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ORIGINAL ARTICLES.

I.—ON THE MOLLUSCA OF THE PLEISTOCENE GRAVELS IN THE
NEIGHBOURHOOD OF CAMBRIDGE.

By MRS. MCKENNY HUGHES.

THE site of Barnwell Abbey has long been excavated for gravel. The pits have been easily accessible to collectors, and have for many years yielded large numbers of Mammalian bones, Mollusca, and a few plant-remains.

These gravels were noticed by the Rev. P. B. Brodie and Prof. Sedgwick in 1838.¹ Prof. Seeley gave a sketch of them in the Q. J. G. S. 1866, in which there was a list of the land and fresh-water shells drawn up by Mr. Dewick. They were described by Mr. Jukes-Browne in his essay on the Post-Tertiary deposits of Cambridgeshire, 1873, and in the Memoir of the Geological Survey.² A list of the species preserved in the Woodwardian Museum was given by Prof. Hughes in the GEOLOGICAL MAGAZINE in 1883. Exact references to some of these papers and to others in which the deposits are mentioned will be found in Mr. Whitaker's list of works on the Geology of Cambridgeshire, privately printed for the Woodwardian Museum in 1873, and reissued with the Geological Survey Memoir above referred to. A list of shells from the Barnwell Gravel is given by Dollfus.³

Whenever any fresh excavations are made in this district, new evidence is generally obtained as to the relations of beds, and the distribution of the life of the period; and it seems desirable to place on record at once any additional facts observed in deposits which are being entirely removed, such as the Barnwell Abbey gravel, and to call attention to any hitherto undescribed sections, such as those near Barnwell Station, at Grantchester, or in the pits west of Barrington Green.

Within the last few years Barnwell Abbey has been acquired by Mr. Sturton, who has laid out the ground in building plots, having previously removed almost the whole of the surface gravel. Mr. Sturton has with great liberality presented to the University what remained of the old Abbey and a piece of the ground around it, and has offered every facility to geologists for examining the sections during the progress of the work. Thus an exceptional opportunity

¹ Trans. Camb. Phil. Soc. vol. viii. 1844, part i. p. 138.

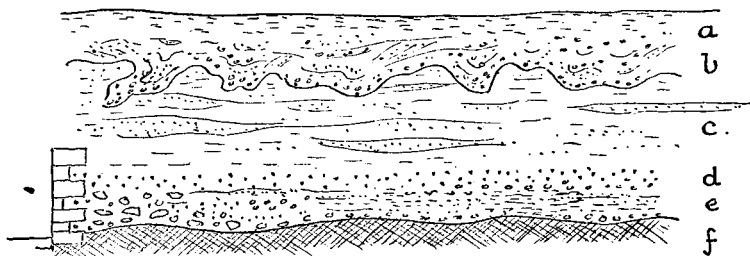
² Explanation of Sheet 51 S.W. 1881.

³ Le Terrain Quaternaire d'Ostende, etc., Bruxelles, 1884.

has been offered for observing the relative position of the beds in which the different species were more or less abundant. None of the shells were confined to definite zones; nor were they distributed through beds bearing any constant relation to one another; but, at varying horizons, and in different parts of the field, lenticular masses and pockets occurred, in which certain species were very abundant, while others were absent there which were common above or below, or at the same horizon close by; whereas, not far off they would be found mixed together in the same bed. In former excavations, in one part of the field, plant-remains were found in abundance near the base of the gravel. Among these were a few *Chara* spores and a quantity of leaves and twigs which are considered by Mr. Clement Reid to belong to one species of *Salix*—probably *S. repens*. From the recent diggings very few plant-remains have been obtained; only an obscure fragment here and there.

It is clear that gravel-pits of inconsiderable size opened in closely adjoining parts of the field might yield a very different group of fossils; but the removal of the whole showed that this depended upon small local variations of the same set of deposits. For instance, there were, in one case associated with Mammoth near the top, and in another resting on the Gault at the very base of the deposits (see

FIG. 1.—Section seen by Ancient Well North of Ruin, on site of Barnwell Abbey. Scale—10 feet to 1 inch.



a, Surface soil, etc.; b, Irregular gravel; c, Fine sand and marl; d, Reddish sand; e, Coarse gravel consisting in places of large subangular flints with a few boulders derived from the drift and passing horizontally into fine beds of chalky gravel and marl full of shells, chiefly *Bythinia*, *Corbicula*, *Unio*, *Falvata*, *Planorbis*, etc.; f, Gault.

Section Fig. 1), lenticular marly beds containing shells and opercula of *Bythinia* in great abundance. In some places no specimen of *Corbicula* (*Cyrena*) could be found; still more often *Unio litoralis* was absent, although these shells occurred somewhere at every horizon. Except, therefore, in the case of very extensive excavations, generalizations, especially where founded largely on negative evidence, must be considered only as tentative.

In the gravel-pits at the other side of the Newmarket Road no shell-bearing beds are now exposed, although a few years ago *Unio litoralis* occurred abundantly in the N.W. corner of the pit, but lower than the level of the present workings.

Following the gravel due north we come to the brick-pit at

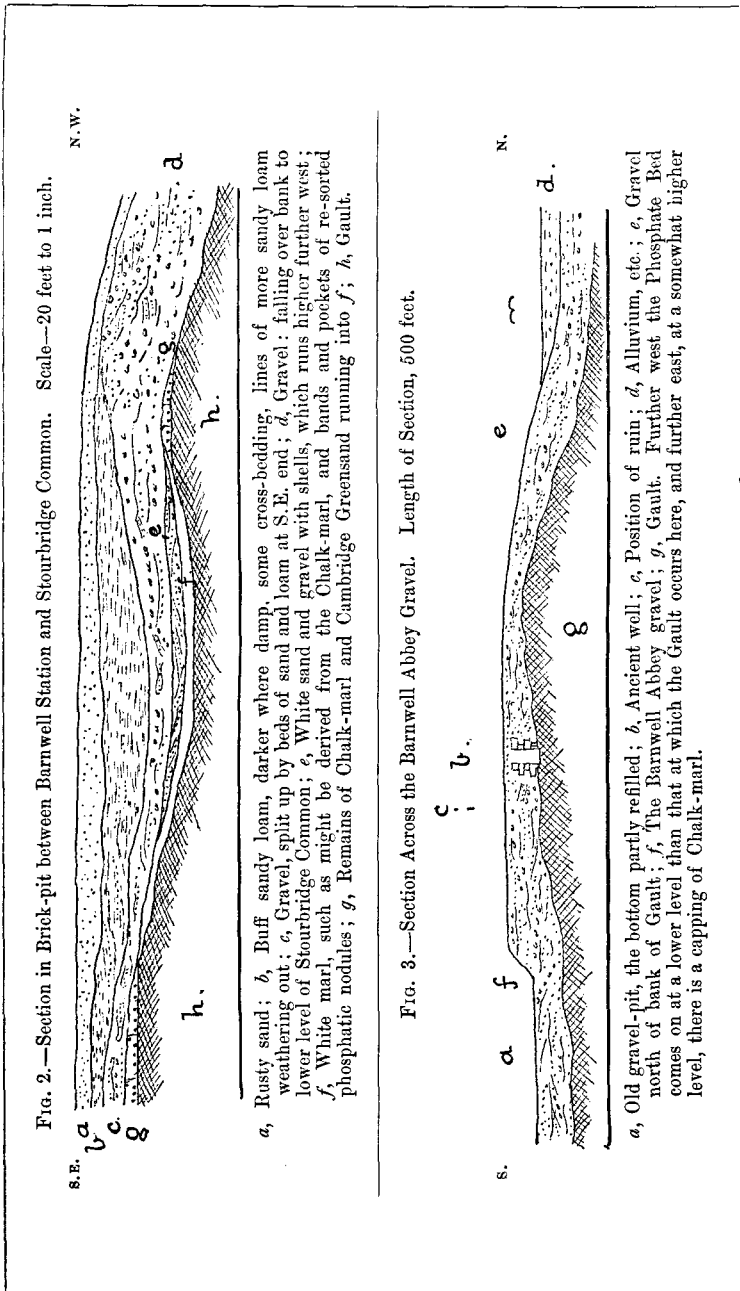
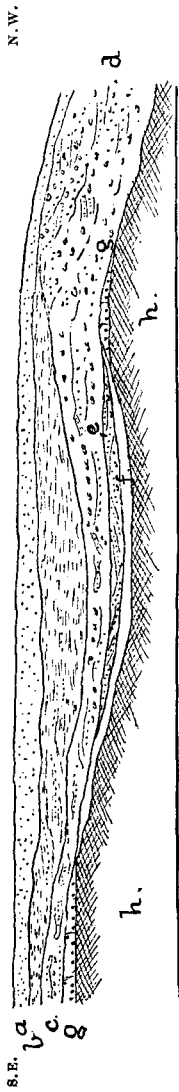
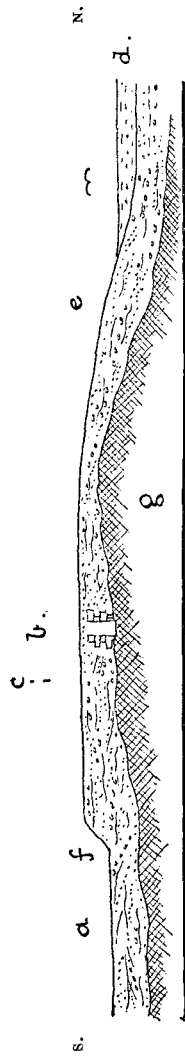


Fig. 2.—Section in Brick-pit between Barnwell Station and Stourbridge Common. Scale—20 feet to 1 inch.



a, Rusty sand; *b*, Buff sandy loam, darker where damp, some cross-bedding, lines of more sandy loam weathering out; *c*, Gravel, split up by beds of sand and loam at S.E. end; *d*, Gravel; falling over bank to lower level of Stourbridge Common; *e*, White sand and gravel with shells, which runs higher further west; *f*, White marl, such as might be derived from the Chalk-marl, and bands and pockets of re-sorted phosphatic nodules; *g*, Remains of Chalk-marl and Cambridge Greensand running into *f*; *h*, Gault.

Fig. 3.—Section Across the Barnwell Abbey Gravel. Length of Section, 500 feet.



a, Old gravel-pit, the bottom partly refilled; *b*, Ancient well; *c*, Position of ruin; *d*, Alluvium, etc.; *e*, Gravel north of bank of Gault; *f*, The Barnwell Abbey gravel; *g*, Gault. Further west the Phosphate Bed comes on at a lower level than that at which the Gault occurs here, and further east, at a somewhat higher level, there is a capping of Chalk-marl.

Barnwell Station; here the gravel is seen resting on the Gault, which is in places troughed in such a manner as to suggest the beds of ancient streams (see Section Fig. 2).

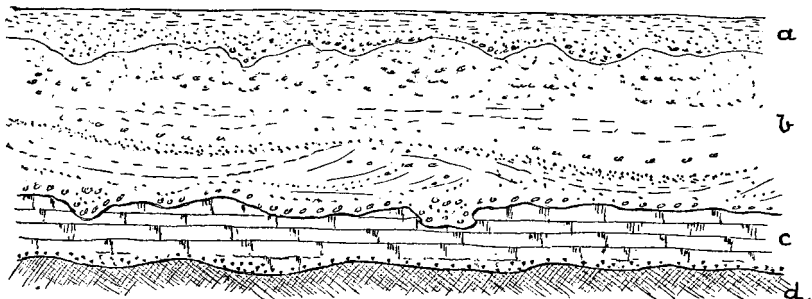
There seems to be one such old channel here at the margin of the gravel, running parallel to the present river-valley. *b*, *c*, *d*, and *e* of the section are river deposits which have filled it up; some of the looping is perhaps caused or increased by the decomposition of underlying chalky beds. The channel here and there cuts just into the top of the Gault, and patches of the overlying Chalk-marl and Phosphate Bed are left; the banks seem to have fallen in in places, and the gravel has sunk into the puddled surface of the clay, so that the Gault, Phosphate Bed and gravel are sometimes kneaded up together in the most irregular manner. The gravel (*c*) thickens out to the west, and falling over the slope to the lower ground forms the main mass of the bank next Stourbridge Common, and corresponds to the gravel near the Holy Well at Barnwell Abbey, which in like manner lies on the west slope of a bank of Gault (see Fig. 3).

This western portion, both here and at Barnwell Abbey, forms the margin of a lower terrace, which being directly derived from the higher level gravels, can hardly be distinguished from them on the ground. The deposit in which the shells occur at Barnwell Station (*e*) is older than this flanking gravel, as, at Barnwell Abbey, the shell-bearing strata are older than the gravels west of the Gault ridge, and between it and the river. When, however, we have to consider the relative age of the shell-beds at Barnwell Station and those at Barnwell Abbey, we find that the question is more complex. The lie of the ground seems to point to their being part of the same mass, but the character of the deposits seems to indicate that though they belong to approximately the same age, they were nevertheless laid down under somewhat different conditions.

With the interruption of the lower level gravels of the Cam Valley, described by Mr. Jukes-Browne, we find beds similar to

FIG. 4.—Section South of Grantchester.

Scale—10 feet to 1 inch.



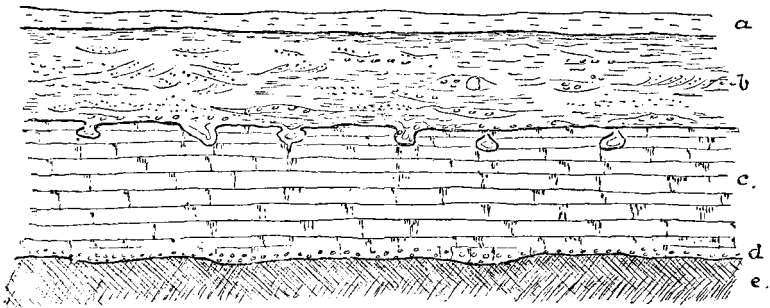
a, Surface soil and rusty gravel from which the Chalk has been dissolved out; *b*, Chalky gravel and marl with pans of peaty silt and bands full of land and freshwater shells; *c*, Chalk-marl and Phosphate Bed; *d*, Gault.

those at Barnwell covering a large area near Shelford, where also *Corbicula fluminalis* is found, and extending by Trumpington to the well-marked terrace of Grantchester

The Grantchester gravel (see Section Fig. 4) occurred in irregular masses troughed into the underlying Chalk-marl, and was exposed by the removal of the whole of the surface in the process of digging for phosphate nodules. It was not clear that it bore any relation to the existing geographical features; but its irregularity and the presence of pans of decomposed vegetable matter and of masses of shells buried in chalky loam, seemed to indicate accumulations along the shifting channels of a river wandering over a tolerably wide area, and deriving much of its material from older gravels, from Boulder-clay, and even directly from the Chalk-marl which it here and there touched in its course. All the shells in the Woodwardian Museum were obtained from one rich deposit of small extent close to the farm track, just beyond the S.W. corner of the camp, at a depth of about 5 to 8 feet from the surface. This pit is now filled up, and although there are here and there openings from which sand and gravel are being dug, no shells have been found in them; nor are any beds now exposed exactly similar to those from which the shells were formerly obtained. The list of Mammalian remains and shells given in Column II. p. 202, has not hitherto been published.

Beyond Grantchester, about four miles to the south-west, the village of Barrington stands on a terrace on the left bank of the River Rhee. This terrace consists principally of loam derived from the Chalk-marl with lines and lenticular beds of sand and gravel to a depth of from 5 to 10 feet.

FIG. 5.—Section seen in pit north of Windmill, near Westgate Farm, Barrington. Scale—10 feet to 1 inch.



a, Surface soil. 1'—2'; b, Chalky loam and sand, with small lines and lenticular beds of gravel. At the southern or lower end of the digging the gravel and sand is looped into the top of the underlying Chalk-marl. 6'—7'; c, Chalk-marl; d, Cambridge Greensand; e, Gault.

The gravel does not appear on the 1-inch Survey Map, probably because at the time that map was made there was nothing at the surface to distinguish the loam which belonged to the gravel from the decomposed surface of the marl, etc. In subsequent phosphate

diggings, however, on the north-east side of the village, this deposit was exposed and described by the Rev. O. Fisher,¹ and referred to in the Survey Memoir.²

About a mile and a quarter W.S.W. of these pits, north of the Windmill, on the other side of Barrington Green, extensive excavations for phosphate have recently exposed other sections in what is the continuation of that terrace, or if now cut off from it by the little valley west of Barrington Green, was originally part of the same.

From the character of the workings, the whole of the deposits belonging to the gravel age can be seen down to the base, where they rest upon the Chalk-marl (see Section Fig. 5). They consist largely of materials derived from the Chalk-marl and from the Boulder-clay, which at that time must have covered a much wider area than now on the adjoining hills. A somewhat larger admixture of far-travelled fragments from the drift might be expected, and as a matter of fact is generally found, in all gravel deposits of the district which occur on higher and older terraces, or nearer the hills.

The portions of the Barrington Gravel, which are of the same coarseness as that of Barnwell, do not differ much from it in composition; in both cases a large proportion of the material consists of ferruginous subangular flints.

The Barrington deposit is exceptionally rich in the number and variety of its Mammalian remains. Small pieces of bone occur through the whole, but the largest and best-preserved bones lie in irregular masses of gravel near the base. In one place just above the Chalk-marl there was a boulder of quartzite about 9 inches in diameter resting upon a large limb bone. The bones are generally scattered and mixed, but occasionally there seems to be evidence of associated remains. Among the valuable specimens secured by Mr. Keeping's skill for the Woodwardian Museum, there are several whole lower jaws of Hippopotamus and a nearly perfect skull of Hyæna. It will be seen on comparing the lists of fossils given below (p. 202), that the Mammalian remains from this pit at Barrington (Column IV.) agree with those from Barnwell Abbey (Column I.), with the exception of *Arvicola*, determined by Mr. Oldfield Thomas, which has not been found at Barrington, and of Reindeer, the occurrence of which at Barnwell rests on the determination of a small fragment of antler. Horse occurs in all four localities.

Bison priscus, *Cervus megaceros*, *C. tarandus*, *Hippopotamus amphibius* (*major*), *Rhinoceros leptorhinus*, and *Meles taxus*, have not been found at Grantchester, but these diggings were unfortunately not so carefully watched as they might have been. Bones have been obtained from the pit near Barnwell Station, but they have, generally, been too fragmentary for determination. The following species have, however, been made out, Red Deer, Mammoth, Rhinoceros and Horse.

At Barrington the shells occurred in rapidly thinning and thicken-

¹ Q. J. G. S. vol. xxxv. 1879, p. 670.

² pp. 94-5.

ing beds of loam and sand in the same manner as at Barnwell Station, but not indiscriminately through coarse gravel and finer deposits as at Barnwell Abbey.

The shells of Barnwell Station (Column III.) and Barrington (Column IV.) seem to represent marginal deposits such as are seen along the edges of ponds and rivers at the present time, occasionally encroached upon by river floods which swept them into holes and embayed corners.

This is suggested by the accumulation of the smaller and lighter shells, just as now seen on the edge of the flood-water, and by the great abundance of *Pupa marginata*, while the rest of the shells are quite consistent with this view. *Anodonta* is rare and usually imperfect.

The shells of Barnwell Abbey (Column I.) and of Grantchester (Column II.) seem to belong rather to the main channel of the river. *Unio* and *Corbicula*, which like river-beds, occur at Barnwell Abbey and Grantchester, but not at Barnwell Station or Barrington. *Pupa*, the characteristic shell of the other two localities, is comparatively rare at Barnwell Abbey and Grantchester.

There is a marked agreement between the Barnwell Abbey and Grantchester Mollusca. All the species which are individually numerous in either locality are common to both. Those which are peculiar to one of the two localities are rare forms. Thus *Hydrobia marginata*, Mich., occurs at Barnwell Abbey, but has not been found at Grantchester. *Limax* is recorded only from Barnwell. Single specimens of *Planorbis nitidus*, Müll., *P. fontanus*, Light., *Patula ruderata*, Müll., *Helix lamellata*, Jeff., *Vertigo pusilla*, Müll., *V. edentula*, Drap., *V. minutissima*, Hart., and *Cæcilianella acicula*, Müll., have been found at Barnwell Abbey and there only. On the other hand, *Planorbis nautilus*, Linn., *Helix obvoluta*, Müll., and *H. aculeata*, Müll., are as yet peculiar to Grantchester. A more careful search would, however, probably result in filling up most of the gaps in both lists (see pp. 200—202):—

I must here acknowledge the kind help which I have received from Mr. Cooke in drawing up the list of shells, and in finding the range of various species.

I am also much indebted to Mr. Dewick for the trouble he has taken in determining my specimens of *Limax* and some other species, by comparison with those in the Natural History Museum, and also for lending me his rarer specimens for examination.

Professor Rupert Jones has kindly determined the Ostracoda for me. He remarks that he has found *Candona compressa*, Koch, in Post-Tertiary beds in Berkshire, Cambridgeshire, also at Fisherton, near Salisbury, from the raised beach of Portland (Prestwich Coll.), and from the Chara Bed near Hitchin (Blackmore Coll.). *Candona candida*, Müll., he says, is very common, both Recent and Post-Tertiary.

An explanation of the isolated or rare occurrence of certain forms in the ancient river deposits is suggested by what is seen at the present time along the Cam above Cambridge, where the artificial

LIST OF FOSSILS FROM GRAVELS IN THE NEIGHBOURHOOD OF CAMBRIDGE.	Barnwell Abbey.	Grantchester.	Barnwell Station.	Barrington.
	I.	II.	III.	IV.
PLANTS.				
Spores and stems of <i>Chara</i>	x			
<i>Salix</i> (probably <i>S. repens</i>). Twigs and leaves.	x			
INVERTEBRATA.				
CRUSTACEA (OSTRACODA).				
<i>Cypris reptans</i> , Baird (see Jones, Post-Tert. Entom. 1874, p. 128).		x		
<i>Candona compressa</i> , Koch (<i>ib.</i> p. 135).	x			
<i>candida</i> Müll. (<i>ib.</i> p. 135).	x			
INVERTEBRATA—MOLLUSCA.				
LAMELLIBRANCHIATA.				
<i>Sphaerium corneum</i> , Linn. (Not very large, mostly young.)	x	x		x
<i>S. lacustre</i> , Müll, York Museum.....	x			
<i>Pisidium amnicum</i> , Müll. (Very abundant. Valves adh.)	x	x	x	x
<i>fontinale</i> , Drap. (Abundant. Valves adherent.)	x	x	x	x
_____ var. <i>Henslowana</i> , Sheppard. (Abundant at Grantchester.)	x	x		x
_____ <i>pusillum</i> , Gmel. (In Mr. Dewick's and also in Mr. Tomlin's Collection from Barnwell Abbey. Several specimens in the Woodwardian Museum from Grantchester.)	x	x		
<i>Corbicula fluminalis</i> , Müll. (Usually of a small size. Great variety in size, shape, texture and sculpture. Very abundant at Barnwell Abbey and Grantchester. Valves often adherent and ligament preserved.)	x	x		
<i>Unio pictorum</i> , Linn.	x	x		
_____ var. <i>limosa</i> , Nils.	x	x		
_____ <i>litoralis</i> , Lamk. = <i>U. rhomboides</i> , Schröt. (Great variation in size, shape and thickness. Both valves often adherent and ligament preserved.)	x	x		
<i>Anodonta</i> , sp.				x
GASTEROPODA.				
<i>Bythinia tentaculata</i> , Linn. (Varies much in size. Many young specimens. Opercula very common in places. Sometimes found still in the shell.)	x	x		x
<i>Hydrobia marginata</i> , Mich. (Rare.).....	x			
<i>Valvata piscinalis</i> , Müll. (Very abundant. Varies very much in size and shape. Many young specimens.)	x	x	x	x
_____ <i>cristata</i> , Müll. (Not common.).....	x	x		x
<i>Planorbis nitidus</i> , Müll. = <i>P. lineatus</i> , Walker. Very rare. (One specimen in Mr. Tomlin's Collection.)	x			
_____ <i>fontanus</i> , Lightf. = <i>P. nitidus</i> , Müll. (Jeff.) British Conchology, vol. i. p. 81. Mr. Dewick has a single specimen in his Collection, from Barnwell.	x			
_____ <i>nautilus</i> , Linn.		x		
_____ <i>glaber</i> , Jeff. (Very rare.).....	x	x		
_____ <i>spirorbis</i> , Müll. (Common at Barnwell Junction.)	x	x	x	x
_____ <i>vortex</i> , Linn. (Rare.).....	x	x		
_____ <i>carinatus</i> , Müll. (Rare.)	x	x?	x	
_____ <i>complanatus</i> , Linn. (Fairly abundant.)	x	x		

	I.	II.	III.	IV.
GASTEROPODA—continued.				
<i>Planorbis contortus</i> , Linn. (Rare.)	x	x	x	
<i>Physa hypnorum</i> , Linn. (Single specimen from Grantchester, in the Woodwardian Museum. One specimen from Barnwell Abbey in Mr. Tomlin's Collection.)	x	x		
— <i>fontinalis</i> , Linn. (Three or four good specimens from Barnwell Abbey in Mr. Tomlin's Collection, and one specimen from Grantchester in the Woodwardian Museum.)	x	x		
<i>Limnæa peregra</i> , Müll. (Not common.)	x	x	x	x
— <i>auricularia</i> , Linn. (Very common. Spire often much intorted. Two specimens from Barnwell Abbey slightly scalariform. Varies much in size. Lines of growth often strongly marked.)	x	x		
— <i>stagnalis</i> , Linn. (A few specimens only from Barnwell Abbey. Fairly common at Grantchester.)	x	x		
— <i>palustris</i> , Müll.	x	x	x	x
— <i>truncatula</i> , Müll. (Common at Grantchester. Many very small specimens.)	x	x	x	x
<i>Ancylus fluviatilis</i> , Müll.	x	x		
— <i>lacustris</i> , Linn. = <i>oblongus</i> , Forbes & Hanley.	x	x		
LAND SHELLS.				
<i>Limax agrestis</i> , Linn.	x			
— <i>arborum</i> , Bonch. Chant. (Mr. Dewick determined two specimens found by me.)	x			
— <i>lævis</i> , Müll. (Two specimens found by myself.)	x			
<i>Succinea putris</i> , Linn. (Very large specimens at Barnwell Abbey and Grantchester.)	x	x	x	x
— <i>elegans</i> , Risso.	x	x	x	x
— <i>oblonga</i> , Drap.	x	x	x	
<i>Hyalina cellaria</i> , Müll.	x	x		
— <i>nitidula</i> , Drap.	x	x		
— <i>radiatula</i> , Alder.	x	x		
— <i>nitida</i> , Müll.	x	x		
— <i>crystallina</i> , Müll.	x	x		
<i>Conulus fulvus</i> , Drap.	x	x		
<i>Patula rotundata</i> , Müll. (Rare.)	x	x		
— <i>runderata</i> , Studer. (A single specimen found by Mr. Dewick.)	x			
— <i>pygmaea</i> , Drap. (One reversed specimen found at Barnwell Abbey by Mr. Dewick.)	x	x		
<i>Helix (Anchistoma) obvoluta</i> , Müll. (One full grown and one young specimen in the Woodwardian Museum.)		x		
— (<i>Acanthinula</i>) <i>aculeata</i> , Müll. (Twelve specimens in the Woodwardian Museum.)		x		
— (—) <i>lamellata</i> , Jeff. (A single specimen found by Mr. Dewick.)	x			
— (<i>Vallonia</i>) <i>pulchella</i> , Müll. (Very abundant.)	x	x		x
— (<i>Fruticicola</i>) <i>hispida</i> , Linn.	x	x	x	x
— (—) <i>concinna</i> , Jeff. (One reversed specimen found at Barnwell Abbey by Mr. Dewick.)	x	x	x	x
— (—) <i>fruticum</i> , Müll. (Rare.)	x	x		
— (<i>Chilotrema</i>) <i>lapicida</i> , Linn. (Three specimens from Barnwell Abbey. One in Mr. Dewick's Collection and two in the Woodwardian Museum. Two specimens from Grantchester in the Woodwardian Museum.)	x	x		
— (<i>Arionta</i>) <i>arbustorum</i> , Linn. (Varies very much. Many of the shells distorted and injured.)	x	x		
— (—) var. <i>alpestris</i> , Ziegler. (Common at Barnwell Abbey.)	x	x		

LIST OF FOSSILS FROM GRAVELS IN THE NEIGHBOURHOOD OF CAMBRIDGE— <i>continued.</i>	Barnwell Abbey.	Grantchester.	Barnwell Station.	Barrington.
	I.	II.	III.	IV.
<i>Helix (Tachea) nemoralis</i> , Linn. [Not very common. Varieties of banding, 12345, 00345, (12345), 1(23)45, 00330, 003(45), 10345.]	x	x	.....	x
————— (<i>Xerophila cricetorum</i> , Müll. (Common at Barnwell Abbey and Grantchester.)	x	x	x	x
————— (—————) <i>virgata</i> , Da C. (Common at Barrington.)	.....	.....	.....	x
————— (—————) <i>caperata</i> , Mont. (Very rare.)	x	x	.....	?
<i>Buliminus montanus</i> , Drap.	x	x	x	.....
————— <i>obscurus</i> , Müll. (One specimen from Barnwell Abbey in the York Museum, and one from Grantchester in the Woodwardian Museum.)	x	x	.....	.....
<i>Pupa marginata</i> , Drap. (Very abundant at Barnwell Station and at Barrington.)	x	x	x	x
<i>Vertigo anti-vertigo</i> , Drap.	x	x	.....	.....
————— <i>Mouliinsiana</i> , Dupuy.	x	x	.....	.....
————— <i>pusilla</i> , Müll. (One in Mr. Tomlin's Coll.)	x	.....	.....	.....
————— <i>angustior</i> , Jeff.	x	x	.....	.....
————— <i>pygmaea</i> , Drap.	x	x	.....	.....
————— <i>edentula</i> , Drap. (One found by Mr. Dewick resembles var. <i>columella</i> of Jeffreys.)	x	.....	.....	.....
————— <i>minutissima</i> , Hartmann. (One specimen found by Mr. Dewick.)	x	.....	.....	.....
<i>Balea perversa</i> ? Linn. Young. Mr. Dewick's Coll.	x	.....	.....	.....
<i>Clausilia rugosa</i> , Drap.	x	x	.....	.....
————— <i>pumila</i> , Ziegler. (Described in former lists as <i>C. bispicata</i> .)	x	x	.....	.....
<i>Azeca tridens</i> , Riet. (Rare.)	x	x	.....	.....
<i>Zua lubrica</i> , Müll.	x	x	x	x
<i>Cæcilianella acicula</i> , Müll. (One specimen found by Mr. Dewick. Young. Filled with gravel.)	x	x	.....	.....
<i>Carychium minimum</i> , Müll. (Common. Several of the specimens found inside <i>H. arbustorum</i> and <i>H. nemoralis</i> .)	x	x	.....	.....
<i>Cyclostoma elegans</i> , Müll. (One specimen only, found by me in the Mammaliferous gravel of Barrington.)	.....	.....	.....	x
VERTEBRATA.				
<i>Bison priscus</i> , Bojan.	x	.....	.....	x
<i>Bos primigenius</i> , Bojan.	x	x	.....	x
<i>Cervus megaceros</i> , Hart.	x	.....	.....	x
————— <i>elaphus</i> , Linn.	x	x	x	x
————— <i>tarandus</i> , Linn.	x	.....	.....	.....
<i>Elephas antiquus</i> , Falc.	x	?	.....	x
————— <i>primigenius</i> , Blum.	x	x	x	x
<i>Equus caballus fossilis</i> , Meyer.	x	x	x	x
<i>Felis spelæa</i> , Goldf.	x	x	.....	x
<i>Hippopotamus amphibius</i> , L. = <i>major</i> , Cuv.	x	.....	.....	x
<i>Hyæna crocuta</i> = <i>spelæa</i> , Goldf.	x	x	.....	x
<i>Rhinoceros leptorhinus</i> , or <i>tichorhinus</i> , Cuvier.	x	.....	x	x
<i>Ursus spelæus</i> , Blum.	x	x	.....	x
<i>Meles taxus</i> , Owen.	x	.....	.....	x
<i>Arvicola agrestis</i> ? sp.	x	x	.....	.....

diversion of the river has produced effects which must have been common in the case of the uncontrolled rivers of former times. On Sheep's Green there are many small ponds which represent deserted portions of the old river-bed; in these many of the less common and irregularly distributed freshwater shells occur—abundantly in one—rarely, or not at all, in another. For instance, we find *Bythinia Leachii* there, as well as in the ditches further south. In one of the ponds seven species of *Planorbis*, including the two rare forms *P. nitidus*, Müll., and *P. fontanus*, Light., also *Valvata cristata*, Müll., and many of the *Pisidia*, are found.

Mr. Tomlin, who has thoroughly searched that locality, informs me that two of the ponds are far richer than any of the others, and that he never met with the two rare species of *Planorbis*, mentioned above, elsewhere in this neighbourhood, except odd live specimens in some of the other Sheep's Green ponds. He never found them anywhere down the river.

Along the margin of these pools *Carychium minimum*, Müll., and *Hyalina nitida*, Müll., abound. Now and then, when the river is in flood, the whole Green is under water, and at such times many of the shells in these ponds and ditches must be carried away and mixed with the common river shells.

From analogy, therefore, it would appear that the winding about of a frequently flooded river, over an alluvial plain, in which ponds remained where the deeper parts of the old river-bed had been, would most easily account for the difference in the facies of the gravel-shells in the different localities.

A careful study of the distribution and mode of occurrence of the gravel fauna and flora ought to give us some clue to the geographical changes which have affected the incoming and disappearance of the various forms of life.

The great majority of Mollusca from these gravels are living in this district at the present day. A few are locally extinct. Of these some are confined to the north and some to the south of England, whilst some have disappeared from the British Isles altogether. Some of the Mammals, but none of the Mollusca, are totally extinct.

The shell which seems to indicate the greatest change of conditions is the *Corbicula (Cyrena) fluminalis*, Müll.

It lives at the present time in Sicily,¹ in the rivers of Asia Minor and Syria and in the Nile. It seems to have made its first appearance in Britain in the time of the deposition of the Norwich Crag, from which it is described and figured by Mr. Searles Wood,² as *Cyrena consobrina*.³

It is recorded from the Weybourn Crag and from the Forest Bed. In the north of England it is found in the gravels of the Humber, of Kelsea Hill, and Hessle; in the basin of the Thames and the adjoining district of Essex it has been recorded from Suttonness, Clacton-on-Sea, Copford, Greys, Ilford, Erith, and Crayford, Faver-

¹ Geol. Eng. and Wales, H. B. Woodward, 2nd edition, p. 478.

² S. V. Wood, "The Crag Mollusca," vol. ii. p. 104, tab. 11, fig. 15.

³ Tylor, Q.J.G.S. vol. xxv. 1869, p. 66.

sham and Reculvers, and by Prof. Prestwich¹ from Summertown near Oxford. It also occurs in the gravels of the basin of the Cam and Ouse. It occurs in Belgium and in France in the ancient alluvium of the Seine and Somme. This therefore appears to be a southern shell, which had formerly a more northern range.

The six following shells are extinct in Britain, but most of them have a wide range in Europe and Asia:—

Unio litoralis, Lamk., is, according to Moquin Tandon,² found in almost all the rivers of France. Kobelt records it also from Spain, Morocco, and Algeria.

Unio pictorum, var. *limosa*, Nils., according to Moquin Tandon, occurs in almost all the rivers and brooks of Northern France.

Hydrobia marginata, Mich., lives in France, says the same author, on dead leaves under water and on aquatic plants at Var, Vaucluse, L'Aveyron, the Haute Garonne and the Jura.

Helix (Fruticicola) fruticum, Müll., is found all over Europe with the one exception of England. It ranges as far north as St. Petersburg.³ Moquin Tandon⁴ says that it is found over almost all northern and central France, but that it does not occur in the southern part.

Miss Esmark records it from North and South Norway, Sweden, and Finland. She says, "It is not very common, but plentiful where it occurs."⁵ I am told by Mr. Cooke that it occurs also in North-West and East Siberia and the Altai Baikal district.

Patula ruderata, Studer, has a very wide range. Kobelt records it from the Caucasus, Europe, Northern Africa, and the whole of Western Asia. Jeffreys from Kamschatka, South Russia and Austria, and North Japan.⁶ Clessin says that it lives in the mountainous parts of Germany and in the Alps. Moquin Tandon says it is found under stones and dead leaves in the Jura. Miss Esmark records it from Norway, Sweden, and Finland, and remarks that it is "one of our most common species, which goes as well to the far north as on our highest mountains, wherever it is possible for any Molluscs to live."⁷ Mr. Cooke informs me that it is found also in West and East Siberia, Amurland, North China, Japan? and North Persia.

Clausilia pumila, Ziegler, is, according to Clessin,⁸ distributed over a great part of Germany, but is most common in the North. Its range is eastward to the Siebenbürgen; southward to Croatia; northward to Livland and Sweden; it finds its western limit in Germany, and does not occur in England except as a fossil.

It has hitherto been recorded from the gravels of Cambridge as *C. biplicata*, but Mr. B. B. Woodward⁹ has shown that all the shells referred to that species are really the *C. pumila* of Ziegler.

¹ GEOL. MAG. N.S. Vol. IX. 1882, p. 49.

² Hist. Nat. des Mollusques.

³ Clessin, Deutsche. Excurs. Mollusken-Fauna, p. 166.

⁴ *Op. cit.* vol. ii. p. 198.

⁵ Esmark, Journ. Conch. vol. v. pp. 106, 126.

⁶ Jeff. Brit. Conch. vol. v. Supplement, p. 158.

⁷ Journ. Conch. vol. v. p. 104.

⁸ *Op. cit.* p. 312.

⁹ Since this paper was sent to press a valuable communication has been made by Mr. Woodward to the Geol. Assoc. (March 2, 1888) on the shells of the Barnwell Gravel, founded chiefly on Mr. Dewick's Collection. *Sphaerium lacustre* has been inserted above on his authority.

There are also in the gravels described some six or eight shells which we do not now find in the neighbourhood of Cambridge, but which occur elsewhere in the British Isles.

Succinea oblonga, Drap., is mentioned by Gwyn-Jeffreys¹ as rare in Wales, Scotland and Ireland and in England is recorded from Braunton Burrows in Devonshire only. Its habitat is "dry ditches near the sea-coast."

Helix (Anchistoma) obvoluta, Müll. This shell, says Jeffreys, lives on stumps and at the roots of trees in woods in Hampshire. Da Costa and Taylor give it a somewhat wider range in the south of England, mentioning also Surrey and West Sussex.

Jeffreys observes that it occurs in France, Germany, Switzerland, and Lombardy, but that it does not seem to inhabit the extreme north and south of Europe.²

Clessin says that it is less common in the north than in the south of Germany, and he records it also from Bohemia.³ This occurrence of *H. obvoluta* in the gravels shows that it is not a form now advancing from the south, but is, on the contrary, a species which is dying out in England, but still survives in the south.

Helix (Acanthinula) lamellata, Jeff., is now found only in the north of England, Anglesey, north and west of Scotland, Ireland, Sweden. Clessin⁴ records it from North Germany. In this shell we have, in contrast to the last-mentioned species, an example of a form which has become extinct in the south of England, but is still fairly plentiful in the north.

Vertigo angustior, Jeff. The habitat of this rare shell is "in the roots of grass in marshy ground." Jeffreys found it near Swansea and in the rejectamenta of the river Avon at Bristol. He records it from Tenby, Battersea Fields, and Ireland, the north-east and south of France, Germany, Switzerland, and from Lugano in Italy.⁵

Mr. Charles Ashford, who kindly examined a specimen which I had discovered at Barnwell, found on comparing it with recent *Vertigo pusilla* in his collection from Yorkshire, that amongst them was one undoubted *Vertigo angustior* which he had hitherto overlooked. I have found it in Westmoreland also. Miss Esmark records it from South Norway and Sweden.⁶

Possibly the following species did not appear in England till after the deposition of these gravels.

Helix (Fruticicola) cantiana, Mont., does not seem to occur in the gravels. It is very common round Cambridge at the present time, and is found in the north and south of England, but not in Scotland or Ireland. It lives in France, Belgium, parts of Germany, Italy, Illyria, and Sicily.

It is doubtful whether *Helix (Fruticicola) rufescens*, Pennant, is found in the gravels. It is now widely distributed over England, and occurs in Ireland, but not in Scotland.

Helix aspersa, Müll., is not recorded from any of the localities

¹ Brit. Conch. vol. i. p. 154.

² *Op. cit.* p. 230.

³ Deutsch. Exc. Moll.-Fauna, p. 134.

⁴ *Op. cit.* p. 129.

⁵ Brit. Conch. vol. i. p. 266.

⁶ Journ. Conch. vol. v. p. 127.

given in the list, nor can I find mention of it from similar gravels elsewhere.

Mr. Gloyne in his paper on the Geographical Distribution of the Mollusca,¹ says, "*Helix aspersa* attains a much larger size in Italy than in England. It is very difficult to believe that so abundant a British species has been introduced; but judging from the reduced size of English specimens, England would, to say the least, not appear to possess the most favourable climate for this mollusc."

Jeffreys says, "It does not appear to inhabit the north of Europe, nor Germany . . . but its range extends southwards through France to Sicily, as well as to Spain, Algeria, and the Azores."²

It occurs also in many widely separated parts of the world to which it is known to have been artificially introduced. As, for instance, Mauritius, S. Australia, Valparaiso, Rio in Brazil, and sea-ports along the east coast of N. America. The only evidence we have bearing upon the time of its first appearance in Britain is its plentiful occurrence in the Roman rubbish pits at Chesterford and elsewhere about Cambridge at such a depth and in such a manner as to preclude the possibility of its having got in subsequently.³

Helix? *pomatia*, Linn., which lives now in the neighbourhood of Shelford, has not been found in any of these gravels, and I have never noticed it among the Roman remains of this district, even where shells of *H. aspersa* appear to have been thrown in in large quantities.

Helix (*Arionta*) *arbustorum*, Linn., is now found with *Helix* (*Tachea*) *memoralis* in the Grantchester woods. It also lives under the willows close to the river, and is seldom found far from the water. A few days ago I noticed numbers of shells of this snail freshly broken by birds lying round the stones on which they had been smashed, all along the bank of the ditch near the bathing sheds on Coe Fen. This species is extremely common in the gravels of Barnwell Abbey and Grantchester. It probably found a hiding-place as at present under willows, of which remains, as we have seen above, occurred so abundantly in one part of the pit at Barnwell Abbey.

Cyclostoma elegans, Müll. I have found one specimen of this shell undoubtedly in the Mammalian gravel of Barrington. It does not now live in the immediate neighbourhood of Cambridge. I found quantities of dead shells, many with the opercula in place, several feet from the surface, in a tumulus of pre-Roman date, at Upper Hare Park, near Six Mile Bottom.

It appears, therefore (see pp. 203—204) that among the shells of the Cambridge gravels we have no fewer than 6 species which are no longer found in Britain. Several species which I have mentioned (see p. 205) have been found in the gravels, but have now disappeared from this district, though they occur in other parts of England, and some species which are common near Cambridge at the present time are absent from the gravels (see p. 205).

¹ Journ. Conch. vol. i. p. 289.

² Brit. Conch. vol. i. p. 182.

³ See also B. B. Woodward, Science Gossip, May, 1883, pp. 115, 237.

It will be seen, also, that of the locally extinct Mollusca, as in the case of the Mammalia, some are distinctly northern, some southern forms, and some have an extensive range from north to south. Considering the wide distribution of the forms, both extinct and living, it is not safe, without taking into account the habitat and range of every species, to generalize upon the climatal conditions of the age. The collective evidence which we gain from the Mollusca as to the climate of the period is more reliable than that offered by the Mammalia, because the various northern and southern Mammals could migrate to and fro with the changing seasons; but the molluscs once having found their way to a locality would remain there until they were slowly driven away by unfavourable conditions. The two shells of most pronounced southern origin, *Corbicula fluminalis* and *Unio litoralis*, being fresh-water forms, would not be affected by changes of temperature so soon as land-shells.

With regard to geographical changes, the whole gravel fauna seems to point to continental conditions, when Europe was connected with Africa, and England was united with France and Belgium. The formation of the British Channel would put an end to the migration of the larger animals, and would cut off the species, which had here reached their furthest limit, from the region of their greatest development. These species, being thus isolated, would in time give way to the more vigorous forms, which were better fitted to their surroundings, and would not be affected by such changes.

II.—ON *HETERASTRÆA*, A NEW GENUS OF MADREPORARIA FROM THE LOWER LIAS.

By ROBERT F. TOMES, ESQ.

(PLATE VII.)

DURING the interval of ten years which has elapsed since my paper on Liassic Madreporaria was read at one of the meetings of the Geological Society, a great many specimens of Liassic *Isastrææ* and *Septastrææ*, chiefly from the Vale of Evesham, have come into my hands, and with this abundance of material I have examined anew the several species, and have arrived at the results contained in the present communication.¹ When making these examinations, I have been invariably struck with the absence of a distinct and well-defined basal wall and epitheca. Further observation also showed that these Liassic forms differed from other *Isastrææ* in having occasional elongated calices, like those of *Latimeandra*. With the latter genus some of the Liassic *Isastrææ* were supposed (though as it now appears erroneously) to hold a near relationship, and one species received the (at that time) appropriate specific name *latimeandroidea*. With this the supposed resemblance ended; for gemmation, which in *Latimeandra* is calicinal, was found to be always marginal in the Liassic forms.² Fuller investigation brought to

¹ More than seventy specimens have been examined and contributed to the results made known in this paper.

² It has become necessary that gemmation in the genus *Isastrææ* should receive further attention. It has been variously stated both by Prof. Duncan and by me to