BRACHIOSAURUS

the biggest dinosaur of them all

by David Young

"Riggs Hill?" asked the nice little lady in purple-flowered dress sitting behind the reception desk in the Grand Junction, Colorado, museum. "Does he work here?"

"No, Madame," I replied. "Riggs Hill is a place."

The receptionist looked somewhat nonplussed and shuffled through some official-looking rosters to gain a second to think. "I've never heard of it," she said finally. "Where is it?"

"That's what I want to know," I replied.

"What is it?"

"They dug up the *Brachiosaurus* there a long time ago."

"A what?"

"A dinosaur."

"Oh," she said with a smile of recognition. "Then you'll have to talk to the paleontologist."

The paleontologist, a young former Harvard University fossil preparator named Lance Erikson, was at that moment lecturing a group of visiting school children on the lifestyle of a thirty-foot ➤

At right, H. W. Menke, geology preparator at Field Museum from about 1898 to 1904, poses with the 675-pound femur of Brachiosaurus. *Date of photo about 1901. Several months earlier Menke had assisted in excavating the fossil from its bed in the Grand River Valley of northwestern Colorado.*

David Young is a reporter for the Chicago Tribune

dinosaur mounted behind him. Yes, he knew where Riggs Hill was located; and, yes, he would take me there.

"You know," Erikson said, "that's where they found the *Brachiosaurus.*"

A thousand miles to the east of Grand Junction stands Chicago's Field Museum —an imposing neoclassical structure which has a main exhibition hall (Stanley Field Hall) large enough to hold the entire Grand Junction museum.

"Brachiosaurus?" said John Bolt, Field Museum's assistant curator of fossil reptiles and amphibians, as he led me to a ground floor storage room where the creature's bones were hidden from public view. "It's right here!"

And it was; there in the dimly lighted temporary storage room reposed the mortal remains of mosasaurs, mastodons, and fossil mammals, many still encased in the protective plaster jackets placed on them years ago as they were dug from the rocks. Among them were the bones of the *Brachiosaurus* taken from Riggs Hill in 1900.

Such is the fate of poor *Brachiosaurus*. He was the largest animal known to have walked the face of the earth, and one of the most anonymous.

Many of the thousands of visitors who each day pour through Field Museum stop to marvel at the huge *Brontosaurus* mounted on the second floor in Hall 38. It is the epitome of the dinosaurs, the "Thunder Lizard," the behemoth of behemoths, the creature in the old Sinclair Oil advertisements, and the monster which chased the heroes through the swamp after King Kong abducted the maiden.

Brachiosaurus *restoration (from Abel).*

But unknown to those visitors who stand and gape at *Brontosaurus* (which by an error in classification is not really *Brontosaurus* but *Apatosaurus*),[1] that ground-floor storage room hides the bones of a creature even larger. They belong to *Brachiosaurus*.

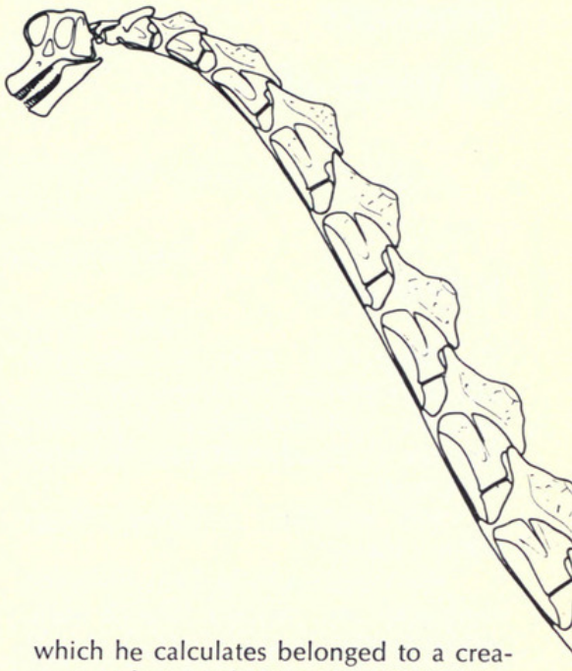
Admittedly, the creature's bones are not much to look at—a total of less than twenty, including seven presacral and two caudal vertebrae, a sacrum, four ribs, a right coracoid, part of the pelvis, a humerus, and a femur. There are not even enough of them to be reassembled into an exhibit. But the dimensions of the *Brachiosaurus* as told by those bones are staggering.

For example, Ziggy, the huge Indian elephant in Brookfield Zoo, weighs approximately seven tons. The weight of *Brontosaurus* in life has been calculated at thirty to thirty-five tons. A *Brachiosaurus* has been calculated to weigh more than twice that—in the flesh![2]

A healthy adult giraffe, the tallest living animal, stands seventeen feet high. The only mounted *Brachiosaurus* skeleton in existence, in the Berlin Museum, stands forty feet tall. But Brigham Young University paleontologist James A. Jensen recently discovered near Grand Junction, Colorado, nine cervical vertebrae which he calculates belonged to a creature with a neck forty feet long. It is too early to tell, however, whether Jensen's sauropod (the family of long-necked dinosaurs that includes *Brontosaurus, Brachiosaurus,* and *Diplodocus*) is a *Brachiosaurus* or an entirely new genus.

So why is the *Brontosaurus* so well known and the gigantic *Brachiosaurus* so anonymous? For the answer, it is necessary to go back nearly a century to America's Wild West—of all places.

In 1877, Chicago was still rebuilding from its famous fire of six years earlier, and the major topic of conversation was still the Sioux Indian War in which Col.



Drawing of the reconstructed Brachiosaurus ► *in the Berlin Museum. The only complete reconstruction of this dinosaur, it stands 40 feet high. The skeleton was excavated by German paleontologists in Tendaguru, in present-day Tanzania, during a four-year expedition that ended in 1912. For comparison, H. W. Menke is shown with the Field Museum femur. At 214 cm. long, the femur of the Tendaguru* Brachiosaurus *is 11 cm. (about 4.3 inches) longer than that of the Colorado* Brachiosaurus.

1. Marsh in 1879 named *Brontosaurus* from some bones found at Como Bluff, Wyo., but the bones later turned out to be from a genus previously named *Apatosaurus*. Even though in error, the name *Brontosaurus,* which means "thunder lizard," caught the public imagination and has been popularly used ever since.

2. Edwin H. Colbert of the American Museum of Natural History in 1962 calculated the weight of 14 different dinosaurs based on body volume and specific gravity. He estimated *Brontosaurus'* weight at a maximum of 35.8 tons; but *Brachiosaurus,* according to his calculations, tipped the scales at an amazing 85.63 tons. *(American Museum Novitates,* No. 2076, 1972.)

George Armstrong Custer and his command had been massacred the year before at the Little Bighorn.

From Como Bluff, Wyoming, an obscure way station along the new Union Pacific Railroad, a couple of railroad employees wrote a letter to a wealthy eastern scientist, telling him of some large bones which they had seen weathering out of the nearby bluffs. The scientist, Othniel Charles Marsh, was interested. He was already engaged in a bitter scientific rivalry with another eastern scientist of considerable means, Edward Drinker Cope.

An assistant sent by Marsh to Wyoming to investigate wrote back that the railroad employees were not lying; there were dinosaur bones "everywhere." Thus began a scientific war between Marsh and Cope that resulted in a pitched battle to see who would dig at Como Bluff.

What the rival scientists dug out of those remote quarries was literally tons of bones, many belonging to a species of sauropod dinosaur which Marsh in 1879 named *Brontosaurus*.

As the exploits of Marsh and Cope and the discoveries of those dinosaurs appeared in the press, the name *Brontosaurus* captured the public imagination. Before the century had ended, other scientists and museums entered the great dinosaur hunt. An expedition from the American Museum of Natural History in New York discovered a shepherd's cabin near Medicine Bow, Wyoming, made entirely from dinosaur bones. The quarry there ultimately yielded a *Brontosaurus* skeleton which now resides in that museum.

And steel millionaire Andrew Carnegie financed an expedition to Split Mountain, Utah, which discovered a rich digging ground that produced more tons of sauropod bones for his new museum in Pittsburgh. The site of those diggings is now Dinosaur National Monument.

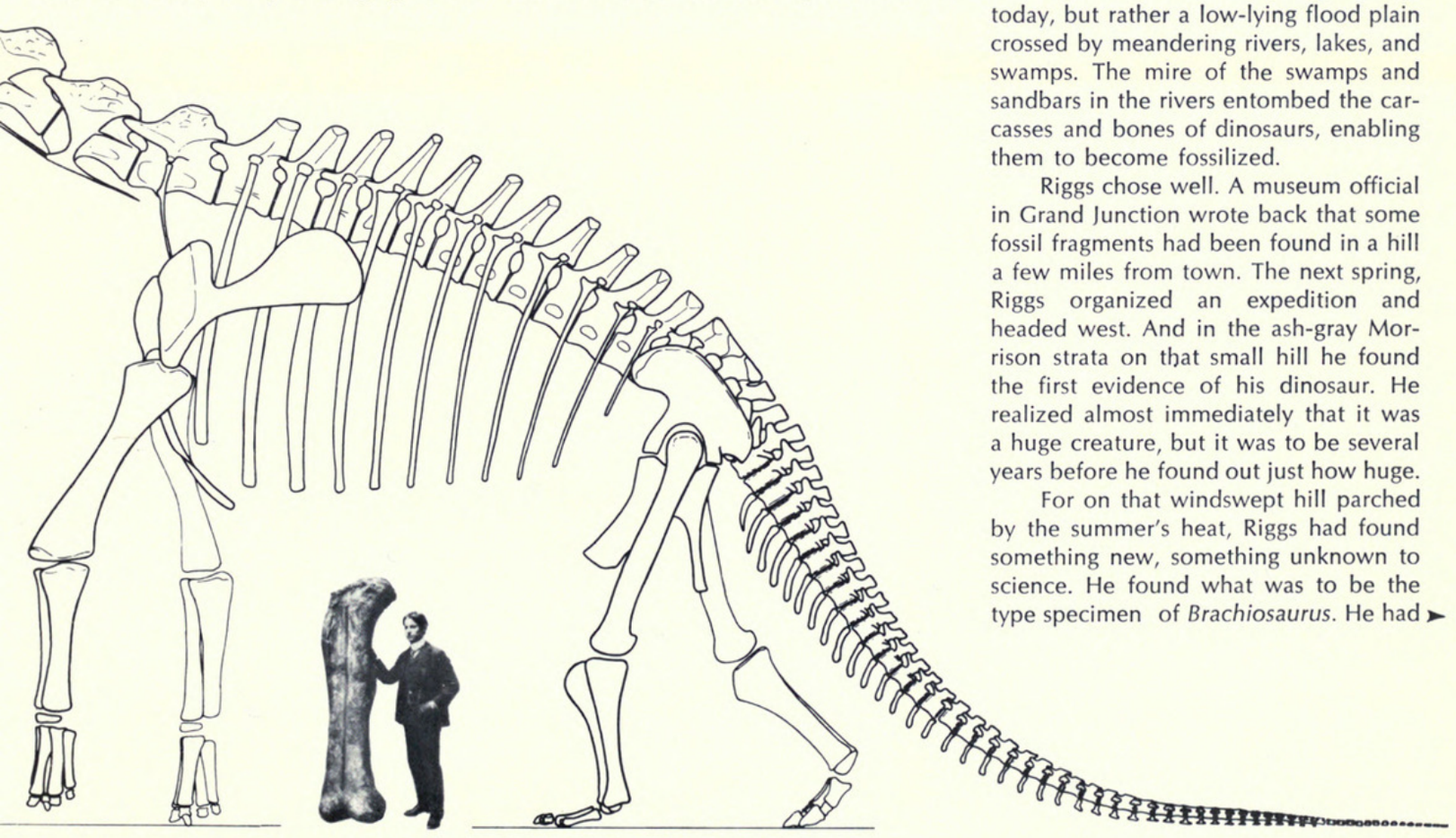
The Field Museum, founded in 1893, somewhat belatedly joined the race for the dinosaurs. Paleontologist Elmer S. Riggs explained it to an interviewer just before his retirement in 1942:

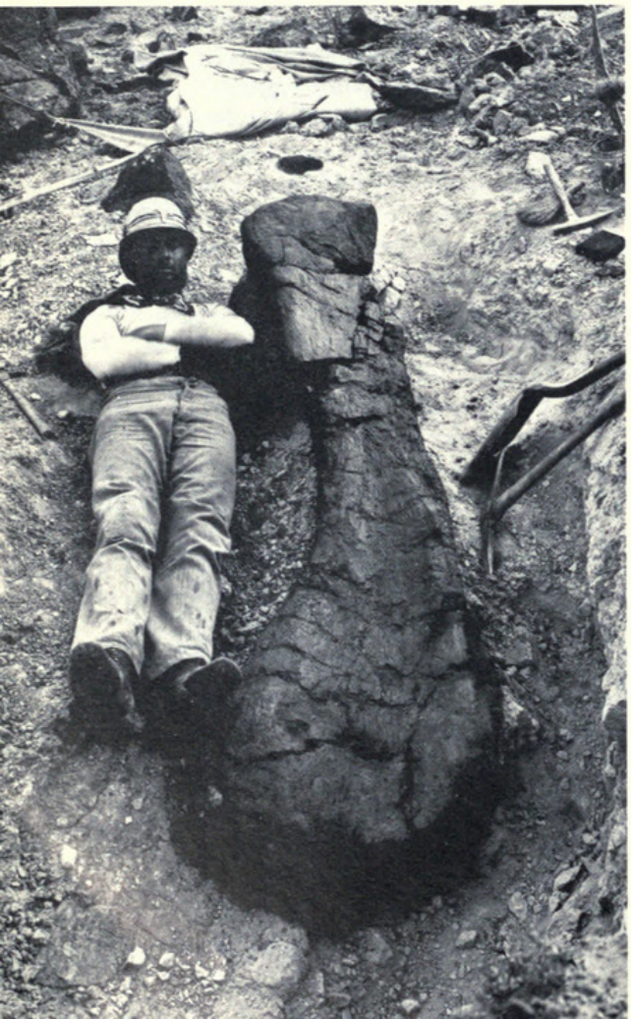
"New departments were being formed in other museums on the strength of new interest in these gigantic reptiles. The name dinosaur was for the first time becoming a household word. The American press was quick to herald throughout the country reports of each new discovery," he said.

Chicago didn't have a *Brontosaurus*, so Riggs wrote persons in several towns along the Denver & Rio Grande Railroad asking if any fossil bones had been found nearby. He chose the area traversed by that railroad because it bisected what is known geologically as the Morrison Formation—a massive deposit covering large portions of Colorado, Wyoming, and Utah. The formation, which is probably the richest dinosaur-fossil digging ground in the world, was laid down some 140 million years ago at the end of the Jurassic geological period. At that time the western part of the continent was not the mountainous region it is today, but rather a low-lying flood plain crossed by meandering rivers, lakes, and swamps. The mire of the swamps and sandbars in the rivers entombed the carcasses and bones of dinosaurs, enabling them to become fossilized.

Riggs chose well. A museum official in Grand Junction wrote back that some fossil fragments had been found in a hill a few miles from town. The next spring, Riggs organized an expedition and headed west. And in the ash-gray Morrison strata on that small hill he found the first evidence of his dinosaur. He realized almost immediately that it was a huge creature, but it was to be several years before he found out just how huge.

For on that windswept hill parched by the summer's heat, Riggs had found something new, something unknown to science. He found what was to be the type specimen of *Brachiosaurus*. He had ➤





Above: Fording streams is all in a day's work for Elmer Riggs and assistants as they make their way to the fossil beds. Left: Expedition assistant poses with the Brachiosaurus humerus, *which at 204 cm., was 1 cm. longer than the femur. Below: Preparator Menke coats the* Brachiosaurus *bones with protective plaster prior to the long haul back to Chicago. Page 7, top: Menke, with clay pipe, and Riggs take a break from bone-digging and enjoy the comforts of life. Hanging from the ridge-pole are partly eaten haunches of antelope, shot by an expedition member. Page 7, bottom: Back at the Museum, Menke and Riggs work on bones collected during the trip. The femur, behind Menke, is still encased in its plaster jacket.*

also found what is still the largest creature known to have walked the earth.

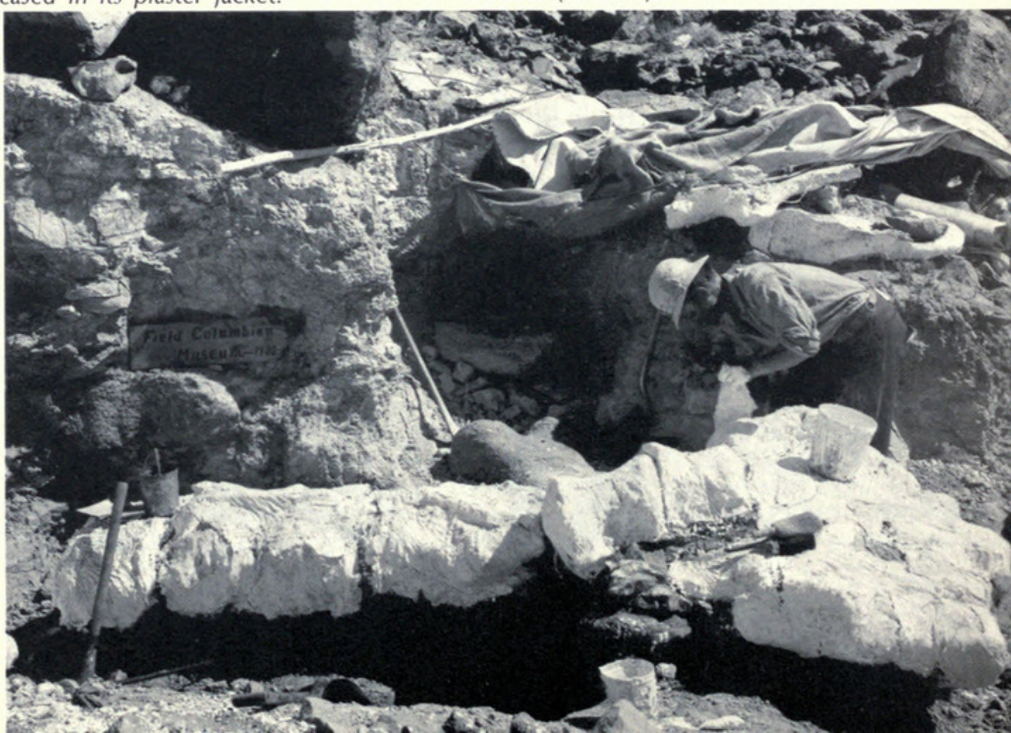
Although Riggs realized at Grand Junction that he had uncovered an exceptionally large sauropod—not the *Brontosaurus* he had been looking for—it wasn't until he got the bones back to Chicago and free from the rocky matrix that he realized its true proportions.

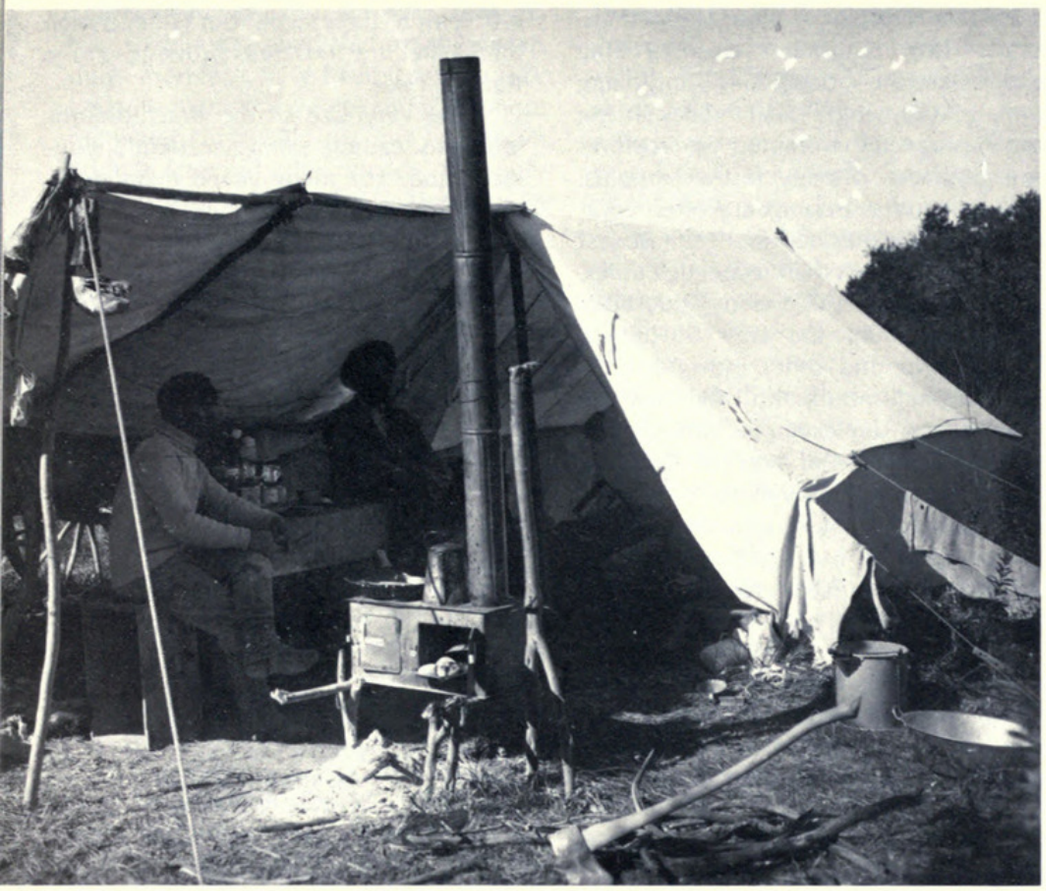
It was the upper leg bones which impressed Riggs the most. The humerus (upper foreleg) of the animal was, at 2.04 meters (about six feet, eight inches), actually larger than the 2.03-meter femur (upper hind leg)—an unheard-of characteristic in sauroped dinosaurs. Most sauropods, like *Brontosaurus*, have a back which reaches its highest point at the hips, then slopes downward to the shoulders. But *Brachiosaurus*, much like a modern giraffe, was taller at the shoulder.

Could there have been a mistake? He rechecked the bones and finally concluded he had found a new animal. He named it *Brachiosaurus altithorax*,[3] and in 1903 published his findings in the *American Journal of Science*. Among his conclusions:

"The length of the humerus and femur, together with the immense size of the thorax, at once establishes the fact that this is the largest and longest limbed of all known land animals."

3. Pronounced *brack-ee-o-sawrus*. The name derives from the Greek *brachion* ("arm") and *sauros* ("lizard").





But with approximately twenty bones to work with, Riggs was unable to determine exactly what the creature must have looked like in life, except to assume it must have looked something like the rest of the more famous sauropods.

Brachiosaurus is, after all, a very close relative of *Brontosaurus,* and both are sometimes placed in the same family.

Since it is almost impossible to whip up public enthusiasm for a few large bones with the tongue-twisting name *Brachiosaurus altithorax, Brontosaurus* remained, as it is today, the most famous of the dinosaurs—more than any other the symbol of those great reptiles which once ruled the earth.

In fact, *Brachiosaurus* remained something of a mystery until a decade later when a German expedition discovered a fairly complete skeleton in the Tendaguru fossil beds of East Africa, now Tanzania—the skeleton, forty feet tall, now stands in the Berlin Museum. Since then, various fragmentary remains identifield as *Brachiosaurus* have been found in Europe, Africa, and the western United States. ►

Today, paleontologists have a fairly good idea of what the creature looked like in life. It had the long neck of a giraffe, only more massive; the bulky body and pillar-like legs of an elephant; a tail relatively shorter than most of its sauropod cousins; and perched atop that long neck was a comparatively tiny head containing a brain no larger than a man's fist, nostrils elevated in a crest on top of the head, and a set of weak, peg-like teeth.

But if paleontologists agree on what *Brachiosaurus* looked like, they have been unable to agree entirely on a number of other puzzling aspects of the beast. Paleontology is a science which reconstructs the past using whatever evidence is available. The men who study dinosaurs must by necessity rely heavily on the bones of the creatures they find buried in rock. Bones can tell a paleontologist much about an extinct creature—how he looked and walked, for example—but they reveal little about such things as internal organs, skin, and physiology. Other fossils found in the same strata can give paleontologists a good idea of the other animals and plant life (the flora and fauna) inhabiting the world at the time and even the environment in which the beast lived. Even animals living today can give some clues as to the lifestyle of their extinct ancestors (the dinosaurs' closest living relatives are the crocodilians), and living animals occupying similar niches in the contemporary environment as creatures long dead can provide further insights. Elephants and sauropods are often compared because they represent the largest herbivores living in their respective times.

Despite all this, many questions remain regarding the way of life of *Brachiosaurus* and other sauropods.

The small mouth and weak teeth of *Brachiosaurus,* for example, immediately raise the question of how so large an animal could eat enough to stay alive. Obviously, the small mouth was a problem to everyone but *Brachiosaurus,* for it lived and flourished for millions of years over large parts of the globe.

One theory is that because the sauropods were reptiles, their metabolic rates and energy requirements may have been less than those of living mammals and they did not require as much food per unit of body weight.[4]

Another is that the sauropods were forced to eat almost continuously to stay alive and grow to such size.

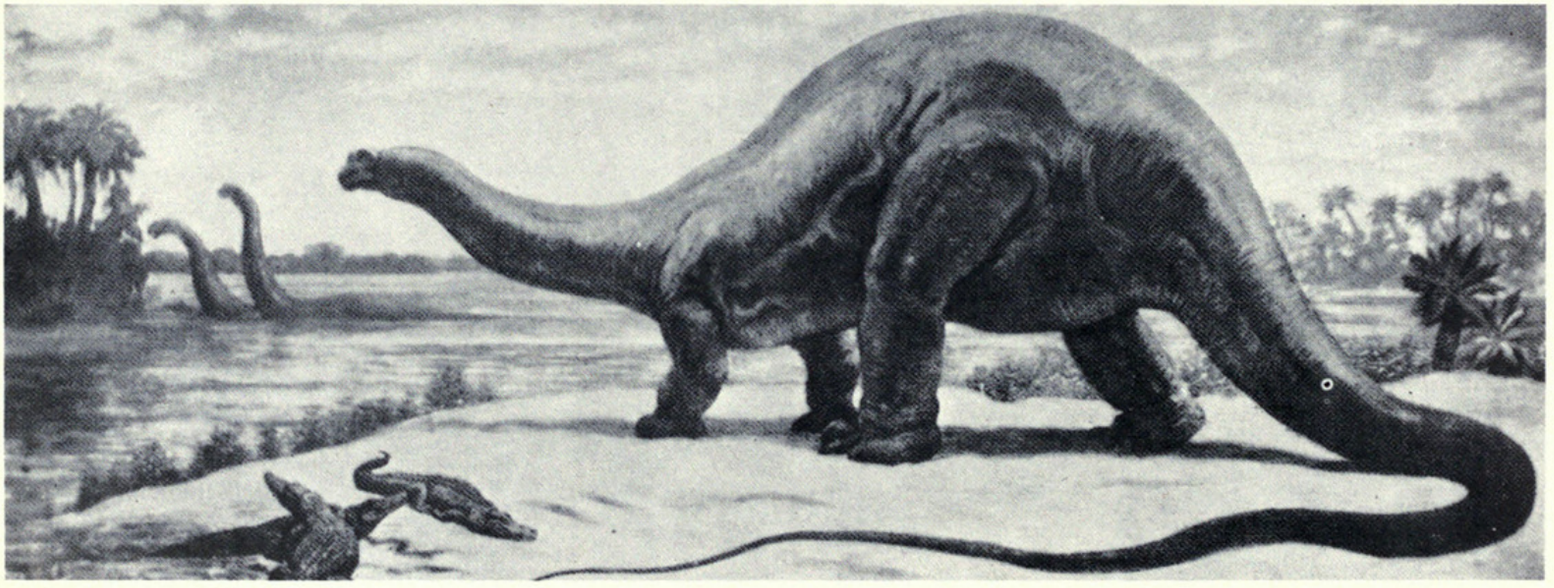
What they ate is still another problem. Some paleontologists believe that the sauropods lived on some sort of soft water plants which would present no problems to their teeth,[5] but James Jensen thinks that *Brachiosaurus* browsed on the tops of trees.[6]

The very size of the *Brachiosaurus* has also caused some academic consternation. For many years, many paleontologists argued that the weight limit for a four-legged animal (tetrapod) was about fifty tons. They reasoned that bone, ligament, and muscle simply could not support a land animal any larger.

But in 1962, Edwin H. Colbert of the American Museum of Natural History in New York calculated the weight of *Brachiosaurus,* based on body volume

4. W. E. Swinton, *The Dinosaurs,* John Wiley & Sons, 1970, p. 192.
5. Bjorn Kurten, *The Age of the Dinosaurs,* McGraw-Hill Book Co., 1968, pp. 92-93. See also Colbert, op. cit., p. 12. There are a number of pitfalls in speculating on the diet of dinosaurs. As Kurten points out (pp. 112-13), the diet of duck-billed dinosaurs, *Hadrosaurs,* was assumed to be aquatic plants because the animals' skeletal structure indicated a semi-aquatic life. In 1922, however, a German paleontologist published a list of the stomach contents found preserved in a *Hadrosaur* fossil, showing that the animal ate conifer needles, twigs, seeds, and fruits from land plants. See also John H. Ostrom, "A Reconsideration of the Paleoecology of Hadrosaurian Dinosaurs," *American Journal of Science,* 1964, Vol. 262, pp. 975-97.
6. Interview with Jensen author, May, 1974.

Brontosaurus *(more properly* Apatosaurus*) restoration, a mural, by Charles R. Knight. The 25-foot painting, with 28 other Knight murals of prehistoric life, is on view in Field Museum's Hall 38. Directly opposite the mural is a 15-foot high reconstruction of a* Brontosaurus *skeleton, discovered by Elmer Riggs near Grand Junction, Colo., in 1901.*



and specific gravity, at more than 85 tons.[7] Colbert argued that *Brachiosaurus* must, therefore, have been a semiaquatic creature living in swamps or lakes where the water could help support its massive body.[8] After all, the whales, the only animals ever to exceed *Brachiosaurus* in size, spend all of their lives in water. *Brachiosaurus'* long neck and nostrils elevated above its head, many paleontologists argue, are characteristics which would enable it to wade along the lake and swamp bottoms with its head still above water.

Colbert has often painted the sauropods as sluggish swamp-dwellers living in steaming jungles where they could feed on aquatic plants with little to fear from predaceous dinosaurs ashore.

Such a life would mean that the giants would have to go ashore infrequently perhaps only to lay their eggs and migrate to new feeding grounds.

However, a number of paleontologists believe that *Brachiosaurus* spent most of its life on land, feeding from the tops of trees in the same way a giraffe does today. Why else would the animal reach such a great height? These paleontologists claim that the structure of the creature's vertebral column indicates, *Brachiosaurus* could not easily lower its head for ground feeding.

Jensen, one of the proponents of this view, believes that *Brachiosaurus* lived on gently rolling uplands not far from the flood plains inhabited by semiaquatic sauropods like *Brontosaurus*. Since upland environments are not conducive to fossilization, this would explain the relative scarcity of *Brachiosaurus* fossils, Jensen reasons.[9]

Its great size would protect it from the predators of the time. Some of these creatures were awesome in their own right. *Antrodemus (Allosaurus)*[10] was a thirty-foot reptile with a gaping mouth armed with serrated teeth. But Colbert calculated that *Antrodemus* weighed only about two tons. For one of them to bring down a full-grown *Brachiosaurus* would be roughly equivalent to a lion killing a six-ton elephant. Modern carnivores—even the crocodile—generally do not attack prey considerably larger than themselves. In other words, their prey must be manageable. If *Antrodemus* ate *Brachiosaurus*, it may have confined itself to younger animals which had not yet grown to such great size.

Ironically, Riggs was one of the early proponents of the theory that *Brachiosaurus* was a land dweller—a theory which he argued in several scientific papers in the early 1900s.[11] He also argued that the feet and limbs of all sauropods indicated the entire group was terrestrial:

". . . but the length and slenderness of the limb, the deep thorax, and broad sacrum, the expanded ilium, and the abbreviated tail of *Brachiosaurus* all point to a great agility and much better adaptation to terrestrial habits than is found in any other representative of the sauropods."

Unfortunately, Riggs' observations were based on a single incomplete *Brachiosaurus* skeleton a decade before the German discoveries in Africa. And his arguments failed to sway paleontologist W. E. Swinton:

"From this view there seems little good evidence to counter the overwhelming array of adaptations for a water habitat."[12]

Whatever its lifestyle, *Brachiosaurus* apparently became extinct around the close of the Jurassic about 140 million years ago. While other types of dinosaurs, even some sauropods, survived the Jurassic and lived on into the Cretaceous, there is no evidence that *Brachiosaurus* was among them. Of course, all dinosaurs are believed to have become extinct 65 million years later at the end of the Cretaceous.[13]

Why did *Brachiosaurus* disappear so much sooner than its dinosaurian relatives? There has been a veritable host of reasons given for why the dinosaurs became extinct—everything from cosmic disturbances to racial old age. Whatever the causes of the extinction of such well known dinosaurs as *Tyrannosaurus* and *Triceratops* about 70 million years ago, *Brachiosaurus* was dead and fossilizing long before they even evolved.

The most common explanation for the extinction of *Brachiosaurus* (and other sauropods) is that its environment changed and it was unable to adapt to a new one. Possibly the low-lying plains on which it lived rose slowly during the late Jurassic and early Cretaceous, draining the swamps and lakes, changing the course of rivers, and altering the environment upon which the huge creature was dependent. There is no way to know for sure.

So the *Brachiosaurus* remains a puzzle, as much so in life as in death—tons of massive bones to titillate the public imagination as well as scientific curiosity. In some ways, we are no closer to solving the riddle of the giant among the dinosaurs than when Chicagoan Elmer S. Riggs first discovered its existence on that lonely hillside in Colorado seventy-five years ago. □

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7. Colbert, op cit.
8. Interview with Colbert by the author in June, 1974. See also Colbert, *Dinosaurs: Their Discovery and Their World*, pp. 91-105; and *The Dinosaur Book*, McGraw Hill Book Co., 1945, pp. 94-95. Further discussion of the semiaquatic theory is in Alfred S. Romer's *Vertebrate Paleontology*, 3d ed., University of Chicago Press, 1966, pp. 153-56.
9. Jensen interview; see 6, above.
10. *Antrodemus* is popularly, but erroneously, known as *Allosaurus* from *Allosaurus fragilis* in 1877. See Swinton, op. cit., pp. 147-49.
11. Elmer S. Riggs, "The Dinosaur Beds of the Grand River Valley of Colorado," *Field Columbian Museum Publication #60*, Geological Series, Vol. 1, No. 9, 1901, pp. 267-74; and "Structure and Relationship of Opisthocoelian Dinosaurs," *Field Columbian Museum Publication #94*, Geological Series, Vol. II, No. 6, 1904, pp. 229-47.
12. Swinton, op. cit., p. 188.
13. *Brachiosaurus* may have survived into the Cretaceous period. However, there is a scarcity of lower Cretaceous fossil strata in the United States and no evidence of *Brachiosaurus* in later deposits. John Bolt, Field Museum assistant curator of fossil reptiles and amphibians, points out that there may be a similarity in the problem of dinosaur extinction at the end of the Cretaceous: that some dinosaurs may have survived into the Cenozoic. No proof of this has yet been published.