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The Pleistocene Succession Around Brandon, Warwickshire

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THE PLEISTOCENE SUCCESSION AROUND BRANDON, WARWICKSHIRE

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New evidence in the area around Brandon, Warwickshire, has amplified our knowledge of the sequence of events in the Saalian, Eemian and Weichselian. Organically rich deposits have been found at the base of Avon No. 2 terrace (mid-Weichselian) and in the Baginton–Lillington Gravels (early Saalian) and their biota, described elsewhere, throws additional light on the climate of parts of Middle and Late Pleistocene time. Six separate episodes of cryoturbation are placed in the time sequence. Certain gravels which occur, in one locality only, at the base of No. 4 terrace are believed to be Eemian, separated by a major time break from the normal gravels of No. 4 which are ascribed to the early Weichselian. The vicissitudes of climate, erosion and aggradation are integrated with a time scale.

1. Introduction

An extensive series of exposures (many of them transient) around Brandon (Warwickshire), have during the past few years provided detail which has elaborated the succession interrelationships and biotal characteristics of the Pleistocene succession of the upper Avon. The general sequence and correlation was worked out in 1953 (Shotton) as follows (Tomlinson, 1925 having established the terrace sequence):

Avon terrace No. 1 Avon terrace No. 2 Avon terraces 3 and 4	Weichsel (Würm)
Dunsmore Gravels Upper Wolston Clay Wolston Sand Lower Wolston Clay Baginton Sand Baginton-Lillington Gravel	Saale (Riss)
Bubbenhall Clay	? Elster (Mindel)

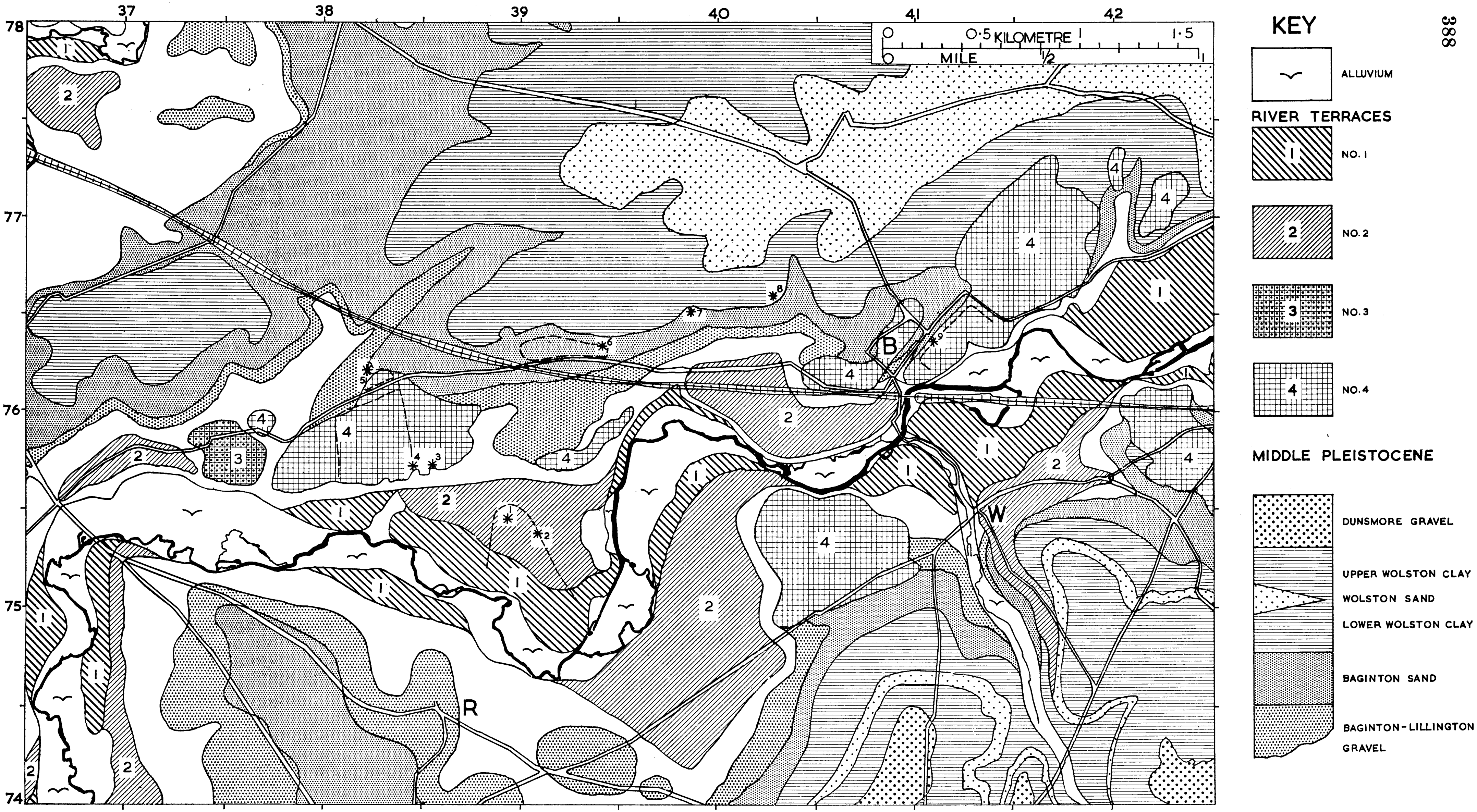

FIGURE 1. The Pleistocene geology around Brandon, Warwickshire. B = Brandon; W = Wolston; R = Ryton-on-Dunsmore. Numbered asterisks refer to localities (Loc.) mentioned in the text.

In the Brandon area, the river terraces are banked against the older drifts so that, for example, the gravels of No. 4 terrace lie upon the Baginton Gravel or even the Baginton Sand. This fact carries with it the disadvantage that deposits of greatly differing age may be confused, but also the great advantage that episodes such as those of frost-wedging, solifluxion and so on, may be more precisely bounded in time if deposits are correctly identified.

Figure 1 shows the Pleistocene geology of the area under discussion. It is a map very little modified from that of Shotton (1953), for the abundant new exposures have in general confirmed the lines of that paper. The only important alteration is that across the wide flat area around 3975 which I originally interpreted as No. 1 terrace, I now realize there is a change of slope which separates a lower flat about 6 ft. above alluvium (No. 1) from another 12 to 15 ft. above the flood plain (No. 2).

2. Avon terraces 1 and 2

In lithology these are typical Avon terraces with perhaps a majority of Bunter pebbles but with flint abundant and always appearing to be the dominant component. Both terraces have been opened up in extensive workings, the gravels reaching a maximum thickness of 12 ft. in No. 1 and 14 ft. in No. 2. With a step between them of only about 6 ft. this means that the top of No. 1 is appreciably higher than the base of No. 2 and there is no exposed rockstep between the two terraces this far up the Avon.

Over an area centred around Locality 1 of figure 1, the bottom of the No. 2 terrace deposits was a dark grey silt which visibly contained molluscs. The grey silt lay rather irregularly upon a pocketed surface of Keuper Marl, reaching a maximum thickness of 1½ ft. and there were some detached blocks of this silt in the lower part of the gravels. Within a few yards of where the silt thinned and disappeared to the south-east, another small but very defined channel or pool filled with peat and silt, occurred at the bottom of the gravels (Loc. 2 and figure 2). This too contained fauna and flora. On closer examination, these deposits have yielded an extensive insect fauna of Arctic affinities which is described in a following paper by G. R. Coope (1968). An upward projection from the main peat layer proved to be a rolled mass almost entirely consisting of twigs and leaves of dwarf *Salix*, and was interpreted as flood debris. It was excellent material for a radiocarbon date and this was determined (NPL-87) as 28200±500 B.P. (on an assumed ^{14}C half life of 5568 years; on the now accepted figure of 5730, the date would be revised to 29000).*

On the installation of ^{14}C dating facilities in the Geology Department at Birmingham University, two further determinations were made upon plants from the peaty fill of the small channel. The results were somewhat different but of the same order of magnitude as NPL-87—32270^{+1029}_{-971} (Birm. 10) and 30766^{+537}_{-520} (Birm. 27).

These dates for almost the commencement of aggradation of No. 2 terrace are interesting when compared with the figure of 38000±700 (GRO 1269) for peat from below the gravels of No. 2 terrace at Fladbury (Coope 1962), some 37 miles lower down the river. This latter figure agrees reasonably well with the two determinations of 41500±1200 (GRO 595)

* Radiometric dates are still being quoted on the Libby half life of 5568 years, so that figures in this paper will all refer to that standard.

and 41900±800 (GRO 1245) at Upton Warren (Worcestershire) on a tributary terrace of the Severn Main terrace, which has itself long been equated morphologically with Avon No. 2 (Tomlinson 1925; Wills 1938) and there is no reason to think that the Fladbury figure is a gross overestimate—indeed, if there is any error, it is likely to be in the opposite sense. Yet the Brandon material was first class in its remote chance of contamination and the dates should be good ones. Hence it could be argued that the aggradation of Avon No. 2 terrace proceeded progressively upstream over a great part of the Mid-Würm Interstadial, or at least for the duration of 7000 years.

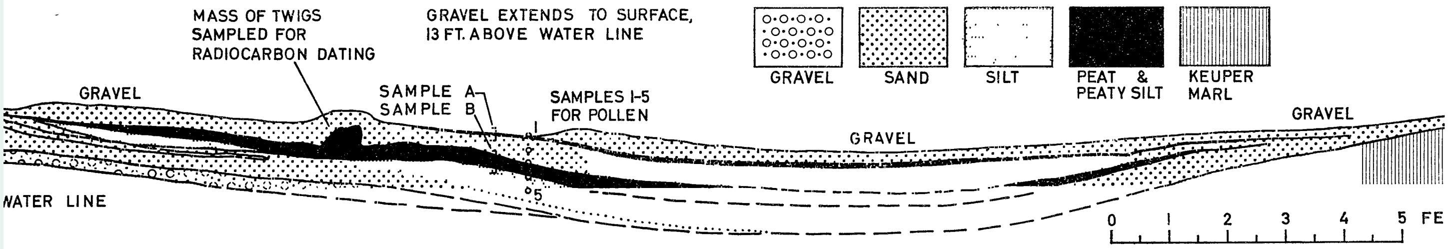

FIGURE 2. Detail of a small channel at the base of the gravels of No. 2 terrace.

The fauna from this locality which is described later, has some affinities with that of Upton Warren (Coope, Shotton & Strachan 1961) and an even closer resemblance to that of Fladbury (Coope 1962) and various sites on the River Tame (Warwickshire, Trent drainage basin) (Coope & Sands 1966) which have a date of $32160\pm^{1780}_{1450}$ (NPL-55) attached to them. Undoubtedly on the basis of their fauna the organic deposits at the base of terrace No. 2 at Brandon and Fladbury would have been correlated and regarded as synchronous before the advent of radiocarbon. In the future, there will be a search for further occurrences of organic material associated with Avon No. 2 terrace along the whole length of the river, with the intention of obtaining a series of radiocarbon dates to test this hypothesis of aggradation creeping upstream. On such dates as are available now, it must be regarded as only very tentative.

3. Avon terrace No. 4

This terrace makes a strong morphological feature along this part of the Avon, but now only about 40 ft. above alluvium level. It is conspicuously flinty, even though the less obvious Bunter pebbles are really the predominant constituent. It has been exposed in several places and at Loc. 9 a cut at right angles to the general course of the river showed

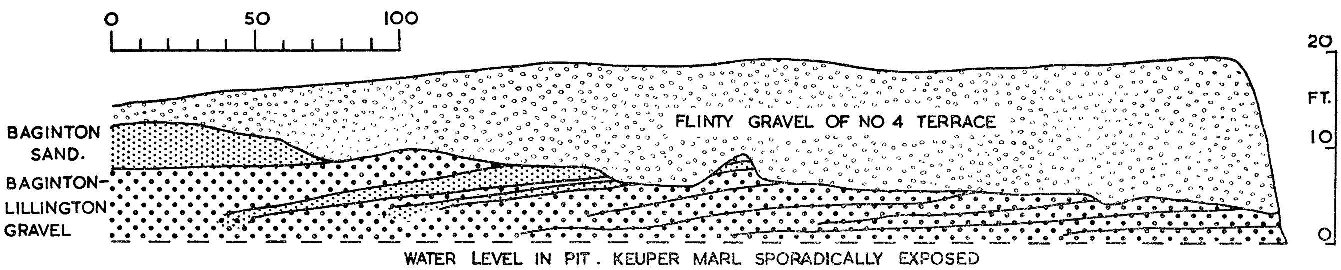

FIGURE 3. Section showing gravels of No. 4 terrace resting unconformably on Baginton–Lillington Gravels at Loc. 9.

a maximum thickness of 15 ft. Here the terrace gravels rest unconformably upon the Baginton Gravels, as they could be expected to from the mapping, and as they similarly do at the critical Brandon Grounds pit (see later). The distinction between the two series is very obvious because of the yellow-ochreous coloration of the terrace gravels compared with the pale reddish colour of the older deposit, and because of the large angular flints in the terrace, whereas the Baginton Gravels are wholly composed of Bunter pebbles. This section was accurately measured and is represented in figure 3.

At the large Baginton Grounds pit (Loc. 4), opened up apparently on No. 4 terrace, most of the working is in fact in the Baginton Gravels, upon which the terrace gravels, here never more than 8 ft. thick, rest with the same obvious distinction of lithology as just described. At the southern edge of the terrace feature, however, there is an unusual development. My original description of this area (Shotton 1953) was written at a time when the only activity here was the building of a crushing and washing plant which necessitated a clean cut down the front of the terrace (Loc. 3) and this I recorded as a typical section. It may be abbreviated as follows:

1. Coarse ochreous gravel, with Bunter pebbles and angular flint—av. 4 ft.
2. Coarse brown false-bedded sand—3–4 ft.
3. Fine gravel with interbedded sand, Bunter pebbles dominant, some pieces of Keuper sandstone and ?Enville Beds, flint very rare. Gravel and sand dark purply-red in colour and with a high clay content—*ca.* 14 ft.
4. Keuper Marl.

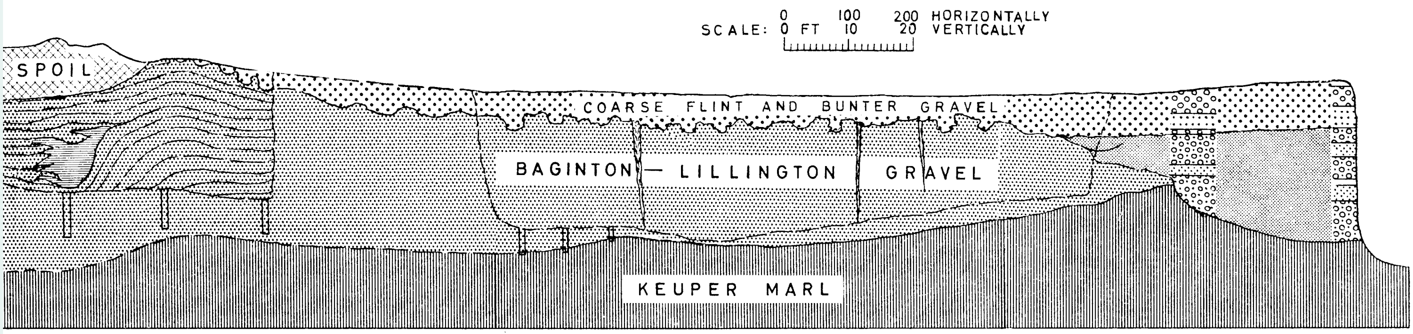

FIGURE 4. Section (with strong vertical exaggeration) from Locs. 3 and 4 to Loc. 5.

I pointed out the contrast in lithology between the two sets of gravels and inferred a considerable time break which I placed below bed 1 because of evidence of cryoturbation in bed 2. Later adjacent exposures which I am about to describe showed that the brown sand of bed 2 could be recognized there but it had below it a few inches of coarse ochreous flinty gravel which placed it in the upper series. The important break is therefore below bed 2, coinciding with the changes in colour, clay content and pebble content and it is this level which coincided with a marked transgressive unconformity.

A series of sections in the position I have roughly indicated by Loc. 4 have been repeatedly cleaned and surveyed by parties of students, and their relationship is most simply indicated by figure 4. The contrast between the two series of deposits, so obvious by colour and clayey texture, is equally clear in the analysis of the pebble content, determined on numerous samples comprising many hundreds of pebbles (table 1).

The scarcity of flint in the lower gravels, together with the content of Keuper and Coal Measure sandstones, the very high amount of Bunter pebbles and the overall admixture of purplish clay suggests that after the Avon valley had been cut down into the Keuper Marl, the lower gravels were deposited and derived from nearby, from the Keuper Marl, the Baginton–Lillington Gravels and the lower part of the Wolston Clay which contains little or no flint. The upper gravels suffered much longer transport which sorted them better and they came from the upper reaches of the Avon where the Upper Wolston Clay, Dunsmore Gravels and Chalky Boulder Clay were being eroded.

Table 1

	Bunter	Keuper sandstone	Coal Measure sandstone	flint	others
upper ochreous gravels	76·5	4	—	19	0·5
lower red clayey gravels	84·5	8	4·5	2	1

Only at this one locality in the Brandon area have these lower clayey gravels been observed. Even here they are rapidly cut out by the overstep of the upper terrace gravels (figure 4) which extend northwards over the Baginton Gravels from which they can be immediately visually separated by the high flint content. They cross the Willenhall–Brandon road and are last seen in the 'Channel Pit' (Loc. 5), an overstep from the clayey gravels of 1400 ft. The terrace gravels (in common with all surfaces of No. 4 terrace) are involved in spectacular solifluxion involutions which extend down about 6 ft., so that the top of the Baginton Gravels may also be involved in these; indeed, in the Channel Pit, the last evidences of the terrace are two or three isolated pockets of flinty gravel entirely surrounded by Baginton Gravels.

4. The relationship of Avon terraces 3 and 4

The morphological flat which forms the top of terrace No. 3 in the Avon valley is clearly newer than No. 4 and older than No. 2; but Dr Tomlinson maintained (1925) and I have agreed with her (Shotton 1953) that the deposits under the terrace features 3 and 4 are of increasing age downwards, being essentially all part of one complex aggradation antedating the formation of the flats. It is only from lower level gravels beneath the feature of No. 3 terrace that have come *Hippopotamus*, *Elephas antiqus*, *Belgrandia marginata* and *Unio littoralis* (Tomlinson 1925, 1935) which indicate the warm climate of the Eemian. In addition, however, at Ailstone in the Stour valley (tributary to the Avon) Tomlinson (1925, p. 143) records a section under No. 4 terrace where 12 ft. of yellow sand and gravel overlie at least 4 ft. of red sand and gravel (a colour change reminiscent of the Brandon section) and in the lower beds occurred *Unio littoralis* together with *Corbicula fluminalis*. These are thus regarded as extensions of the Eemian gravel elsewhere found beneath No. 3 terrace. The upper part of the gravels beneath No. 4 terrace and sometimes all that is preserved, must be not only later than the *Corbicula–Hippopotamus* gravels but deposited also in a cooler climate, for it has yielded *Mammuthus primigenius* at two places on the upper Avon, at Barford (Tomlinson 1935; Jack 1922) and at Heathcote (Playle 1962). It is more reasonable, therefore, to ascribe these gravels to the early Weichselian (Würmian) on climatic grounds rather than to the late Eemian (as I did in

1953). No. 4 terrace gravels must, nevertheless, be early in the Würmian, since they considerably antedate the gravels of No. 2 terrace with their radiocarbon dates that assign them to the Mid-Würm (Upton Warren) Interstadial. No. 4 terrace gravels could therefore even date from before the acme of the Early Würm glaciation and this interpretation seems to me the most satisfactory. The numerous implements of late Acheulian and early Levalloisian type which all seem to be associated with No. 4 terrace (Shotton 1953, 1960) would accord with such a dating.

To equate the lower clayey gravels of the Brandon section with the fossiliferous deposits under No. 3 terrace lower down the river makes an assumption not yet supported by any fossil evidence, but conforming with the space relationships previously postulated. The important point of the Brandon evidence, however, is the clear picture of an older set of gravels covered by the main deposits of No. 4 terrace only after a substantial lapse of time. This interval was long enough for the removal of an unknown thickness of the purple clayey gravels, followed by lateral erosion which cut into the north side of the Avon valley to the extent of 1400 ft., followed by the aggradation of gravels which can be as thick as 15 ft. (Loc. 9 above). Though physical processes may have operated then more quickly than they do now, it would be reasonable to think that the lower clayey gravels are Eemian if the upper flinty gravels cannot be later than early Würm.

5. The Baginton–Lillington Gravels, Baginton Sand and Lower Wolston Clay

The 'Older Drifts' which antedate the cutting of the Avon valley outcrop along its north side where they have been and are being worked extensively. The Baginton Sands have been cut into at a series of pits between Loc. 7 and Loc. 8 where a maximum of about 15 ft. of sand is removed from under an overburden of Lower Wolston Clay, but the underlying Baginton Gravel is usually not extracted. In lower level pits the gravel has been dug —at Loc. 6, where a total thickness of 10 ft. 3 in. was seen between Keuper Marl and Baginton Sand, in the large pit at Loc. 4 where the thickness (beneath No. 4 terrace) has increased to 17 or 18 ft. and in the Channel Pit (Loc. 5) where the total thickness exceeds 30 ft. (see figure 4). With this increase of thickness is associated more sand, but the most important departure from uniformity is the intercalation of a silt-filled channel at Loc. 5 which has yielded an extensive flora and fauna of a period of Pleistocene time which has probably not been previously biologically sampled in Britain, apart from a fauna of larger vertebrates.

The details of shape and lithology of this channel are shown in figure 5. Its edge is cut obliquely on the west side of the pit so that it can be deduced to be a channel running locally in an E.N.E. to W.S.W. direction. On the east side of a narrow cut extending north of the main pit it is well exposed in cross-section.* Under 5 to 7 ft. of bedded gravel of the Baginton–Lillington series, easily identified by being wholly made of derived Bunter pebbles and also being the direct continuation of gravels beneath the flinty terrace deposits, a lens of clay and silt develops as a well marked channel. At the centre of the channel the silts are 6 ft. 6 in. thick. On its north side they die out by interfingering with sands.

* Since writing this the Channel Pit has been almost filled with tip and the section has been concealed.

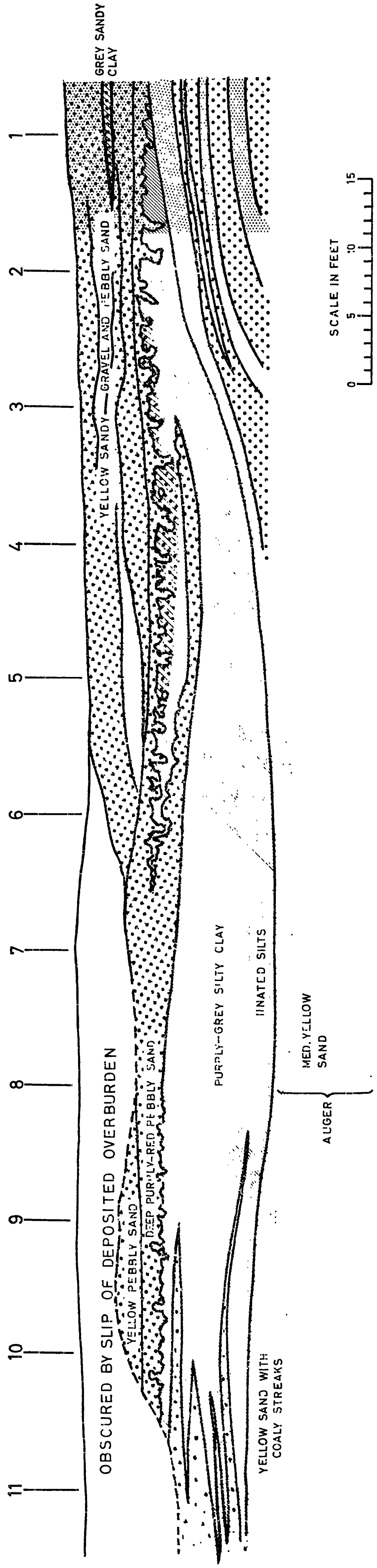

Figure 5. Scale section of the silt-filled channel in Baginton–Lillington Gravels at Loc. 5.

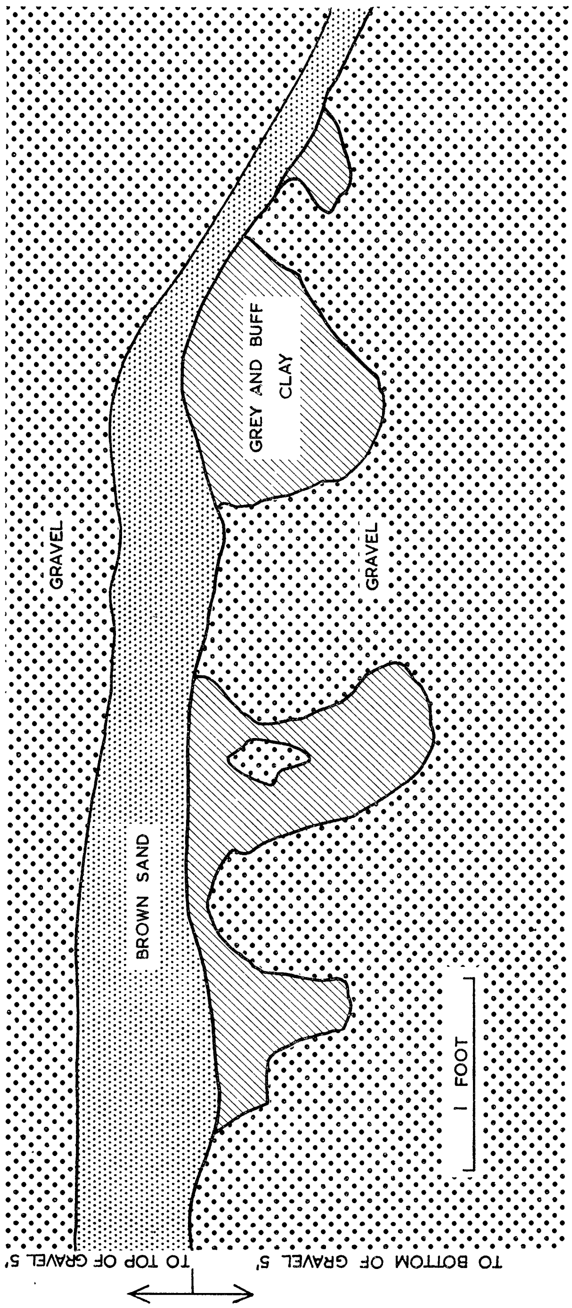

Figure 6. Detail in the middle of the Baginton–Lillington Gravels at Loc. 6.

The silts are grey due to a finely dispersed organic content, except at the top foot or so where they are bright red and in places sandy. This is probably due to a Keuper Marl content, for the colour is not what would be expected from a palaeosol, still less a weathering horizon in a cold climate. Nevertheless, at the top of the channel there is a strong break for there is violent solifluxion at this horizon (figures 5 and 6). This is described and discussed below.

Prior to the discovery of this silt-filled channel, the Baginton–Lillington Gravels had only yielded a vertebrate fauna (Shotton 1953) comprising *Mammuthus primigenius*, *Loxodon antiquus*, *Tichorhinus antiquitatus*, *Bos* or *Bison*, *Rangifer tarandus*, *Equus caballus* and ?*Sus scrofa*. Despite the undoubted presence of two teeth of *Loxodon antiquus*, the much more abundant *Mammuthus primigenius* and the other animals leave no doubt about the coolness of the climate; but the flora and the small vertebrate and invertebrate fauna obtained from the channel and described in papers that follow (Kelly 1968; Osborne & Shotton 1968) greatly amplify our knowledge of the contemporary climate and ecology.

6. Periglacial effects

Within this limited area, there is evidence of no less than six periods of cryoturbation.

(*a*) *In the middle of the Baginton–Lillington Gravels*

Many years ago (Shotton 1929, p. 207 and fig. 5), I described and figured from Pratt's pit at Lillington a disturbed clay layer in the middle of the gravels, which protruded downwards as steep undercut pockets. At that time I did not advance an explanation of successive freeze and thaw, which I would do now. At Loc. 6 of figure 1 there was to be seen a closely similar occurrence again in the middle of the gravels. Several lenses of grey silty clay occurred, presumably representing pools or slack water channels in a regime otherwise of turbulent gravel deposition. Most of these showed some post-depositional disturbance and the most contorted band illustrated in figure 6 closely parallels the Lillington occurrence.

It is probable that this level of clay-filled pools in the middle of the Baginton–Lillington Gravels at Loc. 6 is the same as that which brings in the much bigger silt channel at Loc. 5. Certainly immediately following the filling of the channel there was a period of heavy cryoturbation. It is visible everywhere in the pit where any thickness of silt-filling is to be seen. A length of the main cross-section of the channel where cryoturbation was particularly strong was dug back and cleaned up and this is illustrated in figure 7. It will be appreciated why, in collecting serial samples from the centre of the channel where the filling was 6 ft. 6 in. thick, the top 10 in. was neglected, and for some distance below this it is likely that the sediments were much disturbed. This strong cryoturbation is, however, an important indication of climate corroborating the conclusions drawn from the channel's fauna and flora.

(*b*) *Between the Baginton Sands and the Lower Wolston Clay*

This junction is normally transitional but at one spot (Loc. 9) there was a single fossil frost-wedge, about 4 ft. long, ending against the overlying Wolston Clay.

Figure 7. Detail of cryoturbation affecting the top of the silt filling at the edge of the channel at Loc. 5.

(*c*) *Immediately before the deposition of No. 4 terrace*

Frequent sand-filled frost-wedges, usually only a few inches wide but as much as 16 ft. deep, traverse the Baginton Gravels in the main pit but are truncated by the flinty gravels of No. 4 terrace (figure 4). This episode must coincide with or immediately follow the period of great lateral erosion which precedes No. 4 terrace deposition.

(*d*) *Early in the deposition of the gravels of No. 4 terrace*

The festooning which occurs low down in the flinty terrace gravels (see p. 391) must follow soon after the ice-wedging described above and both episodes confirm the interpretation of No. 4 terrace aggrading in a cold climate. Playle (1966) records a temporary section in No. 4 terrace gravels near Barford, south of Warwick, which showed the same period of frost disturbance. The gravels were 8 ft. 9 in. thick, but cryoturbation only affected the bottom 2 ft. and the underlying Keuper Marl.

(*e*) *Post-No. 4 terrace*

Wherever No. 4 terrace is seen in cross-section, it is affected by great festoons which extend 6 ft. or so downwards from its surface and indicate deep freezing. Such cryoturbations are strikingly displayed at Brandon. To date this episode is not, however, simple, for unlike those described above, it has no stratigraphical bounding upper limit. It could have occurred in the Early Würm glaciation, in the Mid-Würm Interstadial (for intraformational cryoturbation of this age is known at Upton Warren (Coope, Shotton & Strachan 1961) and at Minworth (Coope & Sands 1966)) or during the Late-Würm cold period. Equally well, of course, it could be the product of a long period of time covering much of the Würm. It may be significant that the terrace feature appears to truncate and so post-date the festoons and if this is a valid criterion, the cryoturbation would be Early Würm—but it is difficult to believe that the surface was not again disturbed, in the Late-Würm.

(*f*) *Inter-No. 2 terrace*

Elsewhere within deposits of No. 2 terrace or its equivalent (e.g. Coope *et al.* 1961) there is marked cryoturbation which falls in the Upton Warren Interstadial. Frost-wedging and upturned bedding was observed in the Brandon exposure of No. 2 terrace and it has been indicated by the latest asterisk in figure 8.

7. Geological and climatic summary

The earliest deposit of this neighbourhood is the Bubbenhall Clay but it is little more than a relic separated from the succeeding formations by a long period of erosion. This has been assumed to be during the Hoxnian but there are no known deposits of this age comparable with those at Nechells in Birmingham (Kelly 1964; Shotton & Osborne 1965).

As the Hoxnian Interglacial declined and the Saale Glaciation approached, the Baginton–Lillington Gravels and the succeeding Baginton Sands were deposited by rivers. The fauna and flora in the gravels indicate an environment with scanty trees of birch and a climate cooler than today, but not excessively cold. On a curve of continuous climatic change it is more reasonable to regard this period as early Saale rather than late Hoxnian. The Wolston Series which follows is the result of a major glaciation which first ponded up Lake Harrison and then over-ran its deposits as it advanced as far south as Moreton-in-Marsh (Bishop 1958). This seems to be firmly dated as Saale in age (though whether Saale I or Saale II or both is not certain), because the vertebrate fauna of the Baginton Gravels could hardly be older than this and yet the Wolston Series is clearly earlier than the *Corbicula–Hippopotamus* gravels of the Avon, which are surely Eemian. When the waters of Lake Harrison were released, the River Avon was initiated. In its terraces are preserved what record we have of the Eemian, the Weichselian (Würm) Glaciation and the Post-Glacial. Terrace No. 5, the first halt stage in the backward progress of the Avon, does not reach into the Brandon area, but is probably late-Saale. The dating of the other terraces has been discussed above, ascription to the Eemian or to various stages of the Weichselian depending upon biota or physical evidences of climate such as involutions and frost-wedges, to a limited extent on human artifacts and in the later stages on radiocarbon dating. The area was entirely south of Würm ice limits so that cryoturbation assumes greater significance as evidence of cold climate. The main contributions of the Brandon area to the stratigraphy of the Last Glaciation is the demonstration that

(*a*) the gravels of No. 4 terrace are probably very early Würm preceding the Würm I Glacial maximum.

(*b*) The Würm I glaciation in the north coincides with extensive downcutting in the Avon.

(*c*) Terrace No. 2 represents a long period lying between the Early and Late Würm glaciations. Aggradation may have worked upstream over seven thousand years or so and in this, the Upton Warren Interstadial, climate varied between cool and sub-Arctic.

(*d*) Radiocarbon dating of the Late Würm glacial maximum elsewhere suggest that it is represented here by the period of downcutting between terraces 2 and 1, with terrace No. 1 and the river-alluvium covering the last 20000 years or so.

A summary of the post-Hoxnian events is embodied in figure 8.

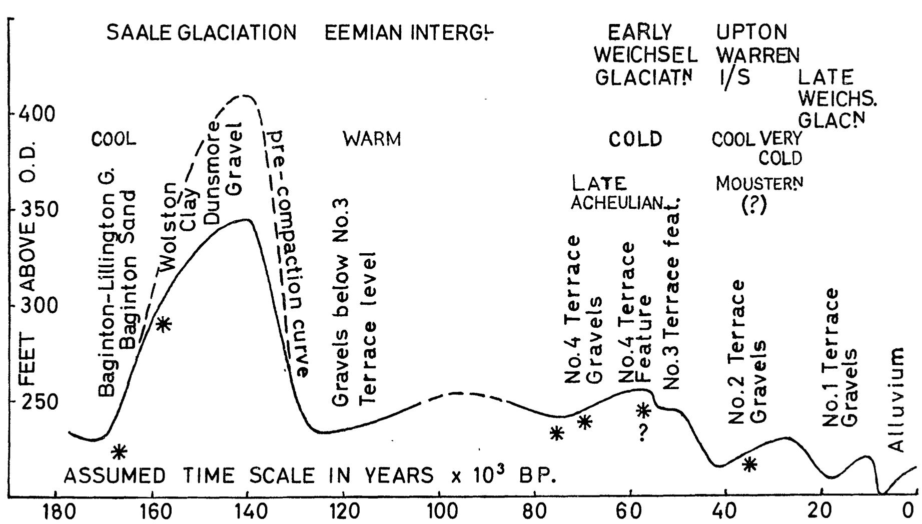

FIGURE 8. Summary of aggradation and denudation, climate, periods of cryoturbation (*), fauna and implements in post-Hoxnian time in the Brandon area.

Appendix. Vertebrate and molluscan fauna of No. 2 terrace

When the silt previously mentioned as occurring at the base of the terrace gravels and in a few detached blocks over the general area of Loc. 1 was washed it yielded remains of the lemming *Dicrostonyx henseli* Hinton, and many examples of a limited molluscan fauna, in addition to the abundant insects and arachnids which form the subject of a separate study by Dr G. R. Coope (1968).

Dicrostonyx henseli occurred as (*a*) the anterior two-thirds of a cranium with dentition complete except for a right third molar and (*b*) the left half of a mandible, with its full dentition. Mr J. N. Carreck confirmed the identification and also pointed out that the specimens pertained to two separate individuals. This species was also recorded from Upton Warren (Coope *et al.* 1961).

The molluscs separated after wet sieving, were submitted to Mr B. W. Sparks, to whom I am indebted for identification and comments. Nine separate samples were submitted labelled 'Original, Ex, C, D1 (three) and D2 (three)'. The 'Original' specimens refer to the discovery site at the northern edge of the silt occurrence, 'Ex' occurred about 10 yards to the south, all the C and D samples lay in another working separated from the first by a supply road and they were 10 to 30 yards further south still. In the following table Mr Sparkes's specimen counts for C and all the D samples have been aggregated since there is no significant variation in the figures, but they clearly differ from those of the other sites which suggest the proximity of other types of environment.

Table 2

	Original	Ex	C D	total
Lymnaea truncatula (Müller)	4 (1%)	16 (35%)	—	20 (2·3%)
L. peregra (Müller)	12 (3%)	11 (24%)	25 (6·1%)	48 (5·6%)
Planorbis laevis Alder	—	1 (2·2%)	—	1 (0·1%)
Succinea pfeifferi var. *schumacheri* Andreae	311 (77%)	—	372 (91%)	683 (80%)
Columella columella (Benz)	5 (1·2%)	—	—	5 (0·6%)
Pupilla muscorum (Linné)	71 (17·5%)	17 (37%)	12 (2·9%)	100 (11·6%)
Agriolimax sp.	—	1 (2·2%)	—	1 (0·1%)
Pisidium sp.	1 (0·25%)	—	—	1 (0·1%)
total	404	46	409	859

Mr Sparks comments as follows:

'Many of the shells are not well preserved and consequently there is some doubt about some identifications. The shells listed as *Lymnaea peregra* are mostly very young: they seem to be what some authors regard as the true *peregra* form and not the *ovata* form. The *Agriolimax* resembles *agrestis* but it is a small, probably juvenile, shell. Only one *Columella* is fully grown. It is undoubtedly the *columella* form, whether this is a distinct species or not.

'The shells listed as *Succinea pfeifferi* var. *schumacheri* are the common form of the species which occurs widely in Early-, Full- and Late-Glacial deposits, such as those at Wretton (Norfolk) Thrapston (Northants) and Velsen in the Netherlands. Some excellent photographs of these from the last site are given by van Regteren Altena (1957), who shows a range of shape very similar to that existing in the Brandon Terrace species. In the past *schumacheri* has been recorded as a variety of both *pfeifferi* and *oblonga* and the same species has also been listed as *S. groenlandica*. By whatever name it is known it is a characteristic form of Pleistocene cold deposits.

'The fauna is very restricted. Presumably the environment included small marsh patches with adjacent drier areas and a shifting or occasional small stream. The C and D samples have a predominant marsh aspect with dominant *Succinea*. Into the "Original" sample were introduced elements of a *löss*-type fauna in small amounts, i.e. *Pupilla* and *Columella*, suggesting dry conditions nearby. The "Ex" sample has a mixture of fresh-water species and elements of the dry fauna but no marsh element, thus suggesting a small, perhaps minute, stream washing in material from the dry parts of the environment.'

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