will indicate the chief distinctions from the previously known species.

M. Hagenbachii.

M. capite postice in collum longissimum subcylindricum attenuato; prothorace elongato-hexagono, angulis anticis porrectis conicis; lateribus spinis tribus æque distantibus armatis (spatio inter spinam posticam et basin fere dimidium prothoracis æquante); elytris foliaceo-dilatatis, angulo basali in lobum transversum antice truncatum porrecto, dilatatione magis cordiformi, latitudine maxima ante medium posita; antennarum articulo secundo longitudine latitudinem ejus duplo superante; scutelli apice rotundato.

Long. corp. unc. $2\frac{1}{2}$, ad apicem elytrorum unc. $3\frac{1}{6}$; capitis lin. 9; prothoracis lin. $7\frac{1}{2}$; elytrorum ad apicem suturæ lin. 14; lat. elytrorum ante medium lin. 17.

Habitat Malaccam in insula Sumatra.

The fact of this species being found in the same locality with *M. phyllodes* forbids our regarding it as a geographical variety; whilst the specific characters given above equally militate against its being a local modification, such, for instance, as occurs in many species of *Carabi* or *Harpalidæ*, respecting which so much discussion has recently taken place amongst Continental entomologists.

The specific name given above was suggested by Mr. Adam White, in honour of the original founder of the genus.

XII.—*Notes on Cambridge Geology.*

By Harry Seeley, F.G.S., Woodwardian Museum.

I. *Preliminary Notice of the Elsworth Rock and associated Strata**.

One of the last labours in England of Mr. Lucas Barrett was the production of a geological map of the country around Cambridge. Of the Lower Secondary deposits, he therein coloured the Kimmeridge Clay, Upper Calcareous Grit, and Oxford Clay. The chief novelty in this was the introduction of the Calcareous Grit; for Professor Sedgwick, many years before, when riding in the neighbourhood of Conington, had somewhere seen a drab-coloured deposit, which, without dismounting, he very na-

* Communicated by the Author, having been read at the Meeting of the British Association at Manchester, Sept. 1861. This paper was to have been incorporated with one on the Strata of England between the Portland and Great Oolites, an intention reluctantly postponed. It will be followed by four papers which were to have been other chapters in the scheme:—1. On the Kimmeridge Clay; 2. On the Tetworth Clay and Coral Rag; 3. On the Rocks of the Oxford Clay; and 4. On the Oxford Clay.

turally supposed to be an outlier of the Shanklin Sands; and so it continued to be regarded until Mr. Barrett discovered that it was really a member of the Oolitic series. On what grounds it was determined to be the particular rock mentioned, or Calcareous Grit at all, I am not aware, unless, indeed, it were from Dr. Wright's speculation that Lower Calcareous Grit had a probable existence in this district; nor have I learnt why the clay above was mapped as Kimmeridge Clay. Some fossils were collected and placed in the Woodwardian Museum. So remarkable was the assemblage, and in some respects so unlike what would have been anticipated, that, after a careful examination of the specimens, I could not but suspect that, in the haste with which the north-west corner had been mapped, something must have been wrongly interpreted. Accordingly, at the first opportunity, I established myself in the village of Elsworth, and proceeded to investigate the nature and relations of the rock on which it stands.

Elsworth is four miles and a half due south of St. Ives—the well-known locality for Oxford Clay,—nearly the same distance due north of Bourn, and about eight miles W.N.W. of Cambridge. The country about is, on a small scale, quite hill and valley, the village of Elsworth itself being built in a rather deep hollow. The hills are mostly of boulder clay, while the valleys produced by its denudation often expose the stratified beds beneath. A brook runs through the village, and ultimately finds its way into the Ouse.

As the streamlet flows between the principal rows of houses, its banks were naturally the first places examined; and here and there along them was seen peeping out a reddish-brown calcareous rock, highly charged with iron-shot oolitic particles, and very hard, but readily separating by cracks into small pieces. It extends throughout the length of the village, and at its southern end dips under a hill of dark-blue stratified clay; to the north it is denuded: this is the nearest approach to a section to be seen. I wished, however, to see the rock where it had not been weathered, as also to obtain fossils from the clay above; and so the Rev. H. Dobson, the rector, kindly granted permission to sink the necessary pits through the rock. The first attempt was a failure; for, though a very promising site was selected within four yards of an exposure by the roadside, it was found, after a large excavation had been made, that the whole deposit was bouldered away. The next trial was more successful; and, singularly, though in the immediate vicinity of the other, there was no trace whatever of the drift clay. We sunk through six feet and a half of a dark-blue laminated clay, which here and there contained a layer, of chocolate- or ferruginous colour, abounding

in minute crystals of selenite and sulphate of barytes, and became extremely hard as we descended. Every now and then, specimens were met with of the *Ammonites vertebralis*, in which the body-chamber was filled with calcareous matter, and the rest of the shell pressed flat, forming what well-diggers call "shapes;" some specimens were also found of the *Gryphæa dilatata*. From these fossils I was inclined to regard the deposit above the rock as Oxford Clay instead of Kimmeridge—a conclusion afterwards in some degree confirmed by the abundance in which the latter fossil occurred in another section. Indeed, the fossils from the clay immediately above were scarcely to be distinguished from those in the clay below. And so, instead of Upper Calcareous Grit, the phenomenon presented appeared to be that of a limestone dividing two beds of Oxford Clay.

Continuing the digging, the rock was reached; and here, where protected, its appearance is very different from the weathered aspect seen by the brook-side. It is a dark-blue homogeneous limestone, which I can compare to nothing but the unseptarious cement-stones of the clays. The oolitic grains were abundant, and as deeply ferruginous as though they had been exposed to the air; while scattered irregularly about, branching and interlacing, were masses of undecomposed iron pyrites. A rock of undivided structure, such as that described, will be easily understood to be difficult to work; and I cannot convey a better idea of its hardness than by stating that, during the ten hours during which two men continued thumping away at it, they succeeded in breaking a five-foot iron crowbar, the iron of one pickaxe, and the handle of another, and did not get up a quarter of a hundred-weight of fragments; and yet it is so easily decomposed by the weather as to be utterly useless for road-mending, building, or any economic purpose.

Before the deposition of the superimposed clay, the rock appears to have been much denuded, and consequently its thickness is very variable. It is commonly about 3 or 4 feet, though in some places not less than 7 feet. The clay immediately above it is of a reddish brown, and, judging from its contents, appears to be coloured by the rubbing up of the rock below. But 7 feet must not be supposed to be the total thickness of the deposit; for on the top of it is a clay of about 5 feet in thickness, and then an upper rock of 18 inches, which forms the surface, and above which, at the places where exhibited, there is very little clay. This middle clay is of a brown-black, and is nowhere well exposed; where best seen, it contained numerous specimens of a small variety of *Ostrea Marshii*. The rock above it has all the outer characters of that below, being equally rusty and quite as oolitic—except, however, at one point, where, getting a section

in a ditch, it was found to be yellowish white, more sandy, and almost free from oolitic particles. The fossils here were few, but, under the slightly altered conditions, differed a little from those met with in other places. In general they are very similar to those of the inferior deposit, though including some forms which, so far as yet explored, have served to distinguish it.

This thickness of about 14 feet appears here to form the entire mass of this peculiar rock. And yet, in tracing the brook to the south, I found in its bed three successive layers of a hard whitish-grey rock, of 6 or 8 inches in thickness, occurring in the clay at heights above the rock of Elsworth of about 7, 15, and 20 feet. However, these only contain a few *Gryphæa dilatata*, and resemble more than anything else layers of hard, dark Lower Chalk. There is nothing to suggest any connexion with the Inferior beds; but it is just possible that they represent the extreme limits of strata which may elsewhere thicken and unite with them. The dip to the south seems to be about one foot in two hundred.

Having become thus far familiar with the exhibition of the rock about Elsworth, I endeavoured to discover whether it were merely local, or a regular stratum which might serve as a boundary between great thicknesses of clay.

From the great accumulation of the clay, sinking for water here is scarcely more profitable than sinking for coal would be; and therefore in the small neighbouring villages there are few deep wells. However, some have been attempted. One of these was at a point rather more than three miles S.S.W. of Elsworth, and sunk to the depth of 150 feet. They dug through 84 feet of a hard dark-blue clay, from which many Ammonites were obtained; but, as the well was made thirty-six years ago, these are not now to be heard of. Below this they came upon 14 feet of alternate bands of stone and sand (the stone was full of small shells), and an extremely hard grey-blue rock, which they had to get up with chisels and blacksmith's hammers, working for six months before they got through it.

The dip of the Elsworth rock has already been given as one foot in two hundred, and the distance of this digging from Elsworth as about 16,000 feet; therefore, if the rock extended continuously, and preserved the same angle of dip, it ought to be found, at this distance, at a depth of 80 feet; and so, when a rock is found there, at that depth, of a thickness, hardness, and appearance identical with that of Elsworth, I must urge that the evidence approaches the conclusion that in both places the rock is one and the same. In Papworth Everard, a village a mile and a half to the west of Elsworth, a rock was met with in a well-sinking at a depth of 7 feet, but not pierced. Papworth

is on higher ground, but the rock at Elsworth dips to the east; hence this stratum will probably be a band some depth underneath it.

Northwards from Elsworth to St. Ives, the country is perfectly flat, and occupied at the surface almost continuously by gravel, the rock having disappeared, probably by denudation. But, on approaching St. Ives from the south, a ridge of high land is seen flanking the town on the west; and on carefully exploring a brick-yard at the base of it, I found abundant remains of a rock which an old brickmaker told me once extended continuously all over the pit to a thickness of 3 feet, quite at the surface, and sometimes parted into two beds by an intervening layer of clay.

Where visible, the rock here is much weathered, but is the same kind of reddish-brown deposit, full of oolitic grains, which occurs at Elsworth. It has long been mistaken for drift, and, as such, is alluded to in the 'Oolitic Echinodermata;' but, though quite at the surface, thin, and often overlain by boulder-clay, there cannot be the least doubt that it is a solid rock of Secondary age accumulated on the clay below. Passing a little to the east, I learned that, in another brick-pit there, a rock had formerly existed, but was now all removed at the surface, having dipped down into the clay to the east of the pit. And still further to the east, at the point where the roads branch to Needingworth and Somersham, it appeared that, in another brick-yard, they sometimes, when digging, came down upon a floor of hard stone, which they have never attempted to get through. To one going over the ground, the conclusion is irresistible that the rocks mentioned at all these pits are one deposit dipping down to the east; but whether this rock is an extension of that of Elsworth, or another bed inferior or superior to it, is a very complex question, difficult to answer.

Rather more than two miles N.N.E. of the last-mentioned pit, and three miles from the pit exposing the rock at St. Ives, is the Bluntisham cutting of the Eastern Counties Railway. This is a piece of high land, which has been cut through to a depth of about 40 feet, and yet the base of the cutting is so elevated that the line descends towards St. Ives at an incline of one foot in less than two hundred; so that the rails here cannot be less than 50 feet higher than they are two miles to the south. Now, in this cutting, just below the surface, is found a rock, of a grey-blue colour and unknown thickness, which was so hard that it had to be blasted in laying the railway drain. I have a fragment, containing iron-shot oolitic grains and shells, quite resembling the rock of Elsworth. It extended continuously for distances of about 100 feet, when, as I was informed, short inter-

vening spaces occurred, in which it was so soft that "one could put his arm in and move it about,"—a circumstance probably indicating a water-bearing stratum at no great depth beneath.

The question here arises, Is this calcareous band identical with that of St. Ives, above which it would seem to be at least 30 feet? If this is assumed, it is clear that as the Elsworth rock dips south, it *cannot* be identical with the stratum at St. Ives, which also would dip south, and therefore be at a very great depth beneath it. Another conclusion from this assumption would be, that the fossils in the clay at Bluntisham should be identical with those of the clay above the rock near St. Ives; while we should expect a considerable difference between the fossils of the St. Ives limestone and that of Elsworth. But neither of these conditions is met with.

Although the clay at Bluntisham is capped with boulder clay, and the fossils of both, which were collected for me, are mixed together, and are therefore to be appealed to with great caution, I think it can yet be said with confidence that they indicate a zone above that of St. Ives; while, after some hours' work in the St. Ives rock, I only obtained, in nineteen, three species not previously met with at Elsworth. This must be conclusive that the Bluntisham rock is superior to that of St. Ives, while it strongly suggests that the latter is not far removed from the zone of the Elsworth limestone. The few fossils from the clay above the rock at the latter place are such that there can be no doubt that the rock beneath is not inferior to that of St. Ives: it may be superior or on the same parallel; while the alternatives with respect to the Bluntisham bed are that it should either be continuous with or inferior to it. Thus, then, we shall have the point of upheaving force greatest either between Elsworth and St. Ives, or at some unknown place further north. If the latter condition obtained, the St. Ives rock would be inclined to the horizon; and as the bed at Bluntisham is in elevation apparently only 30 feet above it, it would, even if the angle of inclination were less than that of the Elsworth bed would lead us to expect, become, when it reached Bluntisham, either coincident with the deposit there or many feet *above* it. Moreover, the Elsworth rock would be 100 feet above that of St. Ives. The fossils, however, as has already been seen, indicate conclusions very different; and so the supposition may safely be dismissed. The point of least resistance in the upheaval, then, was between Elsworth and St. Ives; and therefore the rock, which rises to the surface at Elsworth, must dip down again somewhere to the north in the St. Ives neighbourhood. Hence the question stands thus: Is the Bluntisham rock (or are both it and the St. Ives beds) a continuation of those at Elsworth? If the supposition be adopted that the

two northern bands represent the Elsworth beds, it will be seen that the apparently thick stratum of Bluntisham becomes very thin at Elsworth, being represented by the layers mentioned in the bed of the brook, and that they have ceased to exist at Bourn. The only fact bearing against this view is, that, so far as known, the fossils from the clay above the rock at Elsworth are not identical with those from the clay near Needingworth, but very different. If the other view is taken, the St. Ives rock will be an inferior band separated by a considerable thickness of clay from that above. Now, if the upheaving force met with anything like the same amount of resistance to the north which it did to the south, it will be clear that as Bluntisham is 3 miles north, and Elsworth about five miles south, of St. Ives, there ought to be an anticlinal outcrop of the St. Ives rock in the neighbourhood of Fenstanton, that is, two miles south of its St. Ives outcrop, where it should dip south into the clay, so as to pass under the rock of Elsworth. However, as Bluntisham is on high ground, it will be necessary to allow a further extension of a mile or two north, to balance its height. And so it is highly probable that the pressure from below was greatest very little to the south of St. Ives. Now, in the village of Conington, a mile and a half north of Elsworth, and three miles and a half south of the pit showing the rock at St. Ives, a well was sunk to a depth of 250 feet; and herein, after digging for 100 feet, a rock was pierced 5 feet in thickness. It has already been shown that the rock will dip south. If we suppose this incline to be the same as between Elsworth and Bourn, when the rock reached St. Ives, it would only be 18 feet below the surface; and as no rock is found there at that depth, and as the angle of the incline may be expected to increase as the plane inclined approaches nearer the central action of the inclining force, and also as some allowance must be made for possible difference of heights at the places mentioned, the evidence will be perfectly conclusive that this deep-seated rock of Conington is really the "old red rock" of St. Ives brick-yards, and, therefore, that the Elsworth rock, 130 feet above it, is essentially identical with the limestone at Bluntisham. And this explains the discrepancies between the fossils from the clay above the rock at St. Ives and those met with in the clay at Bluntisham, while the characteristic fossils of the Elsworth clay are, so far as is yet known, identical with those of the latter place. At present I have no further evidence of the extension, in a longitudinal direction, of the Elsworth rock, which has thus been traced for a distance of eleven miles, with every circumstance to indicate that it extends far both to the north and to the south of these limits.

It will, however, be readily seen that this argument is not

necessarily infallible; the facts on which it is founded are too few for it to claim to be more than an inductive guess. Indeed, seeing that it is built fundamentally on the assumption that the rocks at Elsworth and Bourn are the same, it might be quite wrong. All the facts certainly appear to be in its favour; but it must not be forgotten that simplest explanations are often truest; and in this case, if we suppose the country flatter than the preceding argument required it to be, the deep-seated rock at Bourn (80 feet) would be continuous with the deep-seated rock at Conington (100 feet); and therefore the rock at St. Ives would be the Elsworth rock, and the band at Bluntisham probably identical with those in the bed of the Elsworth brook. Nothing but its simplicity is known in support of this hypothesis, which is only mentioned here as a contingency which has not been overlooked. Even should it be ultimately proved true, the result would in no way affect the principal object of this paper, except in giving the arguments greater weight, by showing that the Elsworth rock is really lower in the Oxford Clay than it is now supposed to be. Meanwhile I adopt the explanation previously given as the true one.

It has already been seen that the St. Ives rock dips to the east; therefore the Elsworth beds also will dip in the same direction, and hence the clay to the east will be above the latter deposit.

Two miles eastward of Elsworth is Boxworth*; and here the land rises so that one can see over the Elsworth valley and the country north and north-east of it. Now, on the easterly slope of this hill is a brick-yard; and here also is a rock, about a foot and a half thick. The workmen call it "flint," a name I have also found given in the surrounding district to the septarious concretions of the clays. It is dark blue, very hard, and divided into layers, much as is the Elsworth rock. The only specimen of it I saw was a slab from the upper part, about six inches in thickness, which consisted of two layers—an upper dark-blue one, with a few small shells scattered about in it, and a lower pale-brown layer composed almost *entirely* of shells, chiefly univalves. From the rock I only succeeded in obtaining, in a determinable condition, *Ammonites biplex*, part of another Ammonite, apparently *alternans*, *Pecten lens*, and a new species of *Pecten*, also found at Elsworth, *Alaria bispinosa*, and *Cerithium muricatum*. In the clay beneath I found a single specimen of *Ostrea deltoidea*, another of *Gryphæa dilatata*, and two or three of an Oyster nearly resembling *O. læviuscula*, hereafter to be described as *O. discoidea*. This same Oyster occurs somewhat sparingly, with

* Pronounced *Els'er* and *Box'er*. Papworth is sounded *Parper*.

the *Gryphæa dilatata*, in the clay at Elsworth, and also sparingly, with the *Ostrea deltoidea*, in the clay to the north-east, at Willingham. Thus the Boxworth rock is a stratum above the Elsworth rock, just as the St. Ives bed is beneath it.

It was seen that the Elsworth beds dipped to the south; and consequently the clay in that direction will also be above them. Seven miles south of Elsworth is Gamlingay; and here, in a brick-yard near the bogs, I heard of a rock about a foot and a half thick, seven feet below the level of the pit. From the clay above were obtained single specimens of *Ostrea deltoidea*, *Gryphæa dilatata*, and *Ammonites biplex*. Also, in a brick-yard at the top of Tetworth Hill, the *Ostrea* and *Gryphæa* were found abundantly in unexpected combination with *Serpula tetragona* and portions of *Ammonites Achilles*, which occurs at Bluntisham and in the bed of the Elsworth brook; and beneath was a floor of rock, covered with water at the time I was there; the rock was said to be white, and 18 inches thick. Between these two pits there is another; but during my short stay I failed to get any characteristic fossils, except two or three *Gryphææ dilatatæ*; from this circumstance, and as it is in a hollow, it is probable that the rocks at Tetworth and Gamlingay bogs are the same, and that this is the clay beneath, but at present it is impossible to say so with certainty. Supposing it should be so, I should be still less inclined to express an opinion as to whether this Tetworth rock is the same as that of Boxworth; though, so far as the evidence goes, the natural conclusion would be that it is the same. They are clearly deposits in very nearly the same position, and are mutually inclined; so that, had they extended continuously, and been different beds, there ought to be a second rock in the vicinity of Boxworth; but, as this has not been met with, the probabilities are strong, taken in conjunction with the other circumstances, that the outcrops are both of the same stratum. Above this I know of no other stone bands for a long way up; but there is another one beneath the lowest yet mentioned.

Six miles west by south of Elsworth is St. Neots; and a little to the south of the latter place, near Eynesbury, in laying the plates of the Great Northern Railway, a rock was cut down to. The uppermost band, of about 8 inches, was removed: it held beneath a large quantity of water, which produced the singular effect of giving all the workmen who drank of it the ague. Below this bed of stone was another of clay, and then another of the rock; but whether there were any further alternations was not determined. The rock is described as having the aspect of Cornbrash. In the well at Conington, 150 feet below the St. Ives rock, another rock was reached, but not pierced, a small

supply of very *salt* water being obtained: it is just possible that this rock may be that of St. Neots. There can be no doubt that it holds a place at least that depth below the rock of St. Ives; for the prevailing fossils at St. Neots (*Ammonites spinosus, Duncani,* and *athletus*), which occur almost to the exclusion of other forms, will, with *Ammonites coronatus,* indicate a bed much lower than that of St. Ives, which has *Ammonites cordatus, Lamberti, Eugenii,* &c., as most common. A considerable thickness of strata is probably represented by this change of life in time. Therefore, notwithstanding the circumstance that Prof. Buckman has given the *Ammonites Duncani* and *athletus* (St. Neots fossils) as occurring in the same highest bed of clay with *Ammonites Mariæ* and *Goliathus* (St. Ives fossils), it will be readily granted that the St. Neots rock is lower than that of St. Ives; and this being so, it cannot but happen that it dips to the east, passing under Elsworth; and therefore, if persistent, it ought to occur that the St. Ives rock, by a synclinal, should again crop out somewhere S.W. of St. Ives, while both it and the Elsworth rock should occur between Tetworth and St. Neots. Though I have gone over the whole of this country with some minuteness, it must be reserved for a future paper to say whether they are to be seen or not. But the whole of Huntingdonshire is much obscured by gravel; so that, in the absence of brick-yard evidence or wells, the chances of detecting them would be slight.

Such, then, so far as is yet observed, is the succession of clays and stone bands in the east of Huntingdonshire; but, from observations made in Bedfordshire, there appears to be a great thickness of clay beneath the lowest zone here seen; and therefore it would be premature to conclude that the St. Neots rock is identical with the Kelloway rock, which may yet be found lower down. This being so, the Elsworth and other rocks cannot but be regarded as strata high up in the Oxford Clay, and probably of similar importance with that occurring near its supposed base—conclusions which, it will presently be seen, are also indicated by the fossils.

Facts of no less interest than the succession of rocks are presented by the succession of the clay, which by them is separated into well-marked subdivisions, each distinguished by a peculiar assemblage of fossils. But not only do the organic remains differ, but as the series of strata is ascended a gradual transition is observed from those forms characterizing lower beds to those occurring higher up, until at last some of the peculiar fossils of the Kimmeridge Clay are found blended with those of the Oxford Clay; and further on, the true Kimmeridge Clay itself is met with, as at Cottenham. In the absence of the Coral Rag, this great succession has the appearance of one deposit, admitting,

however, of subdivision into the parts characterized by *Gryphæa dilatata*, by this species and *Ostrea deltoidea* associated, and by the latter fossil and *Exogyra virgula*.

In this country there is nothing to indicate that the middle group should rather be added either to the upper or the lower of these beds. In the South of England, Mr. Pease Pratt added it to the Oxford Clay—a conclusion in which he has been followed by the gentlemen of the Geological Survey. But if it is contended that at Upware, midway between Cambridge and Ely, the Coral Rag occurs beneath the Kimmeridge Clay, it must also be confessed that we are ignorant of what fossils may occur at the base of the clay there, while, on the other hand, the Elsworth rock clearly separates the clay above from the *Gryphæa-dilatata* clay below; so that, did the Elsworth rock attain the thickness of the Coral Rag, there could not be a question about the claim of the middle clay to be considered distinct and intermediate between the Kimmeridge and Oxford Clays. Nor, as it is, can there be any doubt about it, seeing that duration in time is not represented by thickness of deposit, but by change in life; and in this respect the palæontological evidence is conclusive. The fact, too, of the existence of an isolated reef of Coral Rag will be evidence that other deposits must have been made around it. It is therefore proposed to distinguish the stratum as the *Tetworth Clay*.

The fossils from Bluntisham, which it must be remembered are from the lowest part of the clay, are *Gryphæa dilatata* abundantly, *Ostrea deltoidea* rarely, *Ammonites alternans, biplex, serratus* (which is erroneously given in Morris's Catalogues as from the Oxford Clay of Huntingdonshire), and an Ammonite figured by D'Orbigny as the female of *Duncani*, but which is neither that species nor *spinosus*, which latter form has, in the adult state, the characters of its youth, only more developed, while this bears to it much the same resemblance that *Callovicensis* has to *A. Duncani*; and *Belemnites excentricus*. To these may be added, from Elsworth, *Alaria bispinosa, Lima pectiniformis, Pecten lens*, and *Ostrea discoidea*.

Of course it is certain that the agencies depositing strata have ever acted without intermission; and therefore it is that all rocks can only over a limited surface preserve the same lithological characters. Clays being the most persistent of strata, because the most flocculent and therefore widest spread, are less likely to thin out than limestones; and yet it singularly happens that the Tetworth Clay has only been noticed in a few places, and never in company with the Coral Rag, which appears to have a much greater extension. The explanation would appear to be this:—The deposition of the Coral Rag and its associated grits

must have occupied a long period of time: this has usually been regarded as equivalent to the ages required for the change of the fauna of the Oxford Clay to that of the Kimmeridge; it must at least have occupied a large part of that period; and its absence as a representative of time would be indicated by a corresponding break in life. Now, in the country between Elsworth and Cottenham, where the Coral Rag does not occur, it has been seen that there is no break in life: hence there cannot be a great break in time; and so the Coral Rag must be present as a period, although it has ceased to exist as a calcareous formation. The clay, then, must represent it; and hence the Tetworth Clay will be regarded as the argillaceous contemporary of the Oxford Oolite; and therefore it results that the Elsworth rock is directly underneath the Coral Rag, on the one hand, and above the Oxford Clay, on the other; so that the only remaining question about its position is to determine whether it is rather to be classed with the Oxford Clay or with the Lower Calcareous Grit. And this is a problem of some difficulty, since there is no calcareous grit in this district for comparison.

If the Tetworth Clay were replaced by Coral Rag, the Elsworth rock would then be a calcareous bed at the base of it, and apparently forming part of it; but it would also be an Oolitic stratum at the top of the Oxford Clay, and *identical* in lithological structure with similar beds occurring lower down, from which, as already remarked, its species differ but little. In estimating the weight of the fossils as influencing the question, it must not be forgotten that many species are peculiar to clay, and others to limestone; so that, as the gap between the Oxford Clay and Calcareous Grit cannot be very great, there will almost necessarily be many forms in common between the Elsworth rock and the Grit above, which would not occur in the Clay below, while the same cause would prevent the Oxford-Clay fossils living on into the rock above.

The species of the rock are numerous. A good proportion of the forms are peculiar. The following list will serve as indicating the general character:—

Ammonites vertebralis.	*Ammonites Herici.*
—— *biplex.*	—— *canaliculatus.*
—— *perarmatus.*	—— *Goliathus*, var.

It is to be noticed that all these species occur in the Oxford Clay of France, while only two of them have yet been published from the Calcareous Grit. Besides them, there are two new forms, and the *Ammonites Rüppellii* of Münster from Solenhofen, which species must not be confounded with the Corallian *Ammonites Rüppellensis* of D'Orbigny, being nearly related to the *A. biplex*.

The Belemnites are *hastatus* and *tornatilis*, both of which occur in the Oxford Clay below, but neither, so far as I have collected, in superior beds. The *hastatus* is an inflated variety.

The Gasteropoda are *Pleurotomaria reticulata*, a fossil of the Calcareous Grit and Kimmeridge Clay in England and of the Oxford Clay in France, being identical with the *Pleurotomaria Münsteri* of D'Orbigny; *Pleutomaria amphicelia*, a new and peculiar species resembling the Inferior-Oolite *P. ornata*; *Littorina perornata*, a new form intermediate between the Inferior-Oolite *L. ornata* and the Corallian *muricata* (I believe that it occurs in the Coral Rag, Calcareous Grit, &c.); a new species of *Littorina*, a new *Cerithium*, and a *Phasianella*.

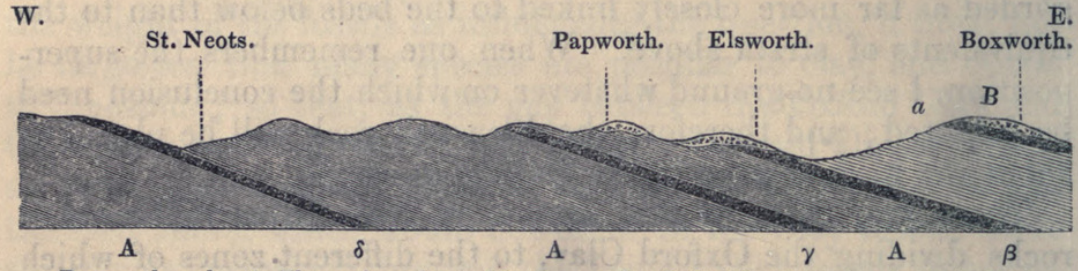
The bivalves are extremely numerous, and the new species many. A few only need be given now. Among the new species are *Avicula pterosphena* and *Gryphæa elongata*. Among the known species are *Pecten fibrosus* (including *vagans*); *Terebratula ornithocephala*, *T. perovalis*, and *T. sphæroidalis*; *Pecten lens* and *Pecten vimineus*; *Gryphæa dilatata*; *Lima pectiniformis*; *Avicula expansa*, *A. ovalis*, and *A. elliptica*; *Trigonia costata*, and a slight variation of Dr. Lycett's variety *decorata* of *Trigonia clavellata*; *Astarte ovata*, *A. lurida*, *Opis Phillipsii*, and a variety of *Myacites recurva*. Although most of these species occur in the Coral Rag and Calcareous Grit, I think, when the circumstances already pointed out are remembered, and also that many Coral-Rag forms range down to the Cornbrash, the fossils will be regarded as far more closely linked to the beds below than to the equivalents of strata above. When one remembers the superposition, I see no ground whatever on which the conclusion need be disputed; and therefore the Elsworth rock will be placed as about the highest zone of the Oxfordian series.

There are, then, in this district at least three well-marked rocks dividing the Oxford Clay, to the different zones of which it will be necessary to apply distinctive epithets when the whole succession shall be satisfactorily elucidated. It would be beyond the object of this paper to add anything further on either the rocks or clay zones; but as it has already been mentioned that the Upper Elsworth rock differs somewhat in fossils from the lower bed, it may be remarked that the circumstances which most attract attention are the presence in the upper band of numerous masses of *Serpulæ*, a difference in the Brachyurous Crustacea, in the spines of *Cidaris*, in the enormous size of *Gryphæa dilatata* (some being 11 inches long), the absence of *Gryphæa elongata*, the presence of plates of a Star-fish, the greater abundance of *Littorina perornata* and of *Pleurotomaria reticulata*, species of *Perna*, many *Ostreæ gregariæ*.

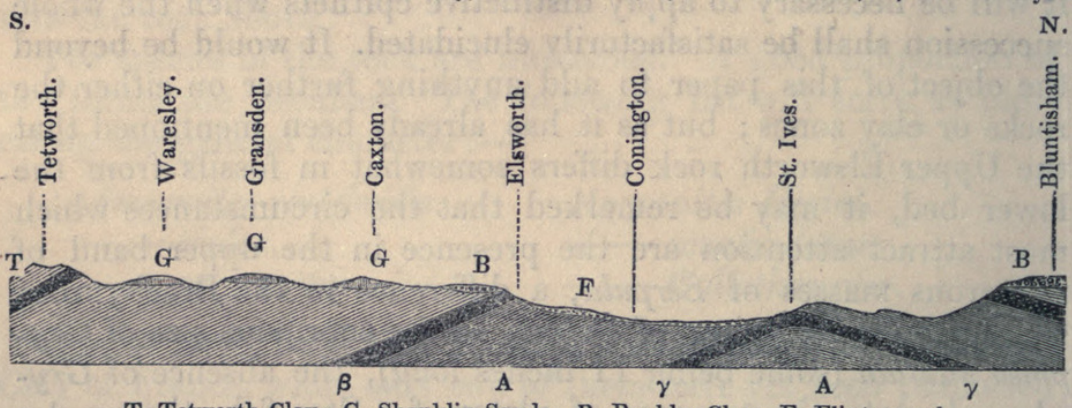
These distinctions may be but local, but in this locality they

will be found constant. In the lower bed are some shell-less Annelides.

It ought to have been previously mentioned, that at Over*, a few miles east of St. Ives, and west of the Kimmeridge Clay, the *Belemnites excentricus* and some other fossils have been met with, identical with those of Bluntisham; and therefore it might be expected that the Elsworth rock should crop out near Holiwell, which is an intermediate point between Over and St. Ives. Now, in the collection of Mr. James Carter of Cambridge is a series of fossils, collected for him twenty years since, which he believes came from Holiwell. The series contains *Ammonites Herici* and many Elsworth fossils, as also some few new forms and several which Elsworth has not produced and probably does not contain, such as *Dysaster bicordatus* and *Holectypus hemisphæricus*, these two species being very abundant. The lithological character of the bed is quite the same as that of the Elsworth rock. I do not insist upon a necessary identity; for the locality is not given with that certainty which such an assumption ought to require; and the pits being now abandoned and filled in, verification will be impossible. The fact must go for what it is worth, and, judging from circumstances in the country to the north-east, where there are other outcrops of rock, it will not be worthless. It may indicate an interesting synclinal between St. Ives and Over, which is probably a consequence of a vast downthrow fault known to exist far to the east.



a, Boxworth rock; β, Elsworth rock; γ, ?St. Ives rock; δ, St. Neot's rock; A, Oxford Clay.



T, Tetworth Clay; G, Shanklin Sands; B, Boulder Clay; F, Flint gravel.

Thus it has been endeavoured to illustrate a succession which will hereafter be elaborated at more appropriate length.

* Pronounced *Uv'er*.