Picturing Nature in the Age of Enlightenment[1]

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STUFFING BIRDS, *Pressing Plants, Shaping Knowledge.*[2] The title of your Society's fine exhibition compresses into almost text-message brevity the essence of the natural-history project that flourished in both Old World and New during the Age of Enlightenment: using specimens to construct new knowledge. I think the most useful contribution I can make here is twofold: first, to sketch the European context of what naturalists such as Thomas Jefferson were doing in the New World; and, second, to do so in particular by complementing the "stuffing birds" and "pressing plants" of your exhibition with a few comments on the distinctive input from the third of the three great "kingdoms of nature," the mineral kingdom, where my own research has lain ever since I turned myself in mid-career from geologist into historian.[3]

"Animal, vegetable, or mineral?" In the traditional guessing game that was still flourishing in my television-free childhood, nothing in nature could be left out, once this first question was answered; and from that starting-point one could home in on the true identity of the unknown object, by asking progressively more detailed questions: in effect, applying a classification. This was the essence of "natural history" in the Age of Enlightenment: nothing to do with "history" in the modern sense of the word, but everything to do with the description

[1] Read 22 April 2004, as part of the symposium "Science, Art, and Knowledge: Practicing Natural History from the Enlightenment to the Twenty-first Century."

[2] Sue Ann Prince, ed., *Stuffing Birds, Pressing Plants, Shaping Knowledge: Natural History in North America, 1730–1860* (Philadelphia: American Philosophical Society, 2003).

[3] Much of this paper is condensed from the fuller treatment of its theme in Martin J. S. Rudwick, *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution* (Chicago: University of Chicago Press, 2005), and in the papers reprinted in Rudwick, *The New Science of Geology: Studies in the Earth Sciences in the Age of Revolution* (Aldershot: Ashgate Publishing, 2004).

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FIGURE 1. Georges Cuvier at the age of about twenty-nine: an engraving after a portrait painted in 1798 by Mathieu-Ignace van Bree

and classification of the amazing diversity of the natural world. And this idea of natural history was in no way invalidated by the injection of a dynamic element into nature, most notably in the early geologists' concept of an eventful *history* of the earth, but also in Charles Darwin's slightly later concept of an evolutionary history for life itself.

Where then was natural history practiced during the Age of Enlightenment? In effect, in two complementary locations: indoors in museums, public or private; and outdoors in the field, close to home or in the most remote and exotic places. The portraits of two leading European savants, both painted in the 1790s, epitomise these two "places of knowledge." The Parisian naturalist Georges Cuvier (1769–1832) sits indoors in his study at the Muséum d'Histoire Naturelle, at this time the greatest museum of its kind in the world (fig. 1). Jars of animal

FIGURE 2. Horace-Bénédict de Saussure at the age of about fifty-six: an engraving after a portrait painted in 1796 by Jean-Pierre Saint-Ours

specimens stand ready for his research on comparative anatomy, and he is poised to put pen to paper to add to the scientific literature represented by the books or periodicals in the background. In contrast, the Genevan naturalist Horace-Bénédict de Saussure (1740–1799) sits outdoors with Mont-Blanc towering in the background; he had been the first savant to climb the highest mountain in Europe (fig. 2). He has a geological hammer in one hand, and in the other a mineral specimen he has collected with its aid; beside him are instruments for recording weather as well as rocks. What unites the two portraits is that Cuvier

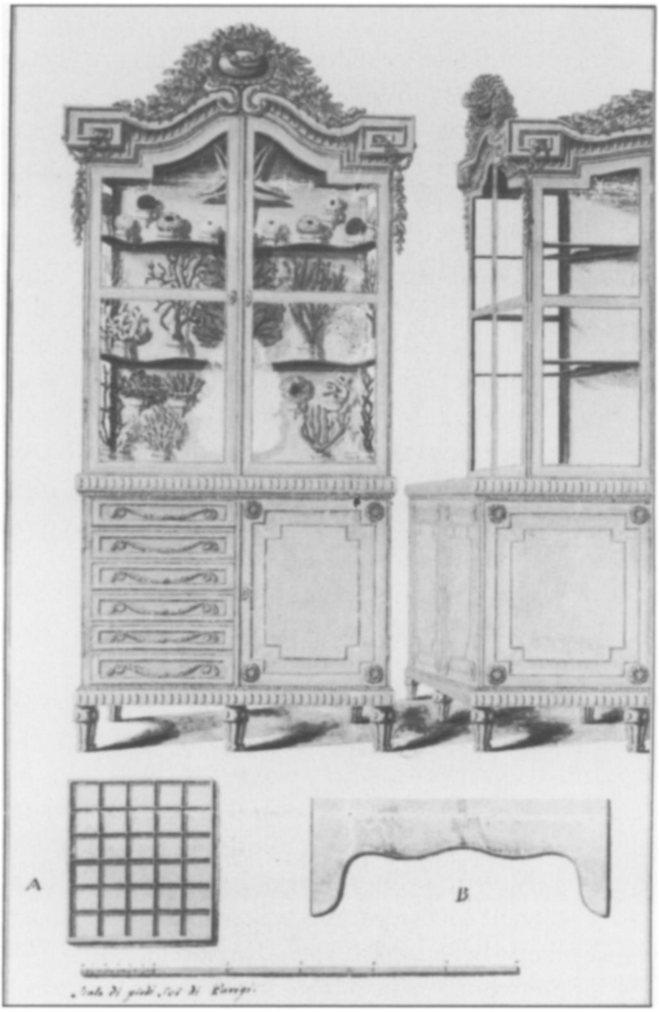

FIGURE 3. A design for the natural history cabinets in the university museum in Pavia, drawn around 1785

and Saussure both look conventionally up to heaven for inspiration: for, whether indoors or outdoors, natural history embodied the integration of observing and thinking, empirical material and intellectual effort.[4]

[4] Figure 1 is reproduced from L. Bultingaire, "Iconographie de Georges Cuvier," *Archives du Muséum d'Histoire Naturelle*, 6e sér., 9 (1932): 1–12, frontispiece. Figure 2 is reproduced from an undated print in the author's collection. See also Adi Ophir and Steven Shapin, "The place of knowledge: a methodological survey," *Science in Context* 4 (1991): 3–21.

Natural History Indoors

First, then, doing natural history indoors, in museums. Museums brought together "specimens" or samples from near and far; some rare, some common. The design for the cabinets in the university museum at Pavia, where Lazzaro Spallanzani (1729–1799) was the professor of natural history, shows how museums catered, as they still do, to both casual and serious interests (fig. 3). The more spectacular specimens—corals, starfish, and sea urchins—are displayed on shelves behind glass, the smaller ones nestling in bowls or on pedestals of turned and gilded wood; others could be stored below in drawers, which are subdivided into small compartments. All such specimens had of course been collected outdoors in the field, but most naturalists treated collecting as a mere means to a more important end. It was the concentration of specimens in one place, indoors in a museum, that made them truly scientific, because only in a museum could they be compared with others from elsewhere, and so be identified and classified.[5]

However, museum collections were of course immobile; a naturalist could see the specimens only by visiting the museum. So in practice they were supplemented with densely illustrated books, each a *museo cartaceo* or museum on paper, which made specimens accessible wherever copies of the book were available. Fossil ammonites, for example, were among the vast range of specimens portrayed in the great paper museum of *Merkwürdigkeiten der Natur* (Remarkable natural objects), published in Nürnburg in the mid-eighteenth century (fig. 4); and a fossil nautilus more than a foot across was remarkable enough to have a plate to itself in the paper museum of fossils from the Brussels region published there by François-Xavier Burtin (1743–1818) in 1784 (fig. 5). These were "proxy" specimens, for they *stood in* for the real thing.[6]

[5] Figure 3 is reproduced from Maria Franca Spallanzani, *La Collezione Naturalistica di Lazzaro Spallanzani: I Modi e i Tempi della sua Formazione* (Reggio Emilia: Comune di Reggio nell'Emilia, 1985), fig. 4.

[6] Figure 4 is reproduced from Georg Wolfgang Knorr and J. C. Immanuel Walch, *Sammlung der Merkwürdigkeiten der Natur und Naturgeschichte der Versteinerungen* (Nürnburg, 1755–75), 2: pl. 1A. Figure 5 is reproduced from François-Xavier Burtin, *Oryctographie de Bruxelles, ou Description des Fossiles tant Naturels qu'Accidentels Découverts jusqu'à ce Jour dans les Environs de ce Ville* (Brussels, 1784), pl. 14. See also Francis Haskell, *The Paper Museum of Cassiano dal Pozzo: A Catalogue Raisonné* (London: Harvey Miller, 1993); and, for the definition of "proxy" illustrations and their analysis, Mark Hineline, "The Visual Culture of the Earth Sciences, 1863–1970" (San Diego: University of California, San Diego [Ph.D. diss.; University Microfilms no. 94-20724], 1993).

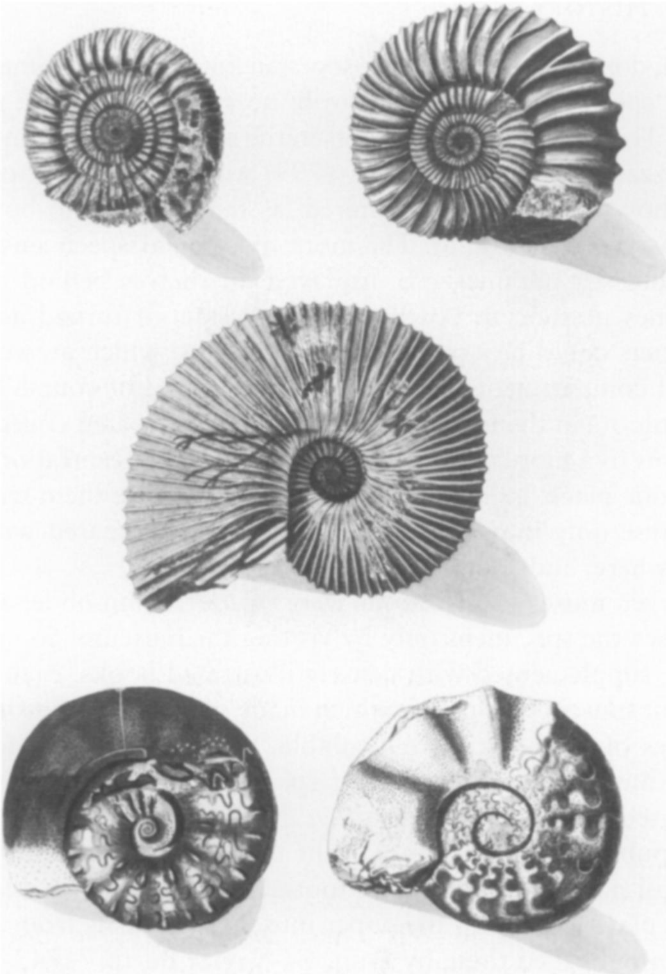

FIGURE 4. Fossil ammonite shells from localities in central Europe: engravings published in 1768 in Georg Knorr and Immanuel Walch's great "paper museum" of minerals and fossils. By permission of the British Library.

The original specimens remained in some specific museum, and in many cases tucked away in a private collection, but the proxies made them public and mobile, available for comparison with other specimens in other collections. To be effective as proxies, specimens had to be portrayed, as these were, in a trompe-l'oeil style and with all the visual conventions of contemporary still-life art. But then they not only helped in naming and classifying; they could also fuel lively debates about the meaning and significance of such objects. For example, were ammonites all extinct? Or were some still flourishing in the ocean

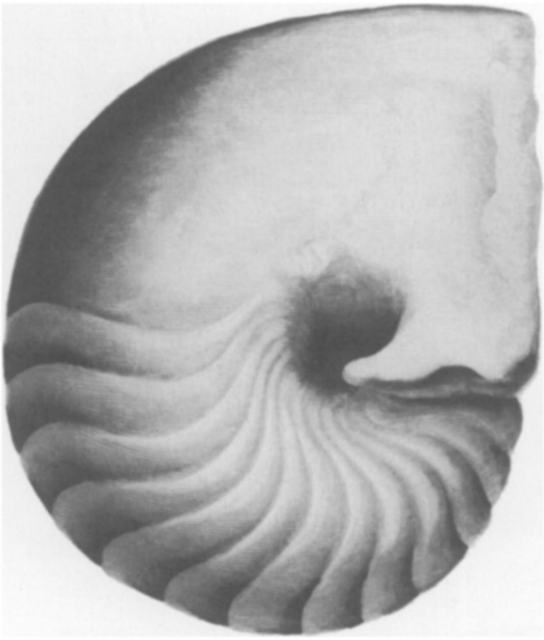

FIGURE 5. A large fossil nautilus shell from near Brussels: an engraving published by François-Xavier Burtin in 1784. By permission of the British Library.

depths or in remote places, as the pearly nautilus certainly was in the seas around the East Indies?

Picturing natural objects in this way was an activity that transcended any nationalistic localism. When huge fossil bones were discovered at Big Bone Lick near the banks of the Ohio in the future Kentucky, they were integrated at once into an already lively international debate. For example, the Parisian naturalist Louis Daubenton (1716–1799) published proxy pictures that juxtaposed a femur from the Ohio with another from Siberia, and compared both with the femur of an elephant that had lived in the royal menagerie at Versailles (fig. 6). He suggested that the variation might be merely due to differences of sex, age, or environment. But his boss, Georges Louis Leclerc, count Buffon (1707–1788), later argued for a different explanation, namely, that the so-called "Ohio animal" was a separate species, truly extinct. Yet he made that point with a proxy picture of a molar tooth found not by the Ohio but in Russia (fig. 7). For leading naturalists such as Buffon and Daubenton, what mattered was where precisely the decisive specimens had been found, not the political complexion of the territory concerned. It was scientifically irrelevant whether they came from the

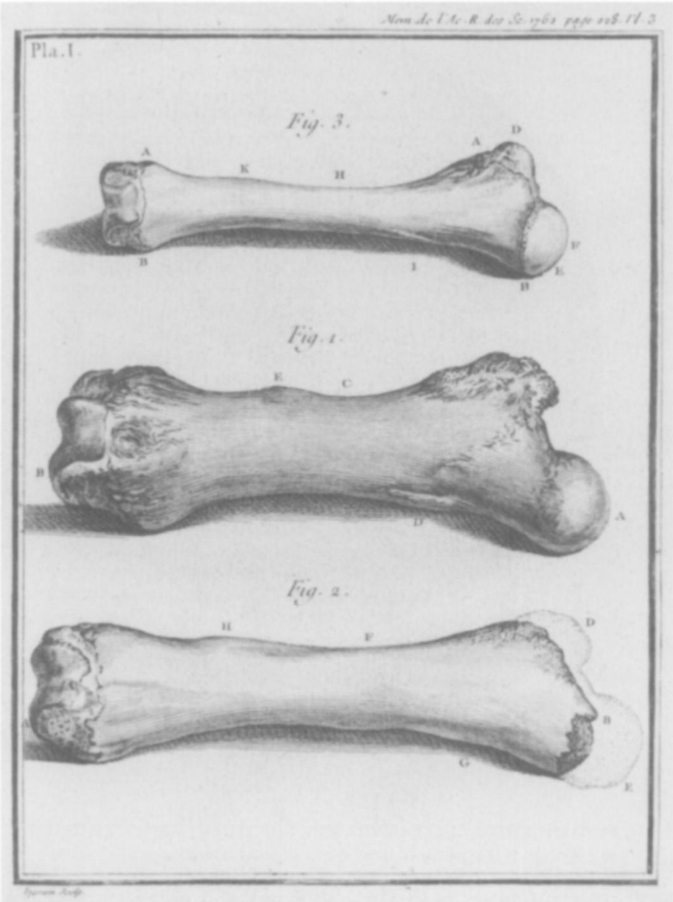

FIGURE 6. Louis Daubenton's engravings (1764) of the femur of the "Ohio animal" (middle) compared with those of the living elephant (top) and the Siberian "mammoth" (bottom); the Ohio bone was more than three feet in length. By permission of the Syndics of Cambridge University Library.

autocratic Russian Empire or from what became—just a few years later—the new American republic.[7]

Towards the end of the century and shortly after the end of the most radical phase of the Revolution in France, the young Cuvier entered this

[7] Figure 6 is reproduced from Louis Jean Marie Daubenton, "Mémoire sur des os et des dents remarquables par leur grandeur," *Histoire de l'Académie Royale des Sciences* 1762 (1764): 206–29, pl. 13. Figure 7 is reproduced from Buffon, *Histoire Naturelle, Générale et Particulière* (Paris, 36 vols., 1749–89), supplément 5 (1778), "Des époques de la nature," pl. 1.

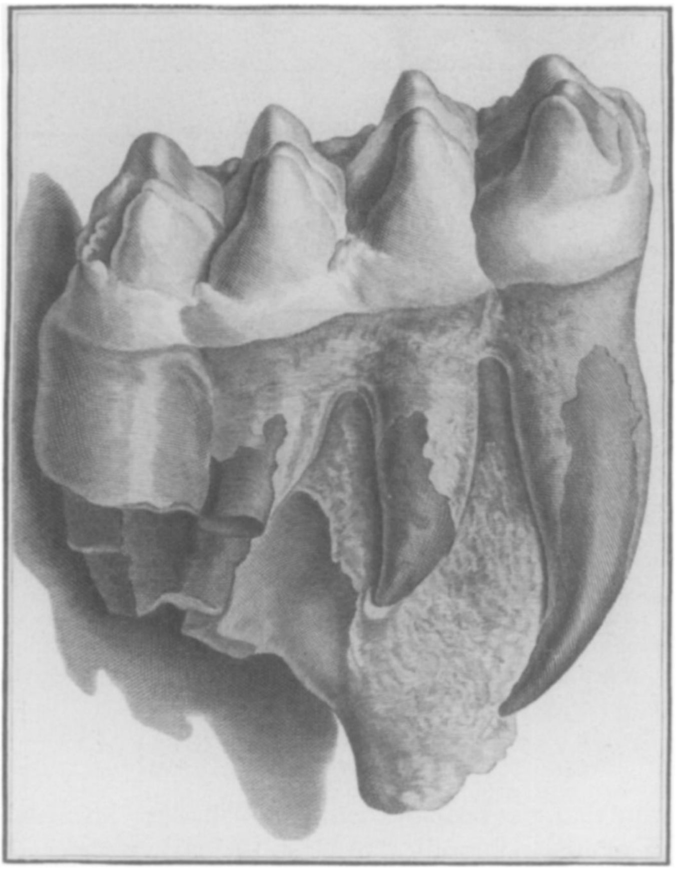

FIGURE 7. Buffon's engraving (1778) of a molar tooth, found in Russia, of the "Ohio animal" (later named, by Cuvier, the mastodon, in allusion to the mammilated crown of the teeth). By permission of the Syndics of Cambridge University Library.

debate about fossil bones, taking over from his now elderly colleague Daubenton and the recently deceased Buffon. He was prompted initially by the arrival in Paris of an engraving of a reconstruction—the first of its kind—that Juan-Bautista Bru (1740–1799) had just put together at the royal museum in Madrid, from bones found in Spanish America (fig. 8). Cuvier then drew his own proxy pictures to argue, with consummate visual rhetoric, that the unknown animal, which he named the "megatherium," or huge beast, was related to the far smaller living sloths (fig. 9). The comparison was possible only because Cuvier had access to the unrivaled collections of skeletons in the Paris museum, and it led to his sensational conclusion that the strange animal was a

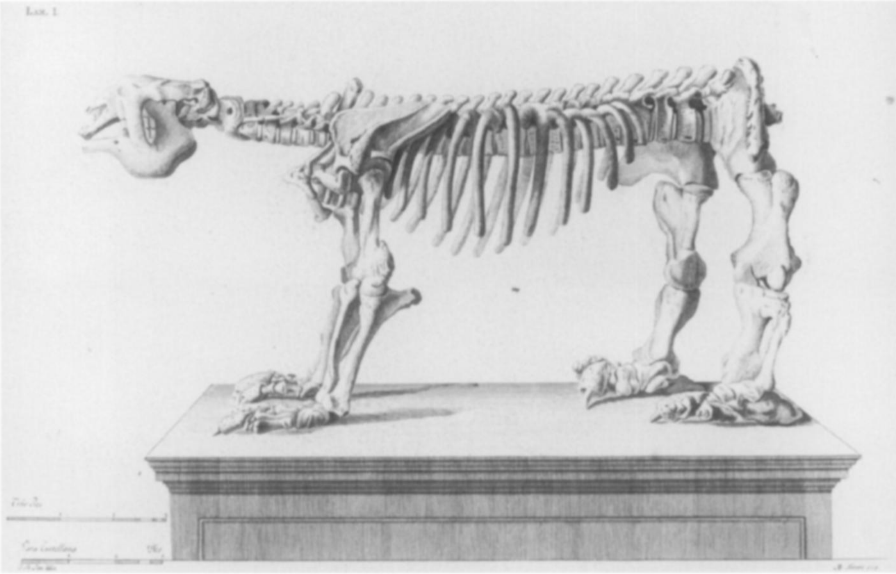

FIGURE 8. An engraving of the huge fossil animal from South America that Cuvier later named the megatherium, as it was reconstructed around 1796 by Juan-Bautista Bru. By permission of the Bibliothèque Centrale du Muséum National d'Histoire Naturelle, Paris.

huge edentate that was probably extinct. He had the Spanish engraving copied into a Parisian periodical to illustrate his own paper; this in turn was re-engraved for an English periodical; and a copy of this English version reached Philadelphia just in time for Jefferson to take it into account when he reported to this Society on what he called the "megalonix" from Virginia.[8]

A few years later, with Napoleon's wars at their height, Cuvier issued an international appeal for specimens, real or proxy, to help in what had become his vast research project on fossil bones of all kinds. Among the many proxies he received in response was a drawing of a

[8] Figure 8 is reproduced from the print used by Cuvier (Bibliothèque Centrale du Muséum National d'Histoire Naturelle, fonds Cuvier, MS 634 [2]), later published in José Garriga, *Descripción de un quadrúpedo muy corpulento y raro, que se conserva en el Real Gabinete de Historia Natural de Madrid* (Madrid, 1796). Figure 9 is reproduced from Georges Cuvier, "Notice sur le squelette d'une très-grande espèce de quadrupède inconnue jusqu'à présent, trouvé au Paraguay, et déposé au cabinet d'histoire naturelle de Madrid," *Magasin encyclopédique*, 2e année, 1 (1796): 303–10, pl. opp. 308. See also Thomas Jefferson, "A memoir on the discovery of certain bones of a quadruped of the clawed kind in the western parts of Virginia," *Transactions of the American Philosophical Society* 4 (1799): 246–60.

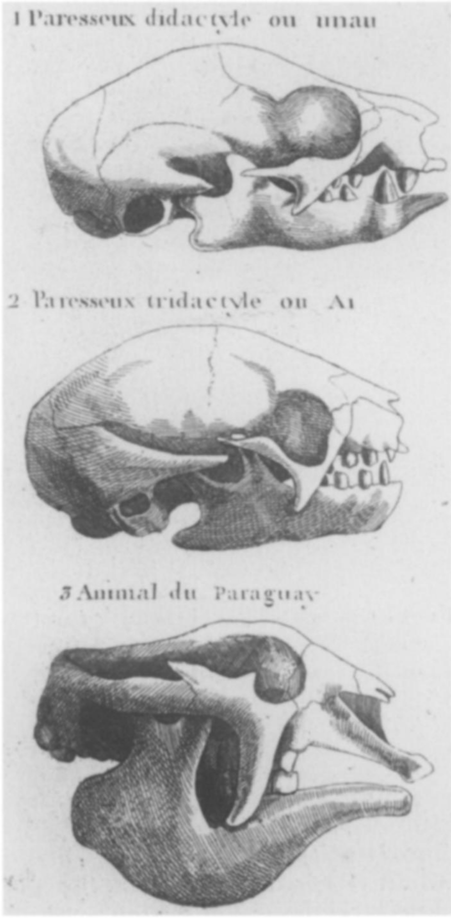

FIGURE 9. Cuvier's engravings (1796) of the skull of the enigmatic "Paraguay animal" (bottom), greatly reduced in relative size to facilitate comparison with the skulls of two species of living sloths (top and middle); he identified the fossil as a huge extinct edentate, which he named the megatherium. By permission of the Syndics of Cambridge University Library.

tooth of the Ohio animal, which was sent from Göttingen by Johann Friedrich Blumenbach (1752–1840); it was of a specimen found not in Germany but at Big Bone Lick (fig. 10). After Charles Willson Peale (1741–1827) excavated his famous fossil bones in upstate New York, his son Rembrandt was sent off as soon as possible to display their second-best reconstructed skeleton in London (the very best remained in Peale's museum here in Philadelphia). Rembrandt and his fossil bones would then have gone on to Paris, if the fragile Peace of Amiens had not collapsed. But a proxy drawing of the Peales' reconstruction was nonetheless sent to Paris in 1804, for Cuvier's benefit, by the English anatomist Everard Home (1756–1832), despite the renewed state of war between their respective nations (fig. 11). And it was Cuvier in Paris who later analysed the Ohio animal with definitive authority and named it the "mastodon," distinguishing it sharply from

FIGURE 10. A worn molar tooth of the Ohio animal or mastodon: a proxy drawing of a specimen from Big Bone Lick, sent in 1801 by Johann Friedrich Blumenbach in Göttingen to help Cuvier with his research in Paris. By permission of the Bibliothèque Centrale du Muséum National d'Histoire Naturelle, Paris.

the true "mammoth" famously found in Siberia, but arguing that both animals must be truly extinct. All this "noble traffic" in scientific information, as Cuvier called it, and above all the traffic in proxy pictures of museum specimens, illustrates perfectly the working of the Republic of Letters—this international network of naturalists and other savants during the Age of Enlightenment—which continued unimpaired through the turbulent period of the French Revolution and the subsequent Napoleonic Wars.[9]

[9] Figure 10 is reproduced from a drawing dated by Cuvier 14 September 1801, Bibliothèque Centrale du Muséum National d'Histoire Naturelle, fonds Cuvier, MS 630(2). Figure 11 is reproduced from a drawing in the same archive, accompanying a letter dated 17 August 1804.

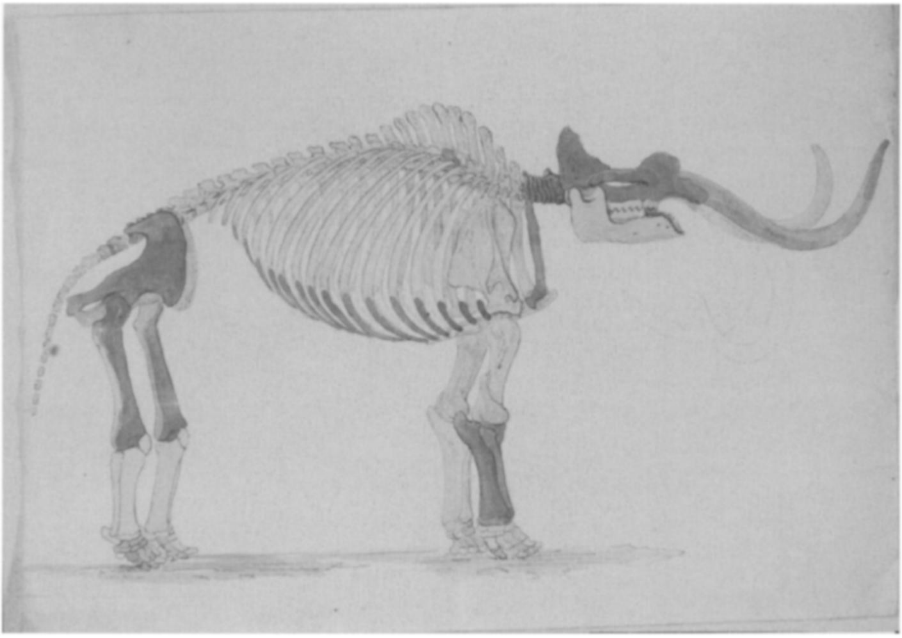

FIGURE 11. A drawing of Charles Willson Peale's reconstruction of the skeleton of the Ohio animal excavated in upstate New York, as exhibited in London during the Peace of Amiens; this sketch was sent by Everard Home to Cuvier in 1804. By permission of the Bibliothèque Centrale du Muséum National d'Histoire Naturelle, Paris.

Natural History Outdoors

I turn now from indoor museum work to outdoor fieldwork. As I have already emphasized, most naturalists treated collecting in the field as a means to an end, not as an end in itself. What was most important was to get the specimens themselves back to the museum in good shape, because that was where their really scientific handling began: the stuffing of birds and the pressing of plants, and hence to the shaping of knowledge. What the specimens brought with them, as it were, from the field into the museum was usually no more than a record of exactly where they had been collected. Until the turn of the nineteenth century, and the famous expedition to Latin America by the great Prussian naturalist Alexander von Humboldt (1769–1859), there were few systematic attempts to record any patterns of distribution among animals and plants, or, in modern terms, any ecology or biogeography.

But natural history was not confined to zoology and botany; it also included the mineral kingdom, which in effect meant the sciences of the earth, or what was just beginning to be called geology. So it was in

FIGURE 12. A part of a typical sheet of the great *Atlas Minéralogique* of France, marked with spot-symbols representing the localities of distinctive rocks, minerals, and fossils, with a key in the margin. This portion of the map depicts an area about 25 km square to the east of Paris. By permission of the British Library.

geology that fieldwork—as more than mere collecting—first became an essential part of natural history. One telling sign of this was the *Atlas Minéralogique* of France. This was compiled by naturalists employed by the government of that superpower of the Age of Enlightenment, among them Antoine-Laurent Lavoisier (1743–1794), and it was based on what was then the world's most accurate and comprehensive topographical survey of its kind. On each sheet of this great mineral atlas, the topography was dotted with symbols for different rocks, minerals, and fossils (fig. 12).[10]

Maps, then, were an important way of picturing nature on a large scale: a way of discovering and then displaying patterns of distribution of all kinds of natural features, far more clearly than any number of

[10] Figure 12 is reproduced from Antoine-Grimoald Monnet et al., *Atlas Minéralogique de la France, Entrepris par Ordre du Roi* (Paris, 1780), part of sheet 27.

FIGURE 13. One of Nicolas Desmarest's detailed maps of specific areas in Auvergne in central France, based on his survey in the 1770s. It shows ancient lava flows that had originated in cratered volcanic cones, flowing down two parallel valleys; between them is a long narrow plateau capped with volcanic rock, which he interpreted as an even more ancient lava flow dating from a still earlier "epoch," isolated by subsequent erosion. By permission of the Syndics of Cambridge University Library.

words. Maps could display the outdoor field evidence for theories and explanations far beyond the scope of any indoor collection of specimens. And they could do so on many different scales, from the local to the global. For example, in the 1770s the French naturalist Nicolas Desmarest (1725–1815) compiled an innovative map of the province of Auvergne in central France, displaying the results of his detailed survey in the field (fig. 13). Sensationally, he interpreted the region as a landscape of extinct volcanoes, some of them as fresh and recent-looking as those that had been witnessed in eruption in other parts of the world, yet wholly unrecorded in the human history of Auvergne, which went back to Roman times. On a quite different scale, Buffon published maps of both polar regions, which he used to expound his theory that the earth is cooling gradually, on a vast timescale, from a white-hot origin towards a wholly icy end (fig. 14). Buffon argued that the Arctic ice was slowly encroaching on more temperate regions, having already wiped out the elephants that formerly roamed the shores of the Arctic

FIGURE 14. Buffon's map of the world in north polar projection, published in 1778, showing the extent of polar ice, which, Buffon argued, would spread inexorably further south as the earth continued to cool. By permission of the Syndics of Cambridge University Library.

Ocean, leaving their fossil bones (i.e., those of mammoths) beneath the Siberian tundra.[11]

[11] Figure 13 is reproduced from Nicolas Desmarest, "Mémoire sur la détermination de trois époques de la nature par les produits des volcans, et sur l'usage qu'on peut faire de ces époques dans l'étude des volcans," *Mémoires de l'Institut National des Sciences et des Arts, Classe des Sciences Mathématiques et Physiques* 6 (1806): 219–89, pl. 7; based on the survey published in preliminary form in Desmarest, "Extrait d'un mémoire sur la détermination de quelques époques de la nature par les produits de volcans, et sur l'usage de ces époques dans l'étude des volcans," *Observations sur la Physique, sur l'Histoire Naturelle et sur les Arts* 13 (1779): 115–26, pl. 15. Figure 14 is reproduced from Buffon, "Des époques de la nature" (1778), part of pl. opp. p. 615.

In both these cases, maps made it possible to transpose features found by fieldwork into the indoor arenas of scientific debate. In Buffon's case, he did not need to stir outside his director's office at the royal museum in Paris: he could examine the fossil bones and teeth brought there by others, from the Ohio or Siberia or wherever. But any specimens that Desmarest collected and took back to Paris were just that: mere specimens or samples, not the real thing. The extinct volcanoes themselves were huge and immobile. Yet Desmarest's map, based on his own fieldwork, did effectively bring his first-hand outdoor experience of the real thing into indoor Parisian arenas such as the Académie Royale des Sciences.

The other way of picturing nature on the large scale, complementing what maps could show, was literally to make pictures on the spot, which could then be transposed from outdoor locations to indoor settings. Proxy landscapes had a clear function within the practice of natural history in the Age of Enlightenment. They mobilised experience. A picture of the Alpine glacier that gives rise to the river Rhône, for example, could make glaciers vividly real to naturalists in, say, Paris or Berlin or here in Philadelphia, even if they had never seen a glacier with their own eyes (fig. 15). Likewise, Saussure published a picture of a huge structure of highly folded strata that he passed every time he travelled from his home in Geneva to Chamonix and Mont-Blanc (fig. 16). This gave the readers of his great *Voyages dans les Alpes* a vivid sense of how the place really looked. And this was no ordinary place. It was of exceptional scientific importance, because it bore on the profoundly difficult problem of accounting for the formation of mountains on the vast timescale of the earth's history.[12]

But the outstanding example of the use of proxy landscapes in natural history was *Campi Phlegraei*, the great illustrated book that Sir William Hamilton (1730–1803) published in the 1770s, while he was living at the foot of Vesuvius and acting as British ambassador in Naples. Among the many pictures of Vesuvius that his artist, Pietro Fabris, painted to illustrate this magnificent work was one of the eruption in 1760 (fig. 17). It was an accurate record of where the lavas had flowed; but it was not a straightforward proxy for the first-hand experience of observing the eruption, because it was drawn as if from a not-yet-invented hot air balloon. In other words, it adopted a pictorial

[12] Figure 15 is reproduced from Jean-Benjamin La Borde and Béat Fidèle Antoine Zurlauben, *Tableaux de la Suisse, ou Voyage Pittoresque fait dans les XIII Cantons et États Alliés au Corps Helvétique*, 4 vols. (Paris, 1784), pl. 181. Figure 16 is reproduced from Horace-Bénédict de Saussure, *Voyages dans les Alpes, précédés d'un Essai sur l'Histoire Naturelle des Environs de Genève*, 4 vols. (Neuchâtel, 1779–96), 1: pl. 4.

FIGURE 15. An engraving of the Rhône glacier in the Swiss Alps, published in 1780, showing the meltwater flowing from the rocky moraine at the snout of the glacier. By permission of the Wellcome Library, London.

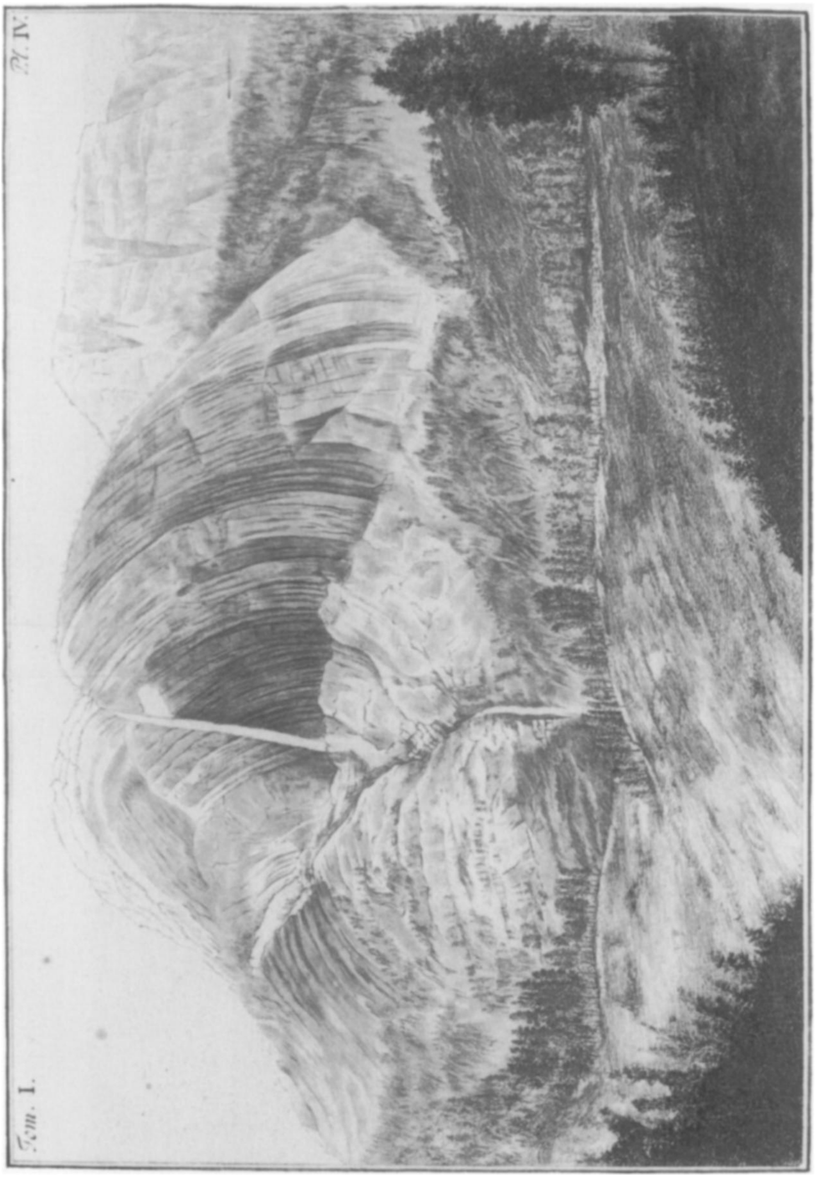

FIGURE 16. An engraving of the eight-hundred-foot waterfall of Nant d'Arpenaz in the French Alps, published by Horace-Bénédict de Saussure in 1779, showing a huge structure of folded strata of solid rock. By permission of the Syndics of Cambridge University Library.

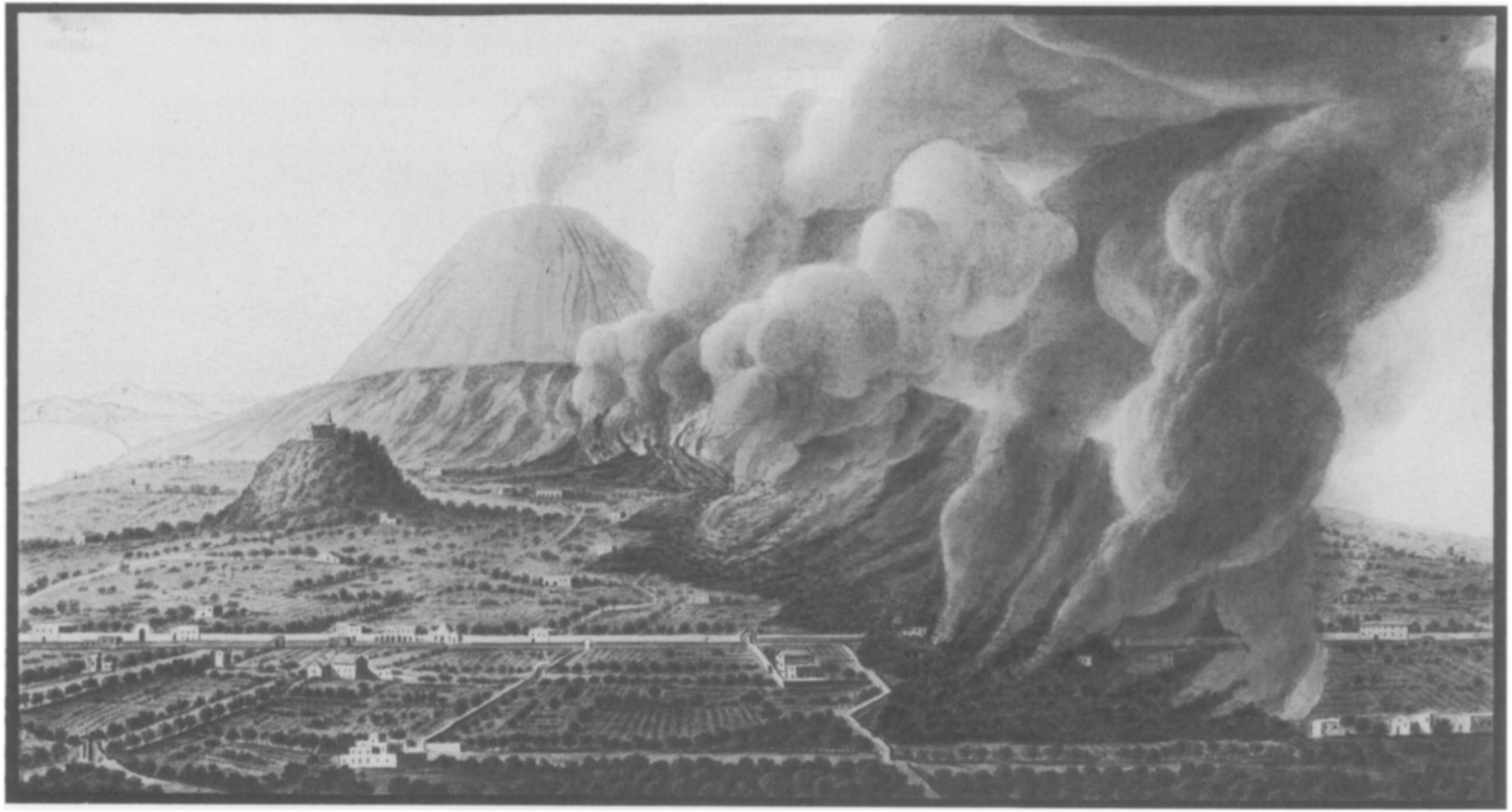

FIGURE 17. An etching of the eruption of Vesuvius in 1760, based on a painting by Pietro Fabris and published in Sir William Hamilton's *Campi Phlegraei* (1776). By permission of the Wellcome Library, London.

FIGURE 18. Fabris's etching of Etna, some ten thousand feet in height and Europe's largest volcano, with the town of Catania in the foreground, published in Hamilton's great book on the Italian volcanoes. Of the many smaller cones on the flanks of the main volcano, the one on the left had been formed in the eruption of 1669, but many of the others apparently dated from before even the earliest human records. By permission of the Syndics of Cambridge University Library.

convention often used at this time for views of cities: an imaginary aerial view, halfway between a landscape and a map. A picture more typical of Hamilton's book is a landscape view of the far larger volcano Etna in Sicily, rising ten thousand feet above the Mediterranean (fig. 18). This, too, adopted a well-established artistic genre, that of picturesque landscapes with figures in the foreground. But Hamilton's picture adapted that genre for scientific purposes, because it displayed the vast scale of the volcano and hinted at its equally vast age. The volcano, Hamilton claimed, dwarfed human life in both space and time.[13]

In the Age of Enlightenment, travel was by our standards slow, uncomfortable, and expensive, and often hazardous, too. So proxy pictures were a vital component in the life of naturalists everywhere. I have argued that the sciences of the earth led the way in this respect, because their scope became far wider than the sciences of living things: rather than just collecting specimens and assembling them in museums, the sciences of the earth focused attention on the large-scale features of the natural world. Features such as mountains and volcanoes were far too large to be transported to the indoor places where savants could discuss their causes and their significance. Hamilton's pictures—or, rather, the pictures that Fabris painted to his instructions—mobilised his first-hand knowledge of volcanic eruptions, making that experience vivid and credible to the readers—or rather, the viewers—of his book, wherever they were, and even if they had never been near a volcano. To be effective proxies, they had to be trusted as honest and accurate depictions of what Hamilton had truly seen at first hand. So in depicting a volcanic landscape in the Campi Flegrei near Naples, Hamilton got Fabris to portray him in the foreground, as if to say, "I, William Hamilton, really saw this view with my own eyes" (fig. 19). And in an accurate record of an eruption of Vesuvius on a particular night in 1771, Fabris depicted not only Hamilton explaining the molten lava to the king and queen of the Two Sicilies in person, but also himself, the artist, faithfully recording the scene (fig. 20). This made it doubly explicit that the picture could be taken to be a reliable proxy, an accurate representation of this striking natural phenomenon.[14]

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[13] Figures 17 and 18 are reproduced from William Hamilton, *Campi Phlegraei: Observations on the Volcanos of the Two Sicilies, as they have been communicated to the Royal Society of London* (Naples, 1776), pls. 12, 36.

[14] Figures 19 and 20 are reproduced from Hamilton, *Campi Phlegraei* (1776), pls. 26, 38.

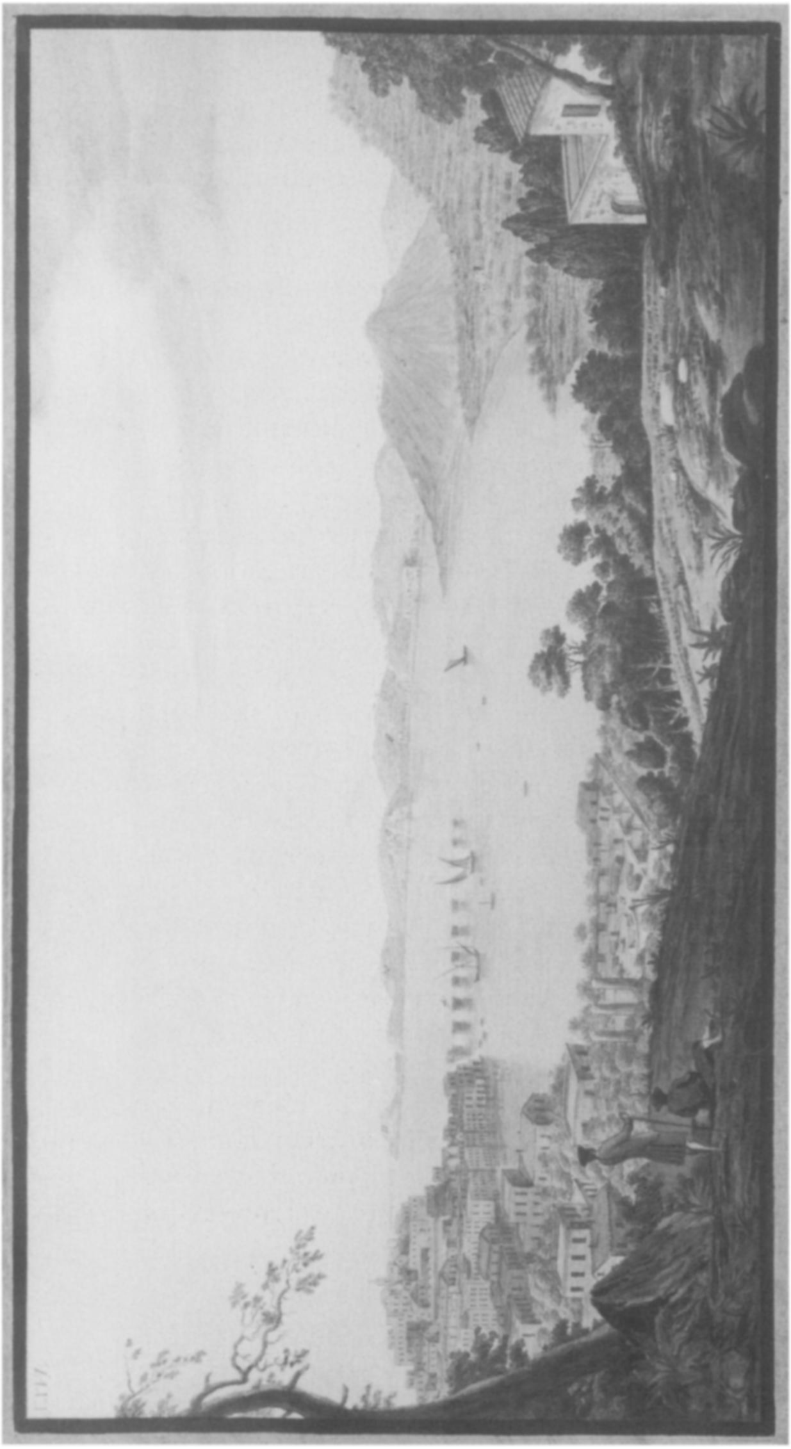

FIGURE 19. Fabris's etching of the coastline of the volcanic Phlegrean Fields near Naples, with the town of Pozzuoli (left) and a cratered volcanic cone that had been formed in 1538 (right), published by Hamilton in 1776. By permission of the Syndics of Cambridge University Library.

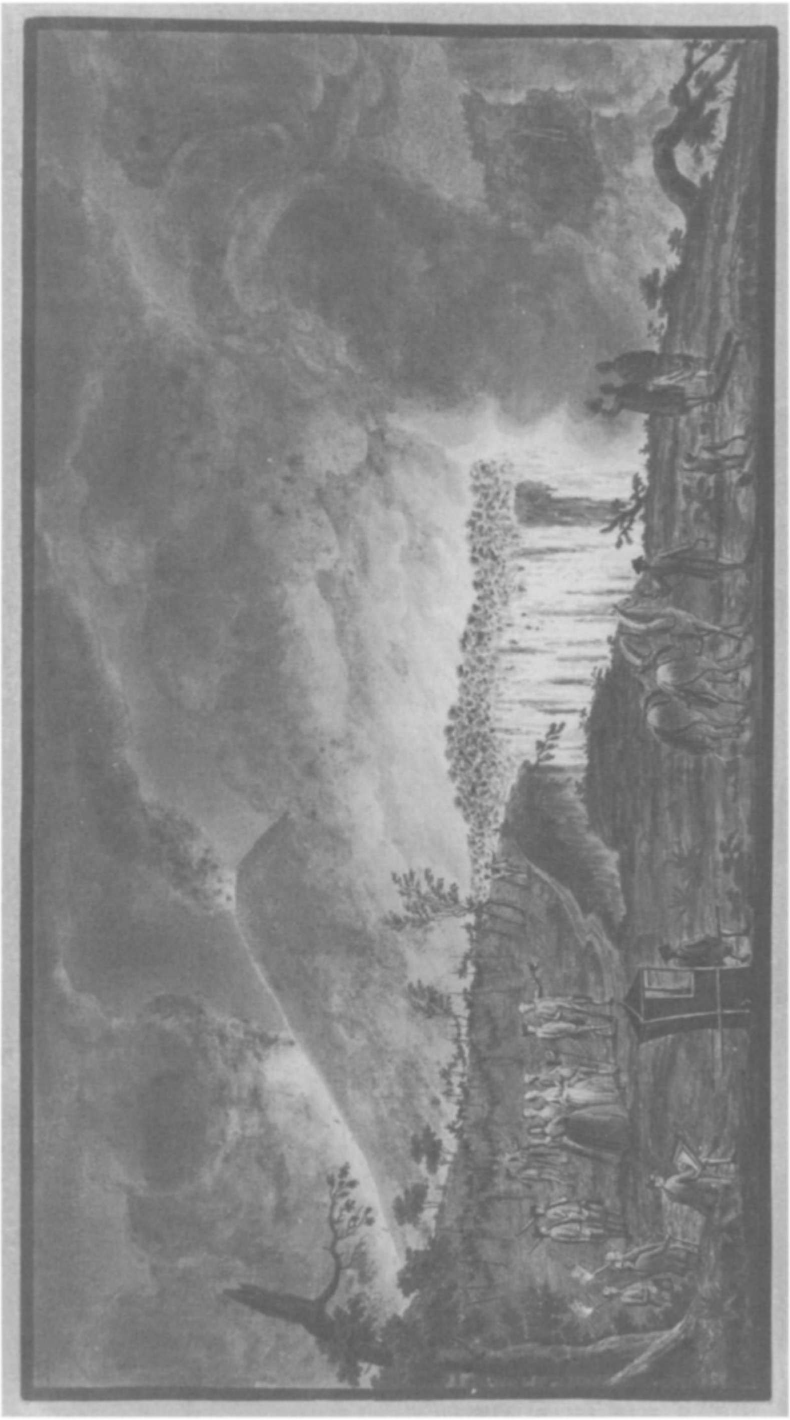

FIGURE 20. Hamilton demonstrating a lava flow to the king and queen of the Two Sicilies and their courtiers, during an eruption of Vesuvius in 1771: an etching based on the drawing that Fabris (left foreground) made on the spot, which was published by Hamilton in 1776. By permission of the Syndics of Cambridge University Library.

Conclusion

To conclude: picturing nature—literally, making pictures of the natural world—was an essential part of the practice of natural history in the Age of Enlightenment. Pictures of animals and plants are perhaps most familiar, and they were matched by similar pictures of inanimate objects such as minerals and fossils. Whatever the object—animal, vegetable, or mineral—such pictures acted as effective proxies, provided they were drawn or painted with all the realism of contemporary still-life art. Specimens that in reality remained in one place were mobilised and made accessible in other places. Collections of real specimens were supplemented with museums on paper, vastly enlarging the range of material available to naturalists in their work of description and classification. But it was in the mineral kingdom that the scientific potential of pictorial proxies was exploited most fully. The sciences of the earth—soon to be given their modern name of geology—were in the forefront, because increasingly they were taking the large-scale immobile features of nature as their central concern. Mountains and volcanoes could not themselves be brought into the meeting rooms of scientific societies such as yours here in Philadelphia. But maps and landscape views could be transposed in that way, and they could act as effective proxies for the first-hand experience of fieldwork. And of course they still do.