Little Oakley

[TM 223 294]

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Highlights

Extremely rare Cromerian deposits, with important molluscan and mammalian faunas, occur here in a channel cut through pre-diversion Thames-Medway gravels. This association is important for the correlation of the Thames terrace sequence with the type Cromerian of Norfolk and the more complete 'Cromerian Complex' succession of The Netherlands.

Introduction

At Little Oakley, in the north-eastern corner of the Tendring Plateau (Figure 5.2), fossiliferous interglacial sediments occupy a large river channel cut through the local Oakley Gravel Formation (this is the oldest Thames-Medway gravel within the Low-level Kesgrave Subgroup, no Thames-Medway equivalent of the older Waldringfield Gravel having yet been identified — see above, Introduction to Part 1). The channel is believed, on the basis of the clast content of its infill, to have been formed by the pre-diversion Thames at a point immediately upstream from its confluence with the Medway (Bridgland *et al.,* 1988, 1990). The palaeontological evidence, which includes rich assemblages of mammals, molluscs and ostracods as well as a detailed pollen record, suggests correlation with an early Middle Pleistocene interglacial, probably within the 'Cromerian Complex' as defined in The Netherlands (Zagwijn *et al.,* 1971) and possibly the Cromerian Stage *sensu* West Runton (Bridgland, 1990b; Bridgland *et al.,* 1990; Gibbard and Peglar, 1990; Lister *et al.,* 1990; Preece, 1990b; Robinson, 1990). This correlation is supported by results of amino acid analyses of shells from this and other sites (Bowen *et al.,* 1989; Bridgland *et al.,* 1990), as well as by palaeomagnetic measurements, which indicate a normal geomagnetic polarity (Bridgland *et al.,* 1988, 1990).

The interglacial deposits at Little Oakley were first discovered in 1939 by Warren (1940; Sutcliffe *et al.,* 1979), who recognized that they were of 'Forest Beds' (Cromerian) age. The site has been frequently cited in subsequent literature as an important Cromerian locality, a considerable rarity outside the type area of north Norfolk (Oakley, 1943; Kerney, 1959a; Turner, 1973; Sutcliffe et al*.,* 1979). However, prior to the recent investigations (Bridgland *et al.,* 1988, 1990), which included re-excavation of the deposits as part of the GCR programme (Bridgland, 1985a), no detailed study of the sediments or *in situ* sampling had been attempted.

Description

Little Oakley lies near the eastern end of a ridge of London Clay, capped with Pleistocene gravels and small remnants of Red Crag, lying between the Stour estuary to the north, Hamford Water to the south and the North Sea to the east. On the only available Geological Survey map (Old Series, Sheet 48), the deposits capping this ridge are classified as 'Glacial Gravel' (Whitaker, 1877). However, gravels of this type throughout Suffolk and Essex have been shown to pre-date the Anglian Stage, during which the principal glacial deposits in this region were laid down, from the fact that their upper layers show evidence of warm-climate soil formation (the Valley Farm Soil) prior to burial by Anglian till. Such gravels are now interpreted as deposits of the pre-diversion Thames and classified as the Kesgrave Sands and Gravels Group (Rose *et al.,* 1976; see above, Introduction to Part 1).

The Kesgrave Sands and Gravels have been progressively subdivided during the past decade (Hey, 1980; Allen, 1983, 1984; Bridgland, 1988a; Whiteman, 1990) and are now considered to represent various formations within High-level and Low-level Kesgrave Subgroups. The gravel in the vicinity of Little Oakley is attributed to the Oakley Formation, which represents the downstream continuation of the Ardleigh Formation ((Figure 5.2); see above, Ardleigh). The Ardleigh and

Oakley Gravels are distinguished on the basis of clast content, the latter deposit containing significantly more material of southern origin (Table 5.2). The change from Ardleigh to Oakley Gravel composition is considered to record the contemporary confluence of the Thames with the Medway (Bridgland, 1988a; (Figure 5.4)C).

The Little Oakley channel deposits were not recognized in the Old Series Geological Survey mapping, although a patch of Red Crag is indicated on the map at their approximate location, suggesting that the fluviatile shelly sand may have been mistaken for part of the Crag. In recent investigations, however, a remnant of Red Crag was encountered between the interglacial channel sediments and the London Clay (Bridgland *et al.,* 1990).

No permanent section has ever existed at Little Oakley, the sediments originally being discovered in spoil from sewer trenches (Warren, 1940). Detailed work at the locality has been carried out in recent years (Bridgland *et al.,* 1988, 1990). Using Warren's notes, the fossiliferous channel was relocated by augering near to the site of the original discovery (borehole LOA, (Figure 5.11); [TM 233 294]). Numerous further auger holes were sunk in the area, enabling the form of the sedimentary body, its internal variability and its relation to the neighbouring sediments to be determined. A strip of undeveloped land, including the site of the original discovery, was selected as a potential GCR site. Temporary exposures were excavated mechanically on this land, allowing the examination of sedimentary characteristics and relations and the bulk sampling of sediments.

Detailed mapping of the interglacial deposits at Little Oakley has demonstrated that they fill a WSW–ENE trending channel between 150 m and 175 m wide (Figure 5.11). The overall geometry and sedimentary fades of these deposits suggest deposition in the channel of a single-thread river flowing under a relatively low-energy regime. They have been given the formal lithostratigraphical name 'Little Oakley Silts and Sands' (Bridgland *et al.,* 1988, 1990). Up to 4 m thick, this member predominantly comprises material in the fine sand, silt and clay grades, with scattered pebbles and occasional thin sand laminae. Mollusca are abundant throughout the deposits (Preece, 1990b; (Figure 5.12), see below), although they are rarer in the upper levels, which are rather poorly bedded and may have suffered some post-depositional decalcification. The dominant species are the gastropods *Valvata naticina* and *Tanousia* cf. *stenostoma* (Nordmann) and the bivalves *Pisidium moitessierianum* Paladilhe and *P. supinum.* The deposits also contain ostracods (Robinson, 1990), pollen (Gibbard and Peglar, 1990) and an important vertebrate assemblage. The vertebrates include two species of early giant deer (*Megaloceros verticornis* Dawkins and *M. dawkinsi* (Newton)), wild boar, horse, spotted hyaena and eight species of small mammal as well as amphibians, reptiles and a large variety of river-dwelling fish (Bridgland *et al.,* 1988; Lister *et al.,* 1990). Particularly significant amongst the fish are records of burbot (*Lota lota*) and carp (*Cyprinus carpio*), the latter being the first recorded from the British Pleistocene. In the area of Newhouse Farm (Figure 5.11) the channel sediments include a thin bed of coarse, shelly red-orange sand containing abundant reworked Red Crag Mollusca as well as indigenous species. The sand itself resembles the Red Crag, which, since it underlies parts of the channel, is probably its direct source. Sandy and pebbly horizons within the silts indicate occasional higher energy flood events. These were found particularly beneath the eastern end of the village, including the area of the GCR site (Bridgland *et al.,* 1990).

The fluviatile Oakley Gravel and Little Oakley Silts and Sands are capped by a complex, poorly bedded unit of variable thickness. This unit, which predominantly comprises silty or clayey sand with pebbles and calcareous nodules, thickening downslope, has been attributed to solifluction (Bridgland *et al.,* 1990). The sequence at Little Oakley can thus be summarized as follows (for thicknesses, see (Figure 5.11)):

3. Colluvium

2. Little Oakley Silts and Sands

1. Oakley Gravel

Pre-Pleistocene strata: London Clay and Waltonian Red Crag

Interpretation

The Little Oakley site, after several decades of neglect, has benefited recently from a multidisciplinary appraisal using modern techniques. The sedimentological interpretation has been restricted, however, by the lack of exposure; the reconstruction of the three-dimensional form of the sediment body has relied primarily on augering and occasional temporary excavations. The best evidence for palaeoenvironmental conditions has therefore come from studies of the palaeontology.

The Little Oakley Silts and Sands contain rich assemblages of freshwater molluscs and ostracods, comprising taxa indicative of deposition in the lower reaches of a large, well-oxygenated, calcareous river, upstream from any tidal influence (Preece, 1990b; Robinson, 1990). Terrestrial mollusca are also present, which testifies that the river had wide, open floodplains with fringing marsh habitats (indicated, for example, by *Vertigo antivertigo* (Draparnaud) and *Zonitoides nitidus* (Müller)) and extensive areas of dry, calcareous grassland (indicated by *Trochoidea geyeri* (Soos) and *Truncatellina cylindrica* (Férussac)) (Preece, 1990b). Pollen analyses have confirmed the presence of grassland, but have suggested that woodland also existed in the catchment during most of the time represented (Gibbard and Peglar, 1990). The vertebrate assemblage includes species typical of fluviatile, marsh, grassland and woodland environments (Lister *et al.,* 1990), supporting the evidence from the pollen and molluscs.

A more detailed assessment of the palynology (Gibbard and Peglar, 1990) reveals that early herb-dominated vegetation gave way to boreal forest, with birch and pine dominant, and then to deciduous forest in which oak and particularly elm were major constituents. This vegetational history was reconstructed from the palynological records of several separate boreholes, since deposits in different parts of the channel were found to represent different time periods (Gibbard and Peglar, 1990). The earliest fossiliferous sediments, shown by pollen analyses to date from the transition from cold conditions at the beginning of an interglacial, have been found only on the southern margin of the channel; the basal channel sediments become progressively younger northwards (Gibbard and Peglar, 1990). The Mollusca from borehole LOO, near the southern edge of the channel, record a progressive replacement of aquatic taxa by marsh snails (as above), thus indicating a shallowing sequence (Preece, 1990b). This suggests that this part of the feature was filled as the active channel shifted northwards. The precise width of the active channel must therefore have been somewhat less than the maximum width of the Little Oakley Silts and Sands sediment body.

The vertebrate assemblages from the channel deposits are fully temperate in character. Knowledge of the modern breeding requirements of certain fish species (Cyprinidae and Percidae) recovered from Little Oakley suggests that during the summer months (May–August) water temperatures must have reached a minimum of 15°C and a maximum of 22°C, whereas in winter (December–March) they must have fallen no lower than 0.6°C. Moreover, the occurrence of the pond tortoise (*Emys orbicularis*) implies mean July temperatures well in excess of 18°C if, as seems likely, this represents a breeding population (Lister *et al.,* 1990).

Palaeogeography

Little Oakley lies in an area that is highly important for the study of Pleistocene geology, since it is one in which the Thames and East Anglian stratigraphies can be compared. The results of clast-lithological analysis indicate that the Oakley Gravel, the terrace formation into which the Little Oakley Silts and Sands are channelled, is part of the pre-diversion Thames drainage system (Bridgland, 1988a; see above). Detailed clast compositional data from the Tendring Plateau (Table 5.2) indicates that the early Thames was joined, as it flowed northeastwards, by an important tributary draining northwards from the Weald, the direct ancestor of the modern River Medway (Bridgland, 1980, 1983a, 1988a; (Figure 5.4)). This ancient fluvial confluence is recognized in the gravels of the area by an increase in southern material, predominantly Lower Greensand chert, an important component of Medway gravels. Thus Thames gravels of Kesgrave Group type change downstream into Thames-Medway deposits (Bridgland, 1988a; (Figure 5.2) and (Figure 5.4)).

The ratio of southern material to quartz and quartzites has been employed to demonstrate the change in clast composition resulting from the confluence between the Kesgrave Thames and the Medway (Bridgland, 1988a; Bridgland *et al.,* 1990). In the gravels upstream from the confluence, this ratio is relatively low, ranging from 0.02 to 0.10. A ratio of approximately 0.10 is considered to represent the upstream limit of Medway influence, this being the highest ratio encountered in Kesgrave Group gravels further upstream. Ratios generally increase downstream from this westward limit to 0.50 and above (Bridgland, 1988a; Bridgland *et al.,* 1990; (Table 5.2)). A gradual compositional change is observed, a phenomenon for which several causes can be envisaged. Firstly, full mixing of the gravel loads of the two rivers may not have occurred for a considerable distance downstream from the confluence. Secondly, the general distribution of gravel deposits in Essex indicates a progressive southward migration of the Thames and an eastward migration of the Medway. This means that the Thames, on its southern flank, would have been reworking west-bank terrace deposits of the Medway, causing an increase in southern material in its bedload gravel several kilometres above the actual confluence.

The composition of the Oakley Gravel in the vicinity of Little Oakley shows it to fall within the Thames-Medway category; in particular, southern to quartz and quartzite ratios in excess of 0.10 were revealed (Table 5.2). However, the analysis of scattered gravel-sized clasts in the Little Oakley Silts and Sands has revealed equivalent ratios close to, but generally below 0.10 (Bridgland *et al.,* 1988, 1990; (Table 5.2)). There are two possible interpretations of this data. Firstly, the Little Oakley channel deposits may be the product of a tributary river that has reworked the Kesgrave gravels over a wide area, mixing material derived from further upstream, remote from the Medway confluence area, with that from the local Oaldey Gravel. Alternatively, the Little Oakley Silts and Sands may have accumulated in the channel of the Thames, immediately upstream from its confluence with the contemporary Medway channel. Therefore the Little Oakley sediments, although attributed to the Thames, might be expected to show some Medway influence, because of reworking either from older Medway terraces (as described above) or from the underlying Oakley Gravel, which represents a wider gravel-covered Thames floodplain that had already coalesced with that of the Medway (Figure 5.4). The palaeontological and sedimentological evidence for the presence of a large river at Little Oaldey, combined with regional stratigraphical evidence indicating that the Thames occupied the area of the Tendring Plateau until the Anglian Stage, provides support for a Thames origin for the Little Oakley Silts and Sands (Bridgland *et al.,* 1988, 1990).

Biostratigraphy and correlation

The palaeontological evidence from the Little Oakley Silts and Sands not only enables detailed palaeoecological reconstructions, but also provides evidence for the relative age of the deposits. The pollen assemblages, from various profiles through the deposits, together represent the early part (biozones I and II) of an early Middle Pleistocene interglacial (Bridgland, 1990b; Gibbard and Peglar, 1990). Hornbeam (*Carpinus*) and 'Tertiary relics' (such as *Tsuga, Carya* or *Eucommia*) are absent, suggesting that the deposits are unlikely to be of pre-Cromerian age. A number of features of the pollen record are suggestive of a Cromerian (*sensu* West Runton) age: *Ulmus* (elm) expands early and becomes dominant, *Picea* (spruce) is present throughout, whereas *Quercus* (oak) expands late and is followed by *Corylus* (hazel). The similarity between this sequence of woodland development and that of the Cromerian stratotype at West Runton, Norfolk, has led to suggestions that the two sites may be correlatives (Bridgland *et al.,* 1988, 1990).

The vertebrate fauna is also suggestive of a broadly Cromerian age for the Little Oakley Silts and Sands (Lister *et al.,* 1990). The presence of the giant deer *Megaloceros verticornis* and *M. dawkinsi,* together with the vole *Mimomys savini,* strongly indicate deposition during the early Middle Pleistocene. In western Europe these two deer species are restricted to deposits of Cromerian and early Elsterian (Anglian) ages, whereas *M savini* extends from the late Early Pleistocene to the type Cromerian, but is replaced in some late pre-Anglian ('late Cromerian') assemblages by its evolutionary descendant, *Arvicola cantiana* (see Chapter 1). The Little Oakley vertebrate fauna is fully temperate in character; it clearly represents an interglacial later than the Pastonian Stage but earlier than those 'late Cromerian' sites with A. *cantiana,* such as Westbury-sub-Mendip (Bishop, 1982).

The rich vertebrate fauna from the West Runton Freshwater Bed (biozones CrIb–IIb) shares with Little Oakley such characteristic extinct taxa as the water vole *Mimomys savini,* the pine vole *Pitymys gregaloides* (Hinton), the Etruscan rhinoceros *Dicerorhinus etruscus* and the giant deer *Megaloceros verticornis* (Stuart, 1975, 1981, 1982a). The much more limited fauna from Little Oakley compares closely with that of West Runton, although pond tortoise (*Emys orbicularis*) has not yet been recorded from the latter. Shrew remains from Little Oakley represent a potentially valuable means of comparison with the fauna from West Runton, in which *Sorex* species of three different sizes occur. There are indications from the collections accumulated to date from Little Oakley that a similar assemblage of shrews occurs, but further sampling is required in order to obtain crucial mandibular remains (Lister *et al,* 1990).

The molluscan assemblage from Little Oakley includes *Tanousia,* a genus known only from the Cromerian in Britain. *Valvata naticina, Bithynia troscheli* and *Unio crassus* are unknown in Britain before this stage. The presence of *B. troscheli* to *the* exclusion of *Bithynia tentaculata* is a feature that characterizes most British Cromerian sites. These features of the assemblage are consistent with a broadly Cromerian age, although the same taxa are found in 'earlier sediments in The Netherlands and elsewhere (Preece, 1990b). Recent consideration of the molluscan assemblages from Cromerian (*sensu lato*) sites in Britain and north-west Europe (Meijer and Preece, in press) suggests that the Little Oakley fauna is peculiar, thus far, to this one locality. Meijer and Preece point to significant differences between molluscan faunas that can be regarded as 'early' and others that can be regarded as 'late' within the 'Cromerian Complex'. Significant taxa amongst the 'early' assemblages are *Valvata goldfussiana* and *Tanousia runtoniana,* extinct species that do not seem to survive into the 'late' faunas. The 'late' assemblages have *V. naticina, Belgrandia marginata* and *Bithynia tentaculata,* which have yet to be found in the 'early' faunas, and are indistinguishable, malacologically, from Hoxnian (Holsteinian) assemblages. The British sites at West Runton and Sugworth both have molluscan faunas that can be classified, according to these criteria, as 'early'. Other British Cromerian (*sensu lato*) sites such as Sidestrand and Trimmingham have yielded the 'late' type of molluscan assemblage. Little Oakley, uniquely, has a fauna that seems intermediate between these two categories. *Valvata goldfussiana,* an element of the 'early' fauna, is absent, whereas *Bithynia tentaculata* is present. The *Tanousia* from Little Oakley is a different species from that found at West Runton and is close to, but smaller than, *T. stenostoma* a species recognized in Denmark (Preece, 1990b). Meijer and Preece (in press) have suggested that the Little Oakley site represents a later temperate episode within the 'Cromerian Complex' than either West Runton or Sugworth.

Significant amongst the ostracod fauna from Little Oakley *are Candona tricicatricosa* (Diebel and Pietrzeniuk), *Ilyocypris quinculminata* (Sylvester and Bradley), *Sclerocypris clavata prisca* (Diebel and Pietrzeniuk) and *Scottia browniana.* None of these is restricted to the Cromerian, but they are unknown together in Britain after the Hoxnian, thus supporting a broadly Middle Pleistocene age (Robinson, 1990).

Bridgland *et al.* (1990) have cited amino acid ratios from shells from Little Oakley, analysed by two different laboratories. Specimens of both *Valvata piscinalis* and V. *naticina* were analysed in London (London Quaternary Centre; laboratory now relocated to the Institute of Earth Sciences, the University College of Wales, Aberystwyth), and ratios from *V. naticina* were also obtained in Colorado (INSTAAR Laboratory). The D : L ratios from V. *piscinalis* are somewhat higher than those from V. *naticina,* which may indicate that epimerization is faster in the former species. Comparison with V. *piscinalis* ratios from other Middle Pleistocene sites is informative, the following being listed by Bridgland *et al.* (1990) and/or Bowen *et al.* (1989):

Site	**Mean D : L ratios**	**Laboratory**
Hoxne	0.243 ± 0.023 (n=3)	INSTAAR
Hoxne	0.261 ± 0.01 (n=4)	London
Swanscombe	0.30 ± 0.016 (n=10)	London
Swanscombe	0.297 ± 0.009 (n=5)	INSTAAR
Clacton	0.299 ± 0.002 (n=3)	London
Little Oakley	0.324 ± 0.004 (n=2)	London
Little Oakley	0.336 ± 0.027 (n=4)	London
West Runton	0.348 ± 0.011 (n=5)	London

These ratios are consistent with a broad correlation between Little Oakley and West Runton and confirm that these sites are older than those at Hoxne, Swanscombe and Clacton, all attributed to the Hoxnian Stage (*sensu lato*)*.* However, ratios from V. *goldfussiana* shells from Sugworth compare closely with those quoted above from Swanscombe and Clacton, despite the convincing biostratigraphical indications that this site is a broad correlative of Little Oakley and West Runton (see Chapter 2, Sugworth).

The stratigraphical record of the lower Middle Pleistocene in Britain, best represented on the Norfolk coast, is now known to be far from complete (Zalasiewicz and Gibbard, 1988). Comparison with the sequence in The Netherlands, in particular, shows that repeated climatic fluctuations occurred in the period following the Matuyama–Brunhes palaeomagnetic reversal and prior to the Elsterian (= Anglian) Stage; four warm/cold climatic cycles are recognized below Elsterian tills in The Netherlands and are collectively termed the 'Cromerian Complex', the magnetic reversal occurring between the peak of the earliest of the four temperate episodes and the trough of the succeeding glacial (Zagwijn *et al.,* 1971; de Jong, 1988; Chapter 1).

Exactly how the Little Oakley interglacial relates to the 'Cromerian Complex' of The Netherlands is difficult to determine, as the four interglacials comprising this complex were distinguished using palynology alone. Correlation with 'Cromerian Complex Interglacial I' (or earlier temperate intervals) is precluded by the absence of Tertiary relics such as *Eucommia* and *Tsuga* (Gibbard and Peglar, 1990). Similarly, the absence of *Taxus* and/or *Carpinus* in the early temperate substage (biozone II) differentiates the sequence in the Little Oakley Silts and Sands from 'Cromerian Complex Intergjacials II and III'. There are similarities, however, between the palynology of little Oakley and Noordbergum, a site in The Netherlands that has been assigned to 'Interglacial IV' (de Jong, 1988). Noordbergum has also been tentatively correlated with the Cromerian stratotype at West Runton (Zagwijn, 1985), a suggestion supported by amino acid ratios from Noordbergum (Miller and Mangerud, 1985). However, the recent recognition of *Arvicola cantiana* amongst collections from Noordbergum (von Kolfschoten, 1988) argues against these correlations, since the earlier vole *Mimomys savini* occurs at both West Runton and Little Oakley, rather than *A. cantiana* (Stuart, 1975, 1981, 1982a; Bridgland *et al.,* 1988). This has led to the suggestion that the Dutch sequence is itself incomplete, that the British Cromerian (*sensu stricto*) is missing in The Netherlands and that Little Oakley and West Runton are broadly of 'late Cromerian Complex' age (Bridgland *et al.,* 1990).

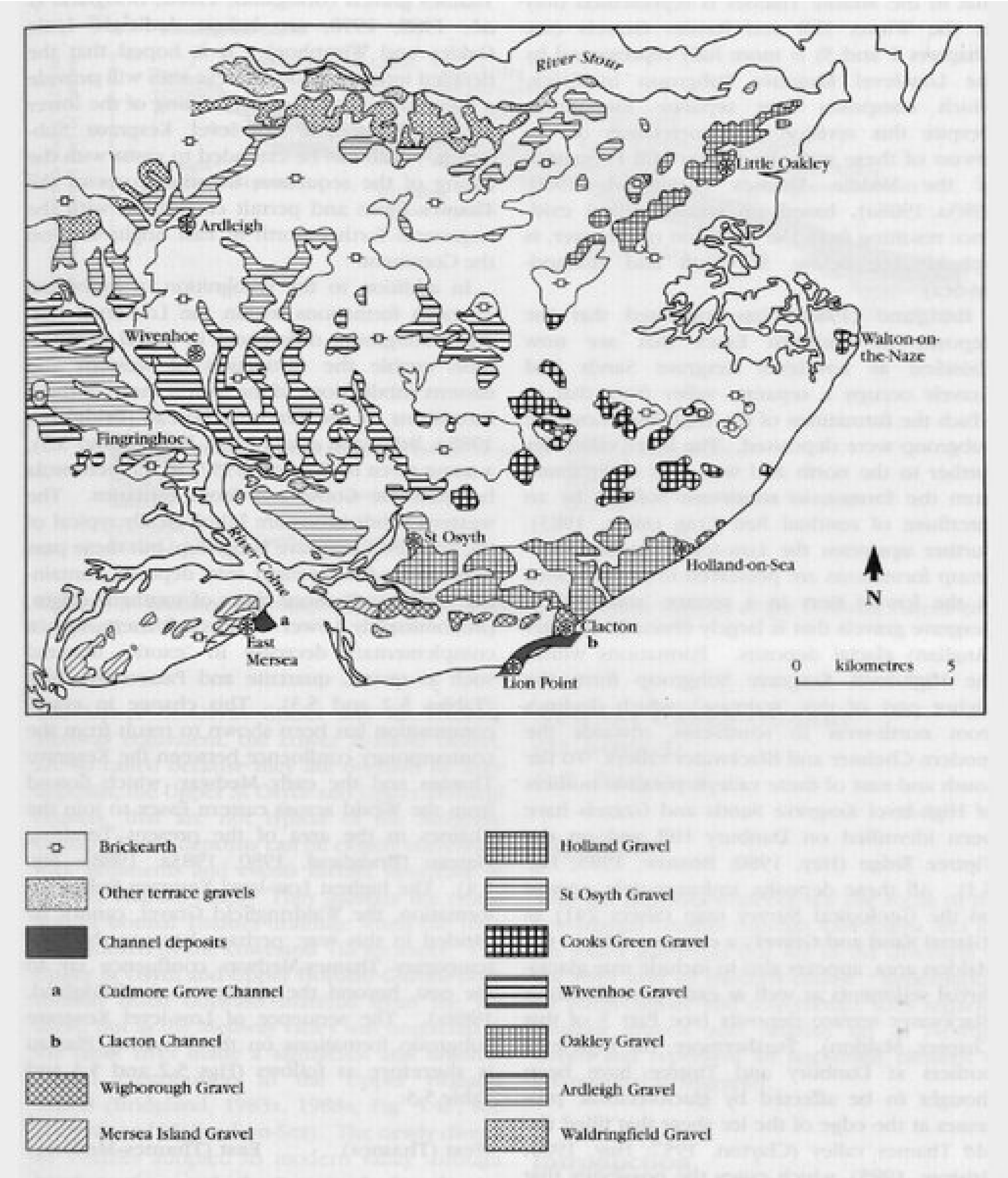
The Matuyama–Brunhes palaeomagnetic boundary is recognized as a highly significant stratigraphical marker within the Pleistocene, widely adopted as the base of the Middle Pleistocene (Richmond and Fullerton, 1986). Since this magnetic reversal approximately coincides, in the sedimentary record, with the end of 'Cromerian Complex Interglacial I' of the Dutch sequence, palaeomagnetic information is of considerable value in the study of sites of 'Cromerian Complex' age. The polarity of the Little Oakley Silts and Sands has been established as normal (Austin, in Bridgland *et al.,* 1990), indicating deposition after the Matuyama–Brunhes reversal and therefore after 'Cromerian Complex Interglacial I' of The Netherlands. This implies an age of somewhat less than 780,000 years BP, the approximate date of the magnetic reversal (Shackleton *et al.,* 1990).

Within the British sequence, the interglacial at Little Oakley has been interpreted as more recent than that at Ardleigh, since the Little Oakley Channel is cut through the local Oakley Gravel, the downstream equivalent of the Ardleigh Gravel (Gibbard, 1988b; Bridgland *et al.,* 1990). It is important to note, however, that the Little Oakley Silts and Sands occupy a position well below the original upper surface level of the Oakley Formation, in an area of considerable dissection (Figure 5.3). The maximum thickness of the fossiliferous sediments is *c.* 4 m and they do not extend higher than *c.* 24 m O.D. (Figure 5.11), whereas the Oakley Gravel terrace surface, prior to subsequent erosion, was probably aggraded to around 28–30 m O.D. It is therefore possible that a later aggradation of Oakley Gravel occurred, after the deposition of the Little Oakley Silts and Sands, and was removed by the erosion of the upper 4–5 m of the terrace deposits. Thus it is possible that the interglacials represented at little Oakley and Ardleigh are one and the same. There is nothing in the palynological records from these two sites to disprove this alternative hypothesis (P.L. Gibbard, pers. comm.), but pollen is the only significant biostratigraphical evidence that the two localities both provide. If the terminology of the climatic model for terrace formation (presented in Chapter 1) is adopted, the two possible interpretations of the relation between the Ardleigh and Little Oakley sequences can be further examined. If the same interglacial is represented at both sites, the gravel into which the Little Oakley channel is incised must be the pre-interglacial (phase 2) part of the Ardleigh/Oakley Formation, with the post-interglacial (phase 4) gravel missing from the immediate area. A single cold-warm-cold cycle would thus be represented in the deposits of the Ardleigh/Oakley Formation. If different interglacials are represented, and the Little Oakley Silts and Sands were deposited by the Thames and not a later tributary, the implication would be that no rejuvenation occurred in this part of the Thames catchment during the cold episode represented by the Ardleigh Upper Gravel.

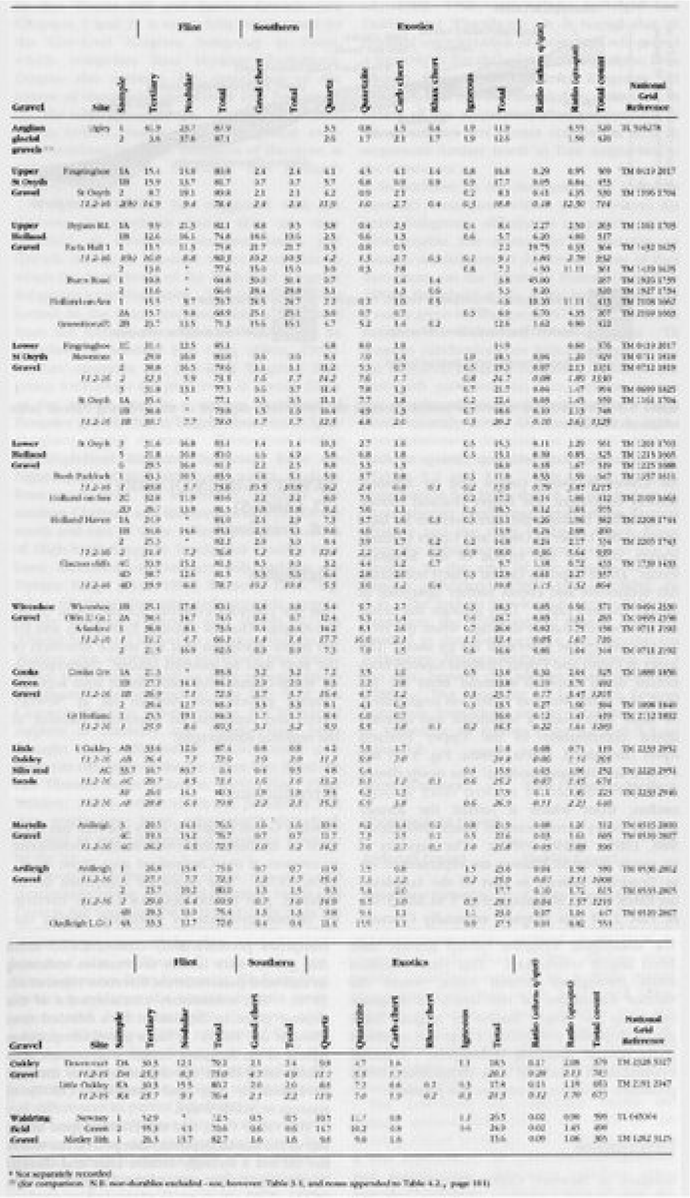
Conclusions

The Little Oakley interglacial site is clearly a critical locality for Pleistocene palaeontology and stratigraphy. The interglacial sediments, filling a channel cut through the local early Thames-Medway gravel (the Oakley Gravel), are richly fossiliferous, yielding pollen and the remains of molluscs, ostracods, mammals and fish. The combination of the various fossil types present indicates that the sediments represent a period of generally warm climate, comparable to that of the present day. The pollen provides a detailed record of climatic and vegetational change during the first half of an interglacial (temperate) period. The mammals include the extinct vole *Mimomys savini,* the Etruscan rhinoceros and the giant deer *Megaloceros verticornis.* These species, as well as certain extinct molluscs from Little Oakley, are characteristic of several temperate-climate episodes that, alternating with colder periods, preceded the major glaciation during which the Thames was diverted. This period of fluctuating climate, recognized in The Netherlands and called the 'Cromerian Complex', covers a long span of Pleistocene time, between around 750,000 and 450,000 years BP. The name derives from the Cromerian Stage, defined in north Norfolk, which is thought to coincide with part of the 'Cromerian Complex'. The significance of the Little Oakley interglacial deposits is heightened by the fact that they occur within the early terrace deposits of the Thames system. They therefore provide a means for dating the Thames terrace sequence and to enable improved correlation between the Thames Basin and Pleistocene sequences in other parts of Britain and western Europe.

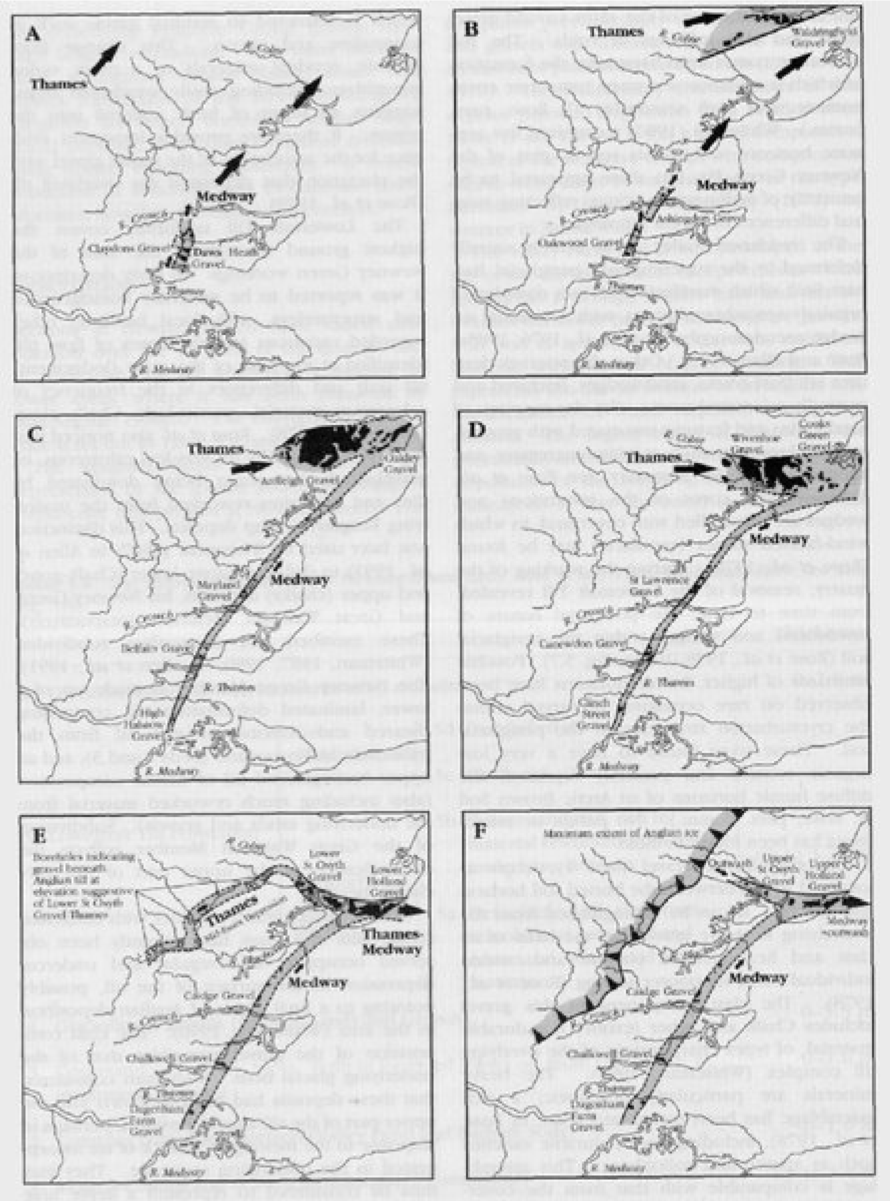
References



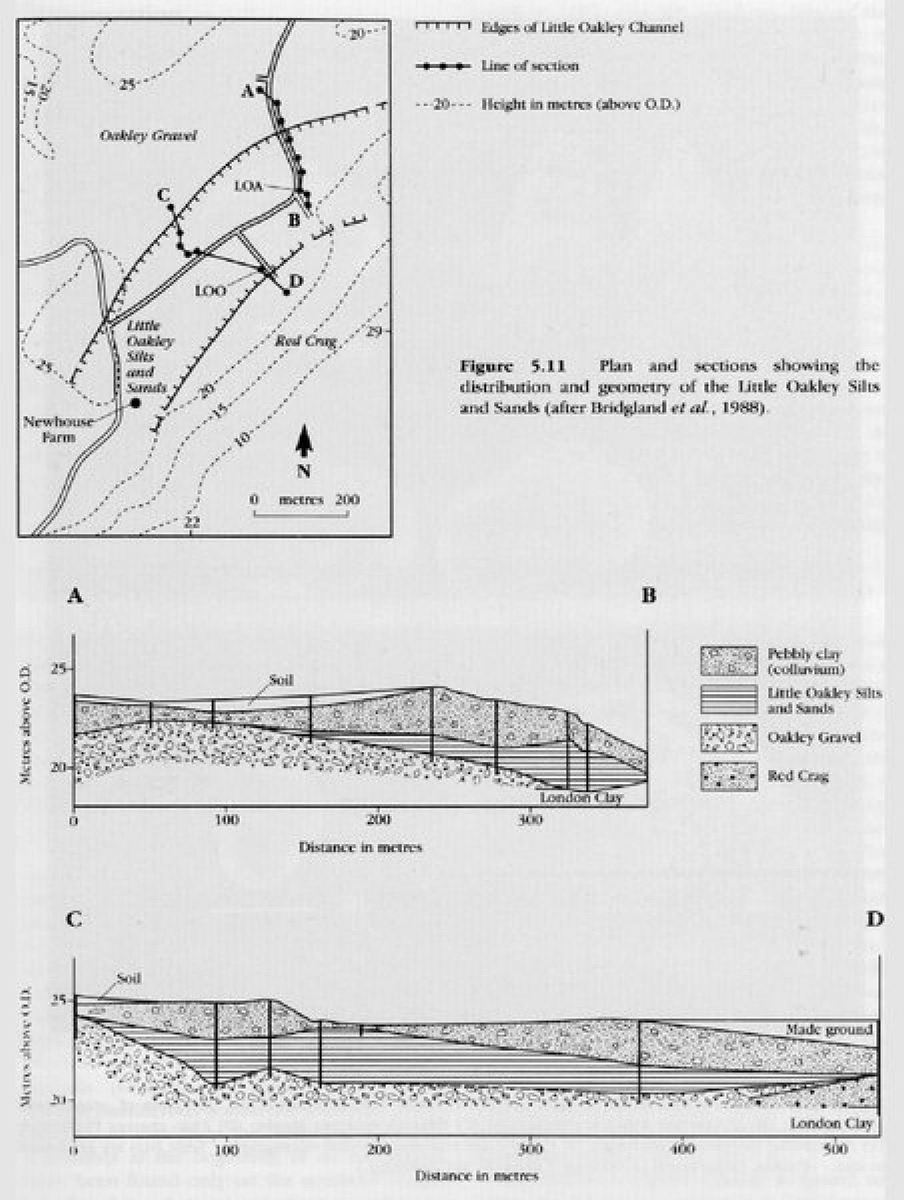
(Figure 5.2) Pleistocene gravels of the Tendring Plateau (after Bridgland, 1988a).



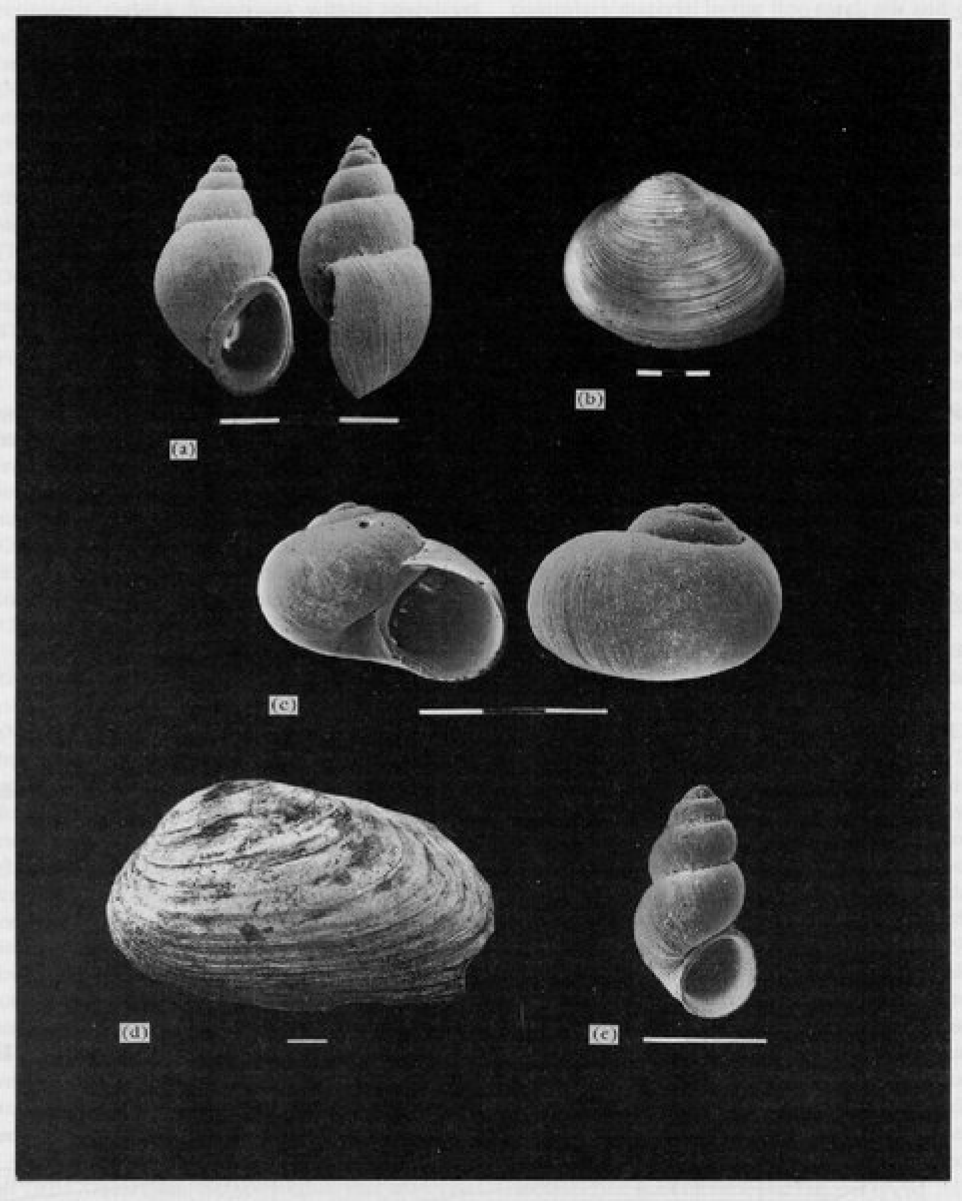
(Table 5.2) Clast-lithological composition of the gravels described in Chapter 5, Part 1.



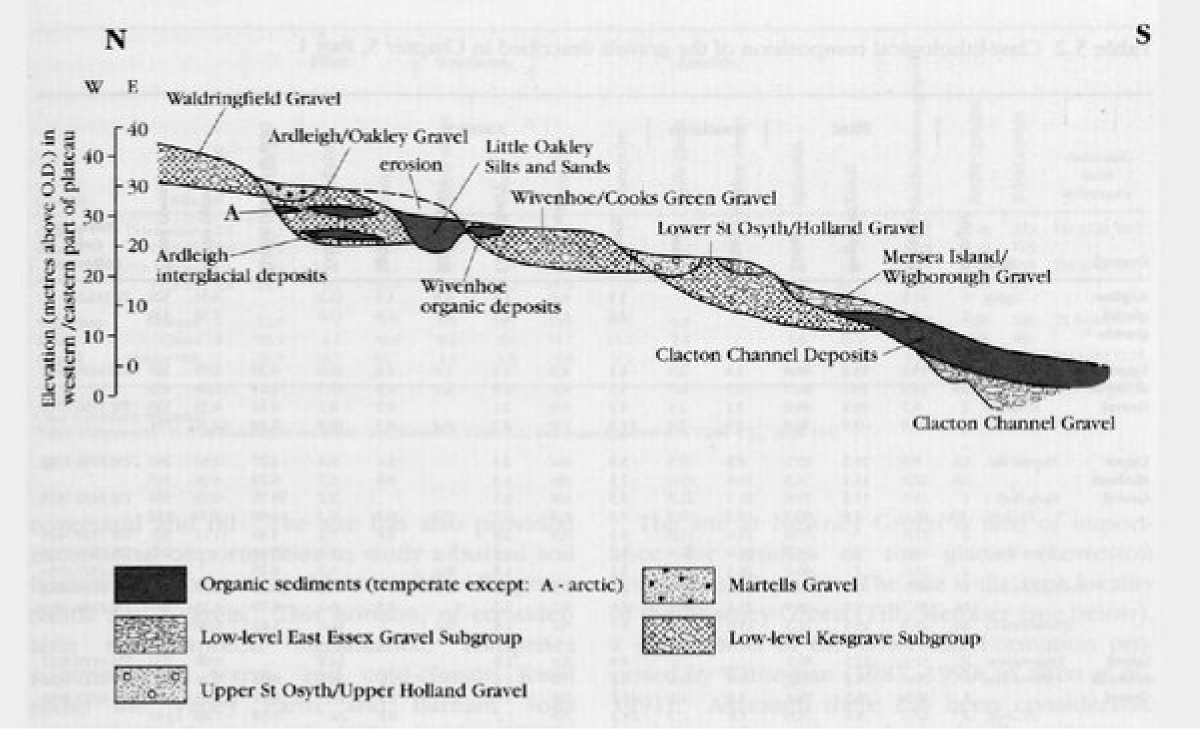
(Figure 5.4) Palaeodrainage of eastern Essex up to the Anglian glaciation (after Bridgland, 1988a): (A) Palaeodrainage at the time of deposition by the Medway of the Claydons and Daws Heath Gravels, part of the Rayleigh Hills gravels. The Thames and Medway are thought to have had separate routes to the North Sea at this time. (B) Palaeodrainage at the time of deposition by the Medway of the Oakwood and Ashingdon Gravels. The Waldringfield Gravel, which might be a correlative of the Ashingdon Gravel, is also shown. It is believed that the Thames and Medway joined during Waldringfield Gravel times, but this confluence is believed to have been situated to the east of the present coastline. (C) Palaeodrainage at the time of deposition by the Thames of the Ardleigh Gravel. (D) Palaeodrainage at the time of deposition by the Thames of the Wivenhoe Gravel. (E) Palaeodrainage during the early Anglian Stage, prior to the inundation of the Thames valley by the Lowestoft Till ice sheet. (F) Palaeodrainage during the Anglian glaciation, prior to the diversion of the Thames but after its valley became blocked by ice. The highly distinctive Upper St Osyth and Upper Holland Gravels were laid down at this time.



(Figure 5.11) Plan and sections showing the distribution and geometry of the Little Oakley Silts and Sands (after Bridgland et al., 1988).



(Figure 5.12) Characteristic Mollusca from the Little Oakley Silts and Sands. (A) Tanousia cf. stenostoma (Nordmann); (B) Sphaerium solidum (Normand); (C) Valvata naticina Menke; (D) Unio crassus Philipsson; (E) Belgrandia marginata (Michaud). A, C and E are scanning electron micrographs. Scale bars are graduated in mm. (Photos: Department of Zoology, University of Cambridge.)



(Figure 5.3) Idealized N—S transverse section through the Pleistocene deposits of the Tendring Plateau (after Bridgland, 1988a).