceramics from the fields to the south of Romden Place, called 'the Orchard', 'the hamlets' and 'black pits'. The ceramics included "two dark coloured pieces....undoubtedly Roman" and "another of lighter colour, either very coarse Roman or Medieval" (Worsfold 1931: 82). Although now lost, these ceramics probably represented East Sussex Wealden and Thameside wares. The bloomery slag was initially considered to be of medieval origin (*ibid.*). Trial trenching in the same month revealed ubiquitous slag and cinder in 'the orchard' and 'black pits'. This place name evidence undoubtedly refers to the charcoal-impregnated nature of the soil resulting from industrial utilisation. As previously, the ceramics recovered were both Roman and local wares (*ibid.*: 83).

Three ponds are evident in the immediate vicinity of the Romden site, which could indicate the presence of ore pits in the Weald Clay. These are located immediately to the SE of Romden Place, 500m to the SE near Romden Wood and 400m NNE of Romden Place. In addition, a belt of densely distributed ponds is located to the SE of the site, covering approximately 6 x 5 km. Although no dating can be assigned, and it is impossible to determine the original use for these pits, they could be indicative of substantial industrial activity at some time (see Fig. 5.4). The correlation between the distribution of the pits and the location of a seam of clay ironstone suggests that the extraction of ferruginous material was the *raison d'être* for the extraction sites. The large scale of operation and the location of the site on such a seam would correspond with the Broadfield site in the western Low Weald, which was also semi-industrial in nature.

The discovery of slag extending over two fields, and the recovery of significant quantities of Romano-British ceramics, suggest the presence of a site approaching semi-industrial output. The slender dating evidence suggests occupation in the second century, which would certainly complement the increase in fleet activity to the south in the Hadrianic era.

BROADFIELD

Prior to their destruction, the extensive agricultural and iron production settlements at Broadfield (TQ 258353) were located on the Weald Clay between the Three Bridges and Broadfield suburbs of Crawley. The earliest discovery was of scatters of iron slag found in association with evidence of an agricultural settlement dating from the second century B.C. at Goffs Park, Southgate West (Slater 1970). The first indications of Romano-British exploitation of ferric resources were discovered during the construction of a sewage trench resulting from the expansion of Crawley New Town during the mid-1960s. The disparate nature of the slag deposits and the wide area and extensive span of occupation from the MIA to the fourth century necessitated the formation of the Crawley and Mid-Sussex Archaeological Group, under the aegis of John Gibson-Hill, which undertook rescue excavations between 1970 and 1975, in conjunction with the

WIRG, DOE, and the Sussex Archaeological Society (Wilson, D. R. 1973: 320). Slag deposits occur at TQ 2602 3293 and TQ 2605 3512, the latter of which was eroded by a small stream. As evidence for iron production included 36 furnaces of domed and shaft type, forges, workmen's accommodation and slag-metalled areas (Gibson-Hill 1972, 1974, 1975a-b, 1976), it is unlikely that these deposits are the debris from the total production of the Broadfield sites. Evidence for settlement extended over 12 hectares, with the nucleus of occupation spanning a shallow valley between a limestone ridge and sandstone hills to the south.

In addition, two apparent charcoal burning areas were found in association with first- and second-century ceramics, which would have been one of the rare instances of their discovery in a Wealden or Romano-British context (NAR TQ 23 SE 19).

The importance of the Broadfield complex is evident from its length of occupation, the variety of furnace types in operation simultaneously, its size and position on the Weald Clay, and its early association with an agricultural settlement. This agricultural activity was supplemented by the production of iron. Expansion in this production occurred shortly after the invasion (Cartwright 1992: 48), when the Goffs Park site was abandoned and the industrial and domestic sites in Vale of Broadfield came into operation. The emphasis of this new planned complex is primarily related to the mining and smelting of ore possibly allowing for its distribution via the Pease Pottage - Colgate trackway to Stane Street to the

London markets (*ibid.*). The site consisted of a rectangular enclosure with several timber domestic buildings.

A further increase in industrial activity occurred during the late-first century A.D. when of new furnace types were introduced, and the domestic settlement was moved. The movement of the domestic settlements has been attributed to the need for cleared land to allow for the construction of more furnaces, in conjunction with possible pollution from smelting.

Difficulties with publication, and the subsequent death of Gibson-Hill, necessitated the re-analysis of the fragmentary excavation archives, delaying final publication until 1992 (Cartwright 1992, Davies, G. 1993: 5). However, the disarticulation of the archive by this date resulted in the absence of any environmental analyses.

The effect of the Broadfield complex on the environment would have been highly complex. The chronology of exploitation suggests that iron production became important during the first century A.D. and expanded after the invasion and again towards the end of the first century, following the general trend of the Weald. The presence of Late Iron Age agricultural occupation, indicated by plough marks and extensive deposits of bones in Goffs Park, suggests that a proportion of the immediate environment was devoted to both arable, and iron production. However, the increase in iron production after the conquest would have enhanced the exploitation of woody resources.

ALFOLDEAN

The probable *mansio* site at Alfoldean (TQ 117330) is situated on Weald Clay, immediately south of the crossing point of the river Arun by Margary's route 15, Stane Street. The nucleus of the one hectare site is located inside a rectangular earthwork. Excavations in 1922 and 1923 by S. E. Winbolt (1923, 1924) suggested that occupation continued at least until the late third century (Black 1987).

The earliest evidence of iron production on the site was recovered by S. E. Winbolt in a trench across Stane Street 1/4 mile north of the station, at Roman Gate, where the road curved to avoid a marshy area. At this point the road was "twenty feet wide, paved with thin sandstone slabs, rested on *a foot layer of iron slag* [my italics] bonded with fine earth and bedded in yellow clay" (Collingwood and Taylor 1928: 208).

Excavation, in 1984, of a trench which cut across the enclosure and beyond revealed evidence for an extra-mural settlement which appeared to extend almost 600m to the south. This was manifested in the form of occupation debris, pits, ditches and "much iron slag", and a possible smelting furnace. (English and Gower 1985). This is suggestive of an industrial area associated with the posting station (Drewett, Rudling and Gardiner 1988: 187). The location of the industrial area outside the *mansio* earthwork is highly characteristic of Roman design. The dangerous nature of smelting operations made location away from major buildings an essential prerequisite. This can be seen in other industrial sites in the Weald which exhibit a dichotomy between the integral domestic and industrial elements. This follows a general trend in Roman military architecture to locate dangerous buildings associated with fire, such as bathhouses and ovens, beyond the bounds, or on the periphery, of settlements.

Alfoldean undoubtedly benefited from its nodal position in the communications network, which would have enhanced both distribution and supply, and provided a steady stream of customers from the posting station. The nodal communication centre suggested by the site's location on Stane Street, at the junction of the crossing of the River Arun, is further emphasised by the identification of a possible wharf structure identified by English and Gower (1985) near the bridge discovered by Winbolt. The importance of the post is further enhanced by a branch route joining Alfoldean from the SE. This linked the site with a hinterland dominated by a density of villas not seen in the High Weald to the east.

THE WEALDEN PERIPHERY

RUNHAM FARM

The villa site at Runham Farm (TQ 875514) is located approximately 300 m to the west of the farmhouse, below the crest of a low rise. The local geology is complex as a result of faulting, which gives rise to a wide variety of soils in the locality of the villa. The main villa site is located on Hythe Beds, comprising sandy limestones and silts. Folkestone Beds are found in the north, running south to a fault at the base of the hill on which the site is located. East-west faulting prevents the local exposure of the Sandgate Beds, but the Folkestone beds are exposed to the north of the site.

From the fragmentary evidence available, from the complex of activity (cf. Monckton 1979), it appears that the villa was occupied from the mid-first century to the beginning of the third. Although occupation did occur in the local area in the fourth century, there appear to be few indications of iron production at this later date. The finds from the villa included fragments of a Syrian scent bottle; Spanish and other wine amphorae; coloured, decorated, and window glass; and decorated samian. Evidence for farming activities included the bones of cattle, in conjunction with sheep and pig with butchery evidence, and roe deer. Fragments of a cheese press and carbonised bread wheat remains were also recovered suggesting the range of activities undertaken at the site. Evidence for spinning derived from part of a ceramic spindle whorl. In addition to iron production, limited bronze working was carried out, as evidenced by the remains of two ceramic crucibles with bronze still adhering.

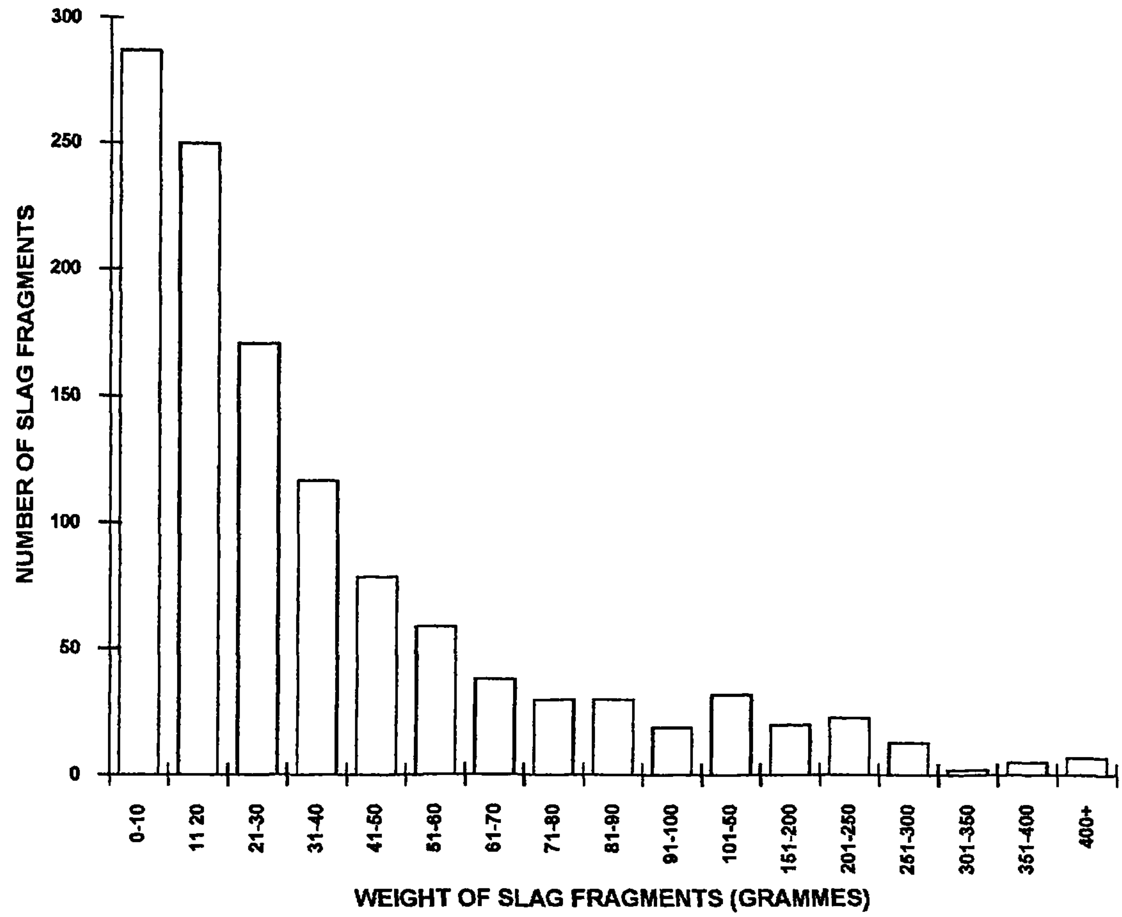


Fig 5. 5 The differential weight of slag fragments recovered from excavations at Runham Farm

Iron production on the site started in the Iron Age, with production sites now under the front garden of the farmhouse (the Dipping Well site), while another scatter of slag is located to the west of the farmhouse. The main villa site, established in the first century, created a continuum of iron production activity on the site. Excavation revealed two smelting furnaces in the vicinity of the villa, both of which had each been relined two or three times each. Many PCBs have been recovered from the main production site. By 1992 excavations had recovered 71,874 pieces of slag deriving from the IA to the mid-Romano-British period.

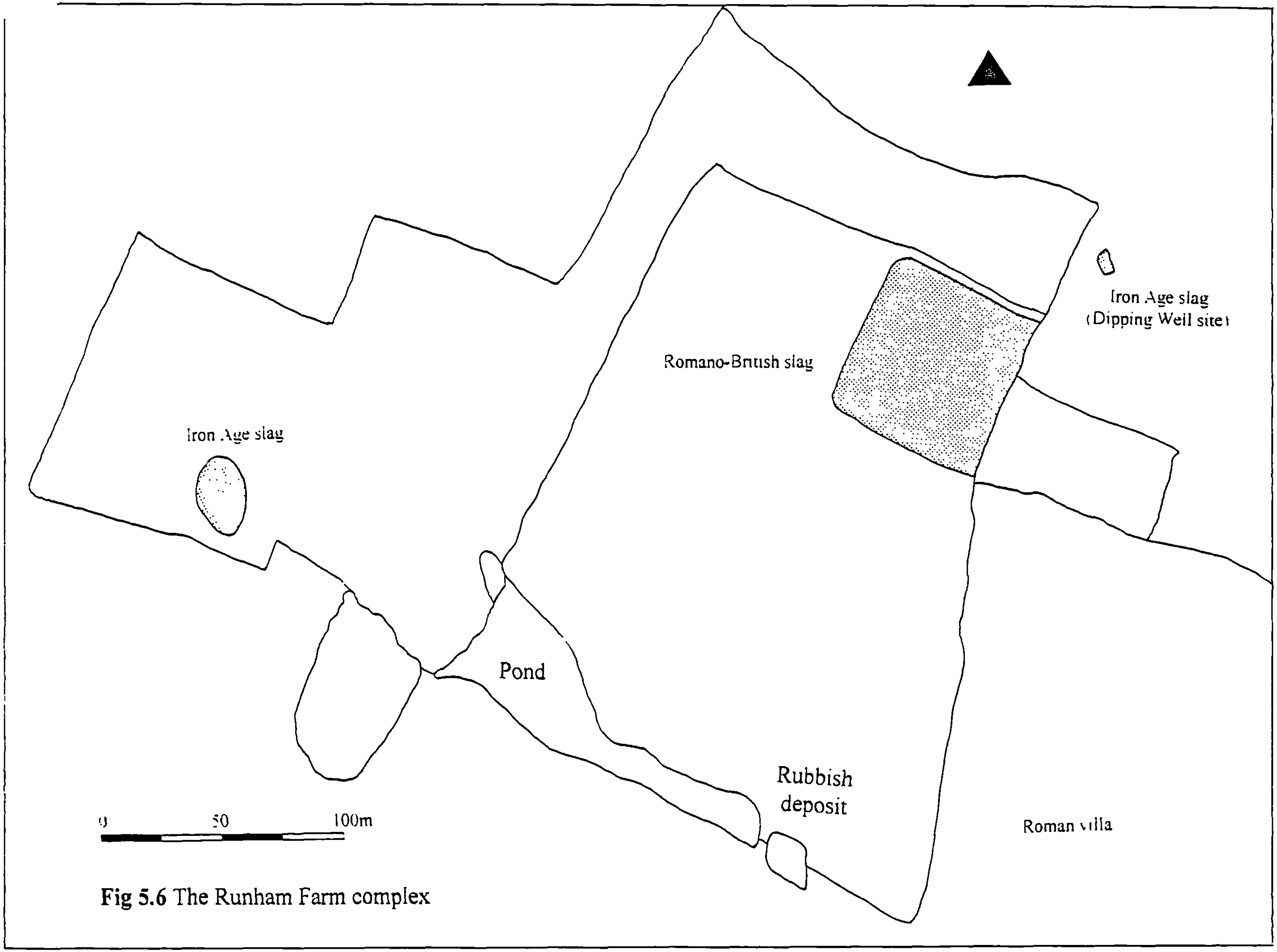


Fig 5.6 The Runham Farm complex

Based on an average of slag weights, this equates to the recovery of approximately 3.2 tonnes of waste material. The large areas of slag-impregnated soil found in conjunction with Romano-British ceramics suggests that the Roman sites were relatively productive. Analysis of the charcoalifed remains associated with iron production activities revealed a dominance of alder, although the original report was unobtainable (G. W. R. Monckton: *pers. comm.*). This contrasts to the oak-dominated assemblages of the Wealden clays and sands. This is possibly a function of the extensive interaction and modification which the environment in this region would have encountered as a result of the pre-Roman activity, and its good agricultural soils. Certainly every field in the vicinity of the villa has produced extensive evidence for anthropogenically-struck flints, suggesting environmental modification from as early as the Mesolithic.

Despite extensive excavation (Philp 1980), in the absence of significant publication, little more can be said about the nature of Romano-British iron production on this important complex of sites.

Excavation, in conjunction with the author, of a mid- to late-fourth century rubbish deposit on the Runham Farm site provided an opportunity to acquire charcoal from a Roman context on the Hythe Beds, which was used to provide a correlate with previous research.

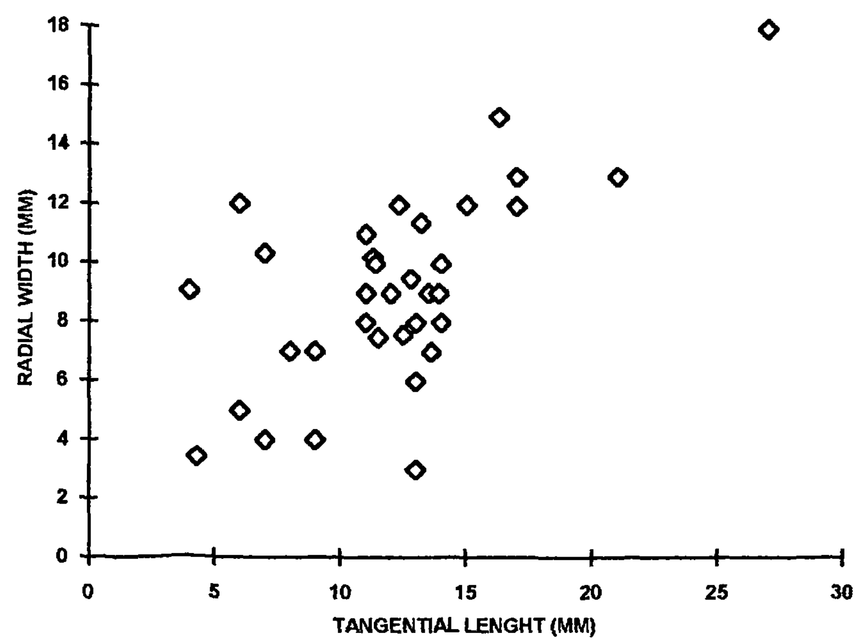


Fig 5. 7 Fragmentation exhibited by charcoal recovered from a fourth-century rubbish deposit at Runham Farm

The charcoal recovered from the site, after manual extraction during excavation, amounted to only 34 identifiable fragments. This low figure was attributed to enhanced attrition and exposure in the waste deposit resulting in degradation of material (cf. Fig. 5.7). No soil samples were recovered.

The taxa profile revealed two major arboreal communities (see Fig. 5.8); an open woodland and scrub community and a damp-loving population. The damp-loving community is indicated by the presence of alder (n = 6), and the *Salicaceae* family (n = 2), which include willow and poplar. Both these taxa would have required a damp environment such as river sides, or spring sides. The presence of a horizon of peat, destroyed by motorway construction, in the vicinity of the River Len could also have provided a location for the growth of alder carr. Unlike the sample extracted from the iron production facility, alder does not dominate the assemblage, however, it still represents 18% of the identified material.

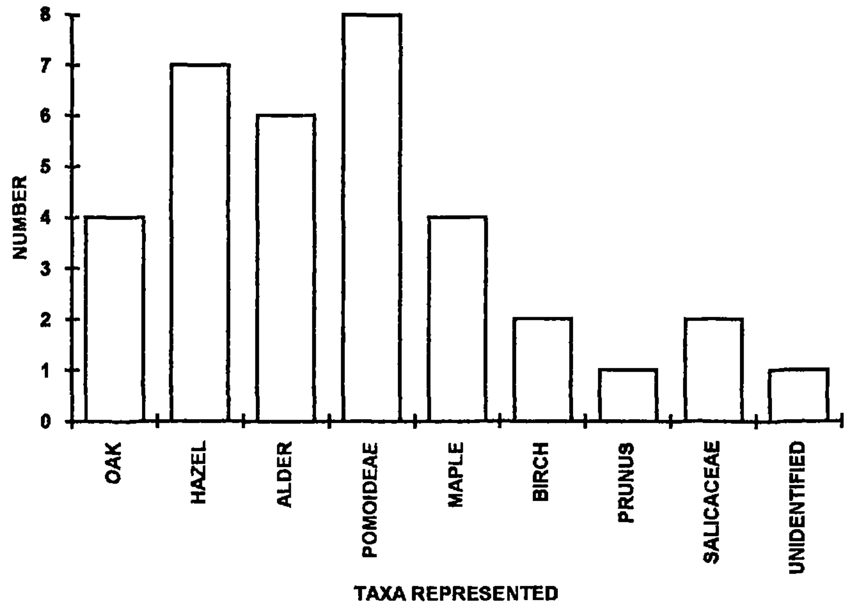


Fig 5. 8 The taxa recovered from a fourth-century rubbish deposit at Runham Farm

The other arboreal community suggested by the taxa recovered is one of relatively open woodland. This is indicated by the presence of maple, in conjunction with the hazel, birch, *Prunus* and *Pomoideae*. These light-loving species are likely to have existed on the margins of woodlands or in clearings. However, the low representation of oak suggests that closed woodland was not a significant feature of this environment. However, the small sample size (n = 34), could introduce unquantifiable bias into the taxa composition. It is highly probable that the light-loving species existed as scrub or open vegetation communities, which does not imply that significant regeneration was evident after the cessation of the villa's occupation.

CHAPEL FARM

The iron production site at Chapel Farm (TQ 908503) is located to the SE of the farmhouse, on a belt of Folkestone Beds of the Lower Greensand. The Gault Clay is situated to the north, while an intermittent band of Sandgate Beds are found to the south; the nearest ferrunginous Lenham beds are 3 km to the north. Reconnaissance prompted by the M20 extension recorded a considerable spread of Roman bloomery slag in a ploughed field. This was found in association with ceramics of the second century. Limited rescue excavation revealed the bases of two Roman shaft furnaces (Miles 1974).

HARRIETSHAM CHURCH

The bloomery site at Harrietsham Church (TQ 875530) is located in the fields to the north of the church. Harrietsham is actually located on the Lower Chalk (Worssam 1963: 8, Fig 12), and as such is not technically a component of the Weald; although, it does appear to be part of the same economic phenomenon as the other Lenham area sites, while its position on the boundary allowed for exploitation of both Wealden and downland resources. Evidence for iron production was first recorded during field reconnaissance by Major-General G. W. R. Monckton, who noted the presence of an extensive surface scatter of bloomery tap slag, cinder and furnace debris. These have been found in close association with Roman tile and other masonry remains, and ceramics of the second and early third centuries. This is highly suggestive of a building connected with iron production, in the manner of Runham Farm, 1.6 km to the south. Contemporary land-use is not conducive to further sub-surface exploration to corroborate this theory.

TANYARD FARM

Evidence for bloomery production at Tanyard Farm (TQ 903519) is located approximately 300m to the SE of the farm buildings. Extensive ploughing of the field has disrupted a deposit of slag which was found in association with second and third century ceramics. This site is located on 3.5 km to the ENE of Runham Farm and is found in close proximity to the chalk of the North Downs.

PETT PLACE

The iron production site at Pett Place is located to the NE of the Pett Place; a LPRIA antecedent at Stalisfield Wood is located 2.0 km to the NNW. A 40m diameter scatter of slag furnace debris and charcoal-impregnated soil was found in association with first- and second-century ceramics.

JUBILEE CORNER

Extremely little is known about the iron production site at Jubilee Corner, which, on the outskirts of Maidstone, is the most westerly of the known bloomery sites of this peripheral Wealden exploitation. Bloomery slag and cinder were found in association with first- and second-century ceramics (G. W. R. Monckton *pers. comm.*), although little surface evidence now remains. The location of the site would have benefited from the proximity of Margary's route 13.

BRAMBLE FARM

The iron production and industrial site at Bramble Farm (TR 04934746) is located approximately 375m NNW of Wye Station. Evidence for industrial activity was first recorded by the Ashford Archaeological Society in advance of development (Bradshaw 1971: 288). The industrial area and iron production site centred at TR 04934746 was one of two recovered *foci* of settlement. Industrial activity included evidence for "iron working and primitive smelting hearths in conjunction with some other industry that required a stone floor for drainage" (Bradshaw 1971: 178). The ceramic assemblage and coin evidence, associated with the iron production, suggested the continuation of occupation on this site from the late first to early third century. The length of occupation attested by the ceramic evidence suggests a site of possibly semi-industrial proportions. However, within the confines of the rescue excavations, no substantial slag deposits were recovered to confirm this. The close proximity of route 130 could have provided a substantial outlet for the removal of slag for metalling purposes.

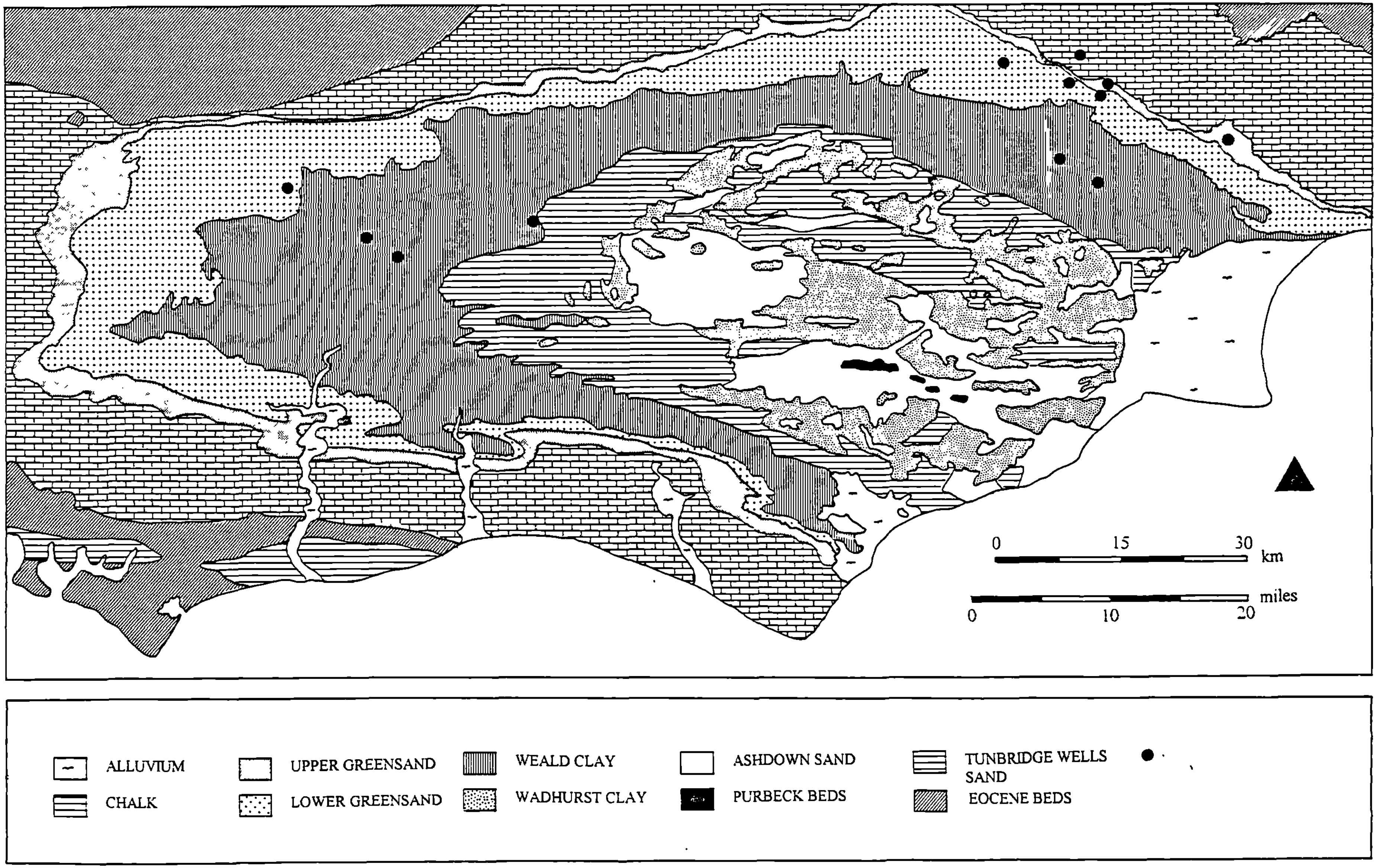


Fig 5.9 The distribution of Roman iron production sites on the High Wealden periphery

Another site of Roman occupation was recovered at TR 04774730, where excavation revealed traces of a ditch. Dating based on coin evidence suggested occupation in the last half of the first century.

IRON PRODUCTION ON THE
THE HIGH WEALDEN PERIPHERY:

THE KENTISH WEALD

LENHAM

Discoveries of sites of Roman iron production sites on the Greensands of the Kentish Weald have been eclipsed by work on traditional High Wealden exploitation sites, which has served to negate the study of the periphery as a discrete entity. This dichotomy has been enhanced by the apparent absence of widespread iron production and working in the corridor of Weald Clay between the High Weald and the Lower Greensand, which has further marginalised research on the Greensand sites. In addition, the immediate attraction of the accessible and well-known archaeological sites of the North Downs and the Greensands, has tended to direct both Sussex-based and external archaeological resources away from iron production sites in this region. As a result, these sites are considered anomalies on the margins of the Wealden production centre rather than as indicators of a coherent economic system.

A significant body of Romano-British iron production sites has been recovered, to the SE of Maidstone, in the Lenham/Harrietsham region. As with much of the Wealden region, this information has been produced by local archaeological research, much of it specifically focused on iron production, such as the work of Major-General G. W. R. Monckton. The recording, by Monckton, of six Romano-British iron production sites between Lenham and Maidstone is complemented by the research of Patrick Thornhill in the 1970s, in the course of which he discovered 15 undated bloomery sites in the unit of land bounded by Ulcombe to the west, and Egerton to the south (see Fig. 5.10). The location of this group of sites is suggestive, as they link exploitation in the Lenham/Harrietsham region with known Roman iron production sites in the mid-Kentish Weald, such as Coldharbour Farm and Romden Place, implying an unbroken continuum of activity across the Low Weald and scarp foot. It is likely that the presence of both confirmed Romano-British activity and undated sites could be indicative of an as yet undisclosed group of sites bounded by routes 13, 130, and 131.

The peripheral sites below the southern scarp edge of the North Downs are located on some of the more complex geology of the whole Wealden region, dominated by two concentric bands of geological formations: the Lower Greensand, and the Gault Clay. Unlike the Wealden periphery to the west of Sevenoaks, the Upper Greensand is not expressed on the scarp foot of the Kentish Weald, where the Wealden geologies ceases at the boundary of the Gault with the Lower Chalk. As with the Weald Clay, extensive denudation of the Gault Clay forms a narrow clay vale contained within the escarpments of the Downs and the Lower Greensand. In certain locations, on the Lower Greensand and in Combe deposits on the Gault, extensive modifications have occurred as a result of the influx of calcareous and other material of colluvial origin from the Downs. These

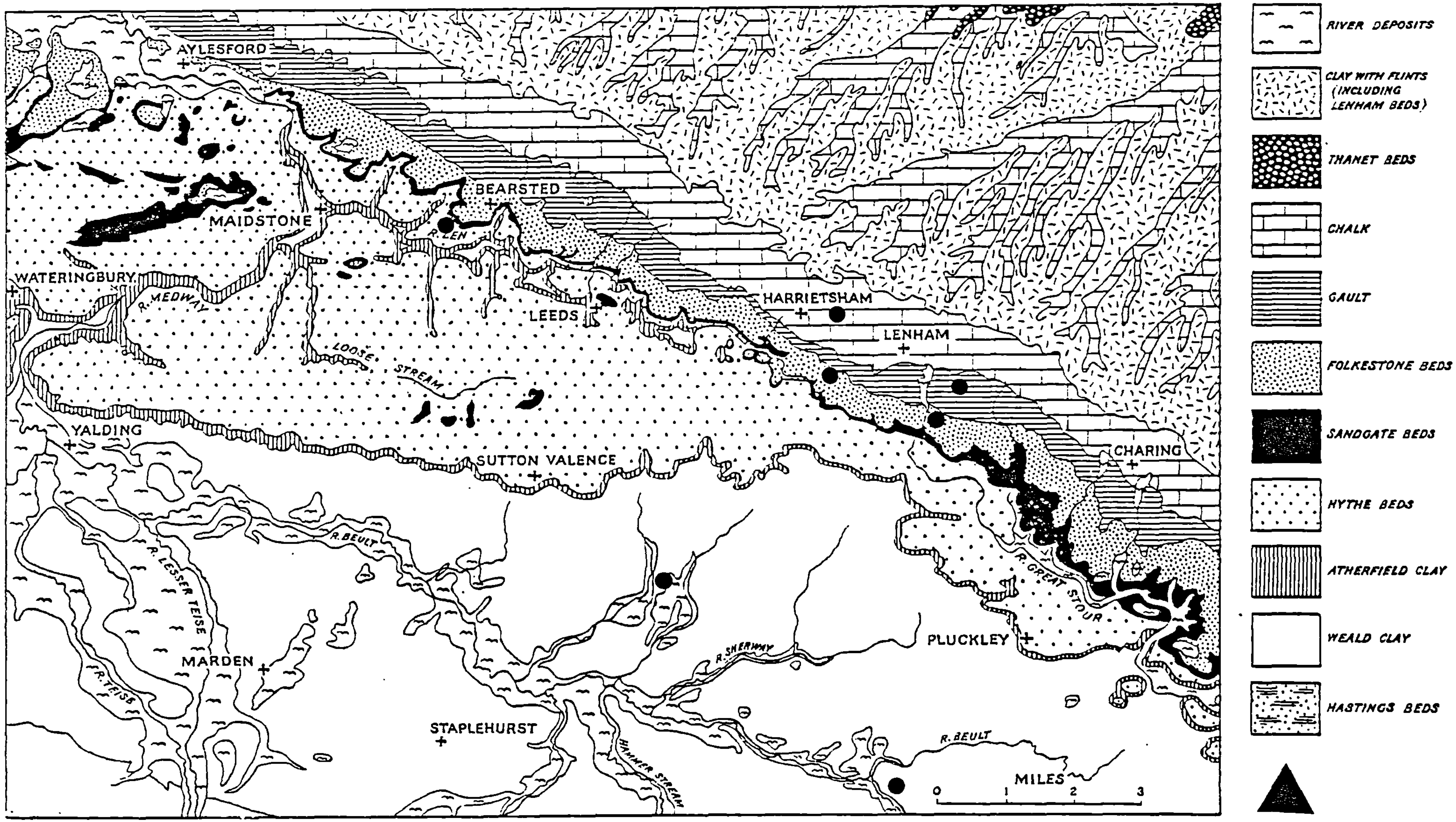


Fig 5.10 The Roman iron production sites of the Lenham hinterland

modified upper horizons comprise the calcareous brown earths of McRae and Burnham's association B (1975: 598). In conjunction with the coarse loamy and loamy argillic brown earths of association E, these serve to facilitate better drainage and enhance fertility. The Lower Greensands are sandwiched between the stagnogley soils of the Weald Clay and the Gault Clay.

The combination of such varied solid geologies and soil types in a narrow belt around the Weald Clay allows for the exploitation of several environments in a relatively small area, resulting in a greater diversity of land-use than in the central Weald. The Downs to the north, the rendzinas, and modified calcareous earths of the Upper Greensand, the stagnogleys of the Gault, and the coarse loamy and loamy argillic brown earths, all occur in a band rarely wider than 4 km in this area. To the south of this exists a broad band of fine loamy and silty argillic brown earths.

The juxtaposition of local solid geology and extensive soil modification, in conjunction with the emergence of the spring line at the scarp foot of the Downs, has resulted in extensive settlement and cultivation from the Neolithic, with precursive activity in the Mesolithic. Certainly, the favourable nature of the modified Greensand lithologies in the Maidstone region, has enhanced the recognition of archaeological evidence in the area. The nature of Romano-British settlement is generally different to that exhibited in the High and Low Weald. Here, iron production is, in many cases, a sub-component of villa or farmhouse economies. The excavation of a villa of moderate wealth at Runham Farm produced extensive evidence for agricultural activity, such as carbonised bread wheat and butchered animal bones, found in association with extensive evidence for iron production (G. W. R. Monckton: *pers comm.*). At Harrietsham Church, iron slag was found in conjunction with masonry and tile in the plough soil, which is suggestive of villa-style occupation.

The high fertility and light nature of the soils in this region facilitated relatively dense occupation during the Romano-British period. The known distribution of Romano-British sites on the Lower Greensand ridge and Head deposits around Maidstone and the Medway valley, immediately to the NW of the contemporary Lenham and Harrietsham area, represents one of the densest areas of occupation in the Wealden region. The density is such that the possibility of a nucleated settlement site, now under the Maidstone conurbation, was proposed by Wheeler (1932: 99-101) and Webster (1975: 59). However, research by Pollard (1977: 32-3) highlights the difficulty of determining whether the density of settlement between the confluence of the rivers Loose and Medway is indicative of a nucleated settlement or the manifestation of high density valley-side settlement.

The precursor of this intense Romano-British activity was the apparent LPRIA *oppidum* at Quarry Wood, which dominated the Greensand ridge above the Loose valley in Maidstone. The probability of the existence of such a site has declined since recent evaluatory excavations failed to find evidence of significant activity. In addition to the increase in population prior to the conquest, there is evidence that the ferric resources of Lenham and Harrietsham were being exploited during the later Iron Age, as evidenced by two pre-Roman iron production sites at Runham Farm and a recently discovered smelting furnace at Stalisfield Wood (G. W. R. Monckton: *pers comm.*). There appear to have been indigenous traditions of both iron production and agricultural production in the region before the conquest. The continuum of these traditions and skills through the native population probably resulted in the localised exploitation evident after the conquest.

The Maidstone region would also have benefited from the presence of Margary's route 13, which appears to have been constructed as a direct consequence of the need to supply the needs of the industrial iron production centres in the Hastings hinterland. The presence of Thameside wares from many of the Hastings industrial-class iron production sites attests to the utilisation of this route by the iron producers.

Excavations at Runham Farm suggest that the villa site was, characteristically, primarily associated with agriculture. This could not have failed to have an effect on the local arboreal environment, with the need to keep agricultural land clear for arable or pasture being diametrically opposed to the natural extension of woodland communities. The charcoalified remains from the iron production facilities at Runham Farm revealed a dominance of alder, in contrast to the High and Low Wealden regions where alder comprises a regular but extremely small percentage of the charcoalified remains from iron production contexts. This can be correlated to the limited evidence for the taxa recovered from Romano-British bloomery sites throughout Britain. It is possible that this could be a perceptual problem, related to the association between alder and damp areas; certainly its fuel properties in an un-charcoalified form are poor.

The ecological preference of alder is for damper soils, characteristic of river banks, marshy ground and damper valley bottoms (McVean 1956: *passim*). Considering the free-draining nature of the majority of local soils, it is likely that the alder would have derived from around river banks, in addition to ponds and springs which are common in the region. Alder is still found today on the marshy ground around the source of the River Len near the site. The fact that alder was not only used as a fuel, but dominated the assemblage, suggests that, in the locality of Runham Farm at least, substantial modification of woodland had occurred. This was possibly a direct result of clearance for agriculture over a long period, in conjunction with rising population in the Romano-British era[†]. A correlation with

[†] There is extensive corroboratory evidence for the heavy utilisation and clearance of calcareous downland environments in southern Britain during the Romano-British era. On the Berkshire Downs the recovery of extensive low-density Romano-British ceramic scatters from large areas of downland was interpreted by Gaffney and Tingle (1989: *passim*) as the archaeological manifestation of widespread arable agriculture on the downs. At the Romano-British temple and settlement site at Lowbury Hill, charcoalified remains suggested that the local environment was predominantly clear of closed woodland and dominated by scrubby species, possibly necessitating the acquisition of wood from the surrounding river valleys (Kaminski 1994: 190). This can be corroborated with evidence from Salisbury Plain where the calcareous lithologies were increasingly cleared from the Neolithic onwards, resulting in a predominantly open landscape by the Romano-British era, dominated by scrubby species clinging to marginal land in conjunction with the clay-with-flints (Entwhistle 1994, Kaminski: forthcoming).

the presence of damp-loving species on the Hythe Beds of the Lower Greensand has also been noted during excavations on the Chart Wood to Limpsfield, Edenbridge road on the Surrey Kent border. A pocket of charcoal found in the bank of the Roman road was identified as exclusively poplar (Graham 1932: 103). Although there are methodological problems with the identifications of the genus *Populus* spp., the presence of the *Salicaceae* family is informative as it indicates damp-loving species in the willow/poplar taxa.

On the North Downs and their associated Greensands, the presence of large numbers of contemporary villas and farmhouses which have evidence for hypocausts does not necessarily negate the concept of a relatively open and modified local environment. The fuel requirement of the hypocausted buildings could have been met by scrubby species, agricultural waste, or local managed woodland stands kept for the purpose.

The volume of slag remaining on the Runham Farm site is relatively substantial. Estimates are difficult, as iron was certainly produced on the site from the Iron Age. However, the extensive distribution of slag associated with material culture in the immediate proximity of the villa site and covering a field to the west of the farmhouse, in conjunction with the use of the material to metal the trackway that runs under Runham Farm, (although the slag used for its construction need not necessarily be of Roman origin), suggest a relatively prolific localised industry. An estimate of 5 tonnes of bloom iron produced over the Romano-British era would be adequate[†] .

The two excavated smelting furnaces at Runham Farm were recovered in extremely close proximity to the villa building, suggesting the perceived importance of iron production to the operators was relatively high. The relatively large volume, for a villa site, of slag recovered, suggests that iron was destined both for use at the site of production and for trade of any surplus material. There would certainly have been a substantial available market from other contemporary villas on the North Downs. In many cases downland villas and farmhouses did not have the raw materials - either fuel and/or significant ore deposits - to sustain iron production, and as a result would have been reliant on external sources of iron or on the provision of finished iron products. However, it is important to emphasise that iron production on the North Downs would have been a significantly more viable prospect than on the South Downs. This is the result of the deposition of drift deposits of clay-with-flints and integral ferruginous beds exclusively on the North Downs. The clay-with-flints would have been conducive to the support of woodland communities to a greater extent than calcareous lithologies, while the ferruginous deposits would have provided ore for iron production. The presence of bloomery sites at Harrietsham and Hollingborne in the Lenham region, and three

---

[†] This is based on a slag scatter of 100 x 100 m which is associated with Romano-British material culture. The scatter appears to have a density of approximately 1 kg/m^2, which over 10,000 m^2 could represent about 10 tonnes of waste material. This could be indicative of the production of 3.3 tonnes of bloom iron, which allowing for taphonomic loss, such as road construction, could be increased to 5 tonnes.

sites at Stelling Minnis in the vicinity of Lympne, suggest that ferric resources could be exploited in this environment on a moderate scale.

As a result of the complex geology of the Lenham region, the iron ore used for smelting could have derived from multiple sources. At Runham Farm exploitation was known to have occurred during the Iron Age as well as the Romano-British era. Such longevity of exploitation implies a source of ferruginous material in the immediate vicinity of the site. It is probable that in this context, the 'carstone' or 'boxstone', a brown, sandy ironstone of the Folkestone Beds, was exploited to sustain iron production (Worssam 1985: 14).

However, the presence of the 'carstone' and other ferruginous Wealden deposits are not sufficient to explain iron production in this peripheral exploitation in totality. The production of iron at Harrietsham Church on the Lower Chalk could have been based on the proximity of the Lenham Beds beyond the scarp edge. The exposure of blocks of ferrunginous sandstone in solution 'pipes' in the chalk around Lenham in Kent has been recorded since 1854 (Gallois 1965: 49). The hypothesis that the ferrunginous Lenham Beds could sustain iron exploitation was first proposed by Topley (1875: 338). This was extremely perceptive, considering that the Romano-British methods of working ore were imperfectly understood, and no complete analyses of the ores had been undertaken (Kirkaldy 1975: 382, Topley 1875: 338). The Lenham Beds represent material deposited in the late Pliocene, but they are outside the defined geological boundaries of the

Weald. In some cases, the effects of geological erosion, colluviation, and arable cultivation would have served to scatter some ferruginous material into the immediate vicinity of the Wealden boundary. It is likely that occupants of the villas and settlements on the Upper Greensand could have exploited the Downs for resources, and as a result would have been aware of the presence of ferric resources. However, in view of the presence of ore sources on the Greensands, it is unlikely that poorer-quality downland ore would have been transported and smelted.

The iron production activities in the Lenham-Harrietsham region were an integral part of many local villa economies. These activities were subsidiary to agricultural production, as attested by the absence of semi-industrial and industrial-class exploitation in the region. Just as the Wealden region is a peripheral socio-economic zone in southern England, so the Weald Clays and Greensands are peripheral to the major ferric exploitation which occurred on the High Weald. These regions would have experienced immediate economic stimulation from both the Weald and the wider south-eastern region. The factors which have influenced the location of local iron production sites on the Greensand to the SE of Maidstone appear to be significantly different to those which influenced the High Wealden sites. It is probable that on the Greensand the size of operations in the Romano-British era was limited by the availability of extensive ore deposits, and, most importantly, the competition between fuel resources and agricultural land in some areas.

ASHFORD

Another example of this Kentish Greensand exploitation has been recovered at Bramble Farm, to the north of Wye. The limited excavation of a light-industrial site, under rescue conditions, suggested occupation from the late first to early third centuries. The site was favourably located at the junction of several communication routes. The Great Stour, which runs immediately to the east of the site, has truncated the Downs to create a link between the eastern Weald and Canterbury. The scarp edge of the Downs is not truncated again until the Medway cuts through the Lower Greensand and the Downs at Maidstone. This natural communication highway was therefore the most favourable crossing point of the eastern section of the North Downs. This was exploited during the Roman era for the construction of route 130 from the eastern Weald to Canterbury. The iron production site would have benefited from the traffic of route 130 which ran only 1.2 km to the west, and the presence of the Great Stour which flows through Canterbury. In addition, the North Downs ridgeway could have crossed in the vicinity (Margary 1956: 259-62), although the exact route taken by such a trackway would have been less rigid than the later Roman arterial routes imposed on the landscape. Considerable doubt has been expressed in relation to the nature of the North Downs trackway, which could have been little more than a series of local trackways (Turner 1980: *passim*). This interpretation would certainly allow for changes in land ownership after the conquest. The longevity of occupation of the industrial site at this particular point appears to be a function of its nodal position on the arterial Romano-British communication routes. It is possible that the construction of the road resulted in the discovery of suitable ore deposits on the valley floor, which later sustained the Bramble Farm site.

In addition to the small industrial site, the Wye valley floor has evidence for two villa sites, one in close association with the industrial area, although unlike the iron production sites at Lenham, the relationship between the industrial site and the villa is less clearly defined. Another villa is located on the Downs above the site. The limited area of the valley floor would have been prone to several impacts, including road building, which could have had a moderately short-term effect, in addition to villa agriculture and industrial activity.

In the context of this relatively concentrated Romano-British occupation, the source of fuel for bloomery operations, on the valley floor, is important. The North Downs would certainly have been heavily utilised, although with less clearance than would have been expected on the classic calcareous lithologies of the South Downs. There is extensive evidence for prehistoric occupation and activity on the surrounding Wye Downs and the North Downs. The presence of

Roman agricultural and pastoral activity in the Wye Valley and on the surrounding Downs would have been detrimental to the regeneration of woodland cover.

It would, however, be unwise to correlate this area with the palynological work undertaken in the immediate vicinity of the South Downs, which suggests that these downland landscapes would have been heavily cleared by the onset of the Iron Age. The North Downs are characterised by superficial deposits of clay-with-flints which have a greater ability to sustain woodland than the unmodified calcareous lithologies (see above).

Arboreal cover would have been considerably reduced, with little or no closed woodland, but it is likely that sufficient cover was maintained in the vicinity of the villa and industrial sites to provide a source of fuel. Based on analogy with the Lenham region, the source of wood for iron production could have been scrubby species; riverside marshy flora such as alder carr; managed stands; or some fuel could have been transported from more distant sources. It is unlikely that the fuel requirements of an iron production and industrial site could have been sustained by external sources for three centuries. In the absence of environmental information from the excavations, it is impossible to determine the nature of the valley floor environment.

Evidence for pre-Roman iron production is attested at Eastwell Park approximately 4 km to the west of Bramble Farm. Here iron slag was recovered only in association with La Tène ceramics, with no evidence of Roman production.

Eastwell Park is found on the scarp edge commanding the Wealden entrance to the Wye Valley. Its position would have had the same implications for trade with traffic coming through the Downs as the later Roman industrial site near Wye. In this context, it is possible that trade goods from the Weald such as iron, which could have been intended for the Kentish lowlands, could have been exchanged or taxed. Iron for smelting was probably obtained directly from the *territorium* of the Eastwell Park site, which would have included iron-rich Wealden land.

Although the Bramble Farm site is located on the Wealden periphery and its association with an apparently heavily populated agricultural landscape suggests a similar nature of exploitation to that exhibited in the Lenham hinterland, there are significant *caveats*. The location of the site on route 130, in conjunction with its exploitation between the first and third centuries, suggest that in this section of the North Down iron production was economically linked with the exploitation of the eastern Weald. This could have been either a direct link, representing an extreme outlier of the eastern High Wealden industries, or, more likely, it represented a site exploiting traffic between the Wealden ironfields and Canterbury. The close correlation between the periods of exploitation of the Wealden heavy industries and the Bramble Farm site could suggest some degree of symbiosis.

Similar evidence for undated bloomery activity occurs on the North Downs, south of Stelling Minnis, where Stone Street cuts across, taking advantage of the topography. Here ferruginous sandstone beds overlying the chalk appear to have provided material for a 200 m^2 bloomery site at Greatfield Farm (TR 129 454), and others at TR 134 430 and TR 167 467 (Hodgkinson 1995: 2). Although there is no indication that these sites are of Roman origin, other than their proximity to Stone Street and Lympne, it does suggest a trend for the utilisation of the communication routes across this section of the North Downs for light industrial activity. The ability to trade with traffic crossing the Downs and the close proximity of roads and tracks would enhance the economic stability of a site.

THE NORTHERN SCARP FOOT

The evidence for Romano-British activity on northern scarp foot is extremely sparse. The activities represented between routes 13 and 140 (Maidstone - Dorking), are dominated by moderately high visibility sites, such as villa sites on the Upper and Lower Greensand, and cremation burials on the Lower Greensand (Bird 1987: Fig. 7.7), which are also possibly indicative of settlement. This evidence is apparently matched by a complete absence of bloomery activity from all eras (Worssam 1985: Fig 3, Fig. 4). This could be a function of the lack of research in this region, as the density of Roman production sites is relatively high in Maidstone region, to the east, while tentative production, in the Farley Heath region, is located to the west. As a result it is likely that the indigenous population would have been aware of the ferric resources of the region, and their potential for exploitation.

THE WESTERN SCARP FOOT

In the Kentish Weald, the Greensands have produced a large number of smaller-scale iron production sites. However, on the western Greensand, there are far fewer sites, dispersed over a wider area. There is evidence for pre-Roman production in the fortified enclosures at Hascombe Copse, on the Lower Greensand (Winbolt 1932), and Piper's Copse, 7 km to the SE of Haslemere (Winbolt 1936). An undated bloomery site has been recovered, on the Lower Greensand, at Combswell (Ovenden 1973), and probable later medieval bloomery activity has been recorded at Lurgashall. The discovery of such limited activity is probably a function of the *ad hoc* nature of research. It has been suggested that the carstone was the source of ore for the Hascombe Hill site (Winbolt 1932). Although this ore has a high silica component in the gangue, it is unlikely that this would have been significantly detrimental to the operations of bloomery furnaces, although it certainly negated smelting by the indirect method in the post-medieval era.

There is a growing body of evidence for Roman iron production in the hinterland of Farley Heath. It has been tenuously suggested by Hanworth (1968: 4-5) that an inscription recovered from the temple at Farley Heath might indicate links with the iron industry. The inscription was dedicated to *Taranis, Sucellus* and their consort *Nantosvelta*; it has been suggested that *Taranis* and *Sucellus* might equate to Jupiter and Vulcan, who have associations with Roman smiths, although *not necessarily* blacksmiths. This is a tenuous conclusion at best, and has been questioned on the basis of the apparent absence of iron production in the locality (Bird 1987: 195), although the branch road of route 15 on which Farley Heath is located terminates at Alfoldean, which has associations with iron production. In addition, ore sources are present in the region of the site, and there was a precursive native tradition of iron production, as evidenced by iron production at Hascombe Camp and both Iron Age and subsequent Romano-British bloomery production in association with settlement evidence recovered at Thorncombe Estate on the Lower Greensand (NAR SU 94 SE 1). These sites are found near the tile-kiln at Wykehurst Farm, near Rapsley (Goodchild 1937), which further emphasises the importance of small scale industrial activity in this locality. Corroboratory evidence from the nearby Weald Clay also indicates the presence of Roman activity and possible iron production at High Billinghurst, to the south-west (Holling 1967).

The inherent fertility which is the defining characteristic of the well-drained Greensands in the eastern fringes of the Weald is not evident in this western region. Here the Lower Greensand is dominated by podzols, sandy brown earths and brown sands of McRae and Burnham's association F (1975: 599-600, Fig 1). These acid, infertile, and coarse-textured podzols have a tendency to support both woodland and heath.

In the SW of the western periphery the proximity to the markets at Chichester could have exerted an intermittent draw. Evidence from a late first-century context in North Street, Chichester, produced bloomery slag, furnace lining and hammer scale. This was interpreted by Butler (1974: 143) as the manifestation of both iron production and refining. It is possible that ore was transported from the nearby western Weald, although the possibility of waterborne transport from the eastern High Wealden coastline cannot be discounted. Cleere's (Cleere and Crossley 1995: 68) suggestion of hypothetical links with the *collegium fabrorum* (RIB I: 91) of Chichester and the iron production of the Hastings region are pure conjecture. The direct links between Chichester and the Low Weald and Alfoldean along Margary's route 15, and along the scarp foot of the South Downs via route 140, suggest a relatively direct route for the supply of iron or iron products to the Chichester markets.

REGIONAL SUMMARY OF THE GREENSANDS AND GAULT CLAY

The evidence for exploitation of ferric resources on the Greensands and associated geologies which form the boundary of the Weald has advanced considerably. However, the contemporary density of one site per 166 km^2 (0.6/100 km^2), is suggestive of considerable under-representation. There is extensive evidence for small-scale production sites on the Greensand of the Kentish Weald. This does not appear to correlate with the available evidence from the western Wealden Greensands, which have produced only sparse evidence of Roman exploitation. This can possibly be attributed to the dichotomy of fieldwork between these two regions, and the greater agricultural exploitation of the Kentish Weald, although it is possible that the numerical differences in bloomery sites between the east and west could be significant, as a result of the differential distribution of ore sources. The population on the Greensands of the Kentish Weald would probably have been greater than that of the western Weald. The high fertility of the soils in the periphery of the Kentish Weald would have supported a denser population. The close proximity of the nodal markets at Canterbury and Rochester emphasises the importance of Kent in the south-eastern region. The Kentish Weald had good access to major transport routes such as routes 13, 130 and 131. The presence of major industrial iron production in the eastern Weald and the relative proximity of the High and Low Wealden exploitation could have been beneficial for the spread of technology and ideas, in addition to providing a stimulus for production.

In contrast, the western Weald represents more of a backwater. It only benefits from routes 140, 150 and 15, although minor roads trackways would have been present. The environment would have been less beneficial for agriculture than that of the eastern Weald, with the inherent implication that there would have been a smaller population. However, archaeological evidence for villa/farmhouse occupation, which was unassociated with iron production, suggests that there was sufficient settlement for an active market for iron in the western Greensand region. It is likely that much of the iron production that did occur would have been associated with these sites, in the same way as those of the Kentish Weald.

It is possible that the comparatively dense distribution of activity in the vicinity of Pulborough and Hassocks to the east could be indicative of small towns (Cunliffe 1973: 69-73); or more probably the nucleation of rural settlement at the junctions of the major arterial routes in the region - the scarp foot route 140, and trans-Wealden routes 15 and 150. The settlement in this region was probably agriculturally oriented, as with settlement in the Maidstone region of the periphery. Certainly, excavation of a Roman well at Hassocks revealed evidence for waterlogged wood of "maple, elder, oak, hazel, alder, hawthorn, rose (with thorns), and wheat straw". These were found in addition to seeds of elder (Couchman 1978: 198). The well was considered to have been abandoned prior to the end of the second century A.D. The implication is that agriculture was a significant element of these communities and that some arboreal modification would have ensued as a result. The taxa composition from the well could indicate the presence of more open woodland communities in the vicinity of the site. The precise method by which the wood became incorporated into the well deposits was probably highly variable, ranging from construction debris, deliberate deposition and accidental loss.

These peripheral settlements would have been another market which would have needed supply of iron, or iron products. It is unlikely that the carstone deposits would have been sufficient for anything greater than local exploitation, although the pull of the Chichester markets could have acted as an additional stimulus for hypothetical iron production. In contrast to the evidence from the Upper and Lower Greensand geologies, the Gault Clay has, as yet, produced no evidence for iron production during the Roman occupation.

It is highly probable that some of the bloom iron produced on the periphery could have supplied the villas on the Downs surrounding the Weald, in conjunction with the villas on the Greensands of the western scarp foot. The movement of materials is attested in the Iron Age by the supply of products to the hillfort at Danebury, in addition to the location of bloomery activity at Eastwell Park at a nodal communication point with the Kentish lowlands, possibly indicating extra-regional trade. This trade would have continued into the Romano-British era with its enhanced population and significant development of villas and farmhouses on the Downs. The North Downs are likely to have retained some woodland cover on the clay-with-flints and as such would have supported an environment significantly different to that of the South Downs. Here there are no significant superficial deposits and the resultant lithologies are calcareous, possibly with little woodland cover during the Romano-British era. There is a corresponding lack of evidence for the manipulation of iron in these contexts - for example, Bishopstone, which produced such a small deposit of slag that the debris was considered to represent smithing or working rather than actual production (Cleere 1977b). The almost complete absence of smelting, probably resulting from the problems of acquiring fuel and ore, is complemented by the low occurrence of iron working. This again was probably a result of the need to conserve fuel for domestic use rather than the conversion to charcoal. The implication is that in the context of the South Downs, iron was predominantly imported in the form of finished products rather than as semi-finished blooms. This would be beneficial economically to the provider as the weight of material to be carried would be reduced, and to the consumer in the preservation of scarce woodland resources.

The large number of villas and farmhouses on the Downs, and to a certain extent on the western Greensands, would have required a substantial amount of iron for construction purposes such, as nails, hinges, and locks, in conjunction with tools and agricultural equipment. Some of this might have been derived from non-local sources such as Chichester or London, which indirectly might have originated from Wealden deposits; however, it is highly likely that a significant component of the supply was derived directly from Wealden sources which would have been relatively consistent in output and in the quality of the material produced.

It must be emphasised that villa sites represent the upper element of the social hierarchy, with significantly less than 1% of the population living on these sites. Their importance in the economies of the calcareous downlands could be over-emphasised as result of their high archaeological visibility, with resilient building materials and prestigious material culture, and the long period of excavation and exploration which has occurred on such sites. The majority of the population, whose agricultural products would have sustained much of consumer-level society, would have inhabited less archaeologically visible villages and communities in and beyond the Weald. The need for iron here would not relate to construction to the same extent, as a result of differing building methods, but agricultural equipment, tools and other implements would have still been required.

THE LOW WEALD

THE KENTISH LOW WEALD

The relationship between the Low Weald and Roman iron production has received the least attention of all the physiographical regions of the Weald. Cleere and Crossley (1985: Fig 19) show only one site on the Weald Clay, at Broadfield on the western boundary of the High Weald. However, iron production has been recorded at Alfoldean to the west of Broadfield, and possibly Hall Place Farm, Dunsfold. Two further confirmed Romano-British iron production sites have been recovered in the Kentish Low Weald at Romden Place and Coldharbour Farm. Of these two sites, Romden Place is almost certainly semi-industrial in nature, with slag and black earth scattered over three fields. The evidence from Coldharbour

Farm suggests much smaller-scale exploitation. The accidental nature of discovery, the depth below the ground surface of the slag deposits, and the absence of further excavation do not allow for confirmation of this hypothesis. The presence of these four iron production sites suggests that the Weald Clay was capable of supporting iron production operations of a substantial nature. However, the current density of one site per 338 km^2 (0.3/100 km^2) in the Low Weald, is the lowest of all the physiographic zones in the Weald. Certainly the presence of a small number of post-medieval blast furnaces on the Weald Clay in the Western Weald (Cleere and Crossley 1985: Fig 74) confirms that large-scale extractive operations could be sustained.

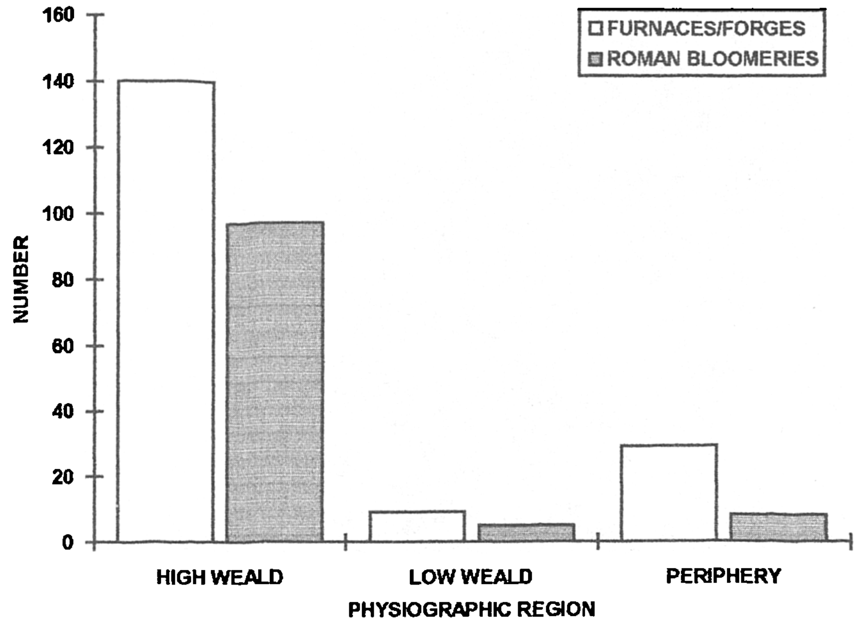


Fig 5. 11 The dominance of the High Wealden iron production sites in the Roman and post-medieval eras

It is probable that the bloomery sites on the Weald Clay would have been less numerous than their counterparts on the High Weald and the Greensands. This would have been a function of the accessibility and distribution of the ore. In the High Weald, ore sources tend to be exposed on the surface to a greater extent, as a result of faulting and denudation, and therefore require fewer resources both to locate and to extract. A later correlation for this can be witnessed in the distribution of blast furnace and forge sites in the peripheral geologies, compared to the High Wealden region (see Fig 5.4). In the Low Weald, the plasticity of the Weald Clay would have served to conceal ore deposits, and where they existed surface mining would have been required to extract the ore. The difficulties of mining operations in the heavy, waterlogged Weald Clays would have tended to deter some of the local exploitation which is evident in the High Weald and on the Greensands. The extensive problems associated with ore extraction on the Weald Clay would have been the difficulty of locating ore sources, the weight of material which required moving, and problems with excavations filling with water after rain. However, this must be balanced against the dominance of extraction and production on the Wadhurst Clay of the High Weald. It is likely that the apparent absence of sites is a function of several elements.

In addition to the lower original number of Romano-British sites, the contemporary recovery of sites is poor. The absence of active local field groups on the Weald Clay of the mid-Kentish Weald has resulted in only two accidental discoveries of iron production sites in the region. The absence of fieldwork is further enhanced by the emphasis of WIRG research to the south in the industrial hinterland of Hastings, and to the west of route 13 in the High Weald, where the majority of members are located. The plasticity of the Weald Clay tends to conceal archaeological sites during reconnaissance and is not beneficial for aerial photography. In addition heavy clays tend to disrupt foundations and abrade ceramics in the soil as a result of seasonal expansion and contraction. The clay geologies also tend to be more heavily wooded than some of the sandy Wealden geologies, although the high fertility of the clays in conjunction with the enhanced mechanisation of contemporary farming is slowly reversing this trend.

The presence of possible semi-industrial class sites at Romden and industrial-class facilities at Broadfield suggests that the supply of fuel for industrial use was not a significant problem, compared with the problems hypothesised on some Greensand regions. The heavy nature of the Weald Clay would not have been beneficial for extensive agriculture, which could have resulted in a substantial decrease in the arboreal community during the Roman era. Correspondingly it is unlikely that the Low Weald sustained impenetrable, closed woodland[†]. There is evidence for increased settlement, during the Romano-British era, on the heavy Bagshot and London Clays between Farnham and Guildford

[†] There is extensive evidence throughout southern Britain that marginal land was exploited in the Romano-British era. This is manifested in the reclamation of land in the Severn estuary (Allen and Fulford 1986, Allen and Fulford 1987), which was intimately bound with the growth of civilian settlement in Gloucester and Caerleon; also the utilisation of the fenlands (Potter 1989) and the exploitation of the alluvial flood plains in the Upper Thames Valley at Barton Court Farm (Miles 1984), Farmoor and Ashville (Parrington 1978). All these examples attest to the importance of the wider exploitation of the environment during the Romano-British era.

(Bird 1987: 178). Differences in the archaeological visibility of Iron Age and Romano-British settlement on the clays could be a contributory factor in this apparent increase in activity. The suggestion that the extension of settlement onto geologies, considered by contemporary standards as difficult, has often been viewed as a manifestation of the introduction of advanced agricultural technology. There is considerable disagreement over the introduction of technology such as the heavy plough. Sufficient corroboratory evidence exists from around the country to emphasise the location of settlement on apparently less suitable geologies and for the general exploitation of new land. This could represent the continuation of a trend which begins in the late Iron Age (Jones 1989: 129).

As with the iron production sites, there is a significant dichotomy between the evidence for settlement on the Greensands and the Low Weald; this is especially pronounced on the Weald Clay in the Kentish Weald. The Greensand provides an excellent source of building material which was utilised both locally and as far afield as Richborough, Reculver, London, Colchester and Dover (Williams 1971: Fig 4, 172-4). The Romano-British building traditions on the Greensand incorporate significant quantities of local masonry where building stone was accessible. This would provide a sharp contrast to the absence of building stone on the Weald Clay. The possibility of timber/wood building traditions on the Clay could account for the apparent low density of settlement on the clay compared with the surrounding Greensand. The absence of substantial quantities of building stone on the clay belt, with the exception of isolated sandstone seams, does not predicate the extensive use of masonry. Corroboratory evidence can be inferred from medieval vernacular architecture, which was timber-dominated from this nuclear forest region. The archaeological visibility of wooden structures such as round houses, or timber framed buildings with wattle and daub infilling, is very low. Unless tile was utilised for roofing, thatch or wood shingles would decay, the wooden frame would rot or possibly larger timbers would be recycled, whilst the daub would breakdown rapidly in the acid, unstable clays. The only evidence likely to remain from such a structure would be burnt clay from hearths or daub fragments (Tingle 1991: 110). Although the material culture generated by the site would serve to enhance the visibility, however, this can often be related to the original prosperity of the settlement. The lower down in the social spectra the more likely that the material culture would be of poorer quality and prone to degradation or of low visibility, such as through the increased use of East Sussex Wealden wares and perishable organic materials for household items. As a consequence, the archaeological visibility of such settlements would be significantly reduced.

There is limited evidence for Romano-British occupation on the Kentish Weald Clay. Two urns were recovered, in 1858, from a timber-lined pit, which was filled with decayed vegetable matter. The ceramic were dated to the first century A.D. (Kaye-Smith 1953: 145, Kelly 1964: 264). This apparently represents a site which is unconnected with iron production, although the vague nature of the reference and the absence of other corroborative archaeological research negates firm conclusions. The location of the Frittenden site 1.5 km east of Margary's route 13, and 5 km north of the *Classis* buildings at Little Farningham Farm, suggests the economic pull of the road was a stimulus to the construction of the Frittenden site. The presence of black earthenware ceramics from the site implies a dominance of East Sussex Wealden Wares which would be consistent with the ceramic assemblages from Bodiam and Bardown. In addition, evidence for six urn cremations (Mace 1905) has been recovered 1.5 km north of Biddenden, to the west of route 13 and on the outskirts of the Romden complex. This limited evidence for settlement in conjunction with the extensive evidence for multi-period minepits in the vicinity of Romden suggests that there might have been considerably more activity on the Weald Clay than has previously been thought. Little other socio-economic evidence has been recovered from the heavy clays.

THE NORTHERN LOW WEALD

No evidence has been recovered for Roman iron production in the band of Weald Clay to the north of the High Weald, between Maidstone and Reigate. On the Weald Clay, the evidence for activity that is witnessed in the Kentish Weald at Romden Place and Coldharbour Farm is only resumed at Broadfield and Alfoldean.

The absence of iron production is complemented by an apparent dearth of settlement evidence. There is limited evidence for undated bloomeries to the SE of Reigate, in conjunction with two blast furnaces. There are seams of clay ironstone present in this region, three of which have been recorded and mapped to the NE of Tenterden (Shephard-Thorn *et al.* 1966: 78-82). In view of the proximity of the nucleation of Romano-British iron production and settlement sites in the vicinity of Lenham and Maidstone to the east, it is probable that the general spread of activity would have continued into the northern Low Weald. The ore sources were available and there would have been an awareness among the local population of the processes and benefits of iron production.

THE WESTERN LOW WEALD

The western Weald is the most enigmatic of all the areas of Romano-British exploitation. The whole region between the Romano-British iron production site at Broadfield on the edge of the High Weald and Alton on the boundary with the Butzer Downs, has, as yet, produced only one confirmed site of Roman iron production at Hall Place Farm, in the Parish of High Billinghurst. By far the most dominant evidence derives from post-medieval blast furnaces, nineteen of which are located on the Weald Clay (Worssam 1964: Fig 1, 1985: 28-9, Fig 8).

The presence of pre-Roman activity on the Weald Clay suggests that ferric deposits were known to the population, and that elements of the local community possessed the requisite skills required for its smelting, although the presence of itinerant smelters and smiths cannot be discounted in some instances. It appears unlikely that such traditions would have been lost after the conquest, since all other parts of the Weald show a strong continuum of post-conquest production in localities which practised iron production prior to the conquest. It is possible that the large volume of iron which was produced in the High Weald, and on sites on the boundaries of this region such as Broadfield, was sufficient to negate significant production in the west. In view of the possible difficulty of mining ore in the Weald Clay, importation of consolidated blooms or finished products might have proved more economically viable. This could account for a decrease in production, but not the apparent absence which is evident. The insular nature of the Weald would not allow for the easy movement of materials across the High Weald; this is emphasised by the absence of evidence for an arterial trans-Wealden road.

The oxidation of siderite to limonite (ferric oxide) under conditions of natural weathering has given rise to the creation of iron pan. Under alternate conditions of impeded drainage and desiccation, characteristic of the heavy clay soils, the iron oxide produced can be mobilised in the presence of acid soil waters, and the subsequent precipitation after dry conditions results in the creation of a distinct iron pan. The viability of such iron pan for extraction is dependent on local conditions. On river gravels which contain limonite nodules, and where there is enhanced percolation of water, much larger deposits can be created (Worssam 1985: 13-4). The discontinuity of such deposits would not have been useful for any long term exploitation, but they are ideal for local bloomery-type exploitation. In the Kentish Weald the iron pan is called crowstone, while in West Sussex it is known as puddingstone or ragstone, and in Surrey it is referred to as shrave (*ibid.*).

As with the exploitation of ferric deposits on the Weald Clay of the Kentish Weald, it is apparent that two major sources of ore were utilised in both the Iron Age and Romano-British iron industries in the western Weald. At Piper's Copse, Winbolt (1936: 246) recorded the presence of burnt and unburnt shrave in a first century B.C. context, in addition to a furnace cut into the slope of the enclosure bank. Certainly Winbolt (1936: 247) considered that the evidence for iron production - the large quantities of ore present on the site and the small size of the enclosure (1.2 acres) - suggested that the *raison d'être* for the site was iron production. In addition to Iron Age ceramics, Romano-British and medieval sherds were recovered from the site, suggesting some form of settlement in these eras, and possibly implying limited iron production. The medieval bloomery at Thundersfield Castle, Horley, utilised shrave as the ore source. Although no Romano-British bloomery site in the Western Weald definitively using shrave has been recovered, it is inconceivable that it was not utilised, considering the LPRIA exploitation of the material. These smaller-scale exploitations contrast with the largest iron production site in the western Weald, at Broadfield, which derives its importance from a seam of clay ironstone immediately below the Horsham Stone.

It is inconceivable that the total absence of discoveries of Romano-British bloomery sites relates to the absence of iron production in this region. Possibly the absence of major belts of clay ironstone in the central western Weald would have tended to eliminate larger, more archaeologically visible, smelting operations. The presence of shrave-type deposits would have been more favourable to less numerous localised operations. Certainly the available evidence for post-medieval blast furnaces on the western Weald Clay tends to concentrate around the major ore seams and avoids the central Weald Clay region in the western Low Weald (Worssam 1972: Fig 1, 1985: Fig 3).

It is more probable that the difficulty in finding Roman iron production sites in the western Low Weald relates to the absence of significant archaeological field work, with the exception of the work of Worssam (1964). The absence of fieldwork is the result of several related factors. The Weald Clay is not an ideal medium in which to conduct archaeological research; its plasticity tends to conceal archaeological features. The exposure of archaeological artefacts during fieldwalking is dependent on highly specific circumstances, relating to ploughing and weather conditions. There are no major population centres in the Western Weald Clay belt; larger settlement concentrates on the boundary of the Weald Clay at Haslemere, Petworth, and Horsham. Originally, these settlements would have exploited the junctions between physiographic zones. Much of the western Low Weald is sparsely populated, and in consequence archaeological sites are less likely to be discovered, recognised or recorded. This can be correlated with archaeological evidence from other periods from the Low Weald.

The western Weald appears to have possessed three major areas where iron production could have been undertaken, based on the location of the ore sources, although definitive evidence for Romano-British exploitation has not been recovered in the most westerly. The boundary of the High Weald around Horsham and Crawley has a substantial seam of clay ironstone which was the ***raison d'être*** for the location of the semi-industrial complex at Broadfield.

A substantial seam of ore is located on the extreme western boundary of the Low Weald (Topley's bed 7), which appears to have sustained the Tudor iron industry in this western periphery of the Weald Clay (Worssam 1972: Fig. 2 and 3). There is no evidence for Roman exploitation of this seam, although little archaeological reconnaissance has been undertaken in this region. Extensive evidence for minepits has been recorded by Worssam along this belt of sandstone and ironstone, which represent both the provision of building stone and ironstone. It is probable that the majority of the visible minepits derive from post-medieval exploitation. The presence of a nucleus of blast furnaces in this region could account for the destruction of some earlier production sites, in addition to the diversion of contemporary archaeological resources. There certainly would have been a large demand for the supply of iron to the villas and farmhouses on the surrounding Weald Clay, Greensands and the downland market. This was certainly evident in the Iron Age and would have been relevant in the Romano-British era, with its increase in population.

REGIONAL SUMMARY OF THE LOW WEALD

There is growing evidence that Roman iron production extended onto the Weald Clay. The available evidence reveals two nucleations in the western Weald and the Kentish Weald. At Broadfield and Alfoldean, Roman exploitation is situated where a seam of iron ore outcrops under the Horsham Stone. To the north of Romney Marsh in the Kentish Weald, Romden Place and Coldharbour Farm are located on several seams of clay ironstone. However, there are only two confirmed sites of Roman bloomery activity away from these seams on the Weald Clay, although a growing number of undated bloomery sites are known to exist. It is probable that limited activity did occur on the Weald Clay, away from the clay ironstone seams, based on the localised exploitation of shrave. The limited and discontinuous nature of such deposits was unlikely to have sustained large-scale operations. As a result, the hypothetical long-term impact on the environment in the Low Weald would have been minimal. The number of production sites would have been relatively small; the volume of iron produced would have been limited by the easily exhausted ore sources. Additionally, the heavy clay environments are significantly less "fragile" or "brittle" than the sandy lithologies of the Weald. The local environment would possibly have sustained a smaller agricultural community than other regions in the south-east. In most cases, the impact on local arboreal communities would have been limited primarily by the unreliable nature of the ore deposits. The impact on landscape morphology as a result of mining localised, discontinuous shrave deposits would have been minimal, as shrave tends only to form to a depth of three metres below the contemporary ground surface. It is likely that the impacts from these operations would have been dispersed throughout the Low Weald over the Roman occupation, and would have been quickly absorbed into the landscape.

In some cases, the exploitation of the clay ironstone seams would have constituted a different form of impact on the environment. With only four confirmed Roman iron production sites exploiting the clay ironstone seams, it is difficult to postulate the impact of the industry. However, there are certain elements which emerge. The sites which exploit these seams are some of the largest outside the High Weald. The exploitation of ferric resources at Broadfield probably continued intermittently throughout the Roman era on a variable semi-industrial to industrial-class basis. In the Kentish Weald, the extent of the slag deposit at the bloomery iron production facility at Romden Place implies that the site was semi-industrial in nature. These industries are found in conjunction with smaller-scale bloomery activity, such as at Coldharbour Farm and Alfoldean

Station. The more reliable ore sources provided by the seams of clay ironstone appear to have benefited from larger-scale working methods. The expenditure of time and resources in mining operations in the Weald Clay could have been offset by larger-scale working, which could account for the predominance of larger-scale sites. This would have induced significant modifications to the local environment; first, morphologically as a result of mining operations; and second, in changes to the arboreal environment. Long-term operations such as at Broadfield would have had to have been based on some form of management practice or the manipulation and utilisation of regrowth to sustain production for at least a century. In light of the absence of systematic archaeological work in the Low Weald, the future potential of this region is considerable.

CHAPTER SIX

THE DISTRIBUTION OF IRON PRODUCTION IN THE EASTERN HIGH WEALD

THE DISTRIBUTION OF IRON PRODUCTION IN THE EASTERN HIGH WEALD

CHRONOLOGY IN THE EASTERN AND WESTERN HIGH WEALD

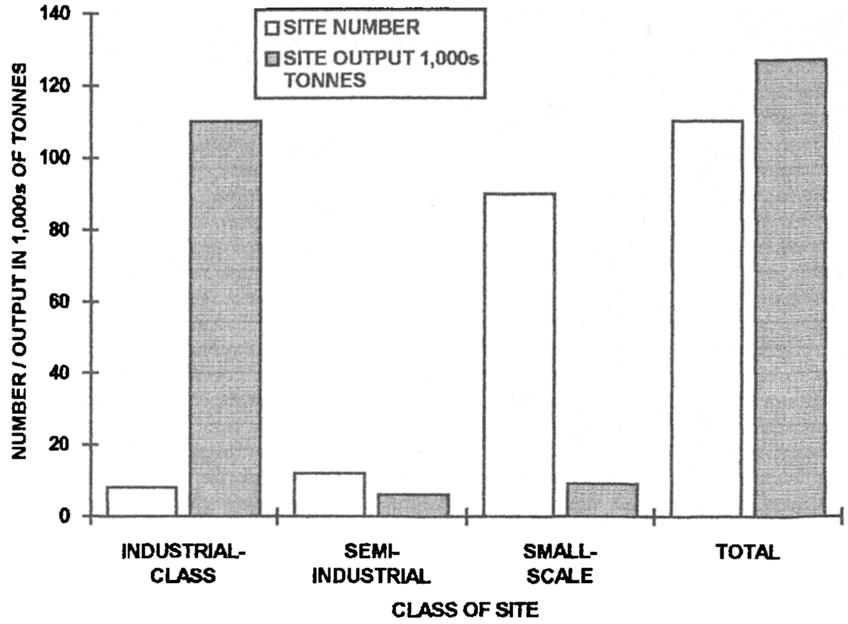


Fig 6. 1 The dominance of small-scale iron production facilities across the Weald, and their relation to hypothetical output

In the context of this chapter the eastern High Weald is defined as the unit of the High Weald to the east of a line drawn between Hastings and Bardown (see Fig. 5.2), but excluding Romney Marsh. This region encapsulates 72% of the known industrial-class operations in the Weald. The larger scale of many of the sites and the longer period of research in the region allows for secure dating of the majority of the iron production sites in this region; it is however in the western High Weald, where the size of production facilities decreases, that there are problems with dating. The poor dating of a significant percentage of the smaller iron production sites in the

Weald results from the predominance of local East Sussex Wealden wares compared to chronologically diagnostic fine wares and exported products. The latter tend to be a phenomenon of non-industrial sites, which are the numerically superior method of exploitation of ferric resources (see Fig. 6.1). As a result some of the following iron production sites, which have only produced undiagnostic East Sussex Wealden ware body sherds for dating, can only be dated broadly to the first two centuries A.D. This has implications for the earlier sites, which could belong to the LPRIA, yet on the basis of ceramic assemblages alone are indistinguishable from Roman sites of the mid- to late-first century.

THE SITES OF THE EASTERN HIGH WEALD

LITTLE FARNINGHAM FARM

The scheduled *Classis Britannica* building and iron production site at Little Farningham Farm (TQ 801352) is located 400 m to the SW of the farm building from which it derives its name. The site is situated at the junction between the Tunbridge Wells Sand and the Wadhurst Clay, with a fault running to the west of the site. The building was situated 90 m east of Margary's arterial route 13. Operations associated with the physical production of iron were certainly undertaken on the site (*Contra.* Cleere 1975: 195, Cleere and Crossley 1985: 297). Slag was scattered both within, and in the vicinity of, the building (Lebon 1958: lxi), whilst Pile (1958) records the presence of "masses of slag iron and cinder encountered all over the site". Although no discrete slag deposit was recovered from the excavated area, it has been suggested that the bulk of the waste material was removed for metalling (Lebon 1958: lxi). It is probably not coincidental that a 5 km stretch of route 130, to the south of the site, is intermittently metalled with slag, as is a small section of route 13 in the immediate vicinity of the site. It is unlikely that the slag on these stretches of road derived from any of the known Wealden production centres, such as the eastern industrial-class sites or Bardown which are almost 10 km away. However, it is possible that further away from Little Farningham Farm, additional, undiscovered iron productions sites situated along route 130 could have contributed slag for metalling.

In addition to the ubiquitous slag, other evidence for iron production includes *tuyères*, an iron bloom (Brown 1964: 502-4) and a possible bellows pot (Lebon 1961: xlviii). The discovery during excavations (Lebon 1958: xlvii) of over of fifty CLBR tiles which exhibit no signs of reuse (Anon. 1957: 224), suggested the presence of fleet activity. The excavated ceramic assemblage was dominated by East Sussex Wealden wares, with some samian and Thameside wares (Pile 1958). This appears to be characteristic of sites on, and to the east of, Route 13, such as Bodiam and possibly Romden. This is a function of the local production of the East Sussex Wealden wares in the Hastings hinterland, in conjunction with peripheral trade from the Thameside region extending down route 13. A selection of the finds is deposited in Maidstone Museum (Kelly 1961).

In addition to the impact of iron production on the site, the presence of 'saggers', used to keep tiles apart during firing, has led to the hypothesis that the fleet building could have had a tile kiln (*ibid.*), although apart from the wide range of tiles and stamps, many in mint condition, no other evidence has been revealed within the limited confines of the excavation. Based on this, Detsicas (1983: 173) has suggested that tiles could possibly have been surplus to the needs of a CLBR building yet to be found.

The size of the iron production operation could have been considerable, but this is impossible to prove. It has been suggested that the Little Farningham Farm site could have received low-grade blooms from surrounding iron works, which could have been resmelted on-site for the production of essential equipment (Lebon 1958: lxi). Alternatively, the blooms could have been collected, then sent overland, or through the Romney channels to Lympne for redistribution. The role of the site appears to have been intimately bound with the organisation, transport, production, and redistribution of iron in the region.

IRIDGE BLOOMERY

The Romano-British bloomery site in Brickhurst Wood (TQ 752277) is located approximately 25 m downstream from the confluence of the Fillbrook and the Iridge Furnace stream which drains into the Kent Ditch. The bloomery is located at the base of a slope, until recently, used to be occupied by Brickhurst Wood. Excavation by the author has provided a Romano-British date for the site.

The *raison d'être* for the location of the site appears to be the point where the down-throw of the Hurst Green fault crosses the Fillbrook, creating a junction between the Ashdown Sand on the valley floor and the Wadhurst Clay higher up in Brickhurst Wood field. Indications of iron production on the site were first recorded by the WIRG, who noticed the presence of extensive quantities of slag and cinder in the stream, where it is crossed by the path to Iridge Furnace (Anon. 1976: 3). Limited time prevented further exploration by the WIRG, although the general appearance and the presence of much burnt clay and tap slag was considered to be characteristic of a Romano-British bloomery, although no dating evidence was recovered (*ibid.*).

Bloomery slag which has eroded out of the stream bank can still be traced in the Fillbrook and at the Furnace stream. A coherent deposit of slag extends for approximately 10 m along the eastern bank of the Fillbrook, centred at TQ 7521 2765. Where exposed in the stream-bank section, the deposit was made up of cinder, tap slag, fire-reddened stone, iron stone, charcoal and excessively roasted ore which would have been unusable for the smelting operations. Much 'massive slag' was also in evidence. No further indications of bloomery iron production were recovered along the tributary stream for 500 m in either direction.

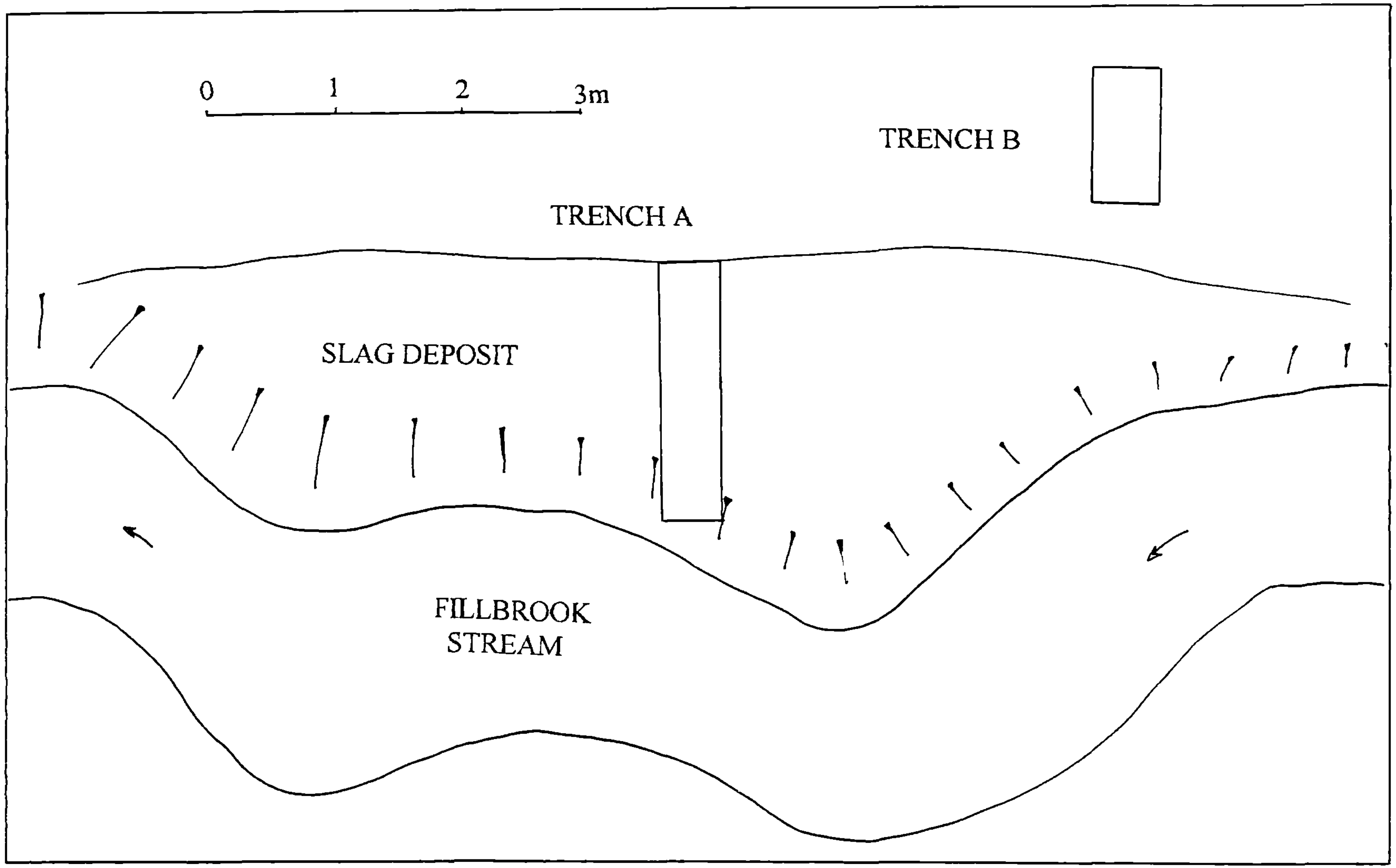


Fig 6.3 The extent of the Iridge bloomery slag deposit

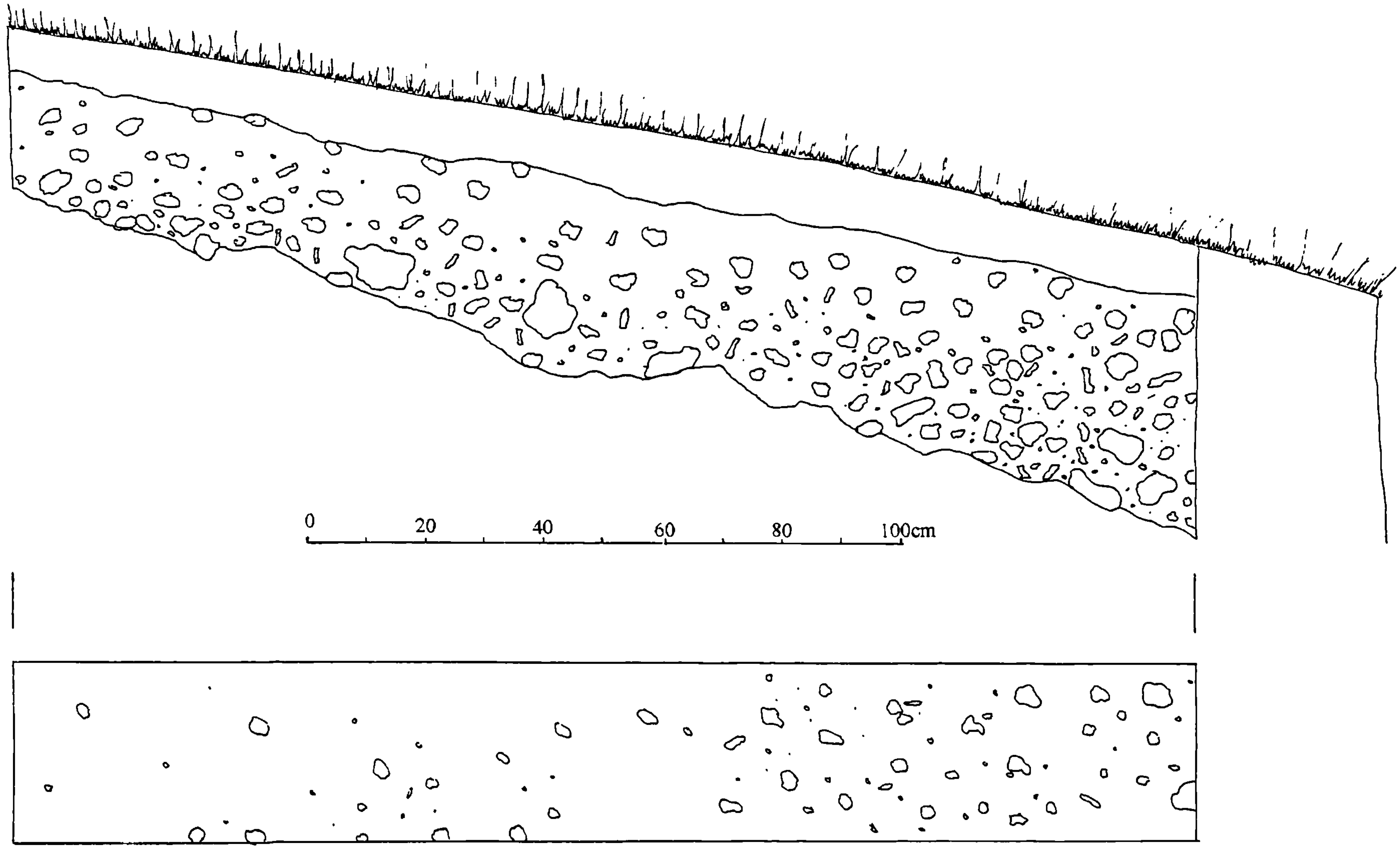


Fig 6.3 Trench A, Iridge Bloomery

The slope above the site, now under arable cultivation, has extensive evidence of patches of charcoal-rich soil which derive from bonfires, probably of recent origin, resulting from the grubbing of Brickhurst Wood. The slag deposit itself does not appear to have been significantly disturbed by human agency since the time of deposition. This appears to be a result of its position at the top of the almost vertical 2 m high stream bank, in addition to the steep gradient of the small terrace to the bank which would have discouraged later cultivation. This compares radically with the gentle decline to the stream evident on the opposite bank. The site is currently heavily overgrown with brambles and holly, in conjunction with an arboreal vegetation of oak, birch, and alder.

Two keyhole trenches were cut by the author to provide evidence for the depth and extent of the deposit and to provide palaeo-environmental evidence from the identification charcoal. Trench 1 produced a single sherd of East Sussex Wealden Ware, of earlier Romano-British date. The presence of iron pan and the ubiquitous blast furnace slag, in conjunction with the overgrown nature of the site, made any form of remote sensing to elucidate the extent of the site impossible. An approximation of the area of the slag deposit was produced by manual probing of the ground surface.

In both trenches, the deposit was overlain by a variable depth of colluvial slope wash, containing characteristic vitrified blast furnace slag washed down from the area that used to be occupied by Brickhurst Wood. The presence of blast furnace slag is not surprising, due to the location of Iridge Furnace 400 m to the west (Straker 1931: 320). Field walking in the surrounding fields revealed extensive evidence of blast furnace slag, which was probably ploughed into the fields during the operation of Iridge furnace as a form of fertiliser. The slag would help to break up the heavier clay soils, while the associated charcoal fragments and flux would have been beneficial to the acidic Wealden soils.

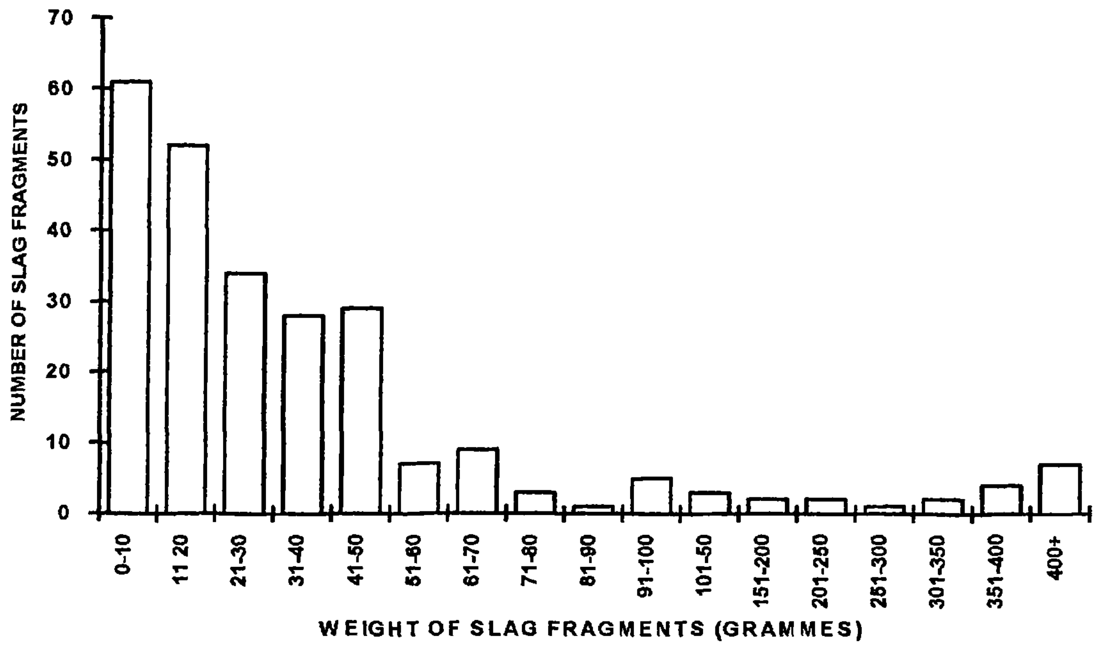


Fig 6. 4 The differential weight of slag fragments recovered during trial trenching of Iridge bloomery.

As a result of colluvial action, the slag deposit extends to a maximum depth of 50-60 cm at the base of the slope, although this was not densely packed. At the top of the slope the slag is hardly evident at all. Although the slag heap extends as a linear deposit for over 10 m along the stream side, and for 3-4 m up-slope, it does not actually represent a significant volume, even allowing for some loss of slag as a result of fluvial erosion. An approximation of the volume of the slag matrix is 12 m^3, of very lightly-packed slag and cinder. It is unlikely that material was removed from the deposit either in antiquity or in the recent past, as a result of the inaccessibility and precarious nature of the deposit. It is also improbable that bloomery slag and cinder were resmelted by Iridge furnace, as there is no evidence of any major disturbance which could not be attributed to natural agency. The slag recovered from approximately 50 cm^3 of the deposit yielded 17.4 kg, of material, which equates to a weight of 139.2 kg/m^3. Based on these figures the total weight of slag in the whole deposit would be 1.670 tonnes.

The presence of carbonised autochtonous arboreal taxa from the slag deposit suggests that the immediate locality was exploited for iron production. Although little ageing evidence was recovered as a result of attrition in the slag deposit, the curvature of the annual rings in the majority of the fragments examined revealed that only one sample might have exceeded a diameter of 10 cm. This suggests that either managed woodland or branchwood was utilised. It is unlikely that managed woodland would have been used unless it was in existence prior to the bloomery operation period. The use of regrowth from a hypothetical earlier episode of woodland interaction and exploitation is also conceivable, although there is no evidence for other bloomery sites in the vicinity, so this cannot be corroborated in the archaeological record.

Based on these assumptions it is probable that exploitation of relatively unmodified woodland occurred. Using the data from Cleere (1976a: 240) a conversion ratio of 7:1 for wood to charcoal, and a weight of c. 250 tonnes of oak branch wood per hectare of relatively unmodified woodland, has been used. The site would have required the lopping of branch wood from a minimum of 0.5 hectares. However, as the density of woodland per unit area is unknown, then the actual area which was exploited for the provision of charcoal alone could have been considerably higher. However, it is unlikely that the clay soils would have sustained much agriculture during this early period, or to have exhibited soil degradation.

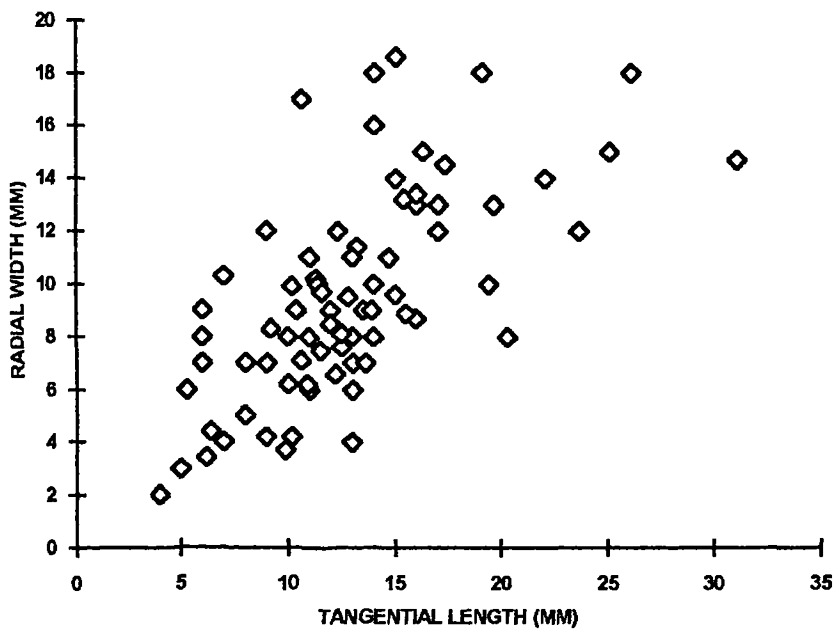


Fig 6. 5 The fragmentation of charcoal recovered from Iridge Bloomery

The pattern of fragmentation of the charcoal recovered from the keyhole trench and river bank section suggests moderate attrition was encountered in the slag deposit. This was a result of the downslope deposition of material, the lack of depth of the deposit in many areas, and the instability caused by colluviation.

The charcoals recovered from the keyhole trench in the slag deposit and the streamside section were characteristically dominated by oak (n = 38) and birch (n = 17). There was, however, evidence for a variety of scrub and underwood type species, such as ash (n = 3), hazel (n = 3), beech (n = 1), *Prunus* (n = 1), *Viburnum* (n = 1), alder (n = 1) and *Salicaceae* (n =1).

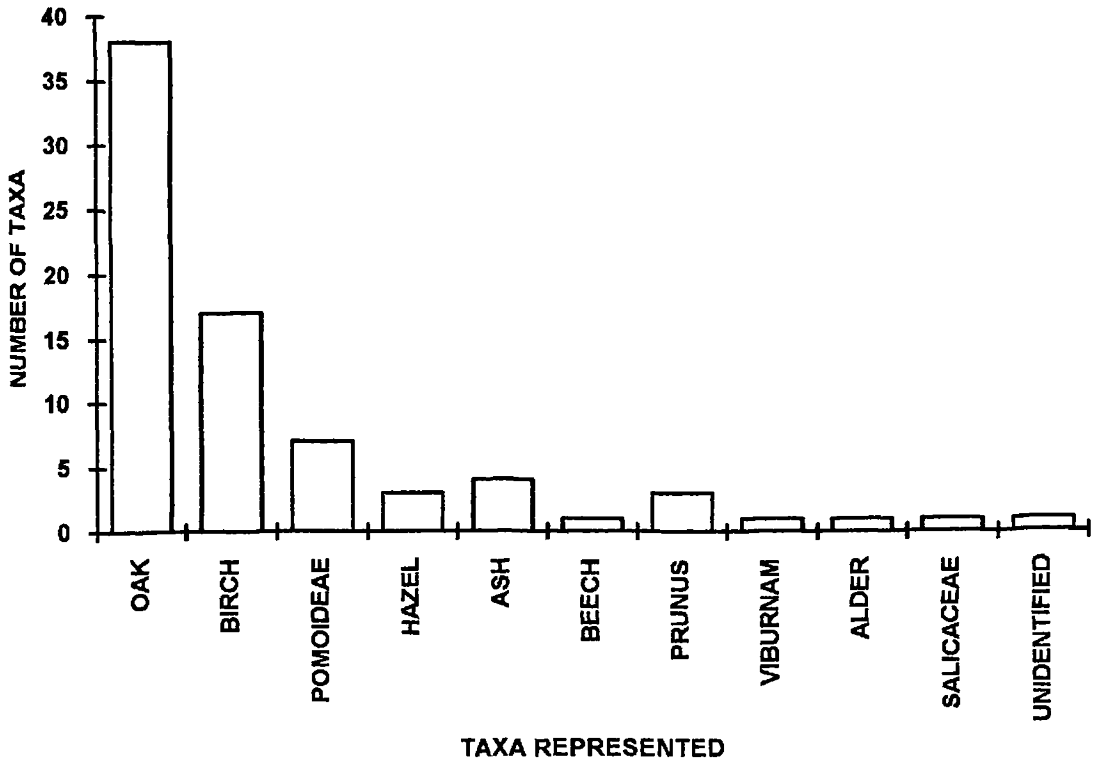


Fig 6. 6 The charcoal taxa recovered during excavation at Iridge bloomery

The presence of *Viburnum*, alder, and *Salicaceae* spp. indicates exploitation of damp environments such as would be seen on the river bank. The *Salicaceae* representing the willows and poplar, are extremely rare on iron production sites in the High Weald, probably due to the slender nature of much of the branch wood of the willow. In addition, willow and poplar wood are a poor fuel source and require a longer drying time prior to use. This could colour perceptions of the viability of the wood as a source for charcoal. The *Salicaceae* fragment came from the upper surface of the slag, so the possibility of intrusion, conceivably from the post-medieval blast furnace 'fertiliser', could explain its presence, although the taxa has been recovered from other iron production sites in the Weald. The presence of beech suggests a component of the closed woodland, probably found in association with the oak and birch underwood, while the other species would have been characteristic of underwood or scrub, either in clearings or on the woodland margins. It would appear that the exploitation of the woody environment for the site was focused on the Wadhurst Clay above the site, which would have supported the denser forest species, which comprise the majority of the species, with some exploitation of the riverbank environment. This is further corroborated by the exclusivity of the deposit on the east bank of the Fillbrook, which suggests small-scale working on the lower slopes of Brickhurst Wood, while the waste was discarded downslope onto the steep banks of the ghyll. The probable site of actual iron production is now under arable cultivation. No evidence of its original location can be discerned, possibly as a result of its position at the base of the slope, covered by colluvium. The Iridge site is located 3 km NW of the Bodiam riverside complex.

BODIAM

The extensive riverside station at Bodiam is located on the south bank of the River Rother, at the crossing point of the Margary's route 13. Romano-British settlement has been located predominantly in the fields, under alluvium, either side of Bodiam Bridge, which ascends to the line of the Kent and East Sussex railway. To the south of this the geology is dominated by Wadhurst Clay. Excavations in the area TQ 783251, by the Battle and District Archaeological Society in 1959 and 1960, under circumstances which can only be described as disarticulated (cf. Darrell Hill 1960: 190; Lemmon and Darrell Hill 1966: 91-2), revealed evidence for eight separate Romano-British occupation horizons.

In the level designated 4 by the excavators the remains of a tiled building with CLBR stamps were recovered in conjunction with two *sestertii* of Trajan (A.D. 98-117). Macrobotanical remains associated with this structure included ash, hazel, birch and willow, possibly from a wattle and daub structure. The lowest level of Romano-British occupation existed at 0.33m O.D., with a blackened trunk or plank at 2.3m O.D. The site rested on blue-grey clay with macrobotanical remains of oak (charcoal), yew (waterlogged), alder (waterlogged), *Salicaceae* charcoal, and other undetermined charcoal.

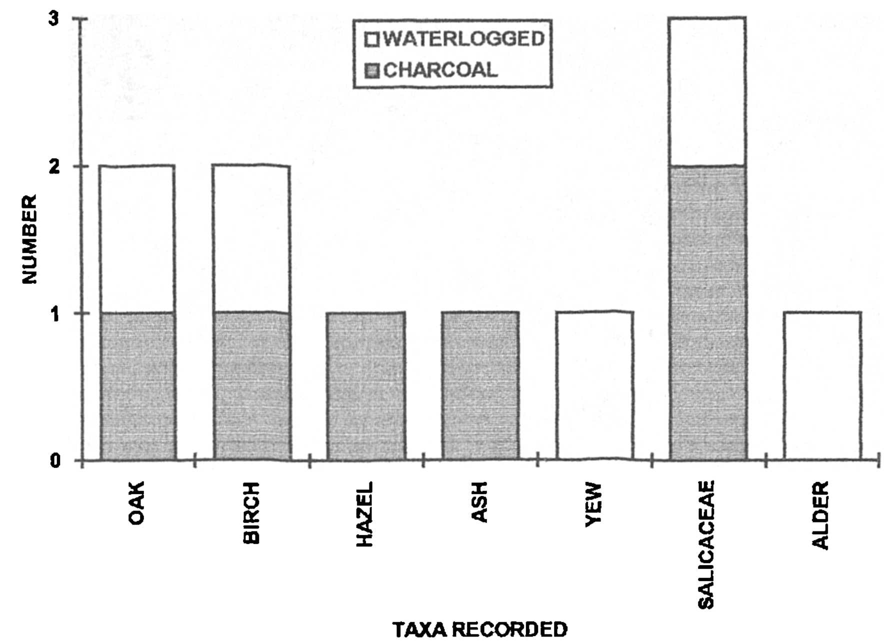


Fig 6. 7 The number of contexts at Bodiam from which various taxa were recovered (Data from: Lemmon and Darrell Hill 1966).

The *Salicaceae* dominated the assemblage, which contrasts to its rarity in iron production contexts in the High Weald. This was probably a function of the presence of willow as an autochtonous taxa of the damp riverside environment, in addition to its selection for wattling as a result of its flexibility. The alder is also a damp-loving species, while the oak probably derived from the clay and sands above the site. The other species recovered could have derived from the higher ground, and are possibly indicative of secondary woodland. Certainly woodland modification would have been evident in the vicinity of the settlement site as a result of the woodland requirements of the settlement, including material for construction and fuel for domestic and limited iron production needs.

The ceramic assemblage recovered from the site, now in Battle Museum, was dominated by East Sussex Wealden wares (76.9%), and Thameside wares

(9.9%), while samian and other wares comprised the remaining 13.2% of the assemblage (Lyne 1994: 130). The characteristic dominance of the local coarse wares is a function of their probable local production centre in the Hastings hinterland, while the presence of Thameside wares is indicative of the penetration of the Upchurch marshland products down Margary's route 13. Low percentages of these wares are a feature of the iron production sites in the triangle between routes 13, 130 and 131. The presence of Thameside wares could give some indication or quantification of the movement of goods or material up, and down, the road to Rochester - the implication is a relatively low percentage. The presence of a wide variety of fine wares from the second century context (Lemmon and Darrell Hill 1966: 95-7) suggests a site of some importance.

Lemmon and Darrell-Hill (1966: 101) suggest that at Bodiam the River Rother could *not* have been either tidal or open estuary, as the riverside settlement would have been vulnerable to flooding. It seems improbable that a settlement with eight recognised occupation horizons would have been situated in a position subject to regular flooding, when higher ground was located immediately to the south. The Rother at Bodiam, during the Romano-British era, was probably a navigable river with solid banks to allow for docking of river craft. Burrin (1988: 50) suggests that the undifferentiated laminated sediments found to the south of the contemporary Rother could indicate the course of the Rother in the Romano-British era.

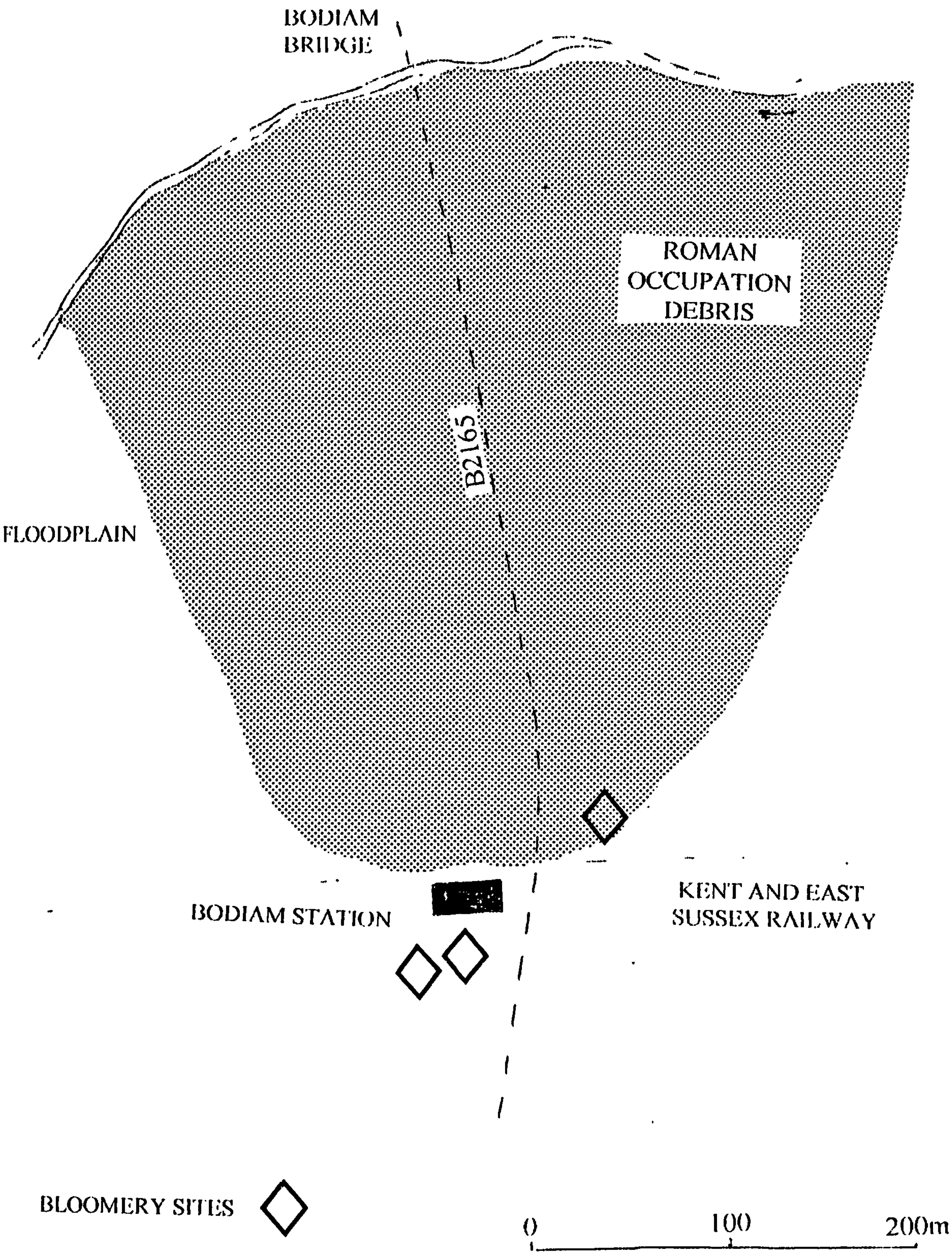


Fig 6. 8 The distribution of Roman bloomery sites at Bodiam

Intensive field research by the Robertsbridge and District Archaeological Group in the area has resulted in the discovery of three discrete bloomery sites on the lower slopes around Bodiam Station. The contemporary landuse was not conducive to the acquisition of palaeobotanical samples, although probing and magnetic survey were used to elucidate their extent. The sites have been given the following designations by the author.

BODIAM 1

A discrete scatter of bloomery slag approximately 14 x 21 m, located in the angle between the B2165 and the railway to the NE of the station (TQ 78142484), found in close association with ceramics of the second century and tile fragments (Gwen Jones *pers. comm.*).

BODIAM 2

A small scatter of tap slag, approximately 7 x 7 m, to the east of Bodiam Station, associated with a ceramic assemblage of the second century, and a fragment of *tuyère*. A 'boss' from a *tegula mammata* was found adjacent to the site.

BODIAM 3

A scatter of bloomery slag, ore and limestone near the entrance to Quarry Farm, found in association with late first century ceramics. Three minepits are visible on the Wadhurst Clay in the immediate area. These could have been associated with the exploitation, although the digging of 'mine' was recorded in the parish until the 1730s and 40s (Gwen Jones *pers. comm.*).

These three episodes of minor industrial activity appear to represent small-scale exploitations of iron during the various stages of settlement development, possibly sufficient to fulfil the immediate needs of the local community. It is conceivable that the Bodiam 1-2 production sites, of the second century could have been associated with the development of the *Classis* establishment. Based on the volume of slag that remains in the plough soil, and the absence of significant disturbance of the sites, it is likely that the scale of operations at these three sites was small - probably sufficient to fulfil the immediate needs of the settlement, rather than sustain export from the site.

BADLAND WOOD

The bloomery site at Badlands Wood (TQ 7739 2134) is located approximately 250 m NW of the Cripps Corner viaduct. The site is equidistant between the industrial-class sites at Chitcombe to the east and Oaklands Park to the SSE. Evidence for iron production was discovered in August 1979 as a result of landscaping work which dissected the slag bank. The bank is situated at about 53 m O.D., on Ashdown Sand, on the south bank of a tributary of Andrew's Gill. A single furnace was discovered during trial trenching of the site by the field group of the Robertsbridge and District Archaeological Society. This was classified as

Cleere's type B.1.ii. However, within the confines of the landscaping operations, the excavation was not total, and, considering the extent of the refuse, it is conceivable that more furnaces existed. Certainly the presence of further features 22 m to the SE (Jones, G. 1980: 37) could indicate more extensive exploitation.

The ceramics derived from the slag bank were two sherds of East Sussex Wealden ware, which originated from the same vessel (*ibid.*). The slag bank, where sectioned, proved to be 40 cm at the top of the bank, progressively thinning to a scatter at the base (*ibid.*: Fig 4). Despite its relatively large area, the depth of the deposit does not indicate substantial production.

FOOTLANDS

The extensive industrial-class iron production site at Footlands (TQ 773200) is located at the head of the Durhamford valley and extends for approximately 400 m to the north and south, 100 m west and 50 m to the east of the stream. Unlike all other known Wealden industrial-class operations, the slag deposits are located on both sides of the stream, although to a greater extent on the western bank than the eastern. Evidence suggests that significant quantities of slag have been removed from the west bank, and previous ploughing has further reduced the mounds. Field survey by the WIRG has determined their original locations (Hodgkinson 1987b: 25, Fig. 1). Slag-impregnated soil now extends for approximately five hectares, although much of this is a function of the scattering of material after ploughing and levelling of the slag deposits in the 1940s.

The site is located on a cap of Wadhurst Clay which rests on Ashdown Sand, while a major fault line runs across the southern edge of the site. This was possibly the *raison d'être* for the original location of the site. Three major ore-pits are found in the vicinity of the site, and could have supplied it; at Cinderbank Shaw TQ 7747 1998; TQ 7731 2000; and Footland Wood TQ 7694 1988. These open-cast pits would have descended into the lower levels of the Wadhurst Clay, providing the most consistent source of ore. (*ibid.*).

Evidence for iron production was first recorded by Straker in 1924 (1931: 327-8), although a coin of Domitian (A.D. 81-96) was recovered from the site in 1907 (Blackman unpublished: May 1925). The main slag bank was described by Blackman (*ibid.*), prior to its levelling by ploughing, as being "80 to 90 yards long and 30 yards wide, 9 or 10 feet high and overgrown with grass: a great deal has been excavated from the centre of the heap." Such a deposit would have contained a volume of approximately 8000 m^3. Based on analogy with other deposits, only 50% of this material would represent actual slag, so a volume of 4000 m^3 can be proposed. Based on the extrapolation of slag/weight ratios provided by Cleere (1976a: 234), this primary deposit could be the waste product from the production of approximately 4,000 tonnes of bloom iron. Although other banks did exist, both

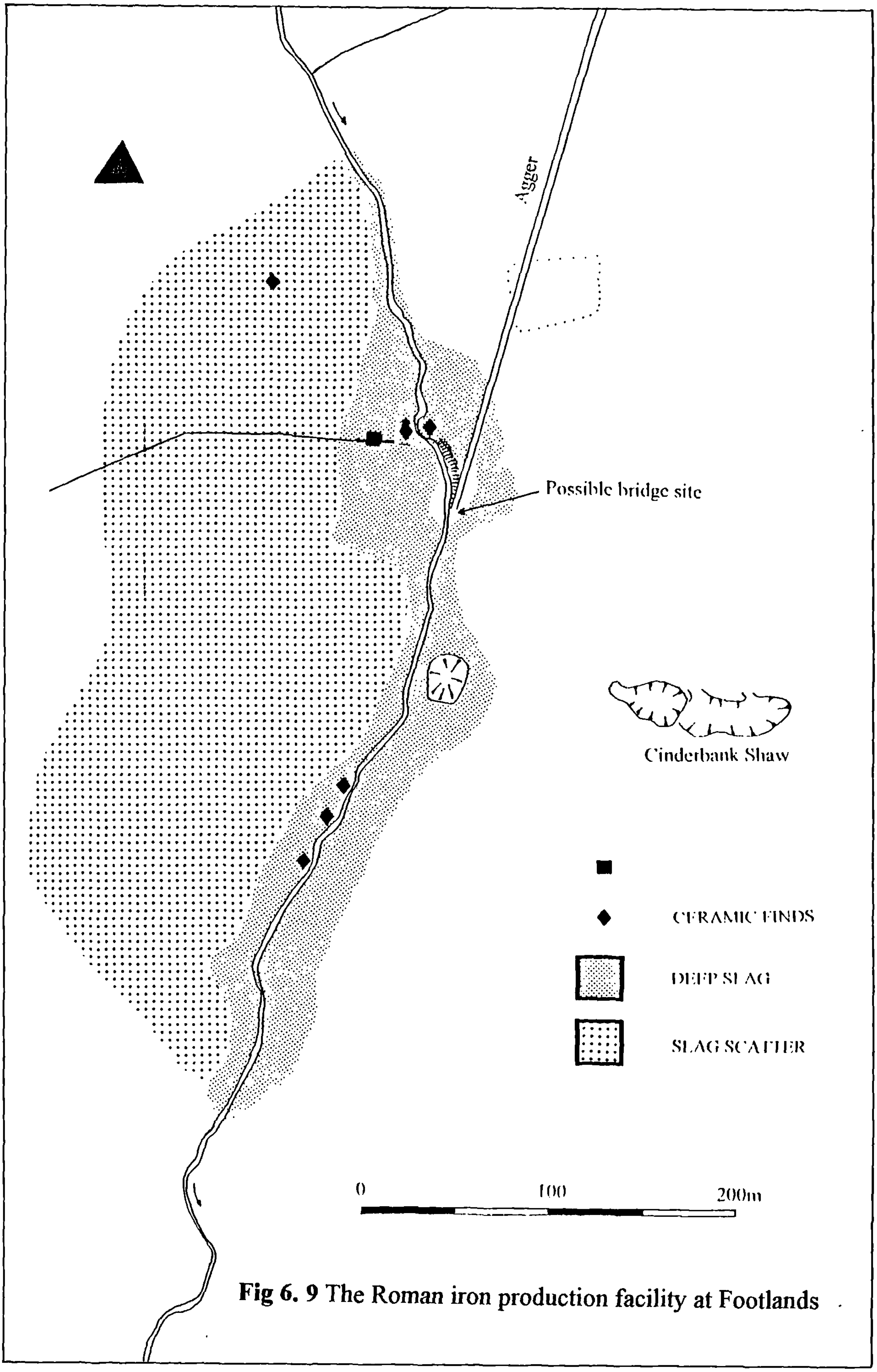


Fig 6. 9 The Roman iron production facility at Footlands

in conjunction with the primary bank on the western side of the stream, and as smaller deposits on the eastern bank, the current distribution of slag scatters is probably a result of the redistribution of slag after levelling. Even with the removal of material during the Romano-British, and later eras for slag metalling, it is unlikely that the combined volume of material could have exceeded 10,000 m^3. It is highly unlikely that the volume of slag ever achieved the 15,000 m^3 hypothesised by Cleere (1976a: Table 1, 238).

Excavations at Footlands, under the aegis of the Sussex Archaeological Society, were carried out in 1925, although these were never published and the records have since been destroyed (Hodgkinson 1987b: 25). It is, unfortunately, from these excavations that apparent evidence for fourth century activity was recovered. One clue as to the contents of the excavation records was provided by Blackman (unpublished: July 16, 1925) who notes that "Mr. Ray has the experts' reports" which suggested that the Roman material culture was "*chiefly* of the first, second and third centuries". This is in accordance with all the other coastal group sites. However, it is possible that some limited fourth century occupation was evident, but this does not necessarily indicate fourth century industrial-class iron production on the site.

Ploughing and levelling of the slag deposits in 1947 resulted in the recovery of extensive waterlogged deposits, from which A. W. G. Lowther recorded the discovery of a "pointed oak-wedge shaped peg or stake, the top of which had a roughly carved face reminiscent of primitive Celtic work". This measured 32 cm and was found in conjunction with an "oak lug-handle, oak beams, thick planks and pottery of c. A.D. 20-120" (Taylor 1948: 96). Although no details of the position of the finds are recorded, they probably derive from the damper valley bottom; certainly lengths of wood can still be seen in the stream embedded in the bank 15 m from the boundary with Kemps Wood beyond the area of slag. Although these are undated, they probably represent the remains of a later crossing point of the stream.

Excavations by Chown (1947, Lucey 1978: 24) during the Second World War resulted in the recovery of a distinctive assemblage of East Sussex Wealden ware of LPRIA and early Romano-British date (Green 1980). Excavations by the Battle and District Archaeological Group in 1951 revealed Romano-British ceramics at TQ 772202, while the Robertsbridge and District Archaeological Group recovered Romano-British ceramics including samian from the stream bank (Hodgkinson 1987b: 27, Martin 1965). Field exploration by the WIRG in 1975 (Anon. 1976: 3) recovered ceramics, including samian and tile suggesting the presence of substantial structures. Two further visits in 1985 resulted in the recovery of East Sussex Wealden ware and samian (Hodgkinson 1987b: 30-1) at TQ 7723 1990 and TQ 7730 2010.

In addition, two partially preserved leather uppers from separate shoes were recovered from the stream bank at TQ 7730 2010. One of the moccasin-type shoes had stylistic affinities which suggested it derived from the first or second centuries (Hodgkinson 1988a, 1988b: 7). Despite shrinkage during conservation, the small size could indicate it belonged to a woman or child. It is possible that such material could represent discard from the domestic settlement of the Footlands site. This could suggest that the domestic settlement housed the families of the iron workers, or that child/female labour was employed for some tasks. Certainly there is extensive evidence from the medieval era that women were involved in heavy industry such as blacksmithing (Geddes 1991: 186-8). This can be corroborated with the exploitation of such labour sources during the Industrial Revolution. The previous recovery of waterlogged wood, during the 1940s, suggests that the valley floor of the Footlands site is highly conducive to the preservation of organic remains.

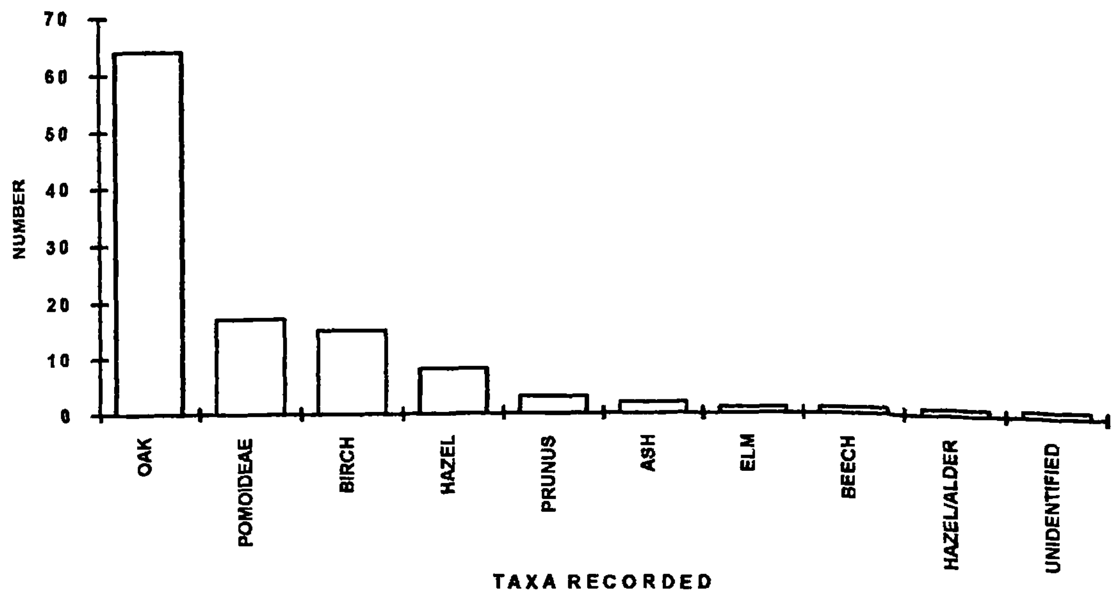


Fig 6. 10 The taxa recovered from the western slag bank at Footlands

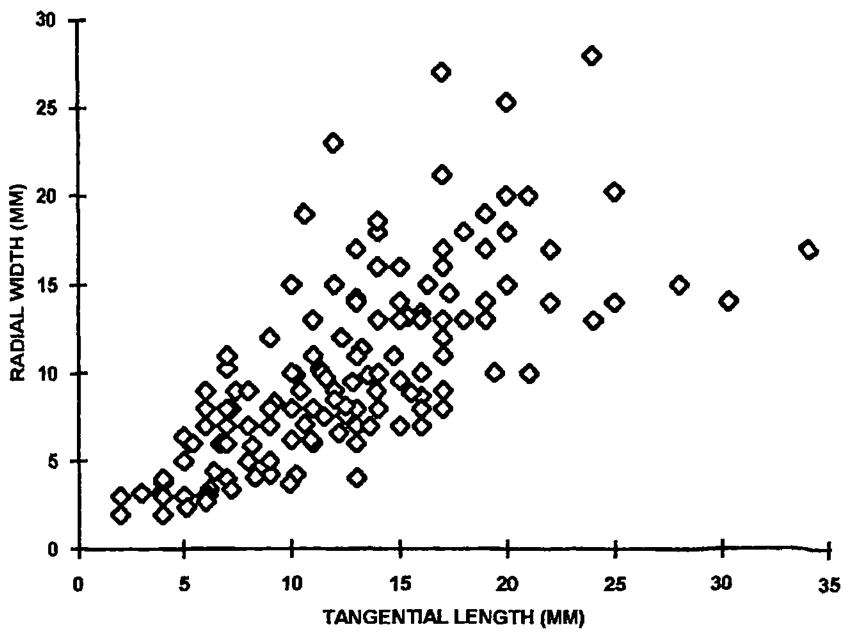


Fig 6. 11 The fragmentation of charcoal from Footlands

Sampling by the author of previously exposed charcoal along a boundary ditch revealed a taxa composition dominated by oak (n = 64), *Pomoideae* (n = 17), birch (n = 15), hazel (n = 8), *Prunus* (n = 3), ash (n = 2), with beech, alder, and elm (n = 1). The domination of oak and birch is characteristic for the area; the presence of the species such as hazel, *prunus* and *Pomoideae* appears indicative of colonisation of woodland margins and clearings, or underwood, while elm and beech could have derived from more closed woodland. The oak domination of the charcoalified material corresponds to the species composition of the waterlogged deposits recovered in 1947, although these early deposits possibly derived from construction or working debris, and as such are likely have been selected to a greater extent than fuel charcoals and to favour the use of oak. However, the fuel requirements of industrial exploitation would have resulted in the exploitation of a wide *territorium*, and the species could therefore have derived from dispersed habitats over a wide time period.

CHITCOMBE

The industrial-class site at Chitcombe (TQ 814211) is conspicuously situated approximately 500 m NW of Chitcombe House. The complex extends between the 30 and 70 m contours, exclusively along the southern side of the Tillingham valley. The site is situated on Ashdown Beds, primarily silty clay and pale grey to yellow silts. The overlying Wadhurst Clay is found on the higher slopes, above 60 m O.D. (Worssam 1988: 5).

The site is characterised by seven distinct tips of slag, which extend for 600 m along the southern bank of the Tillingham. These cover an area of 47,500 m^2, between TQ 808210 and TQ 814212. These tips apparently derive from the discard of the refuse of iron production from Hoath Wood and the three fields called the 'Cindrills' by James Rock (1879: 176). All stages of production are evidenced by material from the slag deposits, including roasted ore, furnace lining, and plano-convex bottoms. Analogy with other excavated industrial-class iron production sites, such as Bardown and Beauport Park, suggest that these complexes were divided into industrial and domestic sectors. The industrial component of the Chitcombe site appears to equate to the land directly above the

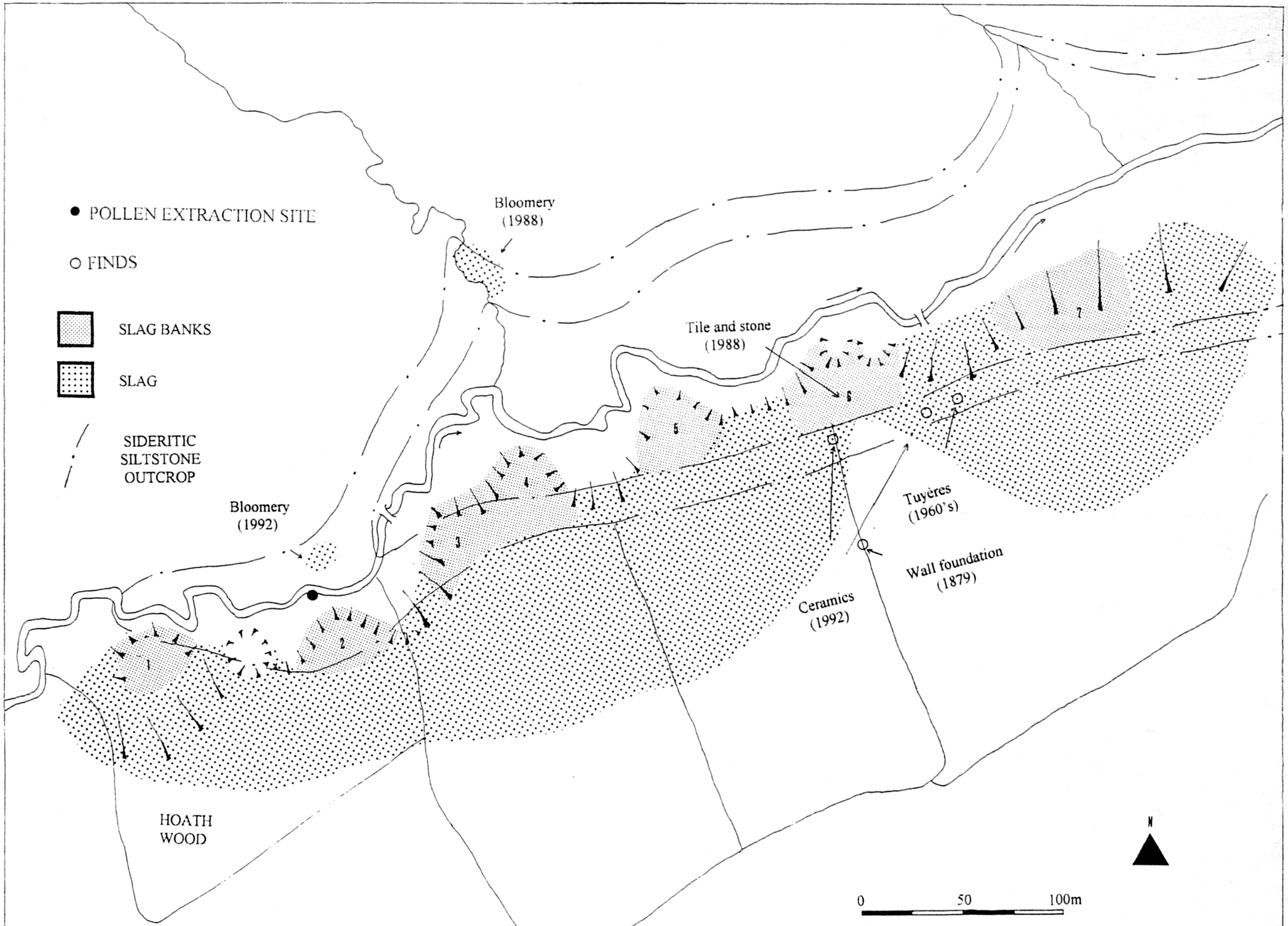


Fig 6.11 The Roman iron production facility at Chitcombe

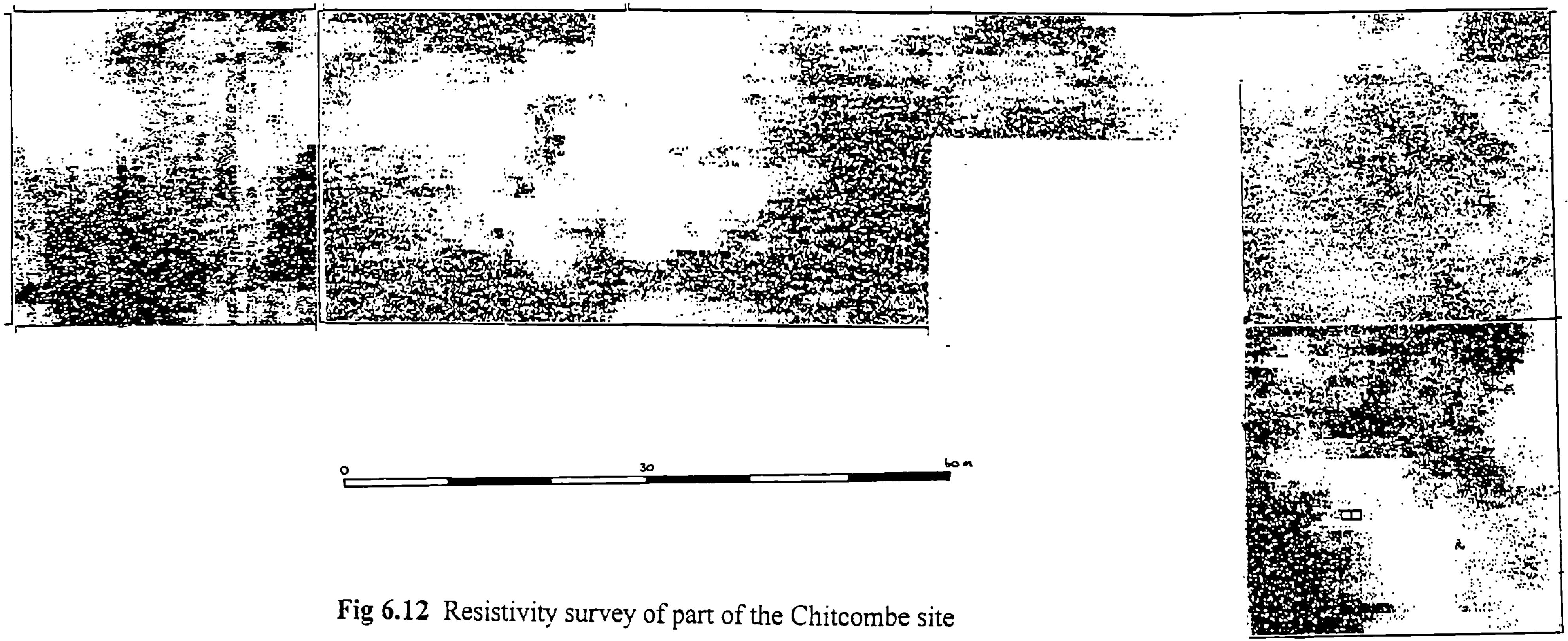
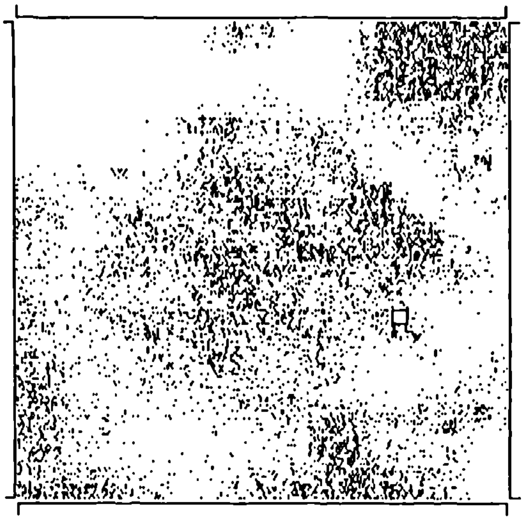


Fig 6.12 Resistivity survey of part of the Chitcombe site

SITE : chitcombe Plotting parameters

Minimum	60.21	-10.00 %	-1.31 SD
Maximum	73.59	10.00 %	1.31 SD
Contrast	3.0	Intensity Multiplier	1.0

GRID : a1
Metres
0 30



SITE : Chitcombe Plotting parameters

Minimum	60.21	-10.00 %	-1.31 SD
Maximum	73.59	10.00 %	1.31 SD
Contrast	2.0	Intensity Multiplier	1.0

GRID : A1
Metres
0 30

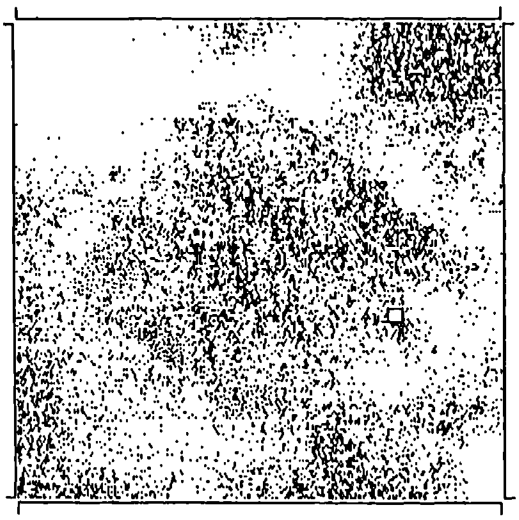


Fig 6.13 Possible structure indicated by resistivity

slag deposits, and this is evidenced by the recovery of *tuyère* fragments and furnace remains during agricultural digging in the area of slag deposit 6 in the 1960s. Research by the author in this slag deposit has shown that the base is characterised by a thin layer of burnt clay, representing light burning on the Roman land surface at some time prior to the deposition of slag. In addition, on the hillside above the site, and probably in the vicinity of the domestic settlement, a Romano-British cinerary urn was recovered in the nineteenth century, although the exact location remains obscure. The industrial area is now under pasture, while the slag banks over-looking the Tillingham support light scrub, in addition to birch, hazel, alder and blackthorn coppice. Resistivity survey by the author adjacent to Hoath Wood suggested that the slag scatters extend for a considerable distance up the field, decreasing in depth towards the summit. Here there are indications of possible structures, although these could be of any date.

In addition to the main Romano-British complex on the southern side of the Tillingham, two further small deposits of tap slag indicative of bloomery sites are located on the northern side. The larger of the two, discovered by the WIRG in 1987 (Hodgkinson 1988b: 4), is centred at TQ 8103 2118, on the eastern bank of a tributary ghyll. This site is situated over 65 m to the north of slag deposit 4, on the 40 m contour. The absence of datable material, in conjunction with the divorce of this deposit from the primary focus of deposition on the southern bank, has prompted Hodgkinson (*ibid.*) to suggest a different period of utilisation than on the main site.

Another scatter of tap slag was discovered during archaeological reconnaissance by the author, centred at TQ 8084 3137, as a result of ploughing in Little Haven field. The scatter of material extended for approximately 7 x 7 m, and is located only 30 m north of the of the nearest slag deposit (2) in the NE corner of Hoath Wood. The close proximity of this deposit to the point where a one metre thick bed of sideritic siltstone crosses the current course of the Tillingham at TQ 8096 2105 (Worssam 1988: 4), could have been the *raison d'être* for the location of this particular site, in addition to the main industrial complex. In the absence of excavation, the volume of material from this site is difficult to determine; however, the density of the magnetic response in conjunction with the small area involved does not indicate a large exploitation. The separation of this deposit from the main production site possibly implies a different period of exploitation.

The source of the ore for the Chitcombe site remains enigmatic. No evidence was recovered by the author for large-scale minepits in the vicinity of the Chitcombe site, despite extensive field exploration and local enquiry. The few pits which were recovered were of such small scale as to suggest a different period of exploitation. The site itself is located on a outcrop of high quality clay ironstone which is exposed in the stream bank. It would appear that this was the primary source of ore. It is possible that the extraction site would have been the exposure of ironstone along the bank of the Tillingham which could have been cut back. This could result in the cliff-type profile evident in the southern side of the valley. This exposure could then have been used as a repository for the waste slag, which in conjunction with the deposition of colluvial material, would have produced the profile and headlands visible in the contemporary landscape. Corroboration of this hypothesis is difficult as a result of the large volume of slag and other debris which have been discarded in this valley.

Rock (1879) suggested that the ceramics derived from the main industrial complex in the nineteenth century, were primarily coarse wares, which in this context probably equates to East Sussex Wealden wares, none of which are still available. The dominance of these wares would be characteristic of other eastern High Wealden industrial-class sites. Additional unrecorded excavations were carried out in the first quarter of the twentieth century by John E. Ray, who noted the presence of samian at Chitcombe (Straker 1931: 347).

Evidence for building materials focuses on the area TQ 811211, with evidence of abraded, striated tile in the occupation horizon at TQ 8114 2117. Blocks of pale brown sideritic siltstone have been cast over the slag deposit, while five fragments of tile are recorded in the stream between TQ 8107 2109 and TQ 8126 2130. Rock (1879: 177) referred to a hedgerow with the "remains of a Romano-British masonry wall," and the hedgerow is still in evidence at TQ

812211, although little now remains of the wall. Fieldwork by the WIRG revealed stone blocks and large fragments of striated tile at TQ 8119 2113 (Hodgkinson 1987a: 2), while fieldwork by the author revealed an additional two fragments of *imbrex* (17 x 24 cm and 10 x 16 cm) brought up by root action and erosion at TQ 812211.

The focus of these scatters of stone and tile at TQ 811211, in conjunction with their absence elsewhere, suggest the presence, in the vicinity, of a hypocausted building, stone- and brick-built with box-flue wall heating and a tiled roof. Three types of building match this description: a villa; administrative building; or a bath-house, all of which are represented in iron production contexts in the Weald. However, in the industrial area of the settlement, a bath-house or administrative building seem more appropriate. Certainly at Beauport Park a military-style bath-house has been recovered and excavated (Brodribb and Cleere 1986). Several similarities exist between this building and the hypothetical structure at Chitcombe. The focus of building debris, and wall footings, at Chitcombe is within the industrial element of the settlement. However, at this point the slag scatters and banks which are evident for 600 m, are absent. The location is comparable to the bath-house at Beauport Park 10 km to the SW. Bath-houses would have constituted a significant fire hazard, which would account for the location of a significant number outside military installations, and civilian settlements associated with iron production facilities. The utilisation of striated tile provides a direct comparison with the materials used in the bath-house at Beauport Park.

In addition to this, the regulations regarding the Spanish silver mining district of Vipasca laid down in the Aljustrel tablets containing the *Lex Metalli Vipascensis* (CIL II 5181), suggest that the provision of heated baths with running water was an essential prerequisite for the maintenance of the mining lease. Although these particular laws related to a substantial Spanish imperial mining estate which exploited silver and copper ores, other similarities with the Chitcombe site may be observed. The production at Chitcombe was on a very large scale.

The presence of a hypocausted building has additional environmental implications. The heating system would have needed a semi-regular source of fuel, probably wood rather than charcoal. This is categorically noted in the *Lex Metalli Vipascensis*, which records that the constant supply of wood to the bath-house was of such importance that the "lessee should not be allowed to sell wood except for branch trimmings unsuitable for fuel." The fine for such a sale was 100 sesterces paid to the fisc. The predominant ligneous fuel type appears to have been branch wood. This correlates with the material utilised for charcoal production and would have been another constant requirement of the environment during the operation of the site.

Trial trenching in Hoath Wood and on other slag banks by the author was designed to provide charcoalified material, to consider the relationship between the taxa found within a single slag deposit, and variation across the site. A pollen sample from a stream section in Hoath Wood was also analysed to determine the post-Roman environment of the site; despite a fragment of East Sussex Wealden ware in the section, the sample appears to be post-Roman; the ceramics probably derived from Hoath Wood by colluvial action (see Appendix 3).

A 1 x 1m test-pit was sunk into the slag bank at Hoath Wood, and charcoal was manually extracted and a soil sample of 1 litre was also analysed. Of all the assemblages recovered by the author from Wealden slag deposits, the Roman slag deposit at the Hoath Wood test-pit was the most oak dominated, with 96% of the 75 fragments deriving from oak, with additional fragments of *Pomoideae*, hornbeam, and birch. There was apparently no vertical variation of taxa in the test-pit. The soil sample was highly consistent with the material obtained from manual extraction, with a sample size of 154 fragments mostly > 10 mm, 97% of the identified material was of oak or possible oak, the remaining 3% were of hazel/alder type. Where applicable the observation of the size and ring structure was indicative of wood of branch size rather than more mature timber.

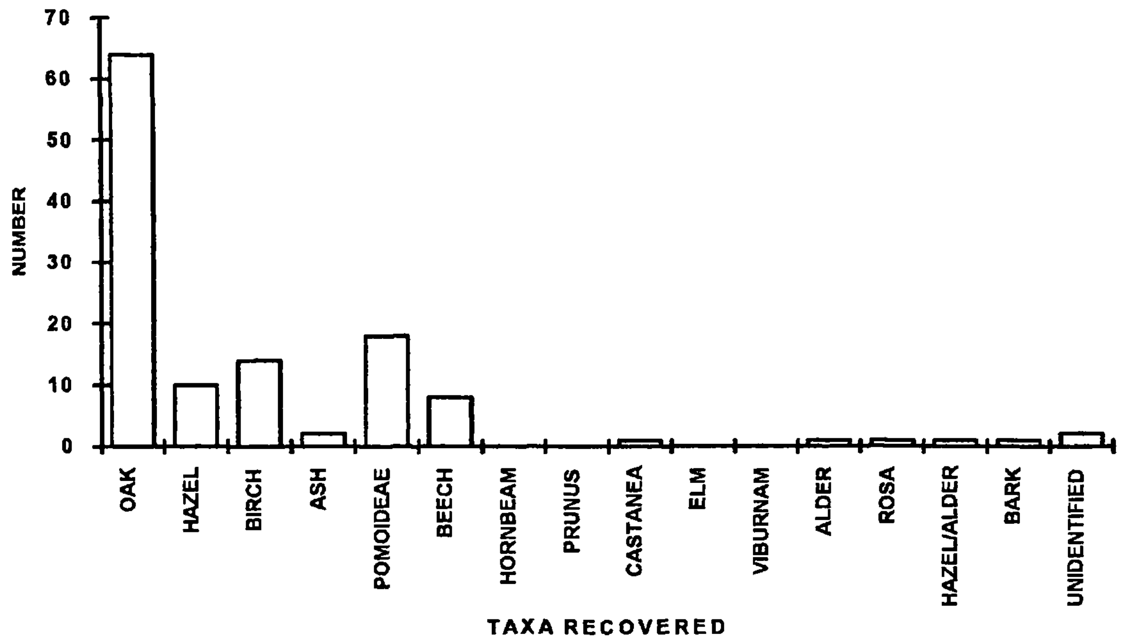


Fig 6. 15 The charcoal assemblage recovered from slag deposit 4 at Chitcombe

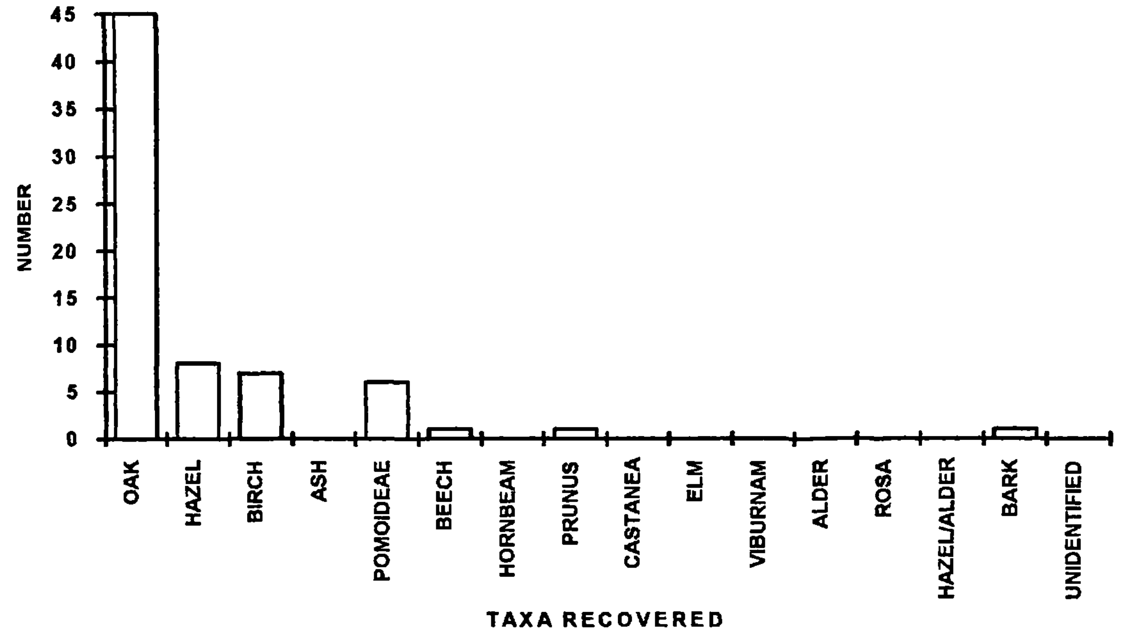


Fig 6. 16 The charcoal assemblage recovered from slag deposit 5 at Chitcombe

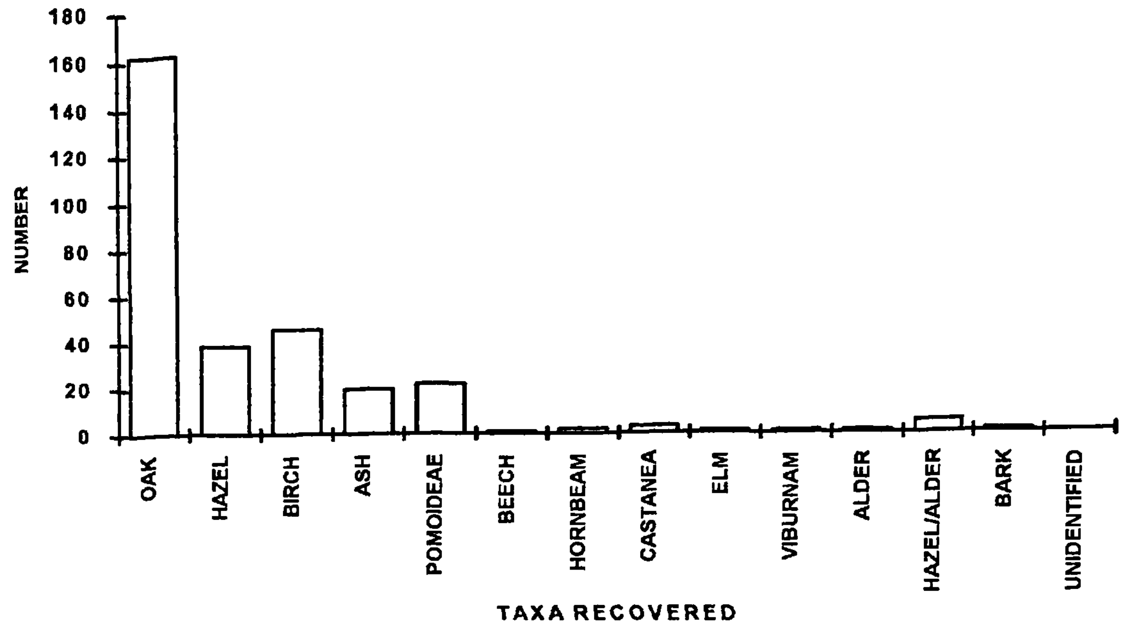


Fig 6. 17 The charcoal assemblage recovered from slag deposit 6 at Chitcombe

Of the 672 fragments of charcoal recovered from the slag deposits at Chitcombe 493, or 71.2%, were of oak, providing some of the most oak-dominated samples from the assemblages analysed by the author. There is, however, considerable variation between the frequency of oak recovered between different slag deposits, ranging between 96% and 58%. The slag deposits also show a certain degree of regularity for the non-oak taxa recovered. Birch, hazel, the *Pomoideae,* and in some instances, ash, are common elements of the assemblages, while other taxa such as beech, hornbeam, *Prunus, Castanea,* elm, *Viburnum,* and alder appear to occur irregularly and in considerably lower frequencies. The consistent presence of hazel, birch and the *Pomoideae* appears to indicate a moderate number of woodland openings which would favour these light-loving taxa. Certainly the extensive wood cutting which would have been a prerequisite for iron production could have favoured the extension of the pioneer and light-loving taxa such as birch and hazel, whose rapid growth rates could, in some instances, have swamped the regrowth of slower-growing oak. In the longer term (16 years +) this would have had less of an effect as the growth of oak would tend to re-establish itself.

The taxa recovered do not appear indicative of closed woodland; although oak dominates, this should not be considered as an indication of mature primeval woodland. The limited evidence from age profiles and the nature of the ring curvature suggests that smaller branch wood was utilised; this does not necessarily indicate if the branch wood of mature trees was selected or if managed coppice/pollard wood was exploited. The other taxa frequencies, such as the consistently low levels of hornbeam, beech and elm, appear to indicate a low ratio of mature woodland, as these taxa are less likely to be found in secondary woodland, although this is not a consistent rule.

Although it is tempting to suggest that the slag deposits appear to represent a continuum of environmental interaction, with Hoath Wood (deposit 2) being the most oak-dominated, while the evidence for indicator taxa of openings in the woodlands such as birch appear to increase westwards along the deposits. This could provide an indication of the date of deposition of the various deposits, with Hoath Wood being the earliest and the other deposits being sequentially later. However, a great deal of caution has to be expressed with such an interpretation.

The possibility that there are major fluctuations of charcoal taxa within slag deposits is very high. Slag banks are not necessarily deposited during a single period but could have multiple phases of deposition spanning the occupation of the site, which would tend to confuse any patterns in the taxa composition. There are certainly increased indications of openings in the environment, although based on the chronology which is available at the present it is not possible to elucidate which slag banks were deposited first.

LUDLEY FARM

The semi-industrial-class site at Ludley Farm (TQ 847206) is located approximately 250 m WNW of the farmhouse. The site is on Ashdown Sand, while the upper slopes of Burnthouse Wood, above the slag bank, are capped by Wadhurst Clay. The site overlooks the River Tillingham 500 m to the south, while the eastern boundary of the site is provided by an intermittent tributary ghyll of the Tillingham.

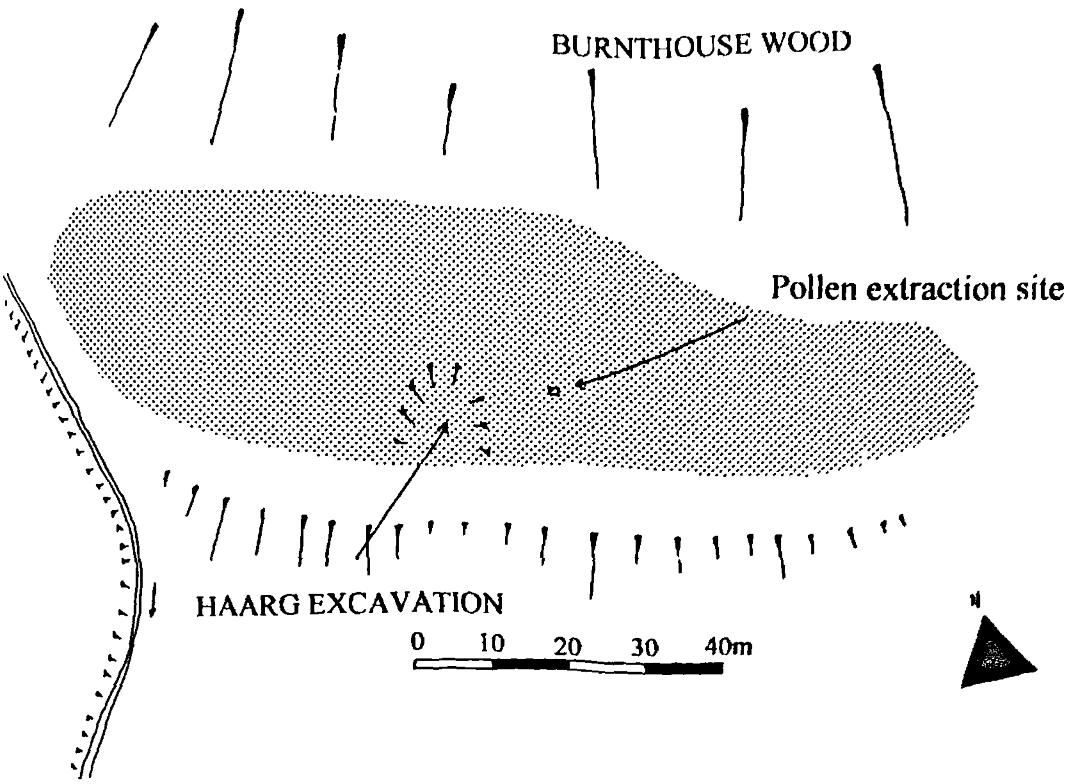
Running up to the ghyll from the site is a small causeway probably constructed to compensate for the steepness of its western bank. This is composed of refuse from the slag deposit, probably taken from where a sunken trackway has cut through the deposit, suggesting a post-Roman date for the causeway. A slag-metalled trackway follows the line of the foot path, although in the light of the possible post-Roman nature of the causeway and sunken trackway, it is also probably of a later date. With the exception of the disruption caused by the sunken trackway, the slag removed for metaling and the small HAARG excavation, the deposit appears to be generally preserved intact. There is a little evidence for undulation and pitting in the surface of the slag deposit, which are characteristic indicators of slag removal after deposition.

Evidence for iron production was first discovered by the Hastings and District Archaeological Group in 1971, shortly after the creation of the group. An extensive slag deposit, centred at TQ 8474 2058, extends for approximately 100 m, bounded by the footpath to the south and extending up to 50 m north to the lower slopes of Burnthouse Wood. Finds included a *sestertius* of Hadrian (A.D. 117-138), and a considerable quantity of Romano-British ceramics, including second century samian (Botting 1973).

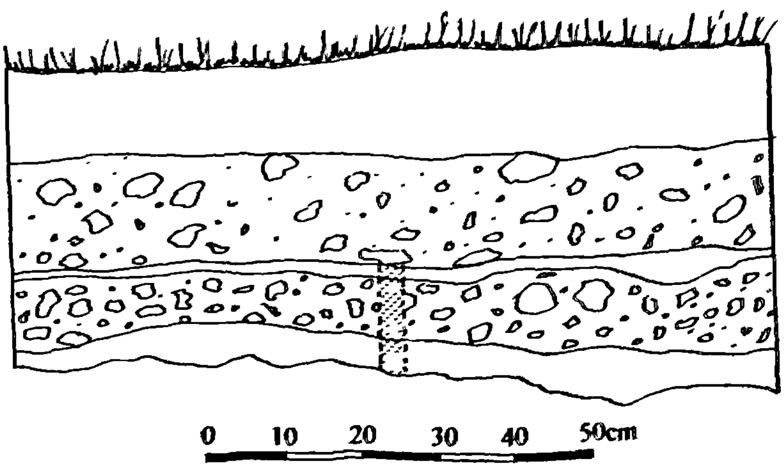
POLLEN ANALYSIS FROM ROMAN DEPOSITS AT LUDLEY FARM

Trial trenching by the author in March 1992 was designed to acquire palaeo-environmental samples for wider research. A single test pit measuring 1m x 1m was cut in an undisturbed area of the slag deposit, at approximately TQ 8474 2058. Beneath the topsoil, the slag was seen to lie in two horizons, each a maximum of 15 cm thick separated by approximately 2 cm of yellow clay between 27 and 29 cm

Fig 6. 18 The Roman iron production facility at Ludley Farm



The soil pollen extraction site



below the ground surface. The slag matrix contained tap slag, cinder, roasted ore, clay iron stone and fire-reddened clay and stone, although no Romano-British material culture was recovered. In addition to the 97 fragments of charcoal which were recovered from the test pit, a monolith of the slag matrix was removed, from the northern face of the test pit, for palynological investigation. The lower horizon of the slag deposit was sealed by a layer of yellow clay which served to prevent intrusion of more recent material from above. This horizon was checked *in situ* for breaches which could have allowed later material in, and was analysed for pollen to determine this horizon's ability to prevent downward movement of material. This meant that the lowest horizon of slag could contain securely dated palaeo-environmental information.

PRESERVATION

The state of preservation from the Ludley Farm slag deposit, as with most soil pollen contexts, is inferior to that normally exhibited in organic deposits. The pollen was in most cases heavily abraded and degraded through bacterial etching of the exine, which caused considerable difficulty in identification. Such degradation might have resulted in the over-representation of pollen with thick exines to the detriment of more fragile grains. In the context of the Ludley Farm pollen spectra the enhanced values of *Alnus, Polypodium* and the *Compositae* are indicative of their ability to support recognition at higher levels of degradation than other taxa. In addition the presence of microscopic fragments of carbon in the pollen slides, which could not be removed during the extraction process, enhanced problems of identification in some samples.

POLLEN ORIGIN

Pollen from mineral soil contexts is generally dominated by pollen of local origin (Evans 1975: 93). The majority of the herbaceous species represented will have grown within a short distance of the site of deposition, probably only a few metres away. However, in the context of slag deposits, which are secondary deposits, the site of deposition is not a single entity. The pollen from the carbon-rich matrix which comprises much of the sample, would have been derived from the site of actual iron production including the furnace and working areas, flora growing on the slag deposit, in addition to elements from other contexts such as possible waste from the domestic settlement. In this material it is conceivable that there will be reworked pollen.

Once the waste material was deposited in the slag deposit it is likely that there would be an influx of pollen derived from herbaceous taxa growing on the margins of the slag deposit, or species growing on the deposit, depending on the rate of deposition of slag and the stability of the deposit. The insect pollinated nature of most herbaceous pollen types would indicate autochtonous flora growing on the site although the exact location remains enigmatic. In addition to the predominantly local herbaceous pollen there would be an influx of material from longer-distance pollen rain which would have derived either through the trunk space of trees (Ct), the canopy space (Cc) or the rain component (Cr) (Moore and Webb 1978: 12-3).

As would be expected in such a scenario, the pollen obtained from the clay horizon was very sparse, while the species recovered from the slag deposit were essentially one homogenous zone. Major fluctuations in the pollen spectra from this context are attributed to variations in preservation exhibited in the matrix of the deposit. The taxa diversity decreases as towards the base of the slag matrix; samples obtained from immediately below the clay horizon reveal a high diversity of herbaceous pollen; however, in these contexts the values of *Alnus, Compositae* and *Polypodium* are reduced. The micro-fossils obtained from the palaeosol essentially mimic those recovered from the carbon rich matrix, which probably indicates leaching of polleniferous material down into the pre-slag deposit ground surface.

Ludley Farm (27-29 cm) <u>Yellow clay horizon</u>

Pollen analysis was undertaken on the yellow clay horizon and the matrix of the slag deposit below this, in conjunction with the palaeosol remnant beneath. Careful investigation of the clay horizon revealed no major breaches. This was seen as an indication of the integrity of the slag deposit below. The density of the clay matrix would have acted as a filter for intrusive pollen from above, which could have negated the validity of the results obtained.

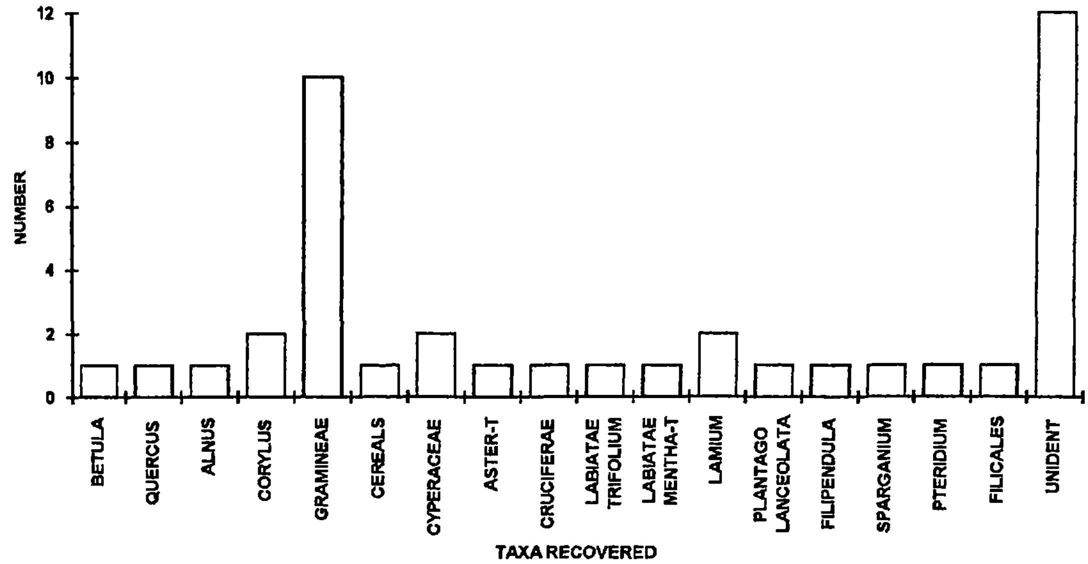


Fig 6. 19 Pollen taxa recovered from the clay horizon at Ludley Farm

Of all the material investigated in this sequence the clay produced the least pollen. The investigation of four slides produced only 43 grains, of which 12 were unidentifiable. A large number of grains recovered, but not recorded, were of fossil Cretaceous pollen. The sample was extracted from the centre of the clay horizon, so the pollen represented would possibly be indicative of material which had become incorporated into the strata while it was being moved from its place of origin to the slag deposit and material which was derived from the vicinity of the slag deposit.

The pollen assemblage recovered from the clay horizon differed from that derived from the carbon-rich matrix from the slag deposit, as indicated by a 79% dominance of herbaceous pollen and 17% of trees and shrubs. The micro-fossil assemblages from the slag deposit only achieved a dominance of 65% for herbaceous pollen. It is, therefore, possible that some pollen could have leeched down from the upper horizon of the slag deposit, although, the density of the clay matrix would not be conducive to the mass-movement of micro-fossils. However, the low number of grains recovered cannot be considered a statistically viable sample for comparison.

Ludley Farm Carbon rich matrix of the slag deposit

The sequence of pollen recovered from the carbon-rich matrix of the slag deposit has been considered as a single entity as a result of the homogenous nature of micro-fossils recovered. Differences which are exhibited between the base of the slag deposit and those just below the clay horizon are probably attributable to preservational inconsistencies and the mechanics of deposition, in a generally poorly preserved sample.

The pollen from the two samples which derived from immediately beneath the yellow clay horizon, exhibit the greatest evidence for anthropogenic modification of the environment. However, it is possible that this could be a function of the better preservation exhibited in these samples compared to those recovered from lower down in the sequence (cf. Figs 6.22-6.32). These two samples have provided the only examples of cereal pollen from the sequence. This could be significant, possibly indicating limited agriculture on open ground in the vicinity. The presence of cereals in the upper samples is corroborated by the presence of pollen of *Chenopodiaceae*, which are not recorded lower in the sequence. These arable weeds (fat hen/goosefoot) are considered to be indicator taxa of cultivated ground, which could be a further indication of limited arable cultivation in the vicinity (Behre 1981: Fig 2). However, a degree of caution has to be expressed in relation to the concept of arable production in the immediate vicinity of the site. Experimental evidence for the dispersal of cereal pollen suggests that at distances of 50 m from cultivation the level of cereal pollen drops to negligible quantities (1%) or is entirely absent (Brinkkemper 1991: 24). The implication that cereal production could have been undertaken within 50 m of the working areas/slag deposit is unlikely considering the high degree of disruption to the environment caused by mining and other iron processing activities. In addition the presence of the nitrophile *Chenopodiaceae* could be an indication of the carbon rich nature of the environment, although it could be a member of footpath and ruderal herbaceous communities.

Another source of cereal pollen could have derived from the debris of cereal processing. The largest source of cereal pollen derives from threshing, or harvest time, which serves to disturb the pollen, rather than during flowering time (*ibid.*).

As with the deliberate cultivation of arable in the vicinity of sites it is highly questionable that threshing of cereals would have occurred on or around an iron production site. It is highly probable that if cereal products were transported onto such a site they would have been in a pre-threshed form. The probable high degree of specialisation which would have been evident on a semi-industrial class site might have resulted in the importation of cereal products rather than their production in the immediate vicinity of the site. The importation of cereal to a site would also provide a source of cereal pollen, for example in the bracts of hulled cereals (Robinson and Hubbard 1977). The possibility that slag deposits were also a repository for domestic rubbish, for which ceramics in the deposits remain the only tangible evidence (see also Taylor 1948: 96), could provide a clue to the source for such pollen. Wet sieving and examination of the soil matrix from the extraction site produced no evidence of material other than carbonised wood. It is conceivable that the pollen could be derived from the faecal matter of the animal/human population which ended up as a secondary deposit in the slag bank. This could go some way to explaining the apparent concentration in one focused point.

Several distinct environments are represented by the fossil pollen recovered from the Ludley Farm slag deposit. The dominant pollen type in all the samples analysed was *Gramineae*. The high representation is indicative of grass which has been allowed to mature and pollinate rather than grass which was under a pastoral regime which would have been prone to constant grazing attrition. The high representation of ungrazed grass could be indicative of communities which were growing directly on, or in the vicinity of the slag deposit or working areas, which would have been less prone to attrition. Alternatively the *Gramineae* could be indicative of hay-meadow in the vicinity of the site, this could be a requirement of the need to provide fodder for draught animals. It is probable that several grassland communities could be represented including those on the slag deposit, and those in the vicinity of the working areas and domestic settlement. The implication is that the iron production site would have been relatively clear of arboreal vegetation during the period of its use. The *Gramineae* exhibit the greatest degree of numerical change of all the taxa recorded; as a result of these fluctuations the percentage values of all other taxa exhibit radical movements despite numerically remaining relatively constant. These major relative changes in the representation of *Gramineae* pollen are not considered to represent major fluctuations in the amount of cleared land in the vicinity of the site. The mechanics of slag deposition are unknown, as are the effects of differential preservation. It is probable that differential growth of grasses in different areas of the site and slag deposit, in conjunction with the inputs from different episodes of tipping and deposition of slag, could account for the fluctuations which could have occurred over a relatively short period of time, prior to the sealing of the lower slag horizon by the anthropogenic deposition of the yellow clay.

The other components of the herbaceous assemblage are dominated by taxa of disturbed, waste or marginal ground such as the *Caryophyllaceae* (*Cerastium-T*), the chickweeds, which are normally a taxa of waste places or disturbed ground, found on acid/sandy soil. Members of the genus *Urtica* (*urens* and *dioica*), representing the nettle family, are also considered indicators of disturbed ground. *Urtica*, in conjunction with *Chenopodiaceae* and *Artemisia* are also nitrophile taxa usually associated with nitrogen-rich areas. These could be associated with the settlement or more likely with the carbon-rich soil that was an integral part of the slag deposit and much of the site of production.

The consistent presence throughout the profile of species such as *Plantago lanceolata* (ribwort plantain), which is frequently regarded as one of the most important of the anthropogenic indicators (cf. Behre 1981, 1990), would normally be considered to signify grazed grassland as a result of its high light requirements. There could be alternative implications in an iron production context. It is important to realise that the indicator value of such species is not primarily a function of their ecological requirements, but rather their resistance to certain types of environmental impacts. The nature of iron production would result in the redistribution of topsoil between different areas of the site, in conjunction with general ground disturbance. In the case of the plantains, grasses, and other perennials, the perennating organs such as roots and rhizomes are not destroyed but moved around the sites allowing for regeneration. The representation of the grasses and plantains is also enhanced by a slightly higher than average pollen productivity, and a greater degree of resistance to attrition. The general appearance of the herbaceous taxa recovered from the Ludley Farm iron production facility is of a generally open, and heavily disturbed site.

The profile of the arboreal taxa, which is consistently under-represented, is suggestive of extra-local and regional influx of pollen from the environs of the site rather than woods growing on the iron production facility.

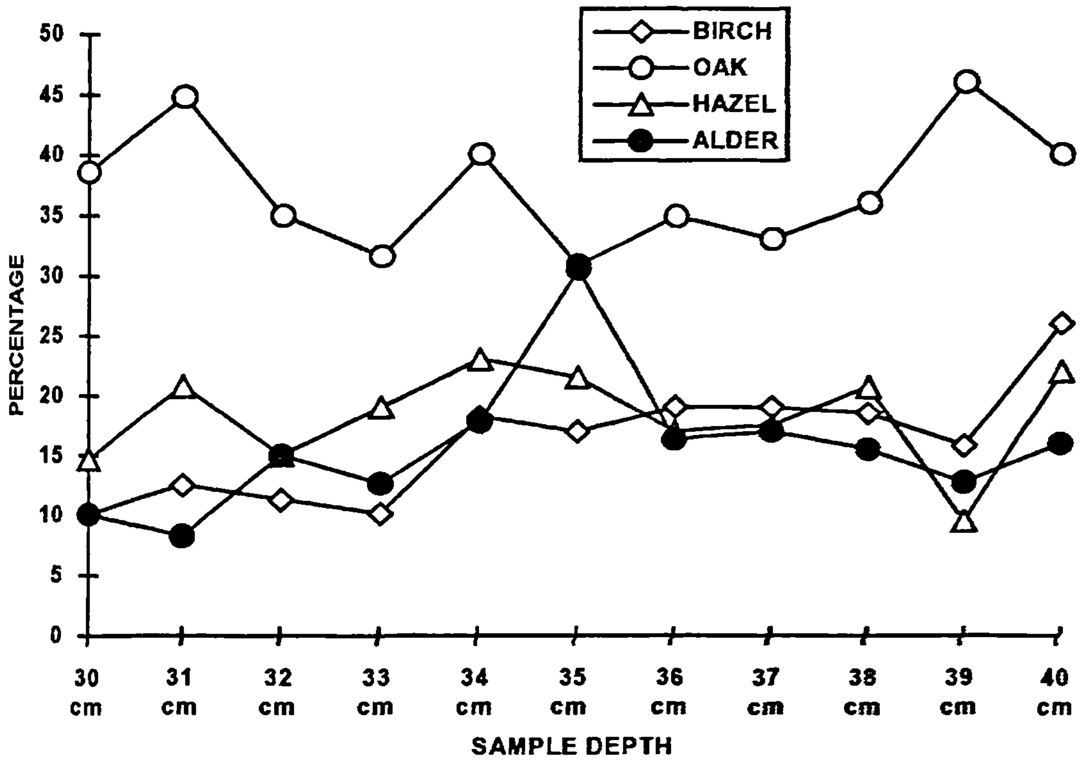


Fig 6. 20 The variation in arboreal pollen recovered from Ludley Farm

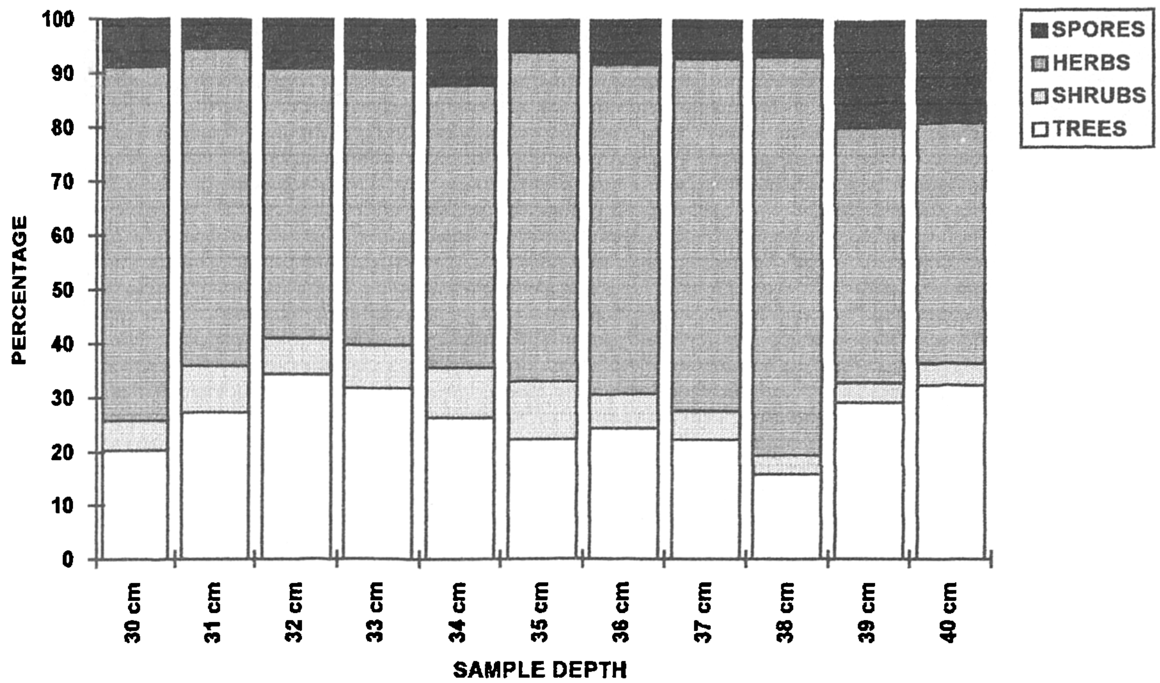


Fig 6. 21 Comparison between the ratio of arboreal and non-arboreal pollen from Ludley Farm

One of the significant differences between the charcoal recovered from the slag deposit and the taxa present in the arboreal pollen spectra, is the constant representation of *Alnus* in the pollen, at a density of approximately 10 grains per 2 slides, compared with its almost total absence in the macrobotanical record. In the pollen spectra *Alnus* is consistently the third or fourth highest represented arboreal taxa. The one fragment of *Alnus* charcoal recovered from the slag deposit, could be supplemented with the addition of some fragments which are indeterminate hazel/alder although it is unlikely that all, if any, of these are *Alnus*. The presence of the damp-loving *Alnus* is difficult to account for; little grows in the vicinity of the site today, and the River Tillingham is over 500 m away. However, a dried-up stream bed runs beside the slag deposit; it is possible that this could have flowed during the Romano-British era, although this is difficult to corroborate. It is however, possible that the presence of a fresh water algal cyst immediately below the clay horizon, in the carbon-rich slag matrix (30 cm), could be an indication of a local water source, as could the presence of aquatic pollen and spores from *Sparganium* (clay horizon), and *Potamogeton* (32 cm). However, the *Alnus* pollen is a highly consistent component of the pollen record from the site; it is unlikely that the damp stream bank, on the edge of the slag deposit, would have sustained an arboreal vegetation for a considerable period of time, in view of its close proximity to the centre of the iron production site. Such fuel-consumptive activity, for domestic and industrial use, would have resulted in the removal of much local vegetation. An indication of this can be extrapolated from the high values for *Gramineae* pollen.

A long term source for the *Alnus* pollen could have derived from the banks of the Tillingham. The slope upon which the site is located descends rapidly onto the alluvial floodplain of the Tillingham; although today this land is under pasture, used for grazing sheep, it is highly likely that during the Romano-British era the ground surface would have been lower. Such alluvial floodplains would have been a continuation of the Romney marshland complex. It is possible that this low-lying region would have sustained *Alnus* carr, which would have been sufficiently prevalent on the low ground to account for the constant representation of the pollen in the Ludley Farm micro-fossil assemblage.

The representation of *Alnus* in the pollen spectra could have a taphonomic significance; the micromorphology of the *Alnus* pollen could have resulted in its enhanced recognition in the highly degraded soil sample. The exine of the grain has a highly distinctive five-pore structure, with wall thickening between the pores, which can remain recognisable even when heavily degraded. However, this does not alter the fact that the pollen is consistently well represented, while the charcoal has only been recovered in negligible quantities. The inherent implication of this dichotomy is that the wood of *Alnus* was selected against, compared to other hardwood taxa. It is highly likely that if *Alnus* was represented in the pollen spectra of a soil core then it would have derived from the locality of the site. It is certain, considering the size of the slag deposit, that this would have been within the *territorium* exploited for woody material. It is therefore likely that deliberate exclusion of this taxa was practised. This would not be unusual. The Roman population was aware of the properties of various woods, and exploited some preferentially for certain tasks; for example, oak was consistently used for Roman construction in both Britain and northern Europe (Brinkkemper 1991: 46).

As a wood fuel *Alnus* is poor, and requires a long drying period for efficient use; its association with damp places would only serve to enhance these perceptions. Certainly *Alnus* is a negligible component of the taxa from Roman slag deposits in the Weald. This is comparable with the other damp-loving taxa, the *Salicaceae*, which are rarer still in charcoalified form.

Pollen analysis of an alluvial sequence obtained from the Pannel valley, immediately to the south of the Tillingham valley indicated a significant rise in the pollen of willow during the early historic era, but a decline in most other arboreal taxa. This could indicate the expansion of willow during this period as a result of its unsuitability for charcoal production; its favourabilty for wattling; in conjunction with its autochtonous nature, this would enhance representation in an alluvial deposit.

Another arboreal taxa which is well represented in the pollen spectra is *Castanea sativa*, the sweet chestnut. Considering that this taxa is thought of as a Roman introduction, it is very well represented in the pollen profile, being recovered from every sample analysed, and ranging between 1.0 and 4.6% of the total pollen. There can be some difficulty in the identification of the charcoal of *Castanea*, as a result of the similarity between it and the *Populus* genus. These in turn have anatomical features which are similar to those of *Quercus* and *Salix*. The identification of *Castanea* and *Populus* is based on anatomical features which characterise these two genera only. The presence of the charcoal is confirmed by the pollen which does not have problems associated with identification.

The lower slag horizon is of early Roman date, certainly prior to the 240s. The trial trench excavated by the Hastings and District Archaeological Group in 1972 (Botting 1973) is immediately adjacent to the pollen extraction site. This produced a coin of Hadrian, which could give an indication of the date of the pollen sample, although this is highly conjectural. Certainly the recovery of evidence for *Castanea sativa* from earlier Roman contexts is very rare. The relatively constant representation of *Castanea* in the pollen profile, but moderate numbers from the slag deposit (n = 4), could be an indication of the growth of the taxa around the site, rather than widely spread throughout the Wealden environment. It is conceivable that the *Castanea* taxa in the local environment could be a by-product of the use of the sweet chestnut as a food source by the Roman population. The efficient transport of the Roman era would easily allow for the movement of the nuts from mainland Europe, and hence to the site of iron production. The possibility must also be addressed that *Castanea* could have first arrived during the LPRIA, as a result of increased continental links during this time.

The dominant arboreal taxa recovered from all samples analysed was *Quercus*. This is entirely consistent with the data recovered from all the charcoal assemblages from the eastern High Weald. The implication is that oak was selected because of its dominance in the arboreal environment rather than as a function of its properties.

Other taxa which might have been associated with the oak woodland would have been *Ulmus*, *Fagus*, *Carpinus* and possibly *Fraxinus* in clearings. All these taxa have the ability to support coppice or pollarding (Rackham 1983: Table 1), although some species of *Ulmus, Carpinus* and *Fagus* are poorly able to form secondary woodland, or in the case of *Ulmus glabra,* tolerate poor soils.

In addition, micro-fossils of *Pinus* are present at Ludley Farm. However, the large grain size and the presence of external *saccae* can result in fragmentation of the grains leading to over-representation, compared to other pollen taxa. The presence of pine micro-fossils was not considered to be indicative of the growth of pine in the region of the production site. *Pinus* is an extremely buoyant grain, which is able to travel long distances. It is probable, considering the absence of *Pinus* from charcoal assemblages in the Weald, and much of southern Britain, that the tree was either absent or found in very low numbers in isolated stands.

The nature of the palaeosol has to be considered in this context. As with the other industrial-class sites examined by the author there was little evidence of a consistent palaeosol from beneath the slag deposits. At Ludley Farm only a few fragments of definitive palaeosol were recovered. This could be an indication of ground modification prior to iron production activity on some larger sites. The taxa recovered from the palaeosol are comparable with those recovered from the slag matrix, which could indicate the leaching of material down from the slag deposit into the palaeosol. However, there is some indication of the environment being slightly more wooded than at some stages in the working life of the iron production facility. Some caution has to be expressed with this interpretation as the number of grains extracted from the palaeosol was lower than those from the slag matrix (see Fig 6.20). There does appear to be an indication that oak, in conjunction with elm, beech and hornbeam, were also better represented. This could further indicate a less modified woody environment prior to Roman iron production. The amalgam of two major sources of pollen, both leached from the slag matrix and the original material from the palaeosol, has a tendency to negate positive interpretations.

CONCLUSIONS

The pollen derived from the Ludley Farm slag deposit is considered to represent a combination of material, including autochtonous flora from the actual slag deposit in conjunction with secondary, derived taxa from the working areas and possible domestic settlement. The taxa represented will therefore provide a useful representation of the herbaceous taxa which grew on elements of the site and the background pollen rain derived from the surrounding woodlands. The sample was dominated by the pollen of the *Gramineae,* which when considered with the relatively low percentages of arboreal pollen, suggests that the site itself was relatively clear of arboreal vegetation. The herbaceous pollen which would have derived from the actual site was dominated by taxa characteristic of disturbance and general anthropogenic interference. The presence of *Calluna* is suggestive of some degree of soil degradation and acidification allowing limited heath development in the locality. This is probably a function of the sandy nature of the

Ashdown Sand sub-soil on which the site is located and the extensive anthropogenic clearance and disturbance which would have prevented arboreal regeneration. The correlation between the arboreal pollen spectra and the charcoal recovered from the slag deposit is relatively consistent, although in some cases such as the *Alnus* and *Salicaceae* it is possible that there was some selection of fuel sources. The impact associated with iron production at Ludley Farm is considered to have taken the form of clearance in and around the site with more limited disturbance further away. The site would have been prone to exploitation for infrastructure development, mining operations, and domestic fuel requirements for the iron workers; all of which would have served to enhance clearance in the immediate locality. The evidence for clearance and high *Gramineae* values should not be confused with local *devastation* of the woodlands. The nature of the pollen sample from a soil context would also tend to emphasise local site taxa to the detriment of extra-local activity.

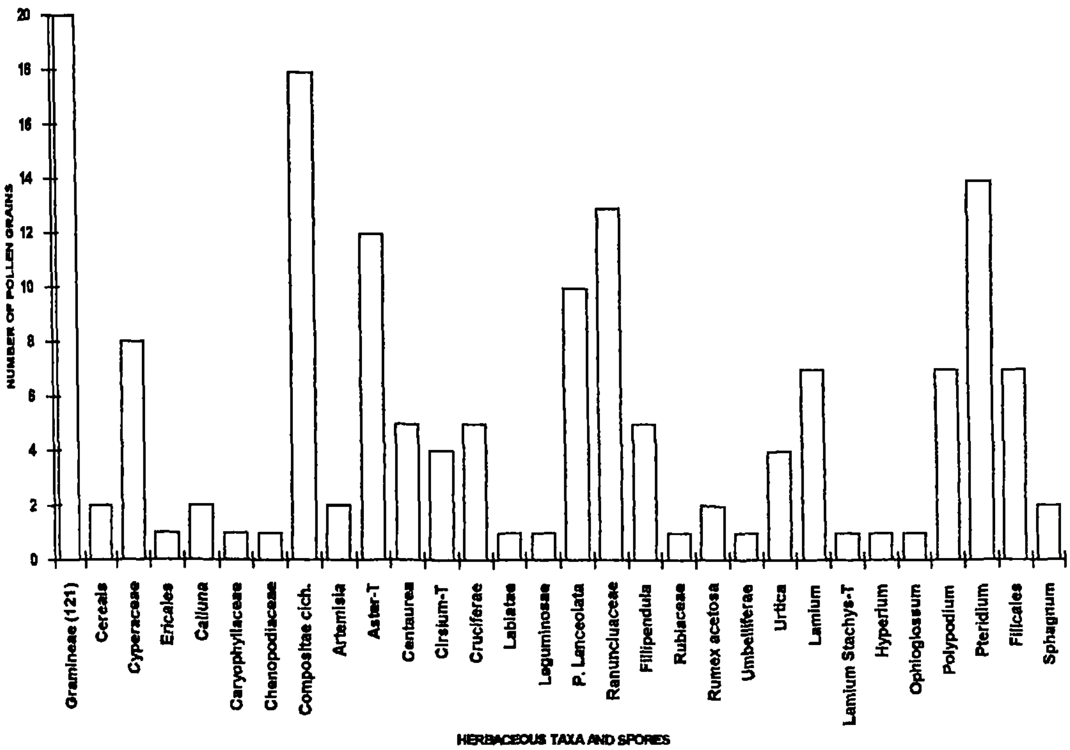


Fig 6. 22 Herbaceous pollen and spores from the carbon rich matrix of the slag deposit at Ludley Farm (30 cm)

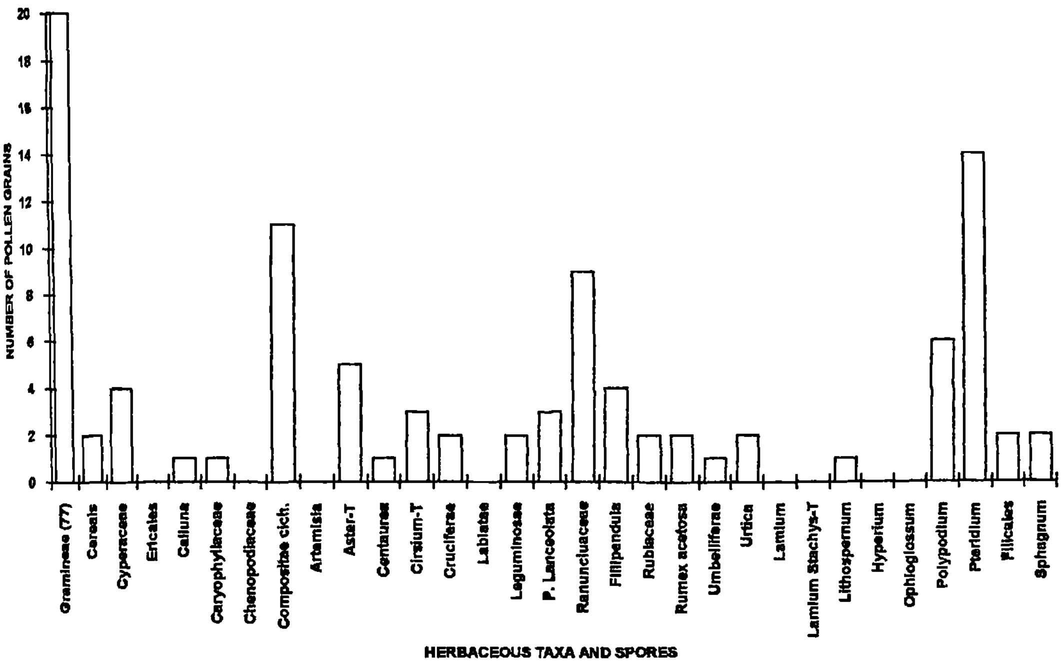


Fig 6. 23 Herbaceous pollen and spores from the carbon rich matrix of the slag deposit at Ludley Farm (31 cm)

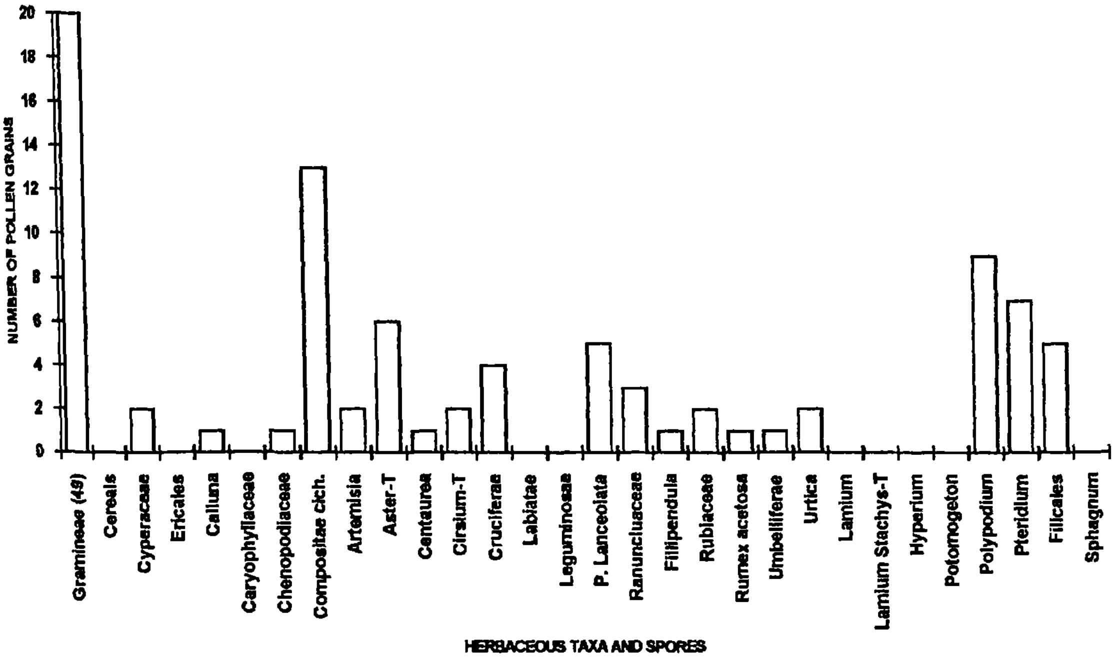


Fig 6. 24 Herbaceous pollen and spores from the carbon rich matrix of the slag deposit at Ludley Farm (32 cm)

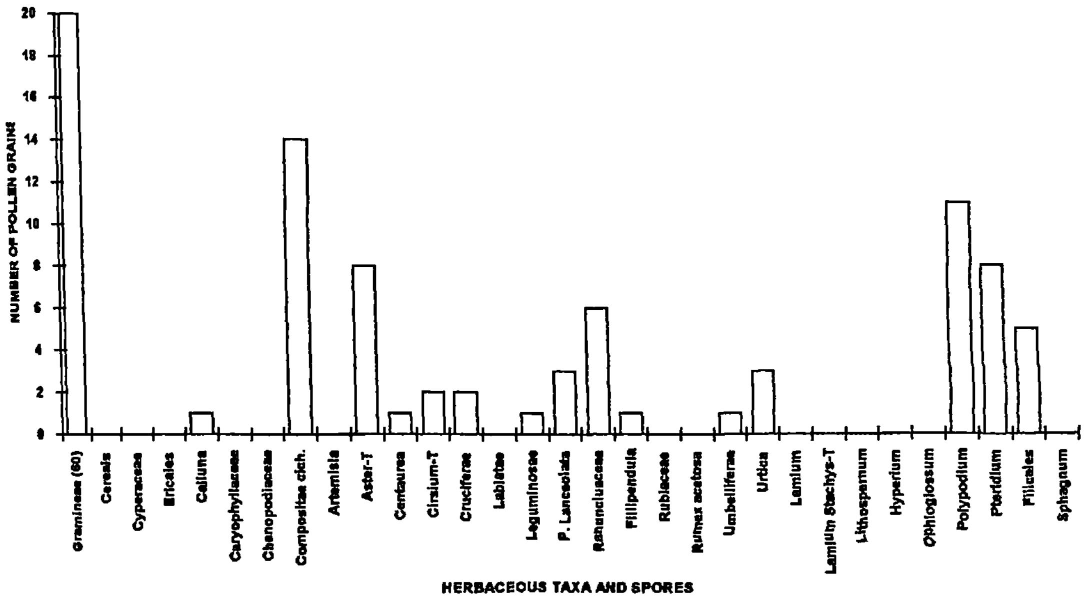


Fig 6. 25 Herbaceous pollen and spores from the carbon rich matrix of the slag deposit at Ludley Farm (33 cm)

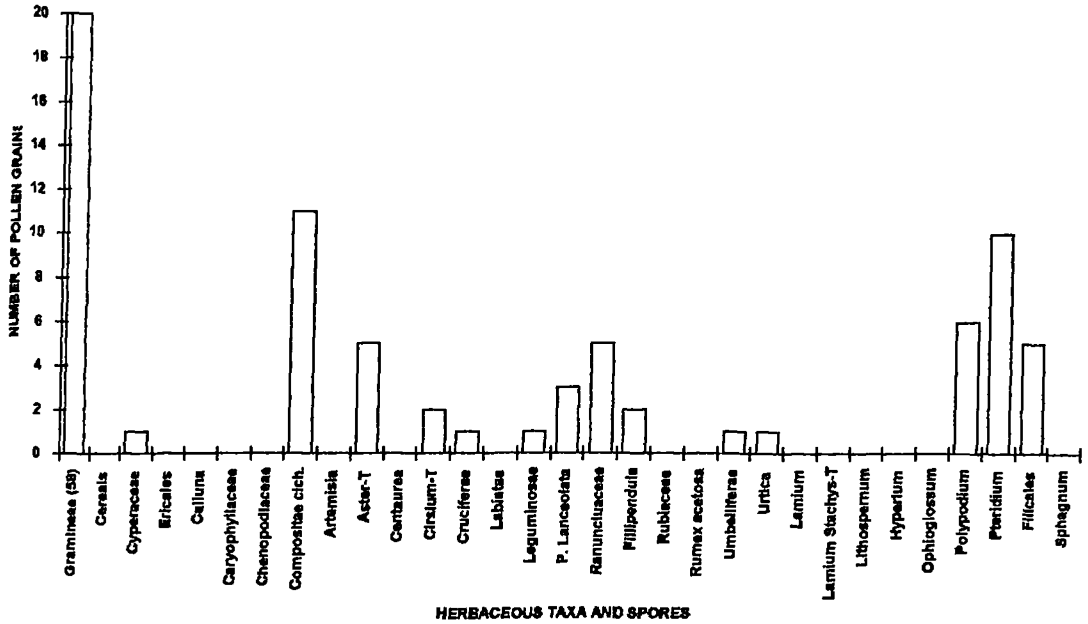


Fig 6. 26 Herbaceous pollen and spores from the carbon rich matrix of the slag deposit at Ludley Farm (34 cm)

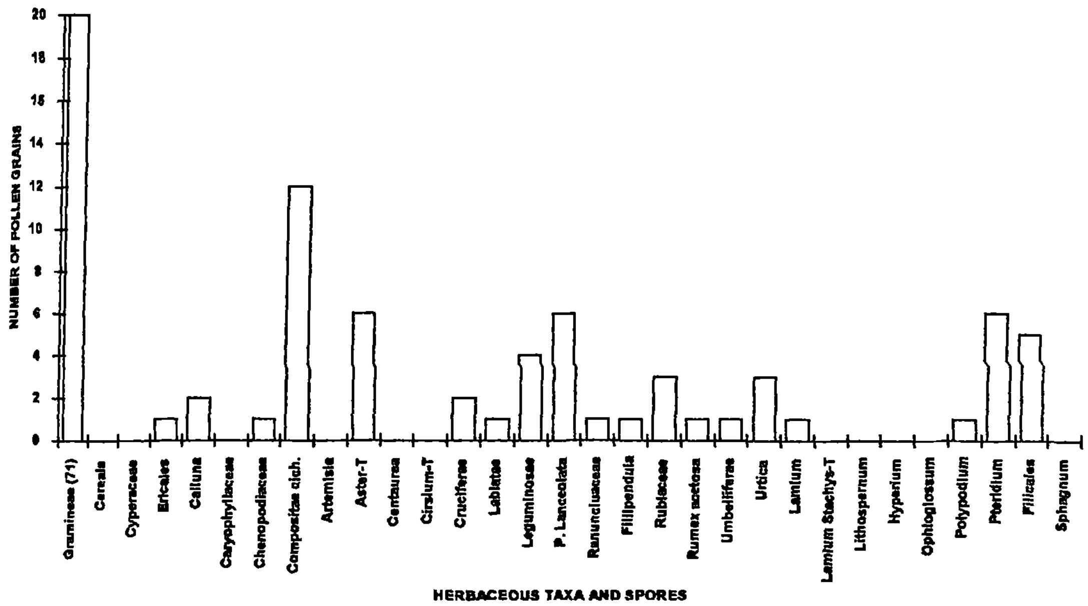


Fig 6. 27 Herbaceous pollen and spores from the carbon rich matrix of the slag deposit at Ludley Farm (35 cm)

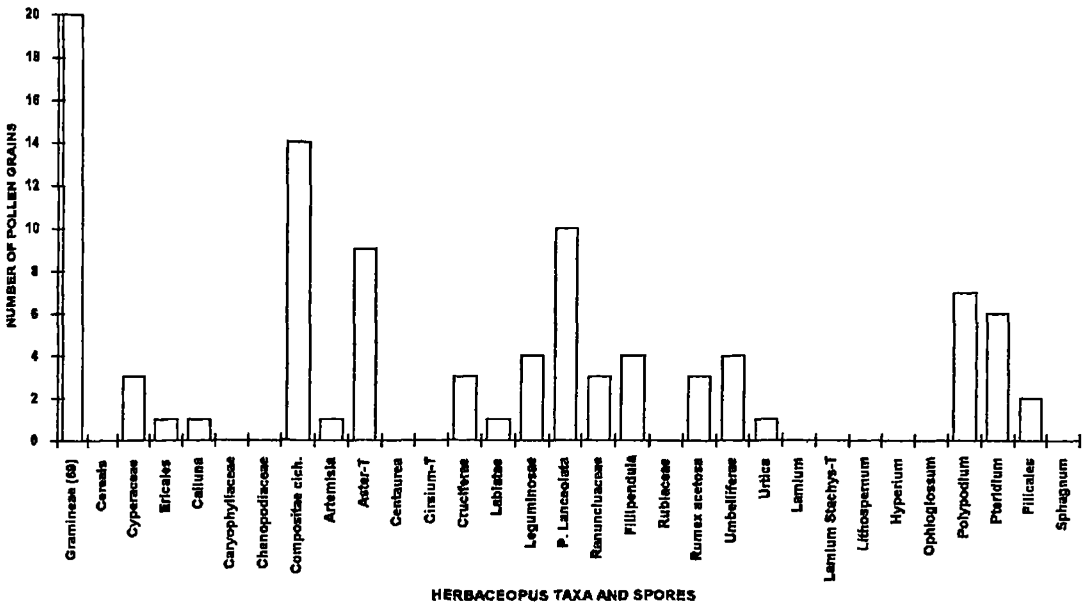


Fig 6. 28 Herbaceous pollen and spores from the carbon rich matrix of the slag deposit at Ludley Farm (36 cm)

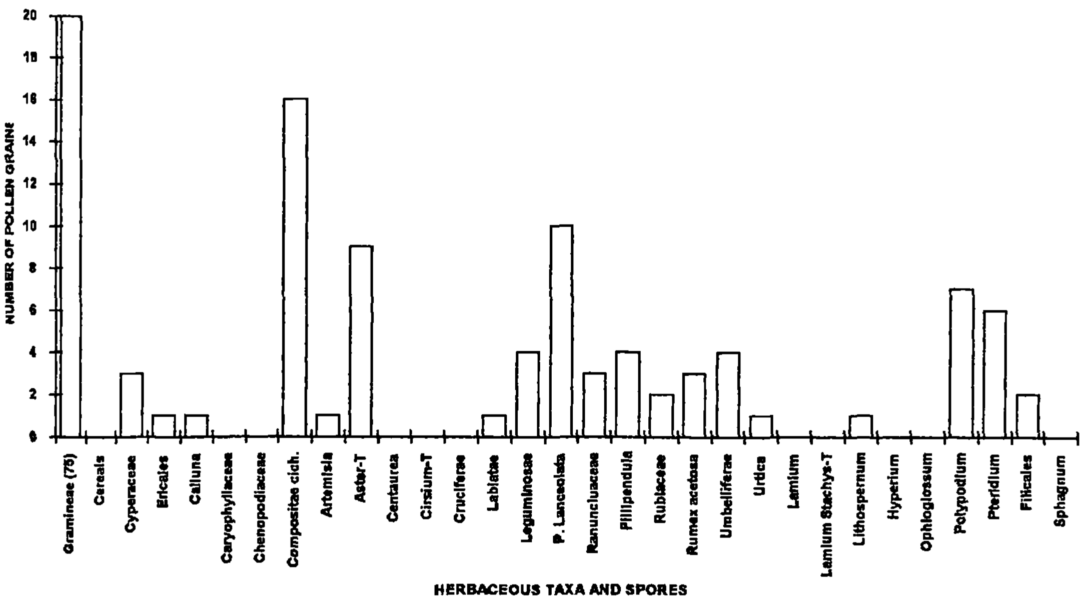


Fig 6. 29 Herbaceous pollen and spores from the carbon rich matrix of the slag deposit at Ludley Farm (37 cm)

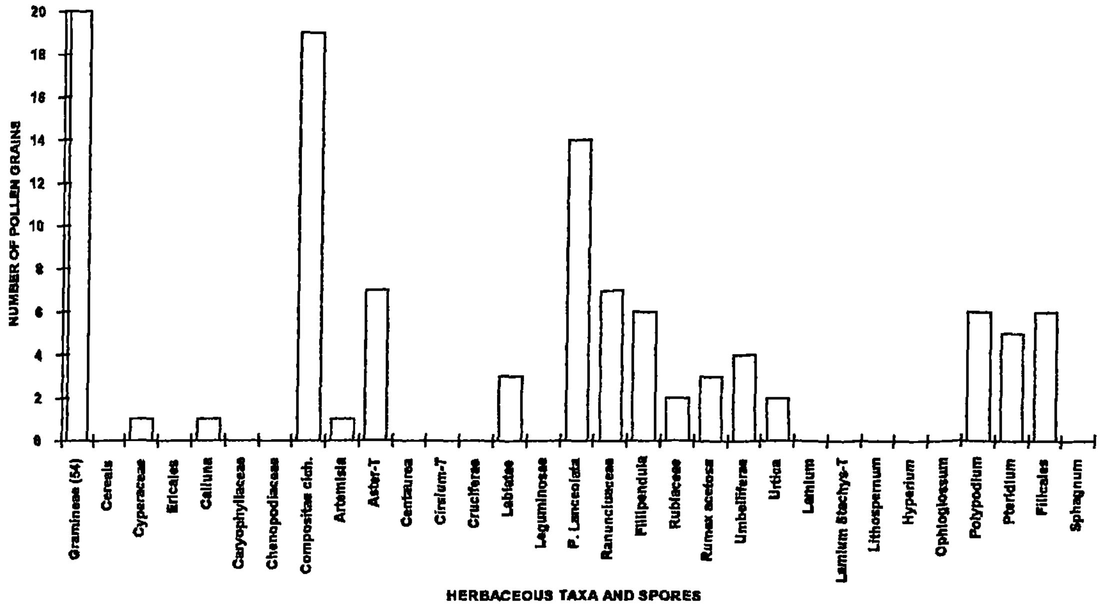


Fig 6. 30 Herbaceous pollen and spores from the carbon rich matrix of the slag deposit at Ludley Farm (38 cm)

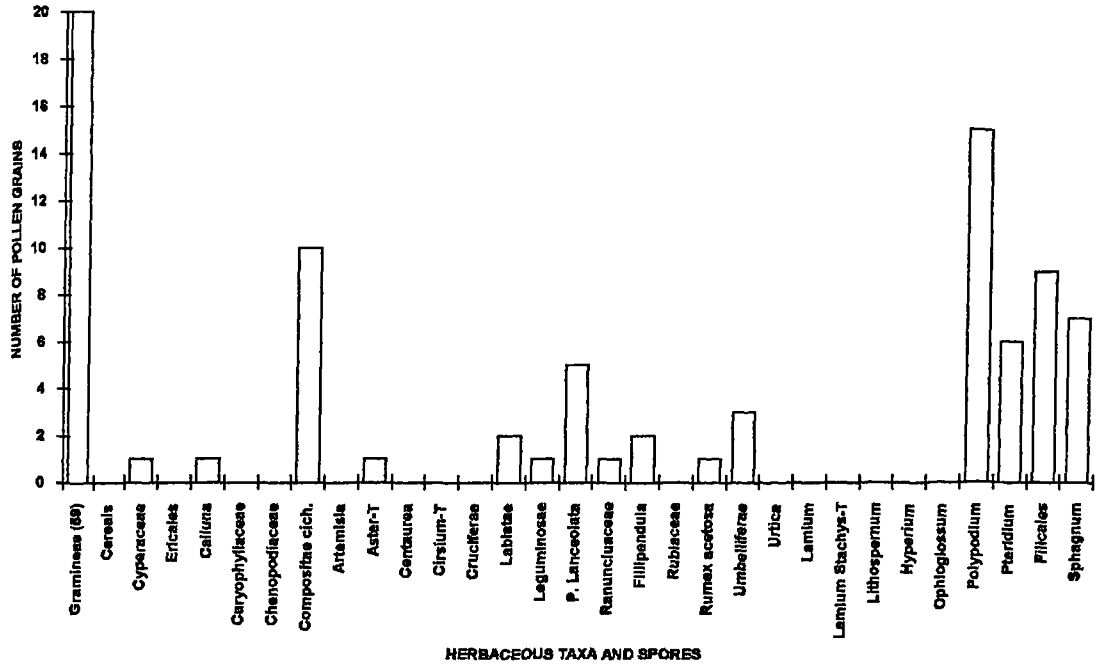


Fig 6. 31 Herbaceous pollen and spores from the palaeosol beneath the slag deposit at Ludley Farm (39 cm)

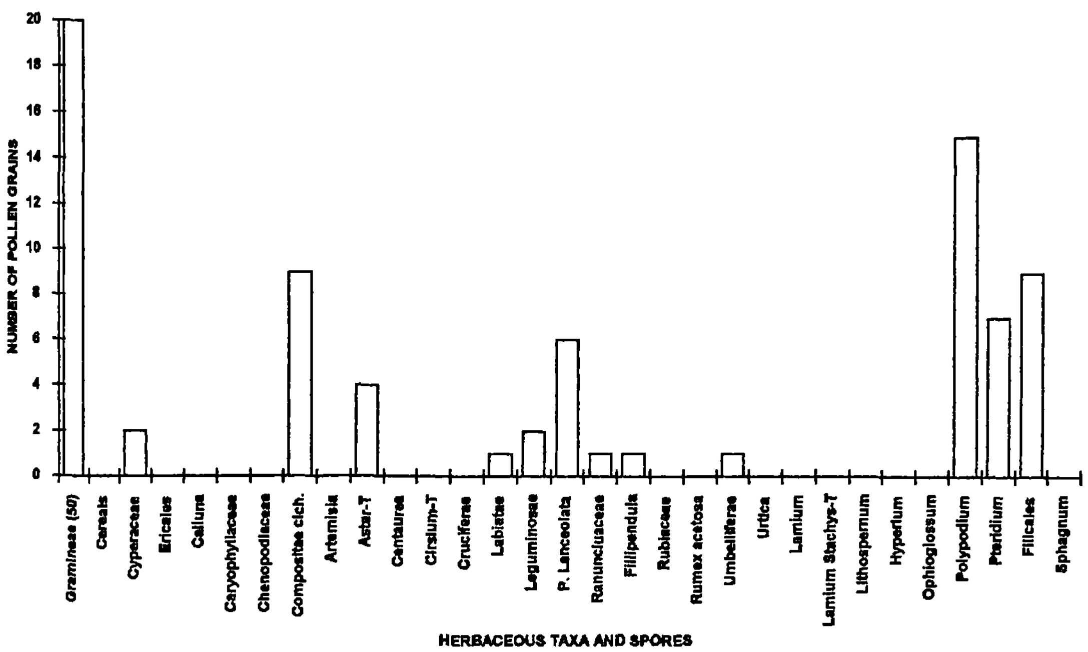


Fig 6. 32 Herbaceous pollen and spores from the palaeosol beneath the slag deposit at Ludley Farm (40 cm)

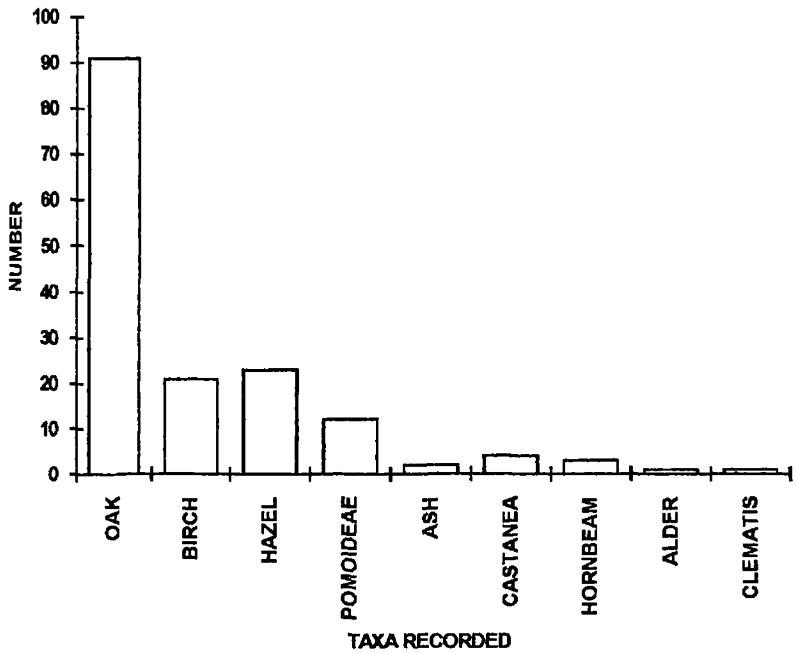


Fig 6. 33 The charcoal taxa recovered from the slag deposit at Ludley Farm

Although the taxa composition of the charcoal recovered suggested an entirely characteristic oak, hazel and birch dominance, a wide variety of other species were recovered including, the *Pomoideae* (n = 12), ash (n = 2), *Castanea* (n = 4), hornbeam (n = 3), alder (n = 1) and Clematis (n = 1). This correlates well with the species found from the soil pollen sample, but quantification of the pollen sample suggested that the immediate environment was dominated by secondary woodland. The oak dominance of the charcoal suggests that a much wider environment was exploited than was evident in the soil-pollen profile. This suggests that the site and its immediate environment were heavily modified due to human interaction, resulting in the creation of secondary woodland, while the wider environment was still able to support oak and birch woodland. In addition to the secondary woodland, palynological analysis suggested that limited arable cultivation might have been present in the area. The presence of heather (*Calluna sp.*) in the profile suggested localised degradation of the environment, probably on the Ashdown Sands, which are more prone to breakdown than the Wadhurst Clays.

The characteristic yellow clay horizons tend to be found in the slag deposits of industrial and semi-industrial class operations, as for example at the industrial-class production centre at Chitcombe only 4 km to the west. From the finds both within the slag deposit, and scattered above the site, the ore appears to be tabular clay ironstone, a low-grade sideritic iron ore from the base of the Wadhurst Clay. It is possible that the ore for the site could have derived from Wadhurst Clay in the upper part of Burnthouse Wood (TQ 847207), where 11 minepits of variable depth are located. However, the limited evidence for securely dated Romano-British minepits from the Weald suggests that open-cast workings were more common than these smaller minepits or bell pits. These minepits have the appearance of medieval exploitation. More substantial open-cast quarries, reminiscent of Roman work, are evident on the southern boundary of Oak Wood with Burnthouse Wood at TQ 851209. These are also on the Wadhurst Clay, approximately 400 m to the NE. As a result of the absence of material culture associated with the minepits, and in the absence of evidence for a slag-metalled trackway between the minepits and the production centre, this cannot be confirmed. Alternatively some ore could have been obtained immediately above the site at the junction between the Ashdown Sands and the Wadhurst Clay.

OAKLANDS PARK

The industrial-class iron production site at Oaklands Park (TQ 785175) is located on the south bank of the river Brede, and extends to both Oaklands and the post-war Pestalozzi Children's Village. The site is situated on Ashdown Sand, with a cap of Wadhurst Clay immediately to the east. Evidence for industrial iron production at Oaklands was first published by Lower (1849b: 174), who noted the discovery of "many Roman coins in a cinder-bed", which were "greatly corroded and some....burnt". Straker (1931: 329) records that a slag bank at Oaklands Farm, "thirty feet high" and of unknown extent, was destroyed during the removal of road metalling for the construction of the Harrow Inn to Watlington road. Finds collected by Mr. Byner, of Sedlescombe, the County Highways Surveyor, included "six coins of Hadrian and also pottery". In addition, brick and tile fragments were recovered from the matrix of the slag deposit, which suggested the presence of masonry buildings. This was later corroborated by Combe (1877: 228) who recorded his discovery "among the iron *scoriae* and cinders," at Oaklands, of "Roman copper coins". In 1850, a year after the publication of Lower's article, T. Wright recorded that the western driveway was constructed for Oaklands Park House (1854: 331). The cinder beds which were used for the provision of hardcore were 7 m deep, and as with Beauport Park, they supported the growth of large oak trees. The finds included several Roman coins, the latest of Diocletian (A.D. 284-305). Wright also noted that in the woods a quarter of a mile from the site there were extensive circular pits suggesting minepits, although their date is enigmatic. Little more was recorded until the Reverend Stuart, in 1945, discovered a single sherd of samian at Oak Cottage, Sedlescombe, on the NW boundary of the industrial complex (Es.SMR).

Field exploration by field officers for the NAR, in January 1973, revealed that cinder could still be found "several feet deep" along the western drive to Oaklands Park between TQ 78421760 and 78521760 (NAR TQ 71 NE 10). Research by Mr. J. A. Paige suggests that the domestic settlement could be situated beneath the Children's Village. A slag-metalled road has been located at TQ 788173 (Cleere and Crossley 1985: 305).

It appears that the industrial site at Oaklands was located exclusively along the south bank of the River Brede, which would have been navigable during the Roman era. The domestic settlement for this would probably have been located further south, under what is now the Children's Village. Cleere has estimated that the site originally contained 20,000 m^3 of slag (1976a: Table 1, 238). However, such a figure has to be viewed with caution. The contemporary land use by the Children's Village has not allowed for the elucidation of sufficient volumetric data on which to base such an estimate. What is known is that between 1838 and 1840 the county highways surveyor extracted hardcore from the site. Based on the removal of 2,000-3,000 cubic yards per annum (Straker 1931: 330), between 6-9,000 m^3 of deposit could have been removed, but slag banks of 7 m still remained after Byner left the site. It is probable that a maximum volume of 15,000 tonnes of slag could have been originally present.

The Oaklands Park site is one of the most enigmatic of the Wealden industrial-class sites, yet it is located in the very heart of the industrial iron production sites of the eastern Weald. The absence of recorded excavation, the removal of thousands of tonnes of cinder in the late nineteenth century, in conjunction with the presence of the Children's Village on the site, have all contributed to the lack of information. Sufficient archaeological evidence remains to indicate that the Oaklands site had a spatially defined *territorium* relating to the distribution of surrounding contemporary industrial sites. Chitcombe is only 4 km to the NE, Footlands 3 km to the NW, while Beauport Park, the largest of the Wealden industrial sites, is located 3 km to the south. In addition, encroachment to the SE would have been prevented by the Icklesham coastal sites.

BEAUPORT PARK

The largest Wealden industrial-class iron production centre, at Beauport Park (TQ 786146), is located beneath golf course and parkland, and covers at least 8 ha. The site is situated on Wadhurst Clay, to the east of three fault lines, near a junction with the Ashdown Sand. Evidence for iron production was first recorded by the Reverend S. Arnott (1869: 138) who noted the presence of the "large cinder bank", although no dating evidence was recorded. The deposit was utilised for the provision of road metalling by Mr. Byner, the County Highways Surveyor. Slag was extracted from the deposit for over a decade, from 1870 (Brodribb 1972: 4, Rock 1879, Straker 1931: 330). During this extraction the Romano-British origins of the site came to light with the discovery of Romano-British ceramics, coins and inhumation burials, which suggested a date range between the later first and the early third centuries (Brodribb and Cleere 1988: 243). The deposit was removed at a rate of 2,000-3,000m^3 a year, which could equate to production of 30,000 tonnes of bloom iron. The site was visited by Herbert Blackman, with Mr. Grinstead, in 1917, which led Blackman to suggest that "a great deal of cinder still remains under the present site" (Blackman: unpublished, Brodribb 1972). Beauport Park was revisited by the men in October 1924, who undertook some limited trial trenching.

The site lies on a NE-facing slope above a small stream centred at TQ 7870 1450. The slag deposits are limited on the north and east sides by small streams, and Cleere suggests an area of 6,223 m^3, or 1.54 acres. Stone foundations were recovered in 1969 at TQ 7867 1445 (Brodribb 1969b), which proved on excavation to be the remains of a well preserved Roman military-style bathhouse buried by a landslide from the adjacent slag deposit. Several of the walls retained a height of 1.5 m. Finds included a 'chimney Pot' (Brodribb 1977: 314, Plate LVa) and *tegulae mammatae* laid on the floor (Brodribb 1979b). The bath-house witnessed two phases of occupation and abandonment. A civilian official (*vilicus*) gave the orders for its reconstruction, possibly when Septimius Severus restored the British province after the revolt of Albinus c. A.D. 200. It has been suggested that the ironworks ceased production at this time (Brodribb 1981: 178).

As with Bardown, Beauport revealed a dichotomy within the settlement, suggesting the presence of a purely industrial area on the west side of the stream, under the present golf course, with concentrations of smelting furnaces and evidence for ore roasting nearby, and a residential/ domestic area to the east.

Waterlogged deposits near the bath-house revealed evidence of "oak shingle, stakes of alder, pieces of willow" (Brodribb and Cleere 1988: 238). In addition, from an early period of pre-bath-house occupation, a tongued-and-grooved wooden water tank made from oak planks, and covered by a section of tree trunk (2.6 m long, 1.2 m wide and 0.2 m thick) was recovered (*ibid.*: 236-8, Fig. 6). This attests to the availability of large timber at an early date.

Large fragments of five different leather shoes from the waterlogged deposits were considered "more likely to have been worn by women or adolescents than adult men" (Brodribb and Cleere 1988: 265). Unfortunately evidence of two children's footprints from the 12.8 tons of tile (*ibid.*: 269) cannot corroborate this as petrological analysis of tiles from the bath house suggest that they were not made locally.

Analysis of the bone assemblage (n = 344) by M. Harman suggested that despite the low numbers, it appeared indicative of a "wooded environment rather than large areas of pasture" (Harman 1988). This was possibly a function of the high occurrence of red deer bones (n = 49) for such a small assemblage.

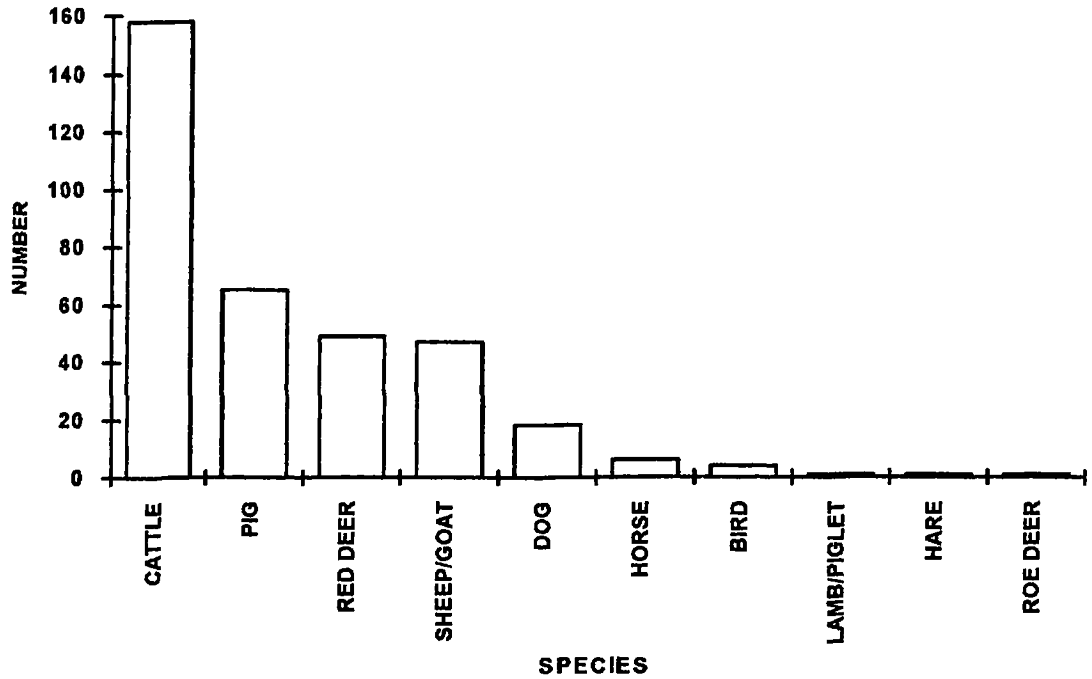


Fig 6. 34 The faunal assemblage recovered from Beauport Park (Data from: Harman 1988)

The ceramic assemblage from the bath-house area, based on percentage by weight, was dominated by East Sussex Wealden wares (73%), amphorae (9%), grey wares (5%), samian (5%), mortaria (4%), and others (4%). Although this dominance is characteristic of many industrial sites in the eastern High Wealden region, and is probably a function of the proximity of the source of the ceramics in the Hastings area, it does have other economic implications, such as the proximity of the production sites to the industrial centres.

Although this was certainly the largest known iron production site in the Weald, by the beginning of the second century it was surrounded by other industrial sites operating contemporaneously. The Crowhurst Park complex located 2 km to the SW, with Oaklands 3 km to the north, and the coastal sites of the Guestling 5 km to the W. These sites help to define the boundaries of the Beauport complex.

CROWHURST PARK

The Crowhurst Park industrial complex (TQ 7749 1273) is located approximately 200m east of Park Farm, on an outcrop of Ashdown Sand surrounded by Wadhurst Clay. Evidence for iron production was first recorded by Straker (1931: 353), who noted the presence of a "considerable bloomery of Roman type", although no dating evidence was recovered. Prompted by this discovery, several trenches were cut by B. H. Lucas in 1936-7, at TQ 7748 1273. These revealed extensive material culture including samian sherds ranging between *circa* A.D. 70-120, and Romano-British coarse wares from between *circa* A.D. 80-120. These were found in conjunction with fragments of very large amphorae. In addition *La Tène* ceramics and East Belgic wares considered to derive from the beginning of the first century were also recovered, suggesting a LPRIA origin for the industrial complex. Sherds of second-century samian were recovered from the surface of a ploughed field to the north of the site. From the available assemblage it appears unlikely that the site was in operation after the end of the second century. The overall composition of the assemblage was East Belgic (10%), East Sussex Wealden wares (10%) and Roman wares (80%). The low percentage of East Sussex Wealden wares so close to their possible sites of origin, in the Hastings hinterland, is unusual when compared, for example, with the 73% dominance of East Sussex wares at Beauport Park only 2 km to the NE. The possibility has to be addressed that the assemblage could be biased by taphonomic factors; the dark colourings of some east Sussex wares could render them difficult to detect, compared to samian or grey wares, in heavily charcoal-impregnated soil. Evidence for industrial activity came in the form of three fragments of *tuyères* (Straker and Lucas 1938). The ore appears to have derived from an extensive cutting above the site.

Analysis of an unknown number of charcoal fragments from the site, by L. A. Boodle from the Royal Botanical Gardens at Kew, resulted in the identification of oak and ash. The oak was designated as having derived from larger wood (Straker 1931: 110).

FOREWOOD

The Romano-British semi-industrial site at Forewood (TQ 751130) is located approximately 950 m west of Crowhurst Station. The bloomery is located on Wadhurst Clay at its junction with a cap of Tunbridge Wells Sand to the south. Evidence for industrial activity is located for approximately 100 m along the western boundary of a 9 m deep north-west gill which provided the eastern boundary of the site. The evidence for iron production extends for approximately 30 m in a westerly direction, and the boundary equates approximately with the position of the modern trackway, beyond which little evidence of occupation can be found. The *raison d'être* for the location of the site appears to be its position on the east-west junction of the Wadhurst Clay and Ashdown Sand. The section eroded by the deep gill would have revealed the ore stratum which undoubtedly sustained the site.

Evidence for iron production in Forewood was first recorded by Straker (1931: 351), who noted the presence of an "extensive bloomery of Roman type", although no dating evidence was forthcoming to corroborate this. The absence of a reliable date prompted the WIRG to cut four exploratory trial trenches in October 1991 (Herbert 1992: 8) and January 1993, in conjunction with the author (Hodgkinson 1993). The later explorations in the slag deposit produced a single sherd of East Sussex ware which was grog-tempered and contained flint inclusions, suggestive of a date in the first two centuries (*ibid.*).

The trial trenches suggested that the southern part of the site was associated with the actual production of iron, as a result of the absence of discrete slag deposits, and the presence of quantities of roasted ore sievings and ore nodules (Herbert 1992: 9). This was further corroborated by the recovery of heavily-burnt clay suggestive of the presence of a smelting furnace (Hodgkinson 1993). This could indicate the presence of an area of the site associated with bloom-smithing or black-smithing. The northern part of the site comprised a slag deposit of considerable depth. Excavation in 1991 was halted at a depth of 0.7 m, while in January 1993 the excavations reached 1.0 m, but probing through the base of the trench suggested that the deposit was certainly deeper than 1.7 m. The deposit was heavily pitted, which probably resulted from the removal of slag for the metalling of trackways in the Forewood area, of which there are a large number. The depth of some of the pits has led Cleere to suggest that some could be back-filled ore pits (Cleere and Crossley 1985: 297). In addition, some disruption could have been caused by previous archaeological excavations.

Straker recovered a lump of impure iron (1931: 352) which, after analysis, was revealed to be an unworked bloom (Brown 1964). Explorations in the slag deposit during January 1992 revealed what appeared to be the remains of another unworked bloom.

The two trial trenches opened by the WIRG in January 1992 were sampled by the author for charcoalified remains. The southernmost trench beyond the bound of the slag deposit, in the suspected working area, did not penetrate too deeply, due to the recovery of evidence of heavily-burnt clay, which was interpreted as being the remains of a furnace or hearth base. The charcoal recovered from this context is therefore of dubious stratigraphical origin. However, the 17 fragments that were recovered appeared to comprise a homogenous sample of comparatively large oak fragments, which exhibited complete and incomplete growth-ring structures of 8 to 21 years, on examples with abraded outer horizons. The larger size of these fragments was a direct result of the favourable depositional environment.

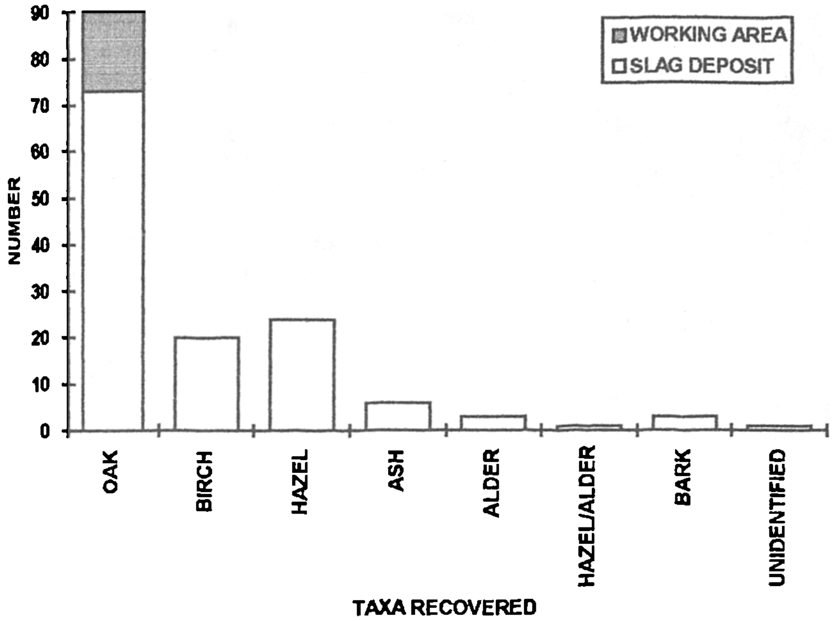


Fig 6. 35 The taxa recovered from the slag deposit, and working area, at Forewood.

The sample from the trial trench in the slag deposit was comprised of much smaller samples, characteristic of the attrition in the slag matrix. Little data relating to age profiles could be attributed to the sample, other than one complete fragment which was 13 years of age and was cut during the growing season of the tree. The taxa composition was dominated by oak (n = 73) while birch, characteristically for this region, was also well represented (n = 20). Other species such as hazel (n = 10), ash (n = 6), alder (n = 3), and 3 of indeterminate bark were also represented. As a result of the charcoal-impregnated nature of the slag matrix, no meaningful stratigraphy was evident in the section, so it was impossible to ascertain how the slag deposit had been built up. There was, however, a noticeable absence of the horizons of yellow clay, which are usually indicative of industrial operations. This could confirm Cleere's hypothesis that these horizons represent a phenomenon related to sealing deposits for hygiene purposes, as this site was probably a satellite of Crowhurst Park, and as a result would have little accumulation of domestic rubbish and no settlements that would be affected by deposition if there were.

Despite much previous robbing, the size and depth of the slag in Forewood still represents a significant and coherent deposit. The volume would have been much the same as the satellite site at Holbeanwood. Certainly the proximity of the industrial complex at Crowhurst Park and their apparently contemporaneous operations suggests a link.

BYNES FARM

The bloomery site at Bynes Farm (TQ 758110) is located approximately 250 m east of the farmhouse from which it gets its name. The site is located on a SW facing slope above the high water level of the postulated tidal estuary. The geology is Wadhurst clay, over looking a belt of Ashdown Sand, which descends to the alluvium of the valley floor. Evidence for industrial activity was first recorded by Straker (1931: 358), who noted that ploughing had scattered cinder over a large area. However, the apparent depth of the slag deposit beneath the ground surface prevented the acquisition of dating evidence. As a result of this information, excavation was undertaken in May 1949 by Barry H. Lucas. A small quantity of cinder had been removed for metalling. The remaining shallow pit in the deposit was used by Lucas as the focus for a trench 1.35 m deep and 3.60 m wide (TQ 7541 1079). The section revealed a characteristic stratigraphy about 15 cm below the actual ground surface, comprising an uppermost horizon of 45 cm of cinder, charcoal and other debris, which overlaid 20 cm of sandy clay. This in turn overlaid another 45 cm of cinder and debris, which covered a thin layer of sandy clay above the ground surface (Lucas 1950a: 17). This resembled the stratigraphy found at Crowhurst Park 2 km to the NE.

The ceramic evidence recovered was characteristically dominated by local coarse wares (n = 8), a fragment of a samian cup (form 27), grey ware, and a rough-cast pot with metallic brown coating, all indicating a date within the later first century and early second century (*ibid.*: 18). The ore appeared to derive from four pits, the two largest being located 0.5 km to the NE of the production area (*ibid.*: 19). Although it is difficult to link mine pits with bloomery sites, the evidence of the large pits would account for the relatively substantial nature of the bloomery site which has been revealed in the past by ploughing. The stratigraphy described by Lucas (*ibid.*: 17) in the cinder bank, also suggests a semi-industrial operation. It could be an outlier of the Crowhurst Park complex.

PEPPERING-EYE FARM

The iron production site at Peppering-Eye Farm (TQ 744139) is located immediately beneath the farmhouse, its garden and associated farm buildings. Evidence for iron production was first discovered in 1925 by Herbert Blackman, whilst digging a cesspool in the garden to the north of Old Peppering-Eye farmhouse, on the east of the farm road. This was recorded by Straker (1931: 351), who noted that a section was cut through "a solid bed of cinder about 3 feet in thickness, which was covered by 3 feet of garden soil". Dating evidence, in the form of "a small fragment of samian" embedded in a piece of vitrified brick, was recovered by Straker, whilst visiting the site at a later date. No other dating evidence has been recovered.

The depth below the surface of the iron slag suggests the deposition of much colluvium from the overlooking slopes. Because of this, the extent of the site is difficult to determine. This is further aggravated by the extensive area covered by the farmhouse, its associated cottage and farm buildings, and concrete roadways. However, the morphology of the surrounding streams and tributaries, to the north and south, appears to have contained the area of smelting and slag deposition. From the presence of bloomery slag in the topsoil of the gardens of the farm house and cottage, it would appear that Peppering-Eye is of similar extent to Forewood.

The depth of slag, in conjunction with its probable extent, suggesting a semi-industrial site, have led Cleere (1975: 198, Cleere and Crossley 1985: 295) to postulate that Peppering-Eye is a possible outlier of the Crowhurst Park complex which is situated 3 km to the south-east.

An exposure of slag from the stream bank at TQ 7443 1391 produced a limited number of charcoal fragments, including oak (n = 12), birch (n = 5), hazel n = 1), *Pomoideae* (n = 1) and alder (n = 1). All the samples were too fragmented to provide evidence of seasonality and age. The oak domination is characteristic, but the limited number of samples from a semi-industrial class site does not provide a statistically valid sample. The species composition appears similar to that from Forewood, another apparent satellite of Crowhurst Park.

PETLEY WOOD

The ore-mining and processing centre at Petley Wood (TQ 7635 1753) is located approximately 900 m ESE of Riglett's Farm. The site is on Ashdown Sand with a small cap of Wadhurst Clay to the east; the river Brede runs to the NE. Two faults are found to the west of the site. The apparent absence, during excavations, of any form of evidence of smelting, such as tap slag or cinder, has led to the hypothesis that the operations on the site were solely associated with ore mining and pre-treatment.

Excavation by the Battle and District Historical Society during 1952 resulted in the cutting of a trial trench approximately 1 x 12 m through an artificial mound in the otherwise heavily-pitted central sector of the wood. The uppermost horizon was a 25 cm cap of blue clay, overlaying 30-45 cm of dark reddish brown ashes. A layer of yellow clay 3 cm thick separated this from 45 cm of charcoal ashes, unconsumed charcoal, and partially burnt and fused ore. This appeared to rest on a rough floor of large or nodule in clay which had been burnt red. This was stabilised by a lower horizon of burnt ore the size of metalling. The recovery of an unused heap of roasted ore 4 m^2 and 55 cm high suggested that this was the product of the site, awaiting movement to an undetermined smelting site. In this context the presence of the industrial complex at Crowhurst Park to the SE could be significant. However, field research by the Royal Commission in January 1973 recorded the presence of a 20 m diameter concentration of bloomery slag and burnt ore centred at TQ 7635 1754 (NAR TQ 71 NE 3). Although no dating evidence was recovered, this could have been one of the bloomery sites supplied by the Petley Wood processing centre.

Extensive evidence of Romano-British ceramics from the second and early third century was recovered (n = 147). Of the 147 sherds recovered, five were of inferior samian, five were of New Forest ware which is suggestive of a post A.D. 270 date, while the remainder were of the local East Sussex Wealden wares, which achieve their characteristic dominance (Lemmon 1952: 28).

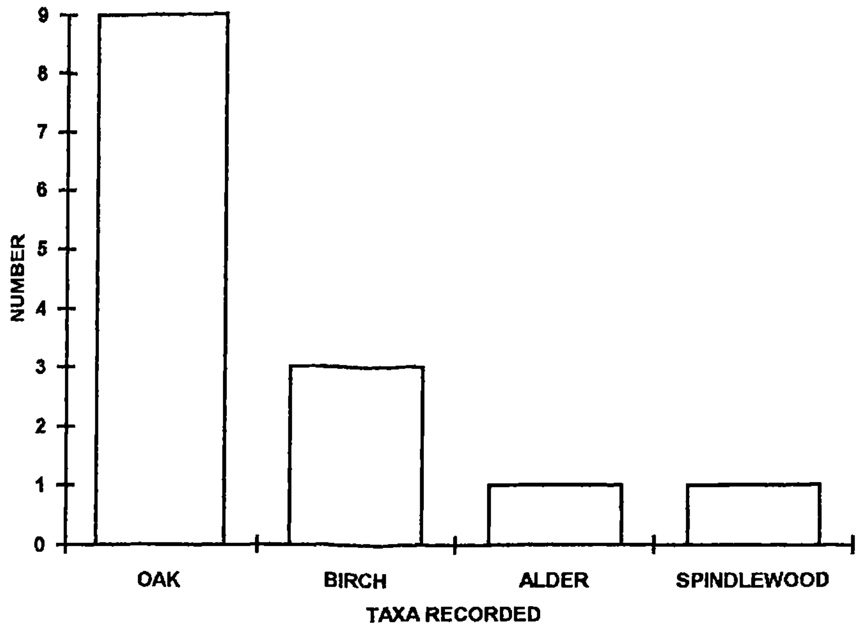


Fig 6. 36 The charcoal assemblage recovered from Petley Wood (data from: Lemmon 1952)

The charcoal from layer 4 was identified by Sir Edward Salisbury of the Royal Botanical Gardens, Kew, who recorded the presence of nine fragments of oak (64%), three fragments of birch (22%), one fragment of alder (7%) and one fragment of spindlewood (7%). The dominance of oak and birch is characteristic, as is the low ratio of alder - this is the first fragment identified in a Romano-British iron production context in the Weald. This probably indicates the exploitation of a damper environment. The record of spindlewood is extremely rare in the Wealden context, although it has been recovered from an iron production context at Woolaston in the Forest of Dean (Fulford and Allen 1992). Spindlewood is an indigenous taxa of calcareous soils.

OLD PLACE FARM

The bloomery site at Old Place Farm (TQ 878165) is located approximately 100 m NW of Icklesham Church. The site is on a ridge of Ashdown Sand, capped with Wadhurst Clay to the south and overlooking the Brede valley to the north. The presence of Romano-British industrial activity was first recorded by Homan (1937: 247) after extraction of building sand at Icklesham in 1936-7 revealed the presence of six bloomery furnaces. However, the data obtained and published by Homan was recovered only after the site was destroyed. The finds from the site included "a clay *tuyère* 5.5 inches long and 7/8 of an inch diameter, bell mouthed at one end.....a sherd of Belgic pottery and a *denarius* of Hadrian" (AD. 117-138) which appeared to have been exposed to considerable heat (*ibid.*).

The presence of a Belgic ware on the site suggests LPRIA activity in the vicinity, however, in the light of the later finds of Romano-British ceramics and the absence of the finds from the 1937 archive, the possibility that the "Belgic ware" could have been a south-eastern ware or East Sussex Wealden ware must be addressed.

The site plan from Icklesham (Homan 1937: 247) reveals the remains of the six furnaces set in a depression surrounded by a "wall of hard sandstone", with the furnaces located around the circumference. The furnaces consisted of "funnel shaped or bowl shaped excavations in the sub-soil and penetrated a short distance into the sand rock." The maximum output from the six furnaces could have been considerable considering the comparable evidence from a six furnace unit at

Holbeanwood, but, the remaining slag bank was not substantial. It appears that the slag was used for the metalling of roads in the surrounding iron-working complexes.

Further finds of burnt clay, in 1978, immediately to the south of the quarry at Old Place Farm, prompted trial trenching by the Hastings Area Archaeological Group. The excavation, under the direction of Mrs. Zoë Vahey, resulted in the exposure of an ore-roasting hearth situated in a bed of slag. A second trench, adjacent to the 1978 excavation, opened in 1981, revealed a slag-metalled road, approximately 6.7 m wide, with steep cambers running slightly north of east. A ditch on the north side of the road cut into the sandstone bedrock. Romano-British ceramics were recovered both on the road surface and from the fill of the ditch (Cleere and Crossley 1985: 301, Rankov 1982: 392).

GREAT WARREN FIELD

The bloomery site at Great Warren Field (TQ 858121) is located on Ashdown Sand, near its junction with the Fairlight Clay to the south. A scatter of bloomery slag is located opposite Great Warren Field (TQ 858121), in association with Romano-British ceramics of the second century (Woodcock 1988: 180). These compare with the ceramics found in Great Warren Field at TQ 857117, which were found in association with a coin of Vespasian (A.D. 69-79)

CHURCH FIELD

The iron production site at Church Field (TQ 881165) is located on a ridge of Ashdown Sand, capped with Wadhurst Clay to the south and overlooking the Brede valley to the north. Evidence for iron production was first recovered in 1986 during HAARG field exploration of the region.

An extensive scatter of slag, cinder, and furnace material was found in conjunction with Romano-British ceramics of the first and second centuries, and tile (Woodcock 1988: 179). This implies the presence of a semi-permanent building in the vicinity, perhaps to house the furnaces, the iron workers, or the administrators.

LOWER CRUTCHES

The bloomery scatter at Lower Crutches (TQ 889170), is located on the lower slopes of a ridge of Ashdown Sand, where it overlooks the alluvium of the Brede Valley to the north. Field research by the HAARG revealed limited evidence of a small, discrete deposit of tap slag and cinder found in association with Romano-British ceramics of the later first and early second centuries.

CHURCH FARM FIELD

The production site at Church Farm Field (TQ 856145) is located on Ashdown Sand with a fault expressing the junction with the Fairlight Clay to the south and east. An extensive deposit of slag is evident, in association with Romano-British ceramics of the second century and tile. This could imply the presence of a semi-permanent building in the vicinity.

GODLEYS FIELD

The iron production site at Godleys Field (TQ 878144) is found on Ashdown Sand. Field research by the HAARG recovered tap slag in association with Romano-British ceramics, of the first and second centuries.

HOLLOW FIELD

The bloomery site in Hollow Field (TQ 883139) is located on Ashdown Sand. Tap slag was found in conjunction with Romano-British ceramics during field research by the HAARG in 1986.

PETT BARN

The iron production site at Pett Barn (TQ 883147) is located on a ridge of Ashdown Sand. An extensive scatter of slag revealed in the plough soil, in association with first and second century Romano-British ceramics and tile, suggested the presence of a semi-permanent building. Additional Romano-British ceramics of comparable date were recovered from Pannel Banks at TQ 883149. This attests to major activity in the area.

PETT BARN 40 ACRES

Iron production at Pett Barn 40 Acres (TQ 892146) is located on a ridge of Ashdown Sand which extends into the western periphery of Pett Level. An extensive scatter of slag was revealed in the plough soil at 40 Acres Field, Pett Barn. It was found in association with first and second century Romano-British ceramics and tile, which suggest the presence of a semi-permanent building. This correlates with the discoveries from Pett Barn, implying significant Romano-British activity associated with iron production in this area.

PRIMROSE DELL

Iron production at Primrose Dell (TQ 886140) is located on Ashdown Sand. An extensive scatter of slag revealed in the plough soil, found in association with first and second century Romano-British ceramics and tile.

TONGS FIELD

Iron production at Tongs Field (TQ 885128) is located on Ashdown Sand, where a discrete deposit of Romano-British ceramics and tap-slag was reported. Pottery was also located at TQ 885138 in Upper Church Field.

THE IRON INDUSTRY OF
THE EASTERN HIGH WEALD

Previous studies of the Romano-British iron industry in the eastern High Weald have concentrated on the massive density of industrial-class facilities in the Hastings hinterland, around Sedlescombe. The presence of five of the largest industrial sites in the country, from the first two centuries of Roman occupation, has acted as a natural focus for fieldwork and research. However, research by the Hastings and District Archaeological group since 1972, has revealed that the distribution of smaller scale iron production sites continues to the south-east of these industrial sites, into the coastal parishes of Icklesham, Pett, Guestling and Fairlight. The methods of exploitation in these two areas apparently differ.

THE COASTAL SITES

The earliest evidence for Roman iron production in the eastern High Weald came from the industrial-class operations at Oaklands, Beauport Park and Chitcombe, in the nineteenth century. However, another small scale, non-industrial bloomery site had been recovered at Blacklands Farm, prior to the extension of the Hastings suburb of Ore (Anon. 1862, Straker 1931: 350). This provided the first evidence of another group of iron production facilities to the SE of Margary's route 13. This was followed 75 years later by the recovery, after quarrying, of a six furnace production site at Old Place Farm (Homan 1937). This was later revealed to be part of larger semi-industrial complex at Carter's Farm. As early as 1975 Cleere (1975: 195) postulated that the discoveries of undated bloomeries by Straker (1931: 339-41) and other sites such as Old Place Farm in conjunction with the provenancing of the clay utilised in the production of some CLBR tiles, could indicate this coastal region as forming part of an "as yet not fully identified group of sites".

The growth of the urban centre at Hastings has certainly destroyed any evidence for the continuation of the coastal sites in a westerly direction. The presence of the possible bloomery site at Blacklands (Anon. 1862, Straker 1931: 350), implies the continuation of the iron production sites seem in the surrounding parishes of Pett, Guestling and Fairlight. In addition to the evidence of bloomery sites, limited evidence of Romano-British activity has been recorded at Hastings Park (Moore 1974).

The iron production sites are generally small-scale or semi-industrial, and are densely located; however, this is predominantly the result of the intensive program of fieldwork adopted by the Hastings and District Archaeological Research Group. There is also limited evidence for agriculture in the area, as revealed by the presence Romano-British ceramics in a lynchet outside Hastings (Rudling 1982), and the presence of cereal pollen in a sealed horizon of Romano-British iron slag at Ludley Farm.

The presence of contemporaneous agricultural activity in the vicinity of the iron production sites of the Hastings hinterland could be the result of limited agriculture needed to sustain the iron production sites themselves or it could represent unrelated agriculture practised by the local or indigenous populations. Agriculture appears to be small scale which could imply limited activity to supplement staples brought along imperial supply lines.

The distribution of small bloomery sites in the parishes of both Icklesham and Pett extends eastwards and ceases only when the sandstone and clays of the High Weald descend into Pett and Brede Levels which would have formed a tidal inlet during the Romano-British era. Here a radical change in the environment would have occurred as the oak-dominated vegetation of the High Weald would have changed to the alder carr and *Salicaceae*-dominated arboreal vegetation of the marshland. Iron production was unlikely to have occurred in this environment as a result of the absence or concealment of ore sources and the instability of the environment, although light fuel-consumptive industries such as salt production certainly did occur.

The whole question of the exploitation of the eastern Wealden iron resources, during the first half of the Roman occupation, is intimately bound with the waterborne transport which could be provided by the tidal lagoon now occupied by Romney Marsh. Extensive research into the marsh by Cunliffe (1980, 1988) and Green, R. D. (1968) has resulted in a hypothetical model for the development of the marsh during the Romano-British era. Green's soil survey work has resulted in the classification of two major marshland types based on the degree of calcium retention. The degree of decalcification has been tentatively interpreted as a chronological indicator, with the older alluvium represented by decalcified material and more recent deposition represented by calcified marshland (Cunliffe 1980: 43). The distribution of these dichotomous marshland types, in conjunction with archaeological evidence for Iron Age and Romano-British activity in the Marsh appears to indicate that during the Roman occupation the three Wealden rivers which now have their outlet at Rye, appear to have converged in a plethora of creeks which lead into a wide estuary (*ibid.*: Fig 19). However, although the general nature of this tidal estuary has been established, with one and a half millennia of subsequent alluvial deposition in the marshland region, the details have not.

It is conceivable that the eastern Wealden sites extend to the north of Romney Marsh and continue across to the Lympne hinterland where the *Classis* fort commanded the mouth of the postulated Romney Marsh tidal lagoon (Cunliffe 1988: 84, Fig 6.1). The presence of undated, relatively large-scale activity at Stelling Minnis, with a primary slag scatter extending over 200 m in length, suggests activity in the Lympne hinterland, although the date of these production sites remain enigmatic. The presence of semi-industrial and non-industrial class iron production sites at Smarden and Coldharbour Farm, suggests the presence of an as yet undisclosed group of sites within the triangle of land bounded by routes 13, 130 and 131. The presence of viable ore sources in the High Weald and clay ironstone seams on the Weald Clay could have provided a source of ore to sustain these hypothetical production sites.

Margary (1946b: 51-56) suggests two branch routes off route 130, terminated at a point north of Rolvenden Station, which would have been on one of the channels leading to the Romney estuary. One is represented by traces of an *agger*, numerous pits and a line of hedgerows (*ibid.*: 51). At Brown's Corner Margary (*ibid.*: 56) suggests that the hollow way in Chennell Park is a north-eastern connection to the estuary, although no archaeological research has been carried out to validate these hypotheses. The south eastern alignment of these short roads suggests that they were used for the movement of material between the High Weald and Romney Marsh. The need for a road or port installation for any other reason at this point on route 130 is questionable. It is probable that these sites would have been served by either wharves or small ports, although the deposition of alluvium which has created the contemporary marshland landscape is not conducive to the recovery of such sites. These would facilitate the transportation of material such as bloom iron derived from production sites, in conjunction with essential supplies destined for these sites, such as Imperial supplies, along with the products of the Marsh, such as salt and animal products. This could correlate with the location of the *Classis Britannica* iron production site at Little Farningham Farm, at a nodal point 100 meters to the east of Margary's route 13, and south of route 130 which is suggestive of a function associated with transport. The presence of iron production on the site does not appear to be the *raison d'être* for the construction of the *Classis Britannica* building. In the Wealden region the association of *Classis* material culture such as tiles has a tendency to be associated with industrial-class iron production, sites such as Beauport Park and Bardown, or transportation and administrative sites such as Bodiam, Lympne or Folkestone. The scale of iron production at Little Farningham Farm, although possibly considerable, is not comparable to industrial-class exploitation, which suggests the sites focus was towards, administration, redistribution and transport.

However, Margary proposes that routes 13 and 130 were constructed during the second or third decade of the third century (Cleere and Crossley 1985: 64) just prior to the collapse of both the iron industry and fleet control in the region. However, absolutely no dating evidence exists for the construction of the roads; the early third century date proposed by Margary for route 130 and 131 relates to the imperfection of their alignments (Cleere and Crossley 1985: 62). It is quite conceivable that the coastal route 130 was a phenomenon of the late second century when there was a need to provide an outlet for the hypothetical eastern Wealden production centres. The *Classis Britannica* tiles from the Little

Farningham Farm site derive from a late second century context, which implies an extension of the fleet's interest in transport in this area during that period.

The distribution of bloomery sites ceases at the suburbs of Hastings, where urban development in the last century has obliterated all traces of Roman iron production. Where intensive archaeological research has been undertaken in Hastings Park, no evidence of the physical smelting of iron has been recovered; however, evidence for Romano-British activity has been recovered. Research by Moore (1974: 168-9) suggests that an early second century hut site existed at Covehurst Wood in Hastings Park, although little evidence for iron production, of any period, was recovered from the town of Hastings. This can be corroborated with limited archaeological discoveries from Hastings itself where coin evidence suggests limited-scale activity throughout the Romano-British era.

To the west of Hastings the distribution of bloomery sites does not resume; this could indicate the actual diminishment of iron extraction on this western coastal stretch, or more probably it could be a function of the absence of fieldwork in this area. It would seem unlikely that iron would not have been exploited to some degree in this region during the Romano-British era, as there are certainly ore sources and the tidal inlets of the Channel coast would provide a ready source of transport for the shipment of materials. Prior to the onset of eastward or longshore drift the coastline would have been considerably more viable for the use of shipping than that exhibited today.

The products of the Eastern Wealden industrial-class facilities were ultimately destined for both military and civilian markets. The most viable example of this is provided by the location of route 130, which extends from Hempsted Junction, near Little Farningham Farm, and ultimately terminates at Canterbury. This alignment is important; a significant investment of resources would have been required to construct a 85 km stretch of road. Yet this road would have had little use for the population of Canterbury, and the two major population centres on the Wealden fringes at Lympne and Rochester were well provided with direct and shorter road links from Canterbury. The only *justification* for such a road link would have been the provision of a overland transportation link from the industrial iron production centres of the eastern Weald to the urban markets at Canterbury and its prosperous hinterland in the south-east and beyond.

The exploitation of the environment in the eastern High Weald can be considered to represent an gradual adaptation to the heavy fuel consumptive industries. Prior to the invasion there was activity in the Eastern High Weald, which was manifested in the recovery of pre-Roman round houses beneath the bathhouse at Beauport Park and the finds of pre-Roman ceramic forms at Footlands. It is unclear if these finds indicate iron production or settlement activity; however, the presence of either would result in the gradual pre-adaptation of the environment for heavy industry. The settlements would have probably required managed woodland for their construction and maintenance. The fuel needs of the settlements would have resulted in the cutting of wood, which could have regrown, or caused limited degradation on the sandy lithologies, or been converted to arable land.

The Roman invasion would have resulted in the eventual conversion of these coastal production sites to Roman control. The exact method by which this was achieved remains unclear. However, the extremely limited evidence for the precursive Roman industries in the eastern High Weald implies a gradual expansion of production rather than a massive *increase*.

The road alignments at the Footlands site, located between the hypothetical port at Bodiam and the iron production sites at Sedlescombe, are instructive. It appears that the original location of Margary's route 13 ran past the iron production site on the eastern side of the river, as indicated by the recovery of an agger and a metalled road by the Battle and District Historical Society (Lemmon 1951, Hodgkinson 1987: Fig 2). The alignment of the two roads has led Hodgkinson (*ibid.*) to suggest that the original road was built through the iron production site, which was diverted at a later date. The implications of this are significant. Initially the production site was of such a size as to attract the attention of the road builders, but its size was not sufficient to interfere with traffic on the road. This could indicate the gradual development from Iron Age output, to semi-industrial activity, and finally the development of industrial-class output probably in the Hadrianic era.

THE OUTPUT OF THE EASTERN HIGH WEALD

Cleere suggest that the output of the six major industrial-class facilities in the Eastern High Weald would have been somewhere in the order of 550 tonnes per annum. This is based on his estimation of the slag volume of the sites and the extrapolation of the weight of iron produced to 99,500 tonnes (Cleere 1976a: Table 1). From these figure the hypothesis has been forwarded that this volume of iron could not have been absorbed by the British military, and if it was not released onto the civilian markets it is probable that it was exported to the European mainland, such as the Rhineland *Limes*. Certainly the seaborne exportation of other metalliferous products of the British province is long attested, such as the discovery of a wreck containing British pigs of lead on the coast of Brittany, in addition to Pliny's comments on the size of the British lead exports.

The apparent evidence for exportation of British iron is based on the volume of iron produced on the industrial-class sites, as estimated by the remaining volumes of slag deposits. However, while the *gross* output from these sites was undoubtedly massive, the actual *nett* gain by consumers could have been somewhat lower. Figures extrapolated from slag volumes represent an estimation of the quantity of bloom iron produced: this does not equate directly to the actual weight of usable iron that was finally available to the consumers, whether of military or civilian origin.

The actual weight of iron produced can be reduced firstly at the point of origin. Modification of the weights of iron produced can start at the slag deposits. The output of Footlands can be reduced from 15,000 tonnes, while Oaklands can be reduced from 20,000 to 15,000 tones (see above). The actual output from the eastern High Wealden industrial-class sites can be therefore, be reduced by at least 10,000 tonnes.

The iron produced as a result of the bloomery process is not sufficiently pure for the manufacture of artefacts. The inclusion of slag within the body of the bloom requires removal. This primary product has to be consolidated, during the process of bloom-smithing, which would result in a decrease in weight. Research by David Sim suggests that bloom-smithing can result in a weight reduction of 16-20% in blooms of high quality ores, or 20-25% in blooms of moderate to poor quality ore (David Sim *pers. comm.*). The Wealden ore would fit into the category of moderate quality, so a possible loss of 20% could be hypothesised.

The process of consolidation results in a semi-pure iron product. This is still insufficient for the production of most tools and implements, as a result of the integral slag, which would cause weaknesses in any materials produced from the bloom. The process of blacksmithing will result in the further expulsion of slag in the form of hammer scale. The quantity of material that is lost can vary considerably, depending on the nature of the products manufactured. If only a little work is required to modify the bloom then losses of 20% have been suggested

(David Sim *pers. comm.*). However, the increase in complexity of the manufacturing process can result in considerable loss of material. The more work required, the greater the loss of the consolidated bloom. Activities such as fire welding can reduce the weight by 50%, while filing and polishing can result in a reduction of up to 20%. The overall loss of material from this stage could be in the region of 25%. This would again reduce the quantity of iron available to the consumer.

The volume of iron produced can further be reduced by losses between the site of production and consumption. This can be divided into accidental and deliberate loss. There is extensive evidence from across Britain from the lead production industry that pigs of lead were stolen during transit, as indicated by the recovery of large numbers, buried in contexts near Roman roads (Tylecote 1986: Fig. 29). This is only evident because of the high archaeological visibility of Roman lead pigs in the archaeological record. Iron from the major production sites in the eastern High Wealden ironfields appears to have been transported in the form of consolidated blooms as indicated by the recovery of blooms during excavations at Little Farningham Farm and Forewood (Brown 1964). In contrast to chemically-inert lead pigs, with their highly visible stamps, Roman iron blooms are almost completely invisible in the archaeological record outside of archaeological excavations. In addition blooms are more vulnerable to chemical attrition, or oxidation, in the soil than many materials. The recorded examples of blooms from the Weald (*ibid.*) were easily transportable, which could have implications for the attractiveness for theft. Tylecote (1986: 68) recorded that there is a direct relationship between the size of such items and their viability for theft; a contemporary American lead processing plant increased the size of ingots from 50 kg to 4 tonnes, to reduce loss during transit. Small items such as blooms are therefore highly assessable to both opportunist and premeditated theft and pilfering. There is literary evidence that theft associated with Roman mining and production sites was a problem. The *Lex Metalli Vipascensis* of the Aljustrel Tablets (CIL II 5181), which dealt with the imperial exploitation of Spanish silver and copper ores, records the penalties which were applicable for the theft of ore (Edmonson 1987). It is probable that if theft was encountered at the primary level of ore extraction then such activities would have been evident at all stages of the metal production process, especially of larger-scale operations.

Accidental loss could be a function of shipwreck, considering the apparently marine orientation of the eastern Wealden sites, or in some cases military activity. Such losses resulting from pilfering are more likely to be applicable to industrial and semi-industrial class sites; where larger numbers of people are involved, there is long-distance transportation of semi-finished products and sufficient bureaucracy and output to absorb such losses. On non-industrial and domestic-scale operations the lower number of people involved and the lower output would make pilfering a high-visibility activity. The total loss resulting from these various depredations could easily account for 40% ± 10% of the iron produced in the eastern High Weald.

THE WIDER ENVIRONMENT

What is significant is the evidence from alluvial pollen sequences from the Pannel Valley, which sustained the coastal sites of Pett, Icklesham, Guestling and Fairlight, suggests that the historical period witnessed a regeneration of woodland cover rather than a decrease, which might be expected if the clear-cutting and subsequent deforestation was evident (cf. Cleere 1976a: 241). This can be further corroborated by the evidence obtained by Smyth and Jennings (1988) from alluvial pollen cores obtained from the Combe Haven Valley (cf. also Waller 1993, 1994).

The implication from these three cores is that some form of management was in operation, rather than deforestation. Long-term fuel consumers are usually concerned to maintain fuel reserves. The cutting of woodland does not result in its death. Wood will regenerate - the efficiency of the regeneration process is a function of the nature of the management practices. From the data which is available from the carbonised material derived from slag deposits, it is not possible to elucidate the exact nature of the woodland processes, other than they resulted in a dominance of branch wood rather than older wood or timber.

Pollarding would prevent the attrition of the young shoots by animals, however, significant additional time would be required in the cutting of the branchwood. The cutting can also be highly dangerous, as a result of the combination of axes and ladders (Rackham 1990: 8). By contrast coppice is easier to cut as a result of the bowl being at ground level; however, there will be a considerable attrition as a result of the feeding of animals. There is no evidence to support the presence of woodbanks as evident in the medieval era to prevent the access of animals; although the use of fencing or the use of hunting might help to reduce the attrition, although this would be highly inefficient. The presence of woodbanks should be visible in the Wealden landscape which has had a below average arable regime.

THE DOMINANCE OF THE HASTINGS HINTERLAND

Some form of explanation has to be forwarded to explain why the Hastings hinterland was chosen a s a focus for industrial-class activity in the Weald. The western High Weald could also sustain industrial-class activity, as revealed by the production facilities at Great Cansiron, and Oldlands, however the majority of the activity in the central Weald is dominated by small-scale activity, dispersed in both time and space. In contrast the Hastings hinterland is a highly concentrated belt of activity, where the exploitation of the environment would in some areas (Beauport Park, Oldlands and Crowhurst Park), have been near the limits of what was sustainable by the local and sub-regional environment.

The natural resources of the eastern High Weald are essentially the same as those of the western High Weald. The ore sources were the same, as were the heavily incised topography, and the extensive faulting, in addition to the vegetation, which appears to have been oak-dominated with intermittent birch, hazel and *Pomoideae*.

In the economic sphere both regions had the same widespread pre-cursive Iron Age local-industries, which could either provide indigenous workers and/or act as a focus for later working. In the northern High Weald there is in fact more evidence for Iron Age activity than that recovered from the eastern High Weald.

The only considerable difference is the nature of communications. The western High Weald was essentially land-locked, while the eastern High Weald benefited from both land and water communications, both enhanced by the presence of fleet activity.

AN IMPERIAL ESTATE

Cleere notes that the situation in the western High Weald is different to that of the eastern High Weald. The arguments forwarded to hypothesise an imperial estate follow two major themes. Cleere (Cleere and Crossley 1995: 67) suggests that "a large tract of country with no early villas and at some distance from any large towns or *civitas* capitals has been taken to imply the existence of a different form of land ownership from the normal, and imperial estates have suggested themselves." There is also evidence from around the empire which attests to the use of imperial estates. Allowing that the elucidation of Roman land tenure is insurmountable, there are problems, based on the hypotheses which Cleere forwards.

The distribution of settlement evidence in the Weald appears to uphold Cleere's hypothesis relating to the distribution of hierarchical settlement. The region is certainly without major nucleated settlement sites, although it is surrounded by those at Chichester, Canterbury, Rochester and London. Of course, the development of settlement in the Weald has been highly specialised, and it has never supported major urban centres. The settlements which do exist, tend to exploit any beneficial geology and physiography, such as the emergence of the spring line; natural communication routes across the Downs; or the junction of major physiographic zones such as Horsham, Crawley and Tonbridge on the boundary of the High Weald and Low Weald; in addition, the use of modified lithologies for agriculture can be seen in the Maidstone district. Similar arguments have been forwarded for the hypothesis of imperial estates in areas such as the fenlands and Cranbourne Chase, which also do not tend to attract major settlement. The other reason forwarded is the apparent cessation of villa[†] activity in the High Wealden region compared to the surrounding Downs and Greensands (Cleere and Crossley 1995: Fig. 19). Several reasons exist for such a distribution; as previously noted, the discovery of villa sites on the chalk is a great deal simpler

[†] The exact definition of a villa in the archaeological record remains enigmatic and has occasioned significant debate. It is likely that villas do not represent a single phenomenon but are indicative of a multitude of uses, such as farmhouses, country estates and investment properties.

than the recovery of such sites on the Wealden geologies. There were probably more villa sites on the chalk originally. Research into the settlement patterns of the Weald has been consistent; a great deal of evidence has been recovered for activity on the Greensands, especially in the Maidstone district, which currently has the densest distribution of known Roman settlement in the Wealden region. In the western High Weald there are three examples of possible villas. At Howbourne Farm, several moderately-sized slag deposits were recovered in association with the foundations of a building, and second century finds. This prompted Tebbutt (1973: 115) to suggest that "at Howbourne there had been a Roman house, with an owner of some wealth, concerned with the iron industry in either a private or official capacity." Similarly at the hilltop settlement at garden Hill, Iron Age round houses were replaced by a rectangular Roman type building and bathhouse after the invasion. While little evidence for smithing and smelting was recovered there was not much evidence for large-scale iron production, which prompted the suggestion that the site represented an administrative centre for iron production in the locality. At Uckfield a stone corn-drying oven was recovered, which could have been associated with a villa site, although no further evidence exists to corroborate this.

The number of such prestige properties in the High Wealden region would tend to be low. Whether a villa is considered to be a country retreat, the centre for a farm estate or an investment property, the High Weald is a highly unlikely place to establish such sites. The tendency towards a harsh environment, and the associated difficulties in communications reduces the desirability of a region for property development.

CHAPTER SEVEN

THE DISTRIBUTION OF IRON PRODUCTION IN THE WESTERN HIGH WEALD

THE DISTRIBUTION OF THE IRON INDUSTRY IN THE WESTERN HIGH WEALD

TROLLILOES

The now destroyed Romano-British iron production site at Trolliloes Bridge (TQ 632152) was apparently located approximately 100 meters to the SW of Broomfield Farm. The site is on Ashdown Sand, while to the south is an extensive cap of Wadhurst Clay. Evidence for bloomery production has been recovered both east and west of the bridge, although nothing now remains. The first reference to iron production on the site was recorded by Straker (1931: 360), who noted that Colonel D. MacLeod had found that the upper bay of Batsford Furnace and forge was partially composed of bloomery cinder (Straker's types AB). The extensive earth movement caused by the construction of the furnace bay disguised the site. It was only in the mid 1970s, in the extreme north west of the fishing lake "under eight feet of silt in the bed of the former pen pond were found and destroyed five or six bloomery furnaces" (Tebbutt 1980: 16). This was not recorded until several weeks after the destruction, so no more evidence as to the nature of the site and the type of furnaces survives (*ibid.*).

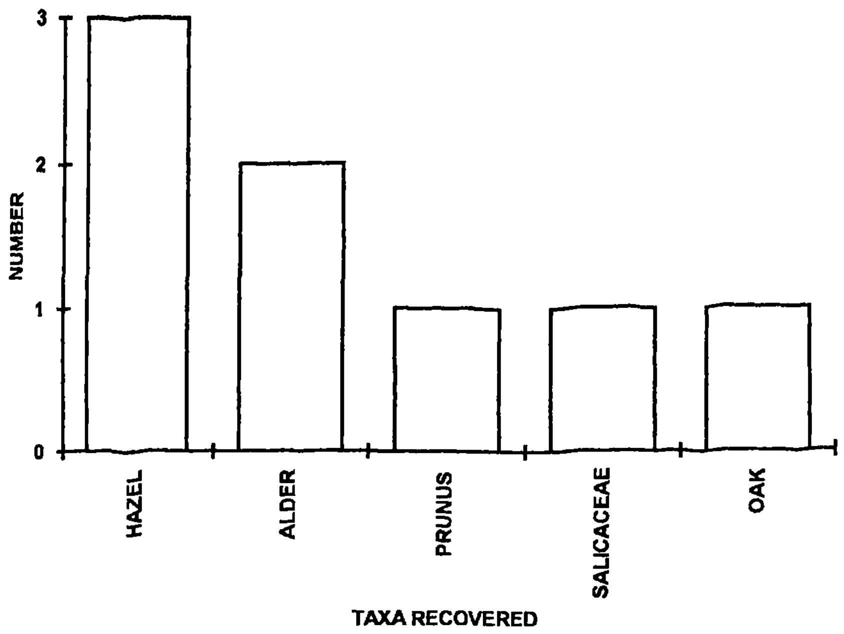


Fig. 7. 1 The charcoal taxa recovered from the Trolliloes site (Post-medieval context)

In 1979, bloomery slag was recorded by W. R. Beswick on the eastern side of Trolliloes Bridge, which was eroding into the Furnace stream. Associated with this was a rim sherd of Romano-British black burnished ceramic, which can no longer be traced. This is unfortunate considering the absence of black-burnished ware from other Wealden contexts. If the ceramic was a BB1 form it could indicate an alternative source of supply for the Trolliloes site, possibly utilising the Pevensey inlets.

The bloomery slag can no longer be seen on the stream bank and has possibly eroded away as a result of the increased volumes of water which flow past due to the construction of the fishing lakes. A deposit of vitrified blast furnace slag is, however, visible. The charcoalified remains exposed in this section were: Hazel (n = 3); alder (n = 2); *Prunus* (n = 1); *Salicaceae* (n = 1) and oak (n = 1). These identifications are consistent with the extensive variety of species recovered during the excavation of the of the blast furnace (cf. Bedwin 1980) which included alder, hazel, beech, plum, willow, sweet chestnut, alder blackthorn, dogwood, hawthorn, ash, lime and elm (Cartwright 1980).

The iron production site at Trolliloes appears to have been a moderately significant producer. The presence of five or six furnaces suggests a site in the same order of magnitude as the six unit production sites recorded by Homan (1937) at Old Place, Icklesham, and Cleere (1970) at Holbeanwood, and could possibly represent a standardised unit of production. The location of a moderate producer in the Herstmonceux / Warbleton region is significant. The presence of the semi-industrial site at Turners Green, and the presence of five or six furnaces at Trolliloes suggests that the site was probably producing a surplus greater than local needs required.

TURNERS GREEN

The iron production site at Turners Green (TQ 642195) is located approximately 200 meters to the NW of Wyatts Farm, on Ashdown Sand. It is a relatively extensive site, which was revealed by the exposure of charcoal-impregnated earth during ploughing, although little slag. Extensive excavation revealed a group of five bloomery furnaces (Private publication, W. R. Beswick *pers. comm.*) associated with two ore roasting sites, a smithing forge, and three outlying sites. Although little slag remains, the area of charcoal impregnation in conjunction with the presence of outlying sites suggests the presence of a semi-industrial operation. Radio-carbon determination provided a date in the early first century A.D.

Analysis of the charcoal from the site, during the excavations, revealed only fragments of oak from mature wood (W. R. Beswick *pers. comm.*). Magnetometer survey of the site revealed the presence of isolated deposits of ore of several kilograms each, which have been interpreted as the archaeological manifestation of the carriage of ore onto the site in baskets or bags, and its subsequent deposition.

The presence of semi-industrial operations at Turners Green must have had considerable local implications for the environment. The absence of significant quantities of tap slag in the soil is suggestive of large-scale removal for metalling. This site was the early Roman equivalent of the Iron Age industrial site at Herrings, 3 km to the ESE. Extensive ploughing has removed most traces of the slag banks at Turners Green, negating the possibility of charcoal extraction from this site.

HEAVEN FARM

The small bloomery site at Heaven Farm (TQ 404261) is located 150 meters SW of the Farmhouse and museum, in an area of woodland called the Toll. An extremely small scatter of slag, with a maximum depth of 15 cm, is located on the stream bank. Two trenches by the WIRG revealed a single sherd of East Sussex ware was recovered from the base of the deposit near the stream. Analysis, based on comparison with the Freshfield Brickwork assemblage, suggested a post-conquest date.

Little charcoalified material (n = 28) was recovered, by the author, during trial trenching of the slag deposit. This was primarily a function of the small area and depth of the deposit, which would have provided little protection for charcoal fragments against weathering and other attritional processes. In addition the presence of a possible post-medieval activity site c.10 meters along the river bank confirms the presence of post-Roman activity in the immediate vicinity of the site, which could have resulted in degradation of friable charcoalified remains as a result of pedo-turbation.

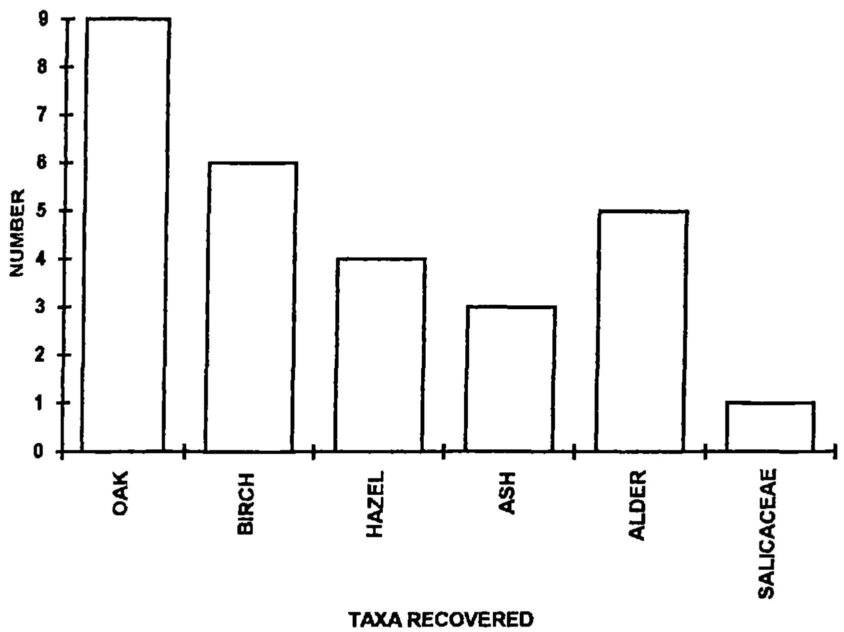


Fig. 7. 2 The charcoal taxa recovered from the Heaven Farm iron production site.

The taxa recovered included Oak (n = 9), birch (n = 6) but also a high percentage of hazel (n = 4), ash (n = 3), alder (n = 5) and willow (n = 1). The presence of alder and willow is significant as these species are characteristic of damp conditions; as such they could have derived from the immediate vicinity of the site which is both damp and marshy. Alder and the *Salicaceae* family are not usually well represented on bloomery sites; the 17.9% which alder achieves is only exceeded in the iron production site at Petley Wood, although in that context the sample size undoubtedly influenced the taxa representation. It is possible that the charcoalified material from the slag deposit does not necessarily derive from bloomery smelting but could derive from roasting or smithing operations. The small size of the site could therefore mean that the arboreal taxa is autochtonous.

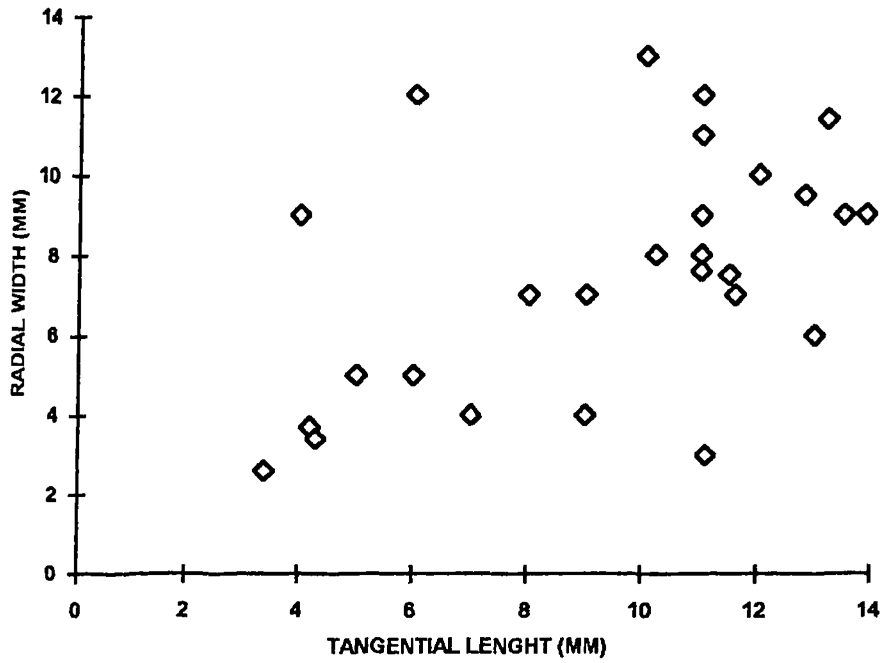


Fig. 7. 3 Fragmentation exhibited by charcoal recovered from the Heaven Farm site.

With exception to the early Roman bloomery site at Freshfield Brickworks, little Roman occupation has been recorded in the Danehill region, although undated bloomery activity is attested at TQ 405259 (Hodgkinson

1988b: 6), while tap slag and furnace lining were located half way between TQ 40562888 and 40832849 (Buckland 1982: 228). Certainly the archaeological research prompted by the laying of the water pipeline between Danehill and Chelwood Gate resulted in the recovery of no evidence of Romano-British activity. This random traverse suggested that the environs were apparently dominated by post-medieval and medieval activity. This would certainly correspond with the almost ephemeral activity at Heaven Farm, which could imply that there was not sufficient Romano-British activity in the vicinity to sustain larger-scale output. Certainly the remaining evidence for Roman activity is smaller than even the site at Coleham (Cleere and Crossley 1995: 299). There is no evidence for the removal of slag from the site. There is no widespread scatter of material such as slag and charcoal which is normally indicative of the removal of material in the past. In addition the site is essentially inaccessible, with a high stream bank on one side and marsh ground on the other negating the easy removal of slag.

FRESHFIELD BRICKWORKS

The light industrial site at Freshfield Brickworks (TQ 385262) is located to the WSW of the brickworks entrance. The excavations for clay at Freshfield during 1936-7 revealed the presence of Iron Age ceramics. Later controlled excavation revealed that the predominant feature was a V-shaped ditch approximately 75 cm wide and 75 cm deep (Hardy, Curwen and Hawkes 1937: 253). The ditch ran approximately in a NW direction for 25 meters then for 19 meters in a WNW direction until it was truncated by an overlying boundary bank of medieval or Post-medieval date.

The lowest level of the ditch fill was dominated by a charcoal-rich sediment. A sherd-rich deposit followed, while the upper horizon of the ditch fill was dominated by burnt sandstone and brick. The mixed horizon of slag, charcoal and clay accumulated after the ditch had silted, or was back-filled, completely (*op. cit.*: Fig B). Excavation of a 12 metre section of the ditch revealed the presence of over 400 sherds of ceramics. In view of the dearth of ceramics on other Iron Age and Roman-British Wealden sites, this could suggest the possibility of ceramic manufacture. The ceramic forms were considered by Christopher Hawkes (*ibid.*: 262) to represent an assemblage of the 'Late La Tène' and as such represent an assemblage of the LPRIA. The presence of a bronze finger ring of "Roman type" could tenuously imply an early Romano-British transitional period, although an indigenous copy or traded item has also to be considered. Certainly the major phase of iron production was one of the final elements of the site's exploitation as indicated by the ditch having silted before the deposition of slag as evidenced by the deposition of slag only after the complete siltation of the ditch.

Despite an exploratory trench, by Hardy and Curwen, at right angles across the ditch and a further one to the north of it, no further evidence of settlement was recovered. Since the excavations in the late 1930s, the Freshfield Lane

Brickworks have expanded, stripping the clay where the ditch was located so the exact purpose of the ditch and its relationship to the industrial site can no longer be established. It appears that the ditch represented a boundary or feature which allowed for the accumulation of industrial debris and waste products from activity which must have occurred in the immediate vicinity, as discarded slag is rarely moved further than is absolutely necessary, as a result of its weight. Despite field exploration by the author in 1992 there is no further indication of iron production or other activity on the site. It must be assumed that the ditch represented a boundary to a settlement or light industrial site now under the site of the brickworks.

LIMNEY FARM

The iron production site at Limney Farm (TQ 540271) is located immediately to the west of the farmhouse from which it derives its name. Evidence for industrial activity was first recorded by Straker, who recovered the base of a New Forest ware pot, considered by R. A. Smith to be of third century date, on the banks of a minepit located at TQ 5442 2719 (Straker 1931: 387). A primary locational factor in the position of the site appears to be the proximity of the Burnt Oak fault on the edge of the Wadhurst clay, which might have acted as a source of ironstone (Cleere and Crossley 1985: 303).

The site is relatively extensive. Several discrete slag deposits have been located. A bed of cinders is located to the east of Limney Farmhouse. The construction of foundations for farm buildings at TQ 5426 2715, revealed a bed of cinders at about 30-40 centimetres below the contemporary ground surface, although no surface indications were evident. A trial hole in this area dug during NAR field survey revealed bloomery cinder at a depth of 30 centimetres (NAR TQ 52 NW 1). Exploratory work by the WIRG, in 1972, revealed two mounds of slag next to the stream in the general region of TQ 540 271. Probing of the ground surface by the author suggests that that either a complex of slag deposits exists between the farmhouse and the east bank of the stream, or a single large deposit is manifested. These may have been in operation simultaneously, consecutively or intermittently over the Roman occupation. The two associated minepits or marlpits at TQ 5428 2722 and TQ 5442 2719 are of significant size; the presence of Romano-British ceramics on one possibly indicates Roman use. If these were both associated with the iron production site, they could certainly have provided the majority of the iron stone for what appears to be a semi-industrial class operation. The presence of third century New Forest Ware certainly implies a phase of operations later than the majority of Wealden sites. The nature of land-use was not conducive to the extraction of charcoal.

ROCKS WOOD

The smelting furnace at Rocks Wood (TQ 5228 3494) is located approximately 150 meters NW of Rocks Farm and 200 meters east of the Mottsmill Stream. The geology of the locality is dominated by Ardingly Sandstone. The single furnace is located approximately 2 meters from the rock face, under a rock overhang which is 3.8 meters high and projects 2.8 meters (Harding and Ostoja-Zagórski 1987: 11, Fig 4). The presence of eight sherds of East Sussex ware provided an approximate chronology despite the heavily-disturbed stratigraphical context, although these could only be attributed within the date range of the 1st century B.C. to the 4th century A.D. (Pollard 1987: 21). The furnace was classified by Cleere (1987: 30) as a domed slag tapping furnace type B.1.ii.

The location of an iron production facility in a rock shelter is, as yet, unique in a Wealden context, although pre-Roman examples are recorded from Scotland (Penniman *et. al.* 1958: 98, 99) and Somerset (*op. cit.*: 121, 123). The primary motive for the siting of a furnace in this location was to take advantage of the cover provided by the overhanging sandstone cliffs. Other excavated examples of the working surfaces of Wealden iron production sites such as Pippingford Park (Tebbutt and Cleere 1973: 29, Fig 1), the possible structures at Cow Park (Tebbutt 1979a), and the smithing hearth at Minepit Wood (Money 1974: 9) produced evidence of postholes which could be indicative of timber structures constructed over the smelting furnaces, apparently to allow operations to continue during inclement weather.

The multi-period utilisation of the site in conjunction with the low height of the surviving furnace remains (Cleere 1987: 30, Harding and Ostoja-Zagórski 1987: Fig 6) did not allow for the acquisition of securely stratified charcoal samples or other environmental evidence from the phase of iron production. Only a moderate quantity of slag was detected during excavations, concentrated in several layers (13, 21, 36) piled behind the furnace (Harding and Ostoja-Zagórski 1987: 16). The presence of a band of yellow clay in the furnace wall suggested relining or rebuilding at least once (Cleere 1987: 30) although the period between relining was probably variable depending on the skill of the operator, so no estimates could be made on the number of smelting operations. The discrete nature of the furnace remains at Rocks Wood therefore suggests a relatively limited exploitation of the local environment. The site has to be viewed with a certain degree of caution as a result of the disturbed chronological context of the body sherds, although statistically more likely to derive from the Romano-British era, they do have an unusual context in a rock shelter. However, the data has to be viewed with caution for while Romano-British iron production and settlement is located at Eridge Park, pre-conquest occupation is evident at Saxonbury Camp. Field exploration by the author has provided no further evidence for iron production in the vicinity of the Rocks Wood shelter. When this is considered in conjunction with the relatively small amount of slag recovered and the low probability of taphonomic loss, the implication is that the site represents the archaeological manifestation of a brief series of smelting operations. This is entirely consistent with the varied nature of metalliferous exploitation in the western High Weald.

SCALAND WOOD

The iron production site at Scaland Wood (TQ 523277), which was located approximately 600 meters SW of Owlsbury Farm, is no longer extant. The site occupied the base of south facing slope below the farmhouse, at the junction between the Ashdown Sand and the Wadhurst Clay. At the lowest point of the slope rises an intermittent tributary ghyll, which has been recently mechanically excavated as a drainage ditch.

The bloomery site was first recorded in 1976, as a result of the extensive area survey instigated by the Wealden Iron Research Group in the High and Low Weald (Tebbutt 1981a, Hodgkinson and Tebbutt 1985, and Cleere and Crossley 1985: 279-283). Trial trenching of the site produced a single sherd of early East Sussex ware, now in Lewes Museum, providing an approximate date of exploitation in the earlier part first century. Green (1981: 61) considered the distinctive 'eyebrow' vessel with its 's' profile to have been the "strongest contender for a pre-conquest date .... from an iron working context."

The site of Scaland Wood was cleared in 1976. The extensive earth-moving operations involved in the grubbing of woodland and its subsequent conversion to arable have obliterated any traces of the site. The area is now under pasture, although fragments of clay ironstone can still be detected within the general vicinity of TQ 523 277, and an isolated fragment of vermiform slag was recorded at TQ 5237 2771. However, no further information is available to pinpoint the original location of the site.

STUMLETTS PIT WOOD 2

The slag deposit at Stumletts Pit Wood (TQ 527272) is located approximately 200 meters ESE of Sparrow Cottages. This site is part of a series of four bloomery sites which are evident for about 1 km along the ghyll, with the Scaland Wood site less than 800 m away. Explorations by the WIRG in March 1986 revealed six sherds of East Sussex Wealden ware (Hodgkinson 1987a, 1988b). An extensive deposit of slag is located at the junction between an intermittent tributary gill and the main stream in Stumletts Pit Wood; the slag can be traced both up and down the main stream bed for about 20 metres. The WIRG trench from the 1986 season was reopened to acquire charcoal. A distinct horizon of this was recovered from the base of the trench, in conjunction with fragments of burnt clay. Such precursive burning episodes have been recovered from the Chitcombe site in the eastern High Weald. Although this could indicate deliberate clearance of vegetation prior to the exploitation of the site, the absence of a burnt ground surface, fired clay and the location of the charcoal in a shallow hollow possibly indicate a natural accumulation of material probably from a single depositionary event.

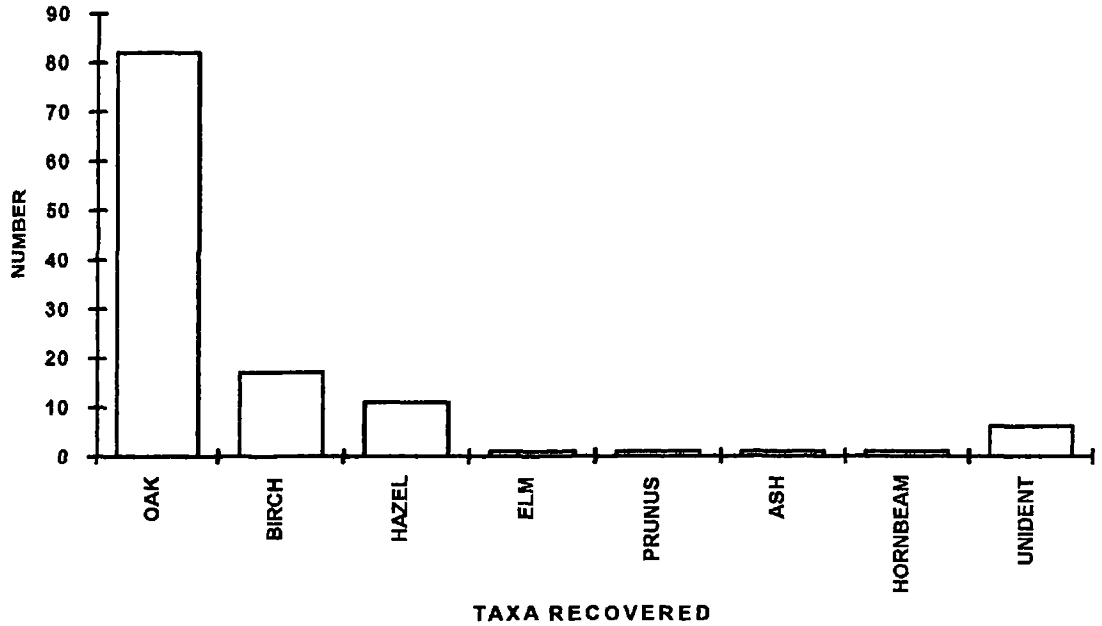


Fig. 7. 4 The charcoal taxa recovered from the Stumletts Pit Wood 2 site.

The taxa recovered indicate a heavily oak-dominated assemblage (71%) with birch and hazel present in low frequencies; however, the *Pomoideae* are absent in this context. The presence of elm and hornbeam could provide an indication to the presence of stands of mature woodland in the vicinity.

STUMLETTS PIT WOOD 4

The bloomery debris at Stumletts Pit Wood (TQ 529277) is located approximately 200 meters WNW of Rumsden Farm exclusively on the east bank of the Stream. The scattered nature of the slag in the top soil produced little charcoal. The slag scatter has been extensively excavated in the recent past, possibly as a result of WIRG activity although this cannot be confirmed.

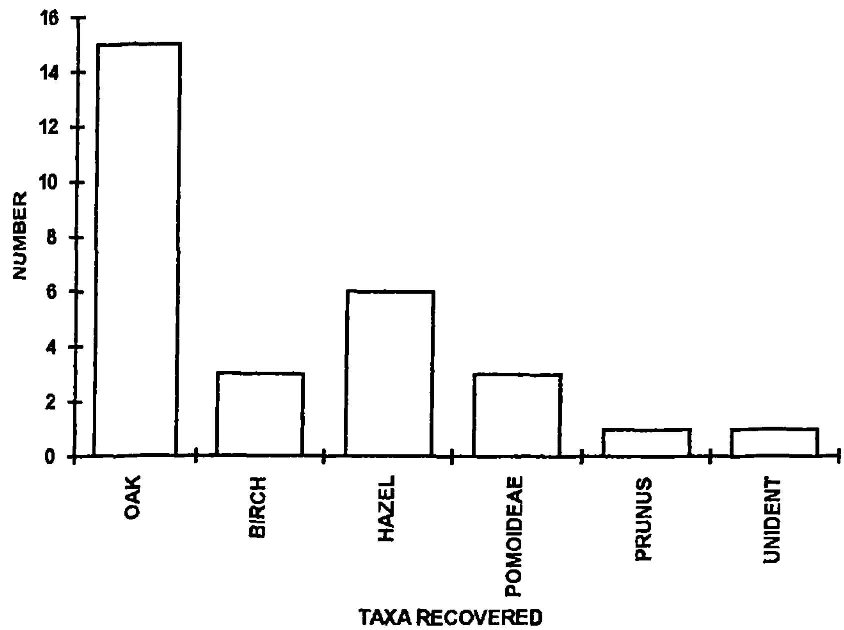


Fig. 7. 5 The charcoal taxa recovered from the Stumletts Pit Wood 4 site

The charcoal recovered from the site corresponds closely to the contemporary arboreal vegetation which, on the stream bank, is dominated by birch, alder, hawthorn, oak, and hazel. However, considering the relatively close proximity to the production site at Stumletts Pit Wood 2, the taxa composition differs at the level of detail. Oak only achieves 54% dominance of the arboreal taxa recovered, while the *Pomoideae*-type taxa are present. Although this could be a result of the smaller sample size, it is likely that the two sample sites could provide an indication of the change in the local environment along the stream bank. A certain degree of caution should be expressed as a result of the possibility that the two sites are not likely to be contemporary.

HOWBOURNE

The bloomery and occupation site at Howbourne Farm (TQ 517249) is located approximately 150 meters south of the farmhouse. The local geology is relatively complex, with Ashdown Sand exposed in the river valley, and Wadhurst Clay on the higher ground. To the south lies a fault at the junction with the Tunbridge Wells Sand. The presence of a bloomery at Howbourne Farm was first recorded by Straker (1931: 390), who noted the presence of cinder along the ghyll and in the field to the south of the farm, although no dating evidence was recovered. Ditching operations in the field to the south of the farmhouse, around 1952-4, revealed significant quantities of tap slag and the remains of a mortared stone wall (Tebbutt 1973). The small finds recorded from the ditching operations and an associated hole at TQ 5163 2488 included samian ware, Nene valley ware, coarse pottery, window glass, and vessel glass considered to be of the second century A.D. by N. E. S. Norris. The presence of window glass and building evidence led to the postulation by Tebbutt (1973: 115) that "at Howbourne there had been a

Roman house, with an owner of some wealth, concerned with the iron industry in either a private or official capacity."

The field ditch and hole were back-filled, but were still visible as depressions in the ground surface during 1972, when Tebbutt visited the site. These are no longer visible in 1992. Cinder can still be seen scattered on the banks of the ghyll and in the surrounding fields, although this is of little depth. A distinct mound of bloomery cinder was first recorded during NAR field exploration in May 1970 (NAR TQ 52 SW 7), on the wooded slopes above the west banks of the stream at TQ 51702488. The mound is about 20 cm high and 12 meters wide. It appears to be the origin for the scatter of cinder which extends downstream for 100 meters although no dating evidence was recorded. Land use precluded the extraction of charcoal from this site.

The limited nature of the discoveries within the confines of the trenching operations does not give a clear idea as to the size of the operations. The presence of a stone building suggests intended occupation of some permanence while the current distribution of slag both on the stream banks and scattered in the fields on the farmhouse side, suggest the production of iron on a scale that was somewhat greater than the immediate needs of building construction and repair. It appears that iron production was an important element of the economy of the building, however, not necessarily the *raison d'être* for its construction.

RIDGE HILL

The semi-industrial iron production site at Ridge Hill (TQ 369355) is located approximately 300 meters SW of Ridge Hill Manor on the south bank of a tributary of the Medway, on a ridge of Tunbridge Wells sandstone. The floodplain of the tributary is covered with sandy alluvium, overlying Wadhurst clay. Exploration by Straker in 1927 resulted in the discovery of almost a metre of vermiform slag exposed by erosion, found in conjunction with Romano-British ceramics. Excavation to provide road metalling later in the same year, revealed the slag deposit to extend 135 x 55 meters.

Stratified within the body of the slag deposit were what Straker (1928: 183) interpreted to be three levels of smelting hearths. However, the description of the hearths being "circular, roughly 8½ to 9 feet in diameter" (*op. cit.*: 184) constructed of sandstone bedded in the slag deposit, with a level surface "without any concavity to receive the bloom" which was burnt red (*op. cit.*: 183), suggests either a charcoal roasting kiln or possibly an ore roasting hearth (cf. Cleere and Crossley 1985: 298).

The ceramic assemblage (n = 23) recovered during excavation provided evidence for activity on the site for over two centuries. The earliest forms included samian form 18, and a rim of form 37, with brown-grey coarse-grained ware which are indicative of material from the later first century. The latest sherd from the late third or early fourth century was of imitation samian with a form 38 flange, and white painted bars on the upper edge of the horizontal flange (Salzman 1935: 30-1). The presence of later Romano-British ceramics within 5-10 centimetres of the surface of the slag deposit suggests that the site was only utilised during the Romano-British era (Salzman 1935: 30). The correlation of the volume of the slag deposit with ceramics from two centuries suggests that the site experienced intermittent use. However, slag from both the bloomery site and the later blast furnace was used as metalling for the road to the iron master's house at Mill Place (Straker 1931: 237). Other finds included two bronze objects (Margary 1933: plate 1) which were tentatively postulated as being attachments for armour such as epaulettes. However, these have a close affinity to bronze saddle horns found at Newstead (Fuentes 1991, Connolly 1990), which appears more viable in the absence of any armour recovered from a Romano-British iron production site in the Weald. The presence of a 15 centimetre square-headed nail, lost by the workmen shortly after discovery, could suggest the presence of a structure associated with the site, or alternatively, in the absence of building debris such as tiles, could represent a product of the site.

Samples of charcoalified wood obtained from the slag deposit by S. E. Winbolt were identified by the Forest Products Research Laboratory as deriving from birch (a large specimen), oak (large specimen), hazel, maple, ash and plum (Straker 1931: 110). No quantities are given for each of the species, but a large variety are present, possibly indicating the presence of secondary woodland. In view of the length of intermittent occupation on the site, this is a distinct possibility.

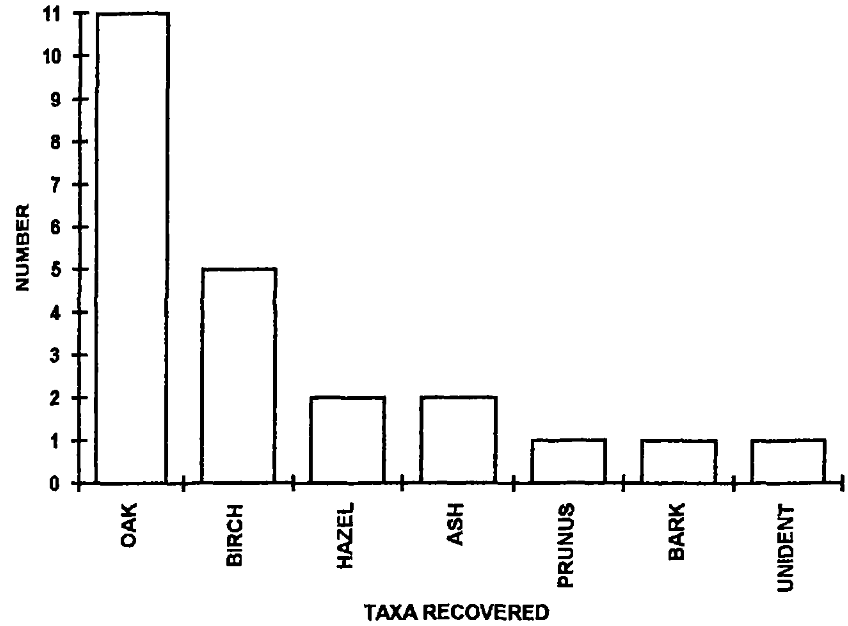


Fig. 7. 6 The charcoal taxa recovered from the Ridge Hill site

The variety of ceramics recovered by Straker is further corroborated by a field visit by the WIRG in April 1987, which resulted in the recovery of five sherds of Romano-British ceramics from the stream bank at TQ 3695 3556, including East Sussex wares, grey wares and sandy buff ware.

Limited extraction of charcoal was undertaken by the author from material exposed in the stream section which runs across the site. The quality of the charcoal, in many cases, was poor, possibly as a result of exposure to a fluvial environment. The taxa recovered were broadly consistent with material obtained by Straker and the general patterns recovered from the High Weald.

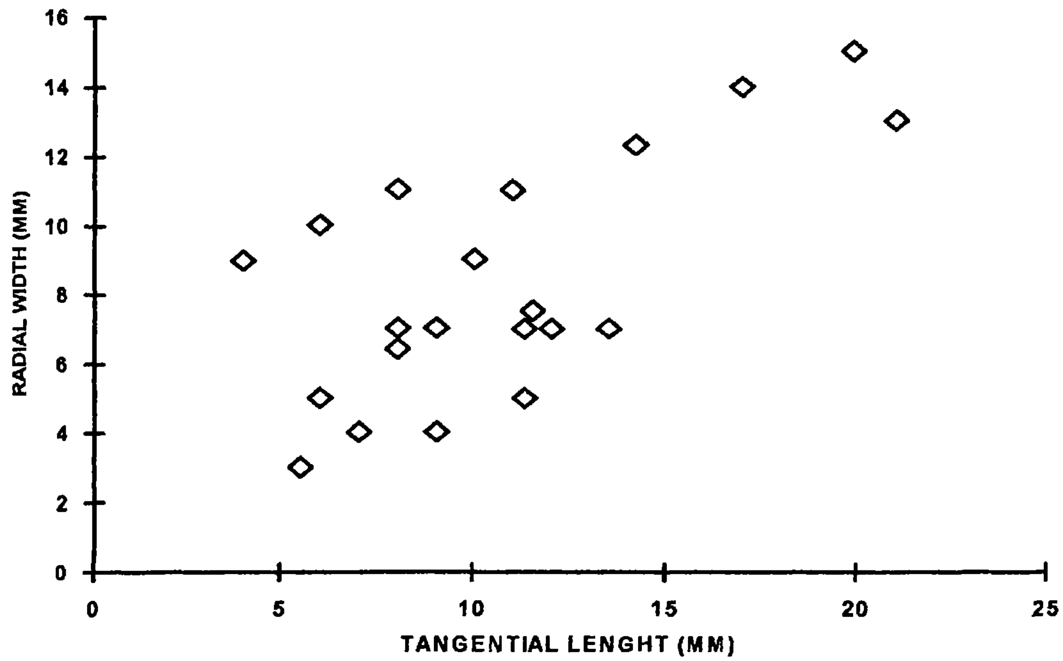


Fig. 7. 7 The fragmentation of charcoal exhibited at the Ridge Hill site.

WALESBEACH

The bloomery site at Walesbeach (TQ 3957 3448) is located approximately 400 meters NW of Charlwood Farm, on the south bank of the Weir Wood Reservoir, which has dissected the site. At low water, the slag exposure on the reservoir reveals almost a metre of densely-packed tap slag and cinder. The remaining slag extends for about 50 meters in diameter. The boundary of the deposit certainly extends to the lower reaches of the field above, and for some distance along the bank. A heavy scatter of slag was recorded in the field 50 meters to the SW, during NAR field exploration in May 1971 (NAR TQ 33 SE 11). This is now under grass although probing does suggest the presence of sub-surface material. There is much evidence of the deposit having been quarried in the past. Little evidence exists to determine how far the site would have extended into what are now the waters of the reservoir. Certainly old editions of Ordnance Survey maps do not give any indication of the existence of a site, which considering the location under pasture and the discovery by Straker is not unexpected. Ore pits have been located at TQ 393341, on the junction of the Wadhurst Clay.

The discovery of the site was prompted by the extensive place name evidence such as Cinderbank Mead, Sindry Bank, and Great and Little Sindrymeads. Excavation in 1928 by Straker and Margary revealed a furnace structure. The ceramic assemblage recovered appeared to derive from the late first to mid-second centuries, fragments of a pink ware flagon and a bowl, of the late first to early second centuries, including a fragment of second century samian and a neck of a flagon of mid-second century origin.

The presence of a fragment of tile from Straker and Margary's limited excavations in 1928, could indicate the presence of a building in the immediate vicinity of the site. In addition substantial ore pits have been recorded at TQ 393341 approximately 450 metre to the SSW on the boundary of the Wadhurst Clay.

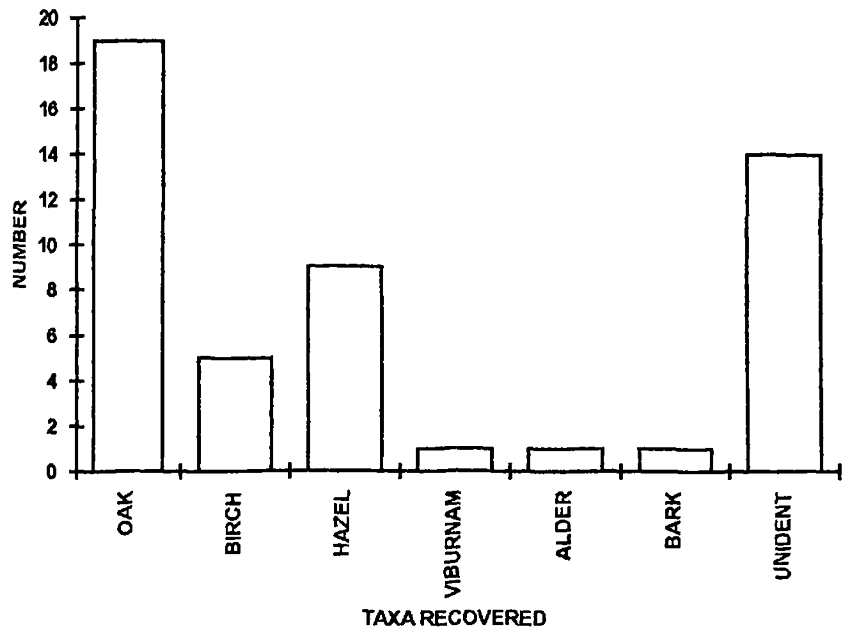


Fig. 7. 8 The charcoal taxa recovered from the Walesbeach site.

A limited collection of charcoal was extracted from the reservoir section although weathering and the constant attrition caused by the undulating water levels have served to degrade much charcoal, accounting for the high number of unidentified fragments. As a result the Walesbeach sample represents one of the poorest preserved charcoal of all the Wealden sites examined. The unidentified fragments are problematical. They do *not* represent degraded oak, whose ring porous structure would still be evident even under extreme cases of attrition. Therefore they are taxa with a non-ring porous structure, which would serve to decrease the percentage of oak in this context. It is possible that as with Ridge Hill there could be a wide variety of secondary woodland taxa present in the sample, especially considering the close proximity of the two sites.

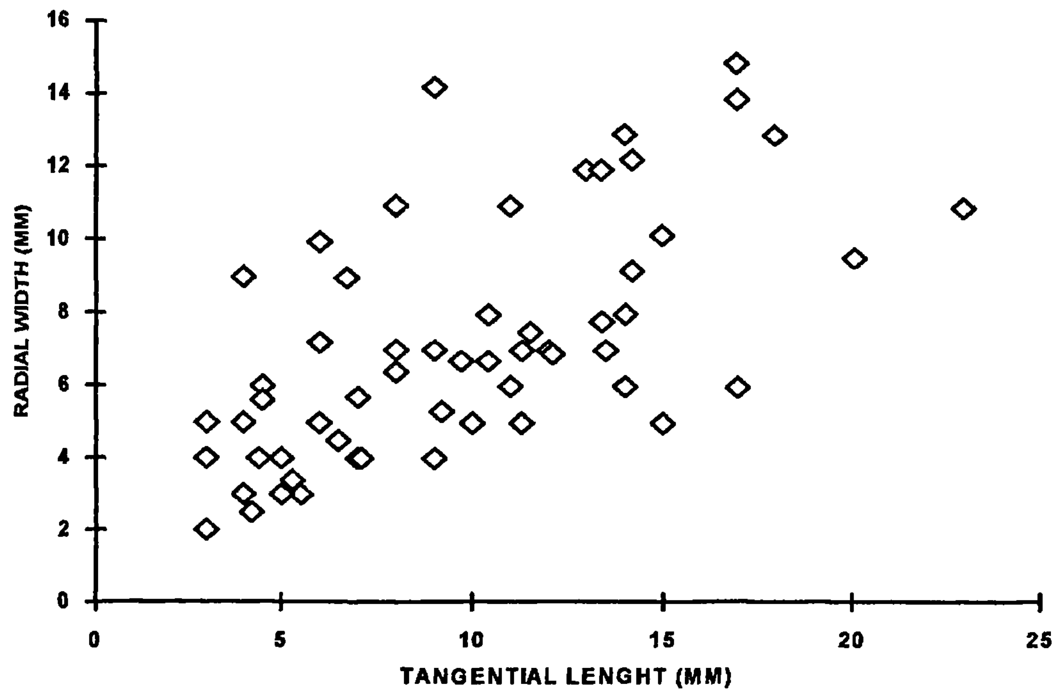


Fig. 7. 9 The fragmentation of charcoal recovered from Walesbeach

STANDEN

The bloomery site at Standen (TQ 3922 3513) is located approximately 550 meters SSE of Standen Farm, overlooking the northern banks of the Weir Wood Reservoir. Evidence for iron production on the site was first recorded by Straker (1931: 239) who noted the presence of a "fairly extensive bloomery". The close proximity of confirmed Romano-British iron production sites at Walesbeach, approximately 750 meters to the SSW, and Ridge Hill 2.3 km to the WNW, prompted exploratory excavations by Ernest Straker and R. T. Mason in 1939 (Straker and Mason 1939: 153).

The site, when trenched, proved to be approximately 40 meters in diameter. The bank in Hollybush Wood was found to be composed of large nodules of cinder and much slag, which possibly gave rise to the name "Cinderbanks". The evidence from Straker and Mason's three trenches suggested an average depth of slag of 35 cm, which decreased progressively towards the edges of the deposit. The ceramic assemblage derived from Straker's trench three, and was composed of fourteen small sherds. These were considered by Dr. A. E. M. Wheeler as "Roman with a strong native influence", which is probably indicative of East Sussex wares, in conjunction with a fragment of second century samian, and a sherd of grey ware of unknown date (*ibid.*: 154). The Standen site still retains some coherence despite periods of ploughing in the adjacent field, and the use of the cinder for the construction of a boundary bank in the past. Field exploration by the NAR (TQ 33 NE 7) revealed the mound to be centred at TQ 3922 3513.

The present author further explored the boundary ditch which cuts the mound and discovered evidence for dense bloomery slag beneath the top soil. The charcoal from the deposit was a characteristic oak-dominated deposit although with a wide variety of additional taxa present in low frequencies, oak (n = 44), birch (n = 3), hazel (n = 7), *Pomoideae* (n = 1) *Prunus* (n = 1), buckthorn (n = 1), hornbeam (n =1) and beech (n = 5). However, unlike the nearby Ridge Hill and Walesbeach sites the sample appears to be an amalgam of classic secondary woodland/scrub taxa in conjunction with characteristic mature woodland taxa such as hornbeam and beech, which achieves its highest representation at this site. A conservative estimate for the remaining slag volume would be between 150-200m^3.

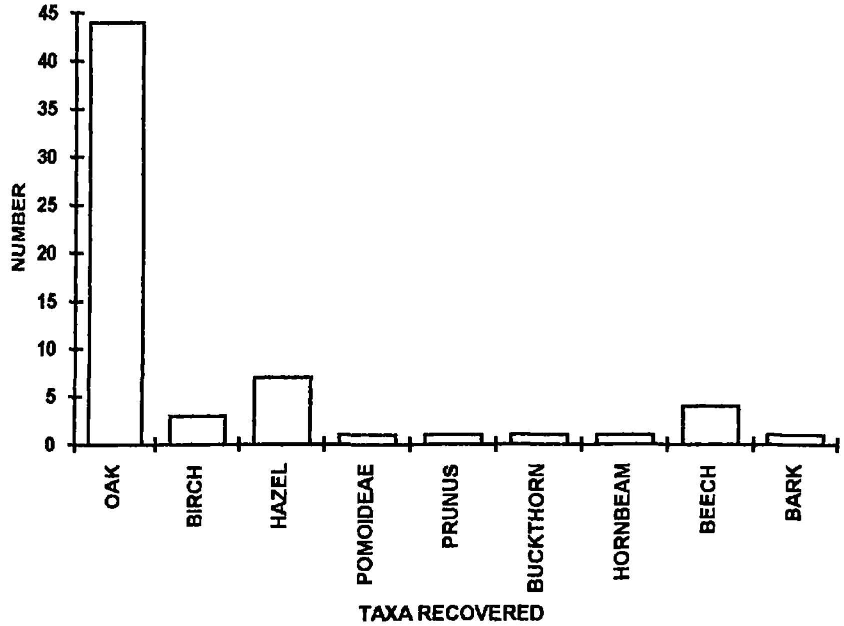


Fig. 7. 10 The charcoal recovered from the Standen site.

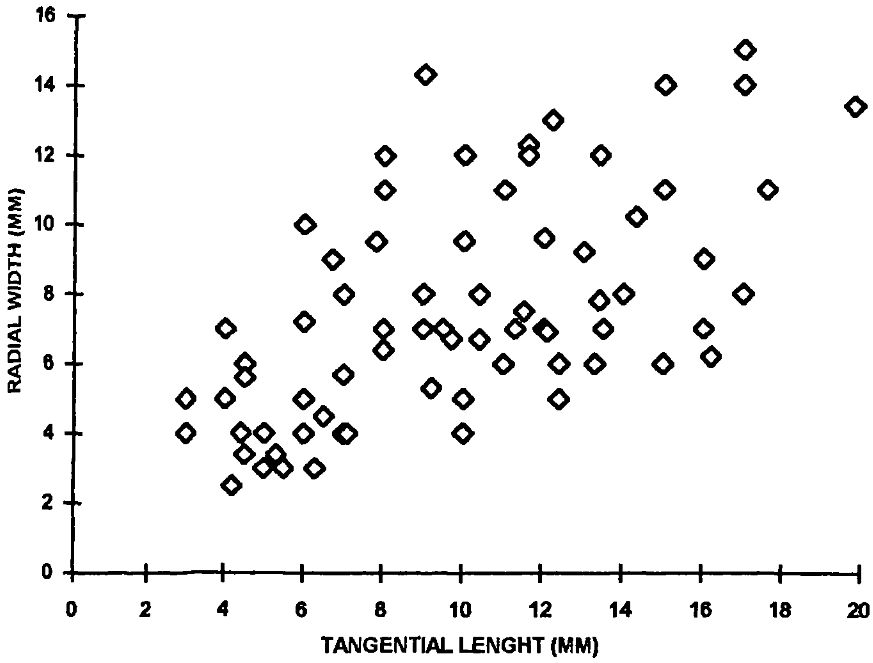


Fig. 7. 11 The fragmentation of charcoal recovered from Standen.

GREAT CANSIRON S.A.M. 403:

The Roman industrial site at Great Cansiron (TQ 4490 3824) is located 500 meters NNW of Great Cansiron Farm, on Ashdown Sand. The site has a screen of individual bloomeries to the east and south, with the Roman bloomery at Little Cansiron 400 meters ENE, and an unnamed Roman furnace with a radio-carbon determination of A.D. 20 (HAR 6390 1930 ± 70) 700 meters to the east (Rudling 1986: 228). In addition, a series of four possible bloomeries, of unknown date, are located between 100 and 200 meters SW of Great Cansiron Farm

Evidence for iron production was first recorded after excavations in 1946 revealed extensive evidence of Roman ceramics in association with significant quantities of cinder. In addition, a burning floor was recorded at TQ 4490 3824 on the bank of a stream. Further research by the WIRG in 1971, after extensive ploughing of the site, revealed bloomery slag and charcoal-rich earth extending over two hectares, in a field called "Blacklands". Finds from field walking included both Roman ceramics and a scatter of building materials (Tebbutt 1972), suggesting the presence of permanent buildings in the industrial area. Two coins recovered during field walking include *dupondii* of Vespasian (A.D. 60-79) and Trajan (A.D. 98-117) (NAR TQ 43 NW 5, Wilson 1971: 286). It appears that the mining of the ore occurred in open-cast quarries, at Puckstye Farm 1.3 km to the east, and possibly Tugmore Shaw 1.2 km to the SE. Both these sites are linked to the main iron working centre by slag-metalled tracks. The largest quarry at

Puckstye is 1.5 hectares, and may have been the primary source of ore (Swift 1982).

The most detailed excavation on the complex has occurred 750 meters to the east at an associated tile kiln, which appears to have supplied the site. Archaeomagnetic dating of the combustion chamber gave a magnetic date of A.D. 100-130 (AML No. 841226) at a 68% confidence level (Rudling 1986: 198), this was later confirmed by radiocarbon determination. Petrological examination of the products of the kiln suggest that local clays were used, as indicated by the inclusions (Foster 1989: 204). It was also hypothesised that the kiln was fired only several times over a few seasons (*ibid.*: 210). The range of products of the kiln appeared to be indicative of material for a bath-house possible on the iron working site (Rudling 1989: 227). This has implications for the wider industry suggesting that during the first quarter of the second century there was a significant technological input.

Extensive environmental analyses were carried out. Tile impressions on some of the tiles recovered were dominated by cat and dog although some red deer was present, characteristically indicating the proximity of woodland. (Foster 1989: 211). Analyses of the charcoals from the tile kiln revealed that birch was the most common, followed closely by oak. In addition, hazel, hawthorn, beech, alder buckthorn, willow and elm were present. However, in the probable LPRIA bloomery furnace to the ENE only oak was found. This could be indicative of either different fuel requirements for the processes of tile production and iron production, or it could indicate changes in the immediate environment since the LPRIA, as a result of the depredations of the industrial complex.

Detailed quantification of the ceramic types from the tile kiln excavation suggested that East Sussex wares only achieved 21.3% of the total assemblage, compared to 78% at Garden Hill (Cawood 1989: 213-4). In addition, the presence of ceramics from the Verulamium area has been used to postulate a market structure in which pottery was imported on the return from exporting iron to the London market, possibly in addition to commodities such as timber and tiles (*op. cit.*). Although little excavation has taken place on the iron production site, it is undoubtedly an industrial-class operation, which benefited from its position 1.6 km west of Margary's route 14.

OLDLANDS

The extensive industrial-class iron production centre at Oldlands (TQ 475267) occupies several hectares surrounding Old Mill Cottage, on Ashdown Sand at the junction with the Wadhurst Clay. The discovery of iron production at Oldlands, in 1844, was prompted by the realisation of the Reverend Edward Turner that ceramics associated with iron slag from Old Land Farm were of Roman origin (Bell-Irving 1903: 166-7, Dalton 1983). Field exploration of the site revealed extensive evidence of Romano-British occupation in conjunction with industrial activity. This is dominated by a horizon of bloomery slag, which extended for approximately "six or seven acres" and varying in depth between "two to ten feet." In addition, evidence was recovered for stone-built structures, inhumation burials, and a coin sequence extending from Nero to Diocletian (Lower 1849a, 1849b: 170-174, Turner 1862: 158). By Straker's time, there was still sufficient slag and *cyrenae* limestone to prevent deep ploughing of the site (1931: 397). Field exploration by the WIRG in March 1982 was designed to elucidate the area of occupation.

Evidence for the former extent of the slag banks is located exclusively on the NW bank of the stream (Tebbutt and Tebbutt 1982: fig 1), and probably extended for 3 hectares. On the southern banks of the stream the ground rises to an exposure of Wadhurst Clay, now occupied by Mill and Furnace Woods, which appears to have been the primary ore source for the site. It has been suggested (*ibid.*: 15) that to the east of the site the valley profile might have been altered at the junction with the clay as a result of quarrying. Large quarries were recorded downstream as far a TQ 474265 (*op. cit.*). The scale of the workings in the central Weald has led Tebbutt (1981: 60) to suggest Oldlands had a function as an administrative centre. The site certainly benefited from its position, only 1 km east of Margary's route 14. The close proximity to an arterial transport route could have been a major economic stimulus, which would account for the site's long period of occupation.

POSSIBLE PRODUCTION SITES

HENLY FURNACE

At Henly furnace, located on a tributary of the river Hall, Straker traced two bays at TQ 601338 and TQ 602336, on Lower Tunbridge Wells Sandstone, which he interpreted as being synonymous with the site of John Carpenter's forge at Brinklaw or Bunklaw, recorded in 1574 (Straker 1931: 275). Crossley suggests that the absence of forge cinder at both sites must make the identification tentative (Cleere and Crossley 1985: 336). Although no precise location is given, Straker notes that within the confines of the site, a small quantity of cinder was found in association with a sherd New Forest ware of possible third century origin (1931: 275). It is therefore conceivable that the Henly Furnace occupied the site of an earlier Roman bloomery.

This is not as improbable as it would first appear. Both bloomery and blast furnace iron production have the same requirements for raw materials, although both ore and charcoal could have been transported to the site from more considerable distances in the later period of occupation. The location, next to the stream, which was dammed in the Tudor era to provide power for the furnace and possible hammer forge, would have been an ideal location in the Romano-British era, as attested by the large numbers of bloomeries in stream side locations.

Although the possibility must be addressed that Romano-British material could have been transported to the site in conjunction with the movement of ore, it is unlikely that both iron slag and ceramic would still retain their association. The Henly Furnace site appears to be located on the site of a small Romano-British bloomery site of the third century, which has been extensively disturbed as a result of the construction of the later blast furnace. A similarly disturbed site has been recorded at Trolliloes.

STEEL CROSS

This site (TQ 5299 3183) is located on a small projection of Wadhurst clay in the Ashdown Sand. Evidence for iron production was first recorded by Straker (1931: 263) who noted that an extensive area of medieval excavations, extending for 12 or 15 acres, had caused a westward diversion of the main Tunbridge Wells to Crowborough road. Straker also noted that the "mounds contain a considerable quantity of ancient cinder, rich burnt ore, and burnt *cyrenae* limestone, but there is no definite heap it having doubtless been disturbed by the later diggings and perhaps for road metal" (*op. cit.*). Some form of excavation by Straker revealed a small fragment of glass bottle, thought to be Roman.

No reference was made to this site by Cleere and Crossley (1985: 295-305), possibly due to the difficulty of ascertaining the date of archaeological glass in the past. The site still contains a nucleus of bloomery cinder, charcoal-rich earth and some iron stone, centred at TQ 5299 3183 and extends for approximately 20 meters. Field survey and excavation for the NAR in 1970 revealed the presence, on the top of the mound, close to the surface, of "parts of the west and south wall foundations of a building, composed of small sandstone boulders" (NAR TQ 53 SW 7). Although this was possibly associated with the period of iron production, its location "close to the surface" of the slag deposit could indicate a post-Roman structure. Certainly significant medieval exploitation occurred in the immediate area. The remains of buildings have been recorded from the original ground surfaces of several Roman slag deposits in the Weald, although predominantly of industrial-class sites (cf. Oldlands). It seems unlikely that in a site of this size that space should have been at such a premium to require building on a older slag deposit. The slag scatter is relatively small, probably indicating local scale exploitation, although the extensive medieval activity could have resulted in the removal of some material.

ARBOREAL TAXA FROM THE WESTERN HIGH WEALD

The evidence from previous charcoal identifications undertaken on material derived from the western High Weald suggests that, as with the eastern High Weald, there was a generally consistent woodland taxa range. This comprises the characteristic oak domination found on *all* sites, in conjunction with birch, hazel and to a lesser extent the *Pomoideae*.

At the Romano-British iron production and working centre at Minepit Wood (TQ 523338) the site and its surroundings are on down-faulted Wadhurst

Clay at its junction with Tunbridge Wells Sand, with a thin belt of Grinstead clay to the north. A concentration of bloomery cinder is centred at TQ 5232 3384, the eastern side of which is bordered by a small ghyll. Examination of the ceramic assemblage by B. Cunliffe suggested that occupation began a decade of two before the Roman conquest and carried on until the later first century.

Identification of the charcoal, from the slag deposit and the furnace structure, revealed the characteristic dominance of oak. "The sample from the furnace was entirely oak. Samples from the slag heap were mainly oak but also contained small quantities of birch and hazel" (Money 1974: 7). The presence of birch and hazel are characteristic in Wealden samples, probably representative of colonisation of woodland clearings and margins.

This same taxa composition is witnessed at the iron production and working site at Pippingford Park (TQ 4460 3146). Excavation in 1969 by the WIRG revealed a single furnace of Cleere's type B.1.ii. (Tebbutt and Cleere 1973: Fig 2), in conjunction with a possible ore roasting hearth and a small domestic hearth with associated Romano-British pottery. The ceramic assemblage was dated by Cunliffe to the Claudio-Neronian period (Cunliffe 1973: 37), as was an associated bronze brooch.

The charcoal assemblage recovered from the furnace was dominated by oak, with some hornbeam in the ratio of 5:1, and two pieces of birch. Other than this no evidence as to the actual numbers involved is given, or can be found in the archive material. However, the fact that the oak and hornbeam is considered as a ratio, while birch is actually quantified suggests a moderate sample size. The domination of oak is characteristic, while hornbeam is relatively rare in Wealden iron production contexts. Its presence in the pollen spectra from Ludley Farm in the eastern High Weald, in addition to charcoal in the western High Weald from Stumletts Pit Wood 2, and Standen, does suggest that it was intermittently present throughout the Wealden woodlands. Its presence is probably indicative of a moderately closed woodland environment possibly in contrast to the pioneer birch taxa. It is possible that as the sample derives from a furnace the contents could derive form a discrete area of woodland, the hornbeam could have originated from one tree. The small size of the slag deposit, in conjunction with the single furnace in operation, suggests a limited period of operation, possibly one or two years. In isolation the long term effects of such an operation would have been minimal.

Limited evidence from the small-scale iron production site at Smythford (TQ 3584 3899), Crawley Down, reinforces the domination of oak in the Wealden woodlands. The charcoalified material identified by Caroline Cartwright came from two contexts, the roasting hearth, and a ditch feature which predated iron production on the site. Only five samples were submitted for identification. These were oak (n = 4) and *Crataegus* sp. (n = 1), which includes the hawthorn species.

The Smythford site is extremely small, even taking into account the removal of slag; it therefore provides an example of local exploitation. This would be entirely consistent with the early archaeomagnetic determination of A.D. 70 ± 20, at a 68% confidence level (Hodgkinson 1985: 18). The single furnace probably had a small output, although the small scatter of slag in the immediate vicinity of the site was not considered to be representative of the total production of the furnace. The possibility was put forward that the slag was utilised for the metalling of Margary's route 150 (London-Brighton) which passes approximately 150 meters to the east and which has revealed traces of tap slag to the north of the Felbridge Water crossing (*ibid.*: 17). The oak domination (80%) of the small sample of charcoalified material is entirely consistent with the other High Wealden samples, although the statistical viability is questionable. It is however, impossible to determine if the *Crataegus* derived from the pre-iron production phase or from roasting.

These analyses all derive from sites which have a transitional or early conquest date. They reveal extremely high levels of oak, in addition to tentative evidence for closed woodland taxa such as hornbeam. In contrast to many of the samples analysed by the author, birch although present is found in fairly low frequencies. It is possible that these early sites could provide traces of the Wealden woodlands prior to the massive modification of the Roman era.

Of the samples examined by the author, oak dominated without exception, ranging between 32% at Heaven Farm to 71% at Stumletts Pit Wood 2 and Standen. The assemblage at Heaven Farm provides one of the lowest frequencies of oak from the Wealden region; this appears to be explained by the utilisation of autochtonous riverside taxa. Certainly the absence of evidence for Romano-British activity in the area of the site could imply a relatively unmodified environment was prevalent in the area.

Other sites with a low percentage of oak and a correspondingly more diverse taxa assemblage are the group of moderate scale production facilities at Ridge Hill (52%) and Walesbeach (39%) in the northern High Weald. This could imply the presence of much environmental modification and the extension of secondary woodland taxa as a result of both iron production and other anthropogenic factors associated with settlement in the area from the Iron Age. The presence of 71% oak dominance at Standen also in this group does not wholly support these findings. However, at Standen the presence of possible scrub taxa such as buckthorn, does imply the presence of woodland clearings.

INDUSTRIAL EXPLOITATION IN THE WESTERN HIGH WEALD

The two known industrial-class iron production facilities in the western High Weald show tentative signs of enhanced activity around the 120s. At Great Cansiron the tilery produced a determination in the 120s. This structure was producing material for a bathhouse, although it has been suggested that these tiles could have been destined for further afield, such as Garden Hill. This is, however, unlikely; the tilery was not in operation for a long period of time, possibly only for a few firings, and it is not likely that this would have produced material for other sites. It is most probable that the material produced was utilised directly on the iron production site. Certainly the production of general-grade tile was likely to have been used on the industrial site as large quantities have been recovered by the Wealden Iron Research Group during field walking. If the bathhouse was on the Great Cansiron site, it would have significant similarities with industrial sites in the eastern High Weald, such as Beauport Park and possibly Chitcombe.

The production of tile on the Great Cansiron site around the 120s has another implication. Tiled buildings imply a certain degree of permanence. It is likely that prior to this large numbers of building on the site would have had thatched or shingle roofs. The use of tile and the construction of a bathhouse suggest that operations were envisaged to continue for a significant period of time, as would have been the case with the supply of the northern frontier. Alternatively the tile construction could be the archaeological manifestation of changes of ownership on the site, or the change in status from semi-industrial to industrial-class output. These scenarios are not necessarily mutually exclusive.

At Maresfield, south of Great Cansiron on Margary's route 14, there is tentative evidence for changes in landuse. However, the industrial site itself was primarily destroyed as a by-product of the extraction of road metalling during the early 1840s (Lower 1849a, 1849b). Very little remains to be seen on the contemporary site, compared with the industrial sites of the eastern High Weald.

As a result there have been few coherent excavations, and no publications. The majority of the material culture recovered represents collections recovered during or immediately after the extraction of metaling from the site. The result is an absence of a definitive chronology for the site other than the discovery of a coin sequence which extended from Nero to Diocletian and Aurelian (Lower 1849b: 170-4), none of which can be related to stratigraphy. However, around 120, at Uckfield, only 5 km to the south, there is evidence for the abandonment of a corn-drying oven. This rare example of evidence for activity in the High Weald could indicate that the boundaries of the industrial site were extended around this time, causing socio-economic change in the locality. Alternatively it could be indicative of changes to land ownership resulting from the need to supply the northern frontier. Such hypotheses are highly tentative, being related only by the proximity of Uckfield to the Oldlands facility.

The analysis of the fuel assemblage from the tile kiln at Great Cansiron (Cartwright 1986) exhibits an interesting taxa composition compared with that found in the slag deposits of other High Wealden sites examined by the current author. At Great Cansiron there was a tendency for the use of birch in fuel context such as the fill of the firing chamber, stoke hole and the main flue. While oak was also present in most of the contexts analysed, it was secondary to birch in many cases (Cartwright 1986: Table 6). The majority of the High Wealden slag deposits examined by the author suggest a dominance of oak with birch as a secondary or tertiary taxa. There are several possible explanations for this dichotomy. It is conceivable that the use of birch represented a deliberate choice on the part of the tile producers to provide a fuel with certain thermal qualities. The use of birch has been suggested as a good fuel source where a fast-burning wood is required. There would certainly be differences in the fuels required for smelting iron and those require for tile production. Smelting would have required charcoal, which would diminish the definable differences between *fuel* types, but ceramic production would only require dry wood, which would have been considerably more variable depending on the taxa exploited. Certainly there does appear to be evidence for the eastern High Weald which suggests that some selection of *woods* for certain tasks was in operation.

It is possible that different fuel taxa were combined to create the desired temperature, so fast-burning birch could have been combined with the more stable, longer-lasting oak to provide an even firing. However, as with charcoal from slag deposits, it is not certain if the charcoal debris derived from a single or multiple firings, or in the case of ceramic manufacture if it entered the kiln as charcoal or branch wood; although with tile production it would not be necessary to use charcoal, as the heat generated from branchwood would have been sufficient for firing.

However, the mechanism by which the charcoals entered the kiln and the subsequent archaeological record is complex. While the deliberate choice of fuel woods could have played a part in the composition of the archaeological assemblage, so does the species composition of the natural environment in the locality. The tilery site was located only 800 m to the east of the iron production site. Evidence from surface finds derived from field walking on the main production facility suggests that activity extended between the late first and second centuries A.D. (Tebbutt 1972). By the time of the construction of the tilery in the 120s the iron production facility would have been in operation for almost half a century. As a result it is highly likely that the environment in the vicinity of the site would have experienced significant modifications. The constant cutting of the original early Roman woodland in the vicinity of the site would have been beneficial for the extension of pioneer taxa such as birch and hazel which are both well represented in the kiln. In the vicinity of the site it is possible that these species, common to woodland margins and underwood, would have expanded at the expense of the slower growing oak woodland. A similar situation has been postulated for Ludley Farm, in the eastern High Weald, where soil pollen analysis from the slag deposit suggested a highly open and modified environment in the vicinity of the site. It is highly probable that in the context of tile production at Great Cansiron that the taxa recovered from the tilery that the taxa derived from autochtonous flora which were growing in the vicinity of the kiln.

Certainly by the time of tile production there is evidence of other modification to the environment. Plant inclusions recovered from tile produced on the site are suggestive of the presence of damp meadow in the vicinity†.

Otherwise the taxa composition of the tilery assemblage shows a strong correlation with that recovered from other High Wealden sites. This includes a low percentage of the damp-loving taxa such as the *Salicaceae* and the alder, a low percentage of other closed woodland taxa such as beech, elm, but a moderate representation of the *Pomoideae* spp.

MOVEMENT INTO THE WESTERN HIGH WEALD

The coin finds from the eastern High Wealden sites derive from two major sources. The most detailed come from the excavation of the bathhouse at Beauport Park (Brodribb and Cleere 1988: 256-7) and excavations at Bardown by Cleere (1970). This information is complemented by the random recovery of coins from excavations and explorations of slag deposits in this region since the mid-nineteenth century.

† These included *Ranunculus* sp. (buttercup), *Cerastium* sp. (chickweed), *Linum catharticum* (purging flax), *Potentilla* sp. (cinquefoil, tormentil), *Bellis perenis* (daisy), *Jugulans conglomeratus*, *Jugulans* sp.(rush), *Luzula* sp. (wood rush),*Carex* sp. (sedge) and *Deschampsia* (hair grass).

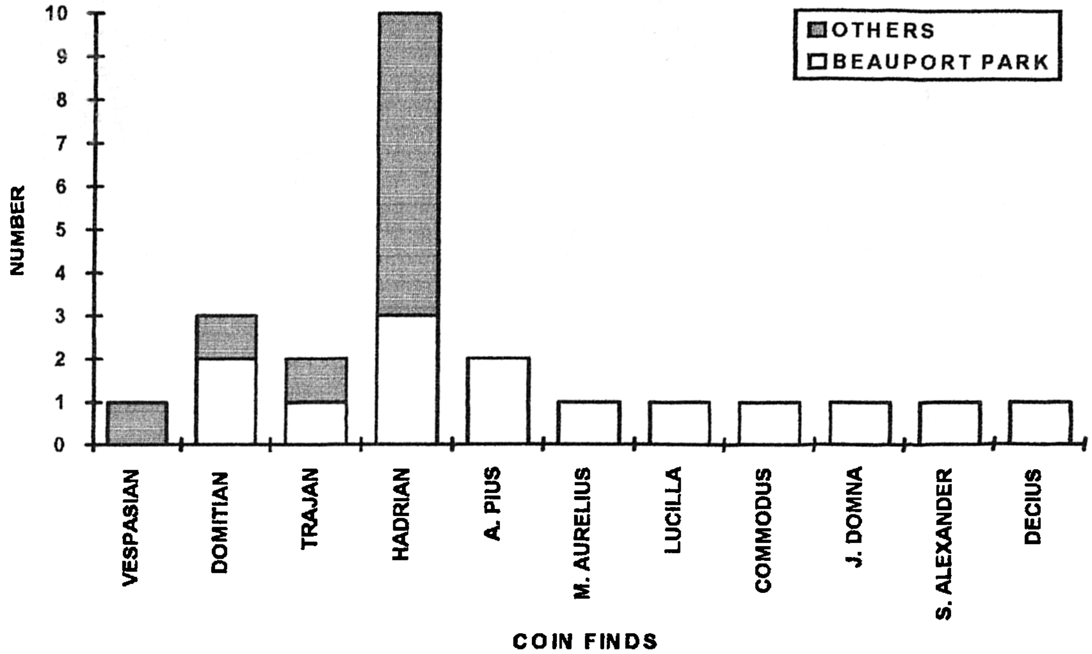


Fig 7.12 The dominance of Hadrianic coin finds from Roman iron production sites of all classes in the eastern High Weald.

The dominant feature of the amalgam of results is the preponderance of Hadrianic currency. While taphonomic factors such as the length of Hadrian's reign (A.D. 117-138) could account for some of the finds, the reigns of emperors such as Trajan (A.D. 98-117) and Antoninus Pius (A.D. 138-161) were also comparable in length. In addition size differences between coin types of coins were not significant until the later part of the second century. It is likely therefore that the dominance of Hadrianic coinage is a function of a significant input of capital during his reign. The construction of the Northern Frontier would provide a correlate for this sort of direct imperial expenditure.

There is no evidence to suggest that the apparent move into the Western Weald in the second century was a response to declining woodland reserves in the eastern Weald. The eastern Wealden sites apparently carried on producing at a high capacity until the general decline in the early third century. The absence of nucleations of large industrial sites in the Western Weald, which are characteristic of the Eastern group, suggests a different management strategy.

CHAPTER EIGHT

THE ENVIRONMENTAL IMPACTS ASSOCIATED WITH ROMAN IRON PRODUCTION

THE ENVIRONMENTAL IMPACTS ASSOCIATED WITH ROMAN IRON PRODUCTION

The anthropogenic interference and manipulation of the environment necessary for iron production and its associated processes would have resulted in significant changes to elements of both the Wealden vegetation and landscape, some which would have been immediately apparent to the Roman population. The component processes of iron production, including ore extraction, ore processing, ore smelting and secondary and tertiary operations, would all have had differing implications for the environment. The scale of the corresponding immediate vegetational impacts is primarily a function of the scale of iron production undertaken and the geological matrix on which it is based. The long term vegetational impacts, defined as those impacts evident in the landscape after the cessation of iron production, are primarily a function of the geology.

The distribution map is a far from ideal tool in elucidating environmental impact. The previously mentioned biases in research in the Wealden region have produced a site distribution skewed towards activity in East Sussex. At its most basic, environmental impact can be considered to be a function of the size and nature of impact over time. The major phase of Roman iron production in the Weald covered about 200 years, from the invasion in AD 43, to widespread cessation in the 240s. The primary method of dating sites derives from the recovery of local ceramics such as East Sussex ware. These are characteristically difficult to date other than in the broadest terms of earlier and later Roman.

A tentative idea of the regional impact of Roman iron production in the Weald can be gained by extrapolation the known distribution of sites. The estimation of the number of Roman sites in the Weald is not possible without a high degree of speculation, however, sufficient information is available from the High Wealden region to provide a probable gauge of the scale of activity. This is commensurate with the long period of excavation and research which has been devoted to the iron industry of the High Weald. The evidence for activity on the peripheral geologies is significantly more prone to speculation. The distribution of sites is primarily a function of the location of suitable geological deposits, and possibly fuel sources in some cases. The movement of raw materials for iron production would only have a negligible effect on the number and distribution of sites.

THE HYPOTHETICAL DENSITY OF BLOOMERY SITES IN THE HIGH WEALD

The evidence for bloomery activity in the High Weald is characterised by the smaller scale/domestic and mid-range operations, rather than industrial-class exploitation. Although industrial-class operations have been estimated as having produced approximately 110,000 tonnes of bloom iron[†] these facilities are highly concentrated in the Hastings hinterland and the vicinity of Margary's route 14 in the western High Weald.

[†] Cleere's (1976a: Table 1, 238) estimates for the six industrial-class eastern High Wealden sites is Bardown (4,500 tonnes), Beauport Park (30,000 tonnes), Chitcombe (10,000 tonnes), Crowhurst (10,000 tonnes), Footlands (15,000 tonnes) and Oaklands (20,000 tonnes). The two major western high Wealden industrial sites at Oldlands and Great Cansiron would probably have produced about 20,000 tonnes between them. The total industrial production based on these figures is approximately 110,000 tonnes of bloom iron, although modifications to this total by the current author suggest that at least 10,000 tonnes can be removed from this total.

Outside of these two nuclear regions the exploitation of iron tends to be in the form of small-scale and mid-range workings. It is therefore small-scale production which has the more far-reaching implications for the environment because of its ubiquitous nature. Some attempt must be made to elucidate the number of sites in the various regions of production. Field research by the WIRG predominantly in the High and Weald provided data for the determination of the distribution of both dated and undated bloomery activity (Tebbutt 1981a, Hodgkinson and Tebbutt 1985). A study area was selected encompassing 182 km^2. Field walking recovered evidence for 246 bloomeries, equating to a density of 1.4/km^2.

The taphonomy of site recovery was considered by Tebbutt who noted a dichotomy between the discovery of bloomery sites on stream banks and those from other areas. "The finding of these stream-side sites is not difficult; some slag is inevitably washed into the stream and carried down to be deposited in shingle beds. By following the slag trail upstream the site can usually be located" (Cleere and Crossley 1995: 281). However, the probability of recovery of bloomery activity was significantly lower away from these smaller streams, as a result of the preponderance of permanent pasture, and woodland in addition to visibility factors in the clay geologies. The location of bloomery sites away from streams was therefore considered to "significant but not great" (*ibid.*).

Fig. 8. 1 The discovery of bloomery sites of different eras in the WIRG study area, using the data of Tebbutt (1981a)

The results of trial trenching, by the WIRG, of a random selection of the undated bloomery sites, in addition to the sites which had been previously dated by other researchers revealed an 82% dominance of Roman sites, with 13% medieval and 5% Iron Age. If these figures are extrapolated for the High Weald without modification the density of bloomery sites would be 1,870 x 1.4 = 2618 bloomery sites in the High Wealden region, of which 2,147 would be of Romano-British date. However, the data needs modification at two levels: the density of undated sites, and the percentage of these assumed to be Roman.

It cannot be assumed that the density of sites proposed is a accurate reflection of the total of sites, if only streams and other random areas were fieldwalked. It is likely that a density in excess of 2.0 undated sites per km^2 was applicable. If it is assumed that for every two streamside sites there was at least one other site then a density of 2.1/km^2 could be envisaged, providing a hypothetical site total of 3927, for the High Weald alone. In the study areas researched by the author this figure is achieved or exceeded.

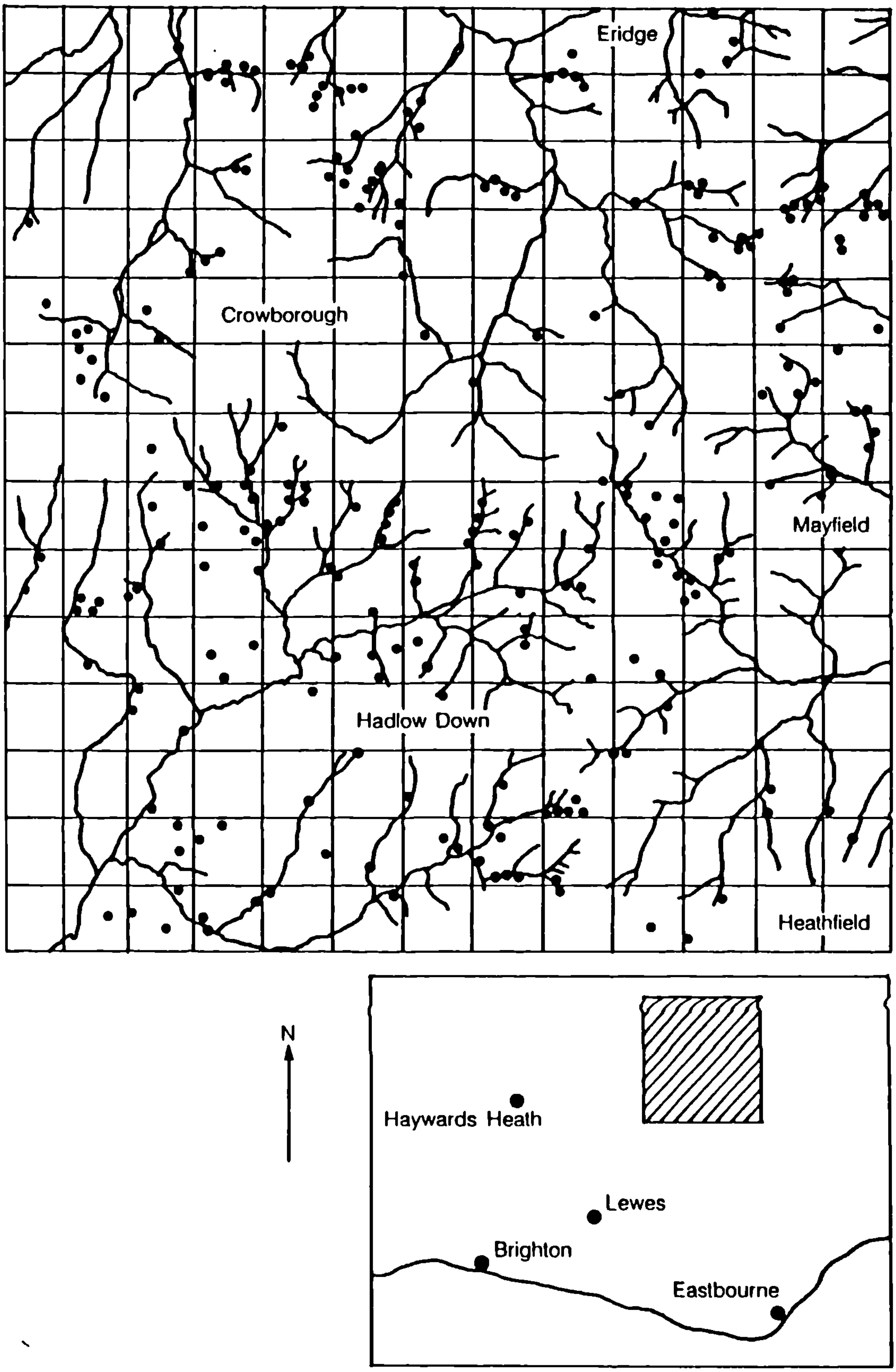


Fig 8.2 The location of the WIRG study area, after Tebbutt (1981a)

The recovery of 33 sites of Romano-British date within the WIRG study area implies a dominance of Roman activity; however, the application of the conversion factor of 82% suggested for High Wealden sites would be unreasonable, considering that the Romano-British era represents only 20% of the possible time-span of bloomery activity. When it is considered that the major phase of activity covered the mid-first to mid-third centuries, then this figure can be reduced still further to 10% of the possible time-span at high production levels and 10% at moderate to low levels of production. The possibility should also be addressed that bloomery sites of other eras do not have the same archaeological visibility as those of the Romano-British era. It is conceivable that in some cases evidence for prehistoric iron production was destroyed by later Roman workings which could have used evidence for previous bloomery sites as a guide of the location of later exploitation. In addition many prehistoric ceramic forms appear prone to degradation in the plough soil (Tebbutt 1995: 282).

Roman activity benefits from the vast range of ceramic forms of local, regional and empire wide manufacture that can occur on these sites. These highly diagnostic ceramic forms have in many cases an enhanced archaeological visibility as a result of differential glazes, firing techniques, and clay sources. The larger scale of ceramic production which resulted from the Roman occupation allowed for the production of a product that had a greater resistance to archaeological attrition.

Saxon exploitation is the most enigmatic of all eras of Wealden industry, with only two bloomery sites recovered from the Wealden region, and none from the WIRG study area. This is suggestive of extreme under-representation rather than of an absence of activity. The Weald was occupied during the Saxon era, if only for the provision of pannage in the Early Saxon era; it would be highly unlikely that the iron resources were unused. It is probable that the use of ceramics was subsidiary to the use of perishable organic containers and artefacts. This would certainly be the case if earlier activity was of a transhumant nature. It has been noted ceramics of Early and Mid-Saxon eras are extremely rare even in heavily occupied sites.

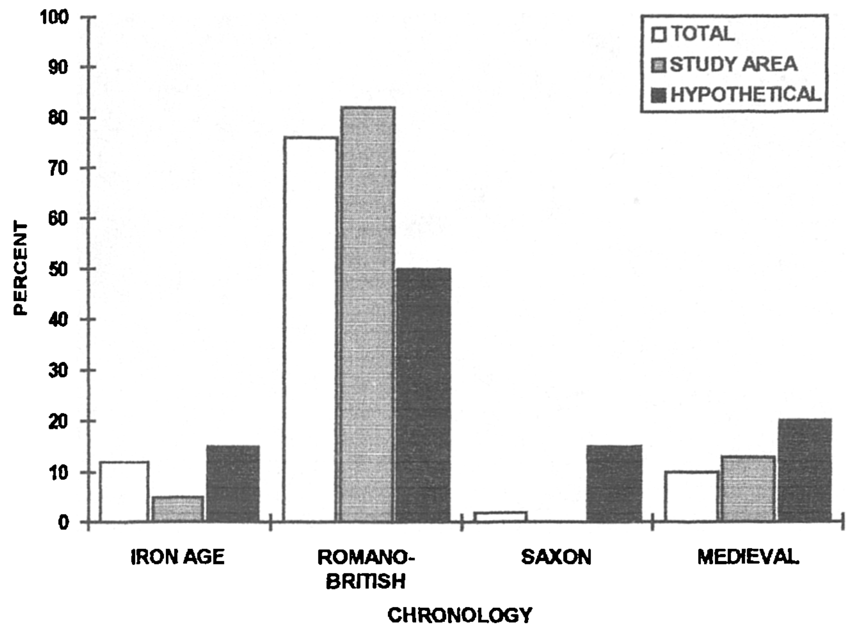


Fig. 8.3 A hypothetical breakdown of numbers of bloomery sites of various eras, based on the total number of known sites in conjunction with the data obtained from the WIRG study area

As a result of the various biasing factors a hypothetical estimate for the number of Roman bloomery sites could be as high as 50% of the sites in *the Wealden region* while prehistoric and Saxon could account for 15% each and the Medieval 20%.

Based on these approximations of the density of Romano-British sites, an estimate of between 1964 to 2000 Romano-British sites for the High Weald could be applied. Based on the available information the degree of accuracy is questionable, so a tolerance of ±500 sites is suggested, providing a highly conservative total of 2000±500 Roman bloomery sites for the High Wealden region. Such a figure is not entirely without precedent. In the Holy Cross Mountains of Poland, field survey has resulted in the recovery of 5000 iron productions sites which were dated to the Iron Age or Roman periods; the sites recorded were considered to have contained over 100 furnaces (Mighall and Chambers 1993: 74). The postulated size of the Roman iron industry in the Weald would have been small by comparison.

THE HYPOTHETICAL DENSITY OF BLOOMERY SITES ON THE LOW WEALD

Compared to the High Weald, considerably less information exists for the Low Weald from which to base extrapolations of site density. The lack of coherent research has produced only four Romano-British sites, from which little meaningful information can be extrapolated when considering a region which covers 35.8 % of the Wealden land surface. However, the distribution and number of post-medieval blast furnaces is better understood. The number of these sites which are currently known, will be a relatively accurate representation of the original number of post-medieval indirect production sites. This data could then be extrapolated to provide a gauge of the percentage of sites which existed off the High Weald in the post-medieval era, and with modification in the Romano-British period.

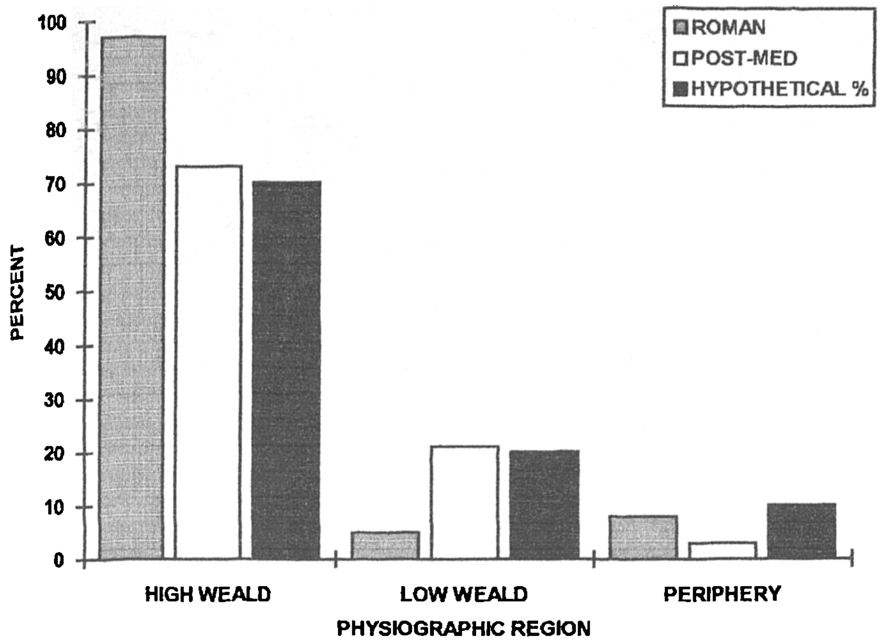


Fig. 8.4 A hypothetical breakdown of the numbers of bloomery sites in the Wealden periphery as seen as a percentage of activity in the High Weald

Twenty-two blast furnace sites have been located on the Weald Clay, out of a total of 96 (178 furnaces and forges), which is equivalent to 21% of blast furnace sites. However, the large requirements of ore needed to sustain indirect operations predicated the location of these later sites on clay ironstone seams which would have provided a relatively consistent output. It has been suggested (Chapter 5) that an additional source of iron for the Low Weald would have been the shrave/iron pan deposits built up as a result of chemical migration of iron oxides through the soil matrix in conditions of impeded drainage, characteristic of the stagnogley soils of the Low Weald. Such discontinuous deposits would not have attracted the later blast furnace sites, but would have been ideal for the smaller bloomery sites. The percentage of these small scale sites could possibly raise the numerical representation of the iron production potential of the Low Weald, as a result of their discontinuity. These advantages must be countered with the difficulties of mining the clays, the heavy vegetation that would have concealed some deposits, the difficulty of agriculture needed to sustain population and a consequent lower population. Allowing for these *caveats* it is possible that the Low Weald might have sustained 20% of the number of bloomery operations hypothesised for the High Weald, or 400 bloomery sites of all periods. The calculations based on such hypothetical data could be prone to considerable revision, and a tolerance of ± 250 could be applicable. The output of iron from these Low Wealden sites would have been highly variable. Sites located on the major ore seams could have sustained a substantial production, however, much of the activity would have been extremely small scale, based on the exploitation of iron pan or shrave on the stagnogley soils.

If evidence for Roman iron production in the Low Weald is tentative, then estimations of the extent of activity in the periphery is highly problematic. There are as yet no indications of larger scale Roman facilities, which is primarily a function of the concentration of activity on the Folkestone Beds, of the Greensands, and the discontinuity of the deposits on other geologies. The Folkestone Beds represent only 24.3% of the total land surface of the scarp foot region (1,110 km^2), which would significantly reduce the number of bloomery operations which could have been expected in this region. The possibility that iron pan deposits could have been exploited on the Gault geologies might serve to increase the number of sites, although not significantly. The general absence of shrave on the Greensands is a function the better drainage than that of the stagnogleys. The hypothetical total could be as little as 10% of that of the High Weald.

IMPACTS ASSOCIATED WITH IRON PRODUCTION

ORE EXTRACTION

Ore was probably extracted in two ways during the Roman exploitation of the Weald for ferric resources. These include surface collection, or, more commonly, open-cast quarrying. There are, however, significant difficulties in the dating of minepits and quarries. The most frequent method is that of proximity; the closeness of a minepit or quarry to an iron production site is seen as an indication of the likelihood of its utilisation by that site. This method alone can not be directly qualified in the archaeological record. In rare instances where modern survey and excavation techniques have been applied, some minepits have been found to be linked by slag-metalled roads to the site of production, which provides the most viable method of linking the extraction site to a iron production site. Examples of such sites include Bardown (Cleere and Crossley 1985: Fig. 10), and Great Cansiron (Rudling 1986: Fig. 1). The most frequent method of providing chronological determinations for Romano-British iron production sites in the Weald is a result of the acquisition of diagnostic material culture, but this method cannot normally be applied to Roman minepits. Minepits and quarries, by their very definition, result from the removal of material from a given location, and, as a result, they do not tend to encourage the deposition of diagnostic material culture. Mining would tend to be an activity which brought workers to the extraction site on a daily basis, or other time scale depending on need, rather than requiring a permanent base around the site of extraction.

The *usual* proximity of mining sites to the site of smelting does not normally allow for significant domestic and residential activity in the vicinity of the extraction site.

Such activity would tend to concentrate on the residential components of industrial and semi-industrial sites, whilst for smaller exploitation sites residential *foci* tend to be located off-site. An exception to this general trend was the recovery of the base of a New Forest sherd by Straker (1931: 387) from a minepit at Limney Farm. In some cases the primary silts in minepits can contain carbonised or organic material suitable for radiocarbon determination, although the cost of dating, the large standard deviations inherent within determinations, and the dispersed nature of the results tends to negate this as a statistically valid method for dating, especially when considering the confines of the Roman occupation. Exceptions include the two medieval determinations of AD 1220 ± 80 and AD 1120 ± 75, obtained from waterlogged timber from minepits at Sharpethorne Brickworks (Swift 1986). No other determinations have been undertaken for minepits in the Wealden context.

The various extractive technologies have differing ecological impacts. Surface collection, as exemplified by the procurement of iron pyrites on the Downs beyond the Wealden periphery, or domestic surface utilisation of exposed faults and pockets of ore in the High Wealden region, would have caused minimal disruption to the environment. The exploitation of surface deposits tends to be associated with small scale-operations, or possibly a negligible component of larger-scale extraction operations. In the absence of significant ground penetration, the effects of such operations on the environment would have been minimal, both morphologically and on the vegetation.

The dominant archaeologically-visible extraction method involved the utilisation of open-cast quarrying. This varied considerably in scale from small extractions to extremely large quarries associated with industrial sites. In some cases, these were morphologically enlarged mine pits, such as at Crowhurst Park. However, the majority of these took the form of cuttings which followed the ore-bearing strata. The size of impact shows a distinct correlation with the size of the smelting operation. There is evidence from the industrial complex at Chitcombe to suggest that significant morphological changes to the profile of the Tillingham valley occurred, possibly over several hundred metres, as a result of the extraction of ore from the clay ironstone bed in the valley side. At Great Cansiron the open-cast quarries at Puckstye Farm and possibly Tugmore Shaw cover a combined area of 2.5 hectares (Swift 1986: Fig 1, 193). These quarries alone would have resulted in the removal of significantly in excess of 100,000 m^3 of geological material, ranging from topsoil and surface vegetation to geological formations including siltstones, sandstones and clays. At Footlands the main quarry at Cinderbank Shaw would have resulted in the removal of approximately 49,500 m^3, while the Quarry in Footland Wood, to the west of the site, would have resulted in the redeposition of 40,000 m^3 of geological material.

Certainly estimations by Worssam for the volume of ore and gangue extracted during the blast furnace exploitation of the Weald suggests a significant volume of material had to be moved. It can be postulated that throughout the Wealden region in the Roman occupation as much or more geological material, than the volume of ore obtained, would have been removed to extract the iron ore deposits. The non-ore bearing matrix could, however, have had limited uses. On the clay-dominated geologies some of the spoil could have provided material for furnace construction and repair, in addition to being the source of the horizons of clay, thought to serve hygiene purposes, in the slag deposits of sites of industrial and semi-industrial class. Smaller iron production sites, with considerably less need for clay for furnaces, could have obtained suitable clay from local sources in the vicinity of the site.

In the author's personal experience, the extraction and movement of undisturbed Wealden clays requires a substantial effort. Experimental work by the author suggests that $1m^3$ of undisturbed Wadhurst Clay would require approximately 100 minutes to extract, although *with practice this figure could probably be reduced to around 90* minutes. The density of the clay in conjunction with the weight of integral water and the dense ground vegetation it supports exacerbates the situation. Based on these figures the quarries at Great Cansiron and Footlands would have required 150,000 and 135,000 hours for quarrying alone. These figures only relate to the extraction of the clay and not its removal from the quarry to the spoil heap, or for the transport of the ore to the smelting site. Such activities would easily double the time required. The majority of known extraction sites in the High Weald are located on the Wadhurst Clay (cf. Fulford 1989: Fig. 4); the manual resources required for the removal of such overburden would have been substantial.

When these figures are considered in conjunction with the other quarrying operations which occurred throughout the Roman Weald on both industrial and non-industrial sites, the results indicate the removal and redeposition of significantly in excess of a million cubic metres of geological material. In the context of the wider Weald, and within the temporal framework of the Roman occupation, this size of impact would have a limited effect, with the exception of the accelerated erosion which would result from the removal of vegetation cover and the redeposition of material. Locally, the redeposition of the gangue outside the quarries could not have failed to have a significant impact on the indigenous vegetation, essentially changing the morphology of the pre-industrial land surfaces in the immediate locality. In addition, in the short term there would have been a significant reduction in surface stability and modification to the soil type with inversion of geological strata with topsoil. The pedological instability which would have resulted from the disturbance of soil and the erosion of quarry faces would have encouraged the expansion of pioneer herbaceous vegetation which is tolerant of ground disturbance such as *Artemisia*, *Gramineae*, and *Caryophyllaceae* on sandy lithologies. The redistribution of geological material would have been beneficial to the spread of taxa with perennial organs. The relatively constant activity which would have been a product of mining operations would not have allowed the extension on such taxa, other than on the margins of activity and in isolated niches in the production area. The constant disturbance would have resulted in rapid ecological change in and around mining operations.

It does not appear that so called 'bellpits' were utilised in the Romano-British era as a method for ore extraction (Worssam 1964: 539). Although the dating of minepits is difficult and rarely achieved, the few dated examples of Wealden bell-pits are all post-Roman. In cases of confirmed Romano-British quarries and extraction sites, such as Tugmore Shaw and Petley Wood, there are often examples of smaller minepits and bellpits cutting the proposed Roman workings, suggesting a latter period of exploitation for this type of extraction method. The tendency appears to be for larger-scale extractive methods in the Romano-British era, while the medieval and later eras witnessed a decline in the use of quarries, resulting in a more extensive utilisation of the landscape through smaller minepits. However, in view of the absence of archaeological research on minepits in the Wealden region, this can only be a tentative hypothesis. Certainly it is probable that in some cases small-scale bloomery activity might have resulted in the creation of correspondingly smaller minepits, but the scant and tentative archaeological evidence does not fully support this. At Heaven Farm, one of the smallest recorded iron production sites from the Roman Weald, the nearest evidence for ore extraction is a large cutting in the side of a slope, with no evidence for minepits.

Unlike evidence from the Forest of Dean, the other major Roman iron production district, and other imperial provinces, there is no evidence for the utilisation of underground mining using shafts and galleries. At Lydney, the entrance to a sloping shaft, which followed the ore seam, was sealed by a late third century hut (Wheeler 1932: 18). Other less securely dated galleries radiate from open cast mines at Coleford and a cave-like aperture at Great Dowland (Bromehead 1947: 361, Coghlan 1977: 15). The apparent absence of Roman sub-surface mines in the Weald could relate to the low archaeological visibility of galleries and shafts. It could be a function of the wide availability of ore sources close to the surface in the Wealden region, which would negate the expense of the construction of shafts and galleries. There are also significant problems in the creation of underground galleries in clay geologies which do not tend to have the stability to support such structures, and as a result require significant timbering.

This was demonstrated by the last attempt to exploit clay-ironstone in the Weald at Snape Mine, between August 1857 and September 1858 (Straker 1931: 290). In some cases, the higher rainfall and lower permeability of some Wealden geologies compared with the sandstones of the Forest of Dean, make shafts more prone to flooding. It could also relate to the continuation of pre-Roman Wealden traditions of ore extraction.

The methods of ore procurement and extraction were primarily a function of the scale of the operation, as were the corresponding impacts. The immediate effects of the environmental manipulation associated with ore extraction would have resulted in the removal of vegetational cover; the redistribution of significant quantities of soil and geological strata; accelerated erosion derived from the enhanced volumes of anthropogenic traffic; and heavy ore-laden transport and the creation of roads and temporary trackways to facilitate the movement of ore to the centres of production.

The creation of quarries and minepits would have entailed significant primary, secondary and tertiary impacts. The primary impacts are defined as those related to the physical penetration of the ground. This would have resulted in the removal of the surface vegetation *in the area of the mining operation, and also in the immediate vicinity* of the extraction, where intensive pedoturbation would have resulted in the trampling of vegetation. The non-ore-bearing spoil from the excavations would have been deposited in the immediate vicinity. The effect of this would be to further modify the immediate locale of the extraction site. Once out of use, the long term effects of ore extraction would be morphological change to the landscape. The deforested areas associated with extraction would in some cases, revert to scrub and woodland vegetation in these sheltered micro-environments. However, in the impermeable clay, minepits have a tendency to fill with water either semi-permanently or intermittently, thus preventing the regeneration of arboreal vegetation, or favouring taxa such as the *Salicaceae* and *Alnus*. The morphological changes associated with iron production have had long-term effects on the environment, although changes in the profile of pits and quarries, as a result of the accumulation of sediment, have also occurred over time.

Secondary impacts can be postulated as a result of the development of a transport infrastructure to link the sites of extraction to the sites of iron production. Where contemporary excavation and survey have occurred on iron production sites, such as Great Cansiron and Bardown, there is evidence of slag-metalled trackways linking the quarries with the smelting sites. In these contexts, although the industrial nature of the sites would have resulted in the heavy clearance of the immediate locality, it is likely that these trackways had a minimal effect on the vegetation. However, on many sites, the presence of both fixed-position metalled trackways and the more variable non-metalled trackways would have had an effect on the environment, with the metalling preventing the regrowth of vegetation and focusing traffic through certain routes. Where no metalling existed, the volume of pedestrian and animal traffic moving to and from the extraction site, and transportation of quantities of ore would have exerted a localised impact under the broad category of pedoturbation. The distance between the site of extraction and production can vary considerably. With the nucleus of extraction on site at Chitcombe and Petley Wood, but significantly away from the site of production at Great Cansiron, industrial sites do not exhibit a standard economic formula. Smaller bloomery sites, which have fewer factors influencing their location, other than ore location, tend to be located in the immediate vicinity of ore extraction (cf. Heaven Farm and Iridge bloomery).

In addition, the transport infrastructure would have required equipment to facilitate transport of raw materials. Little evidence exists for the method of transport of the ore in the Roman Weald. However, both manual transportation and animal power were used, as pack animals are mentioned in the literary sources from the classical era (Euripides fr. 283 N^2, Strabo 14.2.24). There appears to be a considerable reliance in the Classical world on the use of manual labour for the movement of wood and the production of charcoal production. Wood and timber were often moved manually which is seen in the Greek literature (cf. Homer's *Iliad* 23.123, Aristophanes *Acharnians* 272, Menander *Dyskolos* 30-32) and in Roman sources, such as Trajan's Column, and a Gaulish relief of the manual movement of a large tree-trunk (Meiggs 1982). Both of manual and animal traction methods would facilitate the rapid movement of material from the Wealden landscape, some regions of which have the tendency for heavy geological incision, above average density of woodland cover. It certainly appears that at Turners Green, where small deposits of ore were recovered over much of the site, ore was transported to the site in panniers either on the backs of pedestrian or animal traffic (Beswick *pers. comm.*). However, the Turners Green site does exhibit some anomalies compared to other Roman iron production sites, so this might not have been standard practice. It is also unwise to hypothesise from a single site to the wider Wealden region. With smaller-scale bloomery sites, it is conceivable that the limited amount of ore used and the relatively short distances from the minepits to the smelting sites would encourage transportation in panniers. Detailed examination of the Bardown complex by Cleere (1970: 13) revealed no evidence of wheel ruts in the road surfaces examined. However, it has to be noted that the road systems on industrial sites were often resurfaced many times during their period of use (*ibid.*: 9). If this is considered in conjunction with the high resilience to mechanical abrasion exhibited by slag, the possibility that wheel-ruts would not be manifested in the road surfaces is possible. The possibility of the limited use of wagon transport can be deduced on excavated iron production sites by the width of the slag metalled roads which normally exceed five metres, such as those at Carter's Farm and Bardown. The late fourth-century Codex Theodosius provides a list of the major forms of wheeled transport which existed in the late fourth century, and imposed weight limits on these, designed to alleviate wear and tear on the highway system. The major transport types were the ox-drawn cart (capacity 490-750 kg), post carriage (capacity 325-500 kg), the cart (capacity 200-300 kg) and the two-wheeled cart (capacity 65-100 kg) (Hyland 1990: 257, Kendal 1993: 47-8).

It appears likely that many methods were used to transport raw materials to the sites of production in the Roman Weald; however, they were probably dominated by the use of pannier-type transport on manual or animal traffic. These methods would have been highly labour-intensive as both ore and spoil have to be moved. Both of these methods would have required some input from the wider environment. These include flexible withies from hazel, birch or osiers for panniers and other containers, and wood for wagons. As with all transport devices it is possible that they could have been produced outside of the Wealden region, although in most cases this would appear to be extremely unlikely. In addition, some source of fodder would have been required to sustain the draught animals. Certainly the palynological evidence from Ludley farm suggests that in the vicinity of the site hay-meadow may have been present, while the macro-botanical remains from the tile kiln at Great Cansiron suggest damp meadow in the vicinity of the site, as well as grassland. Such environments would be a useful source of fodder for draught animals.

Tertiary impacts are related to the population increase in a locality, resulting from the need to produce iron. This would have an effect on the local environment as a consequence of local food production and fuel wood collection. However, evidence for arable production in the vicinity of Roman iron production sites is limited and is subject to various interpretations. The presence of *Cerealia* pollen in the slag deposit at Ludley Farm could have derived from sources other than arable production around the site and the other indicators of arable production could possibly be present as a result of the extensive ground disturbance encountered on iron production sites.

CHARCOAL PRODUCTION

Of all the impacts associated with the production of iron in pre-industrial revolution society, those associated with the production of the fuel have achieved the widest attention. The fuel needs for the smelting process are highly specific. The impurities found in coal, such as sulphur, can contaminate iron smelted with it, while dry wood could not attain the temperatures required for smelting, due to the heat energy which is wasted in the vaporisation of its integral water. To compensate for this, wood could be converted to charcoal.

Prior to the discovery of the conversion of coal to coke by Abraham Derby, charcoal was the only major fuel available for industrial operations such as smelting. Wood converted to charcoal has two functions in iron production. First, its high calorific value provides an excellent source of heat for smelting. The absence of combined and uncombined water in charcoal compared to wood results in a hotter, more easily controlled heat than could be achieved by dry wood, which is thermally inconsistent during combustion as a result of the vaporisation of internal moisture. Second, in the context of bloomery iron production, charcoal represents more than just a source of heat energy. It represents a source of almost pure carbon which can be converted first to carbon dioxide, then to carbon monoxide. It is this which allows chemical reduction of the ore during smelting.

The production of charcoal from wood results in intrinsic costs to the environment. Accurate estimates of the conversion figures for wood to charcoal are notoriously variable, primarily as a result of the difficulties of quantifying wood in terms of volume and weight, as a result of its irregular shape and variable water content. The ratio of wood to charcoal produced varies between 4:1 and 12:1, an accepted contemporary average is 7:1 (Cleere 1976a: 240).

Charcoal is the carbon residue created by heating wood in the absence of sufficient air for complete combustion. This can be produced deliberately during charcoal production, or to a lesser extent, as a by-product of oxidative combustion.

Charcoalification results first in the removal of water, followed by the volatile compounds. There is little evidence from the archaeological record for the method of charcoal burning used in the Roman period, but classical authors suggest that both charcoal kilns, and pits were used. Theophrastus in his *History of Plants* (V.9.4.) records the progress of a charcoal burn "They cut and require for the charcoal heap straight smooth billets: for they must be laid as close as possible for the smouldering process. When they have covered the kiln, they kindle the heap by degrees ... such is the wood required for the charcoal heap." This can be supplemented with Pliny's account in his *Natural History* (XVI.8.23) of a clay structure used as a charcoal kiln. However, evidence for pit structures are also recorded although predominately by Greek authors such as Theophrastus in his *History of Plants* (IX.3.1-3), and Aelian (NA 1.8) (Olson 1991: 414). There is no archaeological evidence from a Wealden context for pit kilns, which might be evident in the landscape as pits or depressions with a high carbon-rich soil and charcoal content.

Tylecote (1986: 225) suggests that charring pits, or "pit-steads", have been recovered from an EBA context in Mildenhall, East Anglia. He also tentatively suggests that trenches found on the Roman iron production site at Wakerley could be examples of pit-steads. The two methods of charring have differing advantages and disadvantages. The creation of a pit requires a significant input of labour, unless a minepit were to be modified; however, the same pit can be re-used. If several episodes of re-use are undertaken on a single site, then the baking of the pit walls would serve to prevent contamination of the charcoal product. In contrast, the above-ground clamp would be destroyed after every episode of charring, although the same baked earth base could be used again. The major advantage of the above-ground clamp derives from its mobility - the simplicity of clamp construction allows it to be constructed near, or at, the site of wood cutting.

The apparent absence of charcoal production in the archaeological record is not surprising, since the production of charcoal would have occurred in the Wealden woodland and in most cases would not be directly associated with the sites of iron production, although possible exceptions could be evident at Bardown and Broadfield.

Green wood is composed of an average of 50% water, which can be reduced to 30% after exposure and seasoning. The removal of water during charcoalification would result in some volumetric loss. In addition, the nature of wood does not allow for compact transport due to the large volume of air spaces that are created between the branches or timbers. Therefore the transport of wood to the smelting site would result in the requirement of at least 40-50% more transport than if charcoal production were to occur in the woodlands. By contrast, the production of charcoal off-site and the transport of the product would result in a significantly lighter load, greater compaction due to the smaller size of the charcoal pieces compared to branch wood and the loss of volume due to charcoalification. However, the transport of charcoal to the production sites compared to wood would result in some fragmentation and attrition of the brittle charcoal as a result of compaction and movement during transit. The carriage of charcoal was limited to some extent by the inherent friability of the material, and Crossley (Cleere and Crossley 1985: 133, 135) suggests that transport beyond 5-6 km would considerably degrade the charcoal. This would be in accordance with the zones of exploitation postulated for the some of the eastern High Wealden industrial-sites. In some cases the distance between sites was as a little as 3.5 km between Beauport Park and Oaklands, 5 km between Beauport Park and Crowhurst Park. Such degradation during transportation does not apply to the smaller-scale bloomery operations, where it is likely that all the integral elements of production would have occurred in a relatively spatially confined area, and the distinction between on-site and off-site would have become increasingly blurred as the size of exploitation decreased.

Charcoal production is a mobile activity which follows the available woodland resources and is dependent on the demand from iron producers. This mobility does not allow for the development of infrastructure, such as metalled trackways associated with other off-site activities such as mining. The primary components of a kiln would include the wood, the kiln wall, and possibly turfs or clay, which would leave little trace in the archaeological record. When the charcoal is removed from the kiln, the wall is destroyed. In an ideal context the only remaining evidence for charcoal production would be the area of intensely fired earth or clay, carbon-rich soil in the immediate vicinity of the kiln and, in exceptional circumstances, this could be complemented by burnt kiln lining and material culture. However, the absence of above-ground features means that sites only tend to be revealed after ploughing when the carbon-rich soil is exposed, which almost inevitably results in the degradation or destruction of the site.

The heavily wooded nature of large areas of the Wealden landscape has resulted in a large numbers of concentrations of carbon rich soil representing sites of bonfires and possible charcoal production sites. The two processes which produce these features are, however, difficult to distinguish on the basis of physical remains alone. By their very nature, charcoal production sites are not associated with much diagnostic material culture, due to the short periods of occupation and the mobile nature of charcoal burners, who are unlikely to travel with little more than perishable belongings. Bonfire sites are also unlikely to have much material culture. In the absence of material culture, the dating and interpretation of these charcoal scatters is highly problematical, because the ambiguous stratigraphy of these sites, in addition to the cost, deters the use of radiocarbon determination. The major problems associated with the recovery of these sites therefore include the low archaeological visibility, the ambiguity of interpretation of charcoal production and bonfire sites, and the difficulty of dating. As such, no examples of securely-dated, off-site, Romano-British charcoal production facilities have been recovered from the Weald.

In the context of the Roman Weald, one possible example of a charcoal kiln has been recovered, at the industrial complex at Bardown (Cleere 1970: 15). Here a 3 m diameter area of Ashdown Sand had been baked to a depth of 1-2 cm. A little charcoal was found in association with the area, and the feature was sealed by the construction of a slag-metalled road. It is possible that the burning horizon could be the archaeological manifestation of a charcoal clamp that was originally at the periphery of the Bardown site, but later became incorporated into the industrial area. It is likely that the major form of charcoal production would have been through the utilisation of heaps and kilns.

The labour requirements of charcoal production are rarely considered in relation to the manpower requirements of iron production. The physical production of charcoal is extremely labour-intensive. A gauge of this can be derived from analogy with the medieval era; after the onset of the Black Death, the price of charcoal doubled to compensate for the shortage of forest workers (Cleere and Crossley 1985: 99). Further parallels can be drawn with the labour requirements of charcoal blast furnace production. A petition to the Sussex MP's in Michaelmas 1661 noted the condition of the iron works as being "much decayed", a great deal of emphasis was placed on the employment required to cut and cord wood which was essential to sustain iron production (Fletcher 1975: 17).

Several stages are involved in the production of charcoal, not least the location of a suitable source of wood. Under ideal circumstances, a single man can cut a cord of wood a day. However, personal experience by the author suggests that the output of wood is highly dependent on the weather conditions, variable daylight hours, the nature of the tools used, the health of the workers, and the nature of the environment. Accessibility to wood sources is often hampered by the presence of scrub, brambles and other low-level vegetation. In addition, the heavily-faulted topography of the High Weald, with many ghylls, is detrimental to the efficient movement of people and materials. This would have been less of a limiting factor on the Low Weald and much of the periphery.

Once the wood has been cut, it has to be transported to the site of the charcoal clamp, which would normally be a minimal journey, as it would be in the interest of the operator to restrict the distance travelled. The clamp has to be constructed, which does not require a great deal of time, however, the extraction of the turves or sods required does require a significant input of labour (see Appendix 2). Once lit, the clamp has to be tended constantly to prevent accidental oxidative combustion of the charcoal. Although more than one clamp can be lit and observed at any one time, the forest worker cannot leave the area. The hypothesis that the same personnel who smelted iron on industrial sites also produced charcoal cannot be sustained. However, this division of labour would probably only apply to industrial exploitation; it is likely that in smaller operations, the same personnel were responsible for all stages of production.

Aside from the physical cutting of wood, the impacts associated with charcoal burning are related to the construction of the clamp. Clamp construction requires some form of barrier to prevent access of air once charcoalification has commenced. A relatively air-tight barrier could be achieved with leaves and turfs or sods depending on the local availability of material. The creation of the clamp would therefore result in the removal of surface vegetation which could result in some cases in accelerated surface runoff, prior to vegetational regeneration. While at the level of small scale operations this might have been minimal, the industrial-class facilities could have witnessed the removal of hectares of turves and sods to facilitate the annual needs of charcoal production.

WOOD FUEL

Other forms of non-charcoal fuel are required for roasting ore and domestic use, such as cooking (Locke 1986-7) and heating, associated with iron production operations. It is probable that fuel for ore roasting could have been derived from the lop-and-top which was not suitable for the production of charcoal, although, this is by no means certain. Based on the soil pollen analysis from Ludley Farm, it is possible that the area immediately around the domestic site would have supported light scrub, which would have been a major source of fuel for domestic settlements.

The other possible requirement for wood fuel would have been for roasting ore, which did not require the high temperatures of smelting; however, it is impossible to determine if wood or charcoal were used, as generally only charcoalified material survives in the archaeological record. No work has been undertaken to analyse charcoalified material from primary roasting hearth contexts and compare results with those from smelting and slag deposit contexts.

ORE PREPARATION

WASHING

After the physical extraction of iron-bearing materials, some form of preparatory measures would have been necessary to facilitate smelting. These would include washing, roasting and grading the ore. The need for washing was probably related to the nature of the geological matrix surrounding the ore-bearing strata. Washing would facilitate the removal of impurities, which would increase the quality and to some extent the porosity, although the roasting of the ore would achieve that. The limited evidence for ore washing comes from the Near East, but there is no indication of the method of ore-washing in Roman Britain, or whether it was perceived as necessary by the iron producers. It is probable that washing would have been undertaken directly in rivers and ghylls, which would have provided the large volumes of running water that were necessary for flushing out the impurities. Certainly a large number of recorded iron production sites in the Wealden region tend to be located overlooking running water sources. Although there is little evidence for large volumes of ironstone and ore in the ghylls associated with industrial class iron production sites, this would not be unreasonable considering the importance of the material.

If extensive washing of ore did occur in the ghylls associated with iron production sites, then there are significant implications for the wider environment. Washing would result in the mobilisation of substantial volumes of sediment into the fluvial systems. If *washing* was an integral part of the ore preparation processes, then in the industrial eastern High Weald, the sheer tonnage of ore processed during the first three centuries of the Roman occupation could have resulted in the discharge of thousands of tonnes of sediment into the local river systems. Certainly there is evidence for increased sedimentation during the historical periods, which has been interpreted as the manifestation of accelerated erosion, resulting from deforestation associated with the iron industry. It is conceivable that in the context of the Roman iron industry, the enhanced sediment influx into fluvial systems could be the result of many factors, of which vegetational instability could be only one. Others would include ore washing, pedoturbation, and the depredations of the industrial iron production sites located on the major river systems of the eastern High Weald. It is tempting to postulate a link between the enhanced sedimentation which appears to have affected Romney Marsh during the third century (Cunliffe 1988) and the many impacts of the Roman iron industry in the heavily industrialised eastern Weald. However, complementary evidence from the corresponding tidal inlet at Pevensey also shows a distinct accumulation of alluvium at this time, but with the absence of heavy industry.

ROASTING

Although the Wealden ores could have been smelted without preparatory measures, the yield would have been significantly reduced (Ehrenreich 1985: 20). The predominantly sideritic (clay ironstone) nature of the Wealden iron ores (Worssam 1973a: 1) predicates roasting to remove the combined and uncombined water, and integral carbon-dioxide. An exception to this would be contexts where ores had been collected from the surface and had undergone sufficient weathering to degrade the integral water; however, the amount of ore of this type would be a small fraction of the total ore used.

Exothermic roasting could be achieved through combustion of the ore in oxidising conditions. This would result in the expulsion of the vast majority of the water at approximately 105°C, although higher temperatures are required to remove it completely, as a result of the low vapour-pressure of water in a porous medium and in colloidal solution (Clough 1986: 16). The endothermic disassociation of the carbonates occurs between 200-750°C. The removal of the integral water helps to prevent violent reaction within the smelting furnace due to rapid expansion of the water into vapour within the ore nodules. In addition to the removal of the carbon-dioxide and water vapour produced as a result of exothermic combustion, there is a consequent increase in the porosity of the ore which allows better reaction to the reducing conditions inside the furnace and allows the easier disarticulation of the ore nodules into manageable proportions (Gibson-Hill and Worssam 1976: 253-4). The removal of the carbon dioxide (CO_2) from the iron carbonate ($FeCO_3$) requires heat.

$$FeCO_3 + \text{heat} \rightarrow FeO + CO_2$$

The roasting of carbonate ores requires oxidising conditions although the temperatures required have not been fully established. Using experimental data, Cleere (1970) suggests that temperatures between 300-400°C were sufficient; however, Tylecote (1975: 26) suggests that temperatures in the range of 500-550°C were required (Gibson-Hill and Worssam 1976: 254). There is no evidence for the *nature* of the fuel used in roasting operations. There is no archaeological method of determining whether dry wood or charcoal was utilised for roasting, since under normal conditions, only charcoal will survive in the archaeological record. Since roasting only requires the removal of water, and intensive heating would result in excessive roasting which would produce unusable ore, dry wood would be adequate to reach the temperature required. The charcoal which remained unconsumed after roasting would represent another input of charcoal into the slag deposits. However, the oxidising conditions required for roasting would have resulted in substantially less charcoal remaining than at other stages of the operation. Evidence for roasting hearths has been recorded at Minepit Wood (Money 1974), Petley

Wood (Lemmon 1952), Ridge Hill (Straker 1931: 234), Broadfields (Gibson-Hill and Worssam 1976: 255) and Bardown (Cleere 1970).

SMELTING

In the presence of reducing conditions, reduction of iron from its ores occurs at temperatures significantly below that of its melting point at 1535°C or of its oxides Fe_2O_3 at 1565°C, Fe_3O at 1594°C, and FeO at 1396°C (White 1968: 39). Charcoal is an ideal fuel, as it provides both a pure source of energy and a source of carbon monoxide for the reduction processes in the furnace. In addition, the iron ore is separated by waste material, or gangue, which consists predominantly of oxides of silicon, aluminium and calcium. Sufficient heat has to be generated to liquefy the gangue during smelting.

The furnace charge would have consisted of charcoal and roasted ore. The reduction of the ore would have occurred in several forms, including the direct reduction by solid carbon derived from the charcoal. In addition to this the combustion of the charcoal in the presence of the air blast induced from the *tuyères* would have resulted in the presence of carbon dioxide as a result of the combination of carbon (C) and oxygen (O_2). This is converted in the presence of further carbon to carbon monoxide. This would have resulted in indirect reduction, allowing the removal of oxygen atoms in the following stages.

$$3Fe_2O_3 + CO \rightarrow Fe_3O_4 + CO_2$$

$$Fe_3O + CO \rightarrow 3FeO + CO_2$$

$$FeO + CO \rightarrow Fe + CO_2$$

The temperature must be sufficiently high to allow for the liquefaction and drainage of the slag and the combination of the iron particles by welding or sintering (Gibson-Hill and Worssam 1976: 257).

The process of bloomery smelting has significant pre-depositional implications for the charcoal which is used. Charcoal which is not consumed by the smelting process is generally removed with the waste slag from the bloomery furnace. However, the removal of unconsumed charcoal occurs both after the completion of the smelt, with the removal of the bloom, and to a lesser extent during tapping of slag. Tapping would have occurred constantly once sufficient ore had reached a semi-liquid state (Cleere 1976a: 237). Once solidified, the tapped slag would have been broken up and transported to the area designated as a slag deposit. Carbonised material incorporated in the actual bloom would be rendered archaeologically invisible as a result of secondary working processes and its subsequent removal from the site.

It would be expected that material which has entered the archaeological record via the smelting furnace would be identifiable due to its inclusion in the matrix of the slag and cinder, while it was in a semi-molten state. The occurrence of identifiable charcoalified remains incorporated in slag in waste deposits is rare. This is due to the poor accessibility of the charcoalified remains within the matrix of the slag. The primary source of carbonised material in refuse deposits is represented by loose fragments of charcoal found in the soil and refuse matrix in between the individual slag fragments.

The vast majority of charcoalified material which entered the furnace as fuel for smelting would be consumed or crushed within the furnace. Possibly less than one percent of this material passes through the furnace in an identifiable state. The results of contemporary bloom iron smelting experiments suggests that the average size of charcoal fragments remaining in the furnace after the smelting process can be very small, normally less than 10 mm square. Material derived from excavation in the slag deposits can exhibit a larger size of 20 mm, although attrition in the slag deposit reduces this figure considerably. Charcoal which has been exposed to temperatures in excess of 700°C can exhibit a distinctive glassy distorted appearance. The presence of this diagnostic charcoal in slag deposits is extremely rare. Experimental work suggests that working temperatures in early furnaces would have ranged between 1100°C and 1300°C (Salter and Ehrenreich 1984: 146), which corroborates the hypothesis that a significant proportion of the identifiable charcoal had not been exposed to smelting. In addition to this, some of the carbonised woody species recovered from slag deposits still retain the vascular cambium, while in rare instances bark can still be seen *in situ* on the secondary xylem. These highly friable outer layers would represent the first material to be reduced and consumed had they served as fuel for smelting.

This suggests that a significant input of carbonised material entering the slag deposits derives from a source other than material that has passed through the smelting furnace. A possible origin for this could have been the incorporation of loose charcoal from the surface of the smelting area, in conjunction with the deliberate discard of charcoalified material. During smelting operations, charge materials such as charcoal and graded ore would have been kept in the immediate vicinity of the furnaces to replenish supplies and keep the material dry. The process of moving the charcoal from this local supply to the furnace would inevitably result in spillage of some material. Whilst most of this material would succumb to trampling, some would inevitably get incorporated with the other detritus of smelting and be disposed of with the tap slag.

In addition to the accidental spillage during smelting some charcoal could have been deliberately excluded. To maintain an adequate flow of air through the furnace, Cleere (1971a: 75), suggests that the fuel was deliberately sieved to remove smaller fragments, less than 5 mm^3. The removal of the 'fines', or powder and small charcoal fragments, would act as another source of material that would be discarded and in some instances end up in the slag deposits.

On many Wealden sites these charcoal fines can be seen to be incorporated in the slag deposits as distinct horizons or smaller lenses. The constant inclusion of the charcoal fines with the refuse deposits of slag and other debris could, in some cases, explain the carbon-rich nature of the surrounding matrix.

The bloom produced by the smelting process is too friable to transport as a coherent unit, due to the slag and carbon inclusions. In some cases this resulted in the need for secondary working to be undertaken on the site of production to consolidate the bloom, as a prerequisite to transportation (David Sim *pers. comm.*), therefore increasing the fuel required. Archaeological evidence for an anvil structure has been recorded at Minepit Wood (Money 1974: 2). The presence of smithing slag in the archaeological record is difficult to determine without extensive sieving operations in the vicinity of the smithing site. Smithing slag has a much lower ability to resist taphonomic changes than tap slag. This relates to the small size, resulting in loss during excavation and its movement within the soil profile.

The majority of macroscopic charcoal incorporated into slag deposits would represent material which has not passed thorough the furnace. With the exception of the smaller fines, this material would have a statistically higher chance of identification, compared to charcoal which had been subjected to the smelting process. Although a significant percentage of the charcoalified remains found in slag deposits had not been subjected to smelting the charcoal still represents material which has been transported to the site to sustain the fuel needs of the industrial and domestic processes.

The charcoalified woody materials found in slag deposits represent secondary refuse from a variety of contexts - roasting, smelting, and possibly smithing, in conjunction with small quantities from domestic activities. The larger the scale of the operation, the greater the number of sources for which intrusive charcoal is likely to have derived. However, the correspondingly large sample size from such sites would tend to reduce the importance of intrusion. Due to the secondary nature of the deposits, it is difficult to determine if these processes resulted in any selection of wood taxa. The random location of the charcoal within the refuse tips does not predicate the elucidation of material deriving from individual processes. Each charcoal lens within the deposit could represent the archaeological manifestation of the deposition of material derived from a single process. An assessment of materials found in primary deposits associated with different stages of the industrial process is the only method of accurately determining the nature of the fuels utilised for each stage in the production. Excavation and analysis of the carbonised remains from primary contexts relating to different stages in iron production by Cleere (1970) at Bardown, and Money at Minepit Wood (1974), suggest that no selection of wood taxa was undertaken between the different processes.

It must be assumed that a small component of the charcoalifed remains in the slag deposits will represent material from domestic sources. Such intrusive material is extremely difficult to quantify, but could derive from the domestic settlement of an industrial or semi-industrial class facility, or hypocausted buildings in the industrial area. Certainly, the presence of domestic rubbish in the slag deposits suggests that material from the residential settlements was systematically incorporated into the slag deposits for hygiene purposes. It is likely that household debris, such as charcoal from cooking, and heating sources, organic matter, and waste materials would have been incorporated into the slag deposits, although only the non-perishable ceramic sherds would provide an indication of this. This would most closely resemble the process of manuring as manifested in the archaeological record (cf. Gaffney and Tingle 1989: *passim*), with scattered ceramic debris becoming incorporated with decomposing household organic matter, and being moved off-site. In the context of the industrial-class facilities, the possibility of deposition on the slag deposits is likely. This material will represent only a small component of the carbonised material in the slag deposits.

SECONDARY AND TERTIARY OPERATIONS

In some contexts the production of raw bloom iron might have represented the finished product of a smelting site. This could be the case in some smaller-scale production sites where insufficient resources or expertise were available for the consolidation or modification of the bloom. However, recent research suggests that the bloom iron produced during smelting would have been highly friable as a result of the large numbers of slag inclusions and voids in the bloom. This would make the raw bloom difficult to transport as a coherent unit. Where industrial-type operations have occurred, there would have been a need to transport large quantities of bloom iron. In these contexts secondary modifications to the bloom would have necessary to consolidate the bloom and facilitate transport in semi-standardised units. Several examples of structures interpreted as re-heating hearths have been recovered at Pippingford Park. The close proximity of these to the smelting furnaces could suggest that the bloom was still warm when removed from the furnace to minimise the fuel required to heat it from cold.

Substantially less work has been undertaken on the operations conducted after smelting than on the processes of smelting ore. Exceptions include the work of Peter Crew and David Sim (1995). This is primarily a function of the difficulty of ascertaining the function of non-smelting hearths on iron production sites, and the lack of excavation which has occurred on such sites. Much contemporary work has been undertaken on an experimental basis.

The initial stages of bloomsmithing would have required comparatively high temperatures to fire weld the various fragments or different blooms together. The fuel consumption would have been related to the quality of the fuel. The denser hardwoods would have been more suited for longer combustion than less dense hardwoods and softwoods.

The quality of the wood is highly important for the rate of consumption. Wood which exhibits signs of cellular degradation and breakdown as a result of disease, rot, or death, is consumed more rapidly than wood with its internal structure still intact. If the cellular structure of wood is weak then it is more likely to fragment in the furnace. The resulting powder would restrict the flow of air, causing lower yields or cessation of operations. For specialist functions such as bloom- and black-smithing, greater structural integrity of the wood/charcoal is of importance to provide support (David Sim: *pers comm.*)

However, on smaller sites, there is the possibility that the unworked blooms could have been transported off-site in panniers or sacks which would have contained the fragmented raw blooms. However, there is evidence from smaller sites that anvil structures and possibly reheating hearths were present, although the interpretation of the archaeological evidence for such hearths has been questioned (cf. Cleland 1981). Other evidence for smithing operations, such as hammer scale, is rarely encountered in the archaeological record. This is primarily a function of the low archaeological visibility of scale and the absence of sieving operations on iron production sites.

It is highly probable that on industrial and semi-industrial sites items could have been fabricated from the processed blooms on-site to supply the immediate needs of the domestic settlements, and industrial areas. This would include the provision of household metalwork and items for building construction, in addition to tools for metal working. With smaller sites, smithing operations might have occurred on settlement sites, as exemplified by Garden Hill, which has evidence for all stages of iron production, from smelting to smithing, within the confines of the defended enclosure.

As with the smelting operations, smithing requires charcoal as a fuel, although this can in some instances be supplemented by chips of wood fuel. The consumption of charcoal for secondary and tertiary bloom modifications would have been quite considerable.

Where detailed and controlled excavation of iron production sites has occurred, there has been a comparative dearth of actual iron finds. At Bardown the ferric assemblage was dominated by nails characteristic of timber buildings, while other small finds included knives, a file, and household fastenings (Cleere 1970). This sparsity of iron finds is not entirely unexpected on an iron production site. The majority of iron objects in the industrial element of the site would be tools related to smelting and smithing, and as such would have held an intrinsic value to their owners. It is likely that they would have been the property of individual craftsmen, or, if they belonged to the site owners, would certainly have been removed before the cessation of operations. It is unlikely that iron objects would have been discarded on any large scale, as the site would have the facilities to recycle iron. The material which has been recovered tends to be relatively small in size and could indicate accidental loss. The exceptions to this are the recovery of an iron shovel from Bardown (Cleere 1970: Fig 8), and the apparent find of a firedog from Oldlands (Dawson 1903) in the late nineteenth century. A certain degree of doubt must be associated with the authenticity of the Maresfield find, which is now lost and cannot be corroborated, as forgeries were certainly perpetrated, by labourers excavating the slag deposits, and others, for financial reward (Straker 1931: 337, Appendix I).

WASTE PRODUCTS

SLAG

The physical smelting of iron results in the production of certain waste products, the most significant of which is slag, although unconsumed charcoal, ash and gaseous matter are also end-products. The production of slag has significant implications for landscape morphology. Cleere (1976a: 234) estimates that the production ratio of bloom iron to slag produced is approximately 3:1. In volumetric terms this equates to the following equation:

$$\text{slag volume } (m^3) = \text{iron produced } (t)$$

In smaller local exploitations the slag produced would have little impact on the local environment. As the scale of production increases, the corresponding volume of waste products would have increased incrementally. Evidence for the disposal of slag suggests that this tended to occur in close proximity to the site of iron production. The weight and negligible value of the material do not allow for its transportation over significant distances from the production site. In many cases where exploitation has occurred on the banks of a ghyll, slag has been discarded downhill onto the river banks, which requires the least energy for discard. In these low output, sites the results of slag disposal would be limited, with relatively small areas of land surface affected.

Where industrial or semi-industrial class operations have occurred, the significant volumes of slag produced have resulted in the production of beds of slag, as seen at Oaklands, or mounds, as exemplified by the complex at Beauport Park. The volume of slag in these contexts can be sufficient to cause morphological changes to the landscape. It is probable that colonisation of these surfaces by local vegetation would have occurred relatively quickly after the cessation of deposition, utilising the carbon-rich soil that was deposited in conjunction with the slag. It is possible that in some limited contexts, pockets of heavy metal ions and other toxins produced as a by-product of smelting would have inhibited or modified vegetation growth. Certainly research on the plant communities found on later slag deposits resulting from blast furnace production suggests that there can be inhibition of some vegetation types. However, the presence of the matrix of carbon-rich soil, in Wealden industrial and many semi-industrial deposits, would have served to neutralise much of the toxicity which would have otherwise evoked a negative phyto-chemical response.

A layer of fire reddened clay has been found under the slag deposits of the industrial-class facility at Chitcombe. This burning does not relate to the movement of hot slag. This would be a most unlikely as a result of danger to the operators, also all the fragments of slag observed by the author show evidence for cold fractures, there is no evidence for the breakage of slag while it was in any way semi-solid. The burning episodes could have occurred at some point prior to the deposition of slag suggests that industrial activity could have taken place in the area prior to large scale deposition of slag or it could indicate a policy of deliberate burning to clear areas required for iron working.

There is evidence that the morphological changes associated with slag deposits were rapidly incorporated into the perceived Roman and later landscape. At Oldlands, a Romano-British inhumation burial was recovered from the slag bed. By the nineteenth century, the slag mounds at Beauport Park (Arnott 1869: 138) and Oaklands Park (Wright, T.: 1854: 331) were so heavily covered by woodland that few were aware of the slag banks beneath.

In the context of industrial sites it appears that the slag was deposited in conjunction with carbon-impregnated soil and other domestic rubbish. This simultaneous deposition is attested by the horizons of yellow clay which seal horizons of slag and refuse in the waste deposits. These horizons are recorded on industrial-class sites at Beauport Park (Straker 1931: 331), Bardown, Chitcombe, and semi-industrial sites at Ridge Hill (Straker 1928), and Ludley Farm. The lower interface between the slag horizon and the yellow clay tends to be linear and does not show signs of moulding around the slag, as would be expected if it were deposited directly onto a bed composed uniquely of slag. In addition, despite the sealing effect of the yellow clay horizons, there is extensive evidence for a carbon-rich soil matrix between the slag fragments. This matrix could only have been deposited prior to the deposition of the clay horizons.

These yellow clay horizons are only found in slag deposits of industrial or semi-industrial class sites. Despite much more extensive trial-trenching in domestic slag deposits throughout the Weald, no such clay horizons have been recovered in these contexts. It appears likely that these horizons served a function which was unique to larger-scale operations.

The clay was probably derived as a by-product of the minepits and quarries which provided the ore for the larger sites. As a result extraction would have incurred no additional impact on the environment. Analysis of the pollen composition from the clay horizon at Ludley Farm suggested that there was significantly less pollen, and more Cretaceous-derived material, than in other elements of the slag deposits, suggesting that these horizons are unmodified clay. The *raison d'être* for these horizons remains enigmatic. It is unlikely that the clay, if it were derived from the debris or waste from furnace repair, would have been spread so evenly across the slag deposits. As with other material deposited in the waste heaps, it would have been tipped.

The clay horizons have an approximately even thickness of 1 to 2 cm, suggesting that the clay was deliberately spread across the slag deposit. Cleere's hypothesis that these horizons could have related to the requirements of hygiene could be correct. It is only on larger-scale operations that residential and domestic occupation was likely to be located in the immediate vicinity of the production area. They could, therefore, have served to seal the slag and rubbish deposits.

In some contexts, slag was used for metalling roads and trackways, and also provided hard-core for working areas on industrial sites. Even in these contexts, where there is an enhanced perception of the value of the slag, which in conjunction with its weight, rarely allowed for movement significant distances from its site of origin. The majority of the slag was used on the site of production to enhance the infrastructure, such as the creation of road networks to link the mining operations and other arterial routes.

CARBON/ASH/CHARCOAL

A significant feature of the industrial component of Romano-British industrial sites in the Weald is the horizons of carbon-rich soil which demarcate the many of the sites. Analogy between the 'black country' of the industrial midlands during the industrial revolution, and the Romano-British industrial iron production operations is well-founded. The scale of Roman industrial activity in the Forest of Dean prompted T. Wright (1852: 35) to call this region "the Dudley and Birmingham of Roman Britain." Industrial and semi-industrial exploitation certainly resulted in substantial changes to the visual landscape.

Carbon would have been incorporated into the soil profile in two forms: as charcoal dust; or from charcoal which was crushed *in situ*. There is evidence from Bardown that lenses and horizons of fine charcoal were present in the slag deposits (Cleere 1970: 15). This suggests the deliberate sieving of charcoal to remove dust and highly fragmented pieces, which would interrupt the free flow of air through the smelting furnace, significantly reducing the efficiency of the process. The other source of charcoal on an iron production site would be though the casual loss of larger fragments during transportation around the site, during shovelling, and abandonment. Pedoturbation would serve to reduce the size of these fragments and to scatter the pulverised charcoal and carbon around the site of production.

The incorporation of carbon into the soil profile results in two environmental modifications. The first is mineralogical addition to the soil: The minerals which were combined in the organic structure of the wood are not lost, or degraded during the charcoalification process. Once charcoal is crushed and deposited in the soil, these minerals can become a mobile and active element of the soil's mineral composition. Certainly the effect of significant quantities of carbon in a highly-fragmented form in the soil would have a beneficial effect on the soils of an industrial site. The effect of an industrial operation is to concentrate organic material from a wide *territorium* into a fixed area or areas, enhancing the soil of one area while affecting the nutrient cycling of the wider *territorium*. This can be applied not only to carbon but to other nutrients recycled as a result of the concentration of people and animals in one place

This can result in localised modifications to the vegetation, with plants such as the nettle (*Urtica dioica.* and *urens.*) colonising the locality of iron production sites both during and after production. *Urtica* is classified as an anthropogenic indicator species, with an affinity for soil phosphate which can be derived from the enhanced quantities of charcoal-derived products or other degraded organic material in the soil. This also applies to *Chenopodiaceae* and the Artemisia which are nitrophile which have also been recovered from pollen spectra associated with slag deposits at Ludley Farm and Chitcombe. Evidence for the these indicator species from Ludley Farm is limited as a result of the high attrition of pollen grains which resulted from bacterial action.

The carbon-rich soil in slag deposits can have implications for the contemporary environment, as a result of the greater depth of soil and its nutrient rich nature. At Cow

Park, the area of the iron production site was demarcated by surface vegetation of fine grasses in the midst of the coarse grass and bracken of the poor soils of the Ashdown Forest. This corresponded to the area of charcoal impregnation of the soil (Tebbutt 1979a: 47). Similar vegetational modification can be seen on other iron production sites such as Chitcombe and Walesbeech, where the distribution of nettles provides an indication of the areas of heavy charcoal impregnation. Any increase in soil fertility, which could be beneficial for arable production, resulting from the concentration of charcoal and ash in the vicinity of sites, is often negated by the amount of slag and other debris in the soil. This can enhance the preservation of some sites, although contemporary heavy machinery is not effected by the presence of such debris as earlier farm equipment .

GASEOUS WASTE

In addition to physical waste products such as slag, charcoal and ash, there is also a significant output of gaseous products from smelting and roasting operations, such as carbon monoxide (CO) and smoke. In theory charcoal is a smokeless fuel, so smelting should have limited effect; however, although charcoal was probably kept in the vicinity of the furnace prior to use to dry it out, it is likely that this would not have been entirely successful as a result of the propensity of charcoal to absorb atmospheric water, which would initially cause a smoky burn. In addition, the presence of semi-carbonised wood fragments from the slag deposit at Chitcombe indicate that not all the wood was fully converted to charcoal,. This would be another source of smoke. There are inherent implications for air quality. Where contemporary excavation or survey has occurred on industrial-class iron production facilities, evidence is usually recovered for the location of the residential settlement upwind of the industrial component of the site. This is evident at Bardown (Cleere 1970: 8-11), Beauport Park, and probably Chitcombe. This would have had other coincidental benefits for site security and residential safety. The implication is that the sheer volume of smoke and other gases produced was sufficient to significantly affect air quality. Certainly documentary evidence from the blast furnace period of exploitation implies that this was the case, "great damage had been done in several places by smelting works, the smoke and stench whereof had killed beasts and destroyed trees in the neighbourhood where such works were" (Chaplin 1970: 84). Although some exaggeration and hearsay must be incorporated in such a text, it does convey a mixture of public perception and the reality of industrial activity.

THE ECONOMICS OF SMALL-SCALE IRON PRODUCTION

The contemporary distribution of Romano-British bloomery sites in the Weald shows that iron production occurred throughout the Wealden region during the Romano-British era. The numerically superior method of iron production was through small scale bloomery activity, although volumetrically the output of industrial and semi-industrial class sites was the most productive. While the High Weald was undoubtedly a centre for iron production as a result of the accessibility of the ores, here small scale iron production sites are found in conjunction with industrial and semi-industrial class operations. The Low Weald would also have been productive but with a much lower output than the High Weald and dominated by small-scale operations with the exception of the Broadfield site. The nucleations of production on the Greensands and scarp foot of the Downs would have been completely dominated by smaller scale production sites.

However, even allowing for the vagaries of site location, the distribution map is a far from ideal tool in elucidating environmental impact. At its most basic, environmental impact can be considered to be a function of the size of impact over time. The major phase of Roman iron production in the Weald covered about 200 years, from the invasion in AD 43, to its cessation in the 240's. The primary method of dating sites derives from the recovery of local ceramics such as East Sussex Wealden ware. These are characteristically difficult to date other than in the broadest terms of earlier and later Roman.

Within the context of time depth these smaller sites, although numerically superior, do not constitute a major disruption of the environment. These sites would have been widely distributed both spatially and temporally. The impact of the fuel requirements of these smaller sites would in many cases have been borne by clear felling. The short period of operation of the bloomery operations, which comprise the majority of the Wealden sites, would not allow for sufficient generation of regrowth to sustain the fuel needs of the sites. Exceptions to this would include sites where previously managed woodland existed in the vicinity, possibly supplying local settlements, or resulting from the regrowth of previous clear felling episodes. The evidence from smaller scale iron production sites such as Heaven Farm, Iridge Bloomery and the Stumletts Pit Wood sites implies utilisation of arboreal species, such as alder and willow, which were likely to be growing in the immediate vicinity of the production sites, emphasising the local nature of exploitation.

Even if we simulate a twenty fold increase in sites and decrease the time depth from 200 to 100 years, and assuming an optimistic average of two years operation per site, these sites on their own would constitute a negligible impact. That still constitutes approximately 2000 sites, which is equates to 4000 years intermittent running time. The major period of operation would have been in the first half of the second century. In which we could postulate 20 new small scale sites a year. Of course, these figures represent an average. Historical records of blast furnace iron production show that the output of Tudor sites was anything but regular, showing dependence on external and internal economic conditions. In Roman sites, these general trends would have been masked by periods of high and low exploitation.

Periods of high military requirements would result in an increased output at industrial class sites and smaller sites, as industrial sites could no longer divert as much iron onto the civilian market as necessary, so community requirements are made up as needed.

Undoubtedly there would have been examples of accumulated impact in certain localities, but in general most site impacts could have been absorbed into the Wealden environment. Of course, in the absence of detailed archaeological work, size as a criterion for quantifying site impact can have problems. It is essential to know the relationship of small sites to industrial complexes and to regional centres. A small iron production site could relate to the immediate needs of a community, family or individual, alternatively the aim could be to provide a surplus for trade. Production could relate to the output of itinerant smelters. Alternatively smaller sites could be satellites of a local or regional centre as proposed for the Garden Hill site. Possibly the smaller sites could represent satellites of industrial exploitation, or experimental smelting operations which proved inadequate to sustain larger scale utilisation. There is however, considerable variety in the longevity of operation seen in the smaller bloomery sites, ranging between a single smelting operation, as hypothesised for Heaven Farm or a decade or more suggested for operations such as Stilehouse Wood.

HYPOCAUSTS

Evidence for hypocausted buildings has been recovered from Beauport Park, Chitcombe, Great Cansiron, Morphews, Little Farningham Farm and Garden Hill. Evidence from the industrial sites in the eastern Weald suggests that bathhouses could have been an integral part of the sites. Two reasons exist for this, the various activities involved in the production of iron involved heavy manual labour and would have required washing facilities, as would the nucleations of non-iron producers who would have gathered at iron production complexes.

Of course the presence of a hypocaust does not indicate that it was actually used. It is conceivable that hypocausts were a part of the 'blueprint' for certain building types.

The fuel required for hypocausts would have been considerably different to that of the iron production operations. Charcoal would not have been necessary, and brushwood would have been ideal. Experimental evidence for the thermal transfer in hypocausts suggests that hypocausts would have required 24-48 hours to warm up. It would therefore be necessary for the bathhouses to be running continuously, at least during the working seasons. Experimental evidence derived from a small reconstructed Roman bathhouse, suggested that suggested that the temperature of the sweating room could have been around 160 F while that of the warm bath should not have deviated below 130 F. The wood required to sustain such temperatures over a year would be in the region of 114 tons. In some cases the baths consumed sufficient firewood to necessitate a specially designated woodland for their supply (Perlin 1989: 112).

TILE AND CERAMIC PRODUCTION

In addition to the production of iron, there is limited evidence for the production of tiles for infra-structure development, and of ceramics. The most detailed excavation of a tile kiln comes from the Great Cansiron. There is tentative evidence for a tile production facility in the vicinity of Little Farningham Farm, as suggested by the presence of mint tiles and tile spacers or 'saggers', which should not have moved far from the site of production. In addition, petrological examination of the stamped tiles of the *Classis Britannica* suggests that two sources of supply were utilised: one from the continent, while the other probably exploited the Fairlight Clays as a raw material.

Limited-scale ceramic production was also a feature of some elements of the Wealden iron industry. Excavation at Bardown produced evidence of pot wasters which would not have travelled beyond their site of production, indicating the production of so called Bardown Wares (M. Lyne: *pers. comm.*). In addition, the presence of wasters at

Great Cansiron suggests that limited ceramic production was carried out in the vicinity of the tile kiln (Cawood 1986: 214). It has been suggested that approximately a cord of wood was required to fire a cubic foot of brick (Perlin 1989: 116). The fuel used for ceramic production could have been highly variable, however, evidence from the tilery at Great Cansiron revealed an assemblage dominated by branch-wood. The requirements for fuel during the ceramic production process differ from those of iron production. Iron smelting fuel requirements are static; the fuel output of charcoal varies little and is more dependent on the nature of the cellular microstructure. However, ceramic production requires slow-burning wood, with the possible addition of faster-burning wood or woody material to achieve the critical temperatures at the height of firing.

The development and intensification of the iron industry in the Weald during the Romano-British era would have provided a major stimulus to the production of the local ceramic forms, such as the East Sussex Wealden wares.

SHIP BUILDING

The strong evidence for the close association between the *Classis Britannica* and the eastern Wealden region could suggest that the arboreal resources of this region were utilised both for iron production and the maintenance and construction of fleet ships and infrastructure. The oak-dominated arboreal communities of the Weald would have provided timbers useful for ship-building. The natural and irregular shape of the wood would have provided the right components for ships.

This might go some way to explaining why charcoal from mature timbers are less prevalent in eastern Wealden samples than in examples from the western Weald, such as Turners Green. It is conceivable that a symbiotic relationship developed between the fleet and local iron producers.

The Wealden coastline is in the heart of the *Classis territorium* on the southern coast, with the major base at Dover, and another at Lympne. It is likely that most of the tidal inlets and estuaries, which were an integral part of the this eastern Channel coast prior to smoothing by the eastward or longshore drift, would have had either small ports or wharves and jetties suitable for coastal shipping and the movement of materials. Certainly, if a probable wharf structure existed at Alfoldean in the High Weald, then it is highly likely that such structures existed in the coastal region of the eastern High Weald. Major changes in the courses of rivers and extensive deposition of alluvium and colluvium in the vicinity of Romney Marsh would disguise such structures.

In addition, the military would have required timber for construction. Research on the Saxon Shore fort at Lympne, in 1981, revealed 59 timber piles beneath the northern wall of the fortress. Thirty-seven of these were identified as oak, while the remainder were either too degraded for analysis or un-sampled. No record was made of the age of the samples. However, their size does not indicate significant maturity (Hutchinson *et al.* 1985: 223).

Recent excavations at Pevensey Castle revealed the presence of similar supporting oak piles, of young, exclusively oak, timber. The source of timber for the Pevensey site is more likely to be of a Wealden origin, as a result of its location on the

Wealden periphery and the absence of major timber trees on the South Downs. The inherent implication of this is that by the time of the construction of the Saxon Shore forts, there were no longer significant expanses of accessible larger oak timber. A possible cause for the absence of large timber could be related to the depredations of the iron industry, in conjunction with previous exploitation of oak for building and construction. The ages of the timbers from the Pevensey samples are in the range of 60-70 years, which could indicate the regrowth of timber after the decline of iron production in the mid-third century or the systematic exploitation of managed oak woodland It is of interest that the semi-industrial iron production site at Turners Green, which is located only 20 km to the north of Pevensey, produced only mature oak from an early first century AD context.

This Wealden evidence for modifications to the age structure of woodlands would certainly correlate with the data derived from a wide range of sites in Britain. Excavation of the New Fresh Wharf from the London waterfront revealed that the majority of the timber from the early period of construction was of oak. Baulks of four to nine metres in length had simply been squared (Milne 1985: 65-7); this uneconomic use of timber suggests that during the early part of the occupation, the acquisition of large, tall timber trees in the south-eastern region was not a problem. However, by the middle of the Roman era, only smaller timbers could be acquired, resulting in the re-use and splicing of timber.

At Silchester the first phase of the amphitheatre required the timber from at least 27.2 hectares (68 acres) of woodland (Sunter 1989: 164). The restoration of the amphitheatre in the mid-second century utilised small diameter uprights. In addition the construction of the town ramparts and wall, at the end of the second century and later third century respectively relatively young oak and alder (< 40 years old) were used (Fulford 1990: 29). Such data from Roman contexts can be correlated with evidence from Saxon contexts in London where the analysis of large numbers of waterlogged timbers has revealed that during this era there was a decrease in the number of long, knot-free, lengths of large-girth wood possibly as a result of intensification of use during this period (Milne 1992: 129). The implication for Roman Britain is of significant changes to the age profile of woodland throughout much of the country. However, in areas of intensive activity such as the Weald where iron production, construction and ship building exerted simultaneous impacts on the woodlands then this could have been highly pronounced.

CHAPTER NINE

THE WOODLANDS OF THE WEALD

THE WOODLANDS OF THE WEALD

THE IMPENETRABLE WEALD

Perceptions of the Weald prior to the medieval era are traditionally of a region of impenetrable forest. The earliest references to this forest region derive from the *Parker Chronicle* (A) for 893 (92) - The *Laud Chronicle* (E) 892, which when referring to the estuary of Lympne, noted its location "at the east end of the great forest which we call Andred. This forest from east to west is 120 miles long or longer and 30 miles broad". The concept of the impenetrable *Andredswald*, from which the Weald derives its name (the Germanic *wald* or forest), is an integral part of Wealden culture. The Saxon literature was readily used by the medieval chroniclers such as Richard of Cirencester, who emphasised the presence of a "vast forest" during the Roman era in the Weald (Kaye-Smith 1953: 129). Camden in this Britannia of 1789, further reiterated this and noted of Sussex that the northern part of the county was "rendered inaccessible" as a result of its forests (Copley 1977: 29). The concept of the impenetrable Weald was reinstated by Hilaire Belloc (1913: 40-1), who considered the Weald to be a barrier, "formed by the great district of clay, marsh, thickets and brackish water, which under primitive conditions, or indeed under any conditions save those of very active civilisation, must remain but sparsely populated." As a result the Roman roads which crossed the Weald were considered to be "bridges" across the primeval wilderness, which was "unoccupied and wild" compared with the luxurious cities and villas of the coast (Kaye-Smith 1953: 130). This was Lower's "great primeval forest of Anderida" (1862: 207).

It is essentially as a result of the Anglo-Saxon primary source material, and it subsequent interpretations, that the study of the High and Low Wealden regions has never truly escaped from the underlying concept of the primeval boreal forest. The term *woodlands* is rarely used for the nature of the Wealden environment during the Romano-British era. The Weald during the Romano-British era is normally referred to as a forest, in conjunction with highly emotive terminology such as "impenetrable" or "primeval". The word forest was originally a juridical term, derived from the Merovingian Latin word *foresta* - a possible provenance from the Latin *foris*, meaning *outside*. The first appearance of the word *foresta* is in the Laws of the Longobards and the capitularies of Charlemagne. The earliest Merovingian use of forest was related to the exclusion of large tracts of public woodland, in order to insure the survival of wildlife which would allow the royal ritual of hunting (Harrison 1984: 69). A vestige of this meaning has been inadvertently retained in many studies of the Roman Weald, which is considered to be outside the bounds of the normal settlement hierarchy of the province, being the preserve of iron production to the detriment of other activity. Charles Roach-Smith's statement from 1842, that "In early times the whole of the Weald was an uninhabited forest, and continued in a wild and desolate state until after the conquest. Very few, if any, Roman remains have been found in the Weald" could easily apply to the study of most aspects of the Roman Weald other than the location of high visibility iron production sites. The dominance of iron production to the detriment of other settlement evidence often led the supposition of the "Romans interest in Sussex iron only" (Meynell 1945: 44-5).

Certainly there is little evidence for Roman *nucleated* settlement in the central Wealden region. What settlement there is concentrates around the edges of the Weald at Hassocks and Pulborough in the south-west and the Maidstone hinterland in the north. This is still true to a certain extent - the Weald is still poorly populated considering its position in the south-east of England. There is, however, a growing body of environmental and archaeological evidence to suggest that these traditional views of the extension of the apparently primeval Wealden forest into the Romano-British era are not entirely accurate. They do not allow for the diversity of geology, soil type and topography that is evident in the Wealden region, nor do they account for the evidence for pre-Roman settlement.

DEFORESTATION

The literature of the Weald is apparently tempered with a significant body of evidence concerning deforestation associated with iron production, from both ancient sources and in the contemporary environment. In the context of the Weald, Butler (1914: 59) noted that the "great forests were destroyed as firewood for smelting", and to emphasise causality he noted that "Roman coin has been found in the ashes." Iron production is seen to make inroads into the forest, which because of its mature, primeval nature, is not considered to be part of the human domain of rapidly regenerating woodland but of a very slowly recovering forest (Cleere 1976a: 240-1).

The concept of the attrition of woodlands as a direct result of iron production has its origins in the 16th century Weald, apparently as a direct result of blast furnace operations. In 1541 an Act of Parliament was passed which stated that after Michaelmas 1544, when wood was cut, 12 standards of oak had to be left per acre, in addition to other elements designed to preserve woodland. This was followed in 1548 by a commission which considered the "annoyances of the iron mills in Sussex". This essentially stemmed from the dichotomy between domestic utilisation of wood and industrial exploitation, the Sussex coastal towns felt threatened by the increase in price of wood resultant form industrial exploitation (Straker 1931: 113-21). This was not a function of straightforward deforestation but the higher prices which iron-masters could afford for wood and the consequent diversion of wood from domestic and export purposes to iron production. There is little emphasis on the use of managed woodland by iron producers, rather than of timber. Once the concept of the "exorbitance and increase of devouring iron-mills" entered into John Evelyn's, 1664 book *Sylva* (V.II.148) it coloured most later perceptions of the iron industry and its effects on the environment.

This biased documentary evidence is apparently complemented by the ancient authors of the Mediterranean region, for the effects of mining and metal production on the local environments. Strabo (XIV. 6.5) noted that "In ancient times plains of Cyprus were thickly overgrown with forests, and therefore were covered with woods and not cultivated. The mines helped a little against this since the people would cut down the trees to burn the copper and the silver and the building of the fleets helped further." Further analogy can be attributed directly to the iron industry. The island of Elba produced some of the best ores in the Roman world, but could not produce the wood required to roast and smelt the ore; as a result, after some initial roasting, the ore had to be transported to the mainland where charcoal and wood could be obtained from the Ligurian mountains (Forbes 1958: 18). Pliny records in his *Natural History* (xxxiv.96) that "the effect of the shortage of fuel on the roasting operation is particularly noticeable in Gaul", although he does not elaborate which region, in a country that stretched from the shores of the Mediterranean to the Channel. He also notes that there was a shortage of fuel for the Campanion metallurgists (xxxiv.67).

However, direct analogy with the Mediterranean region and southern Europe is not entirely satisfactory if comparison is made with the Weald. The physical and vegetational environment of the Mediterranean and its borders differs considerably to that which is evident in Britain, and the climatic regime is also more extreme. It is probable that many of the factors which influenced deforestation in the Mediterranean region, such as soil erosion were enhanced by grazing, climate and physical relief. Factors which cannot be applied in all cases to Britain. (Mather 1990: 34). A similar hypothesis for extensive deforestation has been postulated for many sites in prehistoric Africa (E. Okafor *pers. comm.*).

In the contemporary Brazilian state of Minas Gerais, and the eastern Amazon region, there is also apparently evidence for the destruction of woodland as a direct result of the fuel requirements of charcoal-based, blast-furnace iron production, which utilises the technology of the European Industrial Revolution. The deforestation in some contexts preceded soils and water degradation and desertification (Ackerman and de Almeida 1990: 661, Fearnside 1989).

A great deal of caution has to be expressed with the use of literary evidence and the extrapolation of this data to elucidate the nature of the Roman environment. The analysis of polleniferous sediments from the vicinity of prehistoric mining sites in the British-Isles has revealed a much more varied response to early mining activity. Pollen obtained from the vicinity of the Bronze Age copper mines at Mount Gabriel, County Cork, suggests that woodland clearance was on an extremely small scale during the operation of the mines, with limited changes to the taxa composition. Analysis of pollen derived from blanket peat near the Bronze Age copper mining facility at Copa Hill, Cwmystwyth, Wales, suggested that evidence for impact could only be discerned as intermittent percentage declines in the representation of taxa such as hazel and oak (Mighall and Chambers 1989). However, despite the use of wood for firesetting to allow for the extraction of ore, there was little need for the production of charcoal, and as such the wood requirements of the mining sites would have been less than those of a similarly sized iron production site.

The estimation by Cleere (1976a: 240-1) for the area of woodland required to provide charcoal for iron production was between 2 km^2 and 3.5 km^2 per annum in the eastern High Weald. Cleere (1976a: 241) concludes that "By the time iron making in the eastern Weald ceased in the mid-third century (with the possible exception of the Footlands settlement), nearly 300 km^2 of forest had been cleared (or 500 km^2 using the larger annual figure), and the area around Battle, ... must have been devastated. Indeed the deforestation in this area may well have contributed in some measure to the Fleet's abandonment of the eastern Weald as its iron making base in the mid-3rd century."

It would be likely that if such hypothetical depletion of woodland resources did occur in the Battle/Hastings region then there could have been a movement into the central High Weald which had predominantly supported small-scale bloomery production, and as a result would have theoretically been better provided with woodland resources. This did not happen in the High Weald during the mid-third century, where there is also a decline in the number of late-third to fourth century bloomery sites.

Where evidence is better in the blast furnace era of production, there is evidence that the Wealden iron industry collapsed prior to the depletion of either fuel or mineral resources. This indicates that natural phenomena were not the only factors to influence industrial activity (cf. Zell 1994: 235). In mid-European woodlands, *long* *term* deforestation is not a function of wood cutting for industrial exploitation, unless the land is converted to a new use which is detrimental to tree growth such as agriculture needed to sustain iron production, or site infrastructure such as working areas or mining sites. In some contexts regeneration can also be prevented by the degradation of the soil profile as witnessed in some sandy lithologies. Small-scale extraction sites would have been less likely to have sustained the development of large-scale site infrastructure although as the size of operations increased the nature of associated infrastructure was also likely to increase incrementally.

Yet research which has been undertaken on the Weald in the last 50 years suggests that settlement and other activity was more widespread than previously thought. Certainly by the onset of the Late Iron Age there is widespread evidence for settlement in the northern High Weald and the northern Greensand periphery. There are certain biases as a result of the dominance of Hillfort sites in these sandy geologies and the comparative ease of discovery of sites compared to some of the heavy clay regions. The limited evidence from excavation suggests that pre-conquest iron production was more prevalent than previously thought. The classic industrial class operations of the eastern High Weald, such as Beauport Park, Crowhurst Park, and Footlands appear to have had LPRIA predecessors. The other industrial class operations at Chitcombe and Oaklands are predominately characterised by unpublished trial trenching operations, and so corroborative evidence of precursive activity is lacking.

The evidence for approximate annual production envisaged by Cleere (1975: 238, Table 1) does have some tentative drawbacks. If LPRIA activity was a precursor to Romano-British industrial class production then the output of the earlier phase of exploitation would become integrated within the estimates of the total slag on the site increasing the apparent volume of slag, hence secondary and tertiary economic simulation based on these figures. As bloomery slag is indistinguishable between different eras, and as no other evidence for iron production has been recovered from the above sites it is important to note that it is actually impossible to determine if iron production was carried out on these site or if they were purely settlement sites. However, it is highly likely that the iron production operation acted as a focus for later activity. The location of the ceramics in some cases can be fixed to the lower horizons of slag deposits, such as Crowhurst Park and Bynes Farm. The industrial output of these hypothetical sites could have been considerable; certainly the semi-industrial operations at Herrings in the Western *High Weald, which were not* disturbed by later workings, suggest that output could be measured in hundreds of tonnes, as attested by the slag deposit which covers an entire hillside, and only contains La Tène III ceramics.

It is probable that the pre-Roman sites would have generated some long and short-term impact on the local landscape. This could be manifested in the form of some limited woodland management necessary to sustain the iron production sites and provide for the needs of the local settlements. Alternatively, the local woodlands could have been cut, and the regrowth would have supplied later users. Only the conversion of land to arable or pasture would have had a significant impact on the arboreal communities, preventing regrowth. However, the disarticulation caused by the conquest could have had a detrimental effect on local agriculture if only in the short term. It is possible that some sites could have accelerated degradation of the local environment although this is impossible to ascertain from the charcoal evidence alone.

In either case at the conquest in certain areas, including the eastern High Weald there would have been a pre-existing economic infrastructure necessary to support iron production and more importantly an arboreal environment which was partially modified as a result of pre-conquest activity. This could form the basis of the fuel supply for the early Roman industries which could then increase production as required.

The evidence from the soil pollen samples recovered from Ludley Farm does not suggest that there was any major deforestation, other than on the site itself and in the immediate locality. Much of the alluvial pollen analysis which has been undertaken on the Wealden coastline shows no major deforestation during the early historical periods. The only exception is the analysis from the Coombe Haven Valley, which is in the catchment area of the Crowhurst Park production site, in addition to semi-industrial operations at Pepperingeye, Forewood, and Bynes Farm. The depredation caused by the close proximity of industrial-class operations could provide a reason for the decline in *Quercus* and enhanced values of *Gramineae.*

THE SELECTION OF WOOD FUEL

There is a significant body of evidence which suggests that ancient societies were aware of the various properties of different woods. These can vary between actual properties and perceptions. The use of wood was however, determined by both its viability as a fuel source, and its abundance in the natural environment.

The evidence derived from the Weald suggests that the exploitation of oak underpinned charcoal production in the Roman Weald. However, ancient perceptions of oak as a source of charcoal were apparently negative. Homer records in the *Iliad* (ix.212) that the use of oak and box were avoided for charcoal production. Pliny in his *Natural History* (XVI.32) notes that the broad-leaved oak "only pays to use it in a copper-smith's workshop, because as soon as the bellows stop it dies down and has to be rekindled repeatedly: but it gives out showers of sparks. *A better charcoal is obtained from young trees*" [my italics].

Theophrastus in his *History of Plants* (V.9. 1-6.) records that "The best charcoal is made from the closest wood, such as evergreen oak, arbustus; for these are the most solid, so that they last longest and are the strongest; wherefore they are used in silver mines for the smelting of ore. Worst of the woods is oak (deciduous), since it contains the most mineral matter, and the wood of older trees is inferior to that of younger, and for the same reason the wood of really old trees is especially bad. The best charcoal comes from trees in their prime, and *especially from trees which have been topped.*"

The theories of the ancient authors does not tally with the oak dominated charcoal assemblages which have been obtained from iron production contexts. This can be attributed to the dominance of the *Quercus* genus in the natural environment. This can be elucidated from the charcoal evidence, the pollen evidence from Ludley Farm and the evidence of the distribution of deciduous oak in the contemporary Wealden environment, where the "Sussex weed" still dominates in some areas despite extensive clearances.

The evidence for the use of wood fuel in metal production contexts from around the British Isles suggests that the wood types which were 'selected' are not consistent In northern England, Wales and Scotland taxa such as alder have a much greater representation in the debris from iron production and other metal production sites, while in southern England the genus is very poorly represented. This is possibly a function of the greater distribution of alder in northern England as a result of the higher precipitation. It is however, conceivable that this could relate to the different indigenous perceptions of the quality of wood fuels. There is significant evidence to suggest that the role of the indigenous populous in iron production was considerable, the presence of some elements of differential industrial technology on the Jurassic ridge, which are not evident on Wealden and southern industrial sites suggests that local traditions do have some importance, such tradition could also include the preferential selection of wood taxa. As a general rule the factors which govern selection are availability foremost followed secondly by real or perceived fuel quality.

Little evidence, from macrobotanical remains, exists for elucidation of selection of arboreal taxa for *specific processes* during iron production. This essentially relates to the low occurrence of excavation and/or macrobotanical analysis of furnace structures or roasting hearths. As a result little statistically valid information can be extrapolated from the data. However, Theophrastus in his *History of Plants* (V.9.1-6.) indicates that selection of wood was apparently practised, in some contexts "different kinds of charcoal are used for different purposes: for some uses men require it to be soft, thus in iron-mines they use that which is made of sweet chestnut when the iron has already been smelted." This implies that all stages of operation were carried out on iron production sites, and there was a difference between the charcoal used for smelting the iron and that used for secondary and tertiary operations. This cannot be confirmed from the archaeological evidence from the Weald.

From what little is known of the High Wealden region there does not appear to be evidence for deliberate selection of wood, rather a specific selection *against* certain taxa. The taxa recorded from the analysis of charcoals derived from High Wealden slag deposits suggests that oak dominated the assemblages of all sites analysed. Other taxa such as birch, hazel and the *Pomoideae* are also exploited regularly. The remaining woodland taxa such as ash, *Prunus*, elm, and beech are also represented intermittently, which is possibly a function of their lower representation in the natural environment. However, the damp-loving taxa such as alder and the *Salicaceae* are consistently under-represented, considering the apparent presence of much alder and willow in the natural environment. It is highly probable that in the case of the *Salicaceae* the negative selection was governed by two factors, the perceptions of poor fuel quality in the green wood and the need for willow for use in wattle and daub structures and basketry. This is confirmed by the relatively common occurrence of the *Salicaceae* and alder from waterlogged deposits on production sites. At Bodiam the *Salicaceae* were recovered from more contexts than any other taxa, while at Beauport Park alder stakes and pieces of willow were common place (Brodribb and Cleere 1988: 238), which is a considerable contrast to the presence of these taxa in slag deposits.

Theophrastus in his *History of Plants* (V.9.1-6.) records that "in general damp wood makes an evil smoke, and for this reason green wood does so: ... damp woods which grow in marshy ground, such as plane, *willow*, abele, black poplar: for even vine-wood when it is damp gives an evil smoke" [my italics]. There is also a dominance of waterlogged *Salicaceae* from constructional contexts such as the wattle structures from Bodiam and the general presence at Beauport Park. The absence of

Salicaceae in the charcoal record differs from the enhanced values of *Salix* which are recorded from the alluvial pollen sequences in the Coombe Haven Valley, during the early historical period (Smyth and Jennings 1988: 41)

MANAGEMENT OR REGENERATION?

Both Theophrastus (*History of Plants* V.9.6) and Pliny (*Natural History* XVI.32) suggest that the best quality of charcoal could be obtained from younger wood and regenerated wood. This certainly appears to correspond with the predominance of branch wood and young wood from the slag deposits of the High Weald.

From the archaeological contexts available as yet it is impossible to determine if the deliberate utilisation of managed woodland products was practised or if regenerated wood was used. The evidence from slag deposits would not be subtle enough to elucidate if the utilisation of regrowth of certain dimensions was practised rather than exploitation of coppice or pollards. Slag deposits are not primary deposits, the wide range of sources of debris in these deposits, in conjunction with the enhanced attrition, also serves to conceal profiles of age and size which might give an indication of the nature of exploitation. The essential difference between the two methods of exploitation is one of perception of the woodland resources. The utilisation of regrowth is an *ad hoc* exploitation without any attempt to influence the natural processes, while the management of woodland implies a knowledge of the regenerative properties of woodlands and a commitment of labour and resources that spanned generations. The concept of management implies a different psychological awareness of the woodlands than that of other economic strategies. The elucidation of Roman perceptions of woodlands is as yet insoluble.

However, the majority of the charcoalified material that has been recovered from slag deposits in the eastern High Weald derive from branch wood rather than the trunk material from mature trees. An exception to this is the early first century site at Turners Green which produced a charcoal assemblage dominated by mature oak, although the exact definition of mature remains enigmatic. This also appears to differ from the data provided by Straker (1931: 110-1), where there was a preponderance of larger timber on Roman sites. There is the distinct possibility considering the dominance of branch wood recovered by the author, that selection procedures based on the size of fragments might have been introduced in earlier charcoal extraction from Roman sites. The domination of branchwood is not entirely unrealistic, the industrial complexes of the eastern High Weald was populated and producing iron prior to the invasion, and after the conquest would have required substantial quantities of wood to sustain the operations. As such the woodlands would have been cut, during the LIA, LPRIA and the early Romano-British. By the second century the majority of wood used for smelting would have been from regenerated or managed sources.

In comparison the pre-Roman exploitation of the western or central High Weald was probably not as extensive as that in the east. Managed or regenerating woodland would represent only a small component of the woodlands in this region at the time of the conquest, which could allow for the high percentage of mature wood at Turners Green. By comparison, the small scale/domestic sites of the central High Weald also appear to have charcoal assemblages dominated by immature and early middle aged wood (> 50 years old). This might appear uncharacteristic considering that this region would have been less likely to have possessed significant amounts of immature woodland. This probably reflects an element of choice on the part of the charcoal producer. In the context of limited scale production of charcoal there is no need to cut down large mature trees. This would entail a significant amount of work to split the trunk with wedges to provide material of the right dimensions for charcoal production, although it is possible that mature tress could have been cut and only the branch wood used. It is probable that underwood was selected to provide wood for charcoal production, in conjunction with fallen and dead wood, and branches cut from mature trees.

In a region the size of the Weald it is apparent that multiple strategies of exploitation would have occurred simultaneously. The Wealden woodlands at any one time would not have been at any one stage of development but at varying stages of growth. It is the modification of this age profile which would have been a primary result of extensive fuel utilisation.

The probability that the industrial iron production centres of the Weald were reliant on coppice management was first forwarded by Rackham (1983: 41). There are certain limitations with the concept of widespread woodland management in the eastern High Weald. The data provided by Rackham essentially projects medieval management strategies onto the Roman Weald, with a classic short rotation coppice system. However, there are two factors which are of concern. During the medieval era there was a significant input of time and energy into the protection of coppice woodlands from predation by grazing animals by the construction of woodbanks. The work of Rackham has resulted in the recovery of large numbers of these structures from medieval contexts. At Rayleigh Hills, in Essex, Rackham (1983: 41), has suggested that beneath possible Anglo-Saxon land boundaries are "faint earthworks which probably mark a set of wood edges in Roman or earlier times." However, despite extensive searches by the author, there is, as yet, no evidence from the Weald of any such woodbanks which can be attributed a Roman origin. It is unlikely that the such banks would have been prone to degradation in the environment of the High Weald, as the region has not been subject to the same extensive agricultural activities as much of southern Britain. The major lithologies of the High Weald are also less likely to be prone to natural erosion.

The most obvious method of protection would have been through the use of pollarding, which would have served to keep the young growing shoots out of reach of grazing animals. However, the subsequent cutting of pollarded wood is both dangerous and time consuming. Alternatively a pro-active approach could have been pursued with the deliberate hunting of deer and other woodland animals to provide food, sport and incidentally reduce numbers. This could account for the moderately high numbers of deer bones recovered from the bathhouse at Beauport Park (Harman 1988). It is conceivable that the protection of woodlands took the form of archaeologically invisible fencing rather than embankment, although the wood required fro such an undertaking would have been considerable, negating any gains from preservation of young shoots, making this highly unlikely. It is also possible that the natural attrition that would have been evident, would have been accepted and considered as a justifiable loss.

The presence of birch and hazel in the taxa composition of charcoal assemblages derived from Wealden slag deposits suggests that openings were evident in the woodland cover. Hazel and birch favour well lit situations; the presence of *Pomoideae* and ash which are also rapid colonisers, could imply the presence of secondary pioneer woodland in the spaces caused by cutting of older woodland. However, in the absence of securely dated sequential deposits from the Roman Weald it is impossible to ascertain if there was a definable increase in these taxa over time. In comparison to the representation of taxa which were less likely to have formed secondary woodland such as hornbeam, elm and beech, is relatively low. The implication is that the woodlands being exploited for iron production were secondary regrowth, as would be expected from such intensive fuel extraction.

The arboreal taxa recovered from the Roman slag deposits in the eastern High Weald and the adjacent western High Weald, are broadly similar. However, limited evidence from the northern High Weald suggests that there could be differences in the arboreal composition. The percentages of oak are reduced and the other light-loving scrubby taxa appear to be better represented. This could indicate more significant changes to the environment of the northern High Weald. The geology is dominated by Tunbridge Wells Sand and which could exhibit an enhanced propensity to degradation. Also sites such as Ridge Hill appear to have operated intermittently over much of the Roman occupation which could serve to enhance degradation. Also there is a growing body of evidence which suggests that pre-Roman occupation of the northern High Weald was considerable. This can be attested by the development of hill forts in the region and also enclosures and field systems on the Ashdown Forest. It is possible that this form of precursive activity on the landscape could have served to open up the woodland communities prior to the invasion, while, constant utilisation during the Romano-British era could have enhanced these tendencies. The location of the activity on the Tunbridge Wells Sand would have also encouraged degradation.

THE USE OF GREEN WOOD

Charcoal production benefits from the use of air-dried wood, as less energy is diverted into driving out the integral moisture in the wood. It is possible that this is to some extent recognisable in the archaeological record. Wood that has a high water content, and is exposed to rapid intense heat, can exhibit a characteristic pattern of splitting (stacking) as a *result of the expulsion of the integral water vapour, through* weak points in the ray microstructure. This splitting represents the modification of the cellular microstructure prior to the conversion of wood to charcoal.

Analysis of the charcoal fragments from industrial-class sites such as Chitcombe revealed that 18% of the charcoal fragments analysed produced evidence of these morphological changes. In some cases this could be indicative of the use of not fully dried wood. This needs qualification, the slag deposits on industrial-class sites possibly contain an assortment of charcoal debris, some of which could derive from domestic sources, which would not necessarily have been subject to drying. It is possible that periods of high output might have resulted in the utilisation of wood which had not completely dried.

In a region the size of the Weald, which encapsulates such geological intricacy, the pattern of woodland exploitation would have been highly complex. Simple models for the utilisation of managed woodland or the exploitation of natural woodland do not allow for the complexity of activity that can occur over a single large site, let alone the immense number of iron production sites in operation over the four centuries of the Roman occupation. Although a simple model based on the hypothesis that industrial type operations were more likely to have maintained a regenerating fuel supply in the locality, while small scale operations would have been more reliant on natural or only partly modified woodland, is a guideline not a rule.

The imposition of such simple models does not allow for the development of sites over time. Many industrial-class iron production facilities may have started life, either in the Late Iron Age or early Romano-British era as settlements unassociated with iron production or as small scale/domestic bloomeries, which gradually increased in output over time. The result would be a gradual modification of the woodlands over time. With iron production, as with other fuel using industries such as ceramic/tile production, salt and iron production, there is often concentrations of activity in specific areas. This could relate partly to the location of raw materials, favourable local economic conditions and transport networks and also the modification of the environment resulting from long-term woodland use.

CYCLICAL OPERATION

It has been suggested by previous authors that iron production was carried out on a cyclical basis (Cleere 1971a). This implies that the same group of people were responsible for all stages of the iron production operation, including the felling of trees, charcoal production, roasting, and smelting.

The primary source of evidence used is the apparently repetitive stratigraphy that is seen in some slag deposits of industrial and semi-industrial class sites. The inherent implication is that during the early Romano-British era on these iron production sites there was no craft specialisation. It is again necessary to reiterate that these industrial sites were the largest iron production sites in the country at the time - so why would the same group of people carry out all stages of the iron production operation.

There are several strands of tenuous evidence which can be brought together.
1) The size of the domestic settlements associated with the industrial class sites are quite large, in some cases covering hectares of land. Some of the population of these sites could have been women and children. Preserved leather shoes from waterlogged deposits at Footlands are certainly too small to belong to adult or adolescent males, even allowing for 30% shrinkage during conservation.

However, both ethnographic and experimental archaeological evidence suggest that the use of actual iron production furnaces was not labour intensive. Cleere uses the analogy of contemporary Indian furnace operation, and suggests 3-5 people could have operated a furnace (Cleere 1963b, 1971b, 1976a: 244). These figures do not adequately explain why such large domestic settlements were present. It could be hypothesised that large domestic settlements were a function of the presence of families and other craft specialists.
2) The characteristic stratigraphy which Cleere suggests is indicative of cyclical operation is only found on semi-industrial and industrial class sites, but not on smaller sites, which, despite their shorter period of operation, are where you would expect to find a single group of people undertaking all stages of the operation. So, the stratigraphy is essentially an industrial phenomenon.
3) The stratigraphy is simplified, because no slag deposit has been investigated in its entirety, the repetitive, cyclical nature of the stratigraphy cannot be proven.
4) Evidence from the season of cutting of the charcoal suggests wood was cut throughout the year. (Careful here - could derive from domestic source).
Outer horizon of the wood where the evidence for seasonality exists is the most vulnerable to attrition, so we do have a small sample.

It is therefore likely that based on the evidence available to date the cyclical stratigraphy found on some non-domestic slag deposits is merely the archaeological manifestation of phases of iron production. However, the imposition of a 365 day time scale onto these operations cannot be sustained on the present evidence, neither can the hypothesis that one group of people was responsible for all stages of operation.

THE MINOR ARBOREAL TAXA RECOVERED FROM THE WEALD

SWEET CHESTNUT (CASTANEA SATIVA)

The sweet chestnut is not an indigenous species of the British Isles. The apparent absence of its charcoal or pollen from pre-Roman contexts has given rise to the hypothesis that the genus was a Roman introduction. The method by which the species was introduced and spread has to be addressed. It appears to be quite well dispersed during the later Romano-British era, examples have been recovered from the Weald, Sussex and Woolaston in the Forest of Dean (Fulford and Allen 1992: Table 6). The fact that the charcoal has been recovered from such contexts suggests that it had become an integral part of the woodland community, at a relatively early date. It would appear that natural advancement of a species could not be so rapid, even allowing for the enhanced communications of the Romano-British era.

It is possible that the method of transport was through the movement of the foodstuffs during the Roman occupation. The chestnuts of *Castanea* are edible, either roasted or raw. The Romans are known to have used chestnut floor and fed the nuts to pigs (Taylor 1981: 54). It was probably through the movement of chestnuts initially as a non-indigenous food source, which could have been grown deliberately or accidentally after discard. The movement of such foodstuffs would have accelerated the progress of the taxa, to a greater degree that that of natural development alone. The possibility that *Castanea* could have a pre-Roman origin, as a result of British links with Gaul or Roman trade cannot be overruled, and would to some extent explain the phenomenal rise in species numbers after the conquest, although no evidence exists for this as yet.

The presence of the pollen of *Castanea* from an early second century context at the semi-industrial site at Ludley Farm suggests that the species was present in close proximity to the site. The pollen from a soil context is corroborated by the presence of the charcoal from the species in the slag deposit at Ludley Farm. The identifications of *Castanea* at Ludley Farm, and Chitcombe are the first recorded examples from a Romano-British Wealden iron production context.

The presence of *Castanea* on slag deposits suggests that it was used as a fuel for some stages in the industrial process. Some authorities suggest that it is not a good wood fuel as a result of its tendency to smoulder and not burn with an intense heat (Taylor 1981: 54), although in the context of iron production it is likely that *Castanea* would have been used in conjunction with other woods such as oak, which dominates all the High and Low Wealden assemblages. Certainly it is unlikely that *Castanea* would have occupied a great percentage of the Wealden woodlands, as suggested by its continually low occurrence in the excavated assemblages. As such any detrimental properties of *Castanea* would have been negated during its use as a fuel.

ALNUS GLUTINOSA (ALDER)

The first recorded example of Alnus from a Romano-British iron production context came from Petley Wood (Lemmon 1952). Alder has now been recovered from less than 50% of iron production sites in the High and Low Weald and on the Wealden periphery. The numbers involved in High Wealden assemblages are small, normally one or two fragments per assemblage. The low occurrence of the genus *Alnus* in previous identified assemblages could be a function of the small numbers of charcoal fragments which were submitted for identification. The strong similarity between alder and hazel could have caused problems with identification especially when this was dependent on the recovery of scalriform perforation plates. However, the low occurrence of alder in charcoal assembles compared to that recovered from both alluvial and soil-pollen sequences suggests that some form of exclusion of this taxa was practised.

The ecological preferences of alder are for base-rich soil with a high moisture content. The numerous ghylls found in the High Weald, with their damp valley bottoms and characteristic micro-climate, provide an ideal environmental niche for alder.

TAXUS BACCATA (YEW)

The only discovery of yew from a Romano-British context in the Weald comes from the basal clays below the Roman port facility at Bodiam. The context is not associated with iron production, although evidence for first century iron production has been recorded on the slopes above Bodiam station. The yew was not carbonised but in the form of waterlogged wood, it was found in association with both charcoal and wood of alder, willow, oak and possibly birch (Lemmon and Darrell-Hill 1966: 100). Technically Yew, as a member of the *Gymnospermae*, is a softwood and as such is the only softwood to have been recovered from a Romano-British slag deposit context in the Weald.

The discovery of yew in the Weald is highly unusual; yew is indigenous to the chalk and limestone regions of southern England, and as such it possibly derived from the North Downs, which are the nearest major outcrop of chalk. In addition it is only tolerant of well-drained soils; the damp riverside clays of Bodiam would not have provided a viable habitat for the yew.

The use of the Bodiam site as a port facility means that the wood could have been transported from some distance, although the site is linked to the Downs via route 13 and 130. An early date is suggested by the recovery of the deposit from the clays at the base of the Bodiam site. This could represent tentative evidence for the importation of wood into the Weald. However, yew does appear to grow on the sandy Wealden lithologies, outcrops of which are found in close proximity to the Bodiam complex. Vidler (1892) certainly recorded the presence of yew from the submerged forests at Bexhill, and the Pevensey Levels.

SALICACEAE (WILLOW/POPLAR FAMILY)

No previous examples of the *Salicaceae* family have been recovered from iron production contexts in the Weald, although both the wood and charcoal willow/poplar was recovered from the river-side settlement at Bodiam. The charcoal assemblages from Heaven Farm and Iridge Bloomery produced examples of carbonised willow/poplar. There is some considerable difficulty in elucidating diagnostic anatomical features between the Genus *Salix* and *Poplus*. As such the species represented could be *Salix alba* (white willow), *Salix viminalis* (osier) *Salix caprea* (goat willow) *Salix fragilis* (crack willow). The poplar family include *Poplus nigra* (Black poplar), and *Poplus tremula* (aspen). Based on the contemporary distribution of willow and popular in the Weald, and the pollen samples from Ludley Farm and Hoath Wood, it is most probable that the taxa represented archaeologically are willow rather than poplar. However, the ecological requirements of both the major indigenous *Salicaceae* are for wet habitats. In the case of willow and poplar large quantities of water are required for maintenance, and as such they tend to be found on stream banks and beside ponds. The numerous ghylls which truncate the High Weald would have provided an ideal habitat for the growth of the *Salicaceae*.

The association with water has a detrimental effect on the quality of the wood as a fuel, both willow and poplar require significant drying prior to use. This was possibly a factor that was known to the users of the wood as it is found only in very low frequencies in a small number of sites. However, it is conceivable that dead or fallen wood was collected, this would have the advantage of being partially seasoned, and would not necessarily be recognisable as willow or poplar. The fine branch wood of willow would have been an ideal source of flexible withies for wattle construction, and it is assumed that the presence of waterlogged willow at Bodiam derived from such as source.

ILEX AQUIFOLIUM (HOLLY)

Only a single fragment of holly has been recovered from an iron production context in the Weald. It is unlikely that holly was a major source of fuel, as a result of the difficulty of cutting as a result of the spiny-lobed leaves, as such it is likely that it entered the slag deposit accidentally as dead wood. Certainly a Latin poem by Nicholas Bourbon, published in Paris in 1517, which described the process of blast furnace production, noted that "the holly, larch and worthless box they leave as useless for the fire" (Straker 1931: 41). However, holly can if left unattended grow into a substantial tree, which might have had some fuel value.

ACER CAMPESTRE (MAPLE)

The only example of maple from a Roman context in the Weald comes from the Semi-industrial iron production site at Ridge Hill (Straker 1931: 110). Although common on calcareous soils, it is able to exist on the more acidic soils of the Weald, it is however unlikely to have achieved great importance as a fuel for the iron industry.

BARK

Bark fragments were more numerous at small scale iron production sites than in the slag deposits of industrial-class facilities. This appears to be a function of the differing nature of woodland exploitation and economy between different classes of site. It is more probable that the production of charcoal at smaller scale sites would have occurred in the vicinity of the smelting site, allowing for the *caveats* of land ownership and woodland coverage. Certainly the taxa recovered from such sites show a tendency towards the exploitation of autochtonous flora, as a result the highly friable bark has less time to detach from the secondary xylem or wood. However, the protection afforded to charcoal within the slag matrix at smaller sites can be significantly less in some cases such as Heaven Farm, than larger-scale waste deposits. In industrial and semi-industrial class operations the charcoal would have significantly further to travel from its point of production in the woodlands to the site of smelting operations, with a longer time to degrade. In industrial operations it is also likely that charcoal would have been stored in greater quantities and for longer periods than that of small-scale sites, further enhancing degradation and attrition of bark and result in its removal away from the final sites of deposition.

CHAPTER TEN

THE ECONOMICS OF THE INDUSTRY

THE ECONOMICS OF THE INDUSTRY

The extrapolation of the basic economy of the Wealden region and its relationship to woodland resources is highly problematical, a consideration summed up by Branigan (1977: 129). "Interpretation of economic evidence, whether it be architectural, faunal, floral or artifactual is difficult; the reconstruction of an ancient economy is infinitely more so. One cannot hope to achieve more than an approximation of the truth at best and the probability is that one will fall short even of this goal." However, a basic attempt must be made to provide a context for the environmental data recovered.

THE PRE-ROMAN INDUSTRY

The earliest literary reference to iron production in southern Britain derives from Julius Caesar, who recorded that iron was produced in the *maritime region* of Britain but that its output was small (*De Bello Gallico*: v.12). However, Caesar's invasions in 55 and 54 BC do not appear to have penetrated the Wealden region (Salway 1981: 26-39). The information must have come either from local informants or represented iron production specifically in coastal Kent. For production to have come to Caesar's attention, the output could not have been that small. The statement could, therefore, have been a comparison with his experience of Republican Roman industry, which would have belittled indigenous Celtic activities. At the beginning of the first century A.D., the Greek geographer Strabo (iv.99) noted that the exports from Britain included iron, in addition to corn, cattle, slaves, gold, silver, hides, and hunting dogs. Although this has been interpreted as an indicator of a significant increase in iron production in the Wealden region between Caesar's invasion and the turn of the millennium (cf. Cleere and Crossley 1995: 55), it could also reflect the change of awareness of Britain as a source of trade by Roman merchants. At the time of Caesar, Britain was still considered to be beyond the bounds of the known world; however, half a century after Caesar's invasions, considerable cross-channel trade is evident from the archaeological record (Salway 1984: 56-9). Alternatively, the stimulus of Roman contact and trade might have been an incentive to iron production.

In addition to the export of iron, possibly to the Gallic provinces, or possibly the Rhine, there would have been significant movement of iron, or iron products, within southern Britain. A rare study of the chemical composition of Mid-Iron Age artefacts from Danebury hillfort, by Salter (1984: 436), suggests that certain artefacts might have derived from iron extracted from the clay ironstone seams of the western Wealden region, as indicated by the high levels of cobalt. The only definitive evidence of pre-Roman iron production in this peripheral region comes from the hillfort site at Hascombe, the Broadfield sites and the settlement site at Thorncombe estate. This activity would not have been sufficient to support regional export. It would appear that the Iron Age industries were more widespread than currently thought. The implication of this activity is that the Mid- to Late Iron Age industry of the Weald was sufficiently organised, and widespread, to produce a surplus sufficient to sustain local, sub-regional and regional needs in addition to supporting export to the continent. It is unclear if this represents social changes in the Weald or is the manifestation of external exchange networks utilising and stimulating the output and resources of the region. Most subsequent industrial developments in the Wealden region were the result of external impetus.

This limited literary and archaeological evidence does not appear to correlate with the known distribution of pre-Roman production sites in the Wealden Region (Cleere and Crossley 1995: Fig 17). There are several taphonomic factors which influence the recovery of pre-Roman exploitation sites. The majority of pre-Roman iron production sites derive from the Later Iron Age; this corresponds with changes in settlement structure around the first century B.C., when the Wealden hillforts were abandoned in favour of non-defended sites with a low archaeological visibility; this also applies to the production of iron. The presence of indigenous iron production operations would, in many cases, have acted as a stimulus for intensive Roman operations, which would serve to obliterate or conceal all traces of earlier activity. Such activity is impossible to quantify as a result of the impossibility of distinguishing the bloomery slags of different eras by morphology alone. Prehistoric slag could have been used for hard-core on roads, which could account for significant losses, as suggested by the recovery of a fragment of *La Tène* III ceramic from the slag hardcore of a road, at Hempsted, near Benenden (Davies 1935: 152).

Despite limited excavation, the heavy industrial sites of the eastern High Weald have yielded pre-Roman ceramics at Crowhurst Park, and Footlands, while excavation of the bathhouse at Beauport Park has produced evidence of round houses representing an earlier phase of occupation. In addition, at Old Place Farm, Icklesham, a sherd of probable pre-Roman ceramic was recovered. Although it is impossible to determine if these precursive sites were actually producing iron or were just settlement sites, it seems highly probable that they did have a small o moderate scale output and as such acted as a focus for later exploitation.

In the western High Weald, the evidence for iron production is more prolific. Radiometric dating of one of the bloomery furnaces outlying the Romano-British industrial-class production site at Great Cansiron produced a determination of a.d. 20. The extensive slag deposits at Herrings have produced only IA ceramics, and as such do not appear to have attracted Roman attention. However, the substantial nature of the slag deposits on this site indicate that iron production was organised on a industrial footing for Iron Age society, although equivalent to Romano-British semi-industrial operations. The output of bloom iron that such an enterprise would have generated suggests it was involved with extensive export. The tenuous dating evidence provided by East Sussex Wealden wares has provided possible pre-conquest or transitional material from sites such as Sandyden Gill, Chillies Farm, and Cow Park, while ceramics which appear to span the conquest have been recovered from Pippingford Park and Minepit Wood. The large standard deviation derived from radiometric analysis at Little Inwoods (130 B.C. - AD 70) makes confidence of a pre-conquest date uncertain, but from the available data this appears highly probable. Other small-scale operations include the pre-conquest ferric exploitation associated with the hilltop site at Garden Hill and similar activities at Saxonbury Camp, which might have exerted a sub-regional influence on the production of iron in the area. The relationship between 'hillfort' sites and iron production is also found in the Wealden periphery. At Eastwell Park, a hillfort site associated with iron production dominated the Wye corridor, which cut through the North Downs. This was later replaced by Roman activity on the valley floor. In the vicinity of Lenham, a pre-Roman industry was well developed, with two pre-conquest production sites at Runham Farm, and one at Stalisfield Wood, which would form the basis for later exploitation. At Hascombe Camp, on the Surrey Greensands iron slag was found in association with pre-Roman ceramics, although in this context there was no evidence of Roman exploitation.

However, as with the biases which resulted in the preferential recovery of industrial-class iron production operations in the nineteenth century, so the presence of iron production on hilltop sites may be over-estimated. Defended enclosures, camps and other hilltop sites have attracted a good deal of attention as a result of their prominent positions and the apparent absence of other, non-iron producing, archaeological sites in the Weald. Certainly the presence of iron production and fabrication of iron products in defended enclosures is not uncharacteristic for the region, with their roles as sub-regional centres for redistribution and *foci* for prestige goods.

On the Low Weald, at Goffs Park, evidence for iron production was found in association with evidence for arable cultivation. Activity later moved to the Broadfield site, where production continued through the Roman era to the fourth century.

Despite extensive biases in the archaeological record, it appears likely that prehistoric iron production of various scales was evident throughout the Weald. There is tentative evidence for a precursive industry in the eastern High Weald, which gave rise to the industrial exploitation of the Romano-British era. This was complemented by activity on the western High Weald (*contra* Cleere and Crossley 1995: 53), and examples of hillforts associated with iron production on the northern fringes of the High Weald and on the Greensands. While evidence for Romano-British output is tentative, the output of the earlier industries is as yet impossible to gauge, however, evidence suggests that sufficient was produced for external trade.

It is likely that these iron production sites would have been associated with settlement sites and the limited agriculture needed to support these local communities. The Roman engineers entrepreneurs and civilians who entered the Weald after the invasion did not, therefore, encounter a primeval forest, but a populated landscape, with a significantly modified arboreal environment and a flourishing arboreal environment.

At its most basic level, the Wealden region was dominated by the Cantiaci in the east and the Regni in the west. However, the insular nature of the Wealden region makes the picture much more complex. Frere (1944: 64) felt that the Wealden culture "did not represent any single tribal unit by the end of the Iron Age, but rather a variegated population of diverse origins." It is therefore probable that the response to the invasion would have been as diverse as the disparate indigenous communities which inhabited the region. The possibility of some degree of resistance can be envisaged from the Weald. At Oldbury there is evidence of refortification around the time of the conquest (Ward-Perkins 1939: 153, 158); at Garden Hill the collapse of the defences has been seen as a response to the invasion (Money 1977); while at High Rocks the hurriedly-constructed defences could have a conquest date (Money 1941: 108-9).

It is possible that the presence of gold and silver coinage of a late Iron Age date in the Wealden region could be indicative of the wealth gained from the production of iron and iron products for the Gallic wars, or regional trade within the country. The period immediately prior to the invasion would have been a major stimulus to the economy of the Weald. It is likely that the region located in the heart of the south-east would have been in a prime position to supply material to tribes who were potentially hostile to the Roman invasion, although with the initial rapidity of the Roman advance through the south-east, this would have been unlikely to have been long lasted.

ROMAN EXPLOITATION

The mechanism by which the transition of Iron Age to Roman bloomery sites occurred can only be speculated on. The available evidence from the Wealden scarp foot suggests that the small scale bloomery activity which had been characteristic of the LIA appears to have continued providing iron for the needs of local communities. As the foothold of Roman influence grew then it is likely that some of these local producers increased production possibly to supply the villas of the ore-deficient downlands. There does not appear to be any evidence of government involvement in these production sites except in the region of Wye and Lympne where sites might have begun to provide for the growing naval establishments on the south coast. A similar scenario can be forwarded for the Low Weald, although the infrequent occurrence of sites does negate any firm conclusions. However, the catalytic influence of Roman society was sufficient to cause the relocation of the Goffs Park Production centre to the Broadfield site.

THE STIMULUS OF THE SECOND CENTURY

The early second century witnessed a substantial increase in both industrial and economic activity in the province, which Fulford (1989: 183) suggests provides evidence for the utilisation of the economic potential of the whole province for the construction of the frontiers works and the subsequent supply of the Northern and Welsh garrisons. This is indicated by significant changes seen in the industrial output of ceramic types (Fulford 1989: 184, Fig 2). It is at this time that the first positive indications of *Classis* activity in the Wealden ironfields are found, with stamped tiles of the fleet at industrial sites. These are complemented by the presence of epigraphic evidence for detachments of fleet personnel on the Northern Frontier (Cleere 1977).

The inherent implication for Wealden iron production, resulting from the construction of the Northern frontiers, would have been a substantial increase in metalliferous output. The apparent presence of *Classis* personnel, both on industrial class iron production sites and in nodal positions on the land and water transport networks of the eastern Weald, suggests a primary role for the fleet in the distribution of materials. A great deal of caution has to be expressed in the hypothesis that the fleet were directly involved with the iron production process. While the fleet were only a subsidiary branch of the army, it is unlikely that it could have afforded to have key personnel tied up with administration, transportation, and the actual production of iron. This would certainly apply to the first century when *Classis* activities would have been dominated by the support role for the advancing armies, and in the second century when the fleet would have had a vital role in the logistics of the construction of the Northern

Frontiers. The smelting and consolidation of iron would have been a highly skilled process (Sim 1995: *passim*), which would have tended to preclude the marines of the fleet from such activities. The presence of an indigenous population and possibly the influx of itinerant, extra-local, and foreign workers into industrial sites could easily have provided the requisite skilled labour force required to run such establishments without the need to involve the fleet. In addition, there has been no evidence from long term contemporary excavations at Bardown and Beauport Park for any items of military equipment. The only apparent exception has been the recovery of two bronze objects thought to be attachments for armour (Margary 1933: Plate 1), during excavations at the semi-industrial iron production facility at Ridge Hill, in the western High Weald. However, these objects are remarkably similar to bronze saddle horns recovered from Newstead (cf. Fuentes 1991). The absence of military equipment cannot be explained on the basis of recycling of iron on such sites, as other iron objects recovered from production sites in the Weald appear to be purely domestic in nature (cf. Lower and Chapman 1866: 62, Dawson 1903). It is possible that the absence of military equipment might relate partly to the lack of manufacture of such material on site. It is highly likely that in many cases iron was shipped in the form of consolidated blooms to the military, where it could be fabricated as required. The evidence for military interaction with these sites derives exclusively from the infra-structure, the CLBR tiles, the military-*style* barrack block at Bardown, and the military-*style* bathhouse at Beauport Park, all of which imply a military link, although not necessarily the large-scale deployment of personnel.

The hypothesis that units of the fleet were *directly* involved in the iron making process has been suggested by Cleere (1976), although this has to be viewed with caution.

The presence of apparent government infrastructure in the eastern High Weald has, as yet, no correlate in the western High Weald, although industrial-class sites, such as Oldlands and Great Cansiron are present. However, tentative evidence of tile production on the Oldlands site, with a radiocarbon determination in the 120s, suggests that heavy-duty infrastructure was implemented on the site at this time, implying a long-term commitment to the production of iron at this time. The wasters and debris from the kiln at Great Cansiron have, however, produced no evidence for *Classis* or other imperial stamps. It appears likely that the needs of the Northern Frontier were also met by industrial output from the western Weald. This could have been both direct or indirect, with the enhanced output for the western Wealden industrial sites either destined for the northern garrisons, or used to make up any shortfall of material from the eastern Wealden sites which was diverted from civilian markets. The second century witnessed a substantial increase in both urban and rural development which was simultaneous with enhanced military activity on the frontier region. Certainly the nodal city of Canterbury, which had road links with the eastern Wealden ironfields, showed a significant increase in building during this period.

However, it is unlikely that the output of Wealden iron production facilities during the second and third centuries witnessed a simple increase and decrease. Analogy with the output of post-medieval blast furnaces suggests that the annual production was highly variable, being highly dependent on external economic conditions. In the context of Romano-British iron production in the Weald, external factors would include the military supply to the Northern Frontier for construction purposes; the supply of campaign armies; and the supply of civilian markets in the south-east, and, to a lesser extent, southern Britain and the east coast, for building programmes and implements. A simple model would suggest that peaks in Wealden iron production would correspond with periods of major campaigns, as a result of the need to equip troops and also to restore losses after military activity, and to major building programmes especially in Roman towns of the south-east. Certainly detailed excavation of the bathhouse at Beauport Park suggests that there was at least one phase of abandonment during the later second century.

THE END OF THE INDUSTRY: PHASE 1

Sometime between A.D. 220 and 240 the major industrial class sites under *Classis* jurisdiction in the eastern High Weald had ceased to operate, causing an almost complete disarticulation of the industrial network in the High Weald. Many of the industrial sites closed, which coincided with the disbanding of the fleet installations in Bodiam, Lympne, and the dismantling of the headquarters at Dover (Philp 1981). This was accompanied by a restructuring of the organisation of the Roman provincial fleets which resulted in the disappearance of the *Classis Britannica*. After this collapse, only a skeletal iron industry remained in the High Weald. It is unlikely that this decline is an artefact of the sites which have been excavated and dated. A sufficiently large number of dated Roman sites have been recovered (n = 110) suggests a viable sample. With the collapse of the fleet infrastructure, it seems likely that the volume of diagnostic ceramic types imported into the region would have been significantly reduced, which might cause some problems with dating some post-decline iron production sites. However, the majority of bloomery sites in the Weald tend to be dated using East Sussex Wealden wares, which are broadly diagnostic between early and late, or pre- and post-decline.

The evidence for general settlement in the Wealden region also appears to decrease during this period, especially in the High and Low Weald although activity of some undisclosed nature is evident from the extensive scatters of coins from the post-decline era. There is little evidence of the extensive building programmes which were characteristic of the last three or four decades of the third century.

The only industrial-class sites with evidence for activity after the collapse of the 240s were those at Footlands in the eastern Weald, Oldlands in the western Weald, and Broadfields on the periphery. These sites are distributed throughout the Weald, although it is unknown if their output matched that of the first and second centuries, nor is it known if ceramics found on these sites equate to actual iron production or merely settlement activity in conveniently cleared areas.

Once the prime economic nucleus for the region declined, a knock-on effect was felt in local industries which were created to supply, or whose operations provided the personnel for, the iron production sites. These include salt production as evidence by the apparently synchronous abandonment of sites in the Dymchurch region of Romney Marsh., some ceramic production, and the extensive yet invisible labour requirements for woodland exploitation. This resulted in what Cunliffe (1988: 86) considers to be a "major dislocation in the socio-economic system of the region."

Small-scale producers of surplus iron and the so called 'entrepreneurs' in the western High Weald could no longer rely consistently on the imperial supply lines to purchase the surplus iron they had produced. They would have had to seek to supply iron primarily to the villas of the surrounding Downs, where they would have become vulnerable to competition from the iron producers on the periphery of what essentially were their home markets, which they had probably supplied from an early date. These peripheral production sites show less evidence of decline in the third century. The agro-industrial complex at Broadfield continued operations until the fourth century, possibly utilising its advantageous location to supply the Downs and London markets. The North Downland and eastern Greensand villa economies which produced surplus iron, such as Runham Farm, with their favourable position in the Downland markets, appear also to have ceased production.

A plethora of reasons to justify the decline of iron production have been forwarded. These have ranged from the depletion of arboreal resources necessary to sustain the industry, the siltation of the tidal inlets now occupied by Romney Marsh, the negative effects of the Germanic raiders on the sea-borne transportation of products. These hypotheses tend to concentrate on local and regional phenomena to explain the dislocation of activity. However, the decline of the Wealden industries can be seen in the general economic context of the province during the third century. The period between the revolt of Albinus in 196-7 and the last four decades of the third century is characterised by apparent economic difficulties. The most important of these was the decline in garrison size on the northern frontier and its hinterland, which caused a reorganisation of the military supply network in the 240s. The work of Fulford (1989), uses the distribution of ceramic types to provide an indication of the major trade routes in the province, suggests that the routes on the east coast had ceased to function by the mid-third century. This would have resulted in the marginalisation of the Wealden industries on the very periphery of the defunct east coast trade routes.

However, possibly even wider scale economic trends can be envisaged. The Roman industrial lead mining establishment at Pentre Farm, Flint, witnessed a similar period of exploitation, with phases of abandonment, and cessation of activity in the 240s, which could indicate the organisation of metal production activity on a large scale, and its reorganisation during this later period. What is clear is that the widespread abandonment of the Wealden region for industrial iron production appears to have had little to do with internal Wealden phenomena, such as the alleged deforestation caused by iron production or the exhaustion of resources, but was intimately linked to the wider provincial economy.

It would be unwise to postulate a purely military solution to the initial decline in iron production. The Wealden industries were not solely reliant on military contracts; the development of the road network in the eastern Weald suggests that the supply of iron also extended to the civilian markets. With the decline in the lucrative military contracts, the industrial sites would have been reliant on these civilian markets to a greater extent. However, in the third century, throughout the Empire, there was a decline in building.

Although Wacher (1989: 94) suggests that the British provincial situation was better than that of the Empire-wide economy, there was still considered to be an "uneven stagnation" in non-military building.

In the late second and early-third centuries, the Wealden iron industries were affected by several external economic phenomena: a decrease in army expenditure; which possibly resulted from a cut in garrison size, the decline in the use of the east coast trade routes; and a simultaneous lack of confidence on the civilian markets. The combination of these factors made the continued widespread industrial exploitation of iron in the eastern Weald untenable. The Weald appears to have reverted to an economic and industrial state little better than that exhibited before the conquest. The Weald required an external impetus, in the form of the Roman invasion, to become an industrial centre; once this was removed, the nature of exploitation changed.

With the virtual demise of the Wealden industrial centres, the other iron production regions could flourish in the absence of competition. The iron industry in the Forest of Dean had steadily grown in importance during the second century. Its close proximity to the northern Welsh garrisons would have allowed it a prime location in the distribution of iron to the Welsh and the western wall region. The presence of a west coast supply route, which would allow for the movement of material northwards, is corroborated by the distribution of BB1 and Severn Valley wares on the Northern frontiers. The supply of ceramic suggests source areas for military supplies in the south-west; the iron from the Forest of Dean, and possibly lead from the Mendips and tin from

Cornwall, would have been elements in this supply route. The Forest industries could now use the primary west coast trade routes to supply the northern frontier.

The archaeological evidence from the Forest of Dean is not as well documented as that from the Weald. Much socio-economic evidence was destroyed as a result of resmelting bloomery slags, and there has been little co-ordinated research on the iron industry as a discrete entity. The presence of the utilisation of river and sea-borne transportation by the iron industry is further corroborated by the presence of a substantial iron production settlement on the Upper Severn at Worcester, which could have been involved in the supply of iron up-river to Wroxeter and the northern Welsh hinterland, in conjunction with the general distribution of bloomery sites along the banks of the Severn in the Forest of Dean and on the Somerset side.

THE END OF THE INDUSTRY: PHASE 2

The later stages of decline in the iron industry came with the gradual relaxation of Roman authority in Britain during the early fifth century. The transition from Roman to sub-Roman is an ephemeral era in British archaeology. This is more pronounced in the Weald, where significant taphonomic factors have consistently biased archaeological research.

The archaeological evidence for sub-Roman and Anglo-Saxon occupation of the Weald is extremely sparse. As a result, the majority of the evidence derives from documentary sources and place-name evidence. In addition, the systematic use of stone as a building material until the late Saxon era further enhances the biases. In common with the Romano-British era the majority of the sites which have yielded environmental evidence from the central Weald have been high-visibility sites associated with iron production. The only archaeological evidence for early bloomery activity comes from the partial excavation, by W. Beswick, of a small iron production site in a waterlogged ditch in Turners Green, Warbleton (TQ 637 197). This produced both preserved timber and charcoal, of unknown taxa, which provided a radiocarbon date of a.d. 567 ± 45 (Wilson and Moorhouse 1971: 134). This correlates with Welch's (1971: 232, Fig 2) hypothesis for the distribution of fifth century Saxon settlement in the Weald, which he argued was concentrated between the Ouse and the Cuckmere, and between the sea and the Weald Clay. The expansion of this settlement by the mid-sixth century would have encapsulated the Warbleton region.

A later oak-dominated botanical assemblage was revealed during rescue excavation by the Wealden Iron Research Group at a small Middle Saxon bloomery site at Millbrook, in the Ashdown Forest (TQ 441 296), in advance of the construction of a mains water pipeline from Horstead Keynes to Black Hill reservoir (Tebbutt 1982; 19). The carbon-rich soil produced an unknown number of fragments of carbonised wood, which were utilised for radio-metric determination. These were identified as oak, and possibly derived from mature timbers. The radiocarbon date of a.d. 730 ± 70, and an associated archaeomagnetic date of A.D. 860 ± 60 could imply a date within the first thirty-five years of the ninth century (Tebbutt 1982: 28). The implication of the recovery of mature timber wood from the Millbrook site is significant. The majority of wood fragments from Roman sites appear to be derived from branch wood rather than timber, although this has to be considered within the confines of taphonomy, which is likely to bias results towards younger wood. The use of timber suggests that significant regeneration of woodland had occurred, possibly since the decline of the first phase of iron production in the mid-third century, or after the cessation of direct Roman rule. The implication is that Saxon inroads into the regenerated Wealden forest were not significant at this time, which would correlate with the earlier evidence from the *Parker Chronicle* for A.D. 477, indicating the size and nature of the Andredswald. This was later reiterated in the life of St. Wilfred, which records that Sussex had remained pagan as a result of the extensive forests which had prevented conquest by other kingdoms "*pro rupium multitudine et silvarium densitate*" (Welch 1971: 232).

It is unlikely that iron production operations ceased entirely during the sub-Roman era. The Weald would still have been inhabited, although the ephemeral nature of occupation would have a low archaeological visibility. The need for iron would still have been a significant factor in society, however, with the breakdown in communications and the loss of the wider market economy, especially in the Wealden region, it is likely that any exploitation of ferric resources would have been at the level of the individual, family or community needs. Changes in building methods during the Saxon era would have had an impact on the needs for iron in society, possibly resulting in a decrease, although iron would have been extensively used for tools, weapons and ship fittings.

Smaller-scale bloomery sites would be less likely to retain diagnostic chronological evidence. With the cessation of production of diagnostic Wealden ceramic forms, the accessibility of ceramic types would have been greatly diminished, supplemented by perishable materials for containers. It is probable that the apparently low representation of Saxon iron production sites in the Wealden region is a function of the availability of ceramic types to the Wealden sites, and not of an actual low production rate. Certainly, Cunliffe (1978: 223) notes that Early and Middle Saxon ceramics are rare even on intensively occupied sites, and where they are present they are highly vulnerable to degradation as a result of weathering and attrition in the plough soil.

The Saxon industries would probably have been characterised by smaller-scale extraction and production sites. As yet, there is no evidence for industrial and semi-industrial type production sites. To a certain extent, this could be a function of the more individualistic nature of early-to mid-Saxon communities compared with Roman society, and the absence of a centrally administered Imperial economy. There are a significant number of bloomery sites from the Wealden region which are undated (cf. Cleere and Crossley 1995: 288-94), either as a result of the deficiency of ceramic types or other chronological indicators during excavation or the absence of excavation.

THE POST-MEDIEVAL IRON INDUSTRY

The charcoalified taxa associated with the slag deposits of the blast-furnace era appear to be significantly different to those of the bloomery deposits of the first millennium. The massive dominance of oak which characterises the non-water-driven bloomery deposits of the High Weald is replaced by a trend towards the dominance of the underwood species. This could be a manifestation of the demand for timber species such as oak for use in construction and ship building, and the use of conservation measures such as coppice with standards to prevent its decline. Oak does not, however, cease to be exploited, and still retains an average of 30% of the taxa recovered. This probably derives from several sources: oak, the natural climax taxa of the Wealden region, was certainly managed. Such harvesting prior to attaining the status of mature trees would account for a significant percentage of the oak recovered. In addition, the fallen branches of mature oaks would undoubtedly have been incorporated into the charcoal clamps, in addition to incidental illegal use of oak, such as through shredding of mature trees.

CONCLUSIONS

An important reason for the success of the Wealden iron industry in the first two centuries of the occupation was that the Roman state tapped into a pre-existing system. The Romans did not introduce the smelting technology, slag taping furnaces have been recovered from second century B.C. contexts at Broadfield. This is further emphasised by the differences in smelting technology across the country, differing regional styles are encountered on the Jurassic ridge which are not evident in Wealden contexts.

What the Roman state brought was the capability and need for widespread industrial-class production. This was achieved through the increase in the number of productive units in operation at any one time, and the development of wider infrastructure to provide a market for and to support production. The Later Iron Age provided an indigenous population which was aware of the value of its ferric resources, and had the requisite skills needed to exploit and manipulate them. This activity was merely intensified during the Romano-British era. The number of people which could be actively involved in the production of iron and other products could have been increased because craft specialisation could have been sustained by the movement of foodstuffs long distances to support specialised activity. The economy of Britain was no longer as insular as that before the conquest but part of a wider empire, which could give support and provide a market.

CHAPTER ELEVEN

CONCLUSIONS

CONCLUSIONS

Previous research into the bloomery iron industry of the Weald has concentrated on the High Wealden region, where the ubiquitous nature of bloomery sites has tended to focus research. The early antiquarians were initially attracted to the large industrial-class sites of the Hastings hinterland. When these sites were discovered, or destroyed for road metalling, archaeological interest gradually moved into the western High Weald where numerically superior numbers of domestic and semi-industrial sites could be found. Extensive bias such as the location of field groups and population centres, in conjunction with variable geologies, has further reinforced these stereotypes to the detriment of holistic Wealden research. The clay vales of the Low Weald, and the geologies of the Wealden periphery, have rarely entered the mainstream academic study of the iron industry. Research by the author suggests that outside the High Weald there was extensive exploitation of ferric resources predominately based on smaller-scale production than much of that witnessed on the High Weald. On the Greensands of the periphery the exploitation was predominantly small-scale, but on the Weald Clay there is evidence for limited semi-industrial activity at Romden Place and Broadfield, based on the clay ironstone seams. On the Greensands the operations appear in many cases to be subsidiary to activities such as farming. In some areas such as Lenham it is proposed that there was stress between the competing needs of fuel and farming land.

The presence of a growing body of Romano-British iron production sites in the periphery of the classic Wealden production areas, has analogies with the study of the iron industry throughout Roman Britain. Certainly there are three nuclear regions of iron production: in the Weald, the Forest of Dean and the Northamptonshire hinterland, as characterised by the presence of industrial-class facilities. There is growing evidence for both Romano-British and undated bloomery activity throughout the country, even in regions thought to be devoid of such activity reveal the presence of bloomery production (cf. Pettitt 1977).

Analysis of the charcoals recovered from Romano-British slag deposits in the eastern and western High Weald have produced three major conclusions. The identification of charcoals suggests that the environment during the major phase of iron production, between the mid-first and mid-third centuries, was dominated by oak, with birch, hazel and *Pomoideae*-type taxa as the major secondary components of the woodlands. Other elements of the closed woodlands, which have a diminished ability to form secondary woodland, such as beech, hornbeam, and elm are only represented intermittently and in very low frequencies. The implication is that the natural distribution of these species is not as widespread in the vicinity of the slag deposits studied, which is considered to be a function of the extensive exploitation of wood fuel and the subsequent extension of secondary woodland. The presence of *Castanea* sp. (sweet chestnut) has been recorded from charcoal assemblages at Chitcombe and Ludley Farm; sites only 4 km apart in the eastern High Weald. It is possible that the presence of this taxa has been missed in earlier investigations as a result of the morphological similarity between *Quercus* and *Castanea*, although its rarity could also account for previous absence. The presence of *Castanea* is considered to be a Roman introduction. The low frequency and apparent nucleation, in an early Roman context could indicate an early expansion of the taxa in the eastern Weald possibly as a result of the importation of the nuts as a food source.

Secondly, the analysis of the growth structure of the charcoalified material suggested that material from the slag deposits was cut throughout the year, although evidence for the season of wood cutting (or growth cessation) characteristically dominated the assemblages of larger-scale slag deposits. This data could not be correlated with the smaller deposits where higher attrition of charcoal in the slag matrix was evident. The cessation of growth during the growing months is taken to imply a deliberate cutting of wood, as trees are less likely to die naturally, as a result of storms, or, to a certain extent, disease, when the sap is circulating. The presence of wood in slag deposits could however, have derived from domestic sources which could account for the spring/summer cut wood.

The apparent age of most of the charcoal identified was low, the attrition in the slag deposits did not allow for widespread age profiling, but despite the taphonomic bias towards younger, smaller wood there was little evidence for wood over fifty years old. The extrapolation of the ring diameters was also suggestive of smaller-diameter wood. This is consistent with the use of branch sized wood. Allowing for the taphonomic biases associated with the destruction of charcoal in slag deposits, there are sufficient data to postulate that younger wood was used of preference as suggested by many ancient authors, and possibly in some industrial and semi-industrial class operations was the only form of wood available for exploitation. The presence of branch-sized wood is matched by an almost complete absence of twig-sized wood. This is considered to be a function of the attrition inherent within slag deposits, and the lack of use of smaller wood for industrial purposes. This could provide a tentative clue as to the nature of the wood being exploited - regrowth and/or managed wood, would have a lower percentage of twig to larger branch wood.

To compliment the dominance of branch wood, there is evidence from some earlier slag deposits such as Turners Green that mature wood dominated the assemblages. This could suggest mature woodland was initially cleared from some sites to provide fuel for industrial class exploitation, which later on had to rely on regrowth after exhaustion of mature wood stands. The use of such mature wood early in the life of industrial and semi-industrial sites would account for its lack of representation in slag deposits.

The widespread exploitation of smaller diameter wood could have been the product of deliberate management policies on semi-industrial or industrial class operations, or merely the *ad hoc* utilisation of regrowth. The static nature of many of the fuel consumptive industries around the Roman countryside suggests that management was practised rather than a random utilisation of the woodlands.

On many smaller scale bloomery operations it is unlikely that management practices would have been implemented. The short period of operations on these sites varying from one smelt to a decade of operations would not allow for the creation of sufficient regrowth to sustain operations. The use of managed woodland operating prior to iron production is a possibility, or alternatively the utilisation of regrowth, deliberate or otherwise, from previous interaction with the woodlands, could have been undertaken.

The third conclusion relates to the low representation of damp-loving taxa in fuel contexts. Taxa such as alder and *Salicaceae,* commonly associated with damp environments such as ghylls and river banks, have been recovered in very low frequencies. The low representation is seen as a function of a deliberate policy of exclusion. This provides a correlate with the average representation of these taxa in waterlogged contexts on sites associated with iron production in the Weald.

The impacts associated with the various bloomery production sites would have been variable. It is likely that negative impacts from smaller scale operations would have been quickly absorbed into the environment, although on some sandy lithologies podsolisation could have resulted. On the semi-industrial and industrial-class operations the effect on the environment would have been more significant; in addition to the obvious morphological changes associated with open cast mining operations and the creation of slag deposits, it is likely that in some localities the extensive use of woodland resources could have resulted in podsolisation in some sandy lithologies. This would correlate with the recovery of *Calluna* pollen from the semi-industrial class slag deposit at Ludley Farm, on the outskirts of the major industrial class operations in the Hastings hinterland. By contrast, the long-term effect of woodland exploitation would have been minimal on the clays of the High Weald, although the effects of mining would have been more noticeable as the Wadhurst Clays appear to have been the favoured source of ore for the iron industry.

The evidence from the Weald does not support the conclusion that the Weald was a primeval forest either during, or prior to, the Roman era. Such hypotheses are considered to be a function of the nature of the Wealden literature and the inherent perceptions which derived from such sources. Pollen evidence suggest that iron production sites could have caused considerable modification to local environments, especially around larger-scale facilities. These could be manifested by the limited extension of grassland, in addition to nitrophile herbaceous communities which would have been attracted to the mineralogical modifications to the soil profile caused by the deposition of carbon debris. Heavily cleared localities near large-scale production sites might have encouraged the extension of pioneer arboreal taxa such as birch, and hazel.

Insular study of the Wealden iron industry has been essential for the development and characterisation of the region during the Romano-British era. However, the impetus for the inception of increased industrial activity after the invasion and the later decline of the industry in the early third century is related to economic factors which effect the province as a whole. The Romano-British Weald represents an enigma. Located in the very heart of southern Britain between the provincial capital of London and the European mainland, this region has remained marginal until recently. Its geological and geographical nature has created an insular society and environment, yet for two major phases in its history the Weald became an industrial Black-Country. These elements of its history however, required an external impetus to produce industrial growth; firstly, the Roman invasion and the incorporation of the province into the wider economic unit of the Roman Empire; and secondly, the transferral of expertise and technology from the Low Countries, starting in the last decade of the fourteenth century. The importance of the Weald was a direct result of its ability to sustain iron production as a result of the easily accessible ore sources and the associated Wealden hardwoods needed to smelt those ore. The Wealden ores are not however, of high quality compared to those of other areas of the country such as the Forest of Dean. The factors which governed when the Roman industries exploited and abandoned the region appear to be related to the wider economy and not internal Wealden factors such as the depletion of the environment. This serves to emphasise

Straker's (1931, vi) assertion that the significance of the Wealden iron industry is much greater than "a mere study in local archaeology."

To conclude the environment of the eastern High Weald during the early Romano-British era (A.D. 43-240), was dominated by *Betulo-Quercetum* woodland. It is highly likely that this would have been dominant on the sandy lithologies. The clays might have supported a greater variety of arboreal vegetation. The impacts of iron production on the Wealden vegetation would have been twofold. The exploitation of timber, in some cases for iron production, but probably mainly for associated infrastructure development, would have resulted in a decrease in the average age of individual trees in the Wealden woodlands. In addition, the opening up of the woodlands which is indicated by the presence of light-loving indicator taxa such as birch and some *Pomoideae*, would have been detrimental for the establishment of taxa such as hornbeam, elm and beech which have a poor or average ability to form secondary woodland. The concept of extensive deforestation is seen to be the result of biases in the literature which have coloured perceptions. The possibility that there was a general move into the western High Weald as a result of deforestation in the eastern High Weald is not considered to be a viable hypothesis.

APPENDICES

APPENDIX 1

THE ASSOCIATION BETWEEN CHARLES DAWSON AND THE BEAUPORT PARK STATUETTE

The Victorian era witnessed a substantial increase in the utilisation of the slag and cinder from Romano-British slag deposits in the Weald for the provision of road metalling (Lower 1849b: 171). The largest of the Wealden deposits, at Beauport Park, was quarried by the Sussex County Highways Department at a rate of 2000-3000 cubic metres *per annum* for at least a decade after 1870. Over this period extensive evidence of Romano-British industrial activity was recovered (Rock 1879: 168-74).

During quarrying in 1877, William Merritt, one of the labourers contracted to dig the slag bank, allegedly discovered a cast-iron statuette, "at a depth of twenty-seven feet" in the slag bank, apparently in close association with a coin of Hadrian (Read 1893: 359). These finds were retained by Mr. Merritt with the hope of selling them at a later date to interested collectors. Six years later he was successful, selling the statuette to Charles Dawson (1864-1916), who visited William Merritt in 1883, with the intention of obtaining geological specimens. It was, however, a decade before the statuette was shown to Wollaston Franks and Charles Read, successive keepers of Romano-British antiquities in the British Museum.

At their suggestion the statuette was first publicly exhibited to the Society of Antiquaries by Charles Read, on May 18, 1893, sixteen years after its original recovery from the slag deposits of Beauport Park (Read 1893). The unique nature of a cast-iron statuette could have occasioned great prestige to Charles Dawson. As a prerequisite to exhibition it was necessary to prove its status as cast-iron. The first sample, comprising 6.77 grains of material from the statuette, was analysed by Professor W. C. Roberts-Austen. He concluded that the "amount of carbon found was very small, and I have no hesitation in saying that the figure was *not* made of cast iron, but was of wrought, malleable, iron, a steel-like iron, such as was manufactured in early times by a direct reduction process from iron ores" (Read 1893: 360).

However, this was not forthcoming. The Society of Antiquaries was not sympathetic to its alleged Roman origin. This, in conjunction with its apparent status as wrought iron, essentially removed it from further serious research. However, this set back did not detract from Dawson's standing in the antiquarian arena, as he was elected to the Society of Antiquaries in 1895. In an attempt to validate his identification of the statuette as cast iron, Dawson contracted Dr. Kelner of the Royal Arsenal, Woolwich, to undertake metallurgical analysis. A core of metal was removed from the left leg of the figure which was broken at the knee. The resulting report directly contradicted the results obtained by Professor Roberts-Austen, stating, "there is not the slightest doubt as to its being cast iron". Dawson (1903: 5) provided no information as to the precise nature of the tests.

With its status as cast iron apparently confirmed, the Beauport Park Statuette later appeared in 1901 as the primary exhibit (Dawson 1903: 33) in a collection of iron objects and pottery from Sussex. The exhibition was organised by Dawson for the Sussex Archaeological Society, at the Castle Lodge, Lewes. The statuette was labelled "Roman iron statuette, found in the iron slag heaps at Beauport Park, near Hastings, Sussex. Dr.

Kelner, analyst of the Royal Arsenal, certifies it to be of cast iron. *It is probably, therefore, the earliest specimen of cast iron known*" [my italics](Dawson 1903: 33). The details of the exhibition were published in the society's collections of 1903 (Dawson 1903, Salzman 1946: 37). As a result of these activities, Dawson was considered by many to be a major authority on Wealden iron production (Straker 1931: vii-viii, Weiner 1955: 85), although this was not based on any original fieldwork. His major treatise on iron production entitled "Sussex ironwork and pottery", (Dawson 1903) was essentially an amalgam of previous articles by Topley (1875) and Gardner (1898). This trait was revealed again in Dawson's history of Hastings Castle (Dawson 1909), which was essentially an unreferenced copy of an earlier unpublished manuscript.

Dawson's relationship with the Sussex Archaeological Society turned sour with his eviction, in 1904, of the society from their Museum and meeting house at 'Castle Lodge', (Anon. 1904: xiv, Salzman 1946: 38, Weiner 1955: 174). The loss of the Lodge, which had been used by the society since 1885, significantly diminished Dawson's standing in the local Lewes community. As a result he became increasingly involved with the antiquarian societies of Hastings, and eight years later, the statuette and other associated iron-work were exhibited in the Corporation Museum in Hastings, in 1909 (Anon. 1909). With Dawson's death in 1916, financial difficulties imposed on his widow Helène, resulted in the sale of much of his loan collection, of which the statuette was a part, to the Corporation Museum in Hastings, with the help of Mr. C. S. Butterfield (Weiner 1955: 175), where it is currently displayed.

Fig A1.1 The Beauport Park statuette (scale 1:1)

The statuette (plates in Dawson 1903: Fig 1 and Straker 1931: 335) is approximately 83 mm high and 51 mm wide. The much corroded head and torso remain intact, the up-raised left arm has been detached at the shoulder, while the lowered right arm remains only as a 5 mm protrusion. The left leg is detached at the knee (from which the metallurgical sample was removed by Dr. Kelner), while the raised right leg remains intact with the exception of the outermost extremity of the foot which has been removed. Sufficient remains of the left turned head to indicate the presence of an angular chin, location of the nose and hair structure. The statuette is sufficiently corroded to obscure anything but the most pronounced surface detail. However, the general stance and the proportions of the right leg are excessive, which is the primary similarity with the large statue at the Quirinal in Rome.

From the first public viewing of the statuette there has been considerable doubt about its authenticity (Read 1893: 360-1; Straker 1931: 336-7). However, the onus of blame for forgery has tended to fall on the manual labourers associated with its original discovery, through whom Dawson obtained the piece (Straker 1931: 335-337). To these labourers the "sale of objects was a valuable source of income..... and it is possible that deception may have been practised" (Straker 1931: 337). Although Oliver Davies (1935: 58) did not question the Roman date of the statuette, he considered that the low carbon content was indicative of a pure wrought iron that had been chased, as suggested by Strabo (631) and Davies (1933). Weiner (1955: 182-3), with the benefit if hindsight, is non-committal about the Beauport statuette.

The association between Charles Dawson and the Beauport Park statuette is significant. Considering his extremely limited fieldwork, Dawson's career as an antiquarian and archaeologist has been associated with an inordinate number of unique, often transitional, artefacts. Several examples have been proved to be fake.

The earliest example of a recorded forgery associated with Charles Dawson dates from 1907, when Dawson exhibited several tiles stamped "HON AUG ANDRIA", to the Society of Antiquaries, which he claimed to have found during excavations at Pevensey Castle directed by Salzman (Dawson 1907).

These were significant because they apparently integrated history and archaeology, conveniently providing Dawson with a unique "novel historical fact" (ibid.:

411), allowing Dawson's name to be associated with a crucial element of Roman history. This was undoubtedly an attempt by Dawson to provide 'archaeological' evidence for Stilicho's Pictish war of A.D. 398, in which Claudian (xxii, 247 ff.) the court poet of Honorius and Stilicho notes of Britannia ... "When I was about to succumb to the attack of neighbouring tribes - for the Scots had raised all Ireland against me and the sea had foamed under hostile oars - you Stilicho *fortified* me". Although there is some debate as to the exact meaning of the word *munivit*, taken as fortified (Salway 1988: 420) the passage refers primarily to defensive operations not large scale offensive operations of the field army. The could have been manifested in the restoration of coastal defences of the Saxon Shore, such as Pevensey (Millar 1975).

In addition the distribution of such unique archaeo-historical 'artefacts' enhanced Dawson's reputation as a generous benefactor. However, thermoluminesence dating of the tiles undertaken by both Dr. S. J. Flemming at the University of Oxford and N. Bradford at the British Museum, provided an approximate date of firing in the early twentieth century (Peacock 1973: 139, Wright *et. al.* 1975).

In 1912, an alleged copy, made by Dawson, of a map of Maresfield forge in 1724 (Crake 1912: 279, Straker 1931: 401), was used to illustrate Crake's article, concerning Maresfield Forge, in the Sussex Archaeological Societies Collections. Although Straker, who used the illustration, (1931: 401) considered the map to be "curious", it was only with the research of Andrews (1974: 166) that the "total absurdity" of the Dawson map was revealed, with the provision of fifteen errors and anomalies.

It was in the same year that the discovery of an alleged ancestral human fossil assemblage in the gravels of the Ouse, at Piltdown near Fletching, provided Dawson with the recognition he had so desperately sought. In all, two assemblages of *Eoanthropus dawsoni*, or the Dawn Man, were recovered from Piltdown and later from Sheffield Park. Both fossil assemblages were forgeries; the associated faunal remains were planted and the stone tools were of Neolithic origin.

However, in addition to Dawson's previous associations with forgeries, the most damning evidence for the identity of the Piltdown forger relates to the timing of the discoveries. The *Eoanthropus dawsoni*, assemblages were recovered over a restricted period of time, between 1912-1915. The later date is significant, because towards the close of 1915 Dawson fell ill with anaemia and could take no part in the excavations of 1916, which produced no 'fossiliferous' remains of any sort. By the tenth of September 1916, the anaemia had developed into septicaemia and Charles Dawson died. Successive excavation and observation by Woodward (1948: 12-3) yielded no further remains, as did the sieving of tonnes of gravel from the Piltdown deposit in 1950 (Weiner 1955: 16). The position of accepting any forger other than Dawson at Piltdown is untenable.

Aside from Dawson's propensity for forgery, it is necessary to consider the similarities between Dawson's later activities and the discovery of the Beauport Statuette. If the statuette was a contemporary forgery introduced into the cinder at Beauport Park, then only two people stood to gain from its discovery. As Straker (1931: 337) noted, the labourer William Merritt would have obtained financial recompense as a result of his sale of the statuette. Alternatively the 'discovery' of the statuette in a secure Romano-

British context would allow Dawson to make the claim that it represented "the earliest known example of cast iron, in Europe at least" (Dawson 1903: 5, 33). The publication and subsequent exhibition of such a unique artefact could have significantly enhanced his reputation in antiquarian circles, which he so yearned for.

It is questionable if a local Sussex manual labourer in 1877, such as William Merritt, would have had sufficient knowledge of the detailed proportions of the Marly Horse group from the Quirinal in Rome to produce a copy in cast iron. If the statuette was made from cast iron, then it was unlikely to have been of local manufacture, as the last blast furnace in the Wealden region, at Ashburnham, ceased production around 1812-3 (Straker 1931: 369). The fabrication of the statuette could therefore have necessitated some degree of travel, all of which would have required a significant input of time and energy, which could eradicate any financial gains derived from the final sale of the artefact. It is conceivable that the statuette was obtained prefabricated on the European mainland, or it could have been a historical or antique piece; the presence of a similar statuette in bronze from Orange in France has been recorded (Read 1893).

Of the two suspects, Dawson was most able to have undertaken such a forgery. He had the knowledge and he is known to have produced forgeries of archaeological artefacts later at Pevensey and Piltdown. In addition, Dawson's later activities relating to the stamped Pevensey tiles proves that he was quite prepared to exhibit forgeries to the Society of Antiquaries, to enhance his standing with the Society (Dawson 1907). Only Dawson could fully appreciate the archaeological implications of a cast iron statuette from an apparently Hadrianic context. As he would later do at Pevensey and Piltdown, Dawson could claim another first, with the earliest example of cast iron in Europe (Dawson 1903: 5, 33). Artistically, if it were real, it would represent a discovery of "great importance", in view of the rarity of Roman artworks from the British province.

The statuette could have been introduced into the slag to provide 'evidence' for its Romano-British age. The apparent six year gap between the discovery of the statuette at Beauport Park, and its sale to Dawson at Westfield in 1883, would at first appear to vindicate Dawson of any links with the statuette prior to this date. However, during the period when the statuette was allegedly discovered, the slag deposits at Beauport Park were under intense scrutiny from James Rock, a historian from Hastings, who was interested in recording the nature of the Roman iron production site prior to its destruction, as a result of the provision of road metalling by the county highways department. In his article on the cinder heaps at Beauport Park and Chitcombe, James Rock does not document the presence of the unique statuette, despite extensive recording of the small finds recovered during cinder extraction and its alleged discovery only two years prior to the publication (Rock 1879: 168-74). Among these finds, Rock noted a coin of Hadrian not unlike the one found in association with the statuette (Rock 1879: 172-3, Weiner 1955: 183). It is known that James Rock, accompanied by Edward Farncomb visited the site at Beauport Park in September 1878, with the labourers present (Rock 1879:

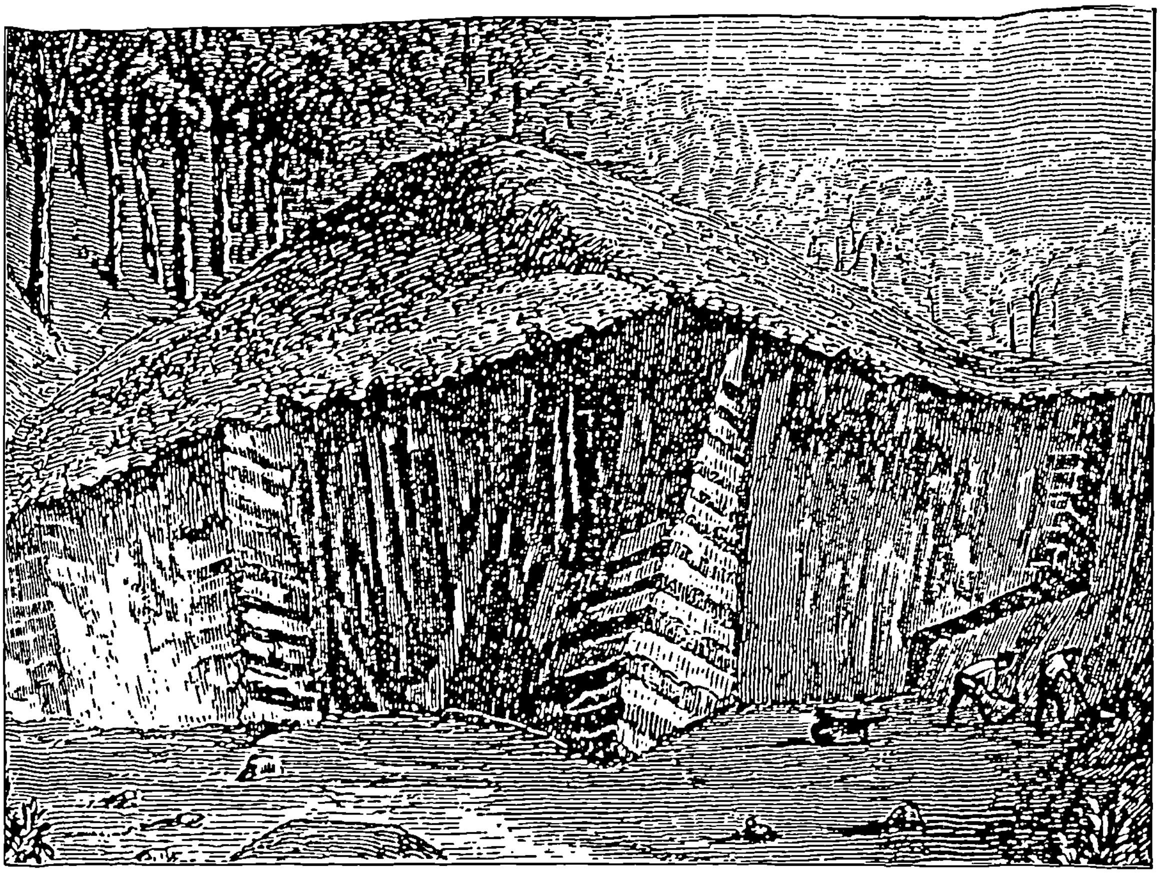


Fig A.2 The cinder bank at Beauport Park in 1879, drawn by Edward Farncomb with the labourers present (Rock 1879: 169)

169, Straker 1931: 331-2). If the statuette was discovered in 1877 as was claimed it is most unlikely that the statuette would not have been offered for sale, or its presence made known to James Rock during his visits to Beauport Park.

The exhibition of the statuette 10 years after its purchase and 16 years after its alleged discovery had two results. The original find-spot, in the slag deposits of Beauport Park, would have been obliterated as the slag banks were removed. As a consequence, the actual details of the circumstances of discovery would have been sufficiently distant to prevent detailed cross-examination of the finder. Certainly Dawson was not averse to utilising workmen to validate the 'discovery' of his forgeries - both the Piltdown assemblage and the Pevensey tiles were predominately found by people other than Dawson.

An underlying need for instrumental discoveries, normally of a transitional nature, in conjunction with a desire for recognition, characterises Dawson's work (Weiner 1955: *passim*). Conceivably, the enhancement of his reputation in geological circles after the discovery of the tooth of *Plagiaulax dawsoni*, in 1891 (and 1911) could have initiated his desire for the discovery of unusual and transitional artefacts, although even with these early fossiliferous remains there is some doubt as to their authenticity (Peacock 1973: 140). In all Dawson's major areas of interest - palaeontology, ironwork and his history of Lewes Castle - he is known to have produced forgeries or plagiarised material. Dawson's discoveries represent an amalgam of actual archaeological material and an increasing number of forgeries. It is unfortunately difficult to distinguish between the two.

Although recent archaeo-metallurgical experiments suggest that Romano-British bloomery furnaces were technically capable of achieving a sustained temperature in excess of 1300°C, necessary for the production of cast iron (Tylecote, Austin and Wraith 1971), few examples of the material have been recovered from secure Romano-British contexts. Authenticated examples come from Wilderspool, Lancashire, where a small block of cast iron was recovered from within a furnace and Tiddington, in Oxfordshire where a 0.56 kg bar of cast iron was recorded. Both these examples are shaped and do not represent primary furnace debris, however, the nature of the castings does not suggest a high degree of sophistication. They possibly represent the tapping of unusable material. The other authenticated evidence for cast iron derives from furnace debris resulting from the excessive temperatures during smelting. Examples have been recorded from a fourth century context at Braughing, Hertfordshire (Tylecote 1986: 168).

The only other apparent examples of cast iron statuettes have been recovered from the German provinces. These include an Egyptian woman (150 mm) from the Roman villa at Plittersdorf, and a cupid (76 mm) from Hockenheim. However, these come from such dubious contexts that Coghlan (1977: 49) considers the statuettes to be "suspect and cannot be relied upon".

If cast iron was deliberately used, it is unlikely that any great deal of sophistication would have been achieved in fabrication, partly as a result of its rarity and partly as a result of its infrequency of use by Roman metallurgists. If the Beauport statuette was of Roman date and is composed of cast iron then its high quality would indicate a work of *extreme* rarity.

Further work on the statuette is limited by the two factors. Firstly it is unknown whether the figure is composed of cast iron or wrought iron. Modern analysis of the material would help elucidate this. Unfortunately all the protagonists in the events surrounding its discovery are now dead, as a result, the ability to prove if the figure was a forgery is greatly diminished. In view of Dawson's role in the Piltdown forgery (Weiner 1955), and in the forgery of the "HON AUG ANDRIA" tiles at Pevensey Castle (Dawson 1903, Peacock 1973), and the fabrication of the Maresfield map the Beauport Park statuette must be considered with caution as must the deliberate use of cast iron in Roman Britain.

APPENDIX 2

EXPERIMENTAL CHARCOAL PRODUCTION

PREPARATION

In late February 1992 an experiment was instigated to elucidate the logistical and economic implications of charcoal production using an above ground clamp. The research was carried out by the author, in conjunction with David Sim and John Ansty, both professional blacksmiths. The location was private land, in Huntercombe, near Henley, in a small stand of secondary woodland which needed clearing for agricultural use. The woodland was highly overgrown with scrub and other ground vegetation. The wood utilised was secondary woodland taxa such as blackthorn, young elm, *prunus* spp., hazel, in addition to the fallen wood of mature oak and beech.

The majority of the wood cut was between 25 mm and 100 mm in diameter, although larger, fallen branch wood (maximum 220 mm) was utilised. The tools used were hand axes and a wood saw, using these tools the cutting of between 300-350 kg of wood took two people eight hours each. This apparently high cutting time was attributable to the overgrown nature of the site, the unfamiliarity of the workers with the use of the tools and the movement of cut wood to the drying stack. The relatively small diameter of the wood selected did compensate for these negative factors by reducing the cutting time.

The cut material was stacked and left uncovered for five months, between February and July. The location of the stack was found to be partially exposed to the prevailing wind, which did appear to enhance the drying process.

CLAMP CONSTRUCTION

John Ansty, who has undertaken several successful charcoal burns, agreed to direct operations at this crucial stage. A level area of ground, 3 m in diameter was selected and cleared of surface vegetation. This would help prevent the spread of fire from the sealed clamp, usually via root systems, to the surrounding environment during the burn. The site chosen was a dell with a 7 meter high bank to the east and gently rising pasture to the west, the presence of woodland to the north and south would help act as a wind-break.

Four lengths of wood, 1.3 m in length were used to construct the central chimney of the clamp. At the chosen central point a chimney was made by driving the four lengths of wood into the ground to form a square with 150 mm sides. The area enclosed by the square was left open. The previously cut metre lengths of branch-wood were stacked vertically around this for approximately a metre radius. In the outer 0.75 m the individual branches were inclined at an angle of 60° to the horizontal. A second layer was added above this first upright one, which differed by stacking wood horizontally rather than vertically. The aim of construction was to produce a structure that was as densely packed as possible, to allow for the even carbonisation of the wood. This would also allow for the more efficient and economical use of space in the clamp. The utilisation of straight coppice poles was certainly more efficient in the use of space rather than the more irregularly shaped 'natural' branch wood, however, over time skill was developed in the proficient interlocking of branch wood which minimised wasted space.

The wood superstructure of the stack was covered with straw to a depth of approximately 70 mm, to enhance the air-tight nature of the clamp. The material used for the creation of the kiln wall was turves cut from a nearby field. All the turves were cut on the day of kiln construction and placed in a pile to prevent excessive drying out. The relatively uniform depth of the turves also allowed for consistent drying. In the context of this site the depth of sods was restricted to approximately 75 mm, as a result of the underlying flint strata. Sods which had large stones in them were found to be of poor quality for the purposes of clamp construction. The stone/flint caused a weak point in the turves which normally resulted in breakage, compromising the integrity of the kiln. The sods were placed grass side inwards to enhance cohesion during construction and to increase the airtight nature of the clamp. The quantity of sods required was considerable, considering the small size of the clamp constructed. The dome-like structure was approximately 1.3 m high and 2.5 m wide; this contained approximately 3.5 m^3 of lightly packed wood. This required approximately 7 m^3 of turves, which covered the clamp; these figures also include some spare turves for use when breaches were found in the structure, and some loss of material during extraction.

THE BURN

After the structure was covered, the central flue was filled with wood chips, twigs and other dry ligneous debris to allow for the initiation of the burn. A fire was made to provide a large quantity of glowing embers; this was allowed to die down. Ten heaped shovels of the glowing embers were deposited in the central flue or chimney. This resulted in almost immediate combustion of the dry wood which was adjacent to the central flue. When this source of embers was exhausted the remaining portion of the flue was filled with small fragments of dry wood. This was allowed to burn for 32 minutes. Changes to the colour of the smoke produced was the determining factor in the sealing of the clamp, with a sod to create an airtight environment.

This resulted in the escape of large quantities of smoke from the upper third of the clamp, through previously un-noticed breaches in the wall structure. The source of the smoke was used as an indicator for air leaks which were sealed immediately with shovels full of earth and in also sods in more serious holes. This prompted the preparation of extra sods which were useful when the shrinkage of the kiln were to have caused a major breach in the walls later in the burn. The clamp was attended constantly to prevent further breaches and destruction of the kiln contents. It was after two days of the burn that the kiln structure was seen to shrink noticeably, it was at this time that the first major breach occurred a section of the upper third of the kiln collapsed, exposing burning wood. This 300 x 400 mm breach was immediately filled with turves and earth deposited directly upon the burning material. This was attended for 4 days allowing the kiln to cool naturally. Despite rain for three of the days the clamp was still warm to the touch on the day of opening.

When opened there was some attempt by the charcoal to flare up, in the breeze, especially when disturbed despite some light rain. As a consequence water was kept in the vicinity of the clamp to douse any further combustion. The effect of the water on the charcoal was not as significant as initially thought. Where the grain structure of the wood was in good condition prior to the burn the water had little or no effect however, in degraded wood it did cause breakdown and the conversion to charcoal paste.

The opened kiln revealed good preservation of the wood, however, on the windward side there was extensive evidence of the combustion of the charcoal inside the clamp. The breeze was sufficient to penetrate the kiln walls of sods, possibly through cracks in the turf which had dried out, and the inner layer of straw. This could have been avoided or diminished with the creation of a windbreak which are attested in the post-medieval literature, however, it is unlikely that all wind penetration could have been prevented.

OUTPUT

The kiln was estimated to contain between 300-350 kg of wood, prior to the burn. This was based on the weighing of 50 kg of material and the extrapolation of the remaining volume. The actual weight of material that was produced was only 34.2 kg, which provided a conversion ration of between 8.7:1 and 10.2:1, deeding on whether 300 or 350 kg were the original weight. The apparently low output, was put down to several factors, including the relative inexperience of the operators, the poor quality of the turves used for covering the stack, the absence of a windbreak, the poor quality of some of the wood used and the small size of the stack which would have enhanced the relative importance of attrition. These figures are therefore not considered to be indicative of the actual output of Romano-British charcoal production operations. With greater experience and awareness of the differing properties of the materials used, the figures suggested by Cleere (1976a) of 7:1 could easily have been achieved.

APPENDIX 3

POLLEN ANALYSIS FROM CHITCOMBE, HOATH WOOD

THE NATURE OF THE SITE

The analysis of pollen from a streamside section in Hoath Wood was prompted by the discovery, during mapping of the Chitcombe slag deposits by the author, of two major, and two minor, burning horizons which were exposed on the banks of the River Tillingham as a result of fluvial erosion. Field exploration revealed that the charcoal was of a regular size, and was associated with 3 fragments of slag and a small body sherd of East Sussex Wealden Ware. Initially this was thought to be indicative of the location of a Romano-British charcoal production site, however, detailed examination of both the charcoals and the pollen from the stream section has prompted a revision of this to a post-iron production context.

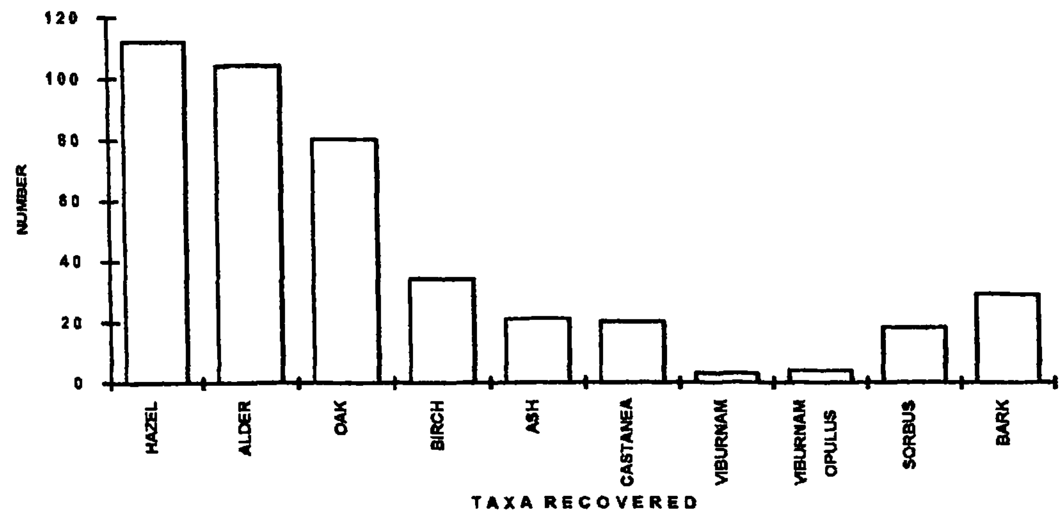


Fig. A3. 1 The charcoal taxa recovered from the stream section at Hoath Wood, Chitcombe

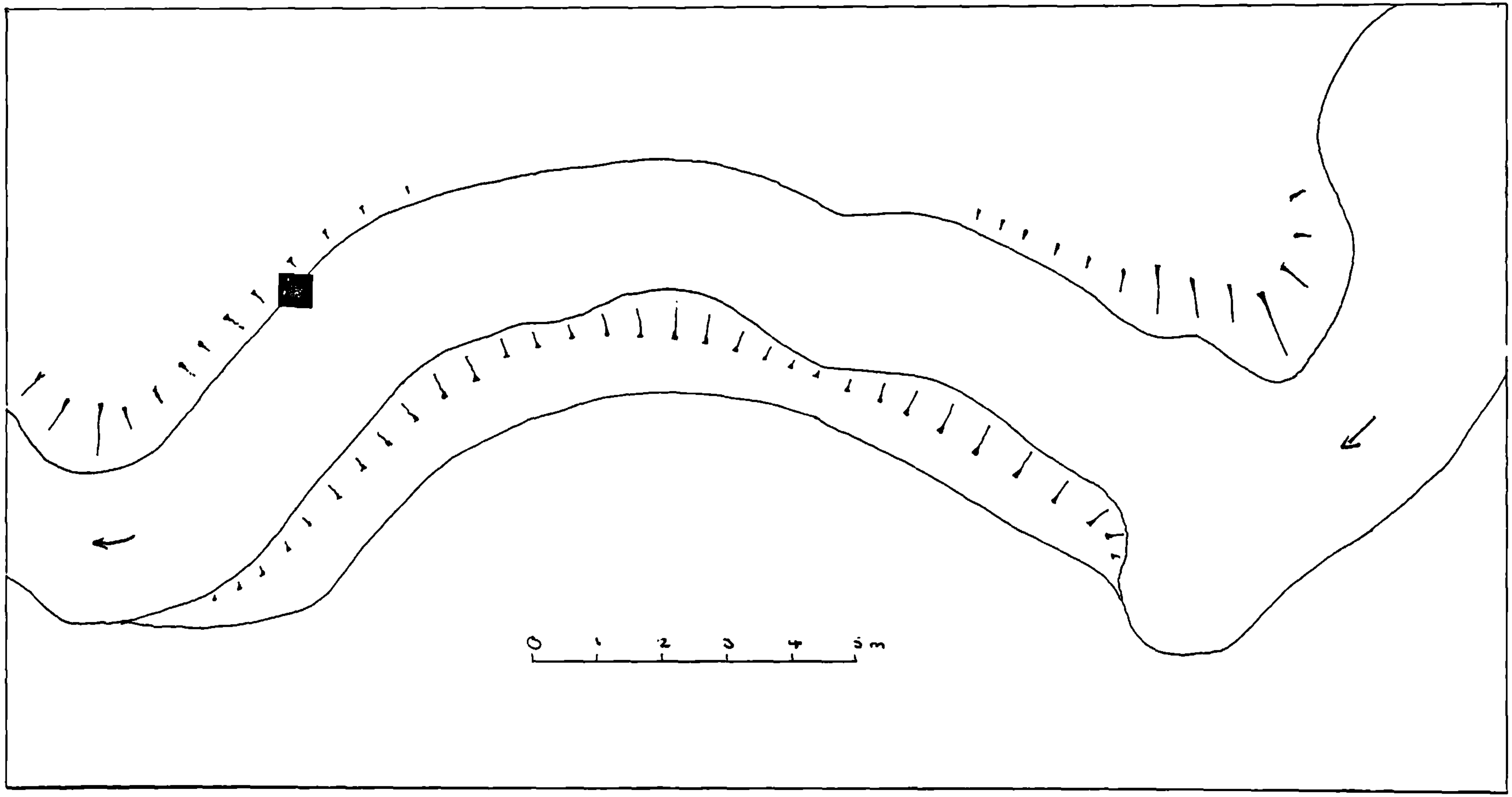


Fig. A3. 2 The pollen extraction site (plan)

Fig. A3. 3 The Hoath Wood stream section

The charcoals recovered from the lower burning horizon, at 65 cm below the ground surface, were unlike any material which has been recorded from Roman slag deposits. The assemblage was dominated by hazel and alder. While hazel is a common constituent of Romano-British fuel deposits alder is very rarely recovered, usually it is in the form of single fragments. At Hoath Wood approximately 104 examples of alder were recovered, comprising 26.3% of the sample. In addition the samples were well preserved, many had a tangential length exceeding 30 mm which suggests that the site witnessed little disturbance or pedoturbation, prior to rapid burial under colluvium. If the burning site was associated with the Chitcombe Romano-British iron production site then it would seem probable that the site would have been extensively disrupted, as a result of its proximity to the working areas and slag deposits. In addition the material recovered from the burning horizon appears to suggest *in situ* activity, the extremely fine layer of burnt clay under the charcoal scatter is indicative of this. In addition the horizon contained five chips of alder wood, which had been cut with an axe, it is highly unlikely that these would have moved far from their point of origin. One of the of the other alder fragments exhibited a anthropogenic cut, after 8 years of growth and outside the growing season. The cut was the result of the use of a flat bladed sharp instrument such as a knife or machete. The angle of the cut was approximately 130° to the vertical, which could, in some contexts, be indicative of management. Cutting upright wood at an angle does not allow for rain to settle on the exposed grain of the wood, which could caused decay. A similar example has been recovered from the same horizon from a nine year old fragment of hazel, also cut out of season and at an angle of approximately 140° to the vertical. The sample also contained 29 fragments of bark which probably became detached during the burning episode. The implications of the charcoal evidence are that the stream side was dominated by alder carr and hazel woodland on the drier ground. The streamside vegetation was possibly complimented by guelder rose (*Viburnum opulus.*), while the background arboreal communities were of oak, ash, birch, *Castanea* and *Sorbus* sp. At some point a phase of woodland cutting or management occurred on the site which resulted in the production of debris which was burned or alternatively but less likely of charcoal production.

The burning site was considered to be in use after the cessation of iron production at Chitcombe, because of the good state of preservation of the charcoal, suggesting lack of attrition. Also the indications of *in situ* woodland on the site despite its location on a Roman iron production site seem to be contradictory. The site also exhibited an unknown degree of fluvial erosion as a result of small-scale derivations in the course of the River Tillingham.

POLLEN ANALYSIS

The location of the burning horizon in an exposed section of clay and silt rich stream bank was considered an ideal opportunity to extract pollen to correlate the evidence obtained from the charcoals recovered. The absence of any leaching of carbon beneath the two burning horizons was considered to be a reliable indication of the absence of movement of pollen through the section. The sediment appeared to have accumulated as a result of colluvial down-wash from Hoath Woods above, which would account for the presence of both Roman ceramic and slag in the section, in addition to limited alluvial deposition in the lower elements of the stream bank. A monolithic sampling system was used to extract the sediment from the stream bank. Close sampling of the sediment immediately beneath the lower charcoal horizon at 65 cm was undertaken to elucidate how comparable the charcoal data were to evidence from the pollen sequence.

Two samples were extracted from immediately beneath the Burning horizon at 65 cm and 65.5 cm below the ground surface. These were not overly rich in polleniferous material. providing only 123 and 139 grains respectively. This could be attributed to the attrition of pollen as a result of heating during burning.

The pollen would have derived from several sources. The major sediment input for the site appears to be colluvium derived from Hoath Wood above the stream bank. As a result of this there is likely to be reworked pollen form this source possibly including some Roman material. It is possible that a little sediment was accumulated from alluvial sources, however, the general absence of pollen from aquatic sources, from the upper part of the sequence, with the exception of a grain of *Sparganium* at 67.5 cm. This could derive from flooding or alternatively accidental carriage onto the site by pedoturbation. The dominant sources of fossil pollen would be derived from taxa growing on the site, in conjunction with a less well defined element derived from colluviation.

The evidence from the pollen spectra suggests that several environments were in evidence in the vicinity of the site. The locality appears to have been dominated by alder carr in the immediate vicinity of the stream bank, which is further corroborated by the macrobotanical axe debris from alder on the site. In addition hazel woodland is also attested possibly in conjunction with the alder and on the drier ground above the site. The input from the damp stream side is further emphasised by the intermittent presence of *Salix* (willow), which is a low pollen producer, holly, and elder (67 cm and 67.5 cm). The apparent absence of willow and elder macrofossils could indicate their fluvial transport to the site from upstream or a general low occurrence in the natural environment. Taxa which are indicative of damp woodland and stream-sides are also present such as mint (*Labiatae Mentha*-T 66.0 cm), golden saxifrage (*Chrysosplenium* 67 cm and 67.5 cm) and the purple loosestrife/water purslane (*Lythrum*). The background, extra-local woodland which would have probably existed on the drier ground around the site. This appears to be characteristically oak and birch dominated woodland with additional beech, *Castanea*, elm, ash, yew, hornbeam, probably forming a generally closed woodland, although this cannot be said with any degree of certainty considering the degree of open ground taxa also recorded in the profile.

The herbaceous pollen spectra displays a degree of consistency. The dominant taxa is that of *Gramineae*, which is a possible indicator of mature grass rather than pasture, which does not have the chance to flower and pollinate due to grazing attrition. In the context of Hoath Wood there are two possible sources. The grass pollen could indicate the presence of hay meadow in the vicinity of the site; certainly there is extensive evidence of widespread anthropogenic activity in the immediate locality. Alternatively it is conceivable that mature grass was growing both on the stream bank, and among the alder and hazel. The presence of autochtonous taxa would account for the constant high representation in the pollen spectra, to a much greater degree than off-site anthropogenic activity. Other activity of this nature such as cereal production is very poorly represented. However, there is a strong representation of weeds of arable such as *Papavar*, *Echium*, *Chenopodiaceae*, *Caryophyllaceae* and *Rumex acetosa.* Although these always occur in low percentages, the activity would have probably have occurred at some distance from the pollen extraction site which had the River Tillingham to the north and the Hoath Wood slag deposit to the south. It is probable that the anthropogenic activity in the locality such as arable and pasture, would have been a important component of landscape exploitation. It is highly unlikely that such production would have been undertaken in the immediate vicinity of a Roman iron production site, further emphasising a post-production date. Anthropogenic indicator species such as *Cannabis sativa* are also represented which have uses as a source of fibre and narcotics; these have rarely been recovered from Roman contexts.

Calluna is a regular component of the pollen profile, normally found in quantities of between one and five grains per sample. This is probably indicative of some degree of limited acidification of the Ashdown Sand on which much of Chitcombe is located, and the subsequent development of a heath-type environment. The relatively low occurrence could be suggestive of small-scale soil gradation in the vicinity of the site or of wider acidification on an extra-local scale, which could explain the absence of *Calluna* in some samples.

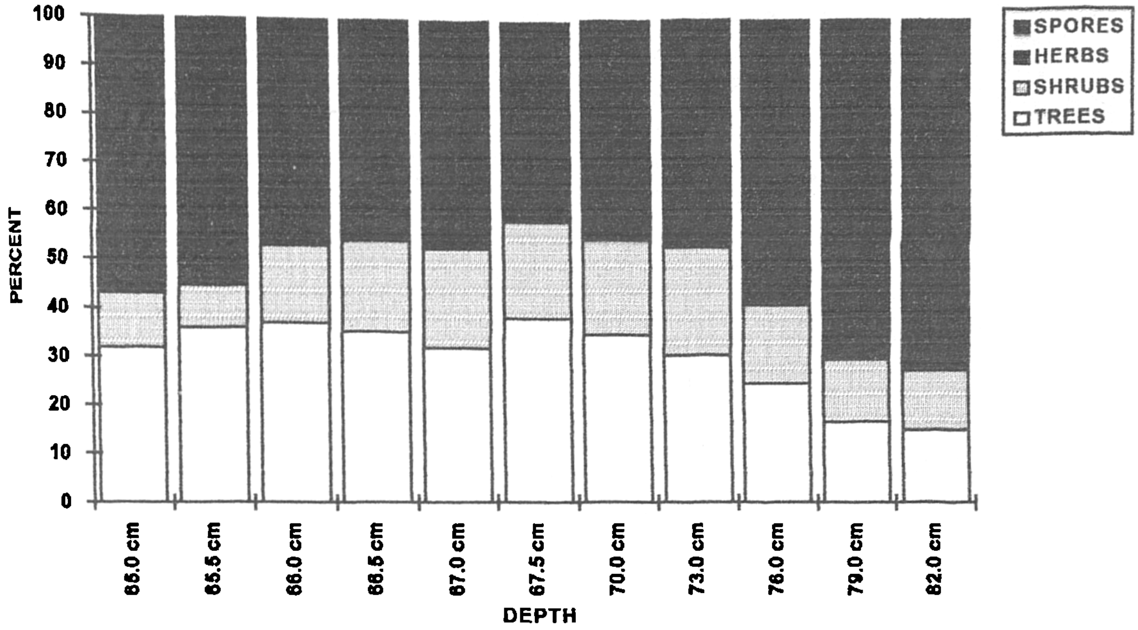


Fig. A3. 4 A comparison of arboreal and non-arboreal pollen from Hoath Wood

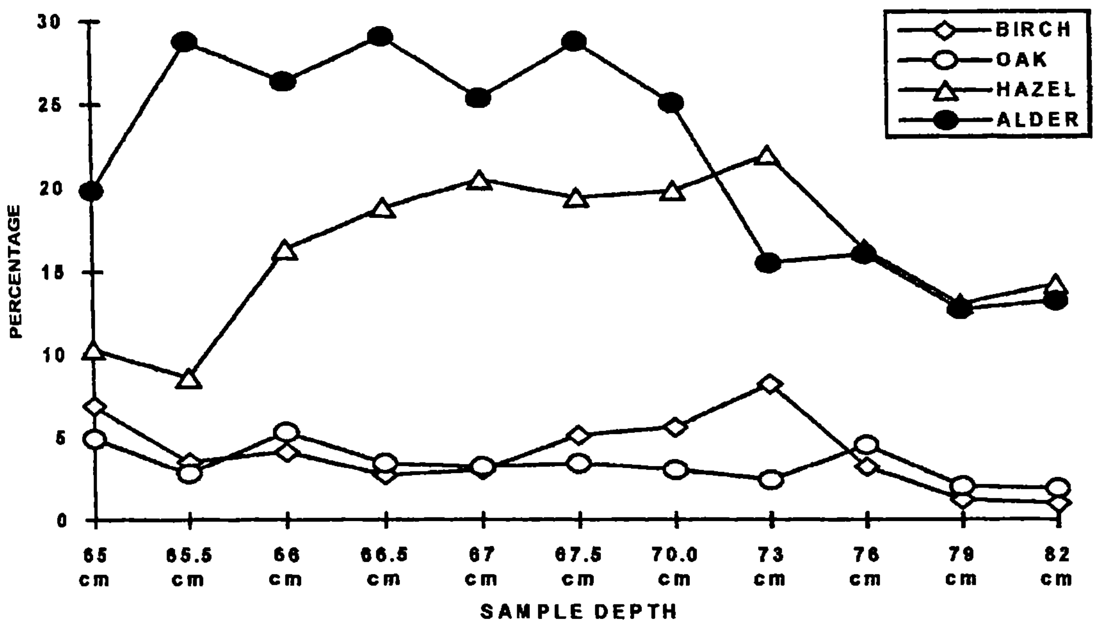


Fig. A3. 5 The variation of arboreal pollen recovered from Hoath Wood

The pollen profile shows both a remarkable correlation with the arboreal taxa recovered from the charcoal analysis and a close correlation with the burning horizons and a decrease in the arboreal and shrubs taxa in the pollen sequence. Close sampling beneath the charcoal horizon (65 cm and 65.5 cm) revealed a decline in the representation of arboreal and shrub vegetation, especially hazel which dominated the macrobotanical remains from the charcoal horizon. The decrease in arboreal pollen was complemented by an increase in herbaceous pollen by 8.8% at 65.5 cm. Prior to this the gross representation of arboreal and herbaceous pollen showed a consistency between 66 cm and 76 cm when the arboreal taxa again decline, while at 79 cm the arboreal and shrub taxa only achieve 29.6% of the total pollen and spores recovered. It is likely that the pollen spectra is representative of localised phases of clearance and regeneration probably in coppice woodland on the site. A great deal of activity is evident in the extra local environment in the form of cereal production, possibly pasture and hay meadow, which is suggestive of widespread anthropogenic environmental interaction in the locality.

A comparison of the major trends exhibited by the arboreal pollen taxa is suggestive of two major groups of arboreal communities. The *Betulo-Quercetum* woodland which is a constant element of the spectra and the autochtonous alder-hazel woodland. The oak-birch woodland is represented by a relatively constant levels of the respective pollen, although there are indications that the slight decline in oak between 70 and 73 cm is matched by a corresponding increase in the representation of birch, indicting the that these woodland types did co-exist. The other major arboreal community represented was of the hazel-alder, as would be expected from autochtonous taxa the values are inflated. The alder pollen exhibits moderate fluctuations between 65 and 70 cm, which could be an indication of the natural variations in pollen rain from the local vegetation, this is not found in the representation of the hazel pollen which remains relatively constant, implying that although the hazel was local it was not heavily represented on the alder dominated stream bank.

COMPARISON BETWEEN THE POLLEN SPECTRA AND MACROBOTANICAL EVIDENCE FROM HOATH WOOD

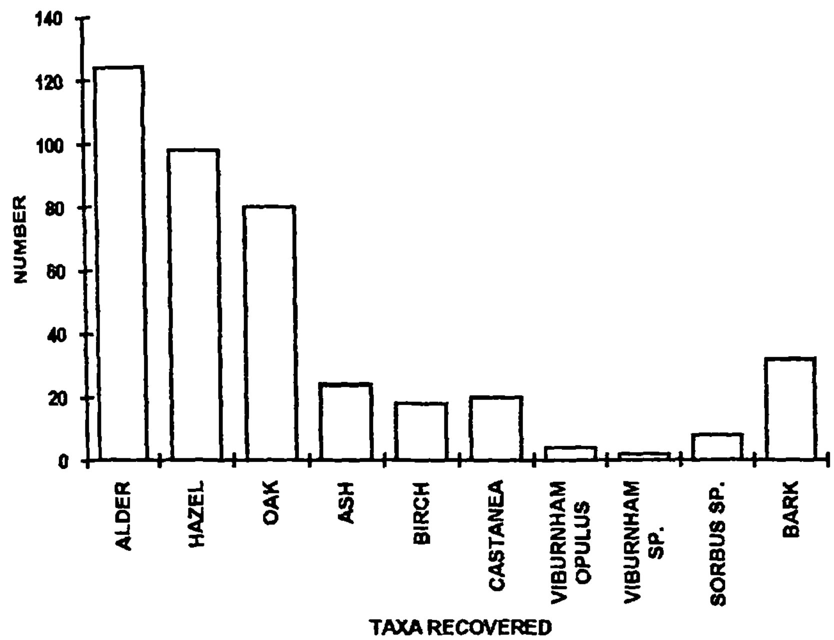


Fig. A3. 6 The charcoal taxa recovered from the burning horizon at Hoath Wood

The evidence derived from the burning horizons at Hoath Wood and the associated pollen spectra show a high degree of comparison between the major taxa groups. The four dominant taxa recovered from the pollen spectra, are also dominant in the charcoal lenses. These are alder, hazel, birch and oak. However, in the pollen spectra alder is consistently the dominant arboreal species while in the charcoal horizon alder is secondary to hazel. Two reasons can be forwarded which might account for such disparity, which relate to the differences between the nature of the evidence between pollen and macrobotanical data. The pollen spectra is dominated by alder, which was probably a direct result of its *in situ* growth on the damp stream bank, which is further corroborated by the axe debris from the lower charcoal horizon. The growth of alder on the site would cause the flood of autochtonous pollen from alder which would tend to suppress the values of other taxa present in the vicinity. The burning horizon however, represents anthropogenic manipulation of the environment. While much of this local alder woodland would have been cut, it is also likely that material from above the stream banks would have been exploited as well. This could account for the enhanced representation of hazel in the charcoal horizon. In addition the distribution of hazel and alder fragments across the burning horizon was not equal. Alder was almost ubiquitous being found in all parts of the horizon sampled, however, hazel was often recovered in distinct accumulations possibly representing the fragmentation of an undetermined number of branches at one point which could have biased the overall results.

The other differences between the pollen spectra and the charcoal horizon relate to the representation of the non-dominant taxa. There are taxa represented in the pollen profile which are not evident in the charcoal horizon and *vice versa*. This appears to be essentially a function of the differential pollen productivity of different species and differing catchment areas, in conjunction with anthropogenic selection of wood. The pollen spectra produced evidence for low values of elm, beech, hornbeam, yew, willow, hawthorn, holly, and possibly elder although there are problems with the distinction of the *Sambucus* genus which comprises both elder and danewort a herbaceous perennial.

All these taxa were not represented in the associated charcoal record. Several possible explanations can be forwarded. The low occurrence could in many instances be indicative of woodland taxa which are some distance away from the pollen sample site, being part of the extra-local and regional woodland mosaic. As such these would not tend to be incorporated into a highly localised burning horizon. Taxa such as elm, beech, and hornbeam might be included in this background moderately closed woodland, in conjunction with the dominant background arboreal flora of oak and birch. The other arboreal taxa represented in the pollen spectra such as yew, willow, hawthorn, holly and elder are less likely to represent elements of the closed woodland community. These taxa are often light demanding, such as hawthorn, or favour damp soils such as willow and holly, most are relatively low or average pollen producers. It is therefore probable that these represent local, or derived, taxa which were selected against or if utilised were in such low numbers as to fail to be recovered from the charcoal horizon.

The charcoal horizon provided two taxa groups which were not recovered from the pollen spectra, these were the *Viburnum opulus/Viburnum* type and the *Rosaceous Sorbus* type. The *Sorbus* genus spans the whitebeams, Rowan, and wild service tree, while the *Viburnum* genus covers the guelder rose and the wayfaring tree. Considering the confirmed identification of *Viburnum* opulus on the site it is likely that the other *Viburnum* sp. are also indicative of the guelder rose rather than the wayfaring tree which favours calcareous soils. Both these taxa are not high pollen producers, which when considered in conjunction with the relatively poor preservation of the samples would account for their absence.

COMPARISON BETWEEN POLLEN PROFILES AT HOATH WOOD AND LUDLEY FARM

The pollen profiles derived from the Roman contexts at Ludley Farm and the post-iron production contexts at Hoath Wood reveal a certain degree of similarity. This has implications for the nature of the Wealden environment on the Ashdown Sands. Both pollen profiles derive from soil contexts, are located on the same geological lithologies, are located only 4 km apart and on the banks of the River Tillingham. The general similarities which are evident are not entirely unfounded, despite the apparently different chronologies. The arboreal composition of the two sites is relatively similar, only at Hoath Wood does the local vegetation of alder and hazel dominate the assemblage which tends to mask the background vegetation of oak-birch woodland *(Betulo-Quercetum)*, with hazel, in addition to beech, elm, ash, hornbeam, and *Castanea* in relatively small percentages. This is generally comparable with the results of the charcoal analyses from Roman slag deposits in the eastern High Weald, which have the same oak, birch and hazel dominance.

Fig. A3. 7 Table of the number of pollen grains of different taxa recovered from Hoath Wood

TAXA RECORDED	65.0	65.5	66.0	66.5	67.0	67.5	70.0	73.0	76.0	79.0	82.0
BETULA	2	5	13	8	11	18	20	28	10	3	2
PINUS	0	0	0	0	0	0	0	7	2	2	0
ULMUS	1	0	1	0	0	0	1	0	0	0	1
QUERCUS	5	4	17	10	12	12	11	8	14	5	4
ALNUS	23	40	84	85	93	101	90	53	50	32	28
FAGUS	0	0	0	0	0	2	1	2	1	0	1
CARPINUS	0	0	0	0	1	0	1	6	0	0	0
FRAXINUS	0	1	1	0	0	0	0	0	0	0	0
TAXUS	0	0	1	0	0	0	0	0	0	0	0
CASTANEA	0	0	0	0	0	0	0	1	0	0	0
CORYLUS	12	12	52	55	75	69	71	75	51	33	30
SALIX	0	0	1	0	0	1	0	1	0	0	0
ILEX	0	0	0	0	0	0	0	0	0	0	0
SAMBUCUS	0	0	0	0	1	0	0	0	0	0	0
CRATAEGUS	0	0	0	0	0	1	0	0	0	0	0
GRAMINEAE	20	42	52	64	78	82	85	76	92	80	87
CEREALIA	0	0	1	2	2	0	1	3	1	2	3
CANNABIS SATIVA	0	0	0	0	0	0	0	1	0	0	0
CHRYSOSPLENIUM	0	0	0	0	1	0	2	0	0	0	0
CYPERACEAE	3	0	1	1	0	1	3	0	0	3	5
CALLUNA	0	0	3	2	2	2	0	5	2	0	2
CARYOPHYLLACEAE	0	0	0	0	0	0	0	0	1	0	1
CHENOPODIACEAE	0	0	0	1	0	0	12	1	0	0	1
COMPOSITAE CICHORIUM.	7	11	19	9	17	10	2	9	16	26	21
ARTEMISIA	0	0	2	0	0	0	0	0	0	0	1
ASTER-T	5	9	19	12	16	11	0	5	7	9	11
CENTAUREA	0	0	0	3	0	2	0	0	0	0	0
CENTAUREA NIGRA	1	3	3	0	3	0	0	0	0	1	1
CIRSIUM-T	1	0	0	1	1	0	0	0	2	0	1
ECHIUM	1	0	0	0	0	0	0	0	0	0	0
EUPHORBIA	0	0	0	1	0	0	0	0	0	0	0
MATRICARIA	1	0	0	0	3	1	0	0	0	0	0
CRUCIFERAE	0	0	1	0	1	0	1	1	2	2	2

LABIATAE	0	0	0	0	0	0	0	0	0	0	0
LABIATAE MENTHA-T	0	0	1	0	0	0	1	0	0	0	0
LAMIUM	0	0	0	0	0	1	1	6	2	1	0
LEGUMINOSAE	0	0	0	0	0	0	1	0	0	0	1
LEGUMINOSAE LOTUS-T	1	0	2	1	0	1	0	0	0	0	0
LEGUMINOSAE TRIFOLIUM-T	0	0	1	0	1	0	0	0	0	0	0
LEGUMINOSAE MEDICAGO-T	0	0	0	0	0	0	0	1	0	0	0
MALVA	0	0	0	0	0	0	0	0	0	1	0
PAPAVAR	0	0	0	0	0	0	0	1	0	0	0
PUECEDANUM	0	0	0	0	0	0	0	1	0	0	0
LYHTRUM	0	0	0	0	1	0	0	0	0	0	0
PLANTAGO	0	0	0	0	0	0	1	0	0	1	1
PLANTAGO LANCEOLATA	2	3	6	4	11	6	5	7	6	5	6
RANUNCULACEA E	1	1	2	6	4	6	5	9	7	4	1
ROSACEAE	1	0	1	0	0	0	1	0	0	0	0
FILLIPENDULA	0	0	0	4	2	1	2	3	0	3	1
RUBIACEAE	0	2	0	0	2	1	1	1	0	0	0
RUMEX	0	0	1	0	1	0	0	0	0	0	0
RUMEX ACETOSA	0	0	0	0	1	0	1	0	0	1	1
SCROPHULARIAC EAE	1	0	0	0	0	0	0	0	0	0	0
SUCCISA	0	0	0	0	0	0	0	0	1	0	0
UMBELLIFERAE	0	0	0	0	0	2	0	1	0	0	0
URTICA	1	2	0	1	2	2	1	3	1	0	0
VICCIA	0	0	0	0	1	0	0	0	0	0	0
VICCIA CRACCA	0	0	0	0	1	0	0	0	0	0	0
OPHIOGLOSSUM	0	0	1	0	0	0	0	0	1	0	0
SPARGANIUM	0	0	0	0	0	1	0	0	0	0	0
POLYPODIUM	0	0	2	2	2	1	2	4	11	11	3
PTERIDIUM	12	7	19	14	12	8	9	10	12	11	10
FILICALES ENDOSPORE	7	4	5	12	15	6	12	14	19	16	22
SPHAGNUM	1	1	1	0	2	1	1	2	1	2	1

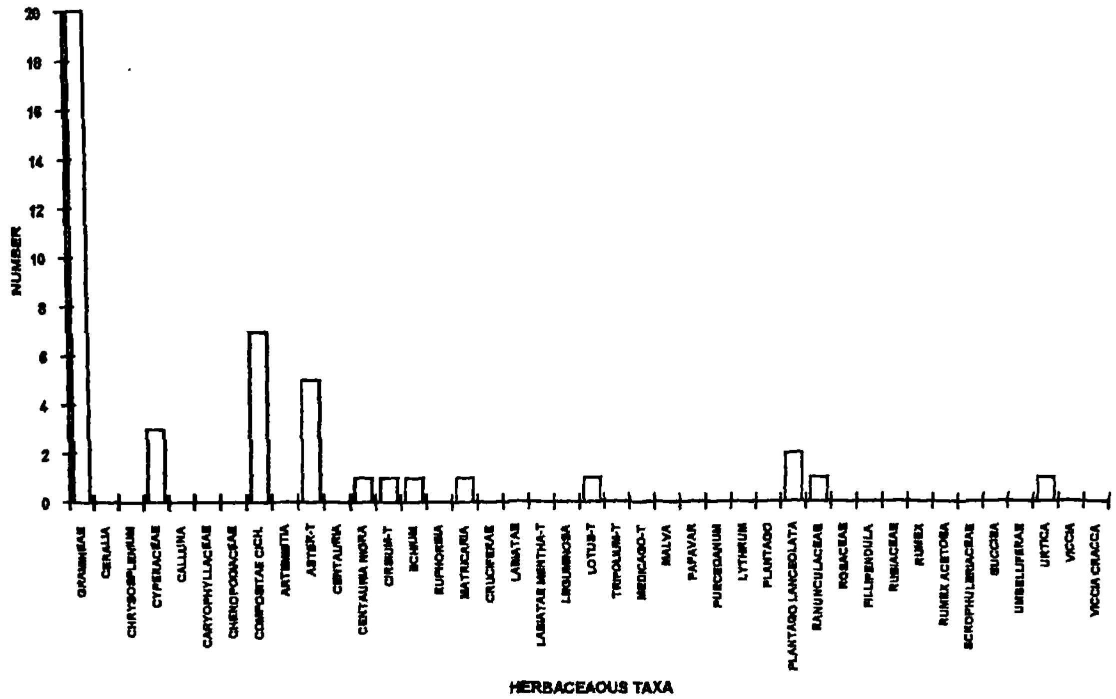


Fig. A3. 8 Herbaceous pollen recovered from Hoath Wood (65 cm)

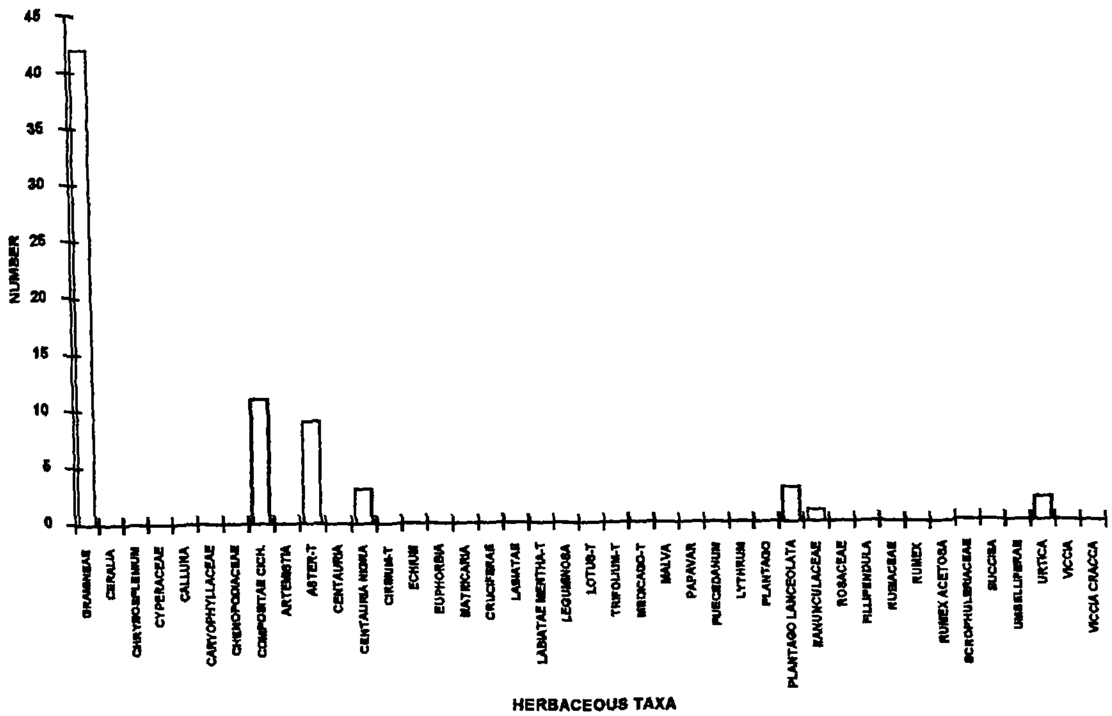


Fig. A3. 9 Herbaceous pollen recovered from Hoath Wood (65.5 cm)

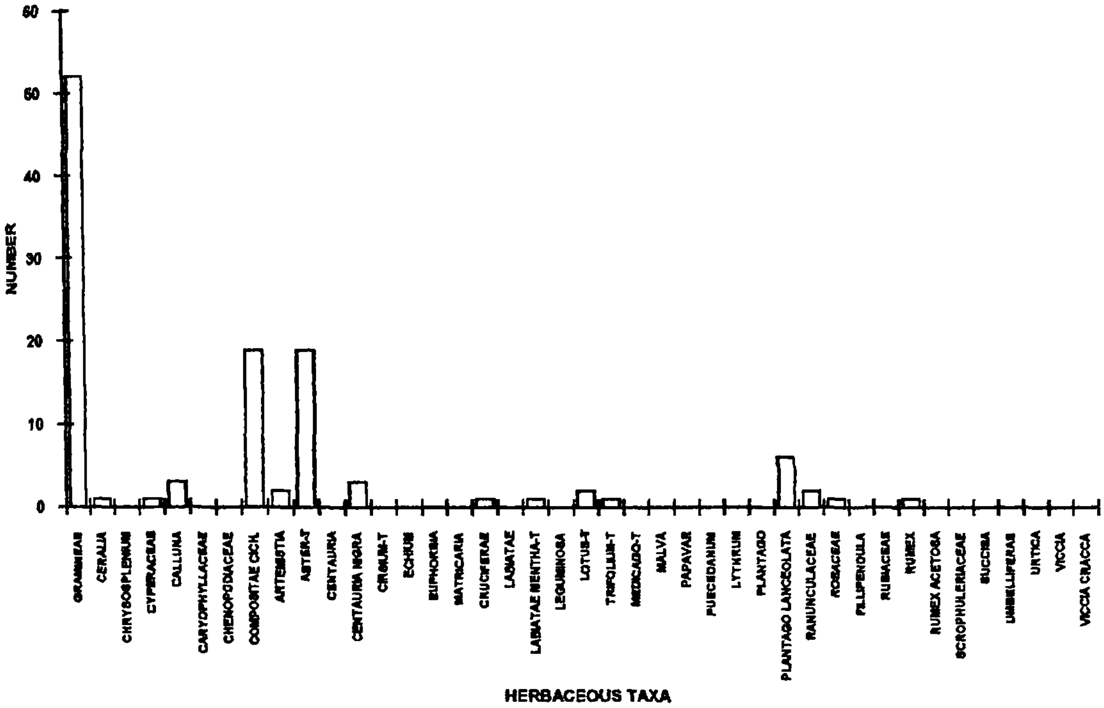


Fig. A3. 10 Herbaceous pollen recovered from Hoath Wood (66 cm)

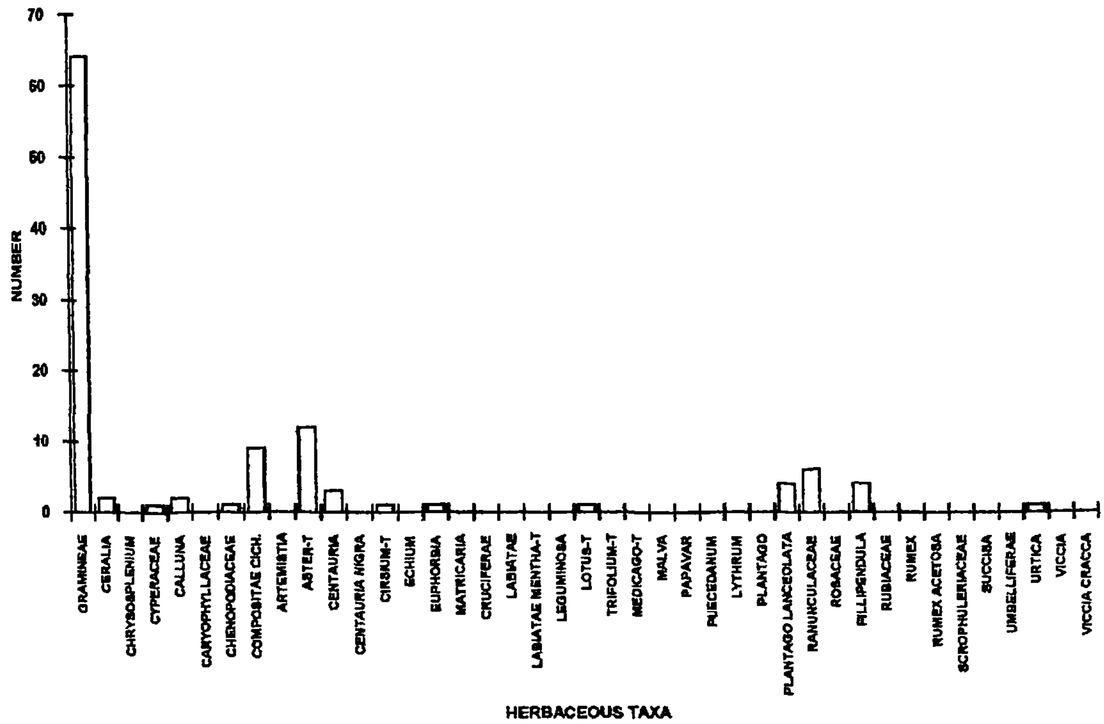


Fig. A3. 11 Herbaceous pollen recovered from Hoath Wood (66.5 cm)

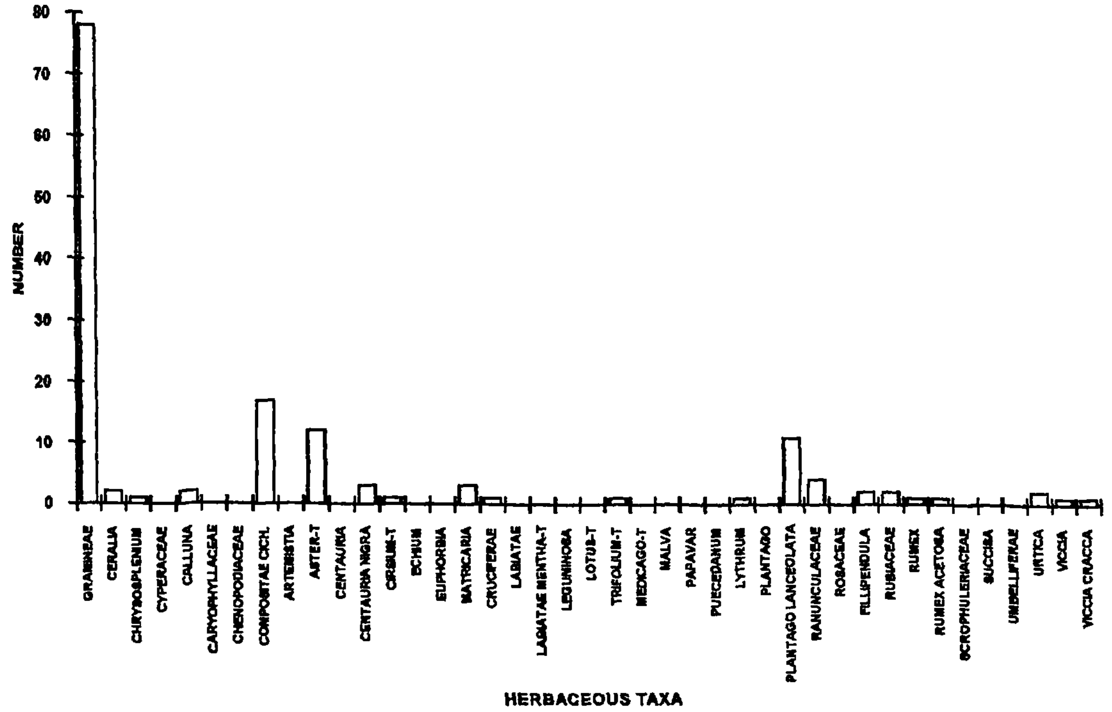


Fig. A3. 12 Herbaceous pollen recovered from Hoath Wood (67 cm)

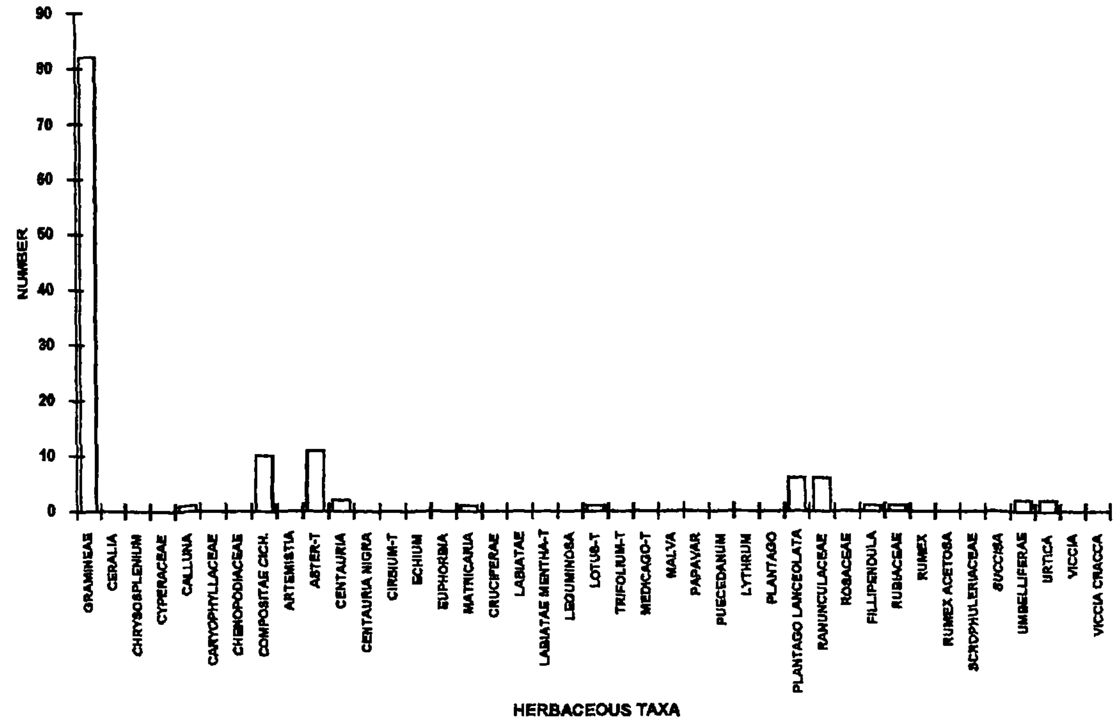


Fig. A3. 13 Herbaceous pollen recovered from Hoath Wood (67.5 cm)

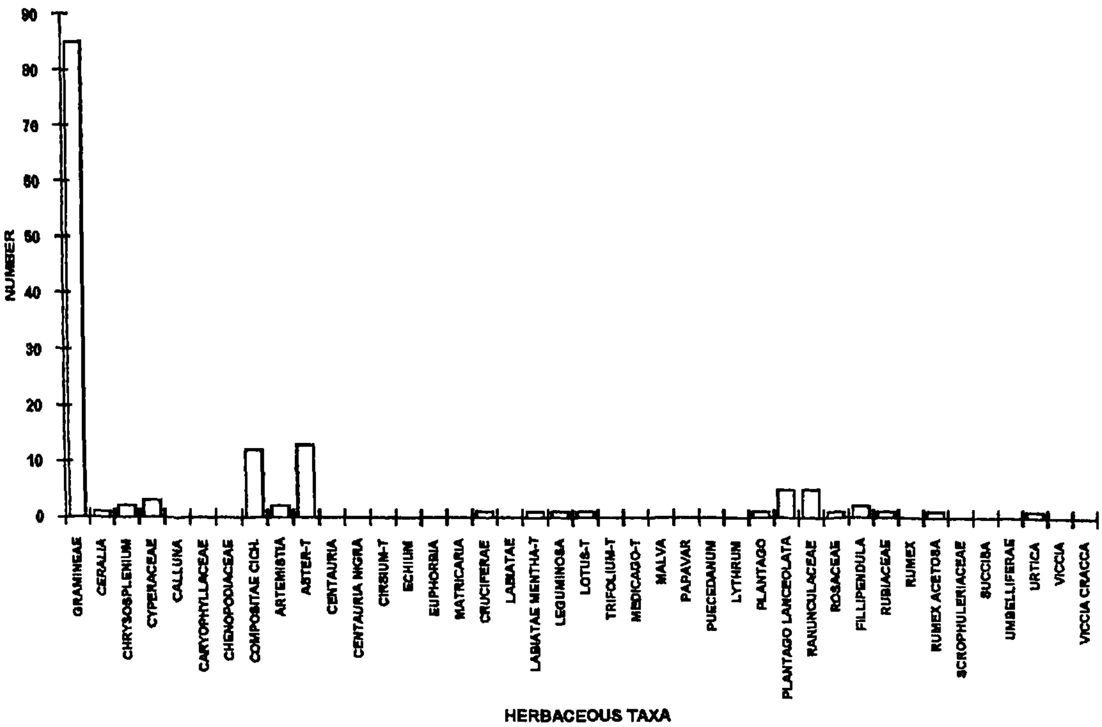


Fig. A3. 14 Herbaceous pollen recovered from Hoath Wood (70 cm)

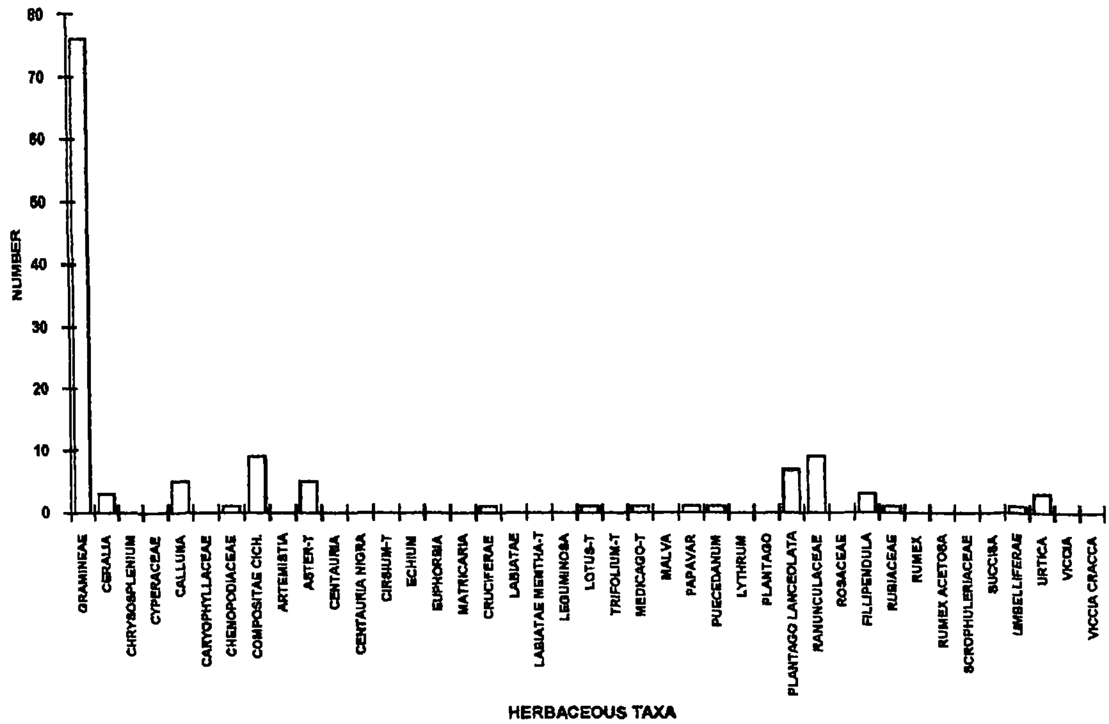


Fig. A3. 15 Herbaceous pollen recovered from Hoath Wood (73 cm)

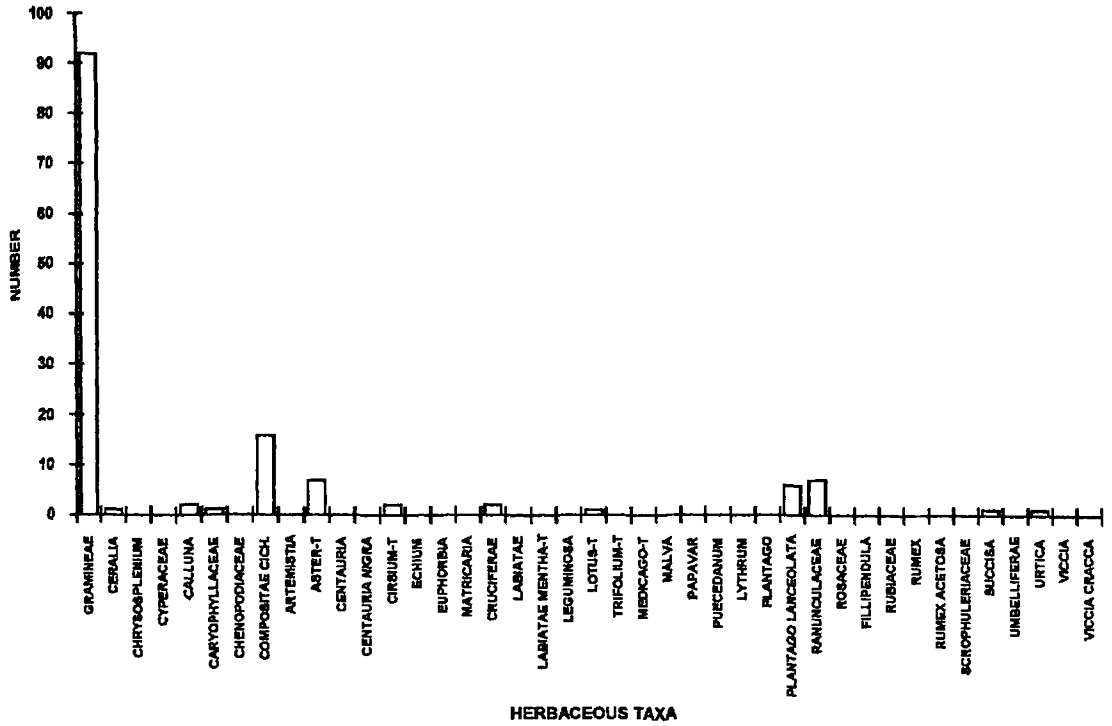


Fig. A3. 16 Herbaceous pollen recovered from Hoath Wood (76 cm)

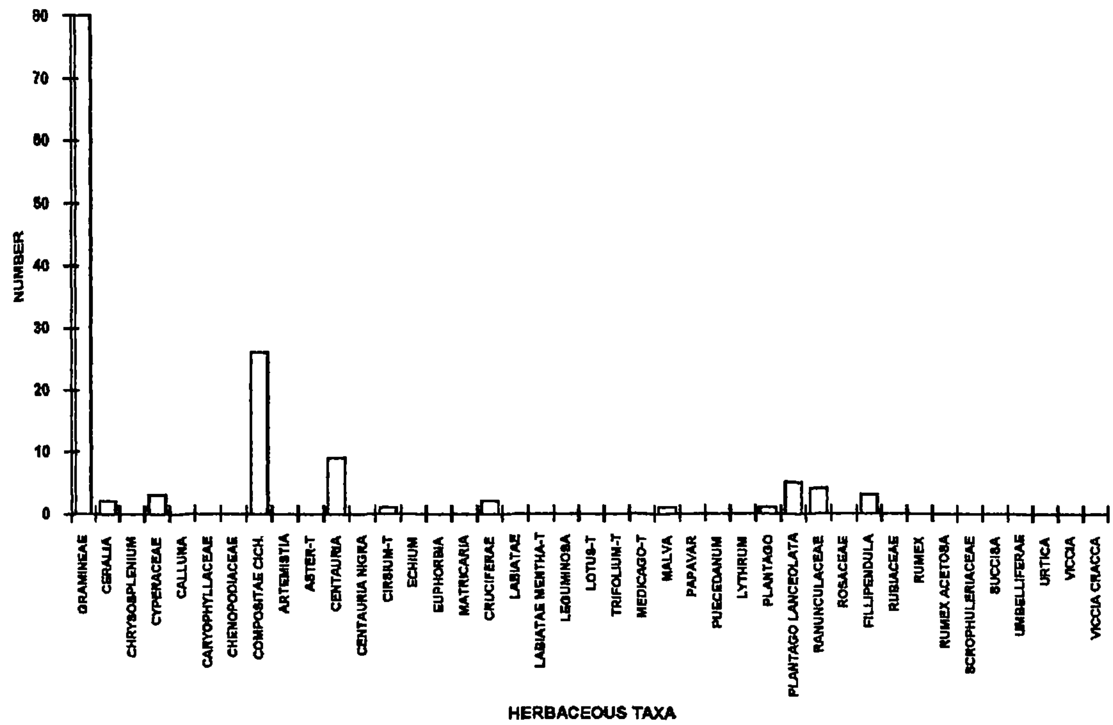


Fig. A3. 17 Herbaceous pollen recovered from Hoath Wood (79 cm)

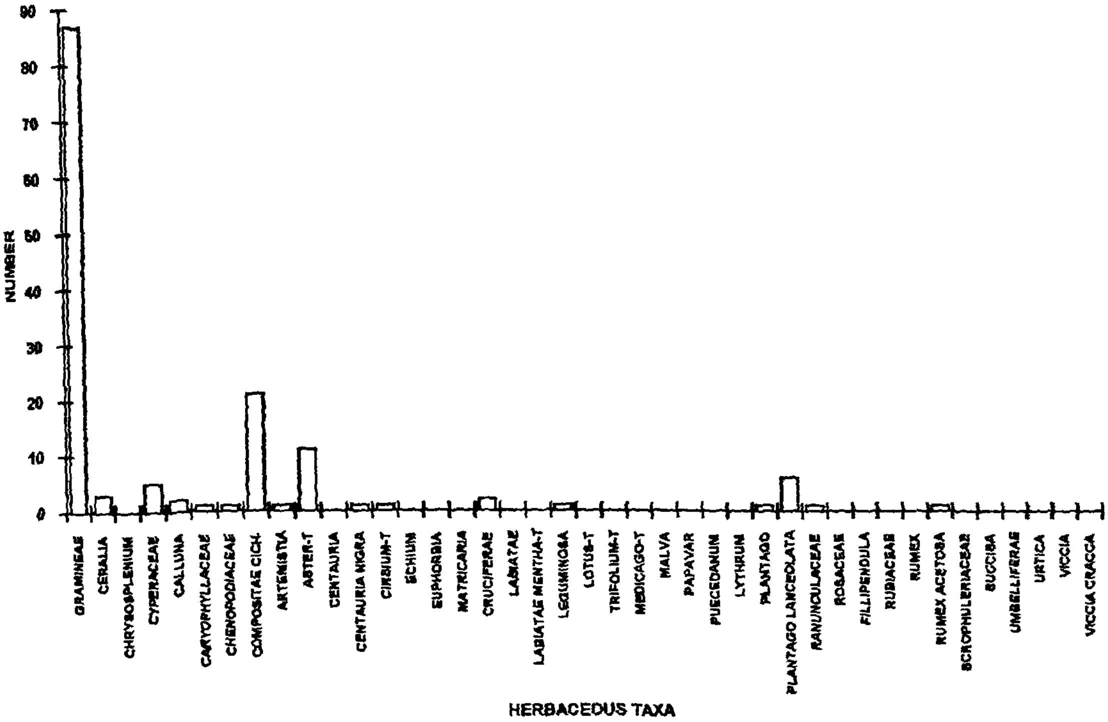


Fig. A3. 18 Herbaceous pollen recovered from Hoath Wood (82 cm)

GLOSSARY

BLOOM Iron which has been produced in a semi-solid state, as a product of the direct process of iron production, or reduction of the iron ore.

BLOOM-SMITHING A secondary operation which is carried out after direct production of bloom iron to consolidate the bloom produced by the expulsion of entrapped slag.

CAST IRON Iron which has been produced from its liquid state, and containing more than 1.9% carbon, in conjunction with other impurities such as silicon and phosphorous. The product is extremely brittle and not malleable either hot or cold.

CHARGE This represents the ore and fuel, of the correct weight ration, which are loaded into the shaft furnace prior to smelting.

CINDER The drossy solid material which collects at the top of the molten slag. This has never achieved a free-flowing condition in the furnace.

CLAMP This is the containing structure of an above ground charcoal kiln,

COASTAL SITES These are the iron production sites in the Eastern High Weald which have been discovered in the coastal parishes of Guestling, Pett, Icklesham and Fairlight. These are not to be confused with the *coastal group* defined by Cleere as the heavy industrial sites of the Hastings hinterland, which in the Roman era were situated on the edge of Romney Marsh.

DOMESTIC/SMALL SCALE The most numerous of all Wealden iron production sites, estimated to have produced between 1 kg and 100 tonnes of bloom iron.

ECOSYSTEM A dynamic complex of plant, animal, fungal and micro-organisms communities and the associated inorganic environment in which they react.

GANGUE The unwanted component of the iron ore which can either be removed during preparation or during smelting. Gangue minerals such as silica, calcia and alumina which are slagged-off during smelting take a proportion of the iron with them as flux.

HAMMER POND The colloquial term given to the reservoirs created after the introduction of the blast furnace, to provide a source of hydraulic power to run bellows and hammers in Furnaces and forges.

HAMMER SCALE This is slag and some metal which has been expelled from bloom iron during secondary and tertiary processes such as bloom and black-smithing. The oxidising effect of its reaction with air results mainly in oxides of iron

INDUCED DRAUGHT A furnace which utilises the chimney effect of hot air rising, as a result of the different density of cold air entering and heated air rising, air is sucked into the furnace. These are often called "air furnaces".

INDUSTRIAL CLASS Industrial class iron production sites are those sites estimated to have produced in excess of 1000 tonnes of unworked bloom iron during the Roman occupation. These sites are Bardown, Beauport Park, Broadfield, Chitcombe, Crowhurst Park, Footlands, Great Cansiron, Oaklands and Oldlands. This is not to be confused with Cleere's (1980) definition of industrial operations, which considers 10,000 tonnes to be the cut-off point.

GHYLL The colloquial term for a deeply incised river valley in the High Wealden region is ghyll, other derivatives of this form include gill. These features are highly characteristic of the High Weald as a result of the fluvial erosion of the sandstones to the basal clays causing steep sided valleys.

PODZOLISATION the chemical migration, under acid soil conditions, of aluminium, iron and/or organic matter from the upper horizon to the B horizon (Macphail 1987: 336).

SEMI-INDUSTRIAL CLASS Semi-industrial class iron production sites are those sites estimated to have produced between 100 and 1000 tonnes of unworked bloom iron during the Roman occupation.

SLAG The silicate complex formed by the combination of earthy material amalgamated with the ore, in conjunction with some of the iron oxide in the charge acting as a flux.

SMELTING This is the chemical reaction between the iron ore and the fuel.

TAP SLAG The slag [see above] which has been removed from the bloomery furnace in a molten state, during the smelting process. This is a prerequisite of the use of a slag-tapping furnace.

TUYÈRE The tube, normally of clay, passing through the wall of the furnace to take the air blast from the bellows.

WILDWOOD A term adopted by Rackham to indicate natural woodland, prior to influence and manipulation by man.

WOOD Wood is used to describe poles, brushwood, firewood, coppice and branch wood. This differs from timber which represents larger ligneous material mainly used for construction.

WROUGHT IRON Iron produced by the direct (bloomery) process. As a result it contains some slag and a low carbon content. The integral slag is normally expelled during bloom-smithing and black-smithing

BOTANICAL NOMENCLATURE

ARBOREAL SPECIES

Alder	*Alnus glutinosa*
Ash	*Fraxinus excelsior*
Beech	*Fagus sylvatica*
Birch	*Betula pubescans, Betula pendula*
Elder	*Sambucus nigra*
Elm	*Ulmus glabra, Ulmus campestre, Ulmus procera*
Guelder Rose	*Viburnum opulus*
Hawthorn	*Crataegus monogyna, Crataegus oxycanthoides*
Hazel	*Corylus avellana*
Hornbeam	*Carpinus betulus*
Holly	*Ilex aquifolium*
Maple	*Acre campestre*
Oak	*Quercus robur, Quercus petraea*
Popular	*Populus nigra, Populus tremula*
Sweet Chestnut	*Castanea sativa*
Sycamore	*Acer psuedoplantanus*
Willow	*Salix alba, Salix fragilis, Salix capre, Salix viminalis*

REFERENCES

PERIODICAL ABBREVIATIONS

Ancient Monuments Lab. Rep.	Ancient Monuments Laboratory Reports
Antiq.	Antiquity
Antiq. Journ.	Antiquaries Journal
Archaeol.	Archaeologia
Archaeol. Cant.	Archaeologia Cantiana
Archaeol. Journ.	Archaeological Journal
Archaeol. Newsl.	Archaeological Newsletter
Archaeol. Rev.	Archaeological Review
Archaeol. Wales	Archaeology in Wales
Brit. Archaeol. Rep.	British Archaeological Reports
Brit. Steelmaker	British Steelmaker
Bull. Exper. Firing Group	Bulletin of the Experimental Firing Group
Bull. Hist. Metall. Group	Bulletin of the Historical Metallurgy Society
Bull. Inst. Archaeol.	Bulletin of the London University Institute of Archaeology
Bull. Wealden. Iron. Res. Group	Bulletin of the Wealden Iron Research Group
Current Archaeol.	Current Archaeology
Econ. Geog.	Economic Geography
Econ. Hist. Rev.	Economic History Review
Gent. Mag.	Gentleman's Magazine
Geog. Journ.	Geographical Journal
Grana Palynol.	Grana Palynologica
Inst. Geol. Sci.	Institute of Geological Science.
Journ. Archaeol. Science	Journal of Archaeological Science
Journ. Biogeog.	Journal of Biogeography
Journ. British Archaeol. Ass.	Journal of the British Archaeological Association
Journ. Ecol.	Journal of Ecology
Journ. Iron and Steel Inst.	Journal of the Iron and Steel Institute
Journ. Geol. Soc. Lond.	Journal of the Geological Society of London
Journ. Roman Studies	Journal of Roman Studies
Journ. Soil Science	Journal of Soil Science
Kent Archaeol. Rev.	Kent Archaeological Review
Landscape Hist.	Landscape History
Lewes Archaeol. Group Newsl.	Lewes Archaeological Group Newsletter

Local Hist.	The Local Historian
Med. Archaeol.	Medieval Archaeology
New Phytol.	New Phytologist
New Scient.	New Scientist
Newsl. Sussex Archaeol. Soc.	Newsletter of the Sussex Archaeological Society
Newsl. Wealden. Iron. Res. Group	Newsletter of the Wealden Iron Research Group
Oxford Journ. Archaeol.	Oxford Journal of Archaeology
PACT	Journal of the European study group on physical, chemical, biological and mathematical techniques applied to archaeology.
Palaeobio.	Palaeobiology
Palaeohist.	Palaeohistoria
Phil. Trans. Roy. Soc. London	Philosophical Transactions of the Royal Society of London
Post Med. Archaeol.	Journal of Post Medieval Archaeology
Proc. Geol. Soc.	Proceedings of the Geologists Association
Proc. Roy. Soc. London	Proceedings of the Royal Society of London.
Proc. Prehist. Soc.	Proceedings of the Prehistoric Society
Proc. Somerset Archaeol. Nat. Hist. Soc.	Proceedings of the Somerset Archaeology and Natural History Society
Prog. Physical Geog.	Progress in Physical geography
Quart. Journ. Forestry	Quarterly Journal of Forestry
Quat. Research	Quaternary Research
Quat. News.	Quaternary Newsletter
Rev. Palaeobotany Palynology	Review of Palaeobotany and Palynology
Surrey Archaeol. Collect.	Surrey Archaeological Collections
Sussex Archaeol. Collect.	Sussex Archaeological Collections
Sussex County Mag.	Sussex County Magazine
Sussex Ind. Hist.	Sussex Industrial History
Trans. Battle Dist. Hist. Soc.	Transactions of the Battle and District Historical Society
Trans. Bristol Glos. Archaeol. Soc.	Transactions of the Bristol and Gloucestershire Archaeological Society
Trans. Inst. Brit. Geog.	Transactions of the Institute of British Geographers
Trans. Newcomen Soc.	Transactions of the Newcomen Society
World Archaeol.	World Archaeology

REFERENCES

Ackerman, F. and de Almeida, P. E. F. (1990) Iron and charcoal: the industrial fuelwood crisis in Minas Gerais, *Energy Policy*, **18.6**, 661-8.

Allen, J. R. L. (1988) Chemical compositional patterns in Romano-British bloomery slags from the wetlands of the Severn estuary, *Journ. Hist. Metal. Soc.*, **22.2**, 81-6.

Allen, J. R. L. and Fulford, M. G. (1986) The Wentlooge Level: a Romano-British saltmarsh reclamation in south-east Wales, *Britannia*, **17**, 91-117.

Allen, J. R. L. and Fulford, M. G. (1987) Romano-British settlement and industries on the wetlands of the Severn estuary, *Antiq. Journ.*, **17**, 237-89.

Andrews, P. B. S. (1974) A fictitious purported historical map, *Sussex Archaeol. Collect.*, **112**, 165-7.

Anon. (1862) The temporary museum at Hastings, *Sussex Archaeol. Collect.*, **14**, xii-xiv.

Anon. (1904) Report for 1903, *Sussex Archaeol. Collect.*, **47**, xiv-xvi.

Anon. (1909) *Catalogue of an exhibition of local antiquities*, Corporation Museum, Hastings.

Anon. (1941) Obituary: the late Ernest Straker, F.S.A., *Sussex Notes and Queries*, **8.8**, 227-8.

Anon. (1952) *Farm incomes in England and Wales: 1949-50*, Ministry of Agriculture and Fisheries, H.M.S.O., London.

Anon. (1957) Cranbrook, *Archaeol. Cant.*, **71**, 224.

Anon. (1976) Inventory of sites visited by WIRG, *Bull. Wealden Iron Res. Group*, **9**, 2-17.

Anon. (1982) The Chronicle award, *Bull. Wealden Iron Res. Group*, **2** (2 ser), 2-6.

Arnott, S. (1869) Contributions towards a parochial history of Hollington, *Sussex Archaeol. Collect.*, **21**, 138-58.

Armstrong, L. (1978) *Woodcolliers and charcoal burning*, Coach publishing and the Weald and Downland open air museum, Horsham.

Ascherson, C. N. (1949) Roman pottery from Ticehurst, *Sussex Notes and Queries*, **12.6**, 161-3.

Baigent, J. (1976) Appendix I: Pollen analysis, in Drewett P. L. (ed.) The excavation of four round barrows of the second millennium BC at West Heath, Harting 1973-1975, *Sussex Archaeol. Collect.*, **114**, 144-7.

Bedwin, O. (1980) The excavation of a late 16th century blast furnace at Batsford, Herstmonceux, East Sussex, 1978, *Journ. Post-Med. Archaeol.*, **14**, 89-112.

Behre, K. E. (1981) The interpretation of anthropogenic indicators in pollen diagrams, *Pollen and Spores*, **23**, 225-45.

Behre, K. E. (1990) Some general remarks on human impact in pollen diagrams, *Pact*, **31**, Impact of Prehistoric and medieval man on the vegetation: man at the forest limit, 35-8.

Bell-Irving, E. M. (1903) *Mayfield, an old Wealden village*, Johnson, Haywards Heath.

Belloc, H. (1913) *The Stane Street: a monograph*, Constable & Co Ltd., London.

Bird, D. G. (1987) The Romano-British period in Surrey, in Bird, J. and Bird, D. G. (eds.) *The archaeology in Surrey to 1540*, Alard & Son, Dorking, 165-96.

Birks, H. J. B. (1989) Holocene isochrone maps and patterns of tree spreading in the British Isles, *Journ. Biogeog.*, **16**, 503-40.

Black, E. W. (1987) *The Roman villas of south-east England*, Brit. Archaeol. Rep. (Brit. ser.), **171**, Oxford.

Blackman, H. (Undated) *Unpublished MSS*, Hastings Museum.

Botting, W. J. (1973) Romano-British ironworking site at Ludley Farm, Beckley, *Sussex Archaeol. Collect.*, **111**, 111.

Branigan, K. (1977) *Gatcombe: the excavation and study of a Roman-British villa estate, 1967-8*, Brit. Archaeol. Rep. (Brit. ser.), **44**, Oxford.

Briault, E. W. M. (1942) Sussex (East and West), in Dudley Stamp, L. (ed.) *The land of Britain*, Geographical publications, London, 471-622.

Brinkkemper, O., Duistermaat, H., Hallewas, D. P. and Kooistra, L. I. (1995) A native settlement from the Roman period near Rockanje, *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek*, **41**, 123-172.

Brodribb, A. G. (1969b) Beauport Park, *Bull. Wealden Iron Res. Group*, **1**, 9.

Brodribb, A. G. (1972) A note on the Beauport Park Roman ironworks, *Bull. Wealden Iron Res. Group*, **3**, 4-6.

Brodribb, A. G. (1977) Beauport Park near Battle, East Sussex, *Antiq. Journ.*, **57**, 314.

Brodribb, A. G. (1979) Tegulae mammatae, *Antiq. Journ.*, **59**, 397-400.

Brodribb, A. G. (1981) Beauport Park, *Current Archaeol.*, **77**, 177-81.

Brodribb, A. G. and Cleere, H. F. (1988) The *Classis Britannica* bathhouse at Beauport Park, East Sussex, *Britannia*, **19**, 217-74.

Bromehead, C. E. N. (1948) Practical geology in ancient Britain, *Proc. Geol. Assoc.*, **59**, 345-67.

Brown, G. T. (1964) A bloom of iron from Cranbrook, Kent, *Journ. Iron Steel Inst.*, **202**, 502-4.

Browne, J. C. (1884) *The forests of England - and the management of them in bygone times*, Simpkin and Marshall, London.

Buckland, L. A. (1982) Archaeological finds in Dane Hill at Chelwood Gate, *Sussex Archaeol. Collect.*, **120**, 228-9.

Burrin, P. J. (1981) Loess in the Weald, *Proc. Geol. Assoc.*, **92**, 87-92.

Burrin, P. J. (1983) *The character and evolution of floodplains with specific reference to the Ouse and Cuckmere, Sussex*, unpublished Ph.D. thesis, London School of Economics, University of London.

Burrin, P. J. (1988) The Holocene floodplain and alluvial deposits of the Rother valley and their bearing on the evolution of Romney Marsh, in Eddison, J. and Green, C. (eds.) *Romney Marsh: evolution, occupation, reclamation*, Oxford University Committee for Archaeology, **24**, Alden, Oxford, 31-52.

Burrin, P. J. and Scaife, R. G. (1984) Aspects of Holocene valley sedimentation and floodplain development in southern England, *Proc. Geol. Assoc.*, **95**, 81-96.

Butler, A.M. (1914) *Steyning, Sussex, The history of Steyning and its church from AD 700 - 1913*, Hayward, Croydon.

Butler, D. S. (1973) The use of bloomery slag in blast furnaces, *Bull. Wealden Iron Res. Group*, **5**, 10-1.

Butler, D. S. (1974) Examination of bloomery slags from Chichester sites, in Down .A (ed.) *Chichester excavations*, **2**, Phillimore, Chichester, 143.

Campkin, H. (1877) The late William Durrant Cooper F.S.A. and the late Mark Anthony Lower F.S.A., *Sussex Archaeol. Collect.*, **27**, 117-51.

Cartwright, C. (1980) Charcoal identifications, in Bedwin, O. (ed.) The excavation of a blast furnace at Batsford, *Journ. Post-Med. Archaeol.*, 110-1.

Cartwright, C. (1986) The charcoal, in Rudling, D. (ed.) The excavation of a tilery on Great Cansiron Farm, *Britannia*, **17**, 220-2.

Cartwright, C. (1992) The excavation of a Romano-British iron working site at Broadfield, Crawley, West Sussex, *Sussex Archaeol. Collect.*, **130**, 22-59.

Case, H. (1969) Neolithic explanations, *Antiq.*, **43**, 176-86.

Caseldine, A. (1990) *Environmental archaeology in Wales*, University College Lampeter, Lampeter.

Cattell, C. S. (1969) A Romano-British bloomery at Heathfield, *Sussex Notes and Queries*, **17**, 101-3.

Cattell, C. S. (1970) Preliminary research findings relating to the bloomery period of the iron industry in the upper basin of the eastern Rother (East Sussex), *Bull. Hist. Metall. Group*, **4.1**, 18-20.

Cattell, C. S. (1971) A note on the dating of bloomeries in the upper basin of the eastern Rother, *Bull. Hist. Metall. Group*, **5.2**, 76.

Cattell, C. S. (1972) Bloomeries in the upper (east) Rother basin, *Bull. Wealden Iron Res. Group*, **3**, 13.

Cawood, T. (1986) The pottery, in Rudling, D. R. (ed.) The excavation of a Roman tilery on Great Cansiron Farm, Hartfield, East Sussex, *Britannia*, **17**, 213-9.

Chaplin, R. (1970) Discovering lost ironworks, *Local Hist.*, **9.2**, 82-8.

Chown, E. (1947) Painted Iron Age pottery at Sedlescombe, *Sussex Notes and Queries*, **11**, 148-51.

Cleal, R. M. J. (1982) A re-analysis of the ring ditch site at Playden, East Sussex, *Sussex Archaeol. Collect.*, **120**, 1-17.

Cleere, H. F. (1963a) A note on Roman bloomery tuyères, *Sussex Archaeol. Collect.*, **101**, 48-53.

Cleere, H. F. (1963b) Primitive Indian ironmaking furnaces, *Brit. Steelmaker*, April, 154-8.

Cleere, H. F. (1968a) Excavations at Bardown, Sussex, 1968, *Bull. Hist. Metall. Group*, **2.2**, 26-7.

Cleere, H. F. (1968b) Excavations at Holbeanwood, Sussex, 1968, *Bull. Hist. Metall. Group*, **2.2**, 28-9.

Cleere, H. F. (1969) Bardown, *Bull. Wealden Iron Res. Group*, **1**, 2-4.

Cleere, H. F. (1970) *The Romano-British industrial site at Bardown, Wadhurst*, Sussex Archaeol. Soc. occ. paper **1**, Chichester.

Cleere, H. F. (1971a) Cyclical operations at Roman bloomeries, *Bull. Hist. Metall. Group*, **5.2**, 74-5.

Cleere, H. F. (1971b) Iron making in a Roman furnace, *Britannia*, **2**, 203-17.

Cleere, H. F. (1975) The Roman iron industry of the Weald and its connections with the Classis Britannica, *Archaeol. Journ.*, **131**, 171-99.

Cleere, H. F. (1976) Operating parameters for Roman iron works, *Bull. Inst. Archaeol.*, **13**, 233-46.

Cleere, H. F. (1977a) The Classis Britannica, in D. Johnson (ed.) *The Roman forts of the Saxon Shore*, C.B.A Res. Rep., **18**, London, 16-20.

Cleere, H. F. (1985) Man as part of the ecosystem, *Nature*, **315**, 718-9.

Cleere, H. F. (1987) Appendix 1: The iron smelting furnace, in Harding, A. F. and Ostoja-Zagórski, J. (eds.) Excavations in Rocks Wood, Withyham, 1982, *Sussex Archaeol. Collect.*, **128**, 11-32.

Cleere, H. F. (1993) Archaeometallurgy comes of age, *Antiq.*, **67**, 175-8.

Cleere, H. F. and Crossley, D. (1969) Wealden iron research group: aims and objectives, *Bull. Wealden Iron Res. Group*, **1**, 19-22.

Cleere, H. F. and Crossley, D. (1985) *The iron industry of the Weald*, Leicester University Press, Leicester.

Cleere, H. F. and Crossley, D. (1995) *The iron industry of the Weald*, (2nd ed.) Merton Priory Press, Cardiff.

Cleland, J. (1981) Roasting, blooming or smithing? *Current Archaeol.*, **77**, 165-7.

Clough, R. E. (1986) *Iron: aspects of the industry during the Iron Age and Romano-British periods*, unpublished Ph.D. thesis, University of London.

Coghlan, H. H. (1977) *Notes on Prehistoric and early iron in the Old World*, Pitt Rivers Museum, Oxford.

Collingwood, R. G. and Taylor, M. V. (1928) Roman Britain in 1928, *Journ. Roman Studies*, **18**, 191-214.

Combe, B. H. (1877) Discovery at Sedlescombe of Saxon pennies of Edward the Confessor, *Sussex Archaeol. Collect.*, **27**, 227-8.

Connolly, P. (1990) The saddle horns from Newstead, *Journ. Roman Military Equip. Studies*, **1**, 61-6.

Copley, G. J. (1977) *Camden's Britannia: Surrey and Sussex-from the edition of 1789 by Richard Gough*, Hutchinson, London.

Corcoran, J. (1963) Excavation of the bell barrow in Deerleap Wood, Wotton, *Surrey Archaeol. Collect.*, **60**, 1-18.

Cornwall, J. (1954) Forestry and the timber trade in Sussex, 1560-1640, *Sussex Notes and Queries*, **14.4**, 85-91.

Crake, W. V. (1912) A notice of Maresfield Forge in 1608, *Sussex Archaeol. Collect.*, **55**, 278-83.

Cunliffe, B. (1973) *The Regni: the people of Roman Britain*, Duckworth, London.

Cunliffe, B. (1980) The evolution of Romney Marsh: a preliminary statement, in F. H. Thompson (ed.) *Archaeology and coastal change*, Soc. Antiq. occ. paper (new ser.), **1**, 37-55.

Cunliffe, B. (1988) Romney Marsh in the Roman period, in J. Eddison and C. Green (eds.) *Romney Marsh: evolution, occupation, reclamation*, Oxford University Committee for Archaeology, **24**, Alden, Oxford, 83-7.

Curwen, E. C. (1954) *The archaeology of Sussex*, Methuen, London.

Dalton, A. (1983) How Oldlands bloomery was really found, *Bull. Wealden Iron Res. Group*, **3** (2 ser.), 34-5.

Darrell-Hill, J. D. (1960) The Romano-British site at Bodiam Station, *Sussex Notes and Queries*, **15.6**, 190-2.

Davies, G. (1993) Recent publications, *News. Wealden Iron Res. Group*, **18**, 5-6.

Davies, O. (1932) Iron smelting furnaces, *Antiq. Journ.*, **13**, 166-7.

Davies, O. (1935) *Roman mines in Europe*, Oxford University Press, Oxford.

Dawson, C. (1903) Sussex iron work and pottery, *Sussex Archaeol. Collect.*, **46**, 1-62.

Dawson, C. (1907) Some inscribed bricks and tiles from the Roman *castra* at Pevensey, *Proc. Soc. Antiq.*, **21**, 410-13.

Dawson, C. (1909) History of Hastings Castle, Lewes.

Detsicas, A. P. (1983) *The Cantiaci: the peoples of Roman Britain*, Alan Sutton, Gloucester.

Dimbleby, G. W. (1954) Pollen analysis as an aid to the dating of prehistoric monuments, *Proc. Prehist. Soc.*, **20**, 231-6.

Dimbleby, G. W. (1957) Pollen analysis of terrestrial soils, *New Phytol.*, **56**, 12-28.

Dimbleby, G. W. (1960) Appendix D: Pollen, in Money, J. (ed.), Excavations at High Rocks, Tunbridge Wells, 1954-56, *Sussex Archaeol. Collect.*, **98**, 212-7.

Dimbleby, G. W. (1961) Soil pollen analysis, *Journ. Soil Science*, **12**, 1-11.

Dimbleby, G. W. (1965) Post-Glacial changes in soil profiles, *Proc. Roy. Soc. London*, **B161**, 355-62.

Dimbleby, G. W. (1969a) Report on Pollen analysis, in Fox, N. P. (ed.) Caesar's Camp, Keston, *Archaeol. Cant.*, **84**, 196-9.

Dimbleby, G. W. (1969b) Pollen analysis, in Brothwell, D. and Higgs, E. (eds.), *Science and archaeology*, Thames and Hudson, London, 167-77.

Dimbleby, G. W. (1975) Pollen analysis, in Drewett, P. L. (ed.) The excavation of a turf barrow at Minsted, West Sussex, 1973, *Sussex Archaeol. Collect.*, **113**, 61-2, 65.

Dimbleby, G. W. (1977) *Plants and archaeology*, John Baker, London.

Dimbleby, G. W. and Bradley, R. J. (1975) Evidence of pedogenesis from a Neolithic site at Rackham, Sussex, *Journ. Archaeol. Science*, **2.3**, 179-86.

Drewett, P. L. (1975a) The excavation of three round barrows of the second millennium BC at West Heath, West Sussex, *Bull. Inst. Archaeol.*, **12**, 19-24.

Drewett, P. L. (1975b) The excavation of a turf barrow at Minsted, Stedham, West Sussex, *Bull. Inst. Archaeol.*, **12**, 24-6.

Drewett, P. L. (1975c) The excavation of a turf barrow at Minsted, West Sussex, 1973, *Sussex Archaeol. Collect.*, **113**, 54-65.

Drewett, P. L. (1976a) The excavation of four round barrows of the second millennium BC at West Heath, Harting, 1973-1975, *Sussex Archaeol. Collect.*, **114**, 126-50.

Drewett, P. L. (1976b) The excavation of barrow IV at West Heath Common, West Sussex, 1975, *Bull. Inst. Archaeol.*, **13**, 58-62.

Drewett, P. L. (1978) Neolithic Sussex, in Drewett, P. L. (ed.) *Archaeology in Sussex to AD 1500*, C.B.A. Res. Rep., **29**, London, 23-9.

Drewett, P. L. (1981) The excavation of five round barrows at West Heath, Harting, West Sussex, *Bull. Inst. Archaeol.*, **18**, 26-60.

Drewett, P. L. (1985) Excavations at Barrows V-IX at West Heath, Harting, 1980, *Sussex Archaeol. Collect.*, **123**, 35-60.

Drewett, P. L., Rudling, D. and Gardiner, M. (1988) *The south-east to AD 1000: a regional history of England*, Longman, London.

Dudley-Stamp, L. (1962) *The land utilisation survey of Great Britain: its use and misuse*, Longmans, London.

Edmonson, J. C. (1987) *Two industries in Roman Lusitania: mining and garum production*, Brit. Archaeol. Rep. (int. ser.) **362**, Oxford.

Edwards, K. J. and Hirons, K. R. (1984) Cereal pollen grains in pre-elm decline deposits: implications for the earliest agriculture in Britain and Ireland, *Journ. Archaeol. Science*, **11**, 71-80.

Ehrenreich, R. M. (1985) *Trade technology and the iron working community in the Iron Age of Southern Britain*, Brit. Archaeol. Rep. (Brit. ser.), **144**, Oxford.

Ellison, A. (1978) The Bronze Age of Sussex, in Drewett, P. L. (ed.) *Archaeology in Sussex to AD 1500*, C.B.A. Res. Rep., **29**, London, 30-7.

English, J. and Gower, J. L. (1985) Alfoldean Roman posting station, interim report, *Sussex Archaeol. Soc. News.*, **47**, 456-7.

Entwistle, R. (1994) The environmental setting of the linear ditches system, in Bradley, R, Entwistle, R. and Raymond, F. *Prehistoric land divisions on Salisbury Plain: the work of the Wessex linear ditches project*, English Heritage, London, 101-21.

Evans, J. G. (1975) *The environment of early man in the British Isles*, Paul Elek, London.

Fearnside, P.M. (1989) The charcoal of Carajas: A threat to the forests of Brazil and the eastern Amazon region, *Ambios*, 18.2, 141-3.

February, E. (1992) Archaeological charcoals as indicators of vegetation change and human fuel choice in the Late Holocene at Elands Bay, Western Cape Province, South Africa, *Journ. Archaeol. Science*, **19.3**, 347-54.

Feuntes, N. (1991) The mule of a soldier, *Journ. Roman Military Equip. Studies*, **2**, 65-99.

Field, D. and Cotton, J. (1987) Neolithic Surrey: a survey of the evidence, in Bird, J. and Bird, D. G. (eds.) *The archaeology in Surrey to 1540*, Alard & Son, Dorking, 71-96.

Fletcher, A. (1975) *A community at peace and war: Sussex 1600-1660*, Longman, London.

Fletcher, A. W. (1956) Primitive bloomeries in Mayfield, *Sussex Notes and Queries*, **14.9**, 173.

Fordham, S. J. and Green, R. D. (1980) *Soils of Kent*, Soil Survey of England and Wales, Harpenden.

Frere, S. S. (1944) An Iron Age site at West Clandon, Surrey, and some aspects of Iron Age and Romano-British culture in the Wealden area, *Archaeol. Journ.*, **101**, 50-67.

Fulford, M. G. (1979) The pottery, in Tebbutt C. F. (ed.) The excavation of three Roman bloomery furnaces at Hartfield, Sussex, *Sussex Archaeol. Collect.*, **117**, 55.

Fulford, M. G. (1989) The economy of Roman Britain, in Todd, M. (ed.) *Research on Roman Britain: 1960-89*, Britannia Monograph **11**, Alan Sutton, Gloucester, 175-202.

Fulford, M. G. (1990) The landscape of Roman Britain: a review, *Landscape Hist.*, **12**, 25-31.

Fulford, M. G. and Allen, J. R. L. (1992) Iron making at the Chesters villa Woolaston Gloucestershire: survey and excavation 1987-1991, *Britannia*, **23**, 159-215.

Gaffney, V. and Tingle, M. (1989) *The Maddle Farm project: an integrated survey of Prehistoric and Roman landscapes on the Berkshire downs*, Brit. Archaeol. Rep. (Brit. ser.), **200**, Oxford.

Gale, R. (1991a) The identification of wood remains, in S. Needham (ed.) *Excavation and salvage at Runnymede Bridge, 1978: the Late Bronze Age waterfront site*, British Museum Press, London, 226-33.

Gale, R. (1991b) Charred wood, in N. M. Sharples (ed.) *Maiden Castle: excavation and field survey 1985-6*, H.B.M.C.E., London, 125-9.

Gallois, R. W. (1965) *The Wealden district*, British regional geology, H.M.S.O., London.

Gardiner, J. P. (1984) Lithic distributions and Neolithic settlement patterns in central southern England, in Bradley, R. J. and Gardiner, J. P. (eds.) Neolithic studies: a review of current research, *Brit. Archaeol. Reps.* (Brit. Ser.), *133*, Oxford, 15-40.

Gardiner, J. P. (1988) *The composition and distribution of Neolithic surface flint assemblages in central southern England*, unpublished Ph.D. thesis, Department of Archaeology, University of Reading.

Gardiner, M. (1990) The archaeology of the Weald: a survey and review, *Sussex Archaeol. Collect.*, **128**, 33-53.

Gardner, J. S. (1898) Iron casting in the Weald, *Archaeol*, **56.1**, 133-64.

Geddes, J. (1991) Iron, in Blair, J. and Ramsey, N. (eds.) *English medieval industries: craftsmen techniques and products*, Hambledon Press, London.

Gibson-Hill, J. (1972) The rescue excavation at Broadfields, *Bull. Wealden Iron Res. Group*, **4**, 25-26.

Gibson-Hill, J. (1974) Notes on lifting the furnace base from the Romano-British bloomery site at Broadfield, Crawley, West Sussex, TQ 258 353, *Journ. Hist. Metall. Soc.*, **8.1**, 50-3.

Gibson-Hill, J. (1975a) The excavation of a Romano-British iron working site at Broadfields, Crawley, West Sussex, *Bull. Inst. Archaeol.*, **12**, 35-42.

Gibson-Hill, J. (1975b) Crawley, Sussex: Roman bloomery site at Broadfields, *Surrey Archaeol. Collect.*, **70**, 149-50.

Gibson-Hill, J. (1976) Further excavation at the Romano-British iron working site at Broadfields, Crawley, *Bull. Inst. Archaeol.*, **13**, 79-88.

Gibson-Hill, J. (1980) Cylindrical shaft furnaces of the early Wealden iron industry: c 100 B.C. - A.D. 300, *Journ. Hist. Metall. Soc.*, **14.1**, 21-7.

Gibson-Hill, J. and Worssam, B. C. (1976) Analyses of Wealden iron ores and their archaeological significance, *Bull. Inst. Archaeol.*, **13**, 247-63.

Godwin, H. (1962) Vegetational history of the Kentish chalk Downs as seen at Wingham and Frogholt, *Veroff. Geobot. Inst. Zurich*, **37**, 83-99.

Godwin, H. (1975) *The history of the British flora*, Cambridge University Press, Cambridge.

Godwin, H. (1975) History of the natural forests of Britain: establishment, dominance and destruction, *Phil. Trans. Roy. Soc. London*, **B271**, 47-67.

Goodburn, R. (1978) Roman Britain in 1977: sites explored, *Britannia*, **9**, 404-72.

Goodburn, R. (1979) Roman Britain in 1978: sites explored, *Britannia*, **10**, 267-338.

Goodchild, R. G. (1937) The Roman brickworks at Wykehurst Farm, in the parish of Cranleigh, *Surrey Archaeol. Collect.*, **45**, 74-96.

Graham, J. (1932) The Roman road on the Surrey-Kent border, *Surrey Archaeol. Collect.*, **40**, 97-106.

Green, C. M. (1981) The pottery, in C. F. Tebbutt (ed.), Wealden bloomery iron smelting furnaces, *Sussex Archaeol. Collect.*, **119**, 57-64.

Green, R. D. (1968) The soils of Romney Marsh, *Bulletin of the soil survey of Great Britain*, **4**, H.M.S.O. London.

Hall, A.D. and Russell, E.J. (1911) *A report on the agriculture and soils of Kent, Surrey and Sussex*, H.M.S.O., London.

Hanworth, R. (1962) The Roman villa at Rapsley, Ewhurst, *Surrey Archaeol. Collect.*, **65**, 1-70.

Hammersley, G. F. (1973) The charcoal iron industry and the fuel, 1540-1750, *Econ. Hist. Rev.*, **26** (2 ser.), 593-613.

Harding, A. F. and Ostoja-Zagórski, J. (1987) Excavations in Rocks Wood, Withyham, 1982, *Sussex Archaeol. Collect.*, **128**, 11-32.

Hardy, H. R. and Curwen, E. C. and Hawkes, C. (1937) An Iron Age pottery site near Horstead Keynes, *Sussex Archaeol. Collect.*, **78**, 252-65.

Harman (1988) The animal bones, in Brodribb, A. G. and Cleere, H. F. (eds.) The *Classis Britannica* bathhouse at Beauport Park, East Sussex, *Britannia*, *19*.

Haverfield, F. J. (1916) Roman remains from Ticehurst, *Sussex Archaeol. Collect.*, **58**, 195.

Heinz, C. (1991) Upper Pleistocene and Holocene vegetation in the south of France and Andora. Adaptations and first ruptures: new charcoal analysis data, *Rev. Palaeobotany Palynology*, **69**, 299-324.

Hodgkinson, J. S. (1985) A Romano-British iron working site at Crawley Down, Worth, Sussex, *Bull. Wealden Iron Res. Group*, **5** (2 ser.), 9-20.

Hodgkinson, J. S. (1987a) Field notes, *Bull. Wealden Iron Res. Group*, **7** (2 ser.), 2-3.

Hodgkinson, J. S. (1987b) Footlands ironworking site, Sedlescombe, *Bull. Wealden Iron Res. Group*, **7** (2 ser.), 25-32

Hodgkinson, J. S. (1988a) Two Roman shoe fragments from Sedlescombe, *Sussex Archaeol. Collect.*, **126**, 231-32.

Hodgkinson, J. S. (1988b) Field notes, *Bull. Wealden Iron Res. Group*, **8** (2 ser.), 2-11.

Hodgkinson, J. S. (1993) Field notes, *Bull. Wealden Iron Res. Group*, **13** (2 ser.), 2-3.

Hodgkinson, J. S. (1995) Field notes, *Bull. Wealden Iron Res. Group*, **15** (2 ser.), 2-4.

Hodgkinson, J. S. and Tebbutt, C. F. (1985) A field study of the Romano-British iron working industry in the Weald of southern England, in Craddock, P. T. and Hughes, M. (eds.) *Furnaces and smelting technology in antiquity*, British Museum occ. paper, **48**, London, 159-64.

Hodson, L. J. and Odell, J. A. (1925) *Ticehurst*, Hall, Haywards Heath.

Holden, E. W. (1970) Militia camps in Sussex, 1793, and the situation of 'Wick' church, *Sussex Archaeol. Collect.*, **108**, 82-5.

Holling, F. W. (1967) Romano-British pit at High Billinghurst, Dunsfold, *Surrey Archaeol. Collect.*, **64**, 164.

Homan, W. M. (1937) Roman bloomery furnaces, *Sussex Notes and Queries*, **6**, 247-8.

Hudson, A. (1986) Napoleonic barracks in Sussex, *Sussex Archaeol. Collect.*, **124**, 267.

Hutchinson, J. N., Poole, C., Lambert, N., and Bromhead, E. N. (1985) Combined archaeological and geotechnical investigations of the Roman fort at Lympne, Kent, *Britannia*, **16**, 209-36.

Hyland, A. (1990) *Equus: the horse in the Roman world*, Batsford, London.

Jacobi, R. M. (1978a) The Mesolithic of Sussex, in Drewett, P. L. (ed.) *Archaeology in Sussex to AD 1500*, C.B.A. Res. Rep., **29**, London, 15-22.

Jennings, S. (1985) *Late Quaternary environmental change at Eastbourne, East Sussex*, unpublished Ph.D. thesis, Polytechnic of North London.

Jones, B. and Mattingly, J. (1990) *An atlas of Roman Britain*, Blackwell, London.

Jones, G. (1980) Badlands bloomery, Ewhurst, *Recologea Papers*, **7.2**, 35-7.

Jones, G. (1985) An Early Bronze Age barrow in Ewhurst parish, *Sussex Archaeol. Collect.*, **118**, 367.

Kaminski, J. (forthcoming) The charcoal, *Archaeol. Journ.*

Kaminski, J. (forthcoming) The Iron Age and Romano-British charcoal from Salisbury Plain.

Kaye-Smith, S. (1953) *The Weald of Sussex and Kent*, Robert Hale, London.

Keef, P. A. M., Wymer, J. J. and Dimbleby, G. W. (1965) A Mesolithic site on Iping Common, Sussex, England, *Proc. Prehist. Soc.*, **31**, 85-92.

Keepax, C. (1975) Scanning electron microscopy of wood replaced by iron corrosion products, *Journ. Archaeol. Science*, **2**, 145-50.

Kelly, D. B. (1961) Cranbrook, *Archaeol. Cant.*, **76**, 197.

Kelly, D. B. (1964) Frittenden, *Archaeol. Cant.*, **83**, 263-4.

Kendal, R. (1993) *A discussion of some of the logistical problems associated with the building of Hadrian's Wall: with particular reference to transport*, unpublished M.A. dissertation, University of Reading.

Kirkaldy, J. F. (1975) William Topley and 'The Geology of the Weald', *Proc. Geol. Assoc.*, **86.4**, 373-88.

Kirkaldy, J. F. and Bull, A. (1940) The geomorphology of the rivers of the southern Weald, *Proc. Geol. Assoc.*, **51**, 115-49.

Lebon, M. C. (1958) Cranbrook, *Archaeol. Cant.*, **72**, xlvii, lx-lxii.

Lebon, M. C. (1959) Cranbrook, *Archaeol. Cant.*, **73**, xlvi-xlvii.

Lebon, M. C. (1961) Cranbrook, *Archaeol. Cant.*, **76**, xlviii-xlix.

Lemmon, C. H. (1952) Fieldwork during the season 1952, *Trans. Battle Dist. Hist. Soc.*, 27-9.

Lemmon, C. H. and Darrell Hill, J. D. (1966) The Romano-British site at Bodiam, *Sussex Archaeol. Collect.*, **104**, 96-102.

Leney, L. and Casteel R. W. (1975) Simplified procedure for examining charcoal specimens for identification, *Journ. Archaeol. Science*, **2**, 153-9.

Levy, J. F. (1969) The condition of 'wood' from archaeological sites, in Brothwell, D. and Higgs, E. (eds.) *Science in archaeology: a survey of progress and research*, Thames and Hudson, London, 188-90.

Locke, M. (1986-7) Working in a Roman kitchen, *Bull. Exper. Firing Group*, **5**, 42-7.

Lower, M. A. (1849a) On the manufacture of iron in Britain by the Romans, *Journ. Brit. Archaeol. Ass.*, **4**, 265-9.

Lower, M. A. (1849b) Iron works in the county of Sussex, *Sussex Archaeol. Collect.*, **2**, 169-220.

Lower, M. A. (1850) Supplementary notices of the iron works in the county of Sussex, *Sussex Archaeol. Collect.*, **3**, 240-8.

Lower, M. A. (1862) Parochial history of Chiddingly, *Sussex Archaeol. Collect.*, **14**, 207-52.

Lower, M. A. (1866) Sussex iron works and iron masters, *Sussex Archaeol. Collect.*, **18**, 10-6.

Lower, M. A. and Chapman, R. (1866) The antiquities preserved in the museum of Lewes Castle, *Sussex Archaeol Collect.*, **18**, 60-73.

Lucas, B. H. (1950) Bynes Farm Romano-British bloomery, *Sussex Notes and Queries*, **13**, 16-9.

Lucey, B. (1978) Twenty centuries at Sedlescombe, London.

Lyne, M. A. B. (1994) *Late Roman handmade wares in south-east Britain*, unpublished Ph.D. thesis, University of Reading.

Mace, J. E. (1905) Biddenden, *Archaeol. Cant.*, **27**, lxx.

MacLeod, D. (1933) Iron slag, *Sussex Notes and Queries*, **4**, 218-9.

Macphail, R. I. (1987) A review of soil science in archaeology in England, in Keeley, H. C. M. (ed.), *Environmental archaeology: a regional review*, **2**, H.B.M.C.E. (occ. paper 1), London, 332-63.

Macphail, R. I., and Scaife, R. G. (1987) The geological and environmental background, in Bird, J. and Bird, D. G. (eds.), *The archaeology in Surrey to 1540*, Alard & Son, Dorking, 31-51.

Margary, I. D. (1930a) A Celtic enclosure in Ashdown Forest, *Sussex Notes & Queries*, **3.3**, 71-2.

Margary, I. D. (1930b) Kings Standing, Ashdown Forest, *Sussex Notes & Queries*, **3.3**, 72-6.

Margary, I. D. (1933) Objects found at the Roman ironworks, Ridge Hill, East Sussex, *Sussex Notes and Queries*, **4**, 177-8.

Margary, I. D. (1946a) Roman roads in west Kent, *Archaeol. Cant.*, **49**, 29-63.

Margary, I. D. (1946b) Roman roads in the Weald, *South East Naturalist*, **51**, 13-5.

Margary, I. D. (1947) Roman communications between Kent and East Sussex ironworks, *Sussex Archaeol. Collect.*, **86**, 22-41.

Margary, I. D. (1953) Recent discoveries by the Ordnance Survey of Roman roads in Sussex, *Sussex Archaeol. Collect.*, **91**, 1-19.

Margary, I. D. (1956) *Roman ways in the Weald*, (3rd ed.) Dent, London.

Margary, I. D. (1965) *Roman ways in the Weald*, Phoenix House, London.

Margary, I. D. (1972) Some memories of Ernest Straker, *Bull. Wealden Iron Res. Group*, **3**, 2-3.

Mather, A.S. (1990) *Global forest resources*, London.

McGinnes, E. A. (1971) Some structural changes involved in the transformation of wood into charcoal, *Wood and Fibre*, **3.2**, 77-83.

McRae, S. G. and Burnham, C. P. (1975) The soils of the Weald, *Proc. Geol. Assoc.*, **86**, 593-610.

McVean, D. N. (1956) Ecology of Alnus glutinosa (L.) Gaertn. VI Post-glacial history, *Journ. Ecol.*, **44**, 331-33.

Meiggs, R. (1982) *Trees and timber in the ancient Mediterranean world*, Clarendon Press, Oxford.

Meiggs, R. (1989) Farm forestry in the ancient Mediterranean, *Social Forestry Network Paper* **8b**, London.

Mellars, P. and Reinhardt, S. C. (1978) Patterns of Mesolithic land-use in southern England: a geological perspective, in Mellars, P. (ed.) *The early Postglacial settlement of Northern Europe: an ecological perspective*, Duckworth, London, 243-94.

Meynell, E. (1945) *Sussex*, Robert Hale Ltd., London.

Mighall, T., Blackford, J. J. and Chambers, F. M. (1990) Bryn y Castell - Late Bronze Age clearances or climatic change?, *Archaeol. Wales*, **30**, 14-16.

Mighall, T. and Chambers, F. (1989) The environmental impact of iron-working at Bryn y Castell hillfort, Merioneth, *Archaeol. Wales*, **29**, 17-21.

Miles, A. (1974) Bloomery slag at Lenham Heath, Kent, *Bull. Wealden Iron Res. Group,* **7**, 8.

Miles, D. (1984) *Archaeology at Barton Court Farm*, C.B.A. Res. Rep., **50**, London.

Millar, M. (1975) Stilicho's Pictish war, *Britannia*, **6**, 141-5.

Milne, G. (1985) *The port of Roman London*, Batsford, London.

Milne, G. (1992) *Timber building techniques in London c900-1400*, London and Middlesex Archaeological Society, London.

Moffat, B. (1984) *An evaluatory study of the methods used in the reconstruction of historical vegetation and land use with reference to part of East Sussex*, unpublished Ph.D. thesis, Polytechnic of North London.

Monckton, A. (1979) A Romano-British site at Lower Runham Farm, Lenham, *Kent Archaeol. Rev.*, **55**, 118-21.

Money, J. H. (1941) An interim report on the excavations at High Rocks, Tunbridge Wells, 1940, *Sussex Archaeol. Collect.*, **82**, 104-9.

Money, J. H. (1960) Excavations at High Rocks, Tunbridge Wells, 1954-56, *Sussex Archaeol. Collect.*, **98**, 212-7.

Money, J. H. (1968) Excavations in the Iron Age hillfort at High Rocks, Tunbridge Wells, 1957-61, *Sussex Archaeol. Collect.*, **106**, 158-205.

Money, J. H. (1971) Medieval iron workings in Minepit Wood, Rotherfield, Sussex, *Med. Archaeol.*, **15**, 86-111.

Money, J. H. (1973) Garden Hill, *Current Archaeol.*, **41**, 181-8.

Money, J. H. (1974) Iron Age and Romano-British iron working site at Minepit Wood, Rotherfield, Sussex, *Bull. Hist. Metall. Group*, **8.1**, 1-20.

Money, J. H. (1977) Garden Hill, Sussex - Interim report, *Britannia*, **8**, 339-51.

Money, J. H. (1978) Aspects of the Iron Age in the Weald, in Drewett, P. L. (ed.) *Archaeology in Sussex to AD 1500*, C.B.A. Res. Rep., **29**, London, 38- 40.

Money, J. H. and Streeten, A. D. F. (1979) Excavation in the Iron Age hillfort and Romano-British ironworking settlement at Garden Hill, Hartfield, East Sussex, *Bull. Wealden Iron Res. Group*, **15**, 16-26.

Moore, J. W. (1974) Hastings town and park: new archaeological finds, *Sussex Archaeol. Collect.*, **112**, 167-72.

Moore, P. D. and Webb, J. A. (1978) An illustrated guide to pollen analysis, Hodder and Stoughton, London.

Moore, P. D., Webb, J. A. and Collinson (1991) An illustrated guide to pollen analysis, London.

Nicholls, H. G. (1860) The ancient iron trade of the Forest of Dean, Gloucestershire, *Archaeol. Journ.*, **17**, 227-39.

Olson, S. D. (1991) Firewood and charcoal in classical Athens, *Hesperia*, **60**, 411-420.

Orme, B. J. (1982) Prehistoric woodlands and woodworking in the Somerset Levels, in McGrail, S. (ed.) *Woodworking techniques before A.D. 1500*, Brit. Archaeol. Rep. (int. ser.) **129**, Oxford, 79-94.

Osborne, P. J. (1974) An insect assemblage of Early Flandrian age from Lea Marston, Warwickshire, and its bearing on the contemporary climate and ecology, *Quat. Research*, **8**, 471-86.

Page, W. (1907) *The Victoria history of the counties of England*, **2**, Archibald Constance & Co, London.

Parrington, M. (1978) *The excavation of an Iron Age settlement, Bronze Age ring ditches and Roman features at Ashville trading estate, Abingdon*, C.B.A. Res. Rep., **28**, London.

Parsons, J. L. (1882) Sussex iron works, *Sussex Archaeol. Collect.*, **32**, 19-32.

Pashin, A. J. and de Zeeuw, C. (1970) *Textbook of wood technology: structure, identification, uses and properties of the commercial woods of the United States and Canada*, **1**, McGraw-Hill, New York.

Peacock, D. P. S. (1973) Forged brick stamps from Pevensey, *Antiq.*, **67**, 138-40.

Pearsall, D. M. (1989) *Palaeoethnobotany: a handbook of procedures*, Academic Press, New York.

Pennington, W. (1969) *The history of British vegetation*, English Universities Press, London.

Penniman, T. K., Allen, L. M. and Wootton, A. (1958) Ancient metallurgical furnaces in Great Britain to the end of the Roman occupation, *Estratto da Sibrium*, **4**, 97-126.

Perlin, J. (1989) *A forest journey: the role of wood in the development of civilisation*, Norton, New York.

Pettitt, J. (1973a) Pushing back the frontier (i), *Bull. Wealden Iron Res. Group*, **5**, 12.

Pettitt, J. (1973b) Pushing back the frontier (ii), *Bull. Wealden Iron Res. Group*, **6**, 3-5.

Pettitt, J. (1977) *Ironworking in Berkshire*, unpublished MS.

Philp, B. J. (1980) Mid-Kent training school: the Romano-British site at Lenham, *Kent Archaeol. Rev.*, **55**, 28-9.

Pile, C. C. R. (1958) Cranbrook, *Archaeol. Cant.*, **72**, xlvii.

Pollard, R. J. (1977) *Cantium*, Unpublished B.A. dissertation, University of Reading.

Pollard, R. J. (1987) Romano-British pottery, in A. Harding and Ostoja-Zagórski (eds.) Excavations at Rocks Wood, Withyham, 1982, *Sussex Archaeol. Collect.*, **125**, 11-32.

Potter, T. W. (1989) The Roman fenland: a review of recent work, in Todd, M. (ed.) *Research on Roman Britain: 1960-89*, Britannia Monograph **11**, Alan Sutton, Gloucester, 175-202.

Rackham, O. (1976) *Trees and woodland in the British landscape*, Dent, London.

Rackham, O. (1980) *Ancient woodland: its history, and uses in England*, Edward Arnold, London.

Rackham, O. (1982) The growing and transport of timber and underwood, in McGrail, S. (ed.) *Woodworking techniques before A.D. 1500*, Brit. Archaeol. Rep. (int. ser.), **129**, Oxford, 199-219.

Rankine, W. F., Rankine, W. M. and Dimbleby, G. W. (1960) Further excavations at a Mesolithic site at Oakhanger, Selbourne Hampshire, *Proc. Prehist. Soc.*, **26**, 246-62.

Rankov, N. B. (1982) Roman Britain in 1981, *Britannia*, **13**, 328-95.

Read, C. H. (1893) Proceedings, *Proc. Soc. Antiq. Lond.*, **14**, 359-61.

Reeves, J. W. (1968) Subdivisions of the Weald Clay in north Sussex, in Surrey and Kent. *Proc. Geol. Assoc.*, **79**, 457-477.

Riden, P. J. (1977) The output of the British iron industry before 1870, *Econ. Hist. Rev*, (2 ser.), **30**, 442-59.

Rock, J. (1879) Ancient cinder-heaps in East Sussex, *Sussex Archaeol. Collect.*, **29**, 168-74.

Roe, D. A. (1968) *A gazetteer of British Lower and Middle Palaeolithic sites*, C.B.A. Res. Rep., **8**, London.

Rudling, D. R. (1982) Rural settlement in Late Iron Age and Romano-British Sussex, in Miles, D. (ed.) *The Romano-British countryside*, Brit. Archaeol. Rep. (Brit. ser.), **103 (ii)**, Oxford, 269-89.

Rudling, D. R. (1986) The excavation of a Roman tilery on Great Cansiron Farm, Hartfield, East Sussex, *Britannia*, **17**, 191-231.

Salter, C. (1984) Metallurgical aspects of ironwork, in Cunliffe, B (ed.) *Danebury: an Iron Age hillfort in Hampshire, 2, The excavations, 1969-1978: the finds*, C.B.A. Res. Rep., **52**, London, 433-7.

Salter, C. and Ehrenreich (1984) Iron Age metallurgy in central southern England, in Cunliffe, B. and Miles, D. (eds.) Aspects of the Iron Age in central southern Britain, Oxford, 146-61.

Salway, P. (1984) *Roman Britain*, Oxford University Press, Oxford.

Salzman, L. F. (1946) A history of the Sussex Archaeological Society, *Sussex Archaeol. Collect.*, **85**, 1-76.

Savery, J. C. (1868) On the ironworks of Sussex, *Journ. Brit. Archaeol. Ass.*, **24**, 335-42.

Scaife, R. G. (1983) *The character and evolution of floodplains with special reference to the Ouse and Cuckmere*, Sussex, unpublished Ph.D. thesis, London School of Economics, University of London.

Scaife, R. G. (1985) Palynological analyses of West Heath Barrows V, VIII, IX, in Drewett, P. L. (ed.) Excavations at West Heath barrows V-IX, West Sussex, *Sussex Archaeol. Collect.*, **123**, 51-9.

Scaife, R. G. (1987) A review of later Quaternary plant microfossil and macrofossil research in southern England; with special reference to environmental archaeological evidence, in Keeley, H. C. M. (ed.), *Environmental archaeology: a regional review*, volume **2**, H.B.M.C.E. occ. paper 1, London, 125-203.

Scaife, R. G. and Burrin, P. J. (1983) Floodplain development and the vegetational history of the Sussex High Weald and some archaeological implications, *Sussex Archaeol. Collect.*, **121**, 1-10.

Scaife, R. G. and Burrin, P. J. (1985) The environmental impact of prehistoric man as recorded in the Upper Cuckmere Valley at Stream Farm, Chiddingly, *Sussex Archaeol. Collect.*, **123**, 27-34.

Schweingruber, F. H. (1978) *Microscopic wood anatomy*, Zurcher AG, Zug.

Schweingruber, F. H. (1990) *Anatomy of European woods: an atlas for the identification of European trees, shrubs and dwarf shrubs*, Paul Haupt, Berne.

Shackley, M. (1981) *Environmental archaeology*, George Allen and Unwin, London.

Sheldon, J. (1978) The environmental background, in Drewett, P. L. (ed.) *Archaeology in Sussex to A.D. 1500*, C.B.A. Res. Rep., **29**, London, 3-7.

Shelley, J. (1973) A memory of Ernest Straker, *Bull. Wealden Iron Res. Group*, **6**, 10-1.

Shennan, S. (1985) *The east Hampshire survey: experiments in the collection and analysis of archaeological survey data*, University of Sheffield, Sheffield.

Sim, D. (1995) *The art of the Blacksmith*, unpublished Ph.D. thesis, University of Reading.

Simmons, I. G., Dimbleby, G. W. and Grigson, C. (1981) The Mesolithic, in Simmons, I. G. (ed.) *The environment of British Prehistory*, Duckworth, London, 82-124.

Sjöström, E. (1981) *Wood chemistry: fundamentals and applications*, Academic Press, New York.

Slater, T. R. (1970) A Romano-British site at Southgate West, Crawley, *Sussex Notes and Queries*, **17.6**, 199-200.

Smith, A. G. (1970) The influence of Mesolithic and Neolithic man on British vegetation: a discussion, in Walker, D. and West, R. E. (eds.) *Studies in the vegetational history of the British Isles*, Cambridge University Press, Cambridge, 81-96.

Smyth, C. and Jennings, S. (1988) Mid- to Late-Holocene forest composition and the effects of clearances on the Combe Haven Valley, *Sussex Archaeol. Collect.*, **126**, 1-20.

Straker, E. (1928) Roman iron works near East Grinstead, *Sussex Archaeol. Collect.*, **69**, 183-5.

Straker, E. (1931) *Wealden Iron*, Bell & Sons Ltd., London.

Straker, E. (1937) An African culture in Sussex, *Sussex Notes and Queries*, **6**, 205-6.

Straker, E. (1939) Lost mills of the Medway, *Sussex County Mag.*, 531.

Straker, E. (1941) The Vachery ironworks, *Surrey Archaeol. Collect.*, **47**, 48-51.

Straker, E. (1942) *Unpublished Mss.* Barbican House Lewes.

Straker, E. and Lucas, B. H. (1938) A Romano-British bloomery in East Sussex, *Sussex Archaeol. Collect.*, **79**, 224-32.

Straker, E. and Mason, R. T. (1939) A Roman bloomery site, *Sussex Notes and Queries*, **7.5**, 153-4.

Sunter, N. (1989) Observation on the reconstruction of the amphitheatre, in Fulford, M.G. *The Silchester amphitheatre excavations of 1978-85*, Brit. Monograph 10, London, 161-76.

Swan, V. G. (1984) *The pottery kilns of Roman Britain*, R.C.H.M.E., **5**, London.

Sweeting, G. S. (1944) Wealden ore and the locating of its industry, *Proc. Geol. Assoc.*, **55**, 1-20.

Tatham, E. H. R. (1890) On the traditional site of a Roman town in the parish of Penhurst, *Sussex Archaeol. Collect.*, **37**, 139-50.

Taylor, M. V. (1948) Roman Britain in 1947, *Journ. Roman Studies*, **38**, 81-104.

Tebbutt, C. F. (1968) A first century corn drying kiln at Uckfield, *Sussex Notes and Queries*, **17.1**, 25-6.

Tebbutt, C. F. (1970) Garden Hill camp, Hartfield, *Sussex Archaeol. Collect.*, **108**, 39-49.

Tebbutt, C. F. (1972) A Roman bloomery at Great Cansiron near Holtye, *Sussex Archaeol. Collect.*, **110**, 110-3.

Tebbutt, C. F. (1973) A Roman site at Howbourne Farm, Hadlow Down, *Sussex Archaeol. Collect.*, **111**, 115.

Tebbutt, C. F. (1974) Kings Standing, Ashdown Forest, *Sussex Archaeol. Collect.*, **112**, 30-3.

Tebbutt, C. F. (1975) The Prehistoric occupation of the Ashdown Forest area of the Weald, *Sussex Archaeol. Collect.*, **112**, 34-43.

Tebbutt, C. F. (1977) Pippingford Cow Park bloomery - preliminary report, *Bull. Wealden Iron Res. Group*, **11**, 4-5.

Tebbutt, C. F. (1979a) The excavation of three bloomery furnaces at Hartfield, Sussex, *Sussex Archaeol. Collect.*, **117**, 47-56.

Tebbutt, C. F. (1979b) Prehistoric finds from Possingworth Park, Framfield, *Sussex Archaeol. Collect.*, **117**, 230-1.

Tebbutt, C. F. (1980) Recent fieldwork: bloomery furnaces at Batsford, *Bull. Wealden Iron Res. Group*, **17**, 16.

Tebbutt, C. F. (1981a) Wealden bloomery iron smelting furnaces, *Sussex Archaeol. Collect.*, **119**, 56-64.

Tebbutt, C. F. (1981b) Ashdown Forest (Millbrook) Saxon bloomery, *Bull. Wealden Iron Res. Group*, **1** (2 ser.), 17-20.

Tebbutt, C. F. and Cleere, H. F. (1973) A Romano-British Bloomery at Pippingford, Hartfield, *Sussex Archaeol. Collect.*, **111**, 27-40.

Tebbutt, M. and Tebbutt, C. F. (1982) Oldlands Roman bloomery, *Bull. Wealden Iron Res. Group*, **4** (2 ser.), 12-5.

Thirgood, J. K. (1981) *Man and the Mediterranean forest: a history of resource depletion*, Academic Press, London.

Thomas, K. D. (1982) Neolithic enclosures and woodland habitats on the South Downs in Sussex, England, in Bell, M. and Limbrey, S. (eds.) *Archaeological aspects of woodland ecology*, Brit. Archaeol. Rep. (int. Ser.), **146**, 147-70.

Thorley, A. (1971) Vegetational history of the Vale of Brooks, *Inst. Brit. Geog. Conf.*, **5**, 47-50.

Thorley, A. (1981) Pollen analytical evidence relating to vegetation of the chalk, *Journ. Biogeog.*, **8**, 93-106.

Tingle, M. (1991) *The Vale of the White Horse survey*, Brit. Archaeol. Rep, (Brit. Ser.) Oxford.

Topley, W. (1875) *The geology of the Weald*, Memoirs of the Geological Survey of the United Kingdom, H.M.S.O., London.

Trueman, A. E. (1971) *Geology and scenery in England and Wales*, Penguin, Harmondsworth.

Turner, D. J. (1980) The North Downs trackway, *Surrey Archaeol. Collect.*, **72**, 1-13.

Turner, E. (1862a) Ashdown Forest, *Sussex Archaeol. Collect.*, **14**, 36-64.

Turner, E. (1862b) Maresfield, *Sussex Archaeol. Collect.*, **14**, 138-70.

Tylecote, R. F. (1975) *Metallurgy in archaeology*, Edward Arnold, London.

Tylecote, R. F. (1986) *The prehistory of metallurgy in the British Isles*, Alard, Dorking.

Tylecote, R. F., Austin, J. N. and Wraith, A. E. (1971) The mechanism of the bloomery process in shaft furnaces, *Journ. Iron steel Inst.*, **209**, 342-63.

Wacher, J. (1989) Cities from the second to fourth centuries, in Todd, M. (ed.) *Research on Roman Britain: 1960-89*, Britannia Monograph **11**, Alan Sutton, Gloucester, 91-114.

Waller, M. P. (1993) Flandrian vegetational history of south-eastern England. Pollen data from Pannel Bridge, East Sussex, *New Phytol.*, **124**, 345-69.

Waller, M. P. (1994) Flandrian vegetational history of south-eastern England. Stratigraphy of the Brede Valley and pollen data from Brede Bridge, *New Phytol.*, **126**, 369-92.

Webster, G. (1975) Small towns without defences, in Rodwell, W. and Rowley, R. T. (eds.) *Small towns of Roman Britain*, Brit. Archaeol. Rep., **15**, Oxford.

Weiner, J. S. (1955) *The Piltdown forgery*, Oxford University Press, London.

Welch, M. G. (1971) Late Romans and Saxons in Sussex, *Britannia*, **2**, 232-7.

Western, A. C. (1969) Wood and charcoal in archaeology, in Brothwell, D. and Higgs, E. (eds.) *Science in archaeology: a survey of progress and research*, Thames and Hudson, London, 178-87.

Wheeler, R. E. M. (1932a) The towns of Roman Kent, Victoria county history of Kent, **3**.

Wheeler, R. E. M. (1932b) *Report on the excavation of the Prehistoric, Roman and Post-Roman site at Lydney Park*, Oxford.

White, J. H. (1968) *The extraction of metals*, Macmillan, London.

Whittow, J. (1992) *Geology and scenery in Britain*, Chapman Hall, London.

Wickenden, N. (1986) Excavation at Chelwood Gate: interim report, *Sussex Archaeol. Soc. News*, **48**, 467.

Wickham, C. (1994) *Land and power: studies in Italian and European social history, 400-1200*, British School at Rome, London.

Williams, J. H. (1971) Roman building materials in south-east England, *Britannia*, **2**, 166-95.

Wilson, D. R. (1971) Roman Britain in 1970: sites explored, *Britannia*, **2**, 242-88.

Wilson, D. R. (1973) Roman Britain in 1972: sites explored, *Britannia*, **4**, 270-323.

Wilson, D. R. (1975) Roman Britain in 1974: sites explored, *Britannia*, **6**, 221-283.

Winbolt, S. E. (1923) Alfoldean Roman station: first report 1922, *Sussex Archaeol. Collect.*, **64**, 81-104.

Winbolt, S. E. (1924) Alfoldean Roman station: second report 1923, *Sussex Archaeol. Collect.*, **65**, 112-157.

Winbolt, S. E. (1932) Excavations at Hascombe Camp, Godalming, June -July, 1931, *Surrey Archaeol. Collect.*, **40**, 78-96.

Winbolt, S. E. (1936) An early Iron Age camp in Piper's Copse, Kirdford, *Sussex Archaeol. Collect.*, **77**, 244-9.

Woodcock, A. (1978) The Palaeolithic in Sussex, in Drewett, P. L. (ed.) *Archaeology in Sussex to AD 1500*, C.B.A. Res. Rep., **29**, London, 8-14.

Woodcock, A. (1981) *The Lower and Middle Palaeolithic periods in Sussex*, Brit. Archaeol. Rep. (Brit. ser.), **94**, Oxford.

Woodcock, A. (1988) Gazetteer of Prehistoric and Roman sites in Romney Marsh and the surrounding area, in Eddison, J. and Green, C. (eds.) *Romney Marsh: evolution, occupation, reclamation*, Oxford University Committee for Archaeology, **24**, Alden, Oxford, 177-85.

Worsfold, B. (1931) Romden Place and its reconstruction, *Archaeol. Cant.*, **93**, 73-84.

Worssam, B. C. (1963) Geology of the county around Maidstone, H.M.S.O., London.

Worssam, B. C. (1964) Iron ore workings in the Weald clay of the western Weald, *Proc. Geol. Assoc.*, **75**, 529-46.

Worssam, B. C. (1972) Iron ore workings near Horsham, Sussex, and the sedimentology of Wealden clay ironstone, *Proc. Geol. Assoc.*, **83**, 37-55.

Worssam, B. C. (1973) Ore for the Wealden iron industry, *Bull. Wealden Iron Res. Group*, **5**, 1-3.

Worssam, B. C. (1985) The geology of Wealden iron, in Cleere, H. F. and Crossley, D. (eds.) *The iron industry of the Weald*, Leicester University Press, Leicester.

Worssam, B. C. (1988) The geology, in Hodgkinson , J. (ed.) Chitcombe Romano-British ironworks, Brede, Sussex, *Bull. Wealden Iron Res. Group*, **8,** (2 ser.), 4-5.

Wright, R. P., Hassel, M. W. C. and Tomlin, R. S. O. (1975) Roman Britain in 1974 II: Inscriptions, *Britannia*, **6**, 284-94.

Wright, T. (1852) The Roman iron district of the Forest of Dean and its neighbourhood, *Gent. Mag.*, (new ser.), **37**, 33-41.

Wright, T. (1854) *Wanderings of an antiquary, chiefly upon the traces of the Romans in Britain*, Nichols and Sons, London.

Wymer, J. J. (1981) The Palaeolithic, in Simmons, I. G. (ed.) *The environment of British Prehistory*, Duckworth, London, 49-81.

Yates, J. (1858) On the mining operations of the Romans in Britain, *Proc. Somerset Archaeol. Nat. Hist. Soc.*, **8.2**, 1-34.

Zell, M. (1994) *Industry in the countryside: Wealden society in the sixteenth century*, Cambridge University Press, Cambridge.