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GEOLOGY.—*Again on Pleistocene man at Vero, Florida.*¹ OLIVER P. HAY, Washington, D. C.

In a conversation held recently between an anthropological friend and myself about the finding of human remains in supposed Pleistocene deposits, about 11 years ago, at Vero, Florida,² he used an expression which implied that the investigations made there, the reports, and the subsequent discussions, proved disastrous for those who affirmed the presence there of Pleistocene man. This remark has prompted the writer to reconsider the case, after having devoted some years previously and the years since that time to the study of the Pleistocene vertebrates and of the Pleistocene geology of North America. I anticipate to say that I regard the investigations as far from having injured the case of Pleistocene man. In the symposium cited above there was no general agreement on the main question and it would be difficult to say who were farther apart in their conclusions, the geologists or the anthropologists.

When the geologists, the anthropologists and the paleontologists arrived on the spot they beheld a low-lying tract composed of thin beds of slightly consolidated materials which looked as if they might have accumulated within a few centuries and which offered for consideration a being almost universally looked upon as a "leitfossil" of the Recent epoch. The lowest stratum in view was a marine shell bed recognized by all as belonging to the Pleistocene, but by most of the company as appertaining to a late time in this epoch—late, because (1) this bed was composed almost wholly of mollusks apparently all of existing species and because (2) it reposed on a terrace,

¹ Received March 8, 1928.

² Journ. Geol. 25: 1-62. 1917.

the youngest of at least three which, according to the prevailing theory, owed their existence to as many successive submergences during the Pleistocene beneath the sea. Overlying this marine marl was a freshwater deposit from 2 to 4 feet thick, composed of sand mingled with a little vegetable matter, some freshwater shells, many bones of land mammals, and a few of reptiles. This bed is known as No. 2. Lying upon this was found a stratum made up mostly of vegetable debris mingled with sand and containing various fossils. It formed a muck bed and was designated No. 3. It, as well as the underlying bed, No. 2, had evidently been deposited by the small stream which had, doubtless for many ages, wandered over the tract.

Now, under the conditions, material and psychological, how was it possible to find room in those thin deposits of sand and muck, for a Pleistocene creature whose skeleton and whose handiwork did not seem to differ from those of a red Indian?

Dr. Rollin T. Chamberlin, of the University of Chicago, made the main reports in opposition to the asserted presence of Pleistocene man.³ He granted that the human bones found in strata Nos. 2 and 3 had been covered up as those deposits were laid down. "This formation [No. 2] contains human bones essentially *in situ* beyond reasonable doubt, together with the scattered bones of many extinct vertebrates."⁴

One can not be mistaken in saying that Chamberlin's efforts were expended in the endeavor to prove that the deposits containing evidences of man were of comparatively recent time. A feature which he regarded as of high importance was the discovery, in a bog immediately west of the fossiliferous locality, of a stratum from 2 to 4 feet thick, of a dark brown to black sandstone firmly indurated by oxides of iron and manganese. It was thought that the accumulation and induration of this may well have required considerable time. On examining the deposit where remains of man had been found (Sellards' No. 2 and No. 3) Chamberlin found numerous pebbles, "balls" and "cannon balls" of a similar dark sandstone. These he explained as fragments which had been brought down the creek and rolled on their passage into their globular form. He accordingly argued that the deposits holding the fossils and these balls were probably much more recent than the sandstone stratum of the bog. Also in his second report he retained his opinion that the sandstone had furnished the

³ Journ. Geol. 25: 25-39; 667-683. 1917.

⁴ Journ. Geol. 25: 27-28. 1917.

rough materials for the balls; hence "the oldest fill in the creek channel is notably younger than the bog deposit." However, one may argue on the other side. As is well known, sandstones saturated with water containing salts of iron and manganese, in the presence of organic materials may harden rapidly. On the west coast of Florida human skulls and skeletons have been found embedded in masses of bog iron, and the bones themselves are sometimes converted into limonite; and yet we are assured that these human remains are of comparatively recent age.⁵ Nor is it necessary to suppose that irregular blocks of sandstone were rolled into balls as they were pushed down stream. Round concretionary masses are common occurrences in bog iron deposits and the formation of these may be effected rapidly. Released by erosion they would need no abrasion and would perhaps increase in size while rolling. It is still more probable, however, that the balls observed at Vero were engendered at the spot where they were discovered. At any rate, the bog sandstone and the creek beds may have been laid down in a relatively short, probably simultaneous time.

In his first report Dr. Chamberlin regarded the bog sandstone as also the source of most of the bones which were found in the creek beds. The animals had, he thought, lived, died, and left their skeletons in the sand before it had become consolidated. Later these bones had been eroded out and transported to their final resting place with the balls just described. This conception appeared to relegate the animals back in the Pleistocene to any convenient time and the deposition of the creek beds forward to any required late date. However, when on Dr. Chamberlin's second visit no bones could be found, either in the bog sandstone or in the creek on their way to the fossil-bearing beds, this hypothesis was abandoned. "The solution of the riddle of the mixture of bones of extinct animals with human bones and pottery was therefore sought on other lines." The critical problem was left "still crying for a satisfactory explanation."

In seeking a solution of the problem Dr. Chamberlin fell into various errors. He appeared obliged to assume a late date for the animals and for man. "Both of these deposits [No. 2 and No. 3] were late in the history of the formations of the region, and the oldest of these formations bears both a paleontological and a topographical aspect of recency."⁶ In speaking of the marine coquina deposit he says that it does not bear evidence of great age, its shells being all of living species;

⁵ Bur. Ethn. Bull. 33: 64-66.

⁶ Journ. Geol. 25: 673. 1917.

and he cites the assignment, by geologists, of the terrace on which the coquina reposes to the late Pleistocene. It would have been instructive to tell us what Pleistocene deposits of mollusks are not composed of practically all existing species. The Upper Pliocene of England contains from 90 to 95 per cent of living species of mollusks and this Upper Pliocene corresponds to the lower portion of the American Pleistocene. Dr. Ralph Arnold⁷ found in the Pleistocene Upper San Pedro beds, near Los Angeles, abundant molluscan species of which only 9.5 per cent were extinct. In Dr. W. C. Mansfield's list of mollusks⁸ are recognized 61 species. Of these there are 19 species (exclusive of young and imperfect specimens) which are not indicated as occurring in the recent fauna. Certainly not all of these are extinct; but no one, I think, can affirm that none of them are. If 6 out of this lot are extinct the percentage will be 10; if only 3 are extinct the percentage will be 5. Another piece of evidence in favor of the early Pleistocene age of the Anastasia marl is the discovery in it of a bone of a camel, as reported by Sellards. What stands in the way of referring the Anacostia marl to the lower Pleistocene?

Dr. Chamberlin fell also into the error of accepting without further investigation the view that the terrace was a late Pleistocene marine formation. It may be permitted to call it the youngest terrace, but that does not fix its place in the epoch. Neither it nor the terraces above it are of marine origin. This is demonstrated by the total absence of marine fossils in all of them, except where local sinkings of the coast have occurred since the formation of the last terrace; and these depressions amount to only a few feet. Had those terraces been submerged they would have been filled with mollusks. Similar terraces are common in Europe along the coasts and many rivers, and on our western coast, and they abound in fossils.⁹ Our east coast terraces are of river origin and were laid down in probably the earliest Pleistocene when the continent stood at a much higher elevation than now. It was probably at this time when the now submarine channel of Hudson River was excavated and the channels of many of our other great rivers were cut deep, to be refilled at a later time. Drs. T. C. Chamberlin and R. D. Salisbury¹⁰ reject the marine theory of the terraces along our Atlantic coast. The reader ought to peruse, on

⁷ Mem. Calif. Acad. Sci. **3**. 1903.

⁸ Fla. Geol. Surv., 9th Ann. Rept., p. 78.

⁹ See HAUG, *Traité de géologie*, and ARNOLD, Mem. Calif. Acad. Sci. **3**. 1903.

¹⁰ *Text Book of Geology* **3**: 452-454. 1906.

pages 412 to 414 of the 15th volume of the *Journal of Geology*, a review signed T. C. C.,¹¹ in order to obtain that writer's opinion about the marine origin of the terraces.

Dr. R. T. Chamberlin further assumed that the animal remains were swept by floods into the positions they occupied. No proof can be afforded that a single bone was thus carried into those creek deposits, although this transportation would not involve their belonging to a Pleistocene stage older than that of the deposit No. 2. However, the animals found there probably died not far distant.

In his efforts to prove the recency of the mammalian remains and the deposits at Vero, Dr. Chamberlin hit upon two ideas which have come to other minds since that time, if not before, and which appear to have given them much comfort. These are (1) that the southern climate was better adapted for mammalian life than that of the northern States and (2) that the mammalian fauna existed longer there than it did elsewhere. These notions appear to inspire a sort of poetical feeling, for the conditions are spoken of almost always as "that genial southern clime" and the animals are tenderly mentioned as "lingering longer there."

Doubtless during the Wisconsin glacial stage the mammals of the northern regions were forced southward, even into Florida and Texas. Reindeer reached Kentucky, musk-oxen migrated to Oklahoma, *Elephas boreus* (*E. primigenius*, of authors) probably strayed as far south as Florida and Texas, and so with many other northern species. When, however, the glacier retreated these animals did not remain there, but they kept as near the glacial front as they found it comfortable. Mastodons and certain elephants doubtless lived in Florida during the wane of the Wisconsin stage, but there is not a whit of evidence that they lived there at a later time than they did in New York or Michigan. For a reindeer and a musk-ox the genial climate is the one which furnishes plenty of snow and the kind of food they need.

Now as to the matter of lingering, it is a certainty that many of the mammals found in the Pleistocene beds at Vero, Peace Creek, Melbourne and many other places in Florida did linger there and elsewhere and become extinct only at a later time. *Myiodon*, one or more species of tapirs, the great ox *Bison latifrons*, and *Equus complicatus* appear to have lived on until the Sangamon interglacial. The American mastodon, *Elephas columbi*, and the giant beaver lived long after

¹¹ Journ. Geol. 15: 412-414. 1907.

the disappearance of the Wisconsin glacier and left their bones in the deposits overlying the drift. It is also true that many other species, specifically unchanged, are still lingering and they constitute the existing fauna of North America. With the species named above there existed at Vero, Peace Creek, and Melbourne *Megatherium*, *Chlamytherium*, *Glyptodon*, *Elephas imperator*, the Florida saber tooth tiger, and one or more camels. In regions farther west and northwest, as at Frederick, Oklahoma; Rock Creek, Texas; "Hay Springs" (Peters) Nebraska, and in the Aftonian deposits of western Iowa, there are found also numerous species of horses, camels, *Mastodon mirificus* and *Elephas imperator*; and these appear not to have existed anywhere after the first interglacial stage. Had they continued to exist their remains ought to be found in the deposits overlying the Kansan, the Illinoian, or the Wisconsin drifts. Outside of the drift region, in the Appalachian ranges from Lookout Mountain, Tennessee, to Frankstown, Blair County, Pennsylvania, in caves and fissures, have been collected numerous species of mammals of apparently mid-Pleistocene times, but none of those mentioned as being characteristic of the first interglacial stage. In northwestern Arkansas an abundant fauna has been discovered in a fissure, but among these were no *Elephas imperator*, no *Mastodon mirificus*, no camels, no *Glyptodon*, no *Megatherium*, no *Chlamytherium*. In the Mississippi embayment, extending from Cairo, Illinois, to the Gulf and on the south from western Louisiana to western Alabama, a very interesting fauna has been collected, consisting of mastodons, elephants, one or two species of horses, tapirs, megalonyx, mylodon, etc.; but again the forms which are taken to be peculiar to the first interglacial, or Aftonian, stage are not found. We are justified, I maintain, in believing that, instead of a few lingering here and there some hundreds of thousands of years, perhaps to conduct to the happy hunting grounds the spirit of some "mid-Recent" red man, they ceased existence near the close of the first interglacial, or at most did not live beyond the Kansan glacial. Therefore, I hold that the creek bed No. 2, at Vero, and its contents belong in the first, or Aftonian, stage of the Pleistocene.

During his second visit to Vero Dr. Chamberlin was especially engaged in determining, at the localities where human remains had been discovered, the relations of beds Nos. 2 and 3 at their plane of contact. His purpose was to learn whether the human remains were really found in No. 2 or in what he regarded as the very recent No. 3. As to the skeleton No. 1, the first one found, he thought that the 9

inches of brown sand overlying it was too thin to permit a safe conclusion.

At the locality of the second skeleton, where there had occurred more vigorous stream action, Dr. Chamberlin carried the plane of contact nearer the layer of shells. His conclusion was evidently that the human bones belonged in the muck layer or at least might have belonged there. That he proved this he certainly would not assert; nor would he perhaps regard it as necessary. The writer believes for the reasons stated above that it can not be successfully contested that the stratum No. 2 is of early Pleistocene age. In case the muck layer belongs to the Recent epoch we may inquire what was the condition of that little valley during the intervening 200,000 or 300,000 years? I think that no evidence can be furnished that additional deposits were laid down and afterwards removed. It is, as already mentioned, probable that the muck had been accumulating ever since the beginning of the Kansan glacial stage, and I believe that the fossils found testify to this proposition. If, now, this is true what becomes of deductions based by Dr. Chamberlin on the skillful work which he did at Vero?

Dr. Chamberlin¹² emphasizes the importance of the presence of the pottery found at Vero. No pottery was found in stratum No. 2. However, nobody has the knowledge or the authority to say that pottery was not used in America by Pleistocene man. As for myself, I would say that its presence in No. 3 is evidence that early man did use it. Recent revelations indicate that in America in Pleistocene times the art of working flint was far more advanced, in some tribes at least, than had been suspected. The same may be true as regards pottery.

It is the writer's conviction that Dr. Chamberlin erred as respects the age and origin of the coastal terraces, the age of the Anastasia marl, the ages of the creek beds and of the bog sandstone, the origin of the spherical concretions, the manner of accumulation of the bones, the composition and fate of the various elements of the fauna, and the position and age of the human remains. Nor can I give assent to any one of the four conditions set forth at the close of his second report.

The geologists appeared to be in agreement that there had passed between the deposition of stratum No. 2 and No. 3 no considerable lapse of time. In that case the apparent break may mark the begin-

¹² Journ. Geol. 25: 682. 1917.

ning of the Kansan glacial stage. The change of climate produced a more swampy condition of the little valley and made it a less agreeable resort for such of the larger animals as yet remained and there was a denser growth of plants. The muck accumulated slowly. There appears to be no evidence of either elevation or depression. If the time that has elapsed be taken as 300,000 years and the thickness as 50 inches the amount added would be one inch in six thousand years. The upper layers may be comparatively young; the lower, very old. While it is possible that some bones were washed up from the lower layer there is no necessity for granting it, for they belong to species which continued to live in that stage.

Dr. Aleš Hrdlička's theory of the presence of human bones in the deposits at Vero was short and simple. They were purposely buried there. No claim was made that there was any visible disturbance of the sand, marl, and muck such as would be caused by digging and refilling the grave. There might at first have been some unnatural mingling over the cadaver, but the materials would soon regain their former relations. He reported that evidences of this tendency to reestablish original conditions were observed already on the dump left by the steam excavator.

Dr. George Grant MacCurdy, of Yale University, recorded his conclusions in two papers.¹³ In each article he figured three of the flint spalls collected by Dr. Sellards. Two were found in stratum No. 2. One of these was shaped somewhat like the blade of a broad ax. The height was one inch; the length of the thin edge was an inch and five-eighths. Dr. MacCurdy's explanation of its presence in the middle bed was that it had worked its way down by the aid of growing roots or burrowing animals. One may be curious to learn at what point of such a spall a root-cap could strike so as to guide it down through a bed of muck. More spalls were found in No. 2 than in the bed above it. Might not one as well assume that some had been washed up from the lower bed into the upper one? The number of animal burrows that have been dug in our broad land may be just a little short of infinite and arrow heads and spalls might work their way into these; but has any anthropologist ever found a flint weapon in such a situation? In the muck bed at Vero fragments of pottery were abundant. How has it happened that none of these were assisted to reach No. 2 either by roots or rodents? The specious value of such explanations was definitely exposed some years ago by the

¹³ Journ. Geol. 25: 56-62. 1917; Am. Anthr. 19: 252-261. 1917.

investigations made at Trenton, New Jersey, by the American Museum of Natural History.

Dr. MacCurdy fell into the same error as Dr. R. T. Chamberlin and various other people, that of regarding the "fauna" found at Vero as an integral thing which existed for a while and later disappeared. I have shown already a number of genera which characterized the first interglacial stage as revealed at Vero and numerous localities and which appear at no later stage. Dr. MacCurdy mentions as occurring in the upper stratum (No. 3) at Vero *Elephas columbi*, *Mammut americanum*, *Chlamydotherium*, horse, and tapir. *Chlamydotherium* may have lived on for a while in the Kansan stage. It may have possessed some of the vitality of its near relative, the armadillo, which is still living in Texas. As for *Mammut americanum* and *Elephas columbi* and certain peccaries, they continued on probably all over the continent down close to or within the Recent. *Myiodon* and some species of tapirs and one of the horses found at Vero, *Equus complicatus*, and possibly *E. leidy*, held on until after the Illinoian glacial stage.

After this article had been put in type the announcement was made by Dr. J. W. Gidley, of the U. S. National Museum, that he had found, in two or three localities in Florida, human bones and artifacts definitely included within stratum No. 2. These discoveries ought to end the dispute about the relationship of man to this important deposit.

PALEONTOLOGY.—*Characters of the brachiopod genus Lingulidiscina Whitfield.*¹ GEORGE H. GIRTY, U. S. Geological Survey (Communicated by JOHN B. REESIDE, JR.).

Many years ago, in the course of studying certain faunas from north-western Arkansas, it became necessary for me to deal with a large series of discinoid shells, and, while discussing the identification of the species I ventured to glance at the generic name that should be used for them. These shells belonged to the group for which Hall and Clarke had revived D'Orbigny's term *Orbiculoidea*, but it appeared to me that on their own showing *Orbiculoidea* was a synonym of *Schizotreta*. Under these circumstances I cast about for some name that was already in the literature rather than propose a new one, and provisionally adopted *Lingulidiscina* Whitfield. Now Whitfield's

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