Lower down these valleys, at Leamington, when excavations were being made in the Jephson Gardens, bones of Elephant and Rhinoceros were found.

It remains now only to speak of the alluvial soil in these valleys and its contents. It does not appear to be anywhere very thick; perhaps 7 or 8 feet is the outside; and it therefore merely fills up slight depressions in the valleys previously existing. The present streams go on adding to the alluvial soil by the frequent floods, and must be considered adequate to have produced the whole of it.

The discovery of bones in this alluvium a few years ago caused considerable interest. This discovery was due to the industry and acuteness of Mr. E. Cleminshaw, then a pupil in the School. He made the discovery entirely his own by finding several places where such bones are to be met with. The most interesting of these are in the bed and banks of the stream near Newton, in the Avon a little below Newbold, and close by the little bridge below the Little-Lawford Mill. These bones have not been specifically determined; and I cannot pronounce on them. A large collection of them is in the Arnold Library at Rugby. Three or four flints were found with them, which have been pronounced by fairly competent judges to be probably flint weapons. But I found in one of these localities, associated with the same bones, a piece of a wine-bottle, some pottery, not ancient, and the bowl of a tobacco-pipe; I am therefore sceptical.

This concludes this short notice on the superficial deposits near Rugby; and I am not without hope it may be found useful to those who are engaged upon the problem of determining the history of the processes which the surface of the midland counties has undergone in the latest geological ages.

3. *On the SUPERFICIAL DEPOSITS of PORTIONS of the AVON and SEVERN VALLEYS and adjoining Districts.* By T. G. B. LLOYD, Esq., C.E., F.G.S.

INTRODUCTION.

In the following paper I propose to describe first of all the facts which I have collected together upon the subject, and secondly to show what probable inferences may be drawn from them, in explanation of the relative antiquity of these river-valleys and their superficial deposits.

PART I. THE SUPERFICIAL DEPOSITS OF THE VALLEY OF THE AVON.

Literature of the Subject.—Sir W. Jardine's 'Memoirs of H. E. Strickland' contain several papers on the Geology of Worcestershire and Warwickshire, in which are found very clear and accurate descriptions of many of the phenomena of the drifted deposits of the Avon valley and surrounding country. An account is given of the late Professor Strickland's discovery of land- and freshwater shells, associated with mammalian remains, in the gravel-beds of

the Avon Valley, near Cropthorne in Worcestershire, which are referred to by Sir R. I. Murchison in his 'Silurian System.' My own investigations are merely an extension of those commenced by Strickland, to whose writings I am much indebted for valuable information, and many suggestions.

In July 1868, a paper was read by Mr. E. Cleminshaw, at a meeting of the Nat. Hist. Society of Rugby School, on the river-gravels of the Avon in the neighbourhood of Rugby; and this was followed in the published report by a note written by Mr. Jas. M. Wilson, F.G.S., which I recommend as worthy of the attention of all who are studying Postpliocene geology. I must also refer to a short paper by the Rev. P. B. Brodie, F.G.S., called "Remarks on the Drift in a part of Warwickshire" (Quart. Journ. Geol. Soc. vol. xxiii.). In Sir R. I. Murchison's chapters on Drift, in the 'Silurian System,' the subject of the *northern drift* is extensively worked out.

General description of the River and Valley of the Avon.—The

Fig. 1.—Section across the Valley of a Tributary of the Avon.
Distance 2 miles.

river Avon rises near Naseby, in Northamptonshire, whence, taking a south-westerly course by Rugby, Warwick, and Stratford-on-Avon, it flows past the town of Evesham through a narrow bend of the valley, below which it enters a broad alluvial plain, and, following a tortuous course by Fladbury, Cropthorne, Pershore, and Defford, finally enters the Severn at Tewkesbury, having accomplished a distance from Rugby, as measured along the valley, of about sixty-four miles. Its principal affluents are the Swift, the Leam, the Arrow, and the Bow. The basement rocks, which belong to the district of the valley between Rugby and Tewkesbury, occur in the following order:—Lower Lias limestone and clay from Rugby to King's Newnham; New Red marl and "waterstones" from King's Newnham to Cloud Bridge; Permian conglomerate from the latter place to within a few miles of Warwick, where the Keuper series reappears; between Stratford-on-Avon and Tewkesbury the Lower Lias clay predominates, the Keuper marls occupying only a narrow area of about six miles in width between Stratford and Evesham, and occurring again on a line of fault near Fladbury. Bredon Hill is an outlier of Blue Lias clay and Inferior Oolite.

Description of Transverse Sections.—In a section taken across the valley of a tributary stream between Rugby and Clifton (fig. 1), *a, a, a* represent beds of Boulder-clay, quartzose flinty gravel

and sand, capping the higher ground at Rugby and Clifton, and descending into the valley, where they increase in thickness; *c, c*, the supposed position of the Lower Lias clay on which the drift lies.

In a section taken across the valley of the Avon, from the summit of the hill on which the town of Rugby stands to the Brownsover intrenchments, excavations made on different parts of the hill show that the Boulder-clay, with its associated beds of gravel and sand probably extends some distance down its flanks. A boring made on the line of section near the river came upon the Lias at a depth of six feet from the surface. On the hill towards Brownsover the existence of the Boulder-clay and other drift could only be inferred. The modern alluvium on each side of the river is the only freshwater deposit apparently existing thereabouts.

Fig. 2 represents a typical section across the Avon valley, from the summit of Bredon Hill to the top of Cracombe Hill, which is taken along such parts of the valley as illustrate in the best manner the relative distribution of the different classes of the superficial deposits.

Provisional Classification of the superficial Deposits of the Valley of the Avon and adjoining districts.*

Upper Series, ranging from 430 feet to 300 feet above the sea:—

* The letters refer to the localities in the Table (p. 216); and the numbers denote the order of the succession of the beds from the surface of the ground downwards.

Fig. 2.—Typical Section across the main Valley of the Avon, near Cropthorne, Worcestershire.—Distance $5\frac{1}{4}$ miles.

A (1). Quartzose flinty gravel and sand (usually stratified). "General Flinty Drift" of Strickland.

B (2). Boulder-clay. A stiff, compact mass of sandy unstratified clay or earth, varying from a slaty blue to a purple colour, full of grooved and striated boulders of blue Lias limestone, white Chalk, and white Lias limestone, smoothed and polished pebbles of quartzite, showing fine striæ on their surfaces, scratched subangular flints, and subangular blocks of syenite. In places there are thin seams and lenticular masses of quartzose sand imbedded in it.

B (2). A light-red, sandy, unstratified clay, compact and hard, containing quartzose pebbles and a few boulders, which occasionally exhibit traces of glacial action. In places the colour of the clay changes to a dark brown or chocolate tint.

C (3). Laminated clay of brown and green colours.

D (4). Laminated sand of a light red colour.

E (5). Clean, quartzose flinty gravel and sharp sand, containing gryphites much water-worn, and other derivative fossils (unstratified).

F. "General quartzose Drift" of Strickland, or "Northern Drift" of Sir R. I. Murchison. It consists, as far as I have been able to ascertain, of a red compact loam, and light-red quartzose sand, which contain quartzite pebbles and fragments of other rocks (mainly unstratified), viz. of white quartz, felstone, flints, &c.

Lower Series, ranging from 300 feet to 50 feet above the level of the sea:—

G. "General Flinty Drift" of Strickland. Beds of quartzose flinty gravel, generally unstratified, but occasionally showing a stratified arrangement in the lowest and uppermost beds.

H. "Local Drift" of Strickland, principally composed of detritus from the Oolitic rocks in its immediate vicinity, with a small proportion of quartzose pebbles, sand, and flints. The beds are stratified, and contain in places marine shells and mammalian remains.

Freshwater Deposits, ranging from about 290 feet near Rugby to somewhat near 30 feet above the level of the sea:—

Quartzose flinty gravel and sand, with occasional seams of clay.	} Land and freshwater shells and mamma- lian remains.
Light-red loam or brick-earth.	
Peat.	
Modern alluvium.	

The above classification may appear to many needlessly detailed; but I have adopted it after a good deal of consideration, as being one which, I think, is best adapted for excluding all theoretical assumptions regarding the relative connexion and sequence in point of time of the different classes into which I have divided the drifted deposits. In some cases the apparent absence of certain beds and the non-occurrence of marine shells and mammalian remains rest entirely on negative evidence, which future investigations may modify.

The late Professor Strickland divided what he called the marine

drifts of Worcestershire and Warwickshire into three classes, viz. “(1) Erratic gravel without chalk-flints, (2) Erratic gravel with chalk-flints, (3) Local or non-erratic gravel;” from which it appears that he was not aware of the existence of the Boulder-clay in those counties, although he mentions the occurrence of a stiff clay, containing fragments of chalk, near Princethorpe, in Warwickshire.

Description of the Drifts of the Upper Series.—Referring to the accurate descriptions of the several classes of drift and their geographical distribution, contained in the papers of Strickland previously mentioned, I shall confine myself to some observations bearing on the extension of the subject which I have had the opportunity of making.

A (1). This deposit of quartzose flinty gravel and sand is found overlying the Boulder-clay in the neighbourhood of Rugby; in some places it rests immediately upon the basement rock, as at Kenilworth, where it shows signs of stratification, the sand being laminated in the middle bed. A small rounded boulder of grey-coloured porphyritic granite was observed lying in the upper gravel-pit adjoining.

B (2). The area covered by the Lower Lias clay defines pretty accurately the boundary of the purple-coloured Boulder-clay in the north-east part of Warwickshire. The deposit is irregularly distributed over the surface of the high ground, whence it descends into portions of the valleys, attaining a considerable thickness in both situations.

B (2), F. After leaving the district of the Lias, and passing downwards to the region of the New Red Marls, we find a change in the composition and colour of the unstratified beds. Although I have separated them into two classes B (2) and F,—their characteristic features are so much alike, that I believe they both belong to the “General Quartzose Drift” of Strickland, or “Northern Drift” of Sir R. I. Murchison. The composition of the beds in the district in question has been described in general terms by Strickland. With regard to the occurrence of flints in them, my observations have led me to conclude that these are distributed through the beds in a persistent manner, although the relative proportion of them to the other components is small. Seams of carbonaceous matter and lumps of drifted coal are not unfrequently met with. In a sand-pit on the north-west side of Cracombe Hill I observed a peculiarly contorted arrangement of the beds. Narrow seams of finely laminated sand of a red colour were seen interbedded between layers of fine sandy gravel. On the right-hand side of the section appeared a thin seam of light-coloured marl following a curved direction. The longer axes of the pebbles and the sand-seams were inclined at an angle of about 70° N.W. At Sheriff’s Lench and in the quartzose flinty gravel at Bredon I have observed somewhat similar phenomena. The liver-coloured and greyish pebbles of quartzite, so abundant in these beds, are commonly found broken in half, having their fractured edges slightly rounded; their surfaces exhibit small hollows of a lightish colour, due probably to disintegration. The pebbles

in the Bunter-conglomerate beds in the neighbourhood of Bromsgrove, present in many cases the same appearances; and some of them are found with cracks across them, which yield to the pressure of the hand.

C (3) has only been observed hitherto at Snitterfield, Welcombe Hill, and in a brickfield near the New Inn, Ridgway, accompanying the beds B (2) and F. It varies from about 7 feet to 4 feet in thickness.

D (4). This bed appears to be the one which is most persistent in its occurrence of any in the upper series. It has been traced from the neighbourhood of Rugby, where it attains to a minimum thickness of about 50 feet near Hillmorton, to near Princethorpe, where it occurs both under the Boulder-clay and between it. It is met with again in the neighbourhood of Warwick and Leamington, continuing down as far as the Lenches, beyond which there is no certain evidence of its occurrence, although it probably underlies the red loam on Cracombe and Charlton hills. The exact thickness of the bed has not yet been ascertained where it occurs in the neighbourhood of Rugby; but in the district of the New Red marl it averages about 10 feet in thickness. In some of the localities it contains quartzose pebbles and flints.

E (5). This deposit bears much resemblance to the freshwater gravel hereafter to be described. It appears to be a well-washed bed of gravel and sand, containing pebbles of white quartz, a few flints, and numerous water-worn specimens of *Gryphæa incurva* and *Belemnites*. I also obtained from it a fragment of coral and what appeared to be a fragment of *Encrinite* limestone. It is doubtful whether it exhibits any signs of stratification or not. The only localities in which I have met with it are at Snitterfield, near Warwick, near the Brickyard, Leamington, and Welcombe Hill, near Stratford-on-Avon. It is said to occur near the "New Inn" on the Ridgway.

In order to make clearer the order of superposition of the deposits above described, I subjoin two typical sections—the one taken from the beds occurring in the Lias district, and the other from the area of the New Red marls.

Section A.

	ft.
A. (1). Average thickness.....	7
B. (2). On the high ground.....	9
" When occurring in a valley ...	30 and upwards.
D. (4). Total thickness unknown	50 and upwards.

Basement rock—Lower Lias clay and limestone.

Section B.

	ft.
B (2) and F. Average thickness about	10
C. (3) Average thickness about	3
D. (4) Average thickness about	10
E. (5) Average thickness uncertain.	

Basement rock principally New Red marl*.

* Some of the localities, although occurring on the Lias, are in the vicinity of the New Red marls.

Before concluding the description of the beds of the Upper Series, it may be well to call attention to a singular arrangement of drift which occurs in a brick-pit on Black Hill, Snitterfield, near Warwick (fig. 3).

A somewhat wedge-shaped mass of compact "clunchy" clay of red and greenish colours was observed on the face of the pit to break the continuity of a bed of light-red loam, and to rest, as far as one was able to judge, upon the laminated clay below. Its dimensions, as measured on the face of the section, were 66 feet from A to B, 30 feet from C to D, vertical depth 19 feet. The total size of the mass is not known, nor was I able to trace its superficial area. It appeared to contain sand mixed up with clay and quartzose pebbles. The locality is on the most elevated ground thereabouts. I could not detect any dislocation of the beds of red loam along the lines A to C and B to D. I may mention here that a fragment of bone, now in the possession of Mr. Kirshaw, F.G.S., of Warwick, was said by the foreman to have been found in the gravel-bed below.

Fig. 3.—Section in Brick-yard at Black Hill, Snitterfield.

a. Surface-soil. b. Light-red loam and sand. c. Carbonaceous seam. d. Finely laminated green and reddish-brown clay. e. Finely laminated light red quartzose sand. f. Quartzose sand and gravel, with *Gryphææ*, *Belemnites*, *Encrinital* limestone, &c.

Lower Series.

G. Starting from the discovery of a bed of unstratified quartzose flinty drift at Bredon, near Tewkesbury, which was described by Strickland under the head of "Marine Erratic Gravel with Flints" (Trans. Geol. Soc. N. S. vi. p. 554), I have succeeded in tracing the existence of beds of a similar character in various localities, from Berry's Coppice, near Donnington, to within a short distance of Tewkesbury. As will be seen from the general Table of Localities, they occupy elevations from 180 feet to 67 feet above the river Avon. As a general rule, decreasing in altitude seaward, on the south-east side of the Avon, between Evesham and Bredon, they range along the upper edge of an escarpment of Lias which lies at the base of what I have termed the main valley; at the bottom of

the escarpment the outer edges of the freshwater beds are seen to rest. On the north-west side of the Avon isolated patches of the same class of deposits are found on the upper side of the valley of the Arrow, near Donnington, on the summits of Green Hill, Evesham, Mount Pleasant, Pershore, and on the commons of Shut-hanger and Shoebarrow, near Tewkesbury. They may be said to consist, for the most part, of red loam and sand, containing pebbles of white quartz, quartzite, and felstone, associated with a considerable percentage of black flints, which seem, in many cases, but slightly water-worn, besides numerous angular flake-like fragments of a whitish siliceous substance, which appear to be composed either of flint or chert. At Bengeworth Hill and Green Hill, near Evesham, the beds average 5 feet in thickness; at the former locality the surface of Blue Lias clay on which they rest is much eroded; their maximum thickness, wherever I have had an opportunity of measuring them, was about 15 feet.

At Berry's Coppice, near Donnington, and on Cropthorne Heath, an unstratified bed of ferruginous gravel contains, in its upper part, small pockets and accretions of a light-coloured siliceous sand, mixed with pebbles (fig. 4). In one part of the pit on Cropthorne Heath I observed a pocket of ferruginous gravel without any intermixture of the whitish sand, in which the pebbles were arranged principally with their longer axes variously inclined, accommodating themselves, as it were, to the truncated conical form of the pocket. In the section a singular ridge and furrow-like outline of the stratified

Fig. 4.—*South Face of Gravel-pit on Cropthorne Heath.*

- a. Light grey vegetable soil with a few pebbles. b. Fine gravel. c. Red sand. d. Fine gravel. e. Red and white sand. f. Coarse ferruginous gravel and loamy sand. g. Blue Lias clay.

portion of the beds is seen, the red sand of which is of a lighter colour than that of the bed below. The pebbles appear to be alike in character throughout the deposit. At Berry's Coppice the highly inclined position of the pebbles in the ferruginous gravel is seen extending throughout a considerable portion of the section. In the same locality stratified sand and gravel was seen near the bottom of the pit. In the seams composed partly of whitish and partly of red

sand I found a fragment of a shell which Mr. Etheridge considered to be a portion of a *Cyprina islandica*, remarking at the time that it was a very difficult piece to determine. At Brick Hill I have observed accretions of whitish sand in a bed of light-red loam; and on Mount Pleasant the same kind of sand has been met with. It may be remarked here that the deposit on Crophorne Heath, described above, is partially surrounded by beds of freshwater origin, between which there is a minimum difference of height of 30 feet.

H. About three years ago, during the construction of the Evesham and Ashchurch railway, a large excavation was made for ballast at the base of Bredon Hill, near Beckford, where the following section was exposed, for an account of which I am indebted to Mr. W. C. Lucy, F.G.S., of Gloucester.

No. 1.

	ft.	in.
(1) Soil.....	3	0
(2) Gravel	9	0
(3) Seam of clay	0	2
(4) Gravel	0	3
(5) Discontinuous bed of clay.....	0	2
(6) Gravel	0	3
	<hr/>	<hr/>
	12	10

Basement bed of Lower Lias clay reached at 17 feet below the surface.

On visiting the locality I found that the former excavations had been filled in; but near the north-east end of the old workings the following section was exposed in a sand-pit.

No. 2.

	ft.	in.
Surface of ground.		
(1) Dark-brown earth without pebbles.....	3	3
(2) Bed of coarse fragments of Oolitic limestone ...	2	9
(3) Beds of small fragments of Oolitic rock, alternating with thin seams of light-coloured quartzose sand.....	7	0
Bottom of pit.	<hr/>	<hr/>
	13	0

The beds nos. 2 and 3 contained Oolitic fossils, quartzose pebbles, and flints.

In a sand-pit at Bredon's Norton I counted as many as thirteen alternations of gravel, sand, and clay in a vertical depth of about $4\frac{1}{2}$ feet.

Judging from the depth of the basement clay in Section No. 1, it would appear that the total thickness of the deposit in the sand-pit at Beckford is about 20 feet. From the contour of the surface of the ground in the neighbourhood, it seems likely that the beds in question form mound-shaped accumulations, which slope upwards towards the summit of Bredon Hill, and extend round a considerable portion of its base.

In Mr. W. Boyd Dawkins's list of Postglacial Mammals (Quart.

Journ. Geol. Soc. vol. xxv. p. 195) the following mammalia are noted under the locality "Beckford."

Cervus tarandus.	Sus scrofa.
Bos primigenius.	Rhinoceros tichorhinus.
Bison priscus.	Elephas primigenius.

The President of the Cotteswold Club, Sir W. V. Guise, Bart., F.G.S., in his address for 1865, stated that, when at Beckford, in company with the Rev. W. S. Symonds, he found a fragment of a shell which Mr. Gwyn Jeffreys pronounced to be a portion of a *Lucina borealis*. I have also seen it stated that Miss Holland, of Dumbleton, found a *Rissoa* at the same place.

Before concluding the description of the Lower Series I may perhaps be permitted to call attention to the occurrence of a stratified deposit occurring on the eastern side of Cropthorne Hill, which has not yielded hitherto any positive evidence to show whether it is of marine or freshwater origin. A section in a sand-pit gives:—

(Surface of ground 110 feet above the sea, and 60 feet above the Avon.)		ft.	in.
(1) Vegetable soil		1	0
(2) Irregular bed of dark red loam, containing large and small pebbles of white quartz and flints ...		4	0
(3) Fine red laminated sand		2	0
(4) Quartzose gravel		0	3
(5) Fine red sand		3	0
(6) Quartzose gravel		0	3
(7) Fine red sand		1	0
(8) Quartzose gravel		0	2
(9) Light-red laminated sand		3	0
(10) Dark red loam		0	6
(11) Dark red sand		4	0
(12) Red clayey loam		0	2
(13) Red sand		2	6
Bottom of pit.			
		21	10

The sand has been excavated to a depth of about 30 feet from the surface without having reached the basement rock. No traces of mammalian or molluscan remains have hitherto been discovered. The summit of the hill on which the village of Cropthorne stands is covered by a capping of gravel, apparently of a similar character to that occurring on Cropthorne Heath, already described. As far as I am aware, boulders are seldom met with in the gravelly drift of the Upper and Lower Series.

Freshwater Deposits.—Quartzose, flinty gravel, and sand, with occasional seams of clay. (Land and freshwater shells and mammalian remains.)

From some point between the villages of Lawford and Stoneleigh, the exact locality of which is not known, beds of alluvial gravel and sand can be traced, with occasional interruptions, on both sides of the Avon, to within a short distance of the town of Tewkesbury, their heights above the river increasing for the most part as they approach its mouth. On the whole they present a remarkable uniformity of composition, thickness, and arrangement of parts,

though between Stratford-on-Avon and Evesham they appear to contain fewer flints in proportion to the rest of their constituents than the deposits of a similar class occurring higher up and lower down the valley. The width of the beds from above Stoneleigh to Evesham is on an average about $\frac{3}{4}$ mile. Between Evesham and Tewkesbury they attain their maximum superficial development, having a width of about $1\frac{1}{4}$ mile. The average thickness of the beds, taken from measurements in eighteen different localities, is 7 ft., their maximum thickness being 12 ft. The inner margins of the beds form in most cases banks about 3 ft. in height above the surface of the modern alluvium. I have no positive evidence to show whether the gravel-beds pass under the latter; but from accounts which I have received of several borings made down to the basement-rock in different localities, it would appear that no gravel was met with. As Strickland formerly remarked, this description of Drift appears to be made up of the other three kinds, viz. the "quartzose, the "flinty," and the "local" drifts. The bed resting on the basement-rock is in most cases composed of sand, which fills up the furrows occurring in the rock.

By means of levels taken at different points across the valley, near Fladbury and Cropthorne, I have been enabled to group together the isolated patches of gravel occurring thereabouts, as will be seen in the following Table:—

<i>Localities situated on the Right Bank of the River.</i>		Approximate heights above the river. feet.
Railway-cutting, Fladbury		30
Gravel-pit in the Rector's Field, Fladbury		25
Gravel-pit near the outer edge of the modern alluvium, Spring Hill		10
Gravel-pit on north side of Farm-house, Spring Hill		20
Gravel-pit on east side of same		21
Gravel-pit near Moore		23
Ballast-pit near Wyre		25
<i>Localities situated on the Left Bank of the River.</i>		
Bank of gravel adjoining the modern alluvium, Fern Hill		14
Gravel-pit in farm-yard, Charlton		29
Ballast-pit, near Charlton		30
Gravel-pit near Cropthorne Ford		21
Gravel-pit in North Charlton Field		25
* Gravel-pit near the "New Inn," Cropthorne		40
* Old Brickyard near Bricklehampton Bank	(about)	37
* { Gravel-pit on top of river-bank, near Wick		31
* { Gravel pit near Little Comberton		40

Some of the localities (bracketed together) are situated on the same plateau of gravel, whilst others are cut off from it by the valleys of small streams. The beds where the localities marked by asterisks occur do not appear to be connected in an obvious manner with the rest. I may therefore, perhaps, be allowed to describe them more in detail.

Cropthorne Heath, where the drift-gravel containing the light-coloured sand is found, occupies a central position with regard to the

localities in question. On the east lies the gravel-pit near the New Inn, separated from it by a small valley, through which a brook runs; the brick-yard near Bricklehampton Bank faces the river on the west; whilst to the south is seen the shallow valley in which the pits near Little Comberton and Wick are situated. As may be seen from the Table (p. 216), the elevation of the drift in the gravel-pit on Cropthorne Heath is 33 ft. above the mean height of the freshwater beds in the four localities just named.

Section in Gravel-pit near the New Inn, Cropthorne.

	ft. in.
Surface of Ground.	
Light-coloured earthy clay, with a few pebbles	1 8
Red cohesive clay	1 6
Quartzose flinty gravel, with chalky-looking seams and layers of red and light-grey sand (whitish)	3 0
Quartzose flinty gravel, with layers of red and whitish sand (no chalky seams).....	1 10
Light-red sand, obliquely laminated with a seam of gravel 1 inch thick	1 0
Red sandy clay, adhesive when moist	1 0
Light-grey sand (whitish).....	1 0
Blue Lias clay.	11 0

A considerable number of large quartzose pebbles were mixed up with the finer gravel. A rounded boulder of Felstone, measuring about 2 ft. 2 in. $\times$ 1 ft., was found lying on the surface of the Lias clay.

The gravel-pit near Little Comberton, remarkable for having yielded a very fine tusk of *Hippopotamus major*, now in the Worcester Museum, is situated at a distance of about a mile from the present river. A section in it was as follows:—

	ft. in.
(1) Surface of Ground.	
(1) Light-coloured marly earth, with a few pebbles.....	2 0
(2) Fine, quartzose flinty gravel, with seams of light-red sand...	4 0
(3) Light-red sand, with small pebbles (chiefly of flint)	0 3
(4) Fine, quartzose, flinty gravel, and red sand.....	1 0
(5) Whitish-coloured sand	0 6
(6) Fine, quartzose, flinty gravel, and red sand	2 6
Blue Lias clay.	10 3

In the bed no. 5 I found numerous specimens of freshwater shells enclosed in streaks of light-red clay. The surface of the basement clay was very uneven. In another part of the same pit, now filled in, the Rev. W. Parker, of Little Comberton, informed me he had found the lowest stratum composed of mud containing freshwater shells and remains of aquatic plants, lying on an uneven surface of blue Lias clay. For a description of the brick-earth and gravel near Bricklehampton Bank, I must refer my readers to the Strickland Memoirs, page 98, and the 'Silurian System,' pages 555, 556).

Boulders are occasionally met with in the freshwater gravels, occurring on the surface of the basement clay. The largest I have seen was found in the ballast-pit near Charlton; it was composed

of Felstone, and measured 4 ft. $\times$ 1 ft. 8 in. $\times$ 1 ft. 4 in. The derivative fossils are chiefly *Cardinia*, gryphites, and corals from the Lias beds, with belemnites &c. from the Oolite. Fragments of silicified wood, such as is found near Coventry, in the Permian Sandstone, are found in the gravel round Warwick.

I am indebted to Mr. R. C. Tomes, F.L.S., for the following remarks on the local distribution of the corals occurring in the gravel:—"In the fluviatile gravel of Leamington (on the river Leam) a species of *Montlivaltia* occurs pretty frequently, which is so plentiful in the upper beds of the Lower Lias at Fenny Compton, about 10 miles distant. Lower down the Avon, at Welford, below Stratford-on-Avon, the gravel contains a small Lias coral, *Montlivaltia rugosa*, found in the corresponding bed in the Lower Lias at Honeybourne, about 5 or 6 miles distant. At Fladbury are found specimens of the Mesozoic *Septastræa Eveshami* and *Haimii* from the adjacent 'Angulatus-beds' of Chadbury. The specimens of *Septastræa* show but little signs of attrition, whilst a Silurian coral (from Charlton ballast-pit) appears much water-worn. Near Upton Snodsbury I obtained a specimen of *Septastræa* from the beds of gravel, which contain but few flints, in the valley of the Bow, where also mammalian remains and freshwater shells have been discovered."

There are only two localities in the valley of the Avon, between Rugby and Tewkesbury, in which deposits of brickearth have been met with, as far as I am aware, viz. at Bengeworth, near Evesham, and at Bricklehampton Bank, near Crophorne, before alluded to. In the latter the workings have been abandoned for many years past, and are now entirely covered up. The beds of brickearth and gravel at Bengeworth are exposed in a brick-yard on the north-west side of Knowle Hill, where they rest on a bed of blue Lias clay at a distance of about half a mile from the river. I have been unable to ascertain their superficial extent, in consequence of the absence of any exposure of them, excepting at the locality in question. On the north-east side of the pit a bed of unstratified quartzose flinty gravel belonging to the "Lower Series" appears to be cut off towards the south-west by the brickearth. The height of the surface of the loam above the river is somewhere about 60 ft. The valley thereabouts is narrow and deep. On the north-east the loam has been removed, and the excavation filled up in part. The dip of the lower gravel-bed is 5° N.E. and S.W. (I have omitted the dips in the preceding descriptions, having found, by repeated trials that, when taken over so limited an area as is exposed in a ordinary gravel-pit, they were not to be relied on.) I believe the mammalian remains were found chiefly in the lower gravel-bed, and that the specimens of *Unio ovalis* occurred in the loam. A section taken near the centre of the pit exhibited the following arrangement:—

	ft. in.
(1) Light-red loam, containing local seams of fine quartzose flinty gravel	20 0
(2) Quartzose flinty gravel and sand	2 6
	<hr/> 22 6

Peat-beds.—A bed of peat about 8 ft. thick, resting on gravel, was cut through some years ago at Chadbury; in it many horns of Red Deer were found.

Modern Alluvium.—This deposit of alluvial silt, containing layers of vegetable matter, mammalian remains, and land and freshwater shells, seems to be continuous from Rugby to Tewkesbury, increasing in thickness as we descend the river, from about 6 ft. to about 15 ft. In the neighbourhood of Rugby, near Little Lawford, a well-known discovery of mammalian remains and shells was made in the year 1815, of which a short account is given in Dr. Buckland's 'Reliquiæ Diluvianæ.' I believe that the Rev. Andrew Bloxam, then residing at Rugby, was the first person to call Dr. Buckland's attention to the discovery. In a letter to me, in reply to a query about the meaning of the term "drift," as applied by him to the deposit in which the remains were found, Mr. Bloxam says, "The drift in your plan, as far as I can remember, was alluvial loamy soil, at the bottom of which, just above the clay (Lias?), was a layer of a few inches thick of a black peaty kind of deposit, in which the bones were deposited, some of which, however, had sunk into the clay beneath." Dr. Buckland remarks, in his work, that the bones appeared not in the least degree mineralized, and had lost scarcely any thing of their animal matter and weight.

As a general rule, the mammalian remains have been found, according to all accounts, either resting immediately on the surface of the basement clay or else in the lowermost beds of the freshwater gravels. The land and freshwater shells have been pretty much confined to the lower beds in the few localities where they have hitherto been found; with the exception of the case recorded by Sir R. Murchison, near Bricklehampton Bank, the bones &c. usually have occurred singly, and the shells were well preserved, with their valves often in contact. No stone implements, as yet authenticated, have, I believe, been found in the superficial deposits of the Avon valley.

List of Mammalia from the Freshwater Deposits of the Avon, compiled from Mr. Dawkins's Table.

Canis lupus.	Bison priscus.	Rhinoceros tichorhinus.
Hyæna spelæa.	Hippopotamus major.	Elephas antiquus.
Cervus tarandus.	Sus scrofa.	E. primigenius.
C. elaphus.	Equus caballus.	

NOTE.—*Canis lupus* is found in the Table under the locality "Tewkesbury."

TABLE OF THE LOCALITIES OF THE DRIFTS OF THE AVON VALLEY AND ADJOINING DISTRICTS, WITH THEIR HEIGHTS ABOVE THE SEA*.

Upper Series, ranging from 430 feet to 300 feet above the level of the sea.

Localities.	Letters of reference.	Approximate	
		Height above sea-level.	Height above the river.
		ft.	ft.
Environs of Rugby (maximum height) ...	A, B, D.	380	89
Stretton, near Dunsmore (vicinity of).....	B, D.	360	75
Kenilworth Common.....	A ?.	325	60
⊕ ?Snitterfield, near Warwick	B, C, D, E.	300	112
Welcombe Hill, near Stratford-on-Avon...	B, C, D, E.	351	211
Brick-yard near the New Inn, "the Ridgeway"	B, C, D, E.	430	390
Weethley and Cook's Hill.....	B, D.	350	250
Oversley Upper Lodge farm, near Alcester	F.	310	190
Church Lench.....	D (G, F?).	355	305
Cracombe Hill, near Evesham	F.	370	320
Sheriff's Lench	F.	350	310

Lower Series, ranging from 300 feet to 60 feet above the level of the sea.

Welford and Weston Holes, near Stratford	F.	224	124
Berry's Coppice, Donnington	G.	280	180
Green Hill, Evesham	G.	200	120
Knowle Hill, Evesham (brick-yard)	G.	160	80
Charlton Hill	? G or F.	160	103
Cropthorne Heath	G.	120	70
Cropthorne Hill (summit of)	G.		
Brick Hill, near Pershore	G.	120	80
Mount Pleasant, Pershore.....	G.	150	110
**Beckford	I.	140	110
Bredon's Norton.....	I.	120	70
Bredon.....	G.	104	67
Shuthanger and Shoebarrow Commons, Tewkesbury.....	G.	114	88

Freshwater Series, ranging from 274 feet to about 30 feet above sea-level.

Beds of gravel and sand from between Rugby and Stoneleigh to near Tewkesbury, ranging from about 10 feet in the upper valley, to 40 feet in the lower valley, above the existing river.

Modern alluvium from Rugby to Tewkesbury.

Brickearth at Bengeworth and Bricklehampton Bank near Cropthorne.

Peat-bed at Chadbury.

* The heights above the river are measured from the point nearest to the locality. The sign ** indicates the presence of marine shells and mammalian remains ; ⊕ indicates mammalian remains without marine shells.

Part II. THE SUPERFICIAL DEPOSITS OF THE SEVERN VALLEY AND
ADJOINING DISTRICT.

Introductory Remarks.—In order to carry out the object I had in view at the commencement, of making the descriptions of the facts belonging to the subject of this paper in a great measure supplementary to those of others, I shall limit myself, as much as possible, to a statement of such of them as I believe have not yet been brought under the notice of the Society.

Literature of the Subject.—Sir Roderick Murchison, I believe, first brought under the notice of geologists, in the ‘Silurian System,’ the discovery of marine shells and mammalian remains in the drift of the Severn Valley, near Worcester; but, as far as I am aware, no detailed account of the facts connected with the nature and mode of occurrence of the gravels and clay of the Severn valley and its neighbourhood was published until a paper appeared (in the Quart. Journ. Geol. Soc. 1864, vol. xx. page 130) entitled “Notes on the Drift Deposits of the Valley of the Severn in the neighbourhood of Coalbrook Dale and Bridgnorth,” by Mr. Geo. Maw, F.G.S., in which, after mentioning the names of other geologists in the same field, the author described some remarkable sections of deposits containing marine shells.

At page clxvi of the Strickland Memoirs the following passage occurs :—“Dr. Falconer conceives that there exists in the valley of the Severn an old *fluvial* Pliocene deposit of great extent, containing the usual association of Pliocene mammalia—*Elephas antiquus*, *Hippopotamus major*, Bison, Deer, &c., with freshwater shells; and also *overlying* beds of gravel, which are described as Estuarine, and drift-gravel containing a few marine shells; *Cardium* and *Turritella*, and the mammalian remains of the Glacial period—*Elephas primigenius*, *Rhinoceros tichorhinus*, Reindeer, Horse, &c.” See Dr Falconer’s views (Proc. Geol. Soc. 1856–57, page 5, &c.). Wishing to refer, if possible, to the original remarks of so eminent an authority as the late Dr. Falconer, I sought for the reference given, but without finding there any allusion to the subject of the foregoing quotation. I then wrote to Sir W. Jardine, who informed me that the reference alluded to was to be found in vol. xiii. page 307 of the Journal; but up to the present time I have failed to discover it.

Referring to the account of the Severn valley and its geological features between Shrewsbury and Bridgnorth, given in the paper by Mr. Maw, already mentioned, I need only add that below Bridgnorth the river continues its general S.S.-easterly course as far as Tewkesbury, passing over beds of New Red marl for a great part of the distance. As we approach the town of Worcester the valley opens out into a broad undulating vale, about 7 miles in width, extending from the base of the Malverns on the west to the narrow watershed on the east, which separates it from the valley of the Avon. The tide rises up as far as Tewkesbury; but the Severn, like its affluent, the Avon, is much altered in its natural course by locks and weirs.

Drifts of the "Upper and Lower Series."—Between Shrewsbury and Bridgnorth these consist for the most part of (1) Upper gravel and sand, (2) Unstratified sandy clay "with muddy gravel," (3) Lower gravel and sand. According to the observations of Mr. Maw, the greatest vertical development of them occurs at Stret-hill, near Ironbridge, where the beds (no. 2) attain a thickness of 70 feet. At Frankwell, Shrewsbury, a locality where marine shells are found in considerable abundance, the following section of the beds is displayed in a sand-pit near the Ferry, on the south side of the Severn.

	ft.	in.
(1) Vegetable soil	2	0
(2) Fine grey-coloured gravel and sand, with a few large pebbles	1	3
(3) Dark- and light-coloured red sand, with thin layers of fine grey-coloured gravel and sand (in places false-bedded) ...	5	0
(4) Compact mass of coarse and fine muddy gravel, with a discontinuous band of light-red sandy clay, about a foot thick, containing in places portions of light-brown clay	15	0
(5) Alternate seams of light-red and grey-coloured sand (in parts laminated), in which occur layers of fine grey shingly gravel, with lenticular-shaped masses of the same	25	0
Bottom of pit.	48	3

The above Section must be considered only approximately correct as regards the thickness of the beds, on account of the loose, uncompact nature of the sands and gravel, which, falling down from above, form a talus obscuring the face of the section. Between the beds nos. 4 and 5 I observed two large angular blocks, about one foot apart, lying on the surface of the sand; and I was told by one of the workmen that a large rounded boulder of grey granite, which I found lying at the bottom of the pit, had fallen from the same level. At the north-west end of the pit, near the surface of the ground, was seen a compact mass, exhibiting alternate layers of dark red sandy clay and dark red sand, in which signs of contortion were marked. I observed a few small pebbles sticking in it, but no boulders. In the heaps of gravel at the bottom of the pit were numerous scratched pebbles, and small boulders, many of which were flat on one surface. The marine shells, some of which were entire, but most of them fragmentary, appeared to occur chiefly in the light-grey-coloured shingly gravel. On the occasion of a third visit to the spot, a clearing away of a large talus of debris towards the west side of the pit exposed a thick deposit (no. 5) of bright-red sand, containing but few seams of shingly gravel.

As examples of the general character of the deposits in the neighbourhood of Worcester, I have selected those found in the gravel-pits of Kempsey and Hawford Bridge.

Section in gravel-pit, Kempsey.

	ft.	in.
Surface of ground.		
(1) Light-red loam, with a few pebbles	2	0
(2) Dark-red loam and pebbles.....	2	0
(3) Dark-red sand	0	3
(4) Fine light-red sand and gravel	1	10
(5) Light-red sand	0	3
(6) Fine light-red sand (obliquely laminated) and gravel	1	0
(7) Dark-red sand	0	3
(8) Fine light-red sand (laminated obliquely), gravel, and large pebbles	1	0
(9) Red sand	0	3
(10) Fine light-red gravel and sand (obliquely laminated).....	1	6
(11) Red sand, containing lumps of red marl	0	9
(12) Fine gravel and sand, containing a large proportion of greenish-coloured pebbles, with many large pebbles inter-mixed	2	0
(13) Clean red sand and shingly gravel, containing pebbles about the size of a bean	1	6
Uneven surface of basement rock of red marl.		
	14	7

Section in a gravel-pit near Hawford Bridge.

A compact bed of gravel, made up of large and small pebbles of the ordinary type; and dark-red loamy sand. In the upper part of the bed were carbonaceous seams, about 2 inches thick, dipping at a slight angle towards the river.....15 0
New red marl.

Composition of the gravel.—The pebbles which form the chief constituents of the gravels of the Severn valley between Bewdley and Tewkesbury are composed of a greenish slaty-coloured rock, containing veins of white quartz, the presence of which distinguishes them in great measure from the “general quartzose drift” of the Avon district, of white quartz, felstone, and a few flints. The occurrence of boulders and pebbles of grey porphyritic granite is most frequent in the upper portions of the valley.

Modern alluvium.—This deposit appears to be the only one of proved freshwater origin which has hitherto been found in the Severn valley between Shrewsbury and Tewkesbury. It consists of a bed of silt, to all appearance like that of the Avon valley. Mr. Maw has kindly supplied me with the following details of a boring made near the edge of the river's bank, close by Buildwas railway bridge.

	ft.	in.
(1) Vegetable soil	1	0
(2) Stiff loam (Loess)	8	6
(3) Running sand	2	0
(4) Gravel similar to that at Buildwas station. Freshwater mussels	4	6
	16	0

Basement rock Wenlock shale, at a depth of 7 ft. below the river's surface.

TABLE OF THE LOCALITIES OF THE DRIFTS OF THE VALLEY OF THE SEVERN AND ADJOINING DISTRICT, WITH THEIR HEIGHTS ABOVE THE SEA.

Upper Series, ranging from 800 feet to 300 feet above the level of the sea.

Localities.	Approximate	
	Height above sea-level.	Height above the river.
Burton, near Much Wenlock, Salop.....	ft. 800	ft. 780
*Willey Park, near Broseley	460	360
*Strethill, near Ironbridge	300	200

Lower Series, ranging from 300 feet to about 50 feet above sea-level.

*Frankwell, Shrewsbury	280	130
Berrington, Salop	250	100
*Leighton, near Buildwas, Salop	260	160
*Buildwas	270	170
*St. James's Pits, Bridgnorth	250	170
*Quat, near Bridgnorth	220	140
Spring Grove, Bewdley	250	140
Railway-cutting, near Bewdley.....	250	140
(Mount Pleasant, near Bewdley)	300	190
Burlish Common, Stourport	150	90
Hartlebury Common	94	35
Hawford Bridge.....	98	50
Barbourn, Worcester	100	52
*Northwick, Worcester	90	40
Perdswell, Worcester.....	90	45
**Bromwich Hill, Worcester	86	36
Road-cutting, Langham Brook	95	45
Cutting of Worcester and Hereford Railway ..	110	70
**Powick, near Worcester	80	55
Two cuttings on the Leominster Railway.....	{ 160 120	{ 135 115
*Kempsey, near Worcester	57	25
Pisham Ferry	55	23
**Fleet's Bank, Sandlin, near Malvern	270	220
Clifton, near Worcester	60	25
*Upton-on-Severn (Railway Station).....	63	25
Tunnel Hill, Upton-on-Severn.....	100	70
Ripple, near Tewkesbury	60	30
Pull Court, Tewkesbury	180	150
⊕Great Malvern (Railway Hotel)	270	240

Fluviatile Series, ranging from 150 feet to 30 feet above sea-level.

Modern alluvium, with underlying beds of gravel and sand, containing freshwater mussels.

Marine shells and Mammalian remains.—A carefully compiled list of the marine shells from the drift at Strethill is given in Mr. Maw's paper before mentioned. In the foregoing table of localities I have distinguished them by the following marks:— * * Marine shells and Mammalian remains; * Marine shells without Mammalian remains; ⊕ Mammalian remains without marine shells. They represent the substance of the information which I have derived from various sources, and the truth of which may require verification. The localities where marine shells have been hitherto most abundantly met with are situated between Shrewsbury and Bridgnorth, whilst the mammalian remains have been at present confined exclusively to the part of the valley lying between Worcester and Tewkesbury—the intermediate area between the St. James's pits below Bridgnorth and Northwick near Worcester not having yielded any recorded examples of either class of remains, as far as I have been able to ascertain. According to Mr. Maw's account, fragments of shells were found in the sandy unstratified clay at Strethill. In the museum at Worcester are a few fragmentary specimens labelled *Turritella communis*, *Purpura lapillus*, *Cyprina islandica*, &c., which were procured by the late Mr. Jabez Allies, of Worcester, from Kempsey, Bromwich Hill, &c. I have myself collected a few fragmentary shells from the grey shingly gravel and sand at Kempsey and Upton-on-Severn. Mr. Allies, in a pamphlet on "Particulars of a Stratum of Coal at Powick and Bromwich Hill," mentions that at the latter place "a fragment of a bone of some large animal, which lay on the top of the marl (Red), together with a rhinoceros's tooth, and several recent species of marine shells, were dug out from the bottom of the gravel, at a depth of about 12 feet from the surface." He also says that "four teeth of a rhinoceros have been lately dug out from the bottom of a pit at Fleet's Bank, Sandlin, besides sea-shells, a coronary bone of a horse, teeth, and a fragmentary horn of a deer."

Some years back, portions of a tusk, and teeth of a species of Elephant were dug out on the site of the Imperial Hotel, Great Malvern. According to Prof. Dawkins's list, the remains hitherto found in drift beds of the Severn valley belong to the following species of Mammalia:—*Rhinoceros tichorhinus* and *Elephas primigenius*.

Recapitulation of the principal Facts.—Commencing with the Avon valley and district, I have endeavoured to show that the Blue Lias clay of the higher ground, for some distance on each side of the valley, and in some of the minor valleys near Rugby, is covered extensively by a Boulder-clay, above which is found a stratified deposit of quartzose flinty gravel, whilst beneath it a thick bed of finely laminated sand forms the lowest stratum hitherto discovered. In the district of the New Red marl, a red unstratified sandy clay, and beds of quartzose gravel containing a few flints, are found in place of the purple-coloured Boulder-clay and stratified flinty gravel above referred to, underneath which the laminated sand occurs also as far as the hills of Cracombe and Charlton. On the north

side of the main valley, between Evesham and Tewkesbury, isolated patches of the unstratified quartzose flinty gravel of the lower series occur on its upper edge, at Green Hill, Evesham, and Mount Pleasant, Pershore, whilst over portions of the main valley itself similar beds are distributed at elevations varying from 103 feet to 67 feet above the river. At the southern base of the same part of the main valley, stratified deposits of "Local Drift" are met with, containing a small percentage of quartzose pebbles, flints, and quartzose sand, as at Beckford, where marine shells and mammalian remains have been found. They appear to extend around a considerable portion of the lower part of Bredon Hill, and may perhaps be considered to form a sort of link serving to connect the unstratified gravel of the lower series of the Avon district with the stratified beds of the Severn valley which contain marine shells and mammalian remains. I have also attempted to show that the freshwater beds of gravel and brick-earth constitute platforms, divided throughout their length by the present river, but capable of being classed as one deposit, which appears to me distinguishable from the adjacent unstratified beds of the lower series.

On reviewing the phenomena presented by the drifts of the Severn valley, we find, for the most part, but little resemblance between them and the superficial deposits of the Avon valley and district. In some localities there are compact beds of loamy gravel, rarely containing marine shells, which somewhat resemble the unstratified drifts of the lower series in the Avon valley. In others we encounter cleanly washed stratified sands and gravels, such as have not been found in any part of the Avon district. The absence of any deposit resembling the freshwater gravels and brick-earths of the Avon valley and some of its tributaries is remarkable, their position with regard to the river being occupied in the Severn valley by beds containing a few traces of marine shells and, occasionally, mammalian remains.

Remarks on the Evidence bearing upon the origin of the Freshwater Gravels of the Avon Valley.

Leaving out of the question any speculative attempts to correlate the drifts of the upper and lower series in the districts of the Avon and Severn, as being premature in the present state of our knowledge of the subject, I propose to confine the following observations to the evidence deducible from the facts already known regarding the probable conditions which gave rise to the accumulation of freshwater gravel in the Avon valley. The supposition, made by Strickland, to explain the occurrence of gravel containing freshwater shells and mammalian remains at Eckington and Defford, and its connexion with the unstratified quartzose flinty gravel at Bredon, is as follows:—"I can offer no other explanation than that formerly proposed, viz. that after the beds of marine gravel had been deposited where we now find them, and had been laid dry by the elevation of the land, a large river, or chain of lakes, extended

down the valley of the Avon, at a height of from 20 to 50 feet above its present course, and that the gravel previously brought into the district by marine currents was remodified by the river-stream, and mixed up with the remains of the mammalia and mollusca which tenanted its banks or its waters" (see Brit. Assoc. Reports, vol. vi. Sections, p. 64). I submit that the above view may be extended to other portions of the same area. Thus there appears to be evidence of:—

(1) A former time when the main valleys of the Avon and Severn existed pretty much in the state in which we now find them.

(2) A period when the greater portion of them were filled up, to a considerable extent, with the drifts of the upper and lower series, during the latter part of which, perhaps when the land was emerging, an arm of the sea occupied the lower portions of the Avon and Severn valleys, reaching probably to a height of from 200 to 300 feet, or thereabouts, above the present sea-level, at which time, we may suppose, with Sir R. Murchison, that the mammalian remains found near Worcester were washed into the ancient estuary from the neighbouring land-surfaces by sudden and local floods, and imbedded along with marine shells in the beds of sand and gravel, the negative evidence of the absence of freshwater shells, coupled with the occurrence of marine shells, preventing our having recourse to fluvial agency for their transport. At the same time probably, the local drift at the base of Bredon Hill, containing marine shells and remains of mammalia, was deposited.

Towards the close of this period, and probably after the state of things just described had passed away, the sea having receded to about its present position by a further elevation of the land, and the action of the retiring waters having perhaps scooped out channels in the marine deposits in parts of the valleys, leaving eroded surfaces of clay and marl, upon which is found so large a percentage of the mammalian remains, the ancient river Avon brought down detritus derived from the adjacent beds of marine gravel, redepositing it in stratified beds along with land and freshwater shells over the surface of the clay; whilst the river Severn, in its turn, may have borne the detrital matter brought down from the marine deposits of the valley, along its comparatively straight course, towards the sea. This process of removal and redeposition may be supposed to have gone on until the final excavation of the beds of the rivers through the basement clay and marl to depths of about 30 and 50 feet respectively, as evidenced by the banks overhanging the present rivers in various localities, had reduced them to their present levels. Finally, the rivers having attained a state of equilibrium, they deposited the silt and vegetable matter brought down in times of flood, and spread them out in beds of modern alluvium. The foregoing outline of the probable succession of events belonging to the later geological history of the district is, it must be confessed, manifestly imperfect, and inadequate to explain satisfactorily many of the facts, partly owing to the necessarily meagre amount of positive evidence attainable, and partly depend-

ing upon the restricted area of the district under review. In order to explain the lowering of the bed of the Avon by an increased velocity of its stream, Strickland supposes a "further elevation of the land," to quote his words; but it appears to me necessary to call in the agency of unequal elevation, the inland district of Warwickshire having risen more rapidly than the portion nearer the sea, as Sir C. Lyell supposes to have been the case in reference to the denudation of the Loess of the Rhine, if we are to resort to a cause of which, as far as I am aware, no collateral evidence exists.

Concluding Remarks.—It would be interesting to know how far the evidence afforded by the marine mollusca found in the drift of the Severn valley may be able to explain the probable conditions under which the latter was deposited. The late Edward Forbes, in his valuable paper "On the Geological Relations of the existing Fauna and Flora of the British Isles" remarks that, *Littorina*, *Purpura*, &c. are genera and species definitely indicating, not merely a shallow water, but a coast-line. Regarding the evidence at present obtainable from the mammalian remains found in the beds containing marine shells at Beckford, and in the neighbourhood of Worcester, and those from the freshwater gravels of the Avon and some of its tributaries, it appears that the number of species is much less in the former than in the latter.

In thus venturing to bring the subject of this paper before the notice of the Society, I may perhaps be allowed to state that I have no pet theory to support, and no inclination to throw "small stones" at those of others, my chief object being to leave the subject in such a condition that future observers may be able to take up its further investigation at the point where I have left off.

In conclusion, let me tender my best thanks to many kind friends for their zeal in forwarding the objects of the present inquiry.

DISCUSSION.

MR. SEARLES V. WOOD, Jun., had long been aware of the existence of both the Chalky Boulder-Clay and the Middle Glacial Sand near Rugby. He pointed out the difference between the fauna of the sands of the Severn valley and that of the Middle Glacial sand of East Anglia, and thought it scarcely possible that the two sands could be identical.

MR. GWYN JEFFREYS was doubtful as to the authenticity of some of the shells which had been brought to Mr. Maw. The fossil shells from the Severn valley, Wolverhampton, Manchester, and Moel Tryfaen were nearly identical, and indicated raised beaches. He thought it possible that a definite line of such beaches might eventually be recognized through that part of England.

MR. W. BOYD DAWKINS did not consider that Mr. Lloyd had shown any marked difference in the mammalian fauna of the Avon and Severn valleys. He had failed to discover any traces of *Elephas antiquus* in either.

MR. PRESTWICH thought that Mr. Lloyd had probably divided the

superficial beds into too many separate deposits, though the facts brought forward were of great value.

Mr. EVANS mentioned that he had received information of the discovery many years ago of a flint implement in association with the bones of extinct mammals at Lawford. This implement had been exhibited at the time to the Geological Society, but had disappeared after the meeting.

Mr. LLOYD and Mr. WILSON briefly replied.