ART. XXXIV.—*Remarks on a paper of Dr. Otto Meyer on "Species in the Southern Old-Tertiary,"* by EUGENE A. SMITH.

IN this paper, one of the objects of the author is to show that the relative position of three of the subdivisions of the Tertiary formation, viz: Vicksburg, Jackson and Claiborne (given in descending order), is not the true one, but that it should be Claiborne, Jackson and Vicksburg, with Claiborne at the top and Vicksburg at the bottom.

This conclusion of Dr. Meyer cannot be allowed to pass without comment; for although no geologist who has ever been across the country where these rocks occur in Alabama, could for a moment be in doubt as to their relative position, yet those unacquainted with the facts in the case might be led by Dr. Meyer's paper to doubt the accuracy of the observations of Lyell, Tuomey, Winchell and others.

So far as I am able to make it out, Dr. Meyer's conclusion is based upon two observations, and upon a number of inferences derived from what he thinks should have been the course of evolution of several species of shells.

The observations are these: (1) Conrad found in one of the lower strata of the Claiborne bluff, below the ferruginous sands which bear the greater part of the well known Claiborne fossils, a specimen of *Spondylus dumosus*; and (2) Dr. Meyer himself, found a specimen of an *Orbitoid* in one of the lower strata at Claiborne. I shall say nothing of the possibility of these specimens having been washed down from a higher level, for it is to be supposed that these two observers were not mistaken as to the actual occurrence of the fossils in the rocks mentioned, nor will I refer to the fact that these two observations, so far as they prove anything, merely show that the two species named have a greater range geologically than has usually been assigned to them, for I know from personal observations near St. Stephens and elsewhere, that they occur in great numbers, *above* the Claiborne sands also, but shall confine myself to stratigraphy, since superposition is after all the only absolute test of relative age.

The term White limestone, has been applied in Alabama to a series of calcareous rocks over 200 feet in thickness. A portion of the upper part of this is a chalky rock quite soft and easily cut when freshly dug, and much used as material for building chimneys. This upper part also in places contains great numbers of *Orbitoides Mantelli*. The lower fifty or sixty feet are more clayey, give rise on disintegration to a limy soil which resembles closely the limy soil of the Rotten

limestone of the Cretaceous. This lower part of the limestone contains also numbers of *Spondylus dumosus*, and vertebræ of *Zeuglodon cetoides*. These facts concerning the character and contents of the White limestone I give from personal observations. By many writers the upper part of this limestone has been considered equivalent to the Vicksburg, and the lower, to the Jackson divisions, but for our purposes it will be sufficient to define as above what we term the "White limestone."

Before offering any proof of the relative position of the White limestone and the Claiborne sands, it may be well to call attention to very important omissions of Dr. Meyer in his quotations of Sir Charles Lyell.

In Dr. Meyer's paper, page 61, we find the following remarks on an extract from a letter of Lyell published in this Journal, II, vol. i, pp. 313-315. "In this letter Lyell speaks on several subjects and says, of the Nummulitic limestone, that it had been referred to a pre-Tertiary age, but he considers it even younger than the Claibornean, 'for it occurs on higher places than the Claiborne bluff, a circumstance which, in a region where the stratification is horizontal, would imply a newer deposit, *even if the section near Suggsville, and Clarkesville, SHOWING SUPERPOSITION had been less satisfactory.* I did not meet with the limestone in question in the bluff at Claiborne which I have no doubt is owing to the fact that the calcareous strata are cut off at the top before they extend upward into the nummulitic beds.'"

Dr. Meyer omits all the words in italics, and thus carefully excludes the *proof of superposition* which Lyell brings forward; and then charges him with putting forth an hypothesis without proof. Moreover, in allusion to the diagram published by Lyell, in this Journal, II, vol. iv, pages 188-189, showing a section from Bettis' Hill in Clarke County to Claiborne, in which the White limestone is very distinctly represented as occurring at the top of the Claiborne bluff, Dr. Meyer insinuates that Lyell represented the dip, etc., not as he observed it, but as he needed it for his hypothesis. That Sir Charles, in saying that he did not observe at Claiborne the limestone in question, meant the *upper or nummulitic part*, is very evident from the figure referred to as well as from the words of Lyell quoted.* Indeed, Lyell's whole description of the relative positions of the various strata and their composition, in the region between the two rivers in the latitude of Claiborne, is remarkably accurate, as any one who is at all familiar with the country cannot fail to see.

Thus, when Dr. Meyer says Lyell has put forward his hy-

* This nummulitic part does, however, actually occur on the hill one mile south of Claiborne, as shown below in § 1.

pothesis of the newer age of the nummulitic limestone without any proof, he does so in contradiction to Lyell's direct and specific statement of what he had actually seen. (This Journal, 1847, pp. 188, 189, 190.) It is because the evidences of superposition are so numerous and unmistakable, that all geologists who have ever examined the country have never questioned it.

I have some sections to present which will remove all doubt, if only we can agree upon what we mean by the terms White limestone, and the Claiborne ferruginous sands. I have already said what I mean by the former. By the latter, I mean the stratum about 15 to 17 feet thick, occurring about midway of the Claiborne bluff (equal to *e* of Meyer's section) consisting of a reddish ferruginous sand full of the fossils described by Lea and Conrad as the Claiborne fossils. This sand is in its appearance and fossil contents unmistakable by any one who has ever seen it once.

The proofs which I wish to offer are of two kinds, viz: (*a*) direct superposition, and (*b*) the geographical position of the outcrop.

a. From direct superposition.

Immediately overlying the red ferruginous sands containing the Claiborne fossils—there are about three feet of ferruginous sands with hard ledges filled with *Scutella Lyelli*. This *Scutella* bed is indicated by *f* in Meyer's section at Claiborne, and it may be seen at all the localities cited below. Close above this *Scutella* bed is a White limestone—in places very argillaceous—sometimes sandy and glauconitic, which is demonstrably the lower part of the White limestone series as above limited. This is seen

1. At Claiborne.* Here there are to be seen between 50 and 60 feet of the clayey and glauconitic limestone (*h* and *i* of Meyer's section)—overlying the Claiborne ferruginous sands and the *Scutella* bed. On going from the plateau on which the town of Claiborne stands—up to Perdue Hill, the upper strata of the White limestone, containing *Orbitoides Mantelli*, may be seen in many places near the road, thus proving the correctness

*The lower part of the Claiborne bluff below the ferruginous sand, which is spoken of by Tuomey, Winchell and others as a limestone, has no resemblance whatever to the "White limestone." It is in fact rather a series of fossiliferous calcareous sands, and calcareous clays, than a limestone.

I can further assert from personal knowledge, that there is, below what I have just defined as the White limestone, nothing whatever in the whole series of Alabama Tertiary strata (at least from the Alabama river westward), which could with any propriety be called a limestone, unless an occasional bed of indurated shell marl, seldom if ever exceeding 15 to 20 feet in thickness, might be so designated.

Meyer's section on p. 69 which he says must supersede all previously made sections, describes *d* as "color a bluish gray" 26 feet, but whether the material is sand, clay, or limestone, he does not say.

of Lyell's statement that at the bluff the upper part of the limestone had been cut off by erosion.

2. At Gosport, a few miles below Claiborne, there is an exposure very similar to that at Claiborne Bluff, and the White limestone appears on the hills a short distance from the river just as it was when Sir Charles Lyell observed it many years ago, and at a higher level than the Claiborne sands—as Lyell said it was.

3. At Rattlesnake Bluff, a few miles below Gosport, we have the Claiborne ferruginous sands with their overlying *Scutella* bed—about 18 feet above the water level. Above the *Scutella* bed occur some 15 feet or more of the White limestone.

4. At the mouth of Cedar Creek, several miles farther down the river, the *Scutella* bed is only about three or four feet above the water level with a few feet of the White limestone over it.

In Meyer's section of Claiborne—the ferruginous fossiliferous sands are 64 feet above the river level; at Rattlesnake Bluff they are 18 feet above, and at the mouth of Cedar Creek, just below the water level. These observations establish the fact of a southerly dip of the strata.

Mr. Meyer questions the fact of such dip, but there is no doubt about it, as may be seen below in 5. C. S. Hale, in this Journal, II, vol. vi, No. 18, Nov., 1848, in an article on the Geology of South Alabama, not quoted by Meyer, likewise demonstrates the fact of the southerly dip of these strata. He also distinctly says that the White limestone overlies the Claiborne ferruginous sands, and brings forward observations of his own to prove it.

5. If we go down the river from the mouth of Cedar Creek, during a low stage of water, we can have the direct evidence of superposition, of the relative places of the Claiborne sands and the White limestone, for the few feet of this latter rock above the *Scutella* bed, mentioned as forming the upper part of the bank at the mouth of Cedar Creek, can be followed down the river till they sink below the water level, but before one of these beds sinks out of sight another appears above it, and the succession of these low bluffs (hardly ever more than 10 to 15 feet high) is so nearly continuous, that practically all of the strata intervening between the *Scutella* bed at Cedar Creek, and the Orbitoidal limestone at Marshall's Landing, may be seen. These strata are mostly argillaceous limestones, glauconitic in places. At Marshall's Landing, this argillaceous limestone is distinctly overlaid by 10 feet or more of limestone filled with *Orbitoides Mantelli*. There is no trace of faulting or disturbance along this part of the river, and the uniform dip of the strata and their succession are unmistakable.

6. The most positive and irrefutable evidence of the relative position of the White limestone and the Claiborne ferruginous sands is to be seen at the St. Stephens Bluff. There can I imagine be no reasonable doubt that this bluff is made up of the White limestone. In its upper part this limestone is in places a mass of *Orbitoides Mantelli*, and in the lower part of the bluff about 15 feet above the water level is a hard projecting ledge, a foot thick, beneath which is a layer consisting of the shells of *Spondylus dumosus*.

A short distance—about half a mile—above the St. Stephens landing, this bluff is interrupted by a ravine, on the other side of which it may be seen again with identical characters; *Orbitoides* limestone forming the upper part as at the landing below. At the base of this part of the bluff occurs a red ferruginous sand full of fossils—among which are *Melongena alveata*, *Crepidula lirata*, *Infundibulum trochiformis*, *Corbula Murchisoni*, *Turritella lineata*, *Cytherea æquorea*, *Oliva Alabamensis*, *Turbinolia Machurei*, *Voluta Defranchii*, *Astarte sulcata*, and a number of other forms which are found at Claiborne. Just over this bed occurs the *Scutella* bed above referred to, and over that, *in direct contact*, the white clayey limestone passing upward into the Orbitoidal limestone. This ought to set the matter at rest forever, so far as the relative positions of the Claiborne sands and the White limestone are concerned. I shall not here attempt to show that the White limestone of Alabama is the representative of the Jackson and Vicksburg strata of Mississippi; but I can assert from personal observations that the lower part of the White limestone of Alabama with its *Zeuglodon* bones and its limy soils corresponds with what Hilgard marks as Jackson on his map, and that the upper part of our White limestone is what Hilgard marks as Vicksburg. In p. 227 of Hilgard's *Geology of Mississippi* it is stated that the *Orbitoides* limestone is directly overlaid by the sandstone of the Grand Gulf group. This it seems to me is evidence that the *Orbitoides* limestone (which Hilgard considers Vicksburg) is at the top of the series with which we are concerned.

In paragraph 222, p. 144 of Hilgard's work, there is a distinct statement that the Vicksburg strata overlie those of the Jackson. The same thing is shown in his diagram No. 32.

b. From geographical position.

The Tertiary formations of Alabama have a southerly dip (S. or S.W.) which will average some 25 to 30 feet to the mile. This dip has been ascertained by L. C. Johnson and myself at several places, and that it is very nearly the average may be seen from the correspondence between our river sections and the records of a boring made at Bladon Springs. These data are very soon to be published.

I might also add in further proof of southerly dip, that all the streams flowing in easterly or westerly directions in the Tertiary territory of Alabama, have steep escarpments on the southern banks, and gentle southerly slopes on the northern.

That with a general dip toward the south, the Tertiary strata will outcrop across the country in approximately parallel belts, the newer beds appearing farthest south, is plain enough. Now in fact we have, going southward, the outcrops of the Tertiary formations in the following order :

1st, Lignitic; 2d, Buhrstone; 3d, Claiborne; and 4th, White limestone. There is but one exception to this order known to us, and that is of very limited extent, and plainly due to a flexure which can be traced out. In the same way, the Cretaceous outcrops lie to the northward of those of the Tertiary.

It seems to me that this relative position geographically of the outcrops of the formations, taken together with the general direction of the dip, would, to say the least, go far to prove their relative age.

Indeed the stratigraphical evidence of the superposition of the White limestone above the Claiborne sands is so abundant, so conclusive, and so completely without contradiction from a solitary fact, that it has, so far as I know, never been called in question by any geologist familiar with the field of their occurrence.