

THE GEOLOGICAL HORIZON OF THE DINOSAURS
HALLOPUS AND *NANOSAURUS AGILIS*.*

CHARLES SCHUCHERT.

ABSTRACT.

Paleontologists have long been in doubt concerning the exact geological occurrence of the dinosaurs *Hallopus* and *Nanosaurus agilis*, and this paper is an attempt to settle the problem. A new dinosaur, *Nanosaurus victor*, "about as large as a fox," was described by Professor Marsh in September, 1877, as coming from a geological horizon that "is probably Jurassic, but possibly in the lower part of the Dakota group" (p. 255). In May, 1881, he made this species the genotype of the new genus *Hallopus* ("leaping foot"), for which he erected the family Hallopodidae and the suborder Hallopoda; now, however, he said that the geological horizon is "near the base of the Atlantosaurus beds [=Upper Jurassic], in Colorado, and perhaps below them" (p. 422).

New evidence has come to light from letters in the Marsh archives at the Peabody Museum which seems to show that the geological horizon of the small dinosaurs *Hallopus* and *Nanosaurus agilis* is not Triassic, as has been generally considered for some years, but rather Jurassic, and near the top of the Morrison formation.

Later, in May, 1890, Marsh raised the suborder Hallopoda into an order, but Baur, who had studied the specimen while on Marsh's staff, said the next month that there can be no doubt that "*Hallopus* is a true carnivorous Dinosaur, near to *Compsognathus*" (p. 570). Marsh in the paper above mentioned says that *Hallopus* was "about as large as a rabbit," but he does not refer to the geological horizon of the specimen.

In This Journal for October, 1891, Marsh proposed the name *Hallopus beds*, thus:

"Near the base of the Jurassic, a new horizon may now be defined as the *Hallopus beds*, as here alone remains of the remarkable reptile named by the author *Hallopus victor* have been found. Another diminutive dinosaur, *Nanosaurus*, occurs in the same strata. The horizon is believed to be lower than the Baptonodon beds, though the two have not been found together. The *Hallopus beds* now known are in Colorado, below the Atlantosaurus beds, but quite distinct from them.

"The Baptonodon beds have been found at many localities . . . everywhere beneath the Atlantosaurus beds, and having below them, at various localities, a series of red beds, which

*This article has had the benefit of criticism by R. S. Lull, C. W. Gilmore, and Barnum Brown.

may, perhaps, contain the *Hallopus* horizon, but are generally regarded as Triassic" (p. 337).

Finally, in his "Dinosaurs of North America," 1896, he adds: "Near the base of the Jurassic in the Rocky Mountain region an interesting geological horizon has been defined as the *Hallopus* beds, since here only remains of a remarkable dinosaurian, named by the writer *Hallopus victor*, have been found" (p. 153). In the diagram on his page 145, the *Hallopus* beds are placed beneath the marine *Baptanodon* beds, but are still retained in the Jurassic. Marsh again says that *Nanosaurus agilis*, the most diminutive dinosaur known, occurs in the same strata.

Why Marsh made this change in the geologic age of these two species is not known, but apparently it was because of the "red" color of the rock holding *Hallopus*, since red is the usual color of the underlying Triassic. What he did not know is that the *Atlantosaurus* beds (= Morrison formation) near Canyon City, Colorado, where the dinosaur was found, have several horizons of variegated beds with red strata, and that near the top there is a zone about 30 feet thick of the same color as the slabs having the bones of *Hallopus victor*, which is nearer chocolate-brown than red. This brown zone is overlain by a massive sandstone usually referred to the Dakota group but now known to be of Lower Cretaceous (= Purgatoire) age. Accordingly, the present writer believes that Marsh's first age assignment, based, as will be seen presently, on statements made by David Baldwin, was the correct one, namely, near the top of his *Atlantosaurus* beds (= Morrison) and not at the base of, or below, this formation. The evidence for this view, presented below, came to light in the course of the preparation of a book on the life of Professor Marsh, which, it is hoped, will be published this year. This evidence is as follows:

The holotype of *Hallopus victor* bears the Peabody Museum accession number [958]. Its arrival was recorded in the accession book on May 8, 1877, and it was sent in by David Baldwin, one of Marsh's collectors. Marsh made further inquiries of Baldwin about it and the latter described it on November 4, 1878, as follows: Two specimens with "bones in red sandstone [really a chocolate-brown] found about April 15, 1878, by John Jennings of Canyon City, and S. C. Robinson of Colorado Springs. Found eight miles north of Canyon City on west side of Four Mile Creek, about three miles above oil wells, half-mile west of Mr. Felch's house. On north side and about 30

feet below the top of low red point, north of first table-topped hill west of Mr. Felch's house. Strata there most certainly Jurassic." This explicit location of the specimen should have been heeded by Marsh, but evidently the color of the rock was regarded by him as of more importance than the information furnished by Baldwin or anyone else.

Baldwin, who lived in Canyon City, wrote Marsh on April 30, 1877, that he had heard a few days earlier of the find above mentioned, and, "knowing from the locality that it must have been found in the Jura and feeling confident that a bird (for so my informant stated) would be particularly valuable, I started late in the afternoon for the locality where it had been found. Sunday I explored the place pretty thoroughly but found nothing other than some very large bones all reptilian I guess." These lay "on a flat about 15 feet higher than the strata where this ['bird' bone] was found." On Wednesday, "went to the Curiosity Shop [at Colorado Springs] and spotted the fossil and proposed selling the dealer some gold specimens I happened to have with me. Next day gave a man three dollars and told him to buy the specimen with it if he could. He succeeded in getting it for three dollars and I am in possession of it." Because of the time taken by Baldwin in getting the two small slabs, Marsh paid him twenty dollars for them.

Marsh, on receiving the specimen, evidently complained to Baldwin that the bones were not those of a bird, and the latter replied that the two slabs are "parts of the same skeleton. The party who spoke to me about it was most positive that the bones were those of a *bird* so I followed it some ten or fifteen days after it had been found. I could not tell whether it was a bird or not though I had my doubts but I believed it was worth sending. To get a real bird from the Jura I'd walk half across the continent."

In a later letter, Baldwin writes: "The two little red slabs from the Jura that I sent you a year ago came from a stratum of solid red rock just underneath those large bones [i.e., *Camarasaurus supremus*] that Lucas (Cope's man) found. There is a little knoll or tent-shaped point around which Lucas has worked and the [bird] bones came from the solid red strata about fifteen feet below the apex of the cone and on the north-eastern side. I have been there looking over the ground and could see no more but I did not dig as they [Lucas party] were working within a few feet of the place in the strata just above."

It is the words "tent-shaped point" that have special significance here, as they are believed to indicate the place known locally as the Nipple. It is known that much of Lucas' collecting in 1877 was in chocolate-colored beds in the upper part of the Morrison formation, from which he dug out the skeleton of the great dinosaur *Camarasaurus supremus* Cope.

On September 13, 1878, Baldwin reported to Marsh that he "could not find small bones in the red rocks [= Triassic] at Canon, though there are many miles of the red strata exposed that I did not explore."

The holotype of the pygmy dinosaur *Nanosaurus agilis*, described by Marsh in the same paper with *Hallopus victor*, and there said to come from a geological horizon "probably Jurassic, but possibly in the lower part of the Dakota group," bears the Peabody Museum accession number [1000]; it was collected by O. W. Lucas, shipped from Canyon City, and received on August 24, 1877. The slab bearing the bones has a reddish color, but this is due to weathering and to the making of plaster casts from it. A fresh fracture shows that the rock is a fine-grained, brittle, conchoidally fracturing, light-buff sandstone. It is not a nodule as is the case with the rock holding *Hallopus victor*. In July, 1894, again discussing this species, Marsh says that the bones are "all entombed in a slab of very hard quartzite" (p. 87).

J. B. Hatcher, in his very valuable stratigraphic paper of 1901, entitled "The Jurassic Dinosaur Deposits near Canyon City, Colorado," reported the results of his reinvestigation of this region for the purpose of getting dinosaur remains for the Carnegie Museum of Pittsburgh. He states in this paper: "Perhaps in no other locality is the geological section from the base of the Trias to the top of the Cretaceous more complete than in the canyon of Four Mile, or Oil Creek from the entrance to Garden Park, some eight miles east by north of Canyon City to the mouth of that canyon where it opens into the valley of the Arkansas River" (p. 328). The Morrison (= Atlantosaurus beds) is best seen on the sides of the narrow gorge of Oil Creek. (Also see Mook 1916, pp. 48-56.)

Above the basal red sandstones usually referred to the Triassic, Hatcher goes on to say, "are a series of brown sandstones, shales and marls with occasional thin seams or lenses of limestone. They have an aggregate thickness of perhaps 450 feet [this includes at the top about 100 feet of sandstone referred

by Cross to the Dakota group], and the whole is about equally divided between sandstones, and shales or marls. The entire series is here referred to the Jurassic on the evidence afforded by the dinosaur remains found in them. These remains are found in considerable abundance at several horizons and occur both in the sandstones and the shales, while the limestone layers above referred to are as a rule very rich in the remains of fresh water gastropoda and from one horizon great numbers of *Unio* shells and casts have been obtained in one of the marl beds" (p. 329).

The Marsh Quarry near Canyon City, which, out of a sandstone layer not over 3 feet thick and in an area of a few hundred square feet, yielded at least a dozen genera and species, and two or three times that number of individual skeletons (Hatcher 1903), is about 100 feet (Mook says about 70 feet) above the red beds of Triassic age. There is another bone-bed about 30 feet beneath the one of the Marsh Quarry.

About 250 feet (Mook says about 225 feet) "above the level of the Marsh quarry and on the same side of Oil Creek, but three-quarters of a mile distant from the Marsh quarry," there is, according to Hatcher, "a thick stratum of chocolate-colored shale best shown in a small rounded butte, locally known as the 'Nipple' . . . It is perhaps 30 ft. in height and is composed entirely of a homogeneous stratum of chocolate-colored shale [really a brown, fine-grained, sandy-muddy siltstone]. This rests on a stratum of sandstone and is capped by another layer of sandstone. . . . The base of this conical hill is about an acre in extent and everywhere about its base the remains of dinosaurs crop out in great abundance" (p. 338). About one-quarter mile southwest of the Nipple in the topmost layer of the chocolate-colored shale and directly beneath a thick sandstone referred by Cross to the Dakota, is the quarry from which Lucas took out Cope's *Camarasaurus*, now in the American Museum of Natural History. "This is a distinctly higher [dinosaur] horizon than the one at [the base of] the 'Nipple' " above referred to (p. 339). (See also Hatcher 1903.)

During the month of December, 1904, Professor Williston was at the Peabody Museum studying the Permian reptiles collected by Baldwin in New Mexico, and on the evening of the seventh the writer had a long talk with him about Professor Marsh and his collections. He spoke at length about the horizon of *Hallopus* and he was much perplexed about this speci-

men's being found in the *Atlantosaurus* beds. He gave the writer the impression at that time that this fossil came either out of the very base of the Morrison formation or, more likely, out of the underlying red Triassic sandstone. In this conclusion he was controlled almost wholly by the brownstone character of the entombing rock of *Hallopus*. He said that he had more than once looked in the Triassic about Canyon City but had never found the first trace of another *Hallopus* bone. The writer did not then know of the brownstone layer at the top of the *Atlantosaurus* beds, nor did Williston mention it. Possibly as a result of this conversation, Williston looked into this matter further and in June of 1905 published his paper entitled "The *Hallopus*, *Baptanodon*, and *Atlantosaurus* Beds of Marsh," in which he says that the *Hallopus* beds are believed to be "a distinct horizon," belonging "not to the Lower Jurassic, but to the Upper Triassic" (p. 338), and this view has been followed by nearly everyone since.

It now turns out that Williston was wrong in thinking that it was M. P. Felch who found the *Hallopus* in August, 1877. As we have seen, it was Baldwin who sent the specimen to Marsh. Felch, however, pointed out to Williston "the precise spot whence the specimen came . . . the base of an escarpment of red sandstone whither the specimen had fallen from an overhanging cliff" (p. 338). This same information may have been given to Marsh by Felch, when the former was in Canyon City in 1880. In the light of our present knowledge, it runs completely at variance with Baldwin's letter, and it may have been based on hearsay. Williston goes on to say that "the block of red sandstone in which the fossil was inclosed left no doubt as to its derivation. This peculiar character of the matrix, so different from anything found in the *Atlantosaurus* beds, has been mentioned by Marsh, though he never gave definite information as to the location of the discovery" (p. 339). Here again we see the wrong assumption that the red- and brownstones do not occur in the Morrison formation. Such occurrences were mentioned first by Baldwin as "a stratum of solid red rock just underneath those large bones that Lucas found." Hatcher states that the *Atlantosaurus* beds "are a series of brown sandstones," etc., and that "a thick stratum of chocolate-colored shale" is best shown in the Nipple. As we shall see, Mook says the same.

C. C. Mook (in Osborn and Mook 1921) actually measured the Morrison formation near Canyon City, with the following result:

At top, thin remnant of Purgatoire sandstones (marine, with Washita fossils found by Stanton), which is the lower part of the old "Dakota series."

Brown joint clay (4'), brown nodules (4", may be the exact horizon of <i>Hallopus</i> , since the bones occur in a nodule), and brown clay (15')	19' 4"
Clay, horizon of <i>Camarasaurus</i> of Cope	5 2
Sandstones and clay	5
Variegated clays	9 6
Sandstone and clay	6 7
Variegated clays	204
Cross-bedded sandstone (8') and clay (1'). Approximate level of Marsh Quarry	9
Lower sandstones and clays	61 6
Total thickness of Morrison here	<u>320' 1"</u>

Hatcher's thickness of about 450 feet was estimated, and included 100 feet of "Dakota" sandstones at the top.

CONCLUSION.

If Mr. Baldwin was correctly informed as to the place where *Hallopus victor* was found by Messrs. Jennings and Robinson—and there appears to be no reason to doubt his information—then the horizon of *Hallopus victor* and *Nanosaurus agilis* is near the very top of the *Atlantosaurus* beds = Morrison formation, and about on the horizon of *Camarasaurus*.

Barnum Brown, on reading these pages, commented to the writer by letter on May 24, 1938, as follows: *Hallopus* and *Nanosaurus* "are probably from the upper part of the Jurassic formation. The reason that I say 'probably Jurassic' is because in the northern deposits of Mesozoic age in Montana and northern Wyoming there are several small coeluroid dinosaurs that in structure approach very closely to *Hallopus*. One of these is, I think, a descendant of *Hallopus*. They are all from the Cloverly formation and less than 100 feet above the top of the Morrison Jurassic.

"The ilium attributed to *Nanosaurus* is a primitive generalized type, but I do not think we have sufficient grounds for

arbitrarily placing it in a lower horizon when all of the geological evidence seems to point to it having been found much higher."

REFERENCES

- Baur, George: Prof. Marsh on *Hallopus* and other dinosaurs. Amer. Nat., Vol. 24, pp. 569-571, 1890.
- Hatcher, J. B.: The Jurassic dinosaur deposits near Canyon City, Colorado. Ann. Carnegie Mus., Vol. 1, pp. 327-341, 1901.
- : Osteology of *Haplocanthosaurus* with description of a new species, and remarks on the probable habits of the Sauropoda and the age and origin of the Atlantosaurus beds. Mem. Carnegie Mus., Vol. 2, pp. 1-75, 1903.
- Marsh, O. C.: Notice of some new vertebrate fossils. This Journal, Vol. 14, pp. 249-256, 1877.
- : Principal characters of American Jurassic dinosaurs, part V. Ibid., Vol. 21, pp. 417-423, 1881.
- : Distinctive characters of the order Hallopopoda. Ibid., Vol. 39, pp. 415-417, 1890.
- : Geological horizons as determined by vertebrate fossils. Ibid., Vol. 42, pp. 336-338, 1891.
- : The typical Ornithopoda of the American Jurassic. Ibid., Vol. 48, pp. 85-90, 1894.
- : The dinosaurs of North America. 16th Ann. Rept., U. S. Geol. Surv., 1894-1895, pt. I, pp. 133-244, 1896.
- Mook, C. C.: A study of the Morrison formation. Ann. N. Y. Acad. Sci., Vol. 27, pp. 39-191, 1916.
- Osborn, H. F., and Mook, C. C.: *Camarasaurus*, *Amphicoelias*, and other sauropods of Cope. Mem. Amer. Mus. Nat. Hist., n.s., Vol. 3, pt. 3, pp. 249-387, 1921.
- Williston, S. W.: The Hallopus, Baptonodon, and Atlantosaurus beds of Marsh. Jour. Geol., Vol. 13, pp. 338-350, 1905.

PEABODY MUSEUM OF NATURAL HISTORY,
YALE UNIVERSITY,
NEW HAVEN, CONN.