THE AMERICAN INCOGNITUM

Given the profound challenges in interpreting fossil remains, it is easy to see why the discovery of large vertebrate bones in the New World would ignite such interest. Apparently, Native Americans began noticing, collecting, and trying to explain the meaning of fossils well before European contact.[50] In 1519, Cortes's conquistadors became the first Europeans to view fossil vertebrates in the Western Hemisphere when the defeated Tlascalan peoples of central Mexico surrendered the bones of what now appears to have been a mastodon. The Tlascalans believed the bones to be the remains of a giant race of humans that their ancestors had annihilated.[51]

Nearly two centuries later, in 1705, American colonists offered a similar explanation for a fist-sized tooth weighing about five pounds discovered near the Hudson River, not far from the frontier outpost of Albany.[52] While the root had badly decayed, its intact enamel vaguely resembled that of a human eyetooth. An assemblyman from Albany, who traded the farmer who found the tooth a half pint of rum for it, eventually presented the fossil to the governor of New York Province, who then dispatched it to the Royal Society of London, a prestigious scientific organization that had been founded nearly five decades earlier. Soon other large teeth and bones of the American incognitum began circulating throughout New York and New England. After viewing the curious remains, the Boston clergyman and scholar Cotton Mather argued that they provided scientific confirmation for the accounts of antediluvian human giants found in the Bible. Mather, a corresponding member of the Royal Society, took particular pride in the fact that the bones of this giant had been unearthed in America. The nationalistic sentiment associated with remains of the American incognitum long continued to shape discussions about the mysterious beast, and the Hudson River valley became one of two major North American sites that would yield large quantities of these bones.[53]

The other particularly productive site was along the banks of the Ohio, in an area that became known as Big Bone Lick, Kentucky.[54] In 1739, Charles LeMoyne, baron de Longueuil, led a French military expedition from Montreal to map the region. After a group of Indian scouts stumbled onto several gigantic bones, Longueuil and his men returned to the area to gather numerous specimens, which they shipped to the Jardin du Roi in Paris.[55] Nearly three decades later (1765), the Indian trader George Croghan ventured to the site and found a "vast quantity of bones," including two six-foot-long tusks that his men loaded onto one of their flatboats.[56] This first set of bones was lost when Indians attacked the party; though struck in the head, Croghan survived and, undaunted, returned to the

FIGURE 2. Mastodon molar from the collection of Thomas Jefferson. Following their initial discovery in North America during the early eighteenth century, fossil remains like this one not only ignited much interest but also much speculation about their origin. Courtesy of the Academy of Natural Sciences, Philadelphia.

area a year later. This time he managed to collect hundreds of pounds of bones, which he shipped to Benjamin Franklin and Lord Shelbourne in London.

As collections of American incognitum bones mounted, so did speculation about their meaning. From exactly what kind of beast did these fossils originate? In his *Natural History of Carolina, Florida and the Bahama Islands* (1731–43), the British artist and naturalist Mark Catesby made passing reference to the discovery of "three of four Teeth of a large Animal" that slaves had uncovered in Biggin Swamp, near Charleston, South Carolina. Ironically, these slaves recognized the resemblance between the molars they had dug up and those of the African elephant, with which they were already familiar, thus providing what the twentieth-century paleontologist George Gaylord Simpson has deemed "the first technical identification of an American fossil vertebrate."[57] In the 1750s and 1760s, Buffon and his anatomist, Louis Jean-Marie Daubenton, compared the bones of the American incognitum that Longueuil had excavated from the Kentucky salt lick with a number of seemingly related species.[58] Those included the living elephant and the mammoth, another large elephant-like creature whose remains had been discovered in Siberia beginning in the early eighteenth century and whose identity was often confused with the fossil elephants of North America.[59] Based on his examination, Daubenton argued that all fossil and living elephants belonged to the same species; to explain the decidedly un-elephant-like teeth found with the remains at Big Bone Lick, he suggested that somehow the teeth of a large hippopotamus had been inadvertently mixed with the femurs and tusks of the Ohio valley specimens. Initially, in his discussion of carnivores in an earlier volume of *Histoire naturelle*, Buffon had suggested that the natural world

contained competing species that might drive one another to extinction, and he listed the mammoth as one of the species that could have been lost by this means. But several years later, at the end of his volume devoted to elephants, Buffon accepted Daubenton's conclusions while denying that the Siberian and American creatures were either larger than elephants or extinct. To address the issue of how such creatures—which now only lived in the tropics—had survived in a much colder climate, Buffon later postulated the idea that the earth had been created when a comet struck the sun. As the earth gradually cooled, these now tropical species had migrated from the poles.

Other naturalists reached different conclusions about the nature of this puzzling creature. In an important essay published by the Royal Society in 1769, the British physician and anatomist William Hunter declared that the "American *incognitum*" was "some carnivorous animal, larger than an elephant."[60] Hunter also argued that the Siberian mammoth and the American incognitum were probably the same species. He based his conclusions on an examination of fossil remains in the Tower of London, Kentucky specimens from the Shelbourne and Franklin collections, jaws of the living elephant belonging to his younger brother (John Hunter), and elephant tusks in the warehouses of London ivory dealers. Since grinders resembling those of the incognitum had been dug up in various other locations, Hunter suggested that the beast had at one time been "a general inhabitant of the globe." He concluded his essay with an expression of relief that the species was now apparently lost: "And if this animal was indeed carnivorous, which I believe cannot be doubted, though we may as philosophers regret it, as men we cannot but thank Heaven that its whole generation is *probably* extinct."[61] In an age that continued to venerate providential natural history, Hunter understood that his opinion would be controversial, and he seems to have been quite cautious here in his choice of words.

The British naturalist Thomas Pennant's opinion proved more acceptable at the time: "Providence maintains and continues every created species, and we have as much assurance, that no race of animals will any more cease while the Earth remaineth, than seed time and harvest, cold and heat, summer and winter, day and night." In his *Synopsis of Quadrupeds*, published only two years after Hunter's essay, Pennant argued that what he called the "American elephant" must still be alive "in some of the vast new continent, unpenetrated yet by Europeans."[62] Clearly, Jefferson was not alone in his belief that the American incognitum must still roam the earth.

Before the mystery of the American incognitum could be definitively solved, a second fossil incognitum came to light. In the spring of 1796, Jefferson received a letter from a friend in western Virginia, Colonel John Stuart. Laborers digging

for saltpeter in a cave near his home in Greenbrier County had found a small collection of bones that Stuart thought might interest the man who was soon to be elected vice president.[63] Jefferson thanked Stuart for the specimens and requested any additional fossils from the site he might find. He was especially interested in obtaining a thighbone of the creature, which would help him estimate its overall size. During this exchange, Jefferson reiterated his views about the implausibility of extinction: "I cannot however help believing that this animal as well as the Mammoth are still existing. The annihilation of any species is so unexampled in any parts of the economy of nature which we see, that we have a right to conclude, as to the parts we do not see, that the probabilities against such annihilation are stronger than those for it."[64]

Extinct or not, Jefferson not only believed the creature was new to science but also that it would provide another opportunity to refute Buffon's "pretended degeneracy of animal nature in our continent."[65] He informed David Rittenhouse, the president of the American Philosophical Society, of his intent to write up a formal description of the beast, which he thought belonged to the "family of the lion, tyger, panther, &c. but as preeminent over the lion in size as the Mammoth is over the elephant."[66] After announcing his plans regarding what he began referring to as the "American lion," Jefferson gained election to the vice presidency of the United States and, following the death of Rittenhouse, presidency of the American Philosophical Society. He assumed the first office only reluctantly; the latter he called "the most flattering incident of my life."[67] Accompanying him on his trip from Monticello to Philadelphia were a box of fossils from Greenbrier County and a completed draft of his manuscript.

On March 10, 1797, the secretary of the American Philosophical Society read Jefferson's paper at a meeting over which he presided. Jefferson had written the first draft with the intent of announcing to the world that he had discovered a giant American lion or tiger. But sometime between the society's meeting and his arrival in Philadelphia a week earlier, he had stumbled upon a copy of a recent issue of *Monthly Magazine,* a British publication containing an abstracted description and a crude engraving of a previously unknown quadruped that had been dubbed the *Megatherium* or "huge beast."[68] The author of the original paper on which this abstract was based was Georges Cuvier, who named and described this clawed fossil creature based solely on an engraving of what was probably the first nearly intact fossil skeleton ever assembled.[69] The bones for the skeleton of the megatherium had been discovered in Buenos Aires, then part of Spanish South America, shipped back to Madrid, and reconstructed by Juan Bautista Bru, a conservator at the Royal Museum. A French official traveling through the area obtained a proof engraving of Bru's fossil skeleton and then passed it on to

Cuvier. Much to Jefferson's disappointment, Cuvier's megatherium seemed to strongly resemble his "American lion," and the self-assured French naturalist had placed it in the family of sloths and anteaters. Based on this newly gained knowledge, Jefferson scrambled to revise his paper. Where he had once unhesitatingly classified the creature with "the lion, tyger, panther, &c.," he now spoke of it more generically as an animal "of the clawed kind" and named it *Megalonyx* (or "great claw").[70] In a postscript, Jefferson noted similarities between his megalonyx and Cuvier's megatherium, while admitting that the former was probably not carnivorous. Yet, he continued to make repeated comparisons between the megalonyx and the lion throughout his paper, even writing that "if the bones of the megalonyx be ascribed to the lion, they must certainly have been of a lion of more than three times the volume of the African."[71] Ironically, filed away among his papers and forgotten, Jefferson owned a drawing of the megatherium skeleton, in Bru's own hand, which had been sent from Madrid in 1789.

But what had become of the megalonyx? As he had done earlier with the American incognitum in *Notes on the State of Virginia*, Jefferson pursued two (related) lines of argument to deny that it was extinct. First, he claimed the creature might still live in the unexplored portions of the continent: "In the present interior of our continent there is surely space and range enough for elephants and lions, if in that climate they could subsist; and for mammoths and megalonyxes who may subsist there. Our entire ignorance of the immense country to the West and North-West, and of its contents, does not authorise us to say what it does not contain."[72] Second, he resorted to the philosophical ideas of the great chain of being and the economy of nature to explain why it must still survive:

> In fine, the bones exist: therefore the animal has existed. The movements of nature are in a never ending circle. The animal species which has once been put into a train of motion, is still probably moving in that train. For if one link in nature's chain might be lost, another and another might be lost, till this whole system of things should evanish by piece-meal; a conclusion not warranted by the local disappearance of one or two species of animals, and opposed by thousands and thousands of instances of the renovating power constantly exercised by nature for the reproduction of all her subjects, animal, vegetable or mineral.[73]

Indeed, Jefferson continued, according to commonly accepted notions of the "economy of nature," it was quite reasonable to expect that a large beast like the megalonyx would be "the rarest of animals": "If lions and tygers multiplied as rabbits do, or eagles as pigeons, all other animal nature would have been long ago destroyed, and themselves would have ultimately extinguished after eating out their pasture."[74]

Several months after Jefferson presented his megalonyx research, the Philadelphia judge George Turner offered a contentious paper on the American incognitum to the American Philosophical Society. Turner argued that there was not one incognitum, as had previously been assumed, but actually two incognita, both of which had been mistakenly lumped together under the name "mammoth." Both were creatures about the size of an elephant, with wide and at least partially coextensive geographic ranges, but one had teeth suggesting it was herbivorous and the other was apparently carnivorous or mixed. Moreover, their large size and once-extensive ranges convinced him that both were now extinct: "I have no hesitation in believing, that they belonged to some link in the chain of animal creation, which . . . has long been lost."[75] Noting the recent discovery of Jefferson's megalonyx, Cuvier's megatherium, and various skeletons of the mammoth found in Europe, Asia, and America, Turner argued that there were likely to be additional large creatures discovered in the future. It was difficult for him believe that "so many and such stupendous creatures could exist for centuries and be concealed from the prying eye of inquisitive man."[76] He discounted a belief in the chain of being or the oral traditions of Indians as sufficient grounds for insisting that these creatures must still survive somewhere. Turner supposed that the carnivorous American incognitum was a powerful beast that could spring a great distance to capture its prey: "With the agility and ferocity of the tiger; with a body of unequalled magnitude and strength, it is possible the Mammoth may have been at once the terror of the forest and of man!—And may not the human race have made the extirpation of this terrific disturber a common cause?"[77] As naturalists began to accept the idea of extinction in the early nineteenth century, the idea of predation by humans would be one of several theories that they used to explain how and why that species loss may have occurred.

NATIONALISM, NATURE, AND THE EXHUMATION OF THE MASTODON

During the revolution and the early years of the young republic, nationalism became an increasingly important lens through which Americans saw the natural world. When it came to thinking about the American landscape—its flora, fauna, and geography—there were various, and sometimes conflicting, ways in how this nationalistic sentiment played itself out.[78] On the one hand, European settlers in the New World had long viewed themselves as a chosen people with a calling to bring the light of civilization to the dark wilderness of the North American continent. That imperative was both moral and economic. Colonists felt they had a God-given mandate to make the wilderness economically pro-

ductive, to transform an evil wasteland into a profitable enterprise. At the same time, as Jefferson's *Notes on the State of Virginia* suggests, by the end of the eighteenth century Americans also began to take pride in some of the wild features of that landscape, especially its sublime scenery and unique plants and animals. Soon they began arguing that America's wilderness was an important legacy that compensated for the young nation's lack of cultural heritage. In either case—whether the American landscape was something to be commodified, cherished, or both—the practice of natural history, the creation of a systematic inventory of the continent's natural riches, increasingly came to be viewed as a patriotic duty.[79] It was in this context that the American incognitum—believed to be the largest beast ever to roam the earth—became a widespread source of fascination and pride. As the historian Paul Semonin has argued, during the American Revolution "the bones began to take their place in the nation's public culture, celebrated in American literature and displayed in the nation's first national history museums."[80]

Charles Willson Peale's museum, in the capital city of Philadelphia, proved central to securing the incognitum's central place in American culture.[81] The museum has its origins in an episode that occurred late in the war, when George Washington authorized Christian Friedrich Michaelis, the physician-general to the Hessian mercenaries serving the British, to search for fossil bones on a farm in the Hudson River valley. Washington was quite familiar with the site in Orange County, seventy miles north of New York City, from a visit he had made in 1780 to view the large fossil grinders that workers had found there while draining a shallow swamp. Although Washington provided Michaelis with a dozen men, tools, and wagons, heavy rains thwarted efforts to excavate any more teeth or bones. Michaelis had to settle for a few specimens the site's owner gave him. When he returned to Philadelphia, Michaelis examined a collection of bones owned by Dr. John Morgan, whose brother had accompanied George Crohgan to Big Bone Lick nearly two decades earlier. Michaelis commissioned Peale, a well-known portrait painter, to make drawings of these Kentucky specimens. The enthusiasm the large bones generated among visitors to his studio set Peale to seriously thinking about creating a natural history museum to accompany his portrait gallery.

In 1786, three years after he completed the set of drawings for Michaelis, Peale began soliciting specimens for "a Repository for Natural Curiosities" that he hoped to append to his portrait gallery and home.[82] After several failed experiments, Peale perfected the technique of taxidermy, and he placed his stuffed animals in glass-fronted cases with painted landscape backgrounds, thus creating some of the first habitat groups that would later become standard in natural his-

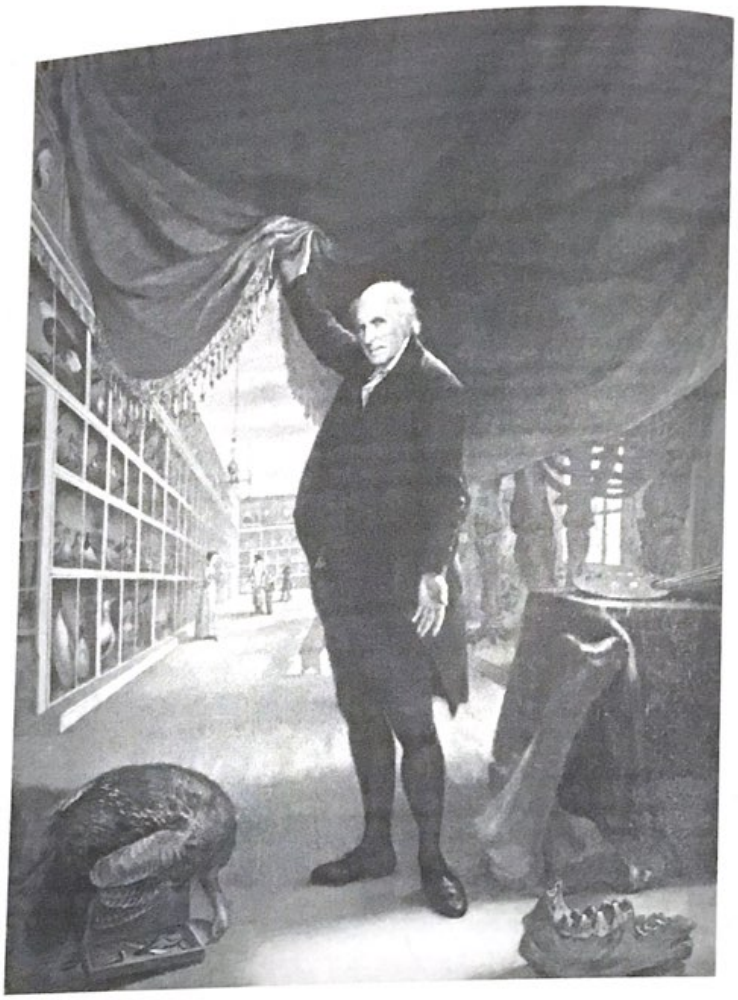

FIGURE 3. Charles Willson Peale, *The Artist in His Museum*, 1822. In this self-portrait, painted near then end of his career, Peale lifts a curtain to reveal his famed natural history museum, which featured a reconstruction of the mastodon as its centerpiece. Courtesy of the Pennsylvania Academy of Fine Arts, Philadelphia, Gift of Mrs. Sarah Harrison (The Joseph Harrison, Jr. Collection), accession no. 1878.1.2.

tory museums. Shells, minerals, fossils, live specimens, and portraits of famous Americans rounded out the growing collection. Within a few years, Peale was referring to the enterprise as the "American Museum," a name that was not only befitting the nationalistic impulses that informed the institution but also his long-standing (though ultimately unsuccessful) attempts to gain public funding to support it. Cramped for space, in 1794 he moved to larger quarters in the American Philosophical Society, the first and most prestigious scientific organization in the United States, which he had been invited to join eight years earlier. With endorsements from Jefferson and other key political leaders, eventually Peale's

museum would become the repository for the specimens found on western exploring expeditions and an important source for a series of American natural history publications.

At about this same time, calls for an intact skeleton of the American incognitum grew more frequent. Near the end of his memoir, for example, Turner pointed out that whoever achieved this goal would "render,—not to his country alone, but to the world,—a most valuable present."[83] Turner was a member of an American Philosophical Society committee that sent out a printed circular requesting information on American antiquities in 1799. A special object of the committee's appeal was "one of more skeletons of the Mammoth, so called, and of such other such unknown animals as either have been, or hereafter may be discovered in America."[84] The committee, which also included Jefferson, Peale, and the Philadelphia anatomist Casper Wistar, suggested that Big Bone Lick was the place where fossil searchers were most likely to meet with success. That same year, however, workmen digging for marl to manure fields in Orange County, New York, uncovered a thighbone that was nearly four feet long and eighteen inches in diameter. When a minister and several physicians convinced the owner of the farm where the marl pit was located, John Masten, that the bones might be worth saving, he invited nearby residents to help him dig for more. A boisterous crowd of a hundred or so people managed to retrieve numerous additional bones, many of which were carelessly broken in the process, before being forced to stop by water oozing into the pit.

When Charles Willson Peale read about the discovery in 1801, he wasted little time in making preparations to visit the Masten farm.[85] If he could recover a complete skeleton of the American incognitum, not only would he help solve a compelling scientific mystery, but he would also bring fame and a steady stream of paying customers to his perennially cash-strapped museum. When he arrived at the site, he found the huge dark bones laid out in Masten's granary, where the farmer charged a small entrance fee for the privilege of viewing them. Anxious not to drive up the asking price, Peale pretended to be interested only in making life-sized drawings of the bones. During dinner later that day, Masten's son asked Peale if might be interested in purchasing them. The next morning Peale offered $200 for the specimens thus far recovered and $100 for the right to search for more on his property. Masten requested several additional items—a new double-barreled shotgun for his son and gowns from New York for his daughters—before agreeing to the deal. After packing up his prized specimens, Peale returned to Philadelphia to begin making arrangements for further excavations.

Peale recognized that retrieving additional bones from Masten's water-soaked marl pit would prove difficult, time consuming, and costly. But, if he managed to

recover a complete skeleton, the scientific and financial payoffs would be great. He proudly displayed the Masten specimens at the American Philosophical Society and sought a $500 loan to finance an expedition to recover more. His letter requesting the loan appealed to the members' nationalism by pointing out that "foreigners . . . have hitherto deprived us of numerous collections of bones from every spot where they have been found."[86] He also requested federal aid from Jefferson, now president of the United States, in the form of a water pump from the navy and tents from the army. In his reply, Jefferson congratulated Peale on his find as well as his efforts to recover additional specimens of "these great animal monuments."[87]

Peale returned to Newburg, New York, in July 1801. After sizing up the land around Masten's farm, he contrived an ingenious device for removing the water that constantly streamed into the bone-encrusted marl pit. Rather than relying on inefficient hand pumps, he would erect a large human-powered mill wheel. A series of buckets attached to this wheel could lift the water to a wooden trough, which would then drain it off to the other side of a small hill. Peale hired a wheelwright and a carpenter to build the device, which he estimated could move more than a thousand gallons of water per hour. He then recruited volunteers from the large crowd that had gathered around the site to power the wheel and hired twenty-five local laborers to dig for bones. Despite nagging problems with water intrusion and collapses in the pit's muddy banks, Peale managed to retrieve most of the bones and parts of the tusk he was still missing but found no underjaw and only parts of the skull. He commemorated this triumph in one of his most famous paintings, *The Exhumation of the Mastodon*, completed five years later.[88]

Anxious to locate the bones still needed for a complete skeletal reconstruction, Peale also searched several nearby sites where bones of the American incognitum had previously been found. To aid in the hunt, his son Rembrandt designed a special device—a long slender steel rod with a wooden handle—that could locate hard underground objects. Using Rembrandt's invention, the expedition party recovered numerous additional bones, including the much-desired lower jaw. In all, Peale estimated they had recovered enough bones for two nearly complete skeletons.

With help from Wistar and others, Peale used a laborious process of trial and error to fit together the bones, many of which were badly broken, into a nearly complete skeleton. With an elephant's skull for a guide, he shaped the missing portion of the skull out of papier-mâché, marking the area with a horizontal red line to indicate that it was conjectural. When completed, the Masten skeleton, which took up most of the Peale family parlor, stood eleven feet high at the shoulder and measured seventeen feet, six inches long from its tusk to its tail,

FIGURE 4. Charles Willson Peale, *The Exhumation of the Mastodon*, 1806. In this, one of his most famous paintings, Peale celebrates his success in excavating a nearly complete mastodon skeleton from a marl pit in the Hudson River valley. Courtesy of the Maryland Historical Society.

quite a bit larger than the estimate of paleontologists today.[89] With nearly $2,000 in debts and his own money tied up in the skeleton, Peale was anxious to recoup his investment. On December 24, 1801, just over three months after he returned from New York, he invited members of the American Philosophical Society to a special viewing of the skeleton. Soon after this premier, he opened the special "Mammoth Room" located on the southwest corner of his museum, charging an admission fee of fifty cents for the privilege of gazing at the beast. A handbill promoted the reconstruction as the "ANTIQUE WONDER" and the "LARGEST of Terrestrial Beings!"[90]

The public flocked to the exhibit, the second fossil reconstruction ever completed. Beyond its continuing popularity, however, we have little sense of how viewers responded to Peale's skeleton. One wag, a British tourist, commented on seeing it: "Perhaps we ought to imagine Noah found it too large and troublesome to put in the ark, and therefore left the poor animal to perish."[91] We do know that the beast, which had long been of interest to naturalists and scholars, now seemed to capture the public's imagination as well, and the term "mammoth"

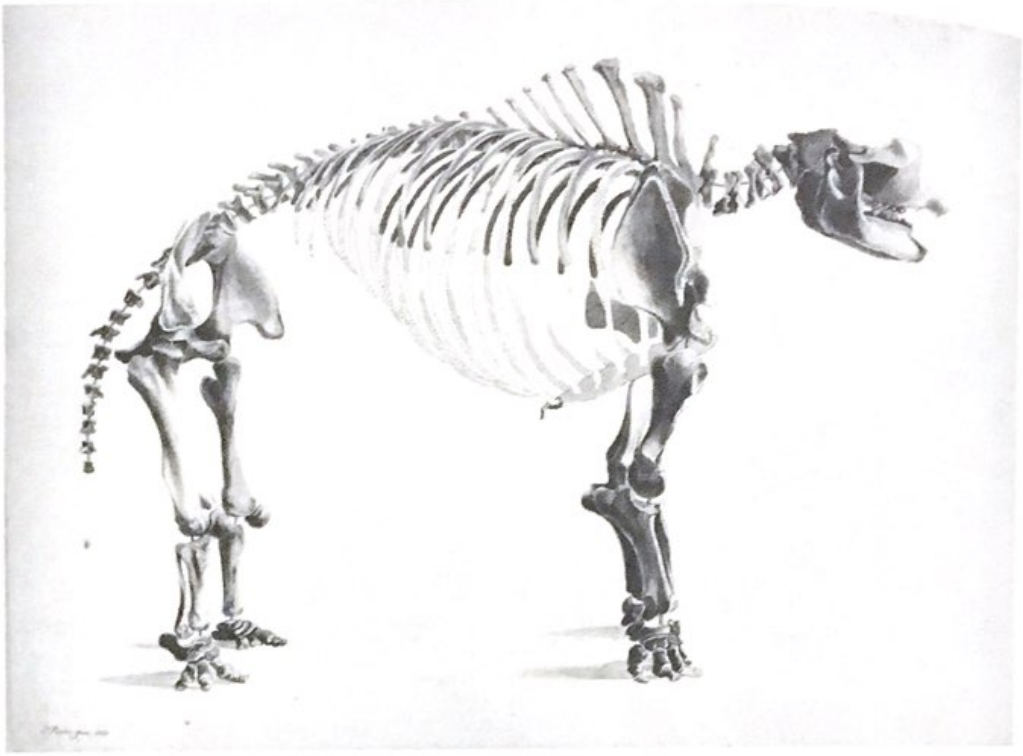

FIGURE 5. Titian Ramsay Peale sketch of Peale's mastodon, 1821. This reconstruction, which Charles Willson Peale completed with the help of the anatomist Casper Wistar, proved a huge hit with visitors to Peale's museum. Courtesy of the American Philosophical Society.

quickly entered into common usage to describe nearly any oversized item.[92] We also know that within a year, Peale was able to show a healthy $2,000 profit for his considerable efforts in locating and reconstructing the creature. As with other examples of wild America, Peale's cherished bones had turned out to be an exceedingly valuable commodity.

Hoping to capitalize on the interest in the beast abroad, Rembrandt and his brother Rubens took the second skeleton on a European tour. To promote the exhibit, Rembrandt authored a lengthy pamphlet entitled *Historical Disquisition on the Mammoth, or Great American Incognitum*. There he detailed how a "perfect skeleton of the "MAMMOTH—the first of American animals" had been unearthed, reconstructed, and displayed "in the first of the American Museums."[93] He also provided a history of various theories attempting to explain what kind of creature it was. Like most of his colleagues, the older Peale remained firmly committed to the idea of the chain of being and therefore reluctant to accept the idea of extinction. His son, however, suffered fewer qualms, declaring in a phrase that clearly echoed Jefferson's recent denial of extinction "the bones exist—the animals do not!"[94] Like Hunter had done earlier, Rembrandt Peale concluded

that the American incognitum was a carnivorous beast that was now utterly lost. The elder Peale placed a copy of this pamphlet in a series of gilded frames that he hung in the Mammoth Room at the museum. Alongside the pamphlet, he also hung a copy of his painting commemorating the discovery of the beast, this glorious symbol of nationalism and one of his most enduring legacies.

CUVIER, COMPARATIVE ANATOMY, AND THE REALITY OF EXTINCTION

Prior to the departure of the Lewis and Clark expedition, Jefferson wrote to his friend, the French naturalist Bernard Lacépède, that he hoped the intrepid explorers might find a "living mammoth and megatherium" still roaming in the West.[95] Jefferson was disappointed that the expedition failed to locate either beast. Lewis did, however, view numerous fossil bones of the American incognitum in Cincinnati, on his way to meet Clark in 1803, including the upper portion of the skull that was missing from Peale's reconstruction. These remains belonged to Dr. William Goforth, who had obtained them from Big Bone Lick. The following year Goforth sent his collection to Pittsburgh, hoping that he could get it transported to Philadelphia and interest either Peale or the American Philosophical Society in buying it, but his agent sold it in London and absconded with the money. In 1807, one year after the return of the Corps of Discovery, Jefferson commissioned William Clark to venture to Big Bone Lick to recover additional fossil bones. With the help of ten hired laborers working for several weeks, Clark discovered a large collection of specimens that he dispatched to Washington. Jefferson spread the bones out in a large unused room in the east wing of the White House and invited Caspar Wistar to help him sort them. He sent one set to Peale, to complete his skeleton, kept a set of duplicates for himself, and sent the bulk to the National Institute in France, where Cuvier had been issuing a series of pioneering publications in comparative anatomy that authoritatively identified the American incognitum and established the reality of natural extinction.

Georges Cuvier had been born in Montbéliard, Würtenberg, an area that while linguistically French was also steeped in German cultural traditions.[96] As a child he stumbled upon a copy of Buffon's *Histoire naturelle* that belonged to his uncle. He read it avidly, spent many hours copying its figures, and developed a keen interest in collecting natural history specimens. At the Stuttgart Academy, Cuvier attended the lecturers of Friedrich Kielmeyer, who became his close friend and taught him the basics of comparative anatomy. During this period, German scholars were developing a new historicist perspective that portrayed the world neither as static nor progressing, but as constantly unfolding.[97]

According to this emerging view, geological strata might be conceived as the "archive" of the planet's unfolding. Rather than being hostile to the notion of extinction, this view tolerated, even embraced the idea of radical change that the permanent loss of species implied.

One of the principle proponents of these ideas was the comparative anatomist J. F. Blumenbach, who taught Kielmeyer and a raft of other influential students at the University of Göttingen. Blumenbach developed a philosophy of nature that portrayed fossils as monuments of past geological ages, and he became a towering figure in the development of paleontology, a role for which has only begun to be appreciated by modern historians. Unlike many of his contemporaries in France, England, and the United States, Blumenbach rejected the notion of the chain of being and the economy of nature. "Nature," he once wrote, "will not go to pieces if one species of creature dies out, or another is newly created,—and it is more than merely probable, that both cases have happened before now,—and all this without the slightest danger to order, either in the physical or the moral world, or for religion in general."[98]

Cuvier adopted Blumenbach's ideas and elaborated them into a highly productive research program. Confident to the point of being cocky, he arrived in Paris in 1795 and shortly afterward gained appointment as an assistant in animal anatomy at the newly reformed National Museum of Natural History, one of the world's premier scientific institutions. With interaction with brilliant colleagues, access to a constantly growing specimen collection, and regular dissections of deceased animals from the museum zoo, Cuvier quickly rose to prominence as a first-rate comparative anatomist. His deep, firsthand knowledge of the structure and function of living vertebrates would prove key to the success of his fossil reconstructions.[99] Based on a belief in the "correlation of parts"—the interdependence of an organism's organs and systems—Cuvier felt confident making educated guesses about the overall structure of a given animal even when he had precious little empirical evidence to guide him. He also developed the idea of "subordination of parts" to identify key structures that were most helpful in classifying organisms. He had just begun his anatomical studies in earnest when he received an unpublished engraving of Bru's reconstruction of a fossil beast from Paraguay. As we have already seen, he dubbed this animal the "megatherium," classified it as a kind of giant sloth, and declared that it was probably extinct since no living example was known.

Cuvier realized that he was now in the position to provide definitive proof of the reality of extinction. With each passing year, he thought it less and less likely that any large new mammal—especially one the size of an elephant, hippopotamus, or rhinoceros—would be discovered still roaming the earth.[100] If he used

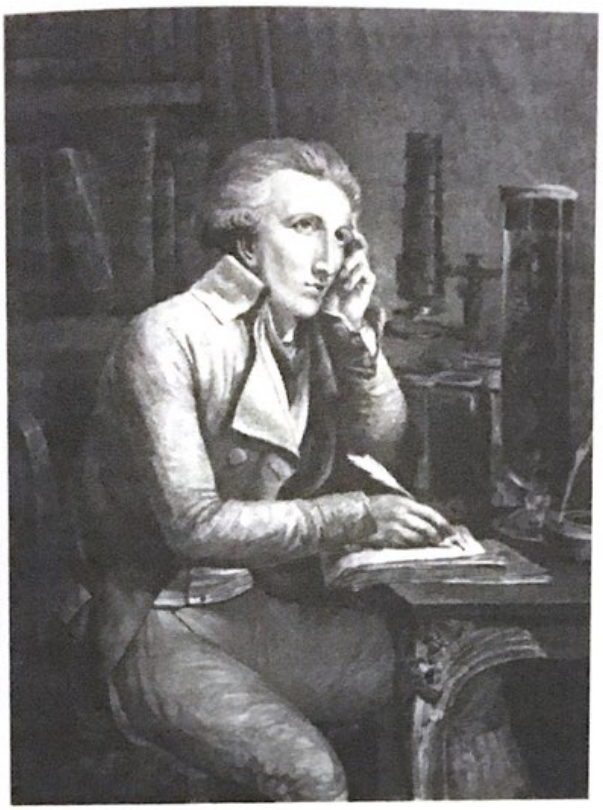

FIGURE 6. Georges Cuvier seated at his desk, 1798. Cuvier's research on fossil and living elephants provided the first definitive proof that extinction had taken place. Based on an oil portrait by Mathieu-Ignace van Brée. From L. Bultingaire, "Iconographie de Georges Cuvier," *Archives du museum*, 6th ser., vol. 9 (1932), frontispiece.

the principles of comparative anatomy to show that the bones of large mammals contained in the collections of the National Museum of Natural History and elsewhere were distinct from any known living species, he would demonstrate that extinction had in fact occurred. The fossil elephants, whose bones had been recovered from many locations and been the subject of so much controversy, provided just such an opportunity. In his first paper on the subject in 1796, Cuvier marshaled evidence to show that the two living elephants, from India and Africa, were distinct species, and that the fossil elephant found in Siberia and in Europe was both distinct from these two species and undoubtedly extinct.[101] He felt at the time that the American incognitum, which he called the Ohio animal, was also a distinct species, but he lacked sufficient evidence to declare it as such. Cuvier was not the first to suggest these ideas, but in the words of Martin Rudwick, his fossil elephant paper provided "detailed and almost irrefutable evidence for the reality of extinction."[102]

Ten years after his initial publication on fossil elephants, Cuvier revisited the pachyderms.[103] This time he benefited from access to Rembrandt Peale's *Historical Disquisition*, various fossil casts of the American incognitum that the elder Peale had sent him, and other previously unavailable material. In his 1806 paper, he identified the incognitum as the mastodon (or "breast tooth"), based on the

animal's characteristic grinders, which were quite distinct from elephant teeth and once the source of so much confusion for Buffon, Daubenton, and other naturalists. The American mastodon was only one of several species of this newly named beast that Cuvier was able to differentiate, and he dubbed the Ohio animal the "grand Mastodonte." At last, the American incognitum had a proper name.

Between his first fossil elephant paper and his return to the subject a decade later, Cuvier described a slew of extinct fossil species—including not only the Siberian mammoth and various mastodons but also lost species of the rhinoceros, the hippopotamus, the Irish elk, a purported bear from caves in Germany, a doglike carnivore from Paris, and others that proved more difficult to characterize.[104] Cuvier concluded that each of these remarkable beings had disappeared, destroyed in one of a series of sudden geological catastrophes or "revolutions" that periodically swept across portions of the globe. Cuvier also realized that fossils could be used as markers of geological strata, and the "older the beds in which these bones are found, the more they differ from those of animals we know today."[105] With each new fossil beast Cuvier described, it proved increasingly difficult to continue to deny the reality of extinction.[106]

EMBRACING EXTINCTION

In an address delivered in 1807, the physician, naturalist, and University of Pennsylvania professor Benjamin Smith Barton argued that one of the "principal desiderata" in natural history was more research on the mammoth, megatherium, and other animals that "no longer exist."[107] Barton not only unapologetically embraced the idea of extinction in his address but also belittled those who continued to argue otherwise: "I speak of these animals as *extinct*. In doing this, I adopt the language of the first naturalists of the age. No naturalist, no philosopher; no one tolerably acquainted with the history of nature's works and operations, will subscribe to the puerile opinion, that Nature does not permit any of her species of animals, or of vegetables, to perish." While certain of the reality of extinction, Barton also continued to champion a belief in the order of nature, which he referred to as "a harmony beautiful and divine." In addition, he accepted the idea of gradation of one species into the next. But he vehemently denied the essential connection between species that had been implied in the notions of plentitude and the economy of nature: "THERE IS NO SUCH THING AS A CHAIN OF NATURE: an absolutely necessary dependence (on this earth) of one species upon another."[108] Barton hoped to publish a volume on extinct quadrupeds, but, like many of his ambitious plans, he never got much beyond announcing his intentions. He did, however, issue *Archaeologiea Americanae* (1814), which consisted of a series of

short memoirs and letters on the subject. In a prescient letter to Thomas Jefferson on the mammoth and the mastodon reproduced in that volume, Barton reiterated his views about extinction while hinting that the processes that had destroyed the mammoth were sure to continue operating into the future. Apparently the swift pace of settlement in North America led Barton to declare that "the steps of this vast and generally unlooked for change, are rapidly preparing, in different parts of the world; and in none, I think, more rapidly than in the portion of it which we inhabit."[109]

Barton was silent on how one might reconcile an acceptance of extinction with the more established notion of a divinely ordered creation. One of his contemporaries abroad, however, the London physician and fossil collector James Parkinson, approached this issue head-on in his three-volume *Organic Remains of a Former World* (1804–11). While many "good and learned men" had dismissed the possibility of the "loss of a single link, in the chain of creation" as impossible, Parkinson argued otherwise: "that plan, which prevents the failure of a genus, or species, from disturbing the general arrangement, and œconomy of the system, must manifest as great a display of the power and wisdom, as could any fancied chain of beings, in which the loss of a single link would prove the destruction of the whole."[110] Rather than entirely jettisoning the chain of being, however, Parkinson reconceptualized one of its major components—the notion of plentitude—in more dynamic terms. The successive creation and destruction of species represented phases in the progress of nature toward a more perfect form: the human species.[111]

Two major compilations of American mammals published in the mid-1820s both included lists of fossil animals, and neither author felt compelled to explicitly defend the increasingly common assumption that these species had gone extinct. In *Fauna Americana* (1825), the Philadelphia comparative anatomist and Cuvier-enthusiast Richard Harlan included eleven fossil species of mammals that (he stated matter-of-factly) "no longer exist in a living state, in this, or any other country."[112] A year later, Harlan's chief rival, the Philadelphia anatomist and physician John Godman, began offering a competing three-volume treatise on North American mammals, *American Natural History* (1826–28). While the two naturalists disagreed on many points, Godman was also unflinching in his acknowledgement of extinction. Writing of the mastodon he reflected: "Enormous as were these creatures during life, and endowed with faculties proportioned to the bulk of their frames, the whole race has been extinct for ages . . . leaving nothing but the 'mighty wreck' of their skeletons, to testify that they were once among the living occupants of this land."[113]

During this same decade, the Scottish zoologist and minister John Fleming be-

gan arguing for a connection between historically documented declines in animal populations and the prehistoric extinction of animals whose fossil remains were being discovered in peat bogs, marl pits, and caves throughout Great Britain.[114] In his view, that common link was humans. "Man," Fleming asserted, "whether we view him as a savage or a citizen, is induced, by various motives, to carry on a destructive warfare against many animals, which he finds to be his fellow residents on the globe."[115] The ability of "rude tribes" to destroy animals was "limited in its objects, and uncertain in its results." But as human society progressed, "the objects of the chace ceased to be limited, while the methods of capture, and engines of death, become more numerous, complicated, and effectual."[116] It is possible, Fleming continued, to show that contemporary humans have greatly altered the geographical range of many species and "may have succeeded in effecting the total destruction of a few."[117] In recent times, the expansion of agricultural production and increased firearm use had reduced the population of many once abundant British birds and quadrupeds. Others, like the horse, the ox, and the boar, no longer existed in the wild. Extinct animals whose fossil remains were uncovered in Britain—fantastic beasts like the Irish elk, the rhinoceros, the hippopotamus, elephants, hyenas, and many others—might have also fallen victim to earlier humans, whose bones and implements were found in "similar situations with their remains."[118] In many cases, fossil remains of extinct species were interspersed with the bones of species still living, so no universal catastrophe, like a flood, could explain why only some animals had been lost. While disease, local floods, and severe weather might have contributed to population declines, Fleming concluded that the "weapons of the huntsman completed the extinction" of these animals.[119]

A decade later, the British geologist Charles Lyell went a step further by arguing that extinction was part of the "regular and constant order of Nature."[120] In the second volume of his influential book, *Principles of Geology* (1832), Lyell embraced the notion that the earth had been changing for vast eons of time.[121] Mountains had risen and fallen, land bridges between continents had emerged and subsided, and bodies of water had expanded and contracted. It would be absurd to assume, Lyell concluded, that through all these profound geological changes, existing associations of plants and animals remained completely unaltered. Rather, as the landscape changed, animals migrated, while seeds were widely dispersed. As they gained a foothold in new regions, these newcomers competed with native flora and fauna, thereby threatening to overturn the previously established balance of that region. Nature, he argued, was fundamentally violent, characterized by a constant "struggle for existence."[122]

To illustrate his point, Lyell suggested considering the impact of the polar bear's migration into a region it had not formerly inhabited. The breakup of ice around Greenland periodically landed polar bears on nearby Iceland, severely frightening the human inhabitants of that island, who banded together to destroy the fearsome beast. Now imagine what might have happened the first time this notorious predator had landed on the island, before humans had begun living there: the "havoc which they would make among the species previously settled in the island would be terrific. The deer, foxes, seals, and even birds, on which these animals sometimes prey, would soon be thinned down."[123] Cascade effects would ensue as the decline of these species led to changes in grass, insect, and fish populations, which in turn would promote the increase of other insects and birds. The "numerical proportion" of many inhabitants of the island might be permanently altered through the arrival of this single species, possibly even driving some of the former inhabitants over the brink of extinction. After some time, though, a new population "equilibrium" would again be established.[124]

Closely following Fleming, Lyell argued that humans were also quite capable of disrupting the balance of nature. Lyell discussed the decline of British indigenous animals using many of Fleming's examples and concluded that they involved only the "larger and more conspicuous animals inhabiting a small spot on the globe."[125] He asked his readers to imagine the "enormous revolutions which, in the course of several thousand years, the whole human species must have effected, and will continue to go on hereafter, in certain regions, in a still more rapid ratio, as the colonies of highly-civilized nations spread themselves over the occupied lands." We should not lament or feel guilty about the havoc we commit, Lyell argued, for extinction, rather human induced or not, was perfectly natural:

> We have only to reflect that in thus obtaining possession of the earth by conquest, and defending our acquisitions by force, we exercise no exclusive prerogative. Every species which has spread itself from a small point over a wide area, must in like manner, have marked its progress by the diminution, or the entire extirpation, of some other, and must maintain its ground by a successful struggle against the encroachments of other plants and animals. . . . The most insignificant and diminutive species, whether in the animal or vegetable kingdom, have each slaughtered their thousands, as they disseminated themselves over the globe, as well as the lion, when first it spread itself over tropical regions in Africa.[126]

Lyell's words reveal just how much had changed in the fifty years since Jefferson penned his first account of the American incognitum. A natural world that

was once thought to be orderly, static, and new was now incomprehensibly old and in constant flux. Large fossil mammals had been reconstructed, named, and placed on public exhibition. Extinction, which had been considered anathema, increasingly came to be viewed as a recurring part of the earth's long history. And humans, both historic and prehistoric, were recognized as possible agents of extinction. For any doubters who might remain, naturalists would soon provide compelling evidence that humans possessed the ability to destroy other species.

CHAPTER TWO

PARADISE LOST

UNRAVELING THE MYSTERIES OF INSULAR SPECIES

We need not marvel at extinction; if we must marvel, let it be at our presumption in imagining for a moment that we understand the complex contingencies on which the existence of species depends.

CHARLES DARWIN, 1859

Should civilized man ever reach these distant lands, and bring moral, intellectual, and physical light into the recesses of these virgin forests, we may be sure that he will so disturb the nicely balanced relations of organic and inorganic nature as to cause the disappearance, and finally the extinction, of these very beings whose wonderful structure and beauty he alone is fitted to appreciate and enjoy.

ALFRED RUSSEL WALLACE, 1869

ISLAND INSIGHTS

By the early decades of the nineteenth century, the idea that myriad species had suffered extinction over the eons of time since the earth's origin presented a formidable challenge to the hoary notion of a static universe. Naturalists who remained firmly in the grips of providential natural history turned to the Noachian flood or other divinely driven catastrophes in an attempt to gloss over the apparent anomaly of recurring extinction across multiple geological strata. Efforts to reconcile fossil evidence with theologically grounded theory became increasingly problematic, however, as the number and diversity of newly discovered fossil forms continued to proliferate. Though the fossil record contained

many gaps, it was already sufficiently complete to raise troubling questions about God's intentions for and role in the natural world. Why had so many species been lost? How had they been destroyed? And what was the significance of these losses?

While grappling with the meaning of fossils, naturalists also struggled to construct a detailed inventory of the world's living species.[1] Beginning in the late Middle Ages and the Renaissance—the dawn of the so-called Age of Discovery—the nations of Europe developed an interest in exploration that strengthened with each passing century.[2] Spurred on by religious zeal, mercantile ambitions, and imperial longings, vessels destined for the far corners of the earth began regularly departing from European ports. They returned home with tales of wondrous new landscapes, accounts of strange new peoples, and specimens of unique plants, animals, rocks, and minerals that soon overwhelmed existing systems of classification. Explorers and naturalists sought out new organisms for a diversity of potential practical uses—as food, fur, and fiber, drugs and dyes, leather and lumber. They also hoped to contribute to the enterprise of cataloging the globe's flora and fauna. Living examples of exotic species found homes in newly established botanical and zoological gardens, institutions that served as biological clearinghouses to promote the movement of potentially useful organisms between colonial powers and their overseas possessions.[3] Preserved specimens were gathered into cabinets of curiosity, museums, and herbaria.[4] The ongoing campaign to produce a complete inventory of the world's plants and animals received a decided boost in the mid-eighteenth century, when Linnaeus developed relatively easy-to-use and widely adopted systems of biological classification and nomenclature to replace the competing systems that had been in place up to that point.[5]

In addition to naming, describing, and classifying newly discovered species, by the end of the eighteenth century naturalists also began trying to discern patterns in how those species were distributed across the globe.[6] Initially, they tended to base their ideas about geographical distribution on a fairly literal reading of the biblical story of the Ark; in short, all the earth's species descended from an original pair that had dispersed from Mount Ararat following the Noachian deluge. Though firmly wedded to the notion that God was directly responsible for the order in the world, Linnaeus also created intellectual space for more secular understandings of geographical distribution. He did so by arguing that all life, including human life, had been created in pairs on a high mountain that included a wide variety of ecological conditions. This mountain paradise contained belts of tropical, temperate, and arctic zones as well as the appropriate assemblage of plants and animals suited for each of these zones. As the primeval waters sub-

sided, Linnaeus speculated, species migrated to their appropriate places on the globe. By the early nineteenth century, the German naturalist Alexander von Humboldt and the French botanist Augustin Pyramus de Candolle established the study of geographical distribution on much firmer scientific grounds through research on plant communities.

As areas with relatively clear boundaries and unusual biota, islands proved a particularly appealing site for naturalists struggling to understand how and why species came to be distributed. By the 1770s, for example, the German naturalist Eberhardt Zimmermann recognized that the number of species common to continents and their neighboring islands decreased as those islands became more distant from the mainland. Writing at about the same time, Johann Forster, a German naturalist residing in Britain who had accompanied Captain Cook on his second tour of the southern hemisphere, suggested that the total number of species on any given island was generally proportional to its circumference.[7] In the second volume of his *Principles of Geology* (1832), Charles Lyell summarized several other well-established generalizations about the geographical distribution of insular flora and fauna: the number of plants declined as islands became more distant from continents, while the proportion of unique (what he and other naturalists were beginning to call "endemic") plants increased and the number of quadrupeds decreased.[8]

Because they are relatively small and isolated, islands also provided early demonstrations of the human power to radically transform the natural world. In a provocative book published just over a decade ago, the environmental historian Richard Groves argued that during the eighteenth century naturalists and colonial administrators on islands like St. Helena, Mauritius, and Cape Colony offered pioneering critiques of environmentally destructive practices that had accompanied European settlement, including wide-scale deforestation, the introduction of exotic species, and the overhunting of native species.[9] Fearful that their island Edens were being despoiled, these naturalist and government officials also formulated policies designed to mitigate large-scale, human-induced environmental transformations. Surely, Groves is on to something important here, but it is unclear whether these initial calls of environmental alarm reached a wider audience or remained buried in dusty archives and obscure, long-forgotten publications.

What is certain is that by the middle decades of the nineteenth century, naturalists on both sides of the Atlantic developed a growing awareness both of the high rates of endemism among island species and the high degree of vulnerability those species faced following encounters with humans and the domesticated animals that invariably accompanied them. At the same time that Charles Darwin

was groping toward his theory of evolution by natural selection—aided by his extensive firsthand experience with insular flora and fauna during the voyage of the *H.M.S. Beagle* (1831–36)—several of his colleagues were dramatically bringing home the reality of historic extinction through a series of publications treating several lost or vanishing flightless island birds: the dodo, moa, and great auk. These publications not only demonstrated that humans had managed to exterminate other species, they also prepared their contemporaries to appreciate the larger-scale continent-wide process of wildlife destruction going on around them.

This chapter explores the growing interest in insular species and insular extinctions during the middle decades of the nineteenth century. The first part shows how, within a relatively short period in the 1830s and 1840s, naturalists reconstructed the story of the dodo, the moa, and the great auk. These pioneering studies provided early, well-documented, and widely accessible examples of human-induced extinction, and, in the case of the dodo, offered what would become the paradigmatic case of this phenomenon. The second part of the chapter examines the critical role that observations about insular species played in the development of the theory of evolution by natural selection. Although Darwin appears not to have been directly influenced by knowledge about the fate of the dodo, moa, or auk, the extensive experience he gained with insular flora and fauna during his global travels proved crucial in the formulation of his ideas about how new species came into being. As it turned out, by providing a convincing explanation for why island species often seemed so vulnerable to predation from humans and newly introduced species, Darwin's theory of evolution provided a coherence to the previously puzzling patterns of insular biogeography. The controversial theory also played a key role in later debates about the meaning of human-induced extinction.

DEAD AS A DODO

During the middle of the nineteenth century, the dodo became the first prototypical symbol of extinction, a veritable icon of oblivion. The dodo (*Raphus cucullatus*) was a swan-sized, flightless bird that once inhabited Mauritius, one of three Mascarene Islands that dotted the vast Indian Ocean, approximately five hundred miles east of Madagascar.[10] It possessed a blue-gray plumage, a large dark bill with a reddish hooked tip, small yellow wings, yellow legs with black feet, and a tuft of white feathers on its rear end. Overall, it had the appearance of an ungainly juvenile bird, almost as though it were a caricature of itself.[11] Little is known about the dodo's life history or behavior except that it seems to have