JOHN LUBBOCK’S EARLY CONTRIBUTION TO THE UNDERSTANDING OF RIVER TERRACES AND THEIR IMPORTANCE TO GEOGRAPHY, ARCHAEOLOGY AND EARTH SCIENCE

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In his writings John Lubbock expounded views on the understanding of past climates, prehistoric faunas, early humans, and the evolution of landscape and river systems. His contributions on some of these related topics are scarcely remembered, despite comparison with modern thinking showing them frequently to have been prescient. He visited the Somme valley, observing river terrace gravels and Palaeolithic artefacts in the company of the leading geologists and archaeologists of his day, visits that furnished knowledge of the early archaeological record and were also formative in terms of his understanding of river-valley and landscape evolution. He noted that terraces represented former valley-floor levels and that rivers had deepened their valleys in response to uplift of the land, something that is often not fully grasped at the present time. He was also an early believer in interglacial–glacial climatic fluctuation, an idea not widely accepted in Britain until after his death.

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John Lubbock, the first Baron Avebury, is perhaps best known for his achievements in relation to the protection of archaeological sites and monuments, which ensure that he will continue to be revered by archaeologists, for whom he is also important as the probable instigator of the terms Palaeolithic and Neolithic.1 His interests in a broad sweep of disciplines, now under more specialized classification within archaeology, physical geography and geology, were undoubtedly honed by his association with Darwin and by his election to the Geological Society of London in 1855.2 There were fruitful collaborations with leaders of their fields, notably the geologist Joseph Prestwich and the archaeologist John Evans (figure 1), with whom Lubbock made visits to the Somme valley (northern France) that proved highly influential in terms of his pioneering views on human history and his less well known (but equally far-sighted) interpretations of issues involving landscape and drainage evolution. In 1903 he (by then Lord Avebury) became the first recipient of the Geological Society’s Prestwich medal, commemorating his former colleague and geological mentor. By the 1950s, however, the low visibility of Lubbock’s varied contribution to science was a topic

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Figure 1. The Somme valley foursome. (a) John Lubbock; (b) Joseph Prestwich; (c) John Evans; (d) Jacques Boucher de Perthes. (Online versions of (a) and (c) in colour.)
for lamentation in the pages of this journal.\(^3\) Periodic resurgence of interest in his work, with attempted assessment of his influence on various branches of science, has not previously included an exploration of Lubbock’s observations on the subjects discussed here, which have continued to be almost entirely overlooked.\(^4\)

**THE ANTIQUITY OF THE GRAVEL TERRACES OF RIVER VALLEYS**

It seems that Lubbock missed out on the first influential visit to the Somme valley, in 1859, because of a ’pressing engagement’; however, this was so considerable a success as far as his colleagues were concerned that it was soon repeated: Prestwich, Evans and Lubbock made annual visits in the four years 1860–63.\(^5\) On these occasions, as in 1859, the British visitors were shown by Jacques Boucher de Perthes (figure 1\(d\)) the artefacts he had discovered in the Somme terrace gravels, sparking an interest in the occurrence of stone tools (handaxes) in the gravel terraces of English rivers (figure 2).\(^6\) The experience clearly convinced Lubbock of the greater antiquity of the archaeology from river terrace deposits in comparison with the caves and rock shelters of the Dordogne, the Swiss lake village sites, and the tumuli and kitchen middens of Denmark, which were principal sources of prehistoric evidence at the time and were also the subjects of his visits and research.\(^7\)

Thus, as a result of his excursions to the Somme, Lubbock was convinced by river terrace deposits as sources of Palaeolithic artefacts and recognized the difference between such artefacts and those from other (later) archaeological contexts. He also realized that the people responsible for the artefacts found in river terrace deposits had shared their world with prehistoric animals, represented as fossils in the same deposits, as well as with beasts that were extant but no longer living in the temperate zone of Europe. An example of the latter is the musk ox (\(Ovibos moschatus\)); in 1855 Lubbock, in the company of Charles Kingsley, discovered the first fossil remains of this animal, showing it to have lived in Britain during earlier periods of intense cold.\(^8\) This discovery was from a gravel pit ‘close to the engine house at the Maidenhead Railway Station’.\(^9\) In the 1913 edition of *Prehistoric Times*, however, Lubbock gave the discovery a later date: ‘in 1856 Mr Kingsley and I were so fortunate as to obtain a portion of a skull from the large gravel-pit near Maidenhead Station’.\(^10\) It seems clear that he was mistaken, because Owen’s (1856) paper on the fossil was read to the Geological Society in December 1855.\(^11\) The 1855 date is further corroborated by the recording of several congratulatory letters to Lubbock,\(^12\) including one from Charles Darwin, dated 19 July 1855 (Darwin had heard of the discovery from Charles Lyell) and another from Prestwich, dated 10 July 1855. In the 1850s Maidenhead Station was at Taplow, just west of the overbridge where the railway crosses what is now the A4 road, 0.5 km west of the current Taplow station. The musk ox discovery has generally been attributed to the Taplow Station Pit, type locality of the Taplow Terrace,\(^13\) and this matches Prestwich’s description of the location.\(^14\) The gravel forming this terrace has been assigned in more recent years to the penultimate glacial, equating with marine isotope stage (MIS) 6 of the deep-sea record (roughly 185000 to 125000 years ago) and associated with further finds of \(O. moschatus\) since Lubbock’s day.\(^15\) Lubbock also discovered \(O. moschatus\) and other mammalian remains near his family home at Downe, north Kent; this was from a small pit ‘at Greenstreet Green, near Bromley’, in the valley of the Cray, a south-bank Thames tributary. This he clarified as the later discovery,\(^16\) although it cannot have been long after the first; bones from this site
Figure 2. Handaxe illustrations from different editions of *Pre-historic Times*. (a) Water-coloured plate from the first edition. (‘Plate II, a flint implement found near Abbeville, slightly reduced. The artist has been so careful to present a faithful image of the specimen, that he has even copied exactly my rough memorandum as to the place and date of its discovery.’) (Online version in colour.) (b) Handaxe from Hoxne, one of two that survived from the first edition (Figs 135 and 136) to the seventh edition (Figs 236 and 237), front and edge views, respectively, in both cases. These are reproduced from Frere. (c) Fig. 246 from the seventh edition, attributed in the text (but not the caption) to St Acheul. (d) Fig. 249 from the seventh edition, again with attribution in the text rather than the caption: ‘a magnificent specimen from the valley of the Axe kindly presented to me by Mr Rolls’. (Online version in colour.)
were referred to in correspondence from Charles Lyell to Lubbock, dated 16 June 1855, in connection with his support for Lubbock’s becoming a fellow of the Geological Society.\textsuperscript{17} The Greenstreet Green deposit was also mentioned in a letter (dated 2 September 1859) from Charles Darwin to Charles Lyell, Darwin noting it to be characterized by angular flints. Although Geological Survey mapping shows only undifferentiated solifluxion deposits and alluvium in the Cray valley hereabouts, it seems likely that the quarry that Lubbock studied exploited a pocket of Pleistocene fluvial sediment.

Lubbock illustrated several handaxes in \textit{Pre-historic Times}, with a notable water-coloured painting in the first edition onwards and photographs in later ones (figure 2). Some, including the water-colour, were from the Somme, but there were others from Britain, such as an impressive specimen that (on account of its slender concave tapering shape) might now be termed a ‘ficron’ from the Axe valley in southeast Devon (figure 2d), as well as other examples from India.

In \textit{Pre-historic Times} Lubbock floated the idea that humans might be implicated in the extinction of the prehistoric animals with which they had shared the Palaeolithic river valleys, which is an issue that continues to be controversial at the present day: ‘When, finally, … the climate had gradually become more like our own, and either from this change, or rather perhaps yielding to the irresistible power of man, the great \textit{Pachydermata} became extinct.’\textsuperscript{18} This is a view shared by many modern scientists, although others prefer to attribute what would now be termed the ‘Late Pleistocene Extinction’ to climatic pressures as the transition to the warmer conditions of the Holocene took place. In several of the latest contributions to the debate, multiple causes have been advocated.\textsuperscript{19} Nonetheless, anyone promoting the interpretation that climatic warming was a significant driver of extinction must explain why this particular glacial–interglacial transition brought about such a drastic loss of large game species, many of which (or their closely related antecedents) had survived comparable climatic changes at the start of earlier interglacials.

\textbf{THE NATURE OF GEOLOGICALLY RECENT CLIMATIC HISTORY AND ENVIRONMENTS}

Detailed notes and drawings were made during the visits to the Somme gravels. One such, illustrated in \textit{Pre-historic Times},\textsuperscript{20} provides an insight into Lubbock’s advanced thinking about the palaeoenvironments of the Quaternary. A drawing of the section in a quarry close to the station at Joinville shows, within an upper angular gravel, a large sandstone boulder (figure 3). Lubbock concurred with Prestwich in ascribing the emplacement of the boulder to floating ice, rather than agreeing with Boucher de Perthes, who preferred to envisage ‘cataclysms’ to explain such phenomena.\textsuperscript{21} Such friendly disagreements were peripheral to the already long-standing debate in the Earth sciences between Uniformitarianism and Catastrophism, which had more recently been influenced by the advent of ‘Glacial Theory’.\textsuperscript{22} Indeed, the explanation of the Joinville boulder, not to mention that of the Maidenhead and Greenstreet Green musk oxen, was related to understanding the variation of Quaternary climate. During Lubbock’s early career, the notion of a ‘Glacial Period’, during which the temperate latitudes had been covered in ice, perhaps floating on water, became well established, having superseded the paradigm under which most superficial (‘drift’) deposits were attributed to the Noachian deluge.\textsuperscript{23} As radical as the theory that Britain had experienced widespread glaciation, generally credited to the influential visit by the Swiss alpinist Louis Agassiz, was the realization, in
Lubbock’s latter years, that there had been numerous glaciations, separated by interglacials. This was a view that again derived originally from the Alps, although the concept of glacial–interglacial cycles had been promoted in Britain during the late nineteenth century by its most ardent early advocates, James Croll and James Geikie. Lubbock frequently hinted in his writing about the importance of such climatic fluctuations; he believed that animals had migrated north–south in response to these cycles, showing that he was unconvinced by ideas of long-distance annual migrations and ‘furry’ hippopotamuses favoured by W. B. Dawkins and J. Prestwich, respectively, to reconcile the palaeontological evidence with their monoglacialist views. Lubbock, in contrast, was much impressed with the theories of Geikie and Croll, the latter of whom gave his name (jointly) to the Croll–Milankovitch (glacial–interglacial) climatic cycles driven by fluctuations in the Earth’s orbit around the Sun and in its axial tilt. Geikie, in *The Great Ice Age*, quoted from the third edition of *Pre-historic Times*: ‘our ancient hippopotamus has been less frequently found in association with the mammoth and the hairy rhinoceros, than with *Elephas antiquus* and *Rhinoceros hemitoechus* (Falc.).’ This was a somewhat cryptic observation in which Lubbock distinguished warm-climate and cold-climate mammalian assemblages.

In all this, Lubbock’s views were in marked contrast to those of many of his contemporaries, who retained stubbornly monoglacialist opinions; none more so than his fellow Prestwich medallist, the amateur malacologist, A. S. Kennard. As with many of the great controversies of his day, on this matter Lubbock is seen to have been on the side that eventually won the argument, having shown both prescience and foresight, often ahead of younger scientists such as Kennard.

**THE EVOLUTION OF RIVER VALLEYS, AS SEEN FROM THEIR TERRACES**

Lubbock’s quite modern understanding of Earth systems is seen in *Pre-historic Times*, in his description of valley evolution: ‘Gradually the river deepened its valley; ineffective, or
perhaps even constructive in summer, in autumn and winter, the melting of the snows turned it every spring into a roaring torrent. This underlines an essential difference in the ‘glacial’, as opposed to the familiar ‘interglacial’ fluvial environment, with a markedly larger discharge peak fed by springtime melting.

Lubbock had views on certain topics that can be related to modern-day controversies: arguments that have continued since his time or have been rekindled by reversals of opinion or the revisiting of older ideas. One of great importance to the main theme of this paper is uplift, which many (but by no means all) modern-day geomorphologists and Earth scientists consider to have been important as an influence on river terrace formation. The influential American geomorphologist, W. M. Davis, had considered regional uplift to be an essential ingredient in his theories of erosion cycles, in which he envisaged episodes of uplift to have been interspersed with periods of landscape planation. Such ideas probably influenced Lubbock, although during his career they were being replaced by a realization that such cycles were rarely, if ever, completed.

Lubbock’s belief in the occurrence of uplift is indicated by a passage from *Pre-historic Times*, in which he wrote:

> The neighbouring shores of England and France show various traces of a slight and recent elevation of the land. Raised beaches have been observed at an elevation of from five to ten feet at various points along the coasts of Sussex and the Pas de Calais... No doubt this change of level has an important bearing on the excavation of the valleys, but I cannot quite agree with Mr. Prestwich as to the effect which it has produced.

This further disagreement with Prestwich refers to the proposal by the latter that the elevation of raised beach deposits was the result of a major marine inundation rather than uplift.

Lubbock opined about the formation of river terraces in several of his publications. In *The Scenery of England* he defined two types of river terrace: ‘erosional terraces’ and ‘weather terraces’. By weather terraces he meant landscape benches caused by differential erosion of strata of different types and degrees of resistance; these can be dismissed as structurally controlled features, of little value as evidence for the history of landscape evolution, as Lubbock indeed recognized. Curiously, the examples of erosional terraces that he described in most detail in this book were from Switzerland (figure 4), despite the title of the treatise. In a recently glaciated area and a montane valley, these would not be comparable with the lowland valley terraces that form the significant bulk of such geological and geomorphological archives, and which, like those of the Somme, have provided much of the Lower and Middle Palaeolithic artefact collections.

Also curious is Lubbock’s suggestion that ‘River-terraces are perhaps not so conspicuous in our country as in some others’, mentioning as exceptions certain Yorkshire (eastern Pennine) rivers, including the Skell at Ripon. This last example, like those in Switzerland, would now be attributed to relatively recent landscape evolutionary processes, having formed since the disappearance of the Last Glacial ice sheets; in contrast, beyond the limit of that ice sheet, British river valleys abound in flights of terraces that date back to the early Pleistocene or the latest Tertiary.

Although this strange statement suggests that Lubbock was largely unaware of the ubiquity of river terraces in English valleys, the illustration in *Pre-historic Times* of numerous artefacts from terrace gravel contexts in different parts of England would seem to indicate otherwise. From the same book comes a tale of yet another friendly dispute with Prestwich and again
one in which Lubbock is seen to be the man of wisdom, revealing a much better understanding of valley evolution in the Somme than his geological mentor:

Mr. Prestwich regards the difference of level between the upper gravels and the loëss as ‘a measure of the floods of that period.’ If the gravel beds were complete, this would no doubt be the case; but it seems to me that the upper-level gravels are mere fragments of an originally almost continuous deposit, and under these circumstances the present cannot be taken as evidence of the original difference.

As the valley became deeper and deeper, the gravel would be deposited at lower and lower levels . . . In Fig. 142 [figure 5b] I have given a diagram, the better to illustrate my meaning; the loëss is indicated by letters with a dash and is dotted, while the gravels are represented as rudely stratified. In this case I suppose the river to have run originally on the level (1), and to have deposited the gravel (a) and the loëss (a'); after a certain amount of erosion which would reduce the level to (2), the gravel would be spread out at (b), and loëss at (b'). Similarly the loëss (c') would be contemporaneous with the gravel (c).

Thus, while in each section the lower beds would of course be the oldest, still the upper-level gravels as a whole would be the most ancient, and the beds lying in the lower parts of the valley the most modern. . . .

It is, however, well known that rivers continually tend to shift their courses . . . During these wanderings from one side of the valley to the other, the river continually undermines and removes the gravels which at an earlier period it had deposited. Thus the
upper-level gravels are now only to be found here and there, as it were, in patches, while in many parts they have altogether disappeared; as, for instance, on the right side of the valley between Amiens and Pont Rémy, where hardly a trace of the high-level gravels is to be seen.39

This text (with the accompanying figure) provides an elucidation of Lubbock’s understanding of the formation of aggradational river terraces; he realized that the valley floor of the Somme was formerly at the higher levels (1 and 2 in his figure; see figure 5b) indicated by the different gravel terraces, and that erosional processes have progressively destroyed the older terrace deposits. It is not entirely clear whether he saw a genetic link between these gravels, which he clearly recognized to have been formed on the valley floor, and the erosional terraces that he had observed in Switzerland. Indeed, he seems not to have used the term terrace in connection with such ancient river gravels and it does not appear in Pre-historic Times.40

Lubbock revisited river terraces in his book The Beauties of Nature: ‘Another prominent feature in many valleys is afforded by the old river, or lake, terraces, which were formed at a time when the river ran at a level far above its present bed.’41 His illustration in support of
this important observation is reproduced as figure 4b. Although he seems to have favoured fluvial response to uplift as a key driver in the formation of river terraces and raised beaches, Lubbock clearly understood the significance of sea-level fluctuation in response to glacial–interglacial climate change, illustrating in the 1913 edition of *Prehistoric Times* a map of western Europe during a sea-level low-stand, presumably at a time of glacial maximum (although no ice was shown). Interestingly, this depicts an English Channel River draining from (but not through) the Strait of Dover, as well as Thames, Rhine and Elbe courses across the floor of the North Sea (figure 6).
In an exposition of what we might now call ‘landscape inversion’, Lubbock noted, in *The Beauties of Nature*: ‘Rivers are in many cases older than mountains. Moreover, the mountains are passive, the rivers are active. . . . Many of our own English mountains were once valleys, and many of our present valleys occupy the sites of former mountain ridges.’ He continued: ‘in fact the mountain tops are not by any means the spots which have been most elevated, but those which have been least denuded; and hence it is that so many of the peaks stand at about the same altitude.’ In this second passage Lubbock seems to be alluding to the recognition of remnants of ancient surfaces, perhaps the ancient landscapes created by planation according to Davis’s theory of erosion cycles, already noted above as influential on Lubbock’s thinking in connection with uplift.

In another quote from *The Beauties of Nature*, Lubbock showed an understanding of gorge formation and drainage superimposition:

> as soon as the land rose above the waters, rivers would begin their work, and having done so, unless the rate of elevation exceeded the power of erosion of the river, the two would proceed simultaneously, so that the river would not alter its course, but would cut deeper and deeper as the mountains gradually rose.

He based this observation on cited examples, namely the Elbe through the Erz Gebirge, the Rhine through the mountains upstream of Coblenz, and the Potomac, Delaware and Susquehannah through the Alleghanies. Rivers indeed do not alter their courses when cutting through harder rocks (which invariably coincide with upland), which means that river terraces, which require a degree of lateral migration, tend to be absent from gorge reaches. A well-known British example is the Wye valley in the Welsh border country, which has a spectacular gorge through Carboniferous Limestone that has taken the whole of the Quaternary to reach its present depth, although there are some cut-off loops that represent occasional preservation of terrace levels.

On the basis of the lines of thinking illustrated thus far, Lubbock also provided a far-sighted explanation of the evolution of the drainage of the Weald, which has a ‘trellis’ pattern of rivers much cited in later text books. His explanation of how the rivers come to drain northwards and southwards in valleys cut as gorge-like reaches through the Chalk, instead of flowing eastwards along the easily denuded clay vales to empty into the sea between the North and South Downs, recognized the superimposition of this drainage pattern from the surface of the Chalk anticline, upon which it was originally formed.

Lubbock clearly realized that much could be learned from detailed study of ancient fluvial deposits; in particular he recognized the importance of identifying the various rocks represented among the gravel-sized material, a study that would now be termed ‘clast lithological analysis’. This is useful as a means of distinguishing between the products of different rivers, according to the geological outcrops in their catchments, although this is only of value beyond a descriptive aid if that origin is in doubt. Perhaps more important is the use of such information to determine changes in catchments and drainage organization over time. An example that is related to the evolution of the Weald was one Lubbock encountered very close to home, in the aforementioned pit at Greenstreet Green: in addition to the bones, he had also found here some cherty pebbles, which he inferred must have come from the Weald at a time when the river Cray rose much farther to the south than at present (its former central Wealden headwaters having been lost to river capture or piracy).
Again it was Lubbock’s French experiences that were influential in his thinking on such topics; he noted that the Seine has, in its gravels, exotic rocks from its headwaters, whereas the Somme valley, which is entirely contained within the Chalk, has none of the pebbles of pre-Cretaceous rocks seen in the adjacent catchment of the Oise, a Seine tributary, ‘and this, though the two rivers are at one point within six miles of one another, and separated by a ridge only eighty feet in height’.51 This confirmed to Lubbock that no catchment changes had taken place for the Somme, such as fluvial diversion, piracy or capture of the sort recognized by W. M. Davis, also from French rivers.52 Indeed, Lubbock wrote about and illustrated drainage modification as a result of river capture in the Upper Rhine catchment around Chur, Switzerland.53

SYNTHESIS AND CONCLUSIONS

John Lubbock, the man who became the first Baron Avebury, was a shrewd scientist with a knack of coming to the right conclusion, even when confronted with complex and controversial ideas that have continued to exercise his scientific successors in more modern times. In a recent review of the unravelling of the progressive accumulation of knowledge on the Stone Age, Lubbock is described as ‘a synthesiser of archaeological, anthropological and geological information’, who was regarded by his contemporaries as something of ‘a dilettante and a man of impulsive interests’.54 Modern scientists would probably be even more suspicious of someone whose scientific endeavour was shared with banking and politics. Nonetheless, as a synthesizer Lubbock had few equals in his day. His writings, the best-known being mostly books, lack detail in comparison, for example, with the works of Prestwich or Sir John Evans, his companions on the excursions to the Somme; however, they contain much insight and little that has not stood the test of time. A detailed investigation of his understanding of landscape and river-valley evolution shows that he could have produced a landmark early textbook on geomorphology; unfortunately he had too much else to do.

Lubbock gained much from his wide travels; his experiences and observations coloured his interpretations and, perhaps especially, his well-informed overview. This might help explain the contrast with the monoglacialist Kennard, whose xenophobic anti-German views fuelled his rejection of the ‘Teutonic’ notion of interglacials.55 Lubbock acknowledged the worth of his experiences in The Pleasures of Life, chapter 7, ‘The Pleasures of Travel’, which he prefixed with a (mis)quotation from Tennyson: ‘I am a part of all that I have seen’.56

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NOTES


J. Prestwich, ‘On the occurrence of flint-implements, associated with the remains of animals of extinct species in beds of a late geological period, in France at Amiens and Abbeville, and in England at Hoxne’, Phil. Trans. R. Soc. Lond. 150, 277–317 (1860); J. Lubbock, ‘On the Antiquity of Man, afforded by the Physical Structure of the Somme Valley’, Nat. Hist. Rev. 2, 244–269 (1862); J. Evans, ‘Account of some further discoveries of flint implements in the Drift on the Continent and in England’, Archaeologia 39, 57–84 (1863); J. Prestwich, ‘Theoretical Considerations on the Conditions under which the (Drift) Deposits containing the Remains of Extinct Mammalia and Flint implements were accumulated, and on their Geological Age’, Phil. Trans. R. Soc. Lond. 154, 247–309 (1864); J. Lubbock, Pre-historic times, as illustrated by ancient remains, and the manners and customs of modern savages (Williams & Norgate, London, 1865).


R. Owen, ‘Description of a fossil cranium of the Musk-buffalo (Bubalus moschatus, Owen) from the gravel at Maidenhead, Berks’, J. Nat. Hist. (2) 18, 188 (1856); idem, ‘Description of a fossil cranium of the musk-buffalo [Bubalus moschatus, Owen; Bos moschatus (Zimm. & Gmel.), Pallus; Bos Pallasii, De Kay; Ovibos Pallasii, H. Smith & Bl.] from the “lower-level drift” at Maidenhead, Berkshire’; Q. J. Geol. Soc. Lond. 12, 124–131 (1856).

J. Lubbock (Lord Avebury), Prehistoric times, as illustrated by ancient remains, and the manners and customs of modern savages, 7th edn (Williams & Norgate, London, 1913), p. 290. The hyphen had been dropped from the title for this edition.

J. Prestwich, ‘On the gravel near Maidenhead, in which the skull of the musk buffalo was found’, Q. J. Geol. Soc. Lond. 12, 131–133 (1856).


17 Hutchinson, op. cit. (note 5), vol. 1, p. 37.
18 Lubbock (1865), op. cit. (note 6), p. 311; see also ibid., pp. 328–329.
20 Lubbock (1865), op. cit. (note 6), p. 293, Fig. 141.
21 Lubbock (1865), op. cit. (note 6), p. 300; idem, op. cit. (note 10), p. 370. ‘Cataclysms’ were, indeed, much favoured by French geologists of the mid nineteenth century as a means of explaining various characteristics and contents of the ‘drift’; Lubbock argued strongly against this view (1865, op. cit., p. 301).
25 J. Croll, Climate and time in their geological relations; a theory of secular changes of the Earth’s climate (Appleton, New York, 1875); J. Geikie, The Great Ice Age and Its Relation to the Antiquity of Man (Appleton, New York, 1874). Croll developed a theory initiated by Joseph Athémar, Révolutions de la mer [Revolutions of the sea] (Carilian-Goeury et V. Dalmont, Paris, 1842).
27 Imbrie and Imbrie, op. cit. (note 22).
28 J. Lubbock, Pre-historic times, as illustrated by ancient remains, and the manners and customs of modern savages, 3rd edn (Williams & Norgate, London, 1872), p. 299.
30 Lubbock (1865), op. cit. (note 6), p. 308.
33 Lubbock (1865), op. cit. (note 6), pp. 310–311.
34 Prestwich (1864), op. cit. (note 6), p. 297.
Lubbock on river terraces

39 Lubbock (1865), *op. cit.* (note 6), p. 309.
40 Pettitt and White (*op. cit.* (note 7)) suggest that *Pre-historic Times* was only nominally updated despite its seven editions, which might perhaps explain this curious omission.
43 Lubbock, *op. cit.* (note 41), p. 298.
51 Lubbock (1865), *op. cit.* (note 6), p. 291.
53 Lubbock, *op. cit.* (note 41), pp. 306–307; *idem*, *The scenery of Switzerland and the causes to which it is due* (Macmillan, New York, 1896).
55 Preece, *op. cit.* (note 29).
59 Lubbock (1902), *op. cit.* (note 26).
60 Lubbock (1896), *op. cit.* (note 53).
61 Lubbock, *op. cit.* (note 41).
62 Prestwich, *op. cit.* (note 6).