

# 1. The Holocene Vegetation History of the Romney Marsh Region

*Martyn Waller*

*Twenty-eight radiocarbon dated pollen profiles constructed from organic sediments within the depositional complex of Romney Marsh are used to evaluate the Holocene vegetation history of the region. Data obtained from the valleys and edges of the marshland provide information on the former vegetation of adjacent areas of the Weald. Dates derived for the Holocene arrival of *Pinus sylvestris*, *Ulmus*, *Tilia* and *Fraxinus excelsior* from Pannel Bridge are some of the earliest recorded in Britain and unusually *Alnus glutinosa* appears to have been present during the early Holocene. This site also contains evidence for the creation of temporary openings within the woodland canopy during the Mesolithic. The data available for the mid Holocene (c. 7800–4000 cal. yr BP) are particularly extensive and suggest the Wealden woodlands were dominated by *Tilia cordata*. Human impact on the vegetation during the late Holocene appears not to have been uniform. Notably, woodland clearance occurred earlier (c. 4000 cal. yr BP, during the early Bronze Age) in the Brede and Pannel valleys than along the northern edge of the marshland and in the Rother Valley. Clear spatial and temporal trends have been identified in the vegetation of the valleys and marshland during the formation of the "main marsh peat". Fen carr dominated by *Alnus glutinosa* persisted in the valleys for c. 3000 cal. yr maintained by base-rich run-off and rising relative sea level. This community grades into a base-poor variant (with more *Betula* and *Salix*) on the marshland. At sites distant from the upland, acidophilic vegetation developed. Wetter conditions c. 2750 cal. yr BP promoted the establishment of an ombrotrophic bog over parts of Walland Marsh. Sites situated close to and within the shingle complex are dominated by herb taxa with little evidence for the successional development of scrub. The paper concludes by summarising the major outstanding issues.*

## Introduction

Incorporated within the Holocene (post-glacial) sequences of the Romney Marsh depositional complex are organic sediments. Using standard palaeoecological techniques, in particular pollen analysis (see Faegri and Iversen 1989; Moore *et al.* 1991), these sediments can be used to reconstruct vegetation history. Up until the 1980s the organic deposits of the Romney Marsh region were poorly understood and their potential to provide information on past vegetation remained unexploited. This situation has now been transformed. Not only has the nature, extent and age of these deposits been clarified, but 28 radiocarbon-dated pollen profiles have been published (Table 1.1). These contain a wealth of information on the vegetation history of not only the former wetland areas

(the valleys and marshland) but also the adjacent upland/dryland and the shingle beaches (Fig. 1.1).

In the context of south-eastern England, the spatially and temporally extensive organic deposits of the Romney Marsh area, represent an exceptional resource. It is the absence of such deposits that has regularly been cited (e.g. Scaife 1982; 1988) as the explanation for the relative scarcity of pollen-based vegetation reconstructions from this region. Studies of the Romney Marsh deposits are beginning to redress this imbalance and provide answers to a number of key questions. The importance of this region arises from the proximity of the Continent and the juxtaposition of sharply contrasting geologies. Little information has been available on the timing of the arrival of tree taxa during the Holocene. However, the spread of

Table 1.1. Radiocarbon dated pollen diagrams from the Romney Marsh Region.

No.	Site	Date Range (cal. yr BP) or approximate age	Pollen sum	Primary publication
1	Pannel Bridge	11300 – post 2000	TLP- <i>Alnus</i>	Waller 1993
2	Brede Bridge	6800 – 3600	TLP- <i>Alnus</i>	Waller 1994a
3	Old Place 80	6400 – 1700	TLP- <i>Alnus</i>	Waller 1998
4	Rye bypass 11	c. 6300	TLP	Long <i>et al.</i> 1996
5	Tillingham Valley TGC	9700 – 9200	TLP	Waller and Kirby 2002
6	Tillingham Valley TG11	c. 7800	TLP	Waller and Kirby 2002
7	Rye bypass 27	c. 1700	TLP	Long <i>et al.</i> 1996
8	Rye bypass 31	c. 5200	TLP	Long <i>et al.</i> 1996
9	Rye bypass 33	c. 3200	TLP	Long <i>et al.</i> 1996
10	Chapel Bank	6300 – 3600	TLP- <i>Alnus</i>	Long, D. <i>et al.</i> 1998
11	Horsemarsh Sewer	6300 – 3300	TLP	Waller <i>et al.</i> 1999
12	The Dowels	5700 – 2300	TLP	Waller <i>et al.</i> 1999
13	Hope Farm	5100 – 1800	TLP	Waller <i>et al.</i> 1999
14	Brookland	4900 – 1800	TLP	Long and Innes 1995
15	Little Cheyne Court	5000 – 950	TLP	Waller <i>et al.</i> 1999
16	Broomhill A	3800 – 3300	AP+Group	Tooley and Switsur 1988
17	Broomhill I	3700 – 3300	AP+Group	Tooley and Switsur 1988
18	Midley 10B	4050 – 2200	TLP	Long and Innes 1993
19	Midley 2B	c. 2900	TLP	Long and Innes 1993
20	Midley 6B	c. 3200	TLP	Long and Innes 1993
21	Scotney Marsh AY17	c. 3300 – 2350	TLP	Spencer <i>et al.</i> 1998
22	Scotney Marsh AW63	c. 3700 and c. 3100	TLP	Spencer <i>et al.</i> 1998
23	Scotney Marsh AW-AX 67	c. 3900 and 3000 – 2800	TLP	Spencer <i>et al.</i> 1998
24	Scotney Marsh A-B 27	c. 2700	TLP	Spencer <i>et al.</i> 1998
25	Scotney Marsh G60	c. 3300	TLP	Spencer <i>et al.</i> 1998
26	Wickmaryholm Pit	post 1950	TLP	Long and Hughes 1995
27	Romney Marsh 7	4600 – 2300	TLP	Long, A. <i>et al.</i> 1998
28	Romney Marsh 18	3500 – 3000	TLP	Long, A. <i>et al.</i> 1998

a number of taxa, from glacial refugia, is likely to have occurred via the south-east of England. The importance of geology, as an influence on the composition of the woodlands of the region prior to extensive human modification, and to the pattern of this interference, has also been the subject of debate. The Holocene deposits of Romney Marsh about the acidic geologies of the Weald. Traditionally these have been seen as supporting a natural woodland cover dominated by *Quercus* (oak). The sandier lithologies have been regarded as being susceptible to early human interference. In contrast, the heavier more intractable soils (e.g. those developed on the Weald Clay)

are often presumed to have remained well wooded into the historic period. In addition to studies of dryland vegetation history, as a result of their extent, the organic deposits of Romney Marsh also present a significant opportunity to examine spatial and temporal trends in the development of coastal wetland vegetation.

After detailing the organic deposits of the Romney Marsh region and considering the interpretation of the pollen diagrams, this paper reviews the evidence currently available to reconstruct the vegetation of dryland, wetland and shingle areas during the Holocene. The discussion focuses on the issues of wider significance, both in terms

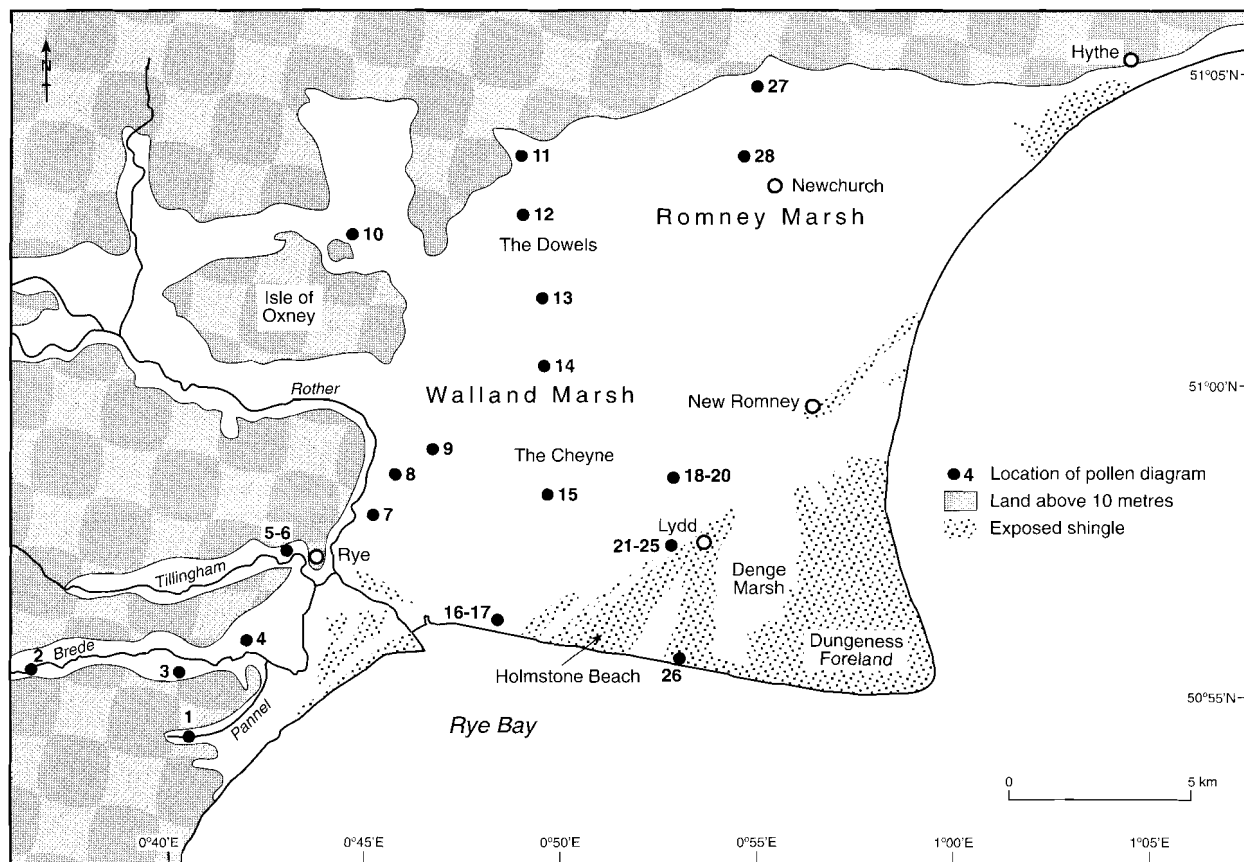


Fig. 1.1. The Romney Marsh region showing the location of the radiocarbon dated pollen diagrams (see Table 1.1 for a key to the numbers).

of the vegetation history of south-eastern England and the development of wetland vegetation in coastal lowland areas.

In spite of being constructed in the relatively recent past, there are a number of inconsistencies between the published pollen diagrams from the Romney Marsh region. Differences in nomenclature have influenced the way in which taxa are referred to on the pollen diagrams. Here the scheme of Bennett (1994) has been followed throughout. There are also important differences in the pollen sums used. In most of the pollen diagrams, pollen taxa are expressed proportionally as a percentage of the pollen and spores counted from a particular sample. The most widely used procedure in recent years has been to express land plants as a percentage of the total land pollen (%TLP) counted (Moore *et al.* 1991). The pollen of aquatics, and pteridophytes spores, are expressed as percentages of a sum in which they are included (%TLP+Aq. and %TLP+Pter. respectively). In many of the sequences from the Romney Marsh area, very high frequencies of *Alnus glutinosa* (alder) are recorded (indicating the local occurrence of fen carr/woodland). As a consequence of pollen counts being expressed in proportions, changes in the other taxa tend to mirror those of *Alnus glutinosa*.

Where wetland vegetation changes have not been the primary focus of the investigation, namely the studies of dryland vegetation history made in the valleys (e.g. Waller 1993; 1994a; 1998; Long, D. *et al.* 1998), the practice has therefore been to exclude *Alnus glutinosa* from the pollen sum (%TLP-*Alnus*). Diagrams from the marshland, where wetland vegetation changes are of principal interest, have generally used a TLP pollen sum. However, Tooley and Switsur (1988) adopted an alternative sum consisting of tree (arboreal) pollen, both to express tree pollen frequencies (%AP) and other groups (%AP+Group).

All the radiocarbon dates mentioned in the text are expressed in calendar years before the present (cal. yr BP) using the mean calibrated age derived from the updated (4.3) version of the program CALIB (Stuiver and Reimer 1993).

### *The Organic Deposits of the Romney Marsh Region*

While thin organic layers occur at depth (Waller 1987; Waller and Kirby 2002), the bulk of the organic sediments of the region are part of a single extensive deposit, the "main marsh peat", found between *c.* -6 m and 4 m

Ordnance Datum (OD). In the upper parts of the valleys, this deposit grades into fluvial clays and silts (Waller *et al.* 1988). It is thickest (c. 6.5 m) in the middle parts of the valleys (e.g. Brede Bridge, Bodiam) where it occurs within 1 m of the present surface. Over most of the lower valley areas and Walland Marsh the “main marsh peat” is more deeply buried, though surface outcrops occur, particularly in the vicinity of The Dowels (Green 1968). While a thin layer extends out from the upland edge towards Newchurch, this deposit is largely absent from Romney Marsh proper (Long, A.J. *et al.* 1998). Organic sediments also occur within the degraded barrier system. At some locations to the north of the gravel outcrop these deposits may represent extensions of the “main marsh peat”. However, organic sediments have also formed in open waterbodies between the shingle ridges (Long and Hughes 1995).

The “main marsh peat” is markedly diachronous (Long, A.J. *et al.* 1998; Waller *et al.* 1999) and in general terms provides palaeoecological information for the mid Holocene in the valleys (e.g. c. 6800–3500 cal. yr BP at Brede Bridge) and the mid/late Holocene (e.g. c. 5000–950 BP at Little Cheyne Court) on Walland Marsh. This layer accumulated rapidly and it has been possible to obtain pollen records with a good temporal resolution (< 150 cal. yr between samples at the sites on Walland Marsh). This is particularly the case for the mid Holocene, when ground water-levels were driven upwards by rising relative sea level (Waller *et al.* 1999), at sites where there is little overburden and hence subsequent compaction. At Pannel Bridge and Brede Bridge interpolation between radiocarbon dates give accumulation rates of 5 to 6 cal. yr cm<sup>-1</sup> during the mid Holocene (Waller 1993; 1994a). Advantage has been taken of these rates at Brede Bridge to obtain high temporal resolution of critical events by sampling contiguous levels (Waller 1994a).

A number of wetland terrestrial vegetation communities are represented within the “main marsh peat”. They can be divided into two basic types: eutrophic (base-rich) and oligotrophic (base-poor). The former included reedswamp, fen (here used to refer to open herb-dominated vegetation) and fen carr/woodland. The latter community was particularly extensive during the formation of this deposit, with *Alnus glutinosa* frequently the dominant species. These communities remain in contact with groundwater and are comparatively well supplied with nutrients. The oligotrophic communities included those that remain in contact with groundwater but receive few nutrients (here termed poor fen), and ‘ombrotrophic’ vegetation (also termed raised bog) where peat has accumulated above the groundwater level. Ombrotrophic communities are dependent upon precipitation and dust for supplies of water and nutrients and are characterised by the presence of Sphagna (bog mosses), Ericaceae (heathers) and/or Cyperaceae (sedges) particularly the genus *Eriophorum* (cotton grasses).

### *The Interpretation of the Romney Marsh Pollen Diagrams*

Pollen diagrams constructed from peats situated in coastal lowland areas such as Romney Marsh pose particular problems of interpretation (Waller 1993; Waller 1998). A key consideration is the source area from which pollen was derived. This will be influenced both by the nature of the *in-situ* peat-forming community and the position of the pollen site within the wetland area. In pollen diagrams constructed from peats much of the pollen (here termed local pollen) is likely to have been derived from the wetland vegetation growing *in-situ* or immediately adjacent to a site. The quantity of pollen produced is much greater in some communities (particularly fen woodland) than others (such as ombrotrophic bog). The proportion derived from distance (here termed extra-local if originating from within a few hundred metres of a site, and regional if originating from greater distances), varies accordingly. Even the structure of the vegetation needs to be considered. Woodland, for example, acts as a filter (Tauber 1965) so that the pollen source area for fen carr/woodland is likely to be considerably smaller than for the open wetland communities.

Position in the wetland area is important as the representation of pollen taxa is strongly influenced by dispersal bias, with wind-pollinated and tall plants likely to be increasingly over-represented in the extra-local and regional components. Studies at Old Place in the Brede Valley (Waller 1998) demonstrate that the representation of dryland taxa varies in relation to distance from the dryland edge. Locations close to this edge have higher proportions of poorly dispersed dryland types such as *Tilia* (lime) and Cereal-type pollen as extra-local pollen is maximised. Pollen sites positioned adjacent to dryland (in the valleys and along the fringes of the marshland) therefore offer the best opportunity of accurately reconstructing the vegetation of upland areas, though it cannot be assumed that the vegetation reconstructed at any one site will be typical for the region (Waller 1998). The pollen record at more distant sites (on Walland and Romney Marshes and adjacent to the gravel outcrop) is likely to be dominated by wetland types. Dryland pollen may derive from a large (though rather uncertain) source area, but will be heavily distorted by dispersal bias.

These factors will influence pollen stratigraphy. Changes in the *in-situ* vegetation (e.g. from fen woodland to fen) and in the distance between a site and a source area affect the pollen deposited at any given site through time (Waller 1994b; 1998). It should be noted that due to rising sea level, expansion in the wetland area is a feature of British coastal lowland areas, including Romney Marsh, during much of the Holocene.

An additional difficulty lies in identifying the community from which certain pollen taxa derive. Taxa originating from ombrotrophic bog and waterbodies are usually distinctive (comprising acidophilous species and

aquatics and marginal aquatics respectively). However, many taxa including *Betula* (birch), Poaceae (grasses), Cyperaceae, *Urtica* (nettles), Apiaceae (carrot family) and Brassicaceae (cabbage family) associated with eutrophic wetland vegetation (e.g. fen carr, fen, reedswamp) also occur in dryland communities. In coastal lowlands this problem is compounded by the proximity of other open habitats including saltmarsh. This brings into question the origin of additional taxa, including a number often regarded as indicators of human activity e.g. Chenopodiaceae (goosefoot family) and *Artemisia*-type (wormwoods).

### Dryland Vegetation History

Deposits of early Holocene age (c. 11,400–7800 cal. yr BP) are scarce in the Romney Marsh region. Only the comparatively shallow and highly localised sequence at Pannel Bridge (Waller 1993) spans this period. Sediments dated to the interval c. 9700–9200 cal. yr BP and to c. 7800 cal. yr BP have additionally been recovered at depth in the Tillingham Valley (Waller and Kirby 2002).

The basal pollen assemblage at Pannel Bridge (PB-1) is largely derived from organic silts and contains a mixture of tree and herb pollen (Fig. 1.2). The former suggest that woodland, with both *Betula* and *Pinus sylvestris* (pine) present, developed rapidly (by c. 11,400 cal. yr BP) in the Pannel Valley in response to climatic warming at the opening of the Holocene. The herb pollen (comprising Cyperaceae and Poaceae) was probably largely derived from plants growing on the wet valley floor. The persistent occurrence of *Alnus glutinosa* pollen (and macrofossils from 1075–1100 cm) suggests this taxon was also present to take advantage of these conditions. However, some caution is required in the interpretation of PB-1 as pre-Quaternary spores are common and this assemblage may contain material reworked from the preceding late-glacial period (including the *Betula* and herb pollen).

Hazel (*Corylus avellana*) was abundant in the early Holocene woodlands of Britain (Godwin 1975) and high *Corylus avellana*-type frequencies are accordingly recorded both at Pannel Bridge (PB-2) and in the Tillingham Valley (TGC) sequence (Waller and Kirby, 2002). Both diagrams also indicate that *Quercus* and *Ulmus* (elm) became established in the Romney Marsh region during this period. For *Corylus avellana*-type frequencies to remain high from 10,200 to 8200 cal. yr BP, suggests hazel was able to out-compete these species from certain habitats. It may have been favoured by the particular climatic conditions (relatively cold winters and cool summers) prevailing in the early Holocene (Huntley 1993). *Quercus* and *Ulmus* are likely to have been confined to the more sandy and acidic areas.

The rapid rise in *Tilia* pollen at Pannel Bridge (the PB-2/3 boundary) marks the establishment of the woodland communities that characterised the dryland of the region

during the mid Holocene (c. 7800–4000 cal. yr BP). With peat formation becoming widespread in the valleys (c. 6800 cal. yr BP) before spreading out across the marshland, the number of sites available to reconstruct vegetation history increases considerably during this period.

The mid Holocene pollen assemblages of the valleys are dominated by tree pollen. *Tilia* frequencies of 5–20% TLP-*Alnus* are recorded at Pannel Bridge, Brede Bridge, Old Place and Chapel Bank. *Tilia* is insect pollinated and flowers in the summer when wind velocities through the canopy are lowest (Huntley and Birks 1983). Frequencies of 5% TLP-*Alnus* are sufficient to infer that lime occurred in some abundance, while higher percentages probably indicate the occurrence of lime-dominated woodland within the pollen source areas. Only a few grains of *Tilia platyphyllos* (large-leaved lime) pollen have been recorded and it is likely that the main species involved was *Tilia cordata* (small-leaved lime). Macrofossils (fruits) recorded at Pannel Bridge, Brede Bridge and Old Place are certainly attributable to the latter taxon. Other major constituents of the mid Holocene woodlands included *Quercus* and *Corylus avellana*. The lower pollen frequencies of the latter species recorded at Pannel Bridge after c. 8200 cal. yr BP suggest hazel became restricted to the under-storey. *Ulmus* (prior to 5800 cal. yr BP) and *Fraxinus excelsior* (ash) (after c. 6700 cal. yr BP) were clearly also present and the latter species is again heavily under-represented in the pollen record (Huntley and Birks 1983). *Betula* pollen is scarce (generally <5% TLP-*Alnus*) at the valley sites, though fruits are consistently recorded leading Waller (1993) to suggest its occurrence as a gap-phase species. Subsequent work on Walland Marsh (Waller *et al.* 1999) indicates the presence here of *Betula* within fen woodland and this now seems a more likely source for these very widely dispersed fruits.

The pre-5800 cal. yr BP (Mesolithic) assemblages from Romney Marsh consistently contain small quantities of herb pollen and fluctuations in the representation of tree taxa, including *Tilia*, are common. Most of the herb taxa can be attributed to either fen, e.g. Cyperaceae, Apiaceae and *Lotus* (birds-foot trefoil), or brackish, e.g. Chenopodiaceae and *Artemisia*-type, environments. However, the irregular presence of, and peaks in, *Plantago lanceolata* (ribwort plantain), *Rumex acetosa/acetosella* (sorrel) and possibly Poaceae pollen, and *Pteridium aquilinum* (bracken) spores at Pannel Bridge (during PB-2b, 3a, 3b and 3c) are suggestive of the creation of temporary openings within the woodland canopy during the Mesolithic (Waller 1993). These may be the product of human activity or natural processes such as senescence, wind-throw or the presence of herbivores (including wild cattle, boar and beaver).

A mid Holocene decline in *Ulmus* pollen is a consistent feature of the Romney Marsh pollen record. It can be distinguished at all the sites which pre-date c. 5800 cal. yr BP (Pannel Bridge, Brede Bridge, Old Place, Chapel Bank and Horsemarsh Sewer). At Pannel Bridge the elm decline

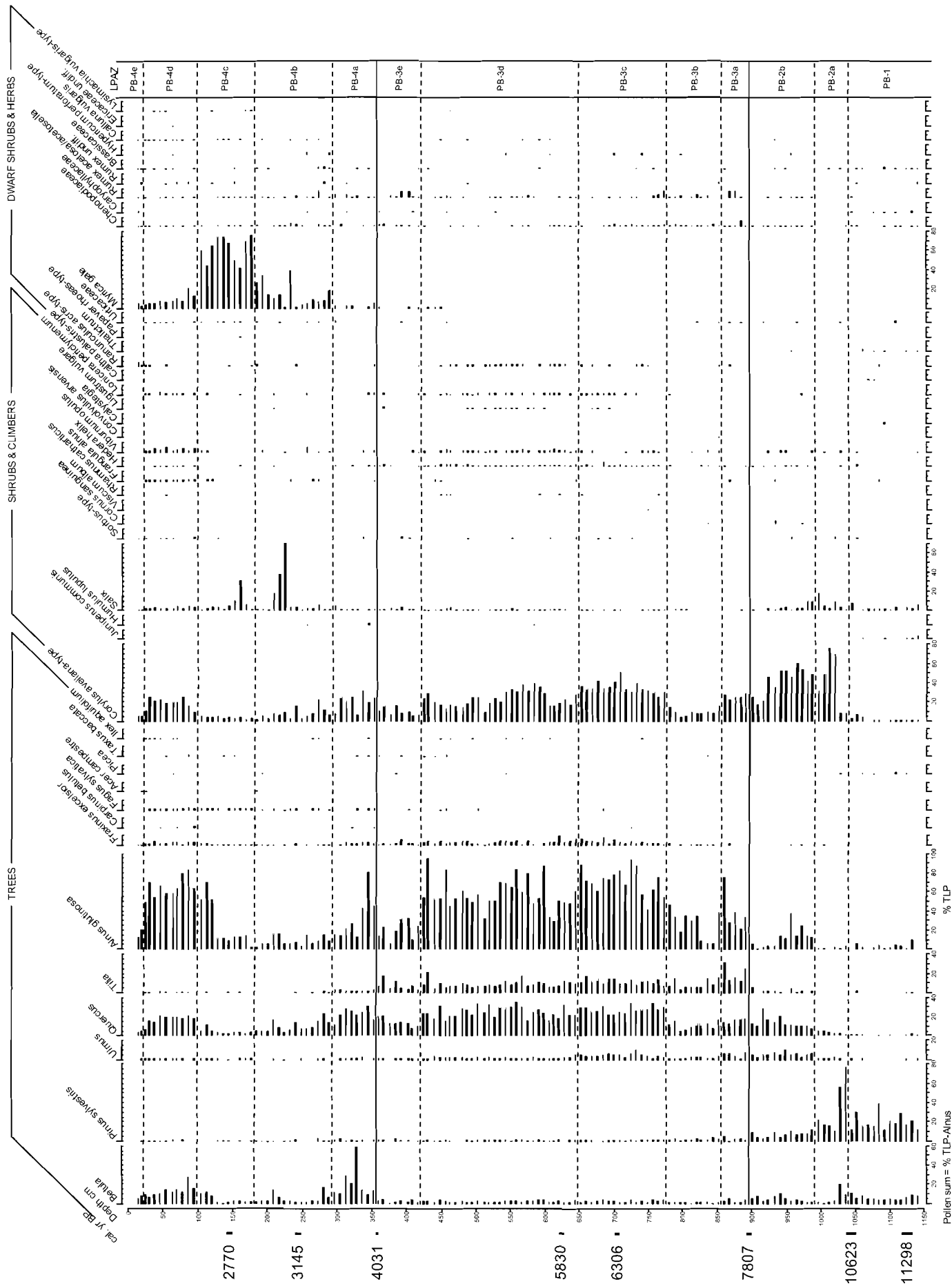
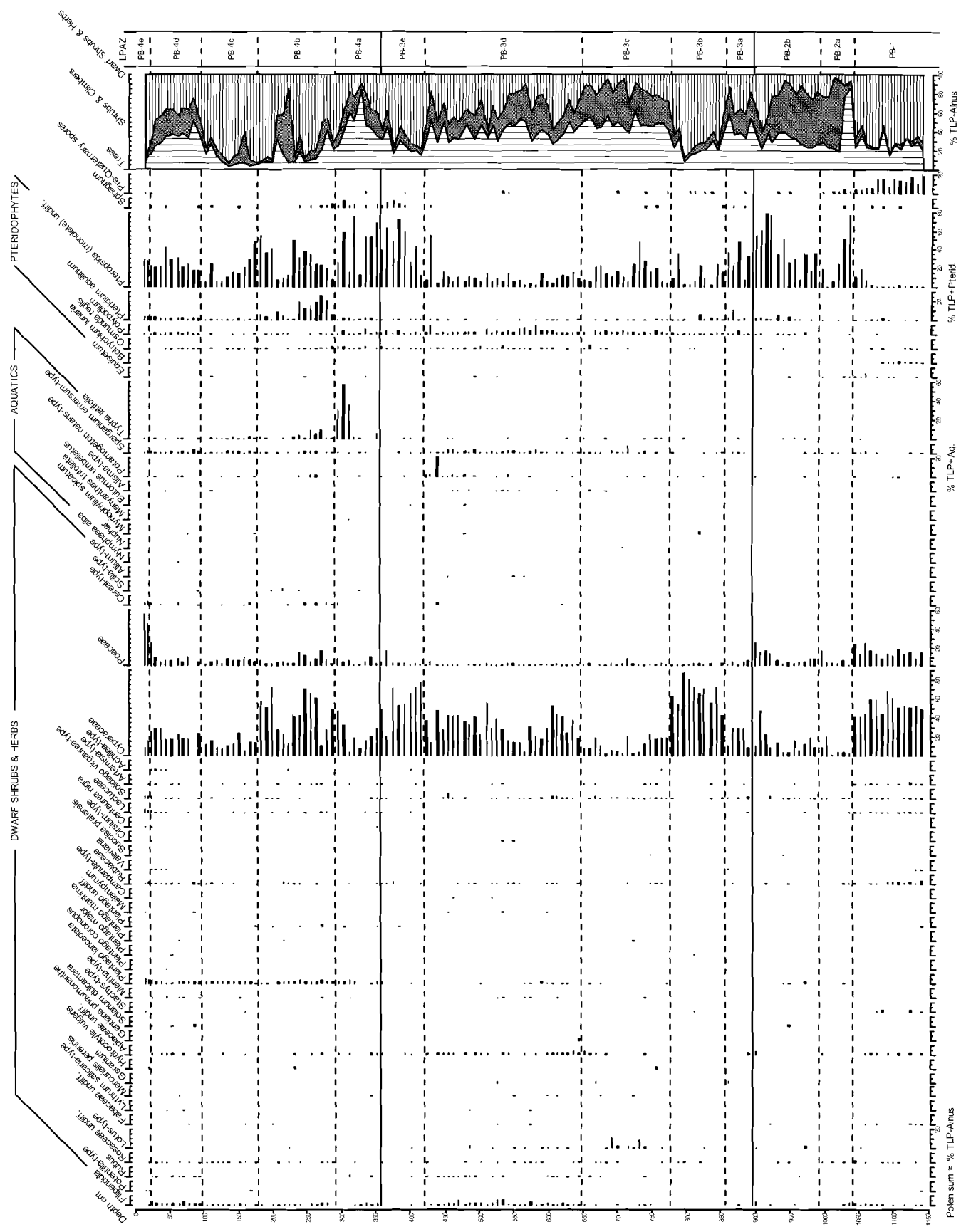


Fig. 1.2. Percentage pollen diagram from Pannel Bridge (after Waller 1993). The radiocarbon dates are expressed as the mean calibrated age.



Analyst: Martyn Walker

Fig. 1.2. continued.

(the PB-3c/3d boundary) has been dated to 5830 cal. yr BP (5040 ± 80 radiocarbon years BP) clearly associating this event with changes seen in pollen diagrams throughout north-west Europe c. 5000 radiocarbon years BP (Godwin 1975). Although only directly dated at one site, the available evidence suggests that the *Ulmus* decline is for all practical purposes a synchronous horizon in the Romney Marsh region and it is probably the only biostratigraphic change which can confidently be used for correlation. *Ulmus* percentages vary considerably between sites prior to the decline (c. 10% to 3% TLP-*Alnus*) and it is most easily distinguished by the very low percentages (always <1% TLP-*Alnus*) which occur immediately afterwards.

The *Ulmus* decline has been the subject of much speculation in recent years with human activity and disease, or a combination of the two, being the most favoured explanations (Birks 1986; Hirons and Edwards 1986; Girling 1988; Peglar 1993). At both Pannel Bridge and Brede Bridge, there is evidence for woodland disturbance accompanying the *Ulmus* decline. Fluctuations occur in the abundance of other tree taxa (most notably temporary declines in *Tilia*), *Plantago lanceolata* occurs consistently and the first Cereal-type pollen grains appear. To examine these changes in more detail a high resolution record of the *Ulmus* decline was obtained at Brede Bridge (Waller 1994a). Contiguous 1 cm samples revealed three stages in the behaviour of *Ulmus*: a stage with consistently high values, a stage where they steadily decline (which lasted c. 60 cal. yr) and finally a stage of fluctuating but generally low values. Signs of human activity (temporary clearances lasting c. 30 to 35 cal. yr) occur during the first two stages, though the lack of conformity between the changes in *Ulmus* values and phases of woodland disturbance suggest an additional selective process was operating upon *Ulmus* (Waller 1994a). Given that the *Ulmus* decline is such a widespread phenomenon it appears most likely that this factor was disease. As has been suggested by other authors, that this event coincides with evidence for human activity is probably a consequence of humans either exploiting the open areas created by the dead elms or facilitating the spread of the pathogen. Subsequently *Ulmus* percentages never regain their pre c. 5800 cal. yr BP values, suggesting that the elm decline marks the first virulent occurrence of a pathogen. Gradual recoveries are punctuated by further sudden declines (one of which occurred c. 4500 cal. yr BP at both Pannel Bridge and Brede Bridge) indicating further outbreaks.

Aside from the scarcity of elm, the post-*Ulmus* decline dryland woodlands of the region appear little changed in the period c. 5800 to 4000 cal. yr BP. However, at both Pannel Bridge and Brede Bridge, a general up-core decline in *Tilia* percentages can be discerned. This phenomenon is likely to be a product of the expansion in wetland area during the mid Holocene resulting in an increase in the distance between sites and dryland source areas and consequently a gradual decline in, poorly dispersed, *Tilia* pollen (Waller 1994b). In addition, at Brede Bridge, two

abrupt falls in *Tilia* values occur after c. 4600 cal. yr BP (Waller 1994a). They are accompanied by changes in the representation of other tree taxa (*Quercus* also declines, while *Corylus avellana*-type, *Fraxinus excelsior* and *Betula* increase) and increases in Poaceae and *Plantago lanceolata*. Human activity is strongly indicated and these events are probably early or distant manifestations of the c. 4000 cal. yr BP decline in *Tilia*.

At Pannel Bridge the sudden drop in *Tilia* values dated to c. 4000 cal. yr BP (the PB-3e/4a boundary) marks the opening of the late Holocene (Waller 1993). Both the abrupt nature and the timing of this decline are paralleled at Brede Bridge, where a high-resolution record has again been obtained (Waller 1994a). Declines in *Tilia* pollen have long been associated with human activity (e.g. Turner 1962), with woodland dominated by *Tilia* likely to have been preferentially destroyed as a result of growing on the soils best suited for cultivation and/or because of the value of the tree, which can be used for leaf fodder, timber or bast fibre (Godwin 1975).

The detailed investigations at Brede Bridge highlight the abruptness of the *Tilia* decline. The major drop in *Tilia* values (from >10% to <1% TLP-*Alnus*) occurs across three contiguous 1 cm samples (Waller 1994a), along with falls in *Quercus* and *Corylus avellana*-type and corresponding increases in herb pollen (notably Poaceae, Cyperaceae and *Plantago lanceolata*). The sudden changes in the representation of taxa with poorly dispersed pollen suggest that woodland on the slopes adjacent to the site was being destroyed. The rise in *Plantago lanceolata* implies the subsequent development of grassland and pastoralism, though cultivation is also indicated by the regular occurrence of Cereal-type pollen. Cultivation was certainly occurring at Old Place (Waller 1998), where, at sites close to the valley side, values for Cereal-type pollen (which is very heavily under-represented) are unusually high (>1% TLP-*Alnus*). At Pannel Bridge, although Poaceae values increase, the major beneficiary of the decline in *Tilia* was *Betula*, suggesting rapid woodland regeneration. The subsequent persistence of *Tilia* at Pannel Bridge (in contrast to the sites in the Brede Valley) may be the result of vegetative regrowth.

In contrast to the Brede and Pannel valleys, *Tilia*-dominated woodlands persisted into the late Holocene in the Rother Valley and along the northern edge of the marshland. Although *Tilia* pollen virtually disappears from Romney Marsh borehole 7 c. 3900 cal. yr BP, other indicators of human activity remain scarce. At sites close to the upland, Chapel Bank (Long, D. *et al.* 1998) and Horsemarsh Sewer (Waller *et al.* 1999), high *Tilia* values (5 to 10% TLP-*Alnus*) are recorded through to the end of peat formation (c. 3600 cal. yr BP and c. 3300 cal. yr BP respectively). Values for Poaceae and *Plantago lanceolata* remain low.

The only site investigated to date, close to the upland where peat formation continued well into the late Holocene, is Pannel Bridge. Here a further phase of woodland



disturbance occurs at the opening of PB-4b. *c.* 3400 cal. yr BP. Again human activity is implicated. *Quercus*, *Betula*, *Corylus avellana*-type values are reduced, *Tilia* virtually disappears, while *Pteridium aquilinum* and *Plantago lanceolata* frequencies increase and Cereal-type grains appear. Unfortunately, from *c.* 3400 cal. yr BP onwards the vegetation history of dryland in the Pannel Valley is obscured by major fluctuations in local taxa, notably Cyperaceae and *Myrica gale* (bog myrtle). In addition, the chronology above 142 cm is insecure with radiocarbon dating prevented by modern rootlet contamination. Although there are indications of limited woodland regeneration towards the end of PB-4b (*c.* 3000 cal. yr BP), the relatively open conditions instigated around Pannel Bridge at the start of PB-4b probably persisted until the beginning of PB-4d. The major increases in *Betula*, *Quercus* and *Corylus avellana*-type at the PB-4c/4d boundary are clear evidence of woodland regeneration. When this occurred is uncertain. The assumption of a constant rate of sedimentation above 142 cm would place this phase as commencing *c.* 2000 cal. yr BP. In apparent contrast support for increased human activity in the region in the period *c.* 2600 to *c.* 950 cal. yr BP is provided by the Little Cheyne Court sequence on Walland Marsh (Waller *et al.* 1999) through higher *Plantago lanceolata* values and the irregular occurrence of Cereal-type pollen (Fig. 1.3).

### Wetland Vegetation History

Although the "main marsh peat" formed diachronously, the pollen diagrams suggest the vegetation changes that accompanied the initial stages of peat development were very similar. Saltmarsh was replaced by a transitional reedswamp community, with the macrofossil remains of *Phragmites* (common reed) particularly abundant at the lithological boundary. Subsequently, emergent aquatic communities/fen, with high frequencies of Poaceae, Cyperaceae and *Sparganium emersum*-type (bur-reed/reedmace) pollen, developed and persisted for several hundred cal. yr. At all sites, except those within or on the edge of the barrier system (Broomhill, Wickmaryholm and Scotney Marsh), tree taxa then invaded, though at this stage important differences emerge between the valley, edge of the marshland and the mid-marshland sites.

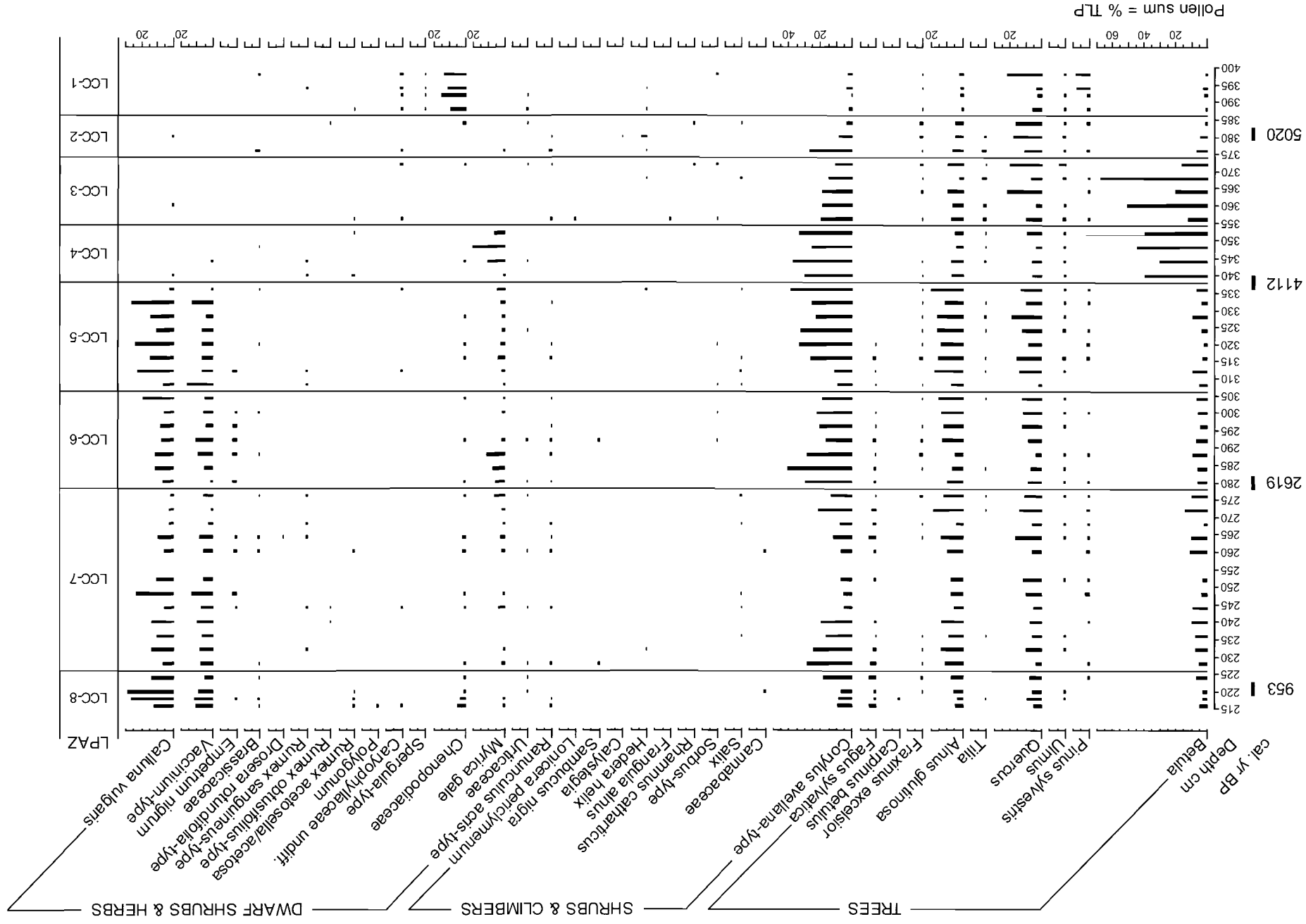
At the valley sites (e.g. Chapel Bank, Brede Bridge, Old Place and Pannel Bridge), peat accumulation largely occurred within fen carr/woodland environments. *Alnus glutinosa*, with pollen percentages exceeding 40% TLP and macrofossil remains abundant, was the dominant taxon from *c.* 6800 to 3900 cal. yr BP. A large number of associated shrub and herb taxa have also been recorded. The shrubs include *Rhamnus catharticus* (buckthorn) *Frangula alnus* (alder buckthorn), *Ligustrum vulgare* (privet), *Viburnum opulus* (guelder rose) and *Salix* (willow) all of which are insect pollinated and therefore

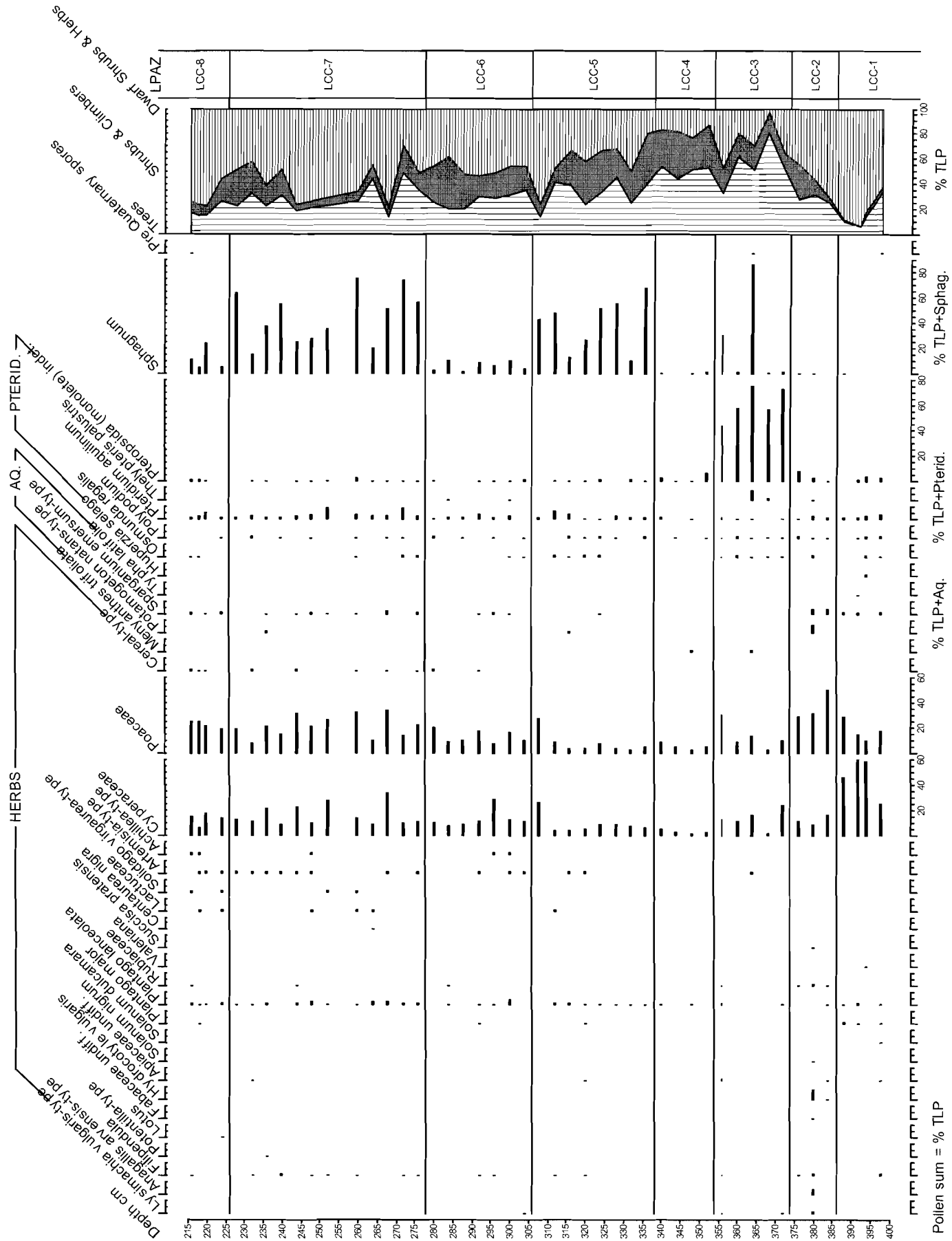
likely to be heavily under-represented in the pollen record, compared with the wind pollinated *Alnus glutinosa*. Herb taxa unambiguously associated with such conditions, or for which macrofossil evidence confirms a local origin, include *Ranunculus acris*-type (buttercups), *Filipendula ulmaria* (meadowsweet) *Lythrum salicaria* (purple loosestrife), Apiaceae undiff., *Lysimachia vulgaris*-type (yellow loosestrife), Rubiaceae (bedstraw family), *Lycopus europaeus* (gipsywort), *Rubus* (bramble), *Valeriana* (valerian), *Solidago virgaurea*-type (members of the daisy family) and Cyperaceae. Several aquatic taxa occur persistently, notably *Alisma*-type (water plantain) and *Sparganium emersum*-type. The spores of *Polypodium* (polypody), an epiphyte on alder, *Osmunda regalis* (royal fern) and other ferns are also abundant at some sites. Such vegetation appears closely analogous to modern fen woodlands, specifically the *Alnus glutinosa*-*Carex paniculata* communities of Rodwell (1991), which are associated with floodplains and are under the influence of eutrophic groundwater.

Spatial and temporal variations are evident within the *Alnus glutinosa*-dominated pollen assemblages of the valleys. The production of multiple profiles from the Brede Valley at Old Place indicates that wetter and more open conditions (and higher Cyperaceae values) prevailed towards the centre of the valley, while drier conditions (fen woodland possibly with *Quercus*) occurred at the valley margins (Waller 1998). Environmental variations may also be reflected in other spatial differences, for example, the unusually high percentages of Apiaceae at Chapel Bank (Long, D. *et al.* 1998) and *Viburnum opulus* at Brede Bridge (Waller 1994). Many of the temporal changes appear short-lived. Fluctuations in *Alnus glutinosa* values (of up to *c.* 20% TLP) frequently occur between adjacent samples. They are attributable to the vagaries of pollen dispersal beneath an alder dominated canopy, with very high *Alnus glutinosa* percentages (over 90% TLP) likely to be the product of the macrofossil deposition of inflorescences (Waller, 1993). With respect to herb and aquatic taxa such variations probably reflect changes in the distribution of wetland plants in relation to the sampled sites, resulting from, for example, temporary openings in the canopy and the migration of water channels. Long-term changes in abundance also occur. For example, pollen values for *Filipendula* consistently increase in the post-*Ulmus* decline assemblages of both the Brede and Pannel valleys, indicating more open conditions (Waller 1998).

*Alnus glutinosa*-dominated vegetation was also widespread on the marshland during the formation of the "main marsh peat". In particular, the early stages of peat growth appear to have favoured establishment, with alder invading from *c.* 5600 cal. yr BP at Horsemarsh Sewer (Waller *et al.* 1999) to *c.* 3500 cal. yr BP at Romney Marsh borehole 18 (Long, A.J. *et al.* 1998). Only at the sites likely to be most distant from the input of base-rich waters (Little Cheyne Court and possibly Midley) was alder apparently absent, being replaced by *Betula* (Waller *et al.* 1999).

Fig. 1.3. Percentage pollen diagram from Little Cheyne Court, Walland Marsh (after Waller et al. 1999). The radiocarbon dates are expressed as the mean calibrated age.





Analyst: Debbie Long

Fig. 1.3. continued.

The *Alnus glutinosa* communities of the marshland appear to represent a base poor facies when compared to the valleys sites, with fewer taxa recorded and notably more *Betula* and *Salix* pollen. Conditions along the northern edge of the marshland (Horsemarsh Sewer and The Dowels) were sufficient to maintain alder throughout the period of peat formation (*c.* 5600 to 2300 cal. yr BP). However, sites further out into the marshland record a shift away from alder.

Oligotrophic conditions prevailed at Little Cheyne Court from *c.* 5000 to *c.* 950 cal. yr BP. The pollen evidence here (Fig. 1.3) is supplemented by plant macrofossil investigations (Waller *et al.* 1999). High values for *Betula*, *Myrica gale*, ferns and *Sphagnum* (during LCC-3/4) indicate the early development of a poor fen environment. This community was replaced by more open oligotrophic vegetation and ultimately ombrotrophic bog. The Ericaceae, both *Calluna vulgaris* (heather) and *Vaccinium*-type (bilberry/cranberry) and *Sphagnum* (including *Sphagnum* section *Cuspidata* indicative of wet conditions) were initially (LCC-5) prominent in the former community. During LCC-6 *Sphagnum* values drop and there are increases in Cyperaceae and Poaceae pollen. The abundance of *Eriophorum* rhizomes and regular occurrence of *Empetrum nigrum* (crowberry) pollen suggest that this assemblage represents a phase of relatively dry conditions. The LCC-6/7 boundary is accompanied by a stratigraphic change to a peat rich in the remains of *Sphagnum imbricatum* spp. *austini*. This taxon is strongly associated with ombrotrophic conditions, and indicates that from *c.* 2600 cal. yr BP onwards (for *c.* 1500 cal. yr) peat growth at Little Cheyne Court occurred independently of the ground water-table. In addition to the high *Sphagnum* values, other indicators of the wet acidic conditions at this time include the only record of *Drosera rotundifolia*-type (sundew) pollen (an insectivorous species) from the Romney Marsh region.

During the late Holocene, oligotrophic communities must have extended over large parts of Walland Marsh. In the west, humified peats from the Rye bypass boreholes (Long *et al.* 1996) contain high *Calluna vulgaris*, *Myrica gale* and *Sphagnum* values which predate *c.* 3150 cal. yr BP (borehole 33) and *c.* 1650 cal. yr BP (borehole 27). At Pannel Bridge, *Myrica gale* (pollen and macrofossils) and Cyperaceae are abundant in the post-3300 cal. yr BP assemblages (Waller 1993). The situation is less clear to the north of Little Cheyne Court where high *Alnus glutinosa* values are replaced by Cyperaceae and *Myrica gale* at Brookland *c.* 3950 cal. yr BP and Cyperaceae, followed by *Salix* then *Myrica gale*, at Hope Farm *c.* 3550 cal. yr BP (Waller *et al.* 1999). Assemblages dominated by Cyperaceae, *Salix* and *Myrica gale* are difficult to characterise in terms of modern communities. In the absence of macrofossil evidence, the Cyperaceae and *Salix* pollen could have been derived from either eutrophic or oligotrophic vegetation. However, the presence of *Myrica gale* confirms a decline in the

groundwater influence since, in modern fen systems, *Myrica gale* occurs on elevated surfaces or where the lateral movement of water is inhibited (Wheeler 1980). In the east at Midley, where peat formation began *c.* 3900 cal. yr BP, it is difficult to separate the local from the regional components of the pollen rain. High *Betula* and Cyperaceae values suggest oligotrophic conditions, though pollen of *Myrica gale* was not separated from *Corylus avellana* (Long and Innes 1993, 1995). There are no unambiguous signs of acidification in the post *Alnus glutinosa* dominated assemblages of Romney Marsh proper, though the eroded upper contact of the peat at Romney Marsh borehole 18 contains some evidence for such a phase (Long, A.J. *et al.* 1998).

The cessation of peat growth and renewed marine inundation appear to have followed complex patterns (Long, A.J. *et al.* 1998; Waller *et al.* 1999). Marine/brackish conditions may have returned to Romney Marsh proper as early as *c.* 3000 cal. yr BP, however, clear indications of rising water-levels (the establishment of emergent aquatic and reedswamp communities) are absent until immediately prior to the inundation of The Dowels and Midley *c.* 2300 cal. yr BP (Long, A.J. *et al.* 1998). Peat formation at Hope Farm, Brookland, Rye bypass borehole 27 and Old Place ceased *c.* 1800–1700 cal. yr BP. However, independent of the ground water-table, the bog vegetation at Little Cheyne Court was able to keep growing and survived for a further *c.* 900 cal. yr after the flooding of these surrounding sites. The extent of this peat island is unknown. In the valleys peat formation only continued into the late Holocene at Pannel Bridge (Waller 1993).

## Shingle Vegetation History

The shingle beaches of Dungeness are today floristically rich and support a variety of habitat types. These range, in what is regarded as being both a spatial (landward) and temporal development, from a pioneering *Rumex-Glaucium* community, through *Arrhenatherum-Silene* grassland, to scrub communities with dwarf *Cytisus scoparius* (broom) and species such as *Sambucus nigra* (elder), *Prunus spinosa* (blackthorn), *Ulex europaeus* (gorse) and *Taxus baccata* (yew) (Scott 1965; Hubbard 1970). In addition, largely confined to Holmstone beach, there are thickets dominated by *Ilex aquifolium* (holly). The status and history of this 'wood' is unclear. Peterken and Hubbard (1972) favour a natural origin before AD 800, though it has only existed with certainty for the last 460 years.

Pollen investigations from sites adjacent to, and within, the gravel complex have the potential to offer a new perspective on the status of these communities. Diagrams have been constructed from two locations on the edge of Broomhill Level (Tooley and Switsur 1988), five sites from the Lydd area (Spencer *et al.* 1998) and, most

importantly, from Wickmaryholm Pit, which is contained within the shingle ridges of Lydd Beach (Long and Hughes 1995). The pollen records probably extend from *c.* 3700 cal. yr BP (at Broomhill) to beyond *c.* 700 cal. yr BP (at Wickmaryholm Pit). Unfortunately, the upper two dates from Wickmaryholm Pit (Fig. 1.4) are inverted indicating the contamination of one or both samples (Long and Hughes 1995).

The pollen assemblages from these sites generally have high values for submerged and floating-leaved aquatic plants, confirming their origin within waterbodies. At Wickmaryholm Pit, both *Myriophyllum alterniflorum* (alternate water-milfoil) and *Potamogeton natans*-type (pondweeds) are continuously recorded. High values for Poaceae and Cyperaceae are also a consistent feature. At Wickmaryholm Pit these taxa form *c.* 25–55% TLP. The open shingle communities of the region clearly therefore have a long and persistent history. Other herb taxa likely to have been derived from such vegetation, recorded in the Wickmaryholm Pit diagram, include the Caryophyllaceae (pink family), Brassicaceae, *Rumex* (dock), Apiaceae and *Campanula*-type (members of the bellflower family) pollen. Elements of both the pioneer and grassland communities appear to be represented, though due to the problems associated with achieving taxonomic precision in pollen identifications, it is not possible to be certain.

Unfortunately many of the characteristic elements of the modern scrub communities of the shingle are likely to be heavily under-represented in the pollen record. This is certainly the case with the Fabaceae (pea family) and makes it difficult to draw inferences from the absence of *Ulex*-type (which includes both *Cytisus scoparius* and *Ulex europaeus*) from the pollen records. However, the general scarcity of shrub pollen from these sequences, particularly from Wickmaryholm Pit (the *Corylus avellana*-type is likely to have been regionally derived), is of note. It suggests scrub is unlikely to have been the dominant vegetation cover on nearby areas of shingle. Some of these sequences are short-lived and probably only coincide with the early stages of shingle vegetation development. However, others persist for over 700 years and thus might be expected to have continued into the scrub stages. Human activity has been recorded on the shingle in the Lydd area back to the Bronze Age (Eddison 2000) and scrub development may have been retarded through heavy grazing and/or the collection of woody material for fuel. *Ilex aquilifolium* has only been recorded, at very low frequency, in one sample (*c.* 3300 cal. yr BP) at Broomhill (Tooley and Switsur 1988). Although general regarded as a sparse pollen producer, *Ilex aquilifolium* pollen is occasionally recorded in some abundance (e.g. Scaife 1982). Therefore, while not conclusive, from the pollen records it seems likely that *Ilex aquilifolium* was not extensively distributed on the shingle in the past and Holmstone 'wood' may not have as long a history as has previously been supposed.

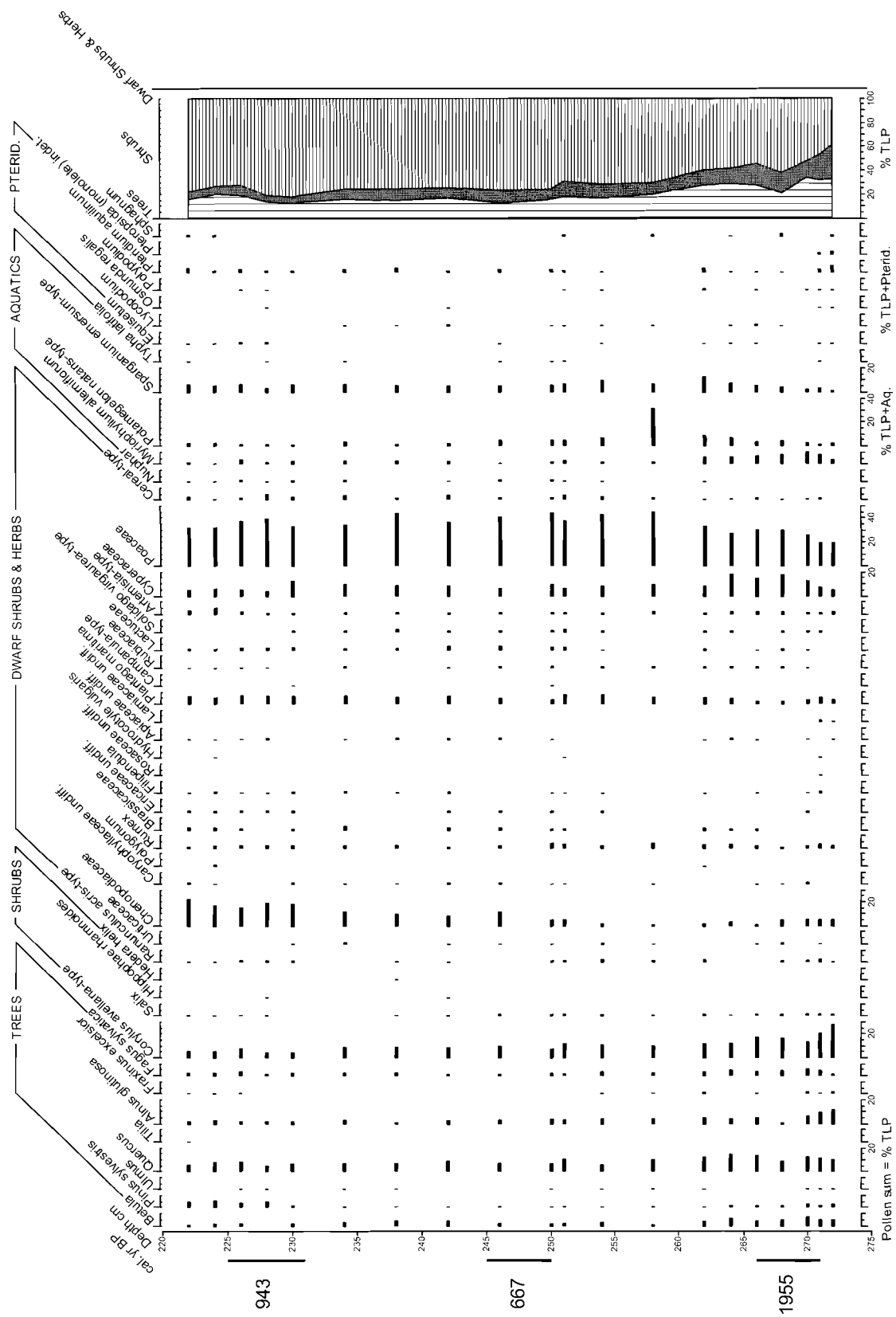
## Discussion

### *The Holocene Arrival of Tree Taxa*

Information contained in the Romney Marsh pollen diagrams as to the first Holocene appearance of tree taxa is significant because of the scarcity of data from south-eastern England and the likelihood that many species including *Pinus sylvestris*, *Ulmus*, *Alnus glutinosa*, *Tilia*, *Fraxinus excelsior* and *Fagus sylvatica* (beech) spread into Britain via this region (Birks 1989; Bennett 1995). Comparable information is only available from the recently published site of Holywell Coombe, Folkestone (Bennett and Preece 1998). Both the timing of their arrival and subsequent expansion is of interest, though in practice these processes are both difficult to detect and distinguish using pollen data (Bennett 1986; Birks 1989). To detect first presence, Birks (1989) advocates the use of the rational-limit (the point at which pollen values begin a sustained rise) for well represented taxa and the empirical-limit (when taxa first become consistently present) for under-represented taxa.

Despite uncertainties over the presence of reworked pollen and the sediment accumulation rate, the Pannel Bridge sequence remains the most useful when considering the post-glacial immigration of tree taxa into the Romney Marsh region. Application of the Birks (1989) criteria suggest *Betula* and *Pinus* were present before *c.* 11,400 cal. yr BP, *Corylus avellana* *c.* 10,500 cal. yr BP, *Quercus* *c.* 10,300 cal. yr BP, *Alnus glutinosa* *c.* 9500 cal. yr BP, *Tilia* *c.* 9300 cal. yr BP, *Fraxinus excelsior* *c.* 7400 cal. yr BP and *Fagus sylvatica* *c.* 4000 cal. yr BP. Values for *Ulmus*, a well represented taxon, rise *c.* 9500 cal. yr BP, though this taxa never attains high frequencies in this region and its earlier appearance is probably indicated by the consistent presence of *Ulmus* pollen from *c.* 10,300 cal. yr BP at Pannel Bridge and *c.* 9700 cal. yr BP in the Tillingham Valley (TGC) sequence (Waller and Kirby 2002). Unfortunately, TGC and the other newly published diagrams from the Tillingham and Brede valleys (Waller and Kirby 2002) add little extra information. *Tilia* is absent and *Alnus glutinosa* scarce in the TGC sequence, though organic sedimentation ceased *c.* 9300 cal. yr BP. The short diagrams from the Tillingham (TG11) and Brede (OP16) valleys serve only to confirm the presence of these taxa about the time they appear to have been rapidly expanding at Pannel Bridge. They do, however, suggest *Fraxinus excelsior* was present from *c.* 7800 cal. yr BP. In addition, the Brede Bridge data (Waller 1994a) indicate *Fagus sylvatica* was present in the region from *c.* 4500 cal. yr BP.

In general terms the data derived from the Romney Marsh region conform to the patterns of tree-spreading proposed by Birks (1989). The presence of *Pinus sylvestris* from *c.* 11,400 cal. yr BP at Pannel Bridge is consistent with the findings of Birks (1989) who indicates the arrival of pine into Britain via the south-east (prior to *c.* 10,700



Analyst: Paul Hughes

Fig. 1.4. Percentage pollen diagram from Wickmaryholm Pit core W20 (after Long and Hughes 1995). The radiocarbon dates are expressed as the mean calibrated age.

cal. yr BP), although it is earlier than the date (c. 11,100 cal. yr BP) Bennett and Preece (1998) derive from Holywell Coombe. The date obtained for *Corylus avellana*-type at Pannel Bridge is, at c. 10,500 cal. yr BP, slightly later than that from Holywell Coombe (c. 10,700 cal. yr BP) though with the rise protracted, the rational-limit of this type is more difficult to define at Pannel Bridge. Both sites are consistent with *Corylus avellana* becoming established first in Britain at sites around the Irish Sea (Birks 1989). The appearances of *Quercus* and *Ulmus* are not well dated at Holywell Coombe though appear compatible with the dates derived from Pannel Bridge (of c. 10,300 cal. yr BP). These data are consistent with the spread of oak from western Britain and an early presence for *Ulmus* in south-eastern England (Birks 1989). Birks (1989) also shows *Tilia* becoming established first in the south-east (prior to 8300 cal. yr BP). The interpolated date derived from Pannel Bridge (c. 9300 cal. yr BP) is much earlier than from Holywell Coombe (8400 cal. yr BP), though *Tilia* pollen has been reported from c. 9000 cal. yr BP in the Thames estuary (Devoy 1980). The presence of *Fraxinus excelsior*, from c. 7800 cal. yr BP, in the Brede and Tillingham valleys, and *Fagus sylvatica*, from c. 4500 cal. yr BP, at Brede Bridge, correspond well with the patterns of spread via south-eastern England derived by Birks (1989) from very restricted datasets.

It is the arrival and expansion of *Alnus glutinosa* that has generated the most debate (e.g. Chambers and Price 1985; Bush and Hall 1987; Bennett and Birks 1990; Tallantire 1992). Geographical trends have proved difficult to establish, leading to the suggestion that alder spread across Britain during the early Holocene before expanding when conditions became locally favourable (Bennett and Birks 1990). Recent work suggests the *Alnus* genus may even have been present during the late-glacial (Wilkinson *et al.* 2000). The occurrence of alder pollen and particularly macrofossils in the early Holocene at Pannel Bridge offers support for these suggestions. One of the aims of the attempt to retrieve deposits of a late-glacial/early Holocene age from Tilling Green (Waller and Kirby 2002) was to provide further information on this matter. Unfortunately the Tilling Green pollen diagram coincides with the lowest *Alnus glutinosa* values at Pannel Bridge. From the data currently available it seems likely that alder was present in the Romney Marsh area at the opening of the Holocene, though suitable areas were initially restricted. Although sea level was rising rapidly, the wetland areas generated would have been quickly submerged. Sites such as Pannel Bridge (where a small wetland area developed at a comparatively high altitude) would have been limited. It was the slowing down in the rate of sea-level rise from c. 7800 cal. yr BP onwards (Waller and Kirby 2002), and the consequent extension of freshwater habitats, that provided the impetus for the major and sustained regional expansion of this taxon.

### Woodland Modification During the Mesolithic

Woodland modification prior to the adoption of agriculture has been the subject of much debate over the last thirty years (e.g. Smith 1970; Smith 1984; Bennett *et al.* 1990; Simmons 1993; 1996). The sand strata of the Weald, as a result of well-drained soils and supposedly relatively open natural vegetation, have long been seen as vulnerable to such interference. The distribution of Mesolithic finds (e.g. Jacobi 1978; Mellars and Reinhardt 1978) and pollen analysis (Dumbleby 1985) has led to the belief that such areas were subject to early clearance leading to the development of heathland. In addition to changes in the structure of the vegetation, such activity may have influenced the representation of tree taxa, with *Alnus glutinosa* possibly benefiting (Bush and Hall 1987; Chambers and Elliott 1989). The Pannel Bridge pollen diagram appears to offer an excellent opportunity to elucidate this matter as not only are the slopes surrounding the site largely developed on the sandy lithologies of the Hasting Beds Group, but a number of Mesolithic flint scatters occur in the Pannel Valley (Holgate and Woodcock 1988). One, situated only c. 70 m north of the Pannel Bridge pollen site, excavated by Holgate and Woodcock (1988; 1989), is thought to represent the remains of short-stay camps visited intermittently during the later Mesolithic.

The Pannel Bridge pollen diagram, in particular the predominance of tree and shrub pollen in PB-2 and PB-3a and the shift to *Tilia* dominated woodland from c. 7800 cal. yr BP, suggests that human activity did not have a major influence on dryland vegetation development during the Mesolithic. The mid Holocene abundance of *Tilia* throughout the region also argues against a widespread and lasting impact. Lime is generally associated with undisturbed woodland. This does not preclude an influence in the immediate vicinity of the archaeological sites and, as already noted, there is good evidence for the woodland of the Pannel Valley not being completely closed-canopy in the period c. 8900 to 7300 cal. yr BP (during PB-2b, 3a and 3b). Temporary openings, which would be consistent with the archaeological evidence, appear to be indicated. However, that human activity was responsible for all, or even most, of the openings is by no means certain. Correlation between the pollen and archaeological records is hampered by the irregular occupation occurring over a long, but imprecisely known, period. The openings could also have been produced by natural processes, from which, in the absence of unambiguous indicators of anthropogenic activity (prior to the adoption of agriculture), human activity cannot be conclusively separated.

Vegetation disturbance would be expected to increase run-off and it is therefore possible that the Mesolithic activity in the Pannel Valley promoted peat formation and the early establishment and expansion (c. 9500 cal. yr BP, the interpolated date for the PB-2a/2b boundary) of *Alnus glutinosa*. Such conditions would, however, have

inevitably developed in response to rising sea level. Although the Pannel Bridge site could not have been directly affected until *c.* 8000 cal. yr BP (see Waller and Kirby 2002), the apparent age discrepancy may be explained by the PB-2a assemblage accumulating over a long period and/or including a break in sedimentation. The landward shifting coastline was certainly responsible for the high Cyperaceae values in PB-3b. These coincide with the maximum inland penetration of marine/brackish conditions (which reached to within *c.* 100 m of the Pannel Bridge site) prior to the development of the "main marsh peat" (Waller 1993).

### *Woodland Composition in the Mid and Late Holocene*

The pollen assemblages from the valleys and edge of the marshland suggest the traditional view, that the Weald was covered by oak woodland prior to extensive human interference, needs to be modified. *Tilia cordata* was clearly prominent, though geology and topography would be expected to produce local variations in woodland composition. Unfortunately it is unrealistic to attempt to assess such variations simply by comparing pollen percentages between sites. In particular, variations in *Tilia* frequencies are as likely to reflect differences in the distance between sites and dryland sources areas, as they are differences in vegetation composition (Waller 1998). The dryland areas adjoining the marshland are geologically complex. The catchments of the rivers draining into the western side of the region are largely developed on the Hastings Beds Group (interbedded clay, siltstone and sandstones), while immediately adjacent to the northern edge of the marshland the Weald Clay outcrops. The data currently available suggest *Tilia* was an important woodland component on the latter as well as the former. *Tilia* frequencies at Horsemarsh Sewer during the mid Holocene are consistently >5% TLP-*Alnus* (note the diagram published in Waller *et al.* 1999 uses a TLP sum). *Tilia* is also consistently recorded, though at comparatively low percentages (maximum >2.5% TLP-*Alnus*) in Romney Marsh borehole 7 through to *c.* 3900 cal. yr BP (Long, A.J. *et al.* 1998, where a TLP sum was used). However, this site is distant from the upland edge and dominated by wetland pollen.

Topographically the region can be divided into slopes and plateaux. It is possible that the *Tilia* dominated woodlands were largely confined to the lower slopes, while *Quercus* preferentially occupied the waterlogged plateau areas. The occurrence of distinct fen edge communities, where *Tilia* was favoured by seepage, has been suggested by a number of authors (Kelly and Osborne 1964; Godwin 1975; Thorley 1981; Brown 1988). The occurrence of very high *Tilia* pollen percentages at sites adjacent to dryland (>30% TLP-*Alnus* at Old Place) and the occurrence of macrofossils strongly support the contention that *Tilia* dominated woodland occupied the lower slopes.

Unfortunately, due to *Tilia* pollen being poorly dispersed, it is difficult to make any assessment of its abundance away from the dryland edge.

Evidence for the importance of *Tilia* in the woodlands of the mid Holocene can be found in pollen diagrams constructed at sites across south-eastern England (Greig 1982; Waller 1994a). Direct comparisons of the pollen percentages between sites is, for the same reasons as noted in the Romney Marsh region, probably unwise. However, even at this scale there is no evidence for lime being confined to particular lithologies. For example, high *Tilia* values have been recorded at a site located at the base of the chalk in the Ouse Valley (Waller and Hamilton 2000). One suggestion is that the pre-clearance soils of south-eastern England displayed a much greater degree of uniformity than today as a result of a blanketing cover of loess (Perrin *et al.* 1974; Burrin 1981; 1988).

*Fagus sylvatica* and *Carpinus betulus* (hornbeam) are common woodland constituents in the region today and it is often assumed that this also reflects the natural vegetation cover. The Holocene history of these taxa in Britain is poorly understood. Both are generally, though not universally, regarded as native to south-eastern England. Godwin (1975) indicated they were present, but scarce, in the mid Holocene, their subsequent expansion being facilitated by woodland disturbance.

The history of *Fagus sylvatica* in the Romney Marsh region appears to follow this pattern. Although present from at least *c.* 4500 cal. yr BP values remain low (<1% TLP-*Alnus*), until the immediate post-*Tilia* decline assemblages at Brede Bridge. *Fagus sylvatica* values also rise after the clearance phase dated to *c.* 3400 cal. yr BP at Pannel Bridge, when an increase in *Fagus sylvatica* in the regional pollen rain is indicated by its persistent occurrence in the Little Cheyne Court diagram (LCC-5 see Fig. 1.3). The highest pollen values recorded (*c.* 3% TLP) are from at latter site after *c.* 2500 cal. yr BP (during LCC-7 and LCC-8). Such increases are consistent with the progressive expansion of beech as secondary woodland developed in the region.

Such woodland would also be expected to support *Carpinus betulus*, a taxon often heavily exploited through woodland management techniques such as coppicing. Grains of *Carpinus betulus* are recorded in the Romney Marsh pollen diagrams from *c.* 6300 cal. yr BP. However, in contrast to *Fagus sylvatica*, values do not rise significantly during the late Holocene. Indeed *Carpinus betulus* has yet to be recorded at values >1% of the pollen sums used. It is difficult to see how this taxon could have occurred in any abundance, in woodlands close to the valleys or marshland, prior to the last 1000 years.

### *Human Activity During the Mid and Late Holocene*

Temporary woodland clearings are indicated during the early Holocene at Pannel Bridge and there is good evidence



for the human exploitation of open areas from the *Ulmus* decline onwards. However, woodland with *Tilia* seems to have remained the principal vegetation cover in the Romney Marsh region into the late Neolithic. The first extensive openings, marked by the declines in *Tilia* pollen at Brede Bridge and Pannel Bridge, occurred *c.* 4000 cal. yr BP. This is consistent with archaeological evidence for the expansion of human activity from the chalkland into the Weald during the late Neolithic/early Bronze Age (Drewett *et al.* 1988). In the Romney Marsh region, the first phase of the construction of the ring ditch at Playden (near Rye) has been dated to *c.* 4000 cal. yr BP (Barker *et al.* 1971). This site has been interpreted in a number of ways with Bradley (1978) suggesting it was used for livestock management. The pollen evidence from the Brede Valley indicates both pastoralism and cereal cultivation were occurring. In the Pannel Valley, the small quantities of later Neolithic/early Bronze Age flint reported by Holgate and Woodcock (1988; 1989) are said to be indicative of transitory activity. This agrees well with the pollen evidence for the rapid regeneration of woodland at Pannel Bridge.

The pollen diagrams from the Rother Valley and the northern edge of the marshland show persistence of *Tilia*-dominated woodland in these areas post *c.* 4000 cal. yr BP. In the lower Rother, the juxtaposition of islands, peninsulas and wetland, appears potentially attractive to human occupation (Long, D. *et al.* 1998). Nevertheless, a concomitant archaeological survey (Gardiner, personal communication) failed to reveal any signs of prehistoric human activity. The delay in human populations penetrating the lower Rother, and particularly the northern edge of the marshland, may be related to the proximity of these areas to the less tractable soils of the Weald Clay. Unfortunately, due to the early cessation of peat growth, the timing of the destruction of the *Tilia*-dominated forests of these areas has yet to be determined.

A second phase of woodland destruction during the middle Bronze Age (*c.* 3400 cal. yr BP) eliminated *Tilia* from the Pannel Valley. The subsequent low tree pollen values indicate the open areas created were maintained into the Iron Age (beyond *c.* 2700 cal. yr BP). However, the high *Pteridium aquilinum* values and the absence of archaeological finds argue against intensive human activity. The subsequent rise in tree pollen values in the Pannel Bridge diagram has not been directly dated, though it seems likely to have occurred as early as 2,000 years ago. It appears therefore contradictory to the expansion of arable farming in the valley, which Holgate and Woodcock (1989) infer from the presence of Roman pottery and traces of medieval ridge and furrow on the upper slopes. However, Poaceae and *Plantago lanceolata* values do not decline and Cereal-type pollen occurs regularly. The development of a vegetation mosaic (areas of woodland, pasture and arable) similar to that characterising the valley today, particularly if the woodland occurred close to Pannel Bridge, is probably indicated.

The increase in human activity from *c.* 2600 cal. yr BP indicated at Little Cheyne Court may relate to the development of the iron industry in the eastern Weald, which was active from the Iron Age onwards (Cleere and Crossley 1995). However, with *Betula* and *Quercus* continuing to be well represented at this site (to *c.* 950 cal. yr BP) and woodland regeneration occurring at Pannel Bridge (*c.* 2000 cal. yr BP), there is no evidence to support the suggestion of Cleere (1976) that the woodlands of the region were devastated to supply fuel for this industry in the Roman period. The latter view does not take into account attempts that may have been made to renew the resource through woodland management techniques such as coppicing and pollarding (Rackham 1980). Unfortunately, the effect such land-use practices have on pollen representation is poorly understood. Clearly a detailed assessment of the impact of the iron industry cannot be made from the evidence currently available.

The pollen data available shows that the post-Neolithic impact of humans on the vegetation of the Romney Marsh region was not uniform. It hints at, though is currently insufficient to fully substantiate, the traditional view of a strong geological control. The information obtained for the late Neolithic/early Bronze Age is extensive and demonstrates land-use strategies varied. Both cultivation and pastoralism were practiced, while elsewhere clearance was followed by regeneration and other areas remained unaffected. Although more limited, the data available for the later periods also suggest a lack of uniformity. This complexity needs to be emphasized as its implications go beyond studies of human and vegetation history. Woodland destruction and subsequent land-use will have had a major influence on the supply of water and sediment to the valleys and marshland (Waller *et al.* 1999). Differential vegetation cover needs therefore to be considered when developing holistic models of the evolution of depositional complex.

### *Spatial and Temporal Trends in the Development of Wetland Vegetation*

Clear spatial trends have been identified in the wetland vegetation of the Romney Marsh depositional complex during the accumulation of the "main marsh peat". Eutrophic, *Alnus glutinosa*-dominated, fen carr communities prevailed in the valleys. Although similar communities initially became established on Walland Marsh these appear to be base-poor variants with frequencies of *Salix* and particularly *Betula* pollen increasing with distance from the upland. This pattern is likely to have become established as a consequence of a decline in the influence base-rich water, draining from the valleys, out across the marshland. The accumulating peat mass itself will subsequently have further inhibited the movement of eutrophic waters across the marshland. This additional isolation probably enabled poor fen communities to progressively develop on Walland Marsh (e.g. first at Little Cheyne Court and subsequently Brookland

and Hope Farm). However, both the maintenance of the *Alnus glutinosa* communities in the valleys and the eventual development of ombrotrophic vegetation at Little Cheyne Court require further explanation.

Alder carr is usually regarded as transitional, both due to the accumulation of organic material resulting in aeration and acidification and the lack of internal regeneration (Walker 1970; Grime *et al.* 1988; Bennett and Birks 1990). The apparent *c.* 3000 year persistence (from *c.* 6800 to 3900 cal. yr BP) of *Alnus glutinosa* dominated pollen assemblages in the Brede and Pannel valleys is therefore noteworthy. It is possible that the over-representation of *Alnus glutinosa* pollen masks local phases of fen carr degeneration and re-establishment. However, it seems more likely that alder carr was sustained in the valleys by a combination of eutrophic run-off from the uplands and rising groundwater levels (Waller *et al.* 1999). Relative sea level rose at a rate of *c.* 2–4 mm yr<sup>-1</sup> over this period (Long and Innes 1993; Long *et al.* 1996). Short-term water-table variations may have been accommodated through changes in the production and decomposition of organic material, though this requires further investigation.

Climate change, a shift towards wetter conditions, at what is traditionally termed the Sub-Boreal/Sub-Atlantic boundary, appears to have been the trigger for the development of ombrotrophic vegetation at Little Cheyne Court. Similar vegetation changes to the shift from *Eriophorum* to *Sphagnum imbricatum* peat at the LCC6/7 boundary have been recorded at sites across north-western Europe (Godwin 1975; Overbeck 1975) and the date obtained at Little Cheyne Court (2619 cal. yr BP) approximates with the timing of this event (2800–2710 cal. yr BP) as recently determined by van Geel *et al.* (1996). However, although also exposed to the wetter conditions, other sites on Walland Marsh failed to develop into ombrotrophic bog at this time. This suggests an additional factor is required to explain the changes seen at Little Cheyne Court. Differences in the antecedent vegetation are likely to be important. The *Eriophorum* community at Little Cheyne Court may have been a necessary precursor, as peat formed by herb vegetation is apparently able to accommodate more vertical movement and consequently the peat surface is less prone to flooding with base-rich water. Giller and Wheeler (1988) suggest it is this mobility that underlies the development of areas of acidic vegetation in the modern fen systems of Broadland.

## Concluding Remarks

Pollen-based reconstructions from the Romney Marsh region began almost 50 years after Sir Harry Godwin initiated such studies in the coastal lowlands of Britain (Godwin *et al.* 1935; Godwin and Clifford 1938; Godwin 1940). One advantage of this late start is that it has been

possible to develop a research strategy informed by recent developments in pollen analytical theory. In addition, the Romney Marsh work has been driven more by specific goals relating to past vegetation, rather than the precepts of sea-level studies or by the chance location of archaeological finds. Consequently not only do we have a comprehensive understanding of the vegetation history of the Romney Marsh region, but the pitfall of attributing vegetation change only to the process under investigation has largely been avoided. The studies undertaken have a wider relevance, in terms of enhancing our knowledge of both Wealden vegetation history and trends in the development of peat-forming communities in coastal lowland areas.

In spite of the progress made over the last two decades, further studies are required to resolve a number of significant issues. These include:

- 1) Studies into the early Holocene vegetation history of the region, to clarify issues such as the presence of *Alnus glutinosa*. Although the Pannel Bridge pollen diagram provides important information, the presence of reworked material and poor temporal resolution impose limitations on additional work at this site. Further high altitude sites may not exist and any that do are likely to suffer from similar problems. The investigations at Tilling Green (Waller and Kirby 2002) demonstrate that early Holocene organic sediments also exist at great depth, though their retrieval is expensive. Engineering works probably offer the best hope of recovering organic sediments of early Holocene age in the future.
- 2) Studies into the late Holocene vegetation history of the Rother Valley and dryland areas adjacent to the northern edge of the marshland. Amongst the many issues to be illuminated are the timing of the destruction of the *Tilia*-dominated woodland and the impact of the iron industry. The major limitation on such studies is the early cessation of peat formation (pre *c.* 3300 cal. yr BP at the sites investigated to date).
- 3) Studies to establish sedimentary and hydrological responses to changes in dryland vegetation cover (particularly woodland clearance). Although often cited as influential, the role played by changes in catchment vegetation, in the evolution of coastal lowland areas such as Romney Marsh, remains poorly understood. Given the evidence for differential land-use, combined investigations into vegetation and sedimentary history need to be undertaken at an appropriate scale (Waller *et al.* 1999).
- 4) Studies into the conditions that promoted and sustained the *Alnus glutinosa* dominated fen carr vegetation in the valleys. The rates of base-level change required need to be quantified.
- 5) Studies to determine the spatial and temporal extent

of the ombrotrophic vegetation recorded at Little Cheyne Court. The role played by this bog in the development of the landscape of Walland Marsh has yet to be fully explored, though it is likely to be significant. For example, Allen (1996) suggests, from the pattern of enclosures, that The Cheyne was a primary (Saxon) land claim that for some time stood clear of any others. This area may have been selected as a result of the bog being comparatively high.

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