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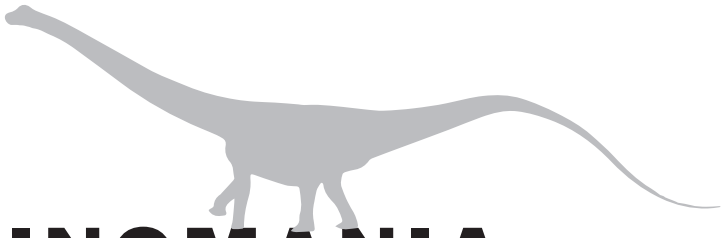


DINOMANIA

GIANT SLOTHS, SEA SNAKES, AND CONCRETE CONTRAPTIONS

***DIPLODOCUS* WAS NOT THE FIRST CREATURE** from "before the flood" whose mounted skeleton could be admired on the European continent. Probably the most spectacular of *Diplodocus*'s predecessors had been a creature that amazed European audiences in the 1840s in much the same way *Diplodocus* would sixty years later. That creation—for that is what it was—was Albert Carl Koch's *Hydrarchos harlani*. Although Koch is habitually cast as one of the charlatans of nineteenth-century American paleontology, his story is not quite as one-dimensional as is often made out.[1] Some of the confusion is due to Koch's quite sincere first appearance on the stage of early paleontology, and the fact that he appears to have been a genuinely devoted and knowledgeable collector. Having immigrated from Germany to the United States in 1826, he initially attempted to earn a living as a museum and theater director in Alabama, and even published an (unsigned) article about human remains that had been found together with fossil bones.

Koch's *Hydrarchos*, a huge composite that we now know combined the remains of several individuals of the Pleistocene whale *Basilosaurus*, has often been simply dismissed as a "fraud." Apart from the very clear goal to generate profit, his objectives and intentions remain vague, but there are reasons to believe that he never intended to

treat this as a scientific specimen.[2] Rather, it was the centerpiece of a very successful business enterprise that made clever use of a mix of sensationalism and the exploitation of scientific plausibility—its embellishments served a very specific but nonscientific purpose. Certainly the public, attracted to Koch's dragonlike chimera, seemed to be unaffected by its lack of scientific trustworthiness.

Koch had been up to this type of caper before. In 1841 he had unveiled the remains of a truly colossal mastodon, an animal that the American public had been obsessed with for some time. The size of this *Missourium theristocaulodon* ("sickle-toothed animal from Missouri") skeleton drew large crowds to his museum and inspired Koch to take the animal on tour across the Eastern Seaboard of the United States. That placed it on view in front of a perhaps less-gullible crowd, and the scientists visiting the exhibit in Philadelphia soon realized that the skeleton owed as much to Koch's imagination and desire to scale up his find as to nature: the animal was in fact a "common" (although still large) mastodon (*Mammut americanum*). Koch was widely criticized for his errors, but that did not prevent him from taking an unredacted *Missourium* to be displayed in London's Egyptian Hall at the end of the same year.[3] There it was, predictably, criticized by British scientists, but they also agreed that the basic material of the animal still constituted a valuable specimen. After further tours throughout Ireland and Germany, Koch was able to sell it, along with the remainder of his fossils, to the British Museum (Natural History) for a sizable sum in 1844. What doubtlessly helped add to *Missourium*'s market value was the rising interest in "antediluvian" creatures caused by the discovery and subsequent description of the first dinosaurs.

The British interest in large reptiles had not passed Koch by, and once back home he quickly set out on another venture. The results of this expedition could be observed the next year in New York and, if anything, it was even more astonishing than his mastodon. Having scoured several fossil sites in Alabama, Koch produced yet another marvel. This time he rearranged several bones of Eocene whales to form an enormous sea snake. The fossils had not been hard to come by; in some areas they were so numerous that they were regarded as a nuisance, and an obstacle for cultivation. Koch's initial investment was therefore minimal, but the return certainly was not. In July 1845 in New York, Koch unveiled his forty-meter-long monster—almost

doubling the original whale and made up of the bones of at least five individuals. Koch remained, apparently purposely, oblique about the precise nature of the beast in his exhibit, although he regarded it as reptilian. He had named it *Hydrarchos sillimani* in honor of a friend, Benjamin Silliman; when Silliman objected, Koch thoughtfully renamed it after the anatomist Richard Harlan, a supporter of Koch during the *Missourium* affair who had very conveniently passed away since and was therefore in no position to object. As for visitors to Koch's exhibit, their mental associations were very probably more biblical in character. Certainly press reports had suggested as much, with much talk about the Leviathan and references to the Ark. In a way, Koch exploited scripture as deftly as he did science.[4]

Although Koch's reputation survived his construction's New York stint more or less intact, things went sour once it was exhibited in Boston. Several Harvard scholars expressed doubts over its reptilian kinship, but it was the British geologist Charles Lyell who dealt it the final scientific blow when he determined the display to consist of several individuals of fossil whale.[5] But just as he had done with *Missourium*, Koch shipped the snake across the Atlantic without changing a thing. London, Dresden, and Berlin audiences were as riveted by the beast as those in New York and Boston had been. The Prussian king Frederick William IV was so impressed that he acquired the monster for the museum of mineralogy (later part of the Museum für Naturkunde) in Berlin. A mishap in the museum subsequently revealed that the animal had a full mammalian inner ear (which evolved from the lower jaw bones in reptiles), confirming Lyell's suspicions about its affinities. Needless to say, Koch came out of his deal with the Prussian king a good deal richer. The king's curator, Johannes Müller, immediately attempted to recoup some of the money by selling a large portion to Adolf Crantz's fossil dealership in Bonn.[6]

Albert Koch does command a certain respect for his audacity but also for the astuteness with which he marketed his chimeras at the heart of American and European science, folklore, and entertainment. While Koch's first appearance in the field of paleontology was an earnest one, from his construction of *Missourium* onward it would be a mistake to consider him a scientist in anything but (stage) name, or *Missourium* and *Hydrarchos* as primarily scientific specimens. Everything indicates that Koch's agenda was purely commercial;

specifically, he hoped to tap into existing sources of authority—be they biblical, popular, or scientific—in order to attract visitors to his attractions.

As for those attractions themselves, they should be viewed as part of the rich history of popular amusement. The line between "highbrow" and "lowbrow" science, art, and related subjects could not, at this time, be drawn as rigidly as it would in later years: Koch's specimens were, after all, examined and reviewed by professional scientists—insofar as one could identify such a category in the 1840s. But at the same time they were part of the prominent nineteenth-century cultural tradition of (often traveling) visual spectacles. Like Barnum's circus in the United States, the London Globe, and the various panoramas that sought to amaze and amuse the masses, *Hydrarchos* was primarily a fairground attraction—and an immensely profitable one at that. Seen in this light, Koch's monstrosities already seem less outlandish than they might appear otherwise.

The fact that many such spectacles proclaimed to contain scientific content was hardly coincidental. Science lent an authority to such exhibits that, for instance, a circus could never aspire to obtain. Consequently, their proprietors could hope to attract a "better" class of visitor—but in a world of social aspiration it also made their attractions more alluring to other social classes. As for Koch, he had chosen, with *Hydrarchos*, an eminently marketable animal to imitate (quite openly)—the sea serpent, an enigmatic marine creature that had been part of European popular culture since ancient times.[7] Wherever it came, posters expressly identified the fossil as such, and neatly played in to the "serpent craze" that gripped both sides of the Atlantic at the time.[8] By the late 1850s Koch had retired to Alabama, but the consequences of the *Hydrarchos* affair for dinosaur exhibits would prove to be longer-lasting.

If we exclude Albert Koch's phantasmagorical creations, the first time the public was exposed to dinosaurs in their full splendor was in 1854, shortly after the Crystal Palace, the center of the Great Exhibition that had been held three years earlier, was relocated to the South London suburb of Sydenham. During the first decades of the nineteenth century fossil remains had come to light that suggested Great Britain had once been inhabited by huge reptiles. In 1842 Richard Owen created the reptilian order Dinosauria (usually translated as "terrible reptiles") to encompass the three genera known at

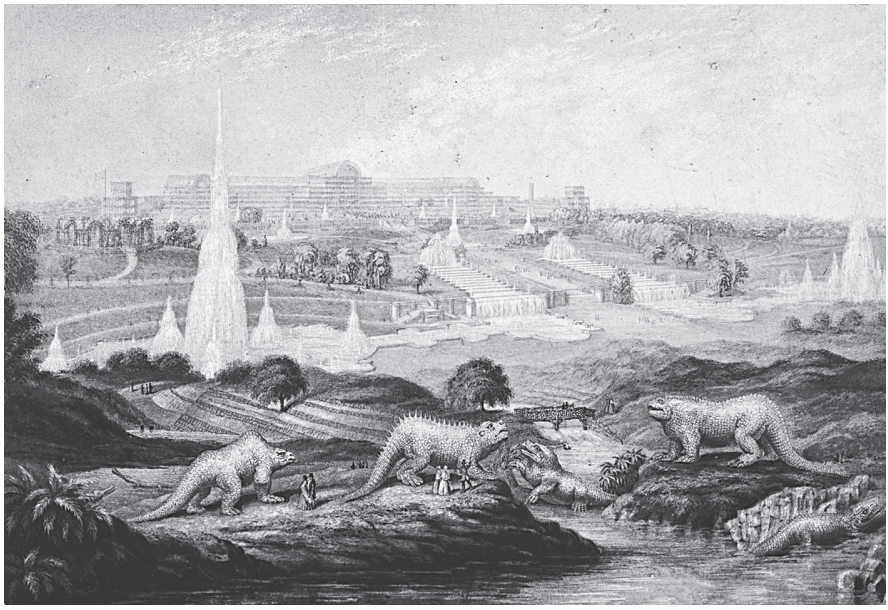


Fig. 1.2 • The "Crystal Palace" from the Great Exhibition, installed at Sydenham: sculptures of prehistoric creatures in the foreground. Colored photomechanical print, later than 1854? Source: Wellcome Collection.

that time: *Hylaeosaurus*, *Megalosaurus*, and *Iguanodon*.[9] These remains caused a surge in public interest that was later termed "dinomania."[10] In the Crystal Palace gardens, the sculptor Benjamin Waterhouse Hawkins built up a "primeval garden" in which brick-and-cement, life-size reconstructions of various extinct animals could be seen, from Irish elk, *Megatherium*, ichthyosaurs, and pterodactyls to the display's highlight: reconstructions of the enormous dinosaurs.

These portrayals bore the hallmarks of Richard Owen's antievolutionist vision on extinct life and consequently ignored progressivist, evolutionary ideas. The reconstructions downplayed any unique characteristics of the extinct animals; *Iguanodon* and *Megalosaurus* looked like huge lizards, *Hylaeosaurus* most resembled a toad. Additionally, the animals were contained—literally—within a biblical framework: the islands on which they stood conjured up associations with the flood, as did the language ("pre-Adamite," "antediluvian") with which they were described. That might have made them more acceptable to

Owen and others wary of evolutionist ideas, but in the long run it did not contribute to their longevity as credible representations.[11]

While the response to the Crystal Park reconstructions in learned circles might not have been universally positive, that did not hinder the public from visiting the statues in droves. After the opening by Queen Victoria on June 10, 1854, forty thousand people converged on the park on the first day alone. And while the exhibits showed countless more extinct animals, the huge dinosaurs drew most of the passing Londoners' attention and were cemented in the public imagination. The dinosaur models became the subject of newspaper cartoons and artworks and would prove to be a lasting template for how the public came to perceive these animals. The Crystal Palace models also proved to be particularly long-lived, not least because they were incorporated in popular works about the "antediluvian" world, such as Louis Figuier's *La terre avant le Déluge* (The world before the deluge; 1863), Camille Flammarion's *Le monde avant la création de l'homme* (The world before the creation of man; 1886), and even much later volumes, until well into the twentieth century.[12]

Several works have represented the attention for the Crystal Palace dinosaurs (the nondinosaurs have often been neglected) as the start of "dinomania," the public obsession with extinct life, mostly dinosaurs.[13] However, crediting the Crystal Palace models with singlehandedly causing a dinosaur craze may not be as accurate as we think. Here we are assisted by culturomics, the study of cultural and social trends through the quantitative analysis of (usually digitized) texts. The Google Books Ngram Viewer is an online tool introduced in December of 2010 that indicates the relative share of words used in books in the Google Books repository. Although its systematic use is potentially problematic for a number of reasons, the frequency of more complicated engrams such as dinosaur names can give us some indication of their common application relative to each other, at least.[14] What immediately becomes obvious when using this tool is that the present dinosaur "craze" is dwarfed by the mania that took the British Isles during the 1840s and 1850s, after the first dinosaurs (*Megalosaurus* and *Iguanodon*) had been uncovered.[15] However, local and cultural differences also come into play: in the case of *Iguanodon*, its fame was decidedly greater in the United Kingdom than in the United States. Numbers in French were initially much lower still but increase significantly after the discovery of a herd of *Iguanodon*

fossils in a coal mine in (French-speaking) Belgium in 1878. Interestingly, the greatest number of published mentions of the animal appears to have been published *before* rather than *after* the unveiling of the statues in Crystal Park, suggesting that rather than the cause, the construction of an *Iguanodon* model was the *result* of great public interest in prehistoric animals in general, and this one in particular. It did probably help to sustain that interest, though. The plethora of books on prehistoric animals on sale to the British public had created a market for such spectacular reconstructions, one that the directors of the Crystal Palace Park were only too happy to exploit.[16]

Hawkins's unique contribution lay in the design of the animals. As misconceived as they might have appeared to later generations, the models still presented a considerable improvement over the fantastic or incomplete efforts of previous artists. With this in mind, it is hardly surprising that they came to function as a template in popular publications. Even if the Crystal Palace dinosaurs did not in themselves establish dinomania, they greatly helped to sustain it by mixing the desire for spectacle with the virtue of scientific respectability, as marketing for the park often emphasized the role of the broadly respected Richard Owen.[17]

The park also established a yardstick for the popularization of dinosaurs, and particularly the establishment of what we might term a dinosaur "canon." Yet the supply of sufficiently complete dinosaurs to that canon was limited, even as late as 1900. Large, headline-filling dinosaurs such as *Brontosaurus* and *Diplodocus* were quickly included, as was the fearsome predator *Tyrannosaurus* quickly after its description in 1905. But other choices were not quite as obvious. The huge flying reptile *Pteranodon*, known since the 1880s but not a dinosaur despite being related to and contemporary with them, was clearly evocative enough to gain entry. Likewise, the pelycosaur (popularly dubbed "mammal-like reptile") *Dimetrodon* was about as closely related to dinosaurs as we are and predated the first of them; yet it quickly became an integral part of the "canon" on the strength of its impressive array of incisors and the strange "sail" on its back. This representation was based far more on titillation than on scientific relevance and interest—it may be argued, then, that the interest for the Crystal Palace dinosaurs did not distinguish itself too much from the attention paid to *Hydrarchos*. For instance, poor *Iguanodon*, although arguably a "core" dinosaur since Owen defined the order

in 1842, quickly fell out of favor, maybe because it had become established as the quintessential basal dinosaur and was not as suited to being described in the same superlatives as some of its kin.

In the long term the Crystal Palace dinosaurs proved to be a troublesome testimony to a time in which these animals were still largely unknown. In his zeal to argue against Lamarck's idea of progressive transmutation, Owen (and in his wake, Hawkins) had relied entirely—rather too much, perhaps—on the method of extrapolating an animal's anatomy from fragmentary remains through association with other life forms.[18] This worked very well when comparing the bones of the extinct New Zealand moa with those of an ostrich, but in cases where very fragmentary remains of dubious quality belonged to hitherto unknown animals, it turned out to be far less practical. As new discoveries came in, it became obvious that creatures such as *Iguanodon* looked nothing like the reconstructed animals in Sydenham—and it led to the uncomfortable suspicion that the other reconstructions might have been wide of the mark, too.

But the Crystal Park models were meant to be both of educational value and a showcase for British scientific prowess.[19] To have them appear both incorrect and outdated was therefore a real problem, but little was to be done except for demolishing the statues, since they could hardly be adapted to newer scientific insights. And whereas the fact that Hawkins's images were being reused ad infinitum might once have been a source of pride, it now only emphasized just how behind the times they were. For instance, in 1911 the German popular science magazine *Die Umschau* published an article that offered a comparison between older and newer reconstructions.[20] It used the Sydenham *Iguanodon* to demonstrate how far the art of reconstructing past life had come since the middle of the nineteenth century—and how much more convincing contemporary German efforts looked. Fourteen years later, Othenio Abel's manual of fossil reconstruction was even less kind to these behemoths from the paleontological past.[21] Hawkins's reconstructions had become the exemplification of obsolescence.

Understandably, the experience of the Crystal Palace dinosaurs made scientists wary of committing themselves to such life reconstructions, especially if they had to rely on fragmentary material. These experiences made clear that skeletal mounts rather than life reconstructions provided the best way to present extinct animals to

the public without sacrificing scientific accuracy. The prominent American paleontologist Othniel Marsh never had life reconstructions made because he considered them to be too speculative; his rival Edward Cope only collaborated with an artist near the end of his life. At that time, however, fossil discoveries had made life reconstructions substantially less speculative.

Skeletal mounts, meanwhile, were a different thing. They had been part of the exhibition tradition of museums for some time and, most crucially, they could—at least theoretically—be remounted if new insights demanded it. Moreover, they turned out to be just as crowd-pleasing as models were. Extinct mammals had been presented to the public from the late eighteenth century onward. Probably the first mounting of the skeleton of an extinct animal in a more or less lifelike pose was that of an Argentine ground sloth (known erroneously as the "Paraguay animal") in Madrid's Royal Cabinet of Natural History, in 1795. Here it attracted the attention of the famous French anatomist Georges Cuvier, who named it *Megatherium americanum* in a paper in Paris a year later.[22] And when a skeleton of the American mastodon was unveiled in Charles Wilson Peale's "American Museum" in Philadelphia on Christmas Eve, 1801, it gained such fame that it turned the mastodon into the quintessential American "primeval" animal.[23]

The first mounted skeleton of a dinosaur could be observed from 1868 onward in the building of the Academy of Natural Sciences in Philadelphia. This was an important moment not only for the display of these animals; it also signaled a permanent shift of emphasis in dinosaur paleontology, away from Great Britain toward North America. It was no coincidence that this shift was provoked by a new breed of scientist. A consummate professional, Joseph Leidy was a far cry from the scholarly dilettantes who had been so instrumental in getting serious research into fossils off the ground in Britain fifty years earlier, or the scientist-trader still common throughout the German and Austro-Hungarian lands. Leidy combined a broad grasp of anatomy and medicine with a near-obsessive work ethic and—at least as important—proximity to dinosaur fossils of a multitude and quality not seen in the British Isles. Although Leidy had been describing dinosaur remains throughout the late 1850s, it was in 1858 that he struck gold at Haddonfield in New Jersey, stumbling upon the skeleton of what he was to name *Hadrosaurus foulkii*.[24]

Its description, one year later, turned most of the assumptions that had guided Hawkins in his Owenian reconstructions at Crystal Palace Park on their head. *Hadrosaurus* possessed hind limbs that were so much longer than the forelimbs that it made an elephantine, four-limbed gait like what *Iguanodon* and *Megalosaurus* had been made to adopt in Sydenham highly improbable. Such doubt was further supported by the affinities Leidy saw between his animal and *Iguanodon*—which implied that these were similar animals in appearance as well.[25]

The collaboration between Leidy and Hawkins that would result in the public display of *Hadrosaurus* in Philadelphia was something of a coincidence. Hawkins, who had come to the United States in March of 1868 in search of work as an artist and lecturer, was soon engaged to help erect a spectacular display of extinct life from North America to be housed in New York's Central Park.[26] Because he lacked any reference material, in New York Hawkins had no choice but to travel to the closest institution that housed North American fossils in any quantity, the Academy of Natural Sciences, Leidy's home institution. Although the remains of this *Hadrosaurus foulkii* were not complete, the large difference in size between the animal's legs and arms did seem to indicate that it had been bipedal and therefore not really comparable to his earlier work in London. Instead of sculpting its life image, as he had done earlier, Hawkins reconstructed the animal's skeleton. However, the absence of *Hadrosaurus*'s skull caused Hawkins—again—to turn to an extrapolated iguana skull instead.

Hawkins had been forced to invent his method as he went along, mainly because of the fragmentary nature of many of the fossils he had to work with; even *Hadrosaurus* was far from complete. This changed dramatically in 1878, when Belgian miners discovered a herd of *Iguanodon* fossils in a coal mine near the town of Bernissart on the Belgian-French border. Suddenly, instead of the usual jumble of fragments, scholars could pick from literally dozens of nearly complete fossils. Many of the *Iguanodon* remains were found as complete, articulated skeletons. These close relatives of *Hadrosaurus* again proved that previous lizardlike models had been incorrect and that new parallels needed to be explored. The chief excavator, Lodewijk De Pauw, faced the task of erecting these in a more or less lifelike position in the Royal Belgian Institute of Natural Sciences in Brussels. Using an elaborate system of ropes, wooden beams, and

pulleys, the *Iguanodon* bones were hoisted up and then hammered into place with wedges on an iron framework.[27] In 1883 the first specimen was unveiled to the public in a glass cage in Brussels and immediately drew international attention; it represented the last nail in the coffin for Hawkins's statues but seemed to affirm much of his work on *Hadrosaurus*. De Pauw's (and later also Louis Dollo's) work was also important for its influence on fossil preparation and exhibition. Whether it influenced later preparators is difficult to ascertain, but considering the scarcity of publications about the mounting techniques used, it is unlikely.[28] Certainly those who have written about preparation techniques have indicated no such relation, and Belgium was as far away from the United States—where the large majority of large dinosaur finds would occur in subsequent years—as the Belgian scientific world was from the American.[29] But the displays at Brussels did affirm just how different these animals were from what had been on view in London.

The Peeping *Brontosaurus*

Parisians who visited a newsstand or bookstore in the spring of 1886 were confronted with the frightening prospect of a dinosaurian intrusion into their sixth-floor apartments. It was introduced to them by a poster that was part of the advertising campaign for Camille Flammarion's new book (and newspaper serial), *Le monde avant la création de l'homme*, and the whole approach of the publicity campaign turned out to be a good indication of the tone of the book.

Up to that point, Flammarion had mostly written about astronomical matters and gained a notoriety for combining scientific concepts with more outlandish ideas, packaged in a form and style that was easily understood by the average Frenchman. As a writer on science and natural history, Flammarion has often been compared to influential popularizers such as (the earlier) Louis Figuier and, in Germany, Wilhelm Bölsche. But contrary to either of these, Flammarion chose to actively oppose, rather than accommodate, the scientific establishment. This became apparent both in the colorful prose in which Flammarion's narratives were cast and in his choice of subject matter. Where the professional pharmacist Figuier dismissed spiritism out of hand, for instance, Flammarion grasped

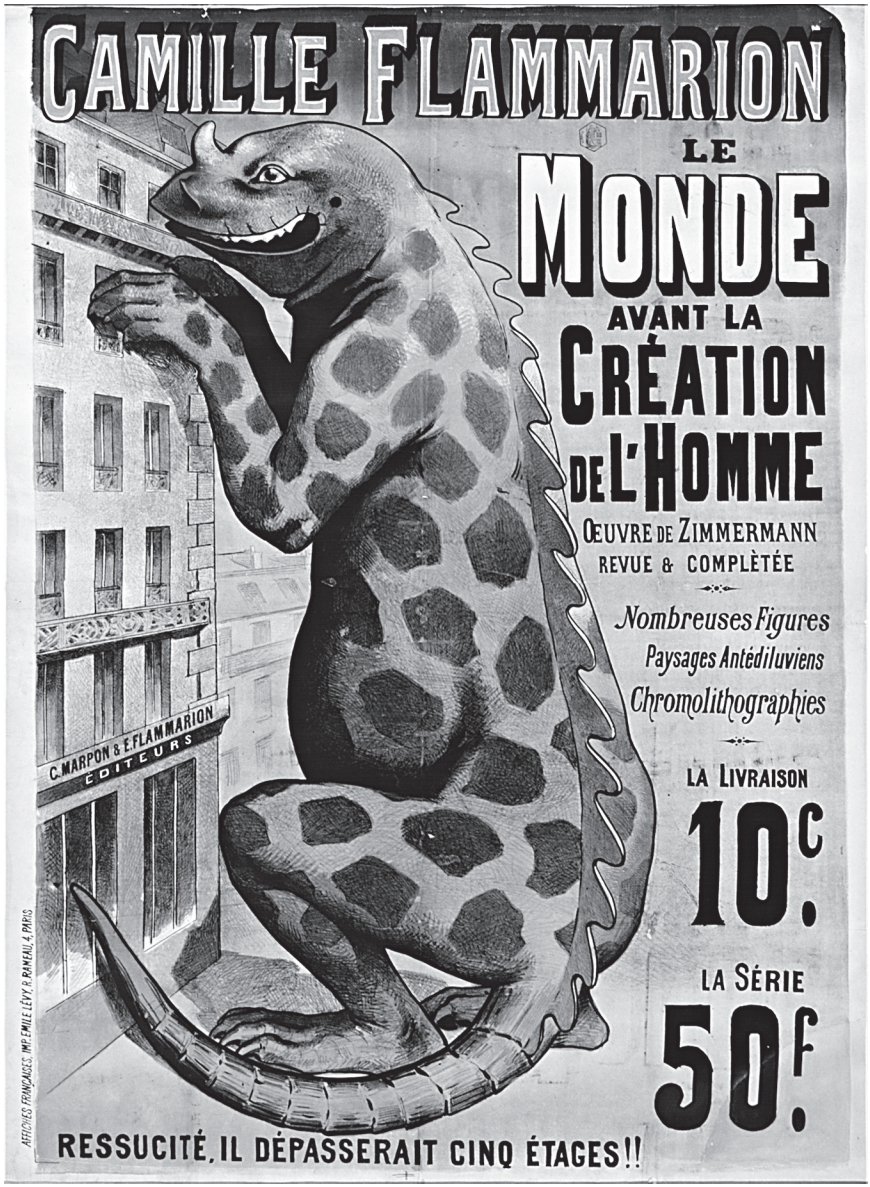


Fig. 1.3 • Poster for the first edition of Camille Flammarion's *Le monde avant la création de l'homme* (The world before man's creation), 1886. Source: Bibliothèque Nationale de France.

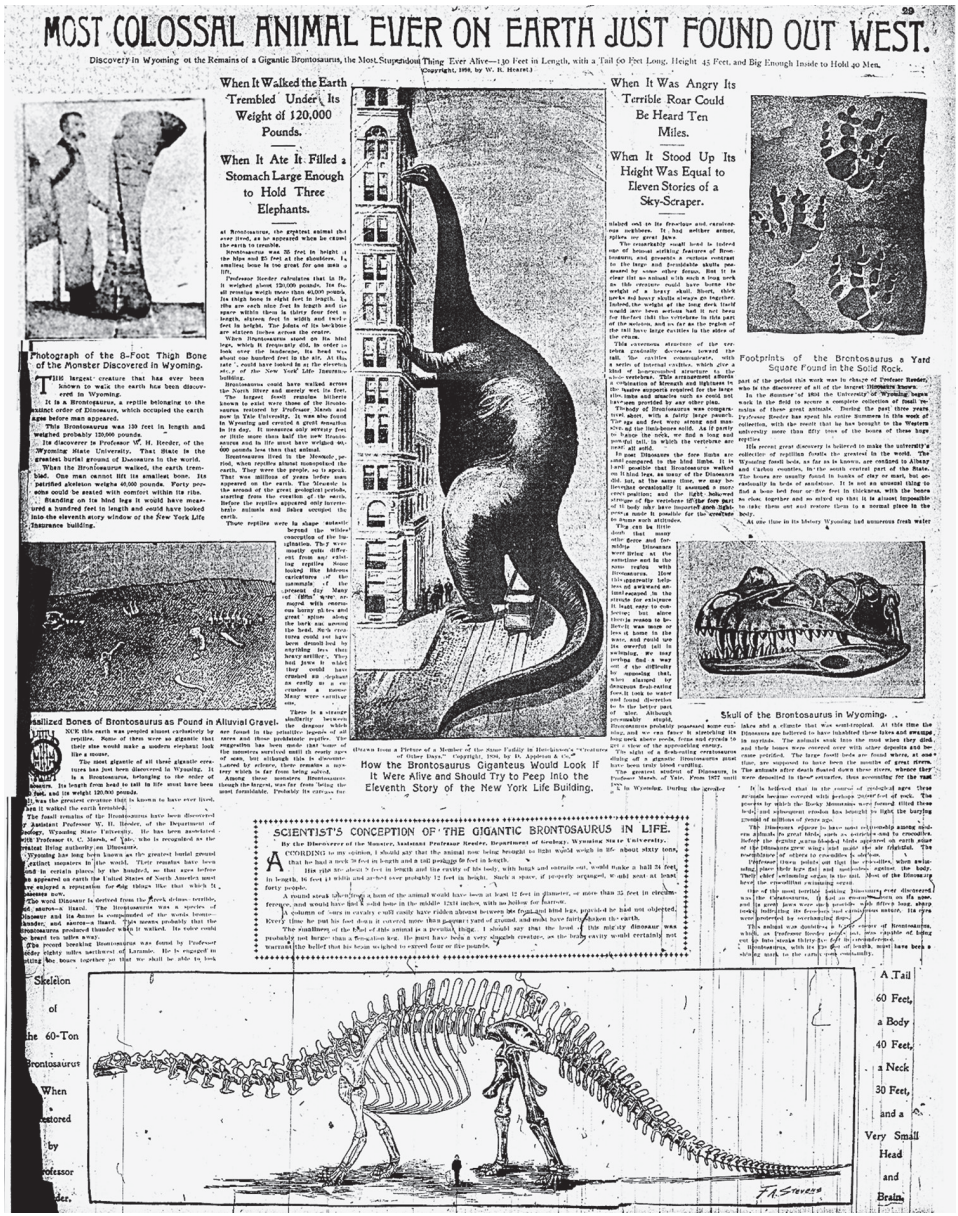
onto the concept and did not shy away from defending it in the face of academic ridicule.[30]

So while Flammarion's book presented itself as a work of popular science, it sought to awe its readers as much as inform them. And although the rather overweight dinosaur here borrows heavily from the reconstructions made about fifteen years earlier by Hawkins for the Crystal Palace exhibition, the image of a dinosaur standing next to a high building looking into its top floors would prove compelling enough to last.

An important element in the early portrayal of dinosaurs had always been their size—and frequently little else. From the early days after their discovery they represented brute, dumb force and were in a way the representatives of the uncontrollable forces of nature—not entirely different from the way in which the savage wildlife of Africa or many unknown peoples were perceived.[31] For the Victorians there was, of course, always the comforting thought of dinosaurs' extinction, something many of their contemporaries envisioned for extant African wildlife as well. Moreover, it was often argued, they appeared to have brought their extinction upon themselves: their small brains impeded them from competing successfully with the far smarter mammals. This represented a valuable moral lesson that could be applied to all other aspects of society—and was.

But no one doubted the (literal) otherworldiness of these animals, which came to light even more when they were placed in surroundings that were familiar to us. The contrast between such huge, unwieldy, and chaotic animals and our own comfortable and controlled surroundings would increase our awe of them (and, of course, our fear). An entire subgenre of "paleo-art" was created to cash in on this confrontation of the ancient with modern life. Predictably, civilization usually suffered the consequences in these depictions. This was, in essence, the artistic version of the "lost world" novel and the predecessor to a long-persisting meme in popular culture.

The device of emphasizing a dinosaur's size by having it look into the windows of a high-rise building therefore dates back to at least 1886. However, a picture from 1898 probably portrays its most famous application—in part because, according to legend, it sparked Andrew Carnegie's interest in (and subsequent sponsoring of) the


MOST COLOSSAL ANIMAL EVER ON EARTH JUST FOUND OUT WEST.

Discovery in Wyoming of the Remains of a Gigantic Brontosaurus, the Most Stupendous Thing Ever Alive—130 Feet in Length, with a Tail 50 Feet Long, Height 45 Feet, and Big Enough Inside to Hold 40 Men.

(Copyright, 1898, by W. R. Hearst.)

When It Walked the Earth Trembled Under Its Weight of 120,000 Pounds.

When It Ate It Filled a Stomach Large Enough to Hold Three Elephants.

When It Was Angry Its Terrible Roar Could Be Heard Ten Miles.

When It Stood Up Its Height Was Equal to Eleven Stories of a Sky-Scraper.

Photograph of the 8-Foot Thigh Bone of the Monster Discovered in Wyoming.

Footprints of the Brontosaurus a Yard Square Found in the Solid Rock.

Fossilized Bones of Brontosaurus as Found in Alluvial Gravel.

Skull of the Brontosaurus in Wyoming.

How the Brontosaurus Giganteus Would Look If It Were Alive and Should Try to Peep Into the Eleventh Story of the New York Life Building.

SCIENTIST'S CONCEPTION OF THE GIGANTIC BRONTOSAURUS IN LIFE.

Skeleton of the 60-Ton Brontosaurus When Restored by Professor Reeder.

A Tail 60 Feet, a Body 40 Feet, a Neck 30 Feet, and a Very Small Head and Brain.

Fig. 1.4 • "Most Colossal Animal Ever on Earth Just Found Out West." New York Journal and Advertiser, 11 December 1898. Courtesy of Kevin Anderson and Tom Rea.

excavation of dinosaurs in the American West.[32] The article is pervaded by typically hysterical Hearstianisms and a general disregard for factual accuracy. The skull, for instance, portrayed as belonging to the plant-eating *Brontosaurus* is in fact that of *Ceratosaurus nasicornis*, a predatory dinosaur that was apparently deemed more impressive than the rather undaunting (and speculative) *Brontosaurus* skull. The way in which the cover art for Flammarion's book was imitated by Hearst's artist is something we see happening over and over with reconstructions of extinct life. The practice of "citing" foreign artwork, especially, flourished in the absence of any meaningful copyright agreements between continental European nations, the United Kingdom, and the United States.

When Carnegie saw the peeping *Brontosaurus* on the front page of the paper, what took shape that very morning, and what was in turn molded itself by Carnegie's involvement, would become known as the "second Jurassic dinosaur rush." Sending the newspaper page to his natural history museum director, William J. Holland, he included a handwritten note in pencil: "Dear Lord—can't you buy this for Pittsburgh—try."[33]

"My Lord Chancellor"

William Jacob Holland was an imposing figure, and he meant to be. Born on August 16, 1848, in Kingston, the capital of the British Crown Colony of Jamaica, and the son of a missionary, his ambitions initially went in the same direction. He graduated from Princeton Theological Seminary in 1874, was ordained into the ministry and started as a pastor in the Oakland district of Pittsburgh, which was then developing as the academic center it is today. In addition, he began to teach classical languages at the Pennsylvania College for Women. Further developing his interest in the sciences, he joined the Eclipse Expedition of 1887, a joint initiative of the National Academy of Sciences and the US Navy, in order to explore Japan. A few years later, in 1891, Holland became chancellor of the Western University of Pennsylvania (now the University of Pittsburgh), and oversaw significant changes and expansion to the school. That post also brought him into contact with other scientific interests, and

gave him the chance to further develop his love for lepidoptery. His marriage to a daughter of a prominent Pittsburgh family of industrialists further enhanced his social status, as did his friendship with the most prominent Pittsburgher of all, Andrew Carnegie.

It was Holland who had to some extent inspired Carnegie's idea of building a complex of institutions in Pittsburgh. After the magnate offered to build the city a new library in 1886, Holland advised him to think on a grander scale. Carnegie wrote to the mayor, suggesting a subsidy of a million dollars for a complex that, in addition to the library, included conference rooms for a scientific society and an art gallery. The reaction to the proposal was not universally positive: some accused him of wanting to build an edifice for himself. But once an idea had formed in his head, Carnegie rarely let go of it. The museum itself was something Carnegie saw as a returned favor to Pittsburgh, the city that had made him what he was—in essence, a scaled-down version of his philanthropic principles. He wanted to give the city this first experiment in large-scale philanthropy. In 1895 the new Carnegie Library was opened as its first phase. It was followed by the Carnegie Institute a year later, and two museums the year after that.

The Carnegie Museum of Natural History started life as a department of the Carnegie Institute in 1896. Its patron professed a solid belief in the Darwinian theory of evolution and as a consequence the museum included displays explaining evolution from the outset. As a friend and close ally of Carnegie, a man of science, and a proven administrator, Holland became the obvious choice to oversee the organization of the new institution. The original remit of the museum had been to show the natural treasures of the Appalachian region, but again Holland soon convinced Carnegie to pursue a more ambitious goal. As David Nasaw noted, Carnegie wanted his museum to have a "dinosaur or two" to affirm its position among the most important museums of the world.[34] But there were other reasons why dinosaurs were attractive objects to acquire for such an institution. Firstly, they fit in perfectly with Carnegie's idea of nature as a cutthroat, competitive surrounding, "red in tooth and claw," in which obsolete forms, however powerful, fell victim to extinction once they failed to adapt to the circumstances. As such, it served as a warning from nature, but also as a form of self-affirmation: after all, the richest man in the world, who obtained that wealth by outperforming his competitors, could thus be considered the most successful human.

Additionally, dinosaurs could be regarded as something akin to a monument of nature. While Europe possessed a cultural legacy expressed in buildings, literature, and art, the United States could boast its own richness in the shape of its nature. The vastness of the prairies and the Grand Canyon, the monumentality of the Rockies and the "Wilderness Cathedral" of the Sierra Nevada—all of these illustrated what was unique about the new country: a scale of nature unknown to Europeans, which seemed to make up for its cultural barrenness.[35] Since the European discovery of the New World writers extolled its breathtaking nature. It translated into unique forms of culture, literature, and painting that used these uniquely American sceneries as their backdrops and, sometimes, their actor. The western, a literary and theatrical genre that made its appearance in the late nineteenth century, combined the vastness of the plains with a mythical assemblage of stereotypes, each of which was shaped by its surroundings: the frontiersman, the cowboy, the outlaw, and so on. Eventually, the fossil digger would become one of them, a trope deftly exploited by museums in search of a heroic backstory to their exhibits.

Aimed at attracting a wide audience, Holland's museum needed to put together a collection that was both scientifically significant and appealed to a broad audience. To do so would demand patience, inventiveness, and a perpetual call on Andrew Carnegie's well-filled coffers. But compared to its sister institutions, it was not a particularly expensive museum, with an annual budget of around $33,000 by the turn of the century—compared to $213,000 for the American Museum of Natural History (AMNH), $120,000 for the Field Columbian Museum in Chicago, and a massive $322,000 for the Smithsonian.[36] And in the wider framework of Carnegie's philanthropic empire, it did not take a very prominent place either, if one looks at the cost.[37] But it is fair to say that its significance as a representation of Carnegie's ambitions was much greater than its financial share.

As a museum director, Holland could be opinionated, stubborn, imperious and overbearing. He ran a tightly organized museum and allowed few people, aside from Carnegie and his cohorts, to influence museum decisions. In combination with a well-developed sense for social hierarchy, this creates the image of a somewhat lonely figure. Although still on friendly terms with Carnegie, he couldn't be a true friend any longer as his employee. The two still addressed

Fig. 1.5 • William J. Holland (*sitting in the foreground, facing right*) in the Carnegie Museum's Taxidermy Lab, around 1906. Copyright Carnegie Institute, Carnegie Museum of Natural History.

one another with their honorary university titles: "Lord Rector" for Carnegie, "Lord Chancellor" for Holland. But there was no misunderstanding about who owed what to whom, and Holland sometimes displayed an almost painful deference.

It is easy to dislike Holland, or to poke fun at him, as some have done.[38] He could be unreasonably imperious to his underlings while demonstrating the most craven sycophancy toward his employer, and he clearly took the credit for some of the work done by others. Although it is not always easy to distinguish between journalists' fabrications and those of others, Holland's claims of having personally discovered the first *Diplodocus* remains in 1899, and the frequency with which they recur, make it unlikely that he played no part in the perpetuation of this fabrication. He possessed a sharp tongue and an even sharper pen, and his excitable temperament more than once led to confrontations with others. In some cases, such as with

his fieldworkers Jacob Wortman or Olof Peterson, he showed little consideration for his employees' ambitions or feelings, treating them more like abstract beings than persons.

The other side of the coin is that despite appearances Holland was a very able administrator and organizer. He might have been responsible for Wortman's exit from paleontology, and his tone might have left something to be desired, but Wortman was not an easy man to get along with and at least partly forced his dismissal upon himself. When an employee showed loyalty and ability—in that order—Holland could be generous, even flowing with praise: his attitude toward his chief preparator and longtime assistant, Arthur Coggeshall, is a case in point. And even his subservience toward Carnegie knew its limits. When Carnegie suggested giving away the original of *Diplodocus* to Argentina in 1911, it earned him a stern "No Sirree!" from his director.[39] Holland saw himself as the main—and possibly *only*—representative of the museum and the defender of its interests, and was genuinely committed to its well-being. He also functioned as its spokesperson, and developed an easy relation with the press.

Holland's attitude toward his employees may look overbearing and patronizing to modern eyes, but it was not at all uncommon in science around 1900 and some time thereafter. If anything, it represented a marked improvement compared to the time of the "bone wars" of some two decades earlier. His fieldworkers lost some autonomy, but they were at least paid properly and promptly. That they were was to a large extent thanks to Holland's financial vigilance. Furthermore, he was no fool in spite of his occasional pomposity. He spoke several languages, built up a respectable fortune through sensible investments, and was a competent painter in his rare spare time. Assessing his ability as a scientist is harder. His prime interest was in entomology, particularly lepidoptery. *The Butterfly Book*, published in 1898, turned out to be a highly successful work, and it demonstrates a genuine love for the subject.[40] On his travels, Holland would always look for butterflies and attempt to collect some specimens for his—and the Carnegie Museum's—collection. In addition, if he had the opportunity he would try to visit entomological collections and congresses. Vertebrate paleontology was far more of an acquired taste. Having trained himself as an entomologist, he had to acquaint himself with paleontology at a later age, and made a reasonably good

job of it. He had initially delegated the coordination and execution of paleontological expeditions to others, but in 1904 was forced to assume responsibility for that part of the museum work, too.

The only people for whom Holland never really developed a social script were his equals. He could be uncertain when dealing with the likes of New York's Henry Fairfield Osborn, Paris's Marcellin Boule or London's Ray Lankester: people his equal in social standing, but his unquestionable superiors as scientists. When Holland was called out on his scientific achievements he also showed himself at his most defensive; in such a situation, the Carnegie Museum director turned out to be a formidable opponent, as we shall see.

Finding a Dinosaur for Pittsburgh

The acquisition of specimens for the Carnegie Museum suitable for illustrating natural history and evolution required an active collection policy, both through purchasing objects and sending out field expeditions. When he received Carnegie's telegram urging him to find a dinosaur of respectable proportions, Holland had just been made responsible for realizing a multitude of ambitions without possessing much of a collection that might help him do so. Holland immediately arranged a meeting with William Harlow Reed, the prospector who had found the colossal thighbone featured in the newspaper article when he was excavating in Wyoming for the American Museum.[41] Holland and Reed struck up an agreement that involved Reed prospecting in Wyoming with two new employees of the Carnegie Museum who had also worked at the American Museum, Jacob L. Wortman and Arthur Sterry Coggeshall.

Soon Reed and the others ran into trouble. The similarly independent-minded and irascible Reed and Wortman got along at first, but after a while ruptures appeared in their relationship. The first real crisis of faith ensued when Reed had to confess that there was no "Most colossal animal ever," as had been trumpeted by the *New York Journal and Advertiser*; all he had found was a single thighbone. Wortman came to regard Reed as incompetent, while Reed resented more and more no longer having the freedom he had enjoyed under previous employers, such as Yale's O. C. Marsh. Having been active as a collector and excavator since the 1870s, Reed had grown accus-

tomed to a fairly large degree of autonomy despite having little to show in the way of academic training or recognition. However, by the beginning of the new century he saw his role reduced to that of an expendable hired hand, under orders from museum-appointed supervisors who could not always command his respect. This caused all sorts of problems and quickly led to a deterioration of his relations to the museum, ending up with his dismissal.[42]

Much had changed for fieldworkers and paleontologists since the days of the bone wars. Contrary to the first "fossil rush" of the 1870s, 1880s, and 1890s, the reorganization of paleontology led to a new, much more rigidly stratified world. In earlier periods, being in the field and away from civilization so much of the time removed a great deal of social division. In the end, everyone on an expedition had to make themselves useful: the parameters for defining social strata may still have been present, but the criteria were very different in the field. Certainly, scientists such as Cope and Marsh could claim a uniquely elevated position, but below that things were much more evened out. When excavating or prospecting, uneducated workers such as Reed could confer on a more or less equal footing with doctorate holders such as Wortman because of their greater experience. Social differences were never totally erased, of course, but they could temporarily (which sometimes meant for long stretches of time) be ignored for the purpose of operating an efficient quarry. In the situation that gradually became the norm after about 1895, paleontology became less about the field and more about the museum than before, and an increase in funds and scale led to a more diversified distribution of tasks. An illustration of these changing social circumstances is the virtual disappearance of women. As the science of paleontology slowly (very slowly) professionalized, possibilities for women to become active participants initially diminished rather than increased.

More than anyone else, the American historian of science Paul Brinkman has explored this transition from a situation in which individual scientists called the shots to a world in which large, urban institutions set the parameters.[43] No longer were the excavators funding their own expeditions. Instead, a hierarchy came into being with the three main elements we see represented in Pittsburgh: a wealthy benefactor (Andrew Carnegie, John Pierpont Morgan, Marshall Field), an institution headed by a director whose prime duty was as

an administrator (William Jacob Holland, Henry Fairfield Osborn, Frederick Skiff), and at the lower end a multitude of professionals. To someone like Carnegie, funding a museum was fundamentally a public relations exercise. That meant that the modus operandi of earlier workers such as Edward Cope, who had hoarded tons of fossils away from public view because they were merely supposed to serve and support his research purposes, was no longer acceptable.

Museums such as the Carnegie Museum, the AMNH, and the Field Columbian Museum maintained an ambivalent attitude toward scientific research. As Lukas Rieppel's study of dinosaur displays at the AMNH in New York shows, they were not primarily intended as research venues but as a "means for bourgeois financiers, merchants, and industrialists to convert some of their considerable economic wealth into cultural capital."[44] But the value of that cultural capital was simultaneously determined by the aura of serious scientific research. In other words, they needed science to gain social acceptability and allow their benefactors to cash in on that cultural capital.

This restructured museum landscape also meant that a different kind of competition arose: rather than the clash of egos seen before, institutions engaged one another in an arms race of sorts, to impress the public with ever more impressive mounted dinosaurs. Casts of the now increasingly outdated and infamous Philadelphia *Hadrosaurus*, iguana head included, were still circulating, among others in Chicago's Field Columbian Museum. But as much larger remains were being unearthed, just putting up a copy of another institution's fossil became increasingly unsatisfying for these large, ambitious institutions. The first to act was the AMNH, where the hind limbs of various dinosaurs (including *Brontosaurus*, *Allosaurus*, and *Diplodocus*) were exhibited by the late 1890s.[45] This in turn provoked other museums to look for similar remains insofar as they did not possess them already.

And bigger was always better. As already noted, the culture of the Belle Époque is resplendent with the fascination for hugeness, be it skyscrapers, bridges, zeppelins, or ocean liners. Large size was equaled with modernity, with progress, and with importance. Nationalist competition became about who organized the most impressive expositions, owned the biggest guns, possessed the fastest and largest ships, and could show the most monumental constructions.[46] Covers of the popular science magazine *Scientific American* often

show comparisons of size, with technological novelties set against a background of recognized huge buildings such as the pyramids of Giza or the Cologne Cathedral. One of Carnegie's own moments of fame had been the completion of the Eads Bridge, which he had conceived of and financed, that crossed the Mississippi near Saint Louis—and he had not forgotten the impression this feat had left on public opinion.[47]

And Carnegie was soon to get his "most colossal" animal with which he could similarly awe the public. Despite tensions within the Carnegie Museum's field party, luck was on their side, and in the early days of July 1899 they struck gold. What they uncovered was a huge skeleton, partly weathered away but mostly intact. As they immediately realized, it was exactly the thing Carnegie had set his heart on.

Diplodocus carnegii

The first discovery of the dinosaur *Diplodocus* took place as one of the many results of the infamous fossil feud between Othniel Charles Marsh and Edward Drinker Cope. This battle determined much of the way in which paleontology would be conducted over the next half century—certainly in the United States. The fossil of what became the holotype of *Diplodocus longus* was discovered in 1877 by two of Marsh's associates, Benjamin Mudge and Samuel Wendell Williston. Mudge was an experienced geologist and paleontologist (and also a lawyer) from Kansas City, while Williston would go on to become one of the most important paleontologists of his generation. As usual in these circumstances, the material was sent to Yale so that Marsh might publish a description of the specimen.[48]

The year was filled with discoveries of dinosaurs, so it took Marsh some time to get to work on Mudge and Williston's material. He gave the animal the name *Diplodocus longus*, meaning "long double beam." The meaning of the generic name (that is, the name of the genus) is, unusually for Marsh, somewhat oblique; it refers to a pair of bony supports at the lower end of the animal's caudal (tail) vertebrae—*not* to two purported "beams" made up by the neck and the tail as has sometimes been supposed. This misunderstanding is understandable considering the animal's shape, and the specific (species) name *longus*, which obviously *does* refer to the length of the whole animal

and not the bony protrusions, does not make things clearer. The specimen that Marsh based his description on was anything but complete; in fact, he had little more than a tail to describe, which explains his choice for a name. Happily, however, those "beams" turned out to be an important diagnostic feature of the animal. This made it possible for Marsh to ascribe a second species to the genus *Diplodocus* in 1884. *Diplodocus lacustris* was based on remains from the Morrison formation of Colorado but, like the first specimen, this animal was also far from complete.[49]

Diplodocus was what has become defined as a sauropod ("lizard-foot") dinosaur. It adhered pretty much to the usual sauropod model: a large animal possessing a long neck, an even longer tail, massive hind legs and much shorter front legs (although some sauropods, such as *Brachiosaurus*, reversed that formula). Sauropods were the largest creatures ever to walk around on earth, sometimes measuring over thirty meters in length; modern estimates put their maximum body mass between forty and seventy metric tons.[50] What made *Diplodocus* somewhat exceptional was that it was very much elongated even by sauropod standards, with an exceptionally long tail, achieving up to twenty-eight meters (in the case of *Diplodocus carnegii*) in total body length. Compared to its relative *Brontosaurus* (or *Apatosaurus*, as it became known later) it was a relatively lightly built animal, and modern estimates usually put it at under twenty metric tons.

By the time the first Carnegie *Diplodocus* skeleton was unearthed in Wyoming, much was already known about these animals due to the work done by Marsh and his associates. Unfortunately, Marsh never found the time—or the inclination—to theorize much about sauropods. His description of *Brontosaurus*, published in 1883, was mostly an anatomical description. And although both *Brontosaurus* and *Diplodocus* were treated in the *Dinosaurs of America* (1896), that work consists mainly of engravings of the bones.[51] Although by no means unusual for the time, the general adoption of Marsh's reconstruction would later give rise to accusations of a "slavish," uncritical attitude on the part of American paleontologists—a somewhat unfair accusation, as we will see.

The specimen that Coggeshall, Reed, and Wortman found on July 2, 3, or 4, 1899, was more complete than most sauropods found up to that date.[52] The dead animal had not been disturbed, since

its skeleton remained mostly intact and the bones seemed to be in the same position as in life. The field party immediately notified Holland by telegram, who in turn informed Carnegie. Holland was quick to travel to the site, by now dubbed "Camp Carnegie"; a party from the AMNH, who worked close by at Como Bluff, also came to investigate the new find that summer, headed by Osborn himself. After a few months' work excavating the skeleton, it was shipped to Pittsburgh to undergo further preparation by Coggeshall and another preparator-*cum*-fieldworker, Olaf Peterson.

By that time Holland had lost his expedition leader. Fighting ostensibly over the taxonomic affinities of the new remains, Wortman had fallen out with Holland in early 1900, and the director had subsequently demanded his resignation.[53] Within nine days, he was replaced by John Bell Hatcher, arguably a more accomplished scientist and certainly a more able expedition leader than Wortman had been.[54] Like Reed, Hatcher had also been in the service of Marsh during the "old days" of American paleontology, but unlike him he did not find the transition problematic. Although never at ease with the bureaucrats in charge of the museum, he appreciated the opportunities that the new state of affairs offered. Part of his grievances against Marsh had been the impossibility to publish about his findings on his own. Born in a farming family in Illinois in 1861, he was of a strongly independent spirit, but much more conciliatory by nature than Wortman. When approached to leave Marsh's employ for the newly formed Department of Vertebrate Paleontology (DVP) at the AMNH in 1890, Hatcher failed to negotiate a contract, but three years later he managed to secure an appointment at Princeton and was responsible for three expeditions to find fossils in Patagonia. Eventually, this position also offered him too few opportunities to further develop as a scientific researcher. Despite being responsible for a large family and possessing few financial resources, he quit his job in November 1899, to be recruited fortuitously shortly after by Holland. During the next summer, Hatcher joined Coggeshall and Peterson, his brother-in-law, at Camp Carnegie.

Soon a second skeleton was found, slightly smaller than the first. However, a conflict over the ownership of the skeletons with the University of Wyoming in which Reed played a dubious role, and Reed's refusal to submit to Carnegie Museum hierarchy, led to his dismissal in June of 1900.[55] A third and fourth set of remains, one including the

hind portion of the all-important skull, was to follow in 1903, when William Utterback, another collector in the service of the Carnegie Museum, stumbled upon it in northern Wyoming. When Hatcher set about publishing the description of the new animal, he only had the first two skeletons at his disposal. By May 15, 1901, his description, the first of the Carnegie Museum's new series of publicized *Memoirs*, was ready to be printed.

Some ninety pages (including illustrations), Hatcher's monograph possessed the most extensive description by far of a sauropod published up to that point.[56] It was not, however, the first one. Two years previously Henry Fairfield Osborn, the director of the AMNH's Department of Vertebrate Paleontology, published a description of an incomplete specimen of *Diplodocus* (*longus*) that appears to have served as a template for Hatcher's work.[57] Osborn disagreed with Marsh about the length of the animal, putting it at approximately sixty feet (eighteen meters).[58] Osborn's monograph did not merely treat anatomy; he allowed for some speculation about the living animal, regarding it as an aquatic but "long-limbed and agile" dinosaur that used its tail for defense on land and for propulsion when immersed in water.

Hatcher had often vented his frustration at his lack of publishing opportunities, so a lot was at stake when he published his first major description. Furthermore, as the first volume of its *Memoirs*, the museum wanted it to be something of a showpiece, and made it possible to include a large number of (expensive) etched plates. The result was an excellent essay, which combined the Carnegie Museum's results with Osborn's earlier description, and remarked that: "Happily, . . . in the preserved and recovered remains of these various skeletons different parts of the frame are represented; so that by combining all, we are enabled to study the restored skeleton almost in its entirety, though still incomplete, in at least one important character, to wit, the fore feet." Because of this completeness, Hatcher was able to include a complete skeletal reconstruction of the animal with his description by making use of Osborn's and Marsh's work (for the skull).[59] The only real point of speculation concerned the hands of the animal: Hatcher assumed it to have had three claws on its middle "fingers." Like Osborn had done, Hatcher closed his monograph with a description of the animal's probable habits, and he largely agreed with Osborn, although he was less inclined to see the animal

Fig. 1.6 • John Bell Hatcher (*seated on table, right*) and staff at the Carnegie Museum vertebrate paleontology lab, probably early 1904. Carnegie Museum of Natural History, Big Bone Room, John Bell Hatcher Miscellaneous Items. Copyright Carnegie Institute, Carnegie Museum of Natural History.

as agile. He did, however, speculate upon the living environment of the animal, and imagined it as an inhabitant of shallow lakes, where it fed upon the "tender, succulent aquatic and semi-aquatic plants." But it needed inexhaustible amounts of it; the animals, Hatcher stated, would be "remarkably ill adapted for maintaining themselves amidst varying conditions."

Later that year, after a partial *Brontosaurus* had been brought in by the Carnegie crew, Hatcher revised his viewpoint slightly when he described that specimen's forelimbs. Contrary to what he had thought, the animal's inner toe appeared to be the only one bearing a claw, which led Hatcher to assume that *Diplodocus*'s supposed claws (still plural) were placed on its inside "fingers" (what is known as an

entaxonic arrangement). It was this arrangement that would eventually find its way into the Carnegie *Diplodocus*.

To his delight, Holland could report to Carnegie that Hatcher had decided to name the dinosaur *Diplodocus carnegii* in honor of their sponsor. Although Hatcher, as the descriptor, was formally responsible for the name, it is likely that his director had a hand in it. It was a calculated move to further commit their benefactor to supporting the museum and its expeditions: "We have called our Diplodocus Diplodocus carnegii, in honor of yourself. It is unmistakably different in some respects from the species called longus by Marsh. It is a bigger beast. The publication of this Memoir I think is going to make a sensation in the scientific world—at least among paleontologists. I am having a proof of the drawing of our restoration framed and shall forward it to you at Skibo."[60] Carnegie was thrilled. By the end of the summer, Carnegie's "namesake" was hanging on the wall of his Scottish castle.