From: P.L. Farber, Finding Order in Nature (JHP: Baltimore, 2000)

1 Collecting, Classifying, and Interpreting Nature

Linnaeus and Buffon, 1735–1788

Natural history emerged in its modern form as a scientific subject in the eighteenth century. Although many people took part in the enterprise, two were central in defining it and giving it direction: the Swedish botanist Carl Linnaeus and a French nobleman and student of nature, Georges Louis Leclerc, comte de Buffon. They came to natural history from different backgrounds and brought to it different perspectives. At the time, no formal training in natural history was available. Universities did not include it as a subject of study, nor did anyone consider it a profession or an occupation.

Linnaeus received some knowledge of natural history by way of the related discipline of medicine. Medical education included the study of anatomy, physiology, and medical botany, and consequently served as a common path to natural history. Many of the early naturalists had similar experiences. Buffon, in contrast, had a general interest in science and what today we would call forestry. Although the two naturalists approached nature from dissimilar perspectives (and harbored professional jealousies), their work came to serve as a foundation for modern natural history. The combined result of their efforts was the development of principles by which to rationally name and classify the natural products of the entire globe. Equally important, Linnaeus and Buffon sought to understand what they believed to be an overarching natural order, bound by specific—and discernible—laws.

Linnaeus

Medical education in Europe in the 1700s reflected its medieval origins. Major countries such as England and France rarely had more than one or two modestly sized medical schools. In these institutions education stressed texts rather than direct experience. Many offered a degree without requiring a person to have studied there, provided that the individual could pass an exam and present an original thesis on a medical topic. Students often had few attractive options, and those from smaller European nations often had to travel to foreign countries to study. Many went to Dutch schools, which were the most celebrated of the time.

During the early eighteenth century, the United Netherlands consisted of seven semi-independent states, six of which had universities. The University of Leiden, the oldest and best-known in the Netherlands, was in the state of Holland and was internationally renowned for its medical training. It had high fees, however, and stiff requirements for a degree. Leiden did not permit students trained elsewhere to obtain a degree by simply presenting a previously prepared thesis and passing an exam. This was in contrast to other medical faculties. For example, at Harderwijk University, in the state of Gelderland, medical candidates could acquire a degree in only a week's time—and at a substantially reduced rate. So, in 1735, Carl Linnaeus, son of a Swedish village clergyman, traveled to Harderwijk University with the goal of obtaining a medical degree. By June 23, six days after his arrival there, he was a Doctor of Medicine.

The twenty-eight-year-old Linnaeus had studied medicine in Lund and Uppsala (although because of the pathetic state of medical education at both Swedish universities he was largely self-taught). He had brought with him to Harderwijk a thesis entitled "A new hypothesis as to the cause of intermittent fevers," which argued that certain fevers resulted from living on clay soils. Linnaeus aspired to a career back in Sweden, and for this he considered a medical degree from a prestigious Dutch university to be critical. Before leaving Sweden he had proposed to the eighteen-year-old daughter of the town physician in the mining center of Falun. The significant dowry his wife would bring to the marriage would help him get established.

Of greater significance to his professional aspirations was that Linnaeus brought to the Netherlands a set of his writings which so greatly impressed an influential circle of Dutch physicians and amateur naturalists that they persuaded him to stay in the Netherlands for three years. During those years he published his earlier writings, along with several newer manuscripts. It was a remarkable period, for in these works he sketched many of the basic ideas he would develop for the rest of his rich and productive life.

Linnaeus concerned himself primarily with the naming and classifying of natural objects. His interest in these activities reflected their importance to the study of natural history in Linnaeus's time: Europeans each year encountered thousands of new species of animals and plants, plus numerous new rocks and minerals. For decades, the botanical gardens in Amsterdam and Leiden had been major centers for receiving plants from Dutch colonial and trading voy-

ages. Many of these exotic plants from Africa, the New World, the Pacific Islands, and Asia were unknown to European science. Naturalists examined these specimens in order to document the Creation and to keep better track of potentially valuable natural products. Along with their French and British counterparts, Dutch merchants and bankers strove to expand their interests around the world. They wisely encouraged the growth of natural history for practical reasons. At the same time, Europeans recorded local species in ever greater detail.

Linnaeus had firsthand experience with the riches of new specimens. Three years before he went to the Netherlands he secured a grant from the Swedish Royal Society of Science to explore the largely unknown natural history of Lapland. For five months he traveled, observed, and collected animals, plants, and minerals in the far North. Later, while in Amsterdam in 1737, he published a botanical account of his trip, the *Flora Lapponica.* On the Lapland expedition he gained direct knowledge of an exotic habitat and a sense of the enormous physical difficulties facing field naturalists. When an influential medical figure asked him to travel to southern Africa to collect plants for Dutch collections (with the added bait of a possible professorship upon his return), Linnaeus turned the offer down. He had a more comfortable alternative, one that would extend his training in natural history. For two years after receiving his medical degree, he served as the superintendent of the garden (and as house physician) to George Clifford, a wealthy financier and director of the Dutch East India Company. The garden and its hothouses contained specimens from southern Europe, Asia, Africa, and the New World. A private zoo housed a dazzling set of exotic animals ranging from tigers to rare birds.

Linnaeus's experiences in Lapland and in Clifford's gardens gave him a vivid sense of the rapidly developing richness of natural history. Though exciting, the new material did raise problems. Foremost, both the exotic and local material presented a confusing picture because much of it did not easily fit into older classification systems. With no standardized procedure for naming plants, animals, and minerals, authors often gave different names to the same plant. They also sometimes failed to recognize male, female, and juvenile forms of the same animal and named them as three different species.

The first manuscript that Linnaeus published after his doctoral thesis consisted of just twelve printed pages. In the *Systema naturae* (1735), he outlined a general system that he believed would bring order to natural history, a task he considered critical. "The first step in wisdom is to know the things themselves," he wrote in his opening remarks. "This notion consists in having a true idea of the objects; objects are distinguished and known by classifying them methodically and giving them appropriate names. Therefore, classification and name-giving will be the foundation of our science."*

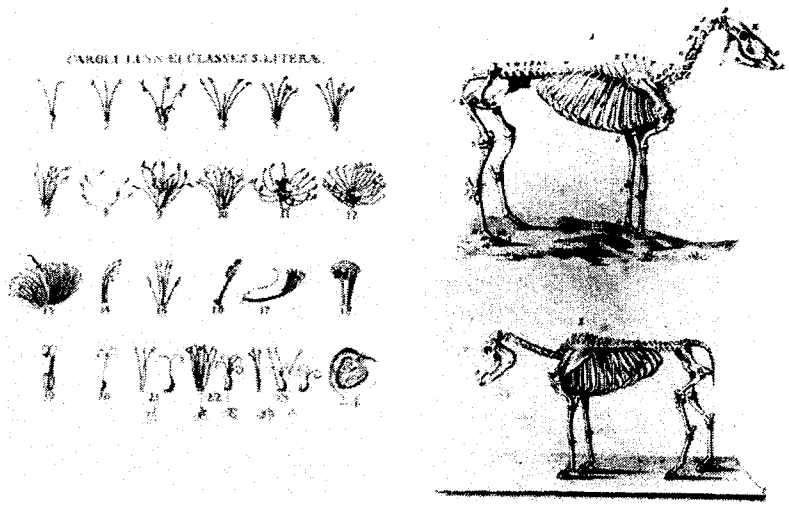
The *Systema naturae* proposed a new system of classification for plants, animals, and minerals. The most original and influential section contained a sexual system of classification for plants. Although the ancients had not understood that plants reproduce sexually, European naturalists by the end of the seventeenth century did. Linnaeus created a brilliantly simple hierarchical system that arranged plants into twenty-four classes according to the number and relative position of their stamens (male parts). He broke down the classes into sixty-five orders, primarily on the basis of the number and position of the pistils (female parts). Using other characteristics, Linnaeus went on to distinguish particular genera, consisting of groups of species with similar characteristics, and even more particular species. The system's simplicity and relative ease of application made it appealing. He used the system in his flora of Lapland and in the splendid catalog he published of Clifford's garden (*Hortus Cliffortianus,* 1738).

Compare Linnaeus's system to that of Joseph Pitton de Tournefort, the famous seventeenth-century French botanist. Tournefort believed that anyone who was serious about the subject should be able to memorize the 698 natural genera that encompassed the 10,000 species then known. By contrast, Linnaeus provided amateurs, travelers, and gardeners with a simpler and more practical method. Acknowledging that his method did not reflect any "real" order in nature, Linnaeus believed that naturalists nevertheless should use his "artificial" system until he developed one that actually conveyed God's plan in nature. He worked the rest of his life at constructing such a "natural" system but was, in the end, unable to formulate one satisfactorily. The sexual system, in the meantime, was widely accepted throughout most of Europe.

In his classification, Linnaeus used terminology that reflected his cultural background. Instead of employing terms like *stamen* or *pistil,* he chose the Greek for "husband" (*andria*) and "wife" (*gynia*). The names of the classes, for example, were *monandria, diantria, triandria,* and so on, reflecting the various types of "marriages" in plants. With the exception of the *monandria,* in which there was one husband and one wife, the others involved multiple so-called husbands, concubines, and other decidedly irregular arrangements. Although some naturalists were shocked by Linnaeus's sexual imagery, his terms stuck.

More important than Linnaeus's use of metaphor were his new rules for

*Carolus Linnaeus, *Systema naturae: Facsimile of the First Edition* (1735; Nieuwkoop: B. De-Graaf, 1964), 19.



A B

Naming Plants and Animals

Classification systems fall into two general categories: artificial and natural. An *artificial system* is a means of organizing and retrieving information and makes no claims about the intrinsic or actual relations among groups that the system defines and orders. Descriptive guides to birds or to wild flowers often rely on artificial classifications—on color alone, for example. Linnaeus achieved great fame for his sexual system of classification (*A*). He divided plants into twenty-four classes based on the number of stamens (male sex organ) of the flower or the stamens' positions or relationships (e.g., four long stamens and two short ones). The first eleven classes, for example, are defined by the number of stamens (one, two, etc.).

A *natural system,* on the other hand, attempts to reflect actual relationships in nature. Buffon believed that he had uncovered among quadrupeds a natural order that reflected historical changes they had undergone. He explained the close anatomical similarity of the horse, zebra, and ass by hypothesizing that they were all descendants of an original stock of horses. A comparison (*B*) of the horse (*top*) and the ass (*bottom*) skeleton shows their close similarity.

■ *A,* From G. D. Ehret's plate (1736) appended to Carolus Linnaeus, *Systema naturae* (Leiden: Haak, 1735). *B,* Georges Louis Leclerc, comte de Buffon, *Oeuvres complètes de Buffon* (Brussels: Lejeune, 1828), vol. 6, pl. 10.

nomenclature, or naming plants. Previously the scientific names of plants consisted of two parts: a word (or words) denoting a group of plants, and then a string of characteristics that distinguished the plant from other similar ones. Because no agreed-upon list of names existed and because over the years writers had used different characteristics to name the same plant, considerable confusion had ensued. Linnaeus's reform made plant names more like people's names: a single name common to all the species in a genus, and another, specific name that distinguished the species from others in the genus.

The basic ideas of Linnaeus's binomial (two-word) nomenclature appeared in a manuscript he published in 1736. He later expanded on his principles and used them in his *Species plantarum* (1753), which recorded all known species of plants. The practice quickly caught on. To this day naturalists use the *Species plantarum* (along with the fifth edition of his *Genera plantarum*) as the starting point for botanical nomenclature. Linnaeus also set down rules for selecting names. The names of genera, for example, have Greek or Latin roots only and may not be compounds of two words or commemorate saints or people unconnected with science.

For Linnaeus the naming and ordering of the products of Creation linked the study of nature with the worship of God. Linnaeus's conception of order reflected his vision of Creation as a balanced and harmonious system. Classification, he thought, could reflect that harmony. In his later writings Linnaeus also described a general balance of nature. Every plant and animal fills a particular place in the network of life and helps maintain that network. Carnivores, he observed, daily destroy animals that if unchecked, would reproduce so quickly as to outstrip their sources of food. Such intricate relationships offered proof of a divinely sanctioned balance. The reciprocal relationship of predator and prey linked each in the overall harmonious, static system. Linnaeus believed that the first species had the same relationships in nature as they do now, even after dispersing from their place of creation to their assigned regions, where they have been found ever since. Linnaeus also initially insisted that the species themselves had not changed since their creation, but he later modified this view to accept the idea that hybridization in time had produced new species from the original ones.

Linnaeus stressed the abundance of nature, and he endeavored to catalog it as fully as possible. In the Netherlands he examined magnificent public and private collections, and upon his return to Uppsala he continued his study in the university gardens and created a sizable personal collection. However grand European collections appeared, Linnaeus knew they were nowhere near complete, and so he corresponded with naturalists throughout the world who were

eager to have him include their findings in the successive editions of his *Systema naturae.* In his desire to extend his grasp worldwide he actively encouraged his students to undertake extensive voyages to help complete his catalog of life. These explorations afforded adventurous naturalists excitement and challenge. Linnaeus called these students his "apostles." They amassed great collections, and their work extended botanical knowledge. For example, Daniel Solander sailed with the English explorer Captain James Cook on Cook's first voyage around the world. Others traveled to North America, South America, Asia, and throughout the Pacific and returned with impressive natural history collections.

Eighteenth-century travel, exhilarating as it may have been, posed serious risks. Linnaeus had recommended his favorite pupil, Pehr Löfling, to the Spanish ambassador in Stockholm, who, on behalf of the King of Spain, was looking for a young naturalist to study the plants of Spain. The young Löfling left for Spain and collected for two years. Shortly thereafter, he sailed to South America, where the climate proved lethal—he succumbed to a fever at only twenty-seven years of age. Similarly, Linnaeus's old companion Christopher Tärnström, a married clergyman with a family, had ambitions to collect in China. He secured free passage on a Swedish East Indian Company ship but got only as far as Indochina, where he caught a tropical fever and died, leaving his widow and children destitute.

The dangers of expeditions, however, did not deter young enthusiasts. Numerous opportunities existed for them because European powers encouraged natural history exploration on account of the potential commercial value of foreign species. European imperialism sought political control to further economic advantages, and the search for natural resources played an important role in European expansion. In naming and arranging products from around the globe, naturalists aided imperial expansion and also implicitly expressed a cultural imperialism. Native peoples might live among a profusion of birds and plants—indeed, the tropics contained a greater diversity than any European country—but from Linnaeus's perspective the local inhabitants were lacking the most basic knowledge. They did not know who created the plants and animals surrounding them, what these objects should properly be called, and how they fit into the established order. According to Linnaeus, the local names possessed no scientific value, nor did they reflect a deeper religious recognition of God's Creation, His Design, or His Will. Just as missionaries attempted to save the souls of indigenous peoples, Linnaeus's apostles sought to save the species of the world for a second naming.

Linnaeus expressed little modesty about his place in this great enterprise.

Adam may have been the first to name God's creatures, but Linnaeus claimed an equally important place. "God has suffered him to peep into his secret cabinet," he wrote, referring to himself in the third person. "God has suffered him to see more of his created work than any mortal before him. God has endowed him with the greatest insight into natural knowledge, greater than any has ever gained. The Lord has been with him, whithersoever he has gone, and has exterminated all his enemies for him, and has made of him a great name, as one of the great ones of the earth."*

Buffon

Linnaeus's main competitor for international preeminence, also born in 1707, outlived him by ten years and was equally significant in the establishment of the modern tradition of natural history. Although they shared a love of nature and a passion for natural history, the two had little else in common. Linnaeus lived the bulk of his career in a small university town, while his rival situated himself in the grandest city of that century, Paris, and served in a highly visible post in the French scientific establishment.

On July 26, 1739, Louis XV of France appointed Georges Louis Leclerc de Buffon, the oldest son of a socially mobile Burgundian family, director of the Royal Garden. The position carried a modest salary and living quarters in the Jardin du roi, as the garden was called. Most important was the prestige and patronage associated with being the head of a royal institution. Buffon, later comte de Buffon, soon became a force to be reckoned with in Paris.

Although politically astute and scientifically informed, Buffon gained his reputation more for his work in the physical than biological sciences. He contributed to introducing Newtonian science in France by translating Isaac Newton's work on the calculus into French, and he entered the Academy of Sciences in 1733 as a member of the mechanics section. The Royal Garden concerned itself with a different set of issues. Louis XIII had established the Jardin du roi in 1635 as a botanical garden for the study of medicinal plants. By Buffon's day, successive directors had expanded its activities. A professional staff gave public lectures on botany, chemistry, and anatomy; gardeners cultivated a wide range of plants; and one of its buildings housed the king's natural history cabinet, or Cabinet du roi.

Although his background did not suggest much expertise in managing such

*Quoted and translated in Knut Hagberg, *Carl Linnaeus* (New York: E. P. Dutton & Co., 1953), 208. The original appears in Elis Malestrom and Arvid Uggla, eds., *Vita Caroli Linaei: Carl von Linnés Självbiografier* (Stockholm: Almqvist & Wiksell, 1957), 146.

activities, Buffon harbored some interests in natural history, and fortunately for him they carried considerable political cachet. His work on the strength of wood and the cultivation of forests, for example, proved to be especially relevant. Louis XV's naval minister, the comte de Maurepas, requested that Buffon collaborate with a well-known scientist to investigate problems in reforestation and improving lumber for ships. The research resulted in several publications as well as a successful commercial venture for Buffon. Later, Maurepas was crucial in supporting Buffon for the directorship of the Jardin du roi.

Buffon's career at the Royal Garden turned out brilliantly. He doubled the size of the garden and vastly increased the natural history collection. With Buffon at the helm, the Jardin du roi developed into the foremost institution in its day for the study of the living world.

Buffon's administrative prowess, however, was not the source of his lasting reputation. Instead, his fame rests on an enterprise that he conceived soon after becoming director of the Jardin du roi. Great collections typically had catalogs (which reflected glory on the collection owner), and one of Buffon's first tasks at the royal garden was to produce a catalog of the king's natural history cabinet. Rather than prepare an annotated list of the curiosities and rarities contained in the royal collection, Buffon envisioned a monumental work: a complete natural history of all living beings and minerals. He estimated that the project would take about ten years—a serious underestimation. Buffon would find it necessary to repeatedly revise his timetable. Over a period of almost fifty years, for the remainder of his life, he published thirty-six volumes in which he outlined a theory of the earth and compiled a natural history of humans, minerals, quadrupeds, and birds. (A team of specialists completed the remaining untreated topics during the two decades after his death.)

Buffon's project to write a comprehensive natural history surpassed any earlier attempts. What would be Buffon's resources for such a monumental effort? His education in Dijon, first at a Jesuit college and then at the law faculty, had not included natural history. So, in preparation for his task, Buffon systematically compiled all previous work related to his concerns. He found the ancients—especially Aristotle and Pliny—to be of greater value than more recent authors.

Aristotle, in his *History of Animals,* stressed the value of detailed, firsthand observation, and he collected an impressive amount of information with the goal of uncovering general principles. He assumed that the living world had a general order to it, and, although he did not construct a system to classify that order, he provided many possible starting points for creating one. For Buffon,

The Twinflower

Linnaeus, who named so many plants and animals, has only one plant named in his honor, the *Linnaea borealis,* commonly called the twinflower. It is a surprisingly modest plant to carry such a weighty honor. Linnaeus with a bit of false modesty described it in one of his writings as a lowly insignificant plant, generally disregarded—like himself.

■ *Linnaea borealis,* 1797; author's collection.

Aristotle's writings reinforced his conviction that natural history should be founded on extensive observational knowledge and that it should aim to go beyond particulars to construct an overall picture of the order in nature.

Aristotle supplied an important inspiration, but it was in the writings of his successor, the Roman author Pliny, that Buffon found his model. Since late antiquity readers had respected Pliny as the greatest authority in natural history. In his thirty-seven-book encyclopedia of the natural world, Pliny claimed to have consulted all of the earlier work of Greek and Roman authors. He effectively combined the information to create a comprehensive survey of the natural world: the heavens, the earth, and the animals, plants, and minerals. Individual articles in his encyclopedia that were especially engaging were read by generations of those curious about nature. Later writers added new information and occasionally challenged specific points, but Pliny's status remained high from antiquity through the eighteenth century. Buffon praised Pliny and frequently quoted from his natural history. Like other authors of his time, Buffon was tolerant of Pliny's fabulous tales and seemingly gullible reports—such as that those who gather honey from hives will avoid bee stings if they carry a woodpecker's beak. Such flaws, Buffon reasoned, could easily be corrected. Buffon saved his contempt for authors of the previous two centuries, whom he castigated for gross inaccuracy and mindless compilation.

From the fourteenth through sixteenth centuries, Renaissance humanists sought to supplement ancient Greek and Roman botanical texts with information about plants unknown to Mediterranean authors. Initially, their interest focused on plants of medicinal value, but it soon expanded to include all plants and animals. Their writings were enhanced with realistic woodcuts by Renaissance artists, creating a golden age of nature books in the early sixteenth century. Otto Brunfels's splendid *Living Images of Plants* (1530) is an especially fine example.

Buffon, however, did not appreciate these works. In his opinion Renaissance humanists uncritically gathered all writings about nature without distinguishing reliable observations from fictional or symbolic stories. Ulisse Aldrovandi, for example, published well-known books on natural history. He reproduced fabulous tales and moral lessons as well as reports of investigations he had conducted in his museum. He sought to delight as well as to instruct, and thus also included popular "emblems," a literary and artistic genre of the Renaissance. An emblem generally consisted of a motto, an illustration, and a short poem that was witty or delivered a particular message (such as the value of patience). Since many of these emblems made use of animals, they offered a rich literary tradition from which authors such as Aldrovandi could draw.

Like other Renaissance naturalists, Aldrovandi worked in a profoundly Christian framework; the hand of God, the Creator, could readily be found in all of history, nature, and art. The study of nature led to a natural theology that complemented the revealed theology of Scripture. Buffon's more secular perspective led him to dismiss much of what Renaissance authors wrote as worthless. In his famous discourse on method, placed at the beginning of his *Histoire naturelle,* he stated that if one were to delete all that was irrelevant to the study of nature in Aldrovandi's writings, only one-tenth would remain.

Naturalists in the seventeenth century expanded the observational base of natural history and were more selective in what they included. For Buffon, however, if the study of the living world aspired to be a science—not merely a literary endeavor—an even more rigorous method would be necessary. To set an example, he included in his first fifteen volumes, on the quadrupeds, anatomical descriptions of internal and external characteristics of animals based on specimens in the royal collection. He summarized the most recent knowledge on distribution, breeding habits, life stages, varieties, behavior, and environmental setting, as well as listed the different names given to the animal through the ages by other naturalists.

Buffon patterned the overall structure of the *Histoire naturelle* after Pliny's work, but he dramatically improved its scientific value. Each volume contained

engravings to accompany the written descriptions, and interspersed among the detailed articles were general essays that synthesized Buffon's investigations on animal generation, distribution, and classification. Buffon had the advantage over Pliny of having at his disposal a significant natural history collection. He worked assiduously to expand the holdings of the Cabinet du roi, and he succeeded in building it into the greatest collection in Europe at the time. Like Linnaeus, he established a worldwide network of correspondents who sent specimens to the Paris museum, and like his great rival to the north, he also possessed an almost complete library of European literature in natural history.

Although Buffon lacked the knowledge that Chinese and Indian scholars had accumulated, and he dismissed information from the many indigenous peoples the French encountered throughout the globe in the eighteenth century, he nonetheless had resources that dwarfed anything Pliny could have imagined. Buffon's encyclopedia of nature, therefore, reflected a qualitatively different subject matter than found in earlier literature in natural history. Buffon's *Histoire naturelle* helped create a new tradition by presenting detailed studies on a comprehensive scale and by using these studies to attempt to uncover the order in nature.

Buffon's natural history also supplied one of the central documents of the Enlightenment, a new worldview that came into prominence after 1750, first in France and then throughout Europe. The philosophes, the major writers associated with the Enlightenment in France, sought to replace a traditional Christian worldview with a naturalistic one based on human reason. In their attempt to break with the past, the philosophes employed diverse intellectual tools. They used the writings of secular, classical Greek and Roman authors, seventeenth-century skeptics who questioned Christian dogma, and foreign philosophical traditions, particularly English writers who stressed the value of observation. Enlightenment thinkers envisioned new intellectual foundations for government, morality, politics, and art. In their naturalistic worldview, science held a privileged position. They regarded Newton's physical science as the epitome of objective investigation, and writers such as Voltaire popularized the "new English science."

In an attempt to free their contemporaries from Christianity, the philosophes constructed an alternative theological view that depicted God as an abstract geometrician who established matter and the laws of motion but left the system to work out the details on its own. The earth and life sciences could not easily develop out of this deist position. Natural history focused on the particular and stressed diversity. To complicate the issue, theologians who were inclined to tolerate an alternative theological view of the heavens were more

Nature's Caprices

Many naturalists of the eighteenth century described nature as perfect and argued that such perfection reflected God's wisdom and, indeed, proved the existence of a divine Creator. Linnaeus held that God's plan encompassed the appearance of plants and animals, as well as their distribution and relationships.

Buffon, in contrast, argued from a secular perspective and acknowledged the existence of monsters and "less happy" creations in nature. Their existence, he contended, contradicted the religious arguments based on a simplistic notion of nature's perfection. One of his favorite examples of nature's "mistakes" was the toucan. Its beak, Buffon held, was excessively large and impractical.

■ Georges Louis Leclerc, comte de Buffon, *Oeuvres complètes de Buffon* (Brussels: Lejeune, 1828), vol. 13, pl. 127.

conservative when it came to natural history. The theologians of the University of Paris, for example, insisted upon a literal reading of Genesis, and an extensive literature of natural theology had developed which argued that the living world stood as a proof of God's existence and a reflection of his moral laws.

Buffon's encyclopedia supplied a new, secular conception of natural history. Buffon crafted his interpretation in the philosophe style: a clear, popular presentation based on accurate information and understandable to the average educated reader. His articles described nature's wonders, and his essays uncovered its order. As important, his work broke with the Christian tradition that had informed European natural history for two centuries; more accurately, perhaps, he transformed that tradition. For Buffon, like other philosophes, believed in an all-pervasive design in nature. He did not regard that design as the handiwork of a personal Christian God whose truths were to be found in the book of nature as well as in Scripture. Instead, Buffon reified nature into a generative power responsible for the harmony, balance, and fullness of creation. His reinterpretation did not simply stand natural theology on its head by providing a nonreligious interpretation of accepted opinions; rather, it provided a new vision of the living world. Buffon contended that the living world, like the physical world, followed natural laws that investigation could discover. He

considered nature an end in itself, however, not a reflection of a higher reality. No suggestion of a Christian Creator or the Christian story of Creation constituted part of his vision.

Buffon even challenged one of the basic premises of natural theology: the perfection of Creation. Although he often described the harmony and beauty in nature, he wrote that "in the middle of the magnificent spectacle" there were "some unheeded productions and some less happy." In his article on the toucan, for example, Buffon explained that nature produces not only monsters like two-headed calves but also monstrous kinds like the toucan, whose beak is "unnatural":

> The true characteristics of nature's errors are disproportion joined to uselessness. All animal parts which are excessive, superabundant, or placed absurdly, and which are at the same time more detrimental than useful, should not be placed in the grand scheme of nature's immediate designs but in the small scheme of its caprices, or if one likes, its mistakes . . . and that whatever proportions, regularity, and symmetry reign ordinarily in all nature's works, the disproportions, the excesses, and the defects demonstrate to us that the extent of its power is not at all limited to those ideas of proportion and regularity to which we would like to fit everything.*

The perfection of nature, then, if one could legitimately speak of it at all, did not consist in the perfection of design or perfection of adaptation. It was not the product of an all-wise and consummate craftsman, who inspired a sense of awe in those who gazed upon his Creation. Rather, the perfection of nature was reflected in the completeness of nature—all that can exist, does.

Buffon's secular vision of nature provided an attractive alternative to Genesis because, in his natural history, Buffon stressed the historical development of Earth and its products. In Buffon's writings, contemporaries found a description of how and when Earth came into being, as well as of the formation of animals, plants, and minerals. Buffon's readers could follow Earth's history from its early molten state to its present stage and could learn the reasons for the current distribution of living forms on the surface of the globe. Buffon explained what animals then existed, how and why they had changed over time, and how fossils had formed.

All of this was described in the *Histoire naturelle* without reference to Scripture or to the direct action of a supernatural power. Instead, Buffon claimed that a basic set of forces, analogous to Newton's concept of gravity, existed and

*Georges Louis Leclerc, comte de Buffon, *Histoire naturelle des oiseaux* (Paris: Imprimerie Royale, 1781), 7:108–9. My translation.

gave rise to animal form and function. These "internal molding forces," as Buffon called them, worked on organic molecules, themselves the result of a chemical evolution on Earth, and thereby led to the diversity of life on the planet. The internal molding forces arose during the early development of the planet. The surrounding environment influenced their expression, and therefore the appearance of the resulting creatures altered over time as animals migrated or as climate and habitat changed. Species that belong to the same "families" would all share the same internal molding force and would be related through descent from an early primitive stock, which arose spontaneously. Dead-end variations left their traces as fossils. Geographical variation resulted from the differing expressions of the internal molding force in different environments.

Like Pliny, Buffon sought to supply his generation with a total picture of nature. He did so in a new fashion: historically. To understand the present, according to Buffon, one had to know the past. If a set of internal molding forces interacted with the environment over time, the key to explaining present-day living forms lay in uncovering the history of life on Earth. This historical dimension of Buffon's science opened a new perspective on life that future generations would develop extensively. It also fit well with a general tendency among the philosophes to explain the present by linking it to the past.

For his contemporaries, Buffon was significant mainly for having written a secular Genesis, which gave the appearance of being grounded on an extensive scientific foundation and on a broad observational base. His scientific peers criticized the underlying speculative elements of his writings, but they also appreciated its boldness. Buffon began to publish his secular creation story in 1749, one year after Montesquieu published his discourse on government, *The Spirit of the Laws.* Diderot and D'Alembert published their monumental project, the *Encyclopédie,* between 1751 and 1772. (It consisted of seventeen volumes of text plus eleven volumes of plates.) The *Encyclopédie* attempted to survey human knowledge from a secular perspective. More than any other document of the French Enlightenment, it served as a manifesto that argued for a rational approach to knowledge and a humane program to change people's thinking and encourage social, intellectual, economic, and political reform. Buffon's *Histoire naturelle, générale et particulière* appeared at a critical period in European thought. His contemporaries regarded it as *the* encyclopedia of the natural world, one that complemented the more general *Encyclopédie.*

The Legacy

Buffon's encyclopedia, combined with Linnaeus's brilliant work in classifying and naming, laid the foundation for the emergence of natural history as a scientific discipline during the second half of the eighteenth century. This is not to say that Buffon and Linnaeus saw themselves as partners. Linnaeus regarded Buffon's flowery prose as a distraction to those who sought knowledge of nature, and Buffon considered Linnaeus's classification systems as little more than boring tables in which to store information. But the combined result of their individual efforts was to set a new level of rigor in investigation, one that gave primary importance to knowledge gained through observation. Nature was seen to operate through natural laws and contained a structure that humans could fathom. The key to understanding nature did not come from Scripture, or contemplation, or mystical insight. It consisted in careful study, comparison, and generalization.

Linnaeus valued naming and classifying. For him, natural history's goal was to construct the catalog of life. The discipline, although based on observation, maintained a deep, religious significance. Many later naturalists who shared his taxonomic bent did so from a wholly secular point of view. In contrast, Buffon placed a secondary value on classification. For him, natural history as a science sought to uncover the broad outlines of the order in nature. That order constituted more than just a list of individual kinds. It portrayed a grand tableau on which natural relationships, driving forces, geographical distribution, and historical change could be recognized. To Buffon, this wondrous picture of nature inspired awe, but he consciously did not conceive of it as connected to the Judeo-Christian story of Creation, or the theological attempts to ground a belief in the existence of God in knowledge of the natural world.

Linnaeus and Buffon thought of themselves as representing different approaches to nature, but they had a lot in common. They each strove for an understanding of the order in nature, and they each chose to conduct their work using a large natural history collection rather than doing their own research out in the field. Museum-based, they valued the arrival of new specimens that would extend the global dimension of natural history. Each formed a network of correspondents to enlarge their collections. Linnaeus and Buffon grasped that much of the globe was still unexplored, leaving them ignorant of much of the planet's richness. They had supplied a foundation, but they knew it would remain for others to complete their project.