MUSEUMS
and
Other Institutions of Natural History
Past, Present, and Future

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Editors' Note

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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES

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Introduction to the Symposium and Volume

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In 2003, the California Academy of Sciences celebrated its 150th year of existence. Founded on 4 April 1853 by seven amateur naturalists with an abiding interest in the flora and fauna of their new surroundings, the Academy has grown to be one of the major research and public natural history museums in the world. As a public museum, it has devoted no less than 130,000 square feet of space to public exhibits. It has managed an on-site aquarium, ranked as one of the finest anywhere. It built from ground up its own planetarium, star projector included, which was hand crafted in the Academy's instrument shop, a holdover from the Second World War when it repaired optical equipment for the Navy. And, the Academy's leadership role in its outreach programs includes such innovative productions as *Science in Action*, a long-lived public television program under the guidance of and starring the late Academy Curator and Superintendent of the Academy's Steinhart Aquarium, Earl Stannard Herald; this program preceded *Nova* and other science education programs that are now so popular on television.

Although founded in 1853, the Academy, then known as the California Academy of Natural Sciences, a name subsequently shortened to California Academy of Sciences in 1868 during the presidency of Josiah Dwight Whitney, did not have its own museum building until 1874, when it acquired a lease on the recently vacated First Congregationalist Church on Dupont Street. It was there that the museum and its "cabinet" were opened to the public in 1876, during the hours of 9 a.m. and 4 p.m. daily, and there it remained until 1891. In 1891, the Academy moved lock-stock-and-barrel to a magnificent building built for it on Market Street, in downtown San Francisco. This event was made possible by the generosity of San Francisco hotel magnate, philanthropist, and recluse James Lick, who donated the land to the Academy in 1876 and additional moneys for the building on his death. In 1882, again through the generosity of other persons of wealth, namely Leland Stanford and Charles Crocker, the Academy acquired its first major materials for public exhibit from Henry Augustus Ward of Rochester, New York. This, plus the ethnographic, botanical, and zoological specimens, especially from Western North America, that Academy members had been donating over the 30-plus years of its existence, and the multiple donations of literally

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RESEARCH COLLECTIONS in large natural history museums, botanic gardens, and other institutions of natural history preserve samples of the worlds' biodiversity, living and extinct. They support not only research by scientists and students training to become the next generation of systematists and students of evolution, but they provide much of the information that the institutions' Education and Public Exhibits Departments use to teach students, teachers, and the public-at-large of the of the facinations of the richness of their environment, of the joys of understanding its diversity, and of the need to engage in conservation and preservation of their natural heritage. Shown here are a few samples from the research collections of the California Academy of Sciences: (A) Entomology (Insects); (B) Anthropology (Human cultural artifacts); (C) Ornithology (Birds); (D) Ichthyology [Fishes]. Photos by Dong Lin. The California Academy of Sciences is home to moree than 18 million specimens.

thousands of books by the Smithsonian Institution (all duplicates from its own library, through the kindness of Smithsonian Secretary Joseph Henry) propelled the Academy into one of the world's leading institutions devoted to the study of natural history.

The devastating earthquake and fire of 18 April 1906 that engulfed San Francisco and its Academy of Sciences might have spelt *fin* to its noble efforts to play a leading role in natural history research and education but, nearly 10 years later almost to the day, the Academy reopened in its new home in Golden Gate Park, in two buildings, one devoted exclusively to public exhibits, the other to research. Even during 1906 to 1916, when the Academy's departments were scattered throughout the city, its curators and their colleagues at neighboring institutions, the University of California at Berkeley and Stanford University, carried on an aggressive program of research and field work.

In 1917, in response to a bequest to the City of San Francisco by Ignatz Steinhart, and with the approval of the voters of San Francisco, the Academy was asked to take on administration of the newly authorized Steinhart Aquarium, which was to be build on land immediately adjacent to the newly opened Academy halls. The Steinhart Aquarium opened to the public in 1923.

Dynamic institutions like the California Academy of Sciences never cease to grow, never cease to look for innovative ways to reach out to the public and to conduct research. The exploration and interpretation of the wonders of the natural world are the bread and butter of natural history museums like the Academy and its sister institutions, other natural history museums, botanical gardens, and, in recent years, zoological gardens or zoos.

After nearly 90 years, some of the Academy's buildings showed their age. No longer could simple maintenance or even substantive upgrading meet the seismic requirements for public buildings; neither could patchwork changes meet the needs of an institution that was looking ahead to the 21st century, nor to the requirements of its research program, with its ever expanding collections and demands for space to house them, nor to those of an institution that was seeking innovative ways of reaching out to the public-at-large to inform it about the environment in which its people live and work and about how best to conserve its heritage in that natural world.

But, the Academy is not alone in this venture. Other institutions of natural history face similar concerns, and to share solutions to these problems, we organized this symposium — to look at the past, to look at the present, and to look into the future! Our symposium participants have done their homework. Each contributor surveys a different aspect of museum life. Yet, none is neglectful of the whole and their collective stories are revealing.

Dr. Sally Kohlstedt leads off with an overview of the museum movement in the United States dating from 1794 when Charles Willson Peale rented space in the recently built Philosophical Hall in Philadelphia to open a public gallery to display his collection of art and natural history artifacts. Kohlstedt traces the development of the buildings themselves that house museums of natural history inasmuch as they distinctly reflect the changing perceptions and even the needs of the community in which they are located.

Dr. Pamela Henson provides an overview of the development of a national science from its beginnings during the Colonial era to the establishment of the Smithsonian Institution and its National Museum of Natural History, with special reference to the Institution's first Secretary, Joseph Henry and his entrepreneurial Assistant Secretary, Spencer Fullerton Baird. Baird is responsible for establishing the protocols for many aspects of today's natural history museums in the United States. But, beyond the nation's capitol, regional differences have imprinted themselves.

Dr. Barbara Ertter looks at both regional and disciplinary aspects of the museum movement. She focuses on California and, notably, on botany in the San Francisco area where three natural history museums came into being during the second half of the 19th century. Her contribution deals more with the human aspect of museums, the clash of personalities, and how these influenced the location of museums and related programs.

Natural History Museums place their numerous artifacts on display for the public to see. Just how much the public learns from what they see, aside from being awed by the strange creatures before them, prompted people like Charles Willson Peale and his successors in museums to find better ways in which to exhibit their wares. Hanna Rose Shell deals with one of the most successful of these innovators, William Temple Hornaday, who, in the late 19th century, developed what was to become a widely accepted way of presenting material to the public, the habitat group, and to inform the public about emerging issues of conservation long before it became a household topic.

The Smithsonian Institution and notably its National Museum of Natural History, formerly the United States National Museum, has had a deep and lasting impact on the modern natural history museum movement in the United States. It is also the second oldest surviving public natural history museum of its kind in the country that has major commitments to both public education and research programs in the natural sciences. Only the Academy of Natural Sciences in Philadelphia, founded in 1812, is senior, and the California Academy of Sciences, founded in 1853, its immediate junior. Therefore, it is always a matter of considerable interest to see how the National Museum has fared over the years, and this is the subject of Dr. Ellis L. Yochelson's interesting essay which deals with the ups and downs of the administrative history of the institution from its founding to the present day.

Not all institutions of natural history are museums, and not all deal with a panoply of natural history disciplines. There are others, and some have narrower foci, such as the United States Geological Survey, founded in 1879, and the Scripps Institution of Oceanography, established in 1903. The former, for many decades the premier scientific agency of the United States government, is the subject of a contribution by Dr. J. Thomas Dutro, Jr., who looks at the program of one of the Survey's divisions, the Paleontology and Stratigraphy Branch, and the people and programs that occupied its attention from immediately following the Second World War to its demise in the late 1990s.

Too often, natural history museums neglect much of the natural history associated with more than two-thirds of the Earth's surface, most often because (save for aquaria fish) the oceans and their depths do not lend themselves to public display and their scientific study often requires resources that are beyond the means of the museums themselves. Dr. Ronald Rainger presents a birdseye view of one institution, the Scripps Institution of Oceanography, now part of the University of California, San Diego, whose programs are devoted almost exclusively to the study of the seas and to the education of future generations of young scientists to continue the work of their forebearers. Rainger supplies the political and economic history context necessary to understand the history of Scripps.

University-based natural history museums are not new; they have been around for a long time, but they are responsible to a different audience than the large, free-standing, public museums. They sponsor research and field work, as do the large public natural history museums. But their clientele are the students, undergraduate and graduate, and their programs are largely tailored to these ends. Dr. Jere Lipps, in his contribution on the Museum of Paleontology at the University of California, Berkeley, treats us to an insider's view of that venerable program, which leads us to the observation that institutions devoted to the study of the natural sciences are, in reality, not so different from one another despite the venue of their operations.

The 21st century is now upon us; it is in its infancy; there are 95 years left before the century clock strikes the witching hour again. That is a goodly span of time and museums, like all other human endeavors, must take a moment to step back, look at the past, evaluate the present, and after gazing thoughtfully into the crystal ball, make some predictions for the future. For natural history museums, this is an especially demanding time; they are vulnerable to changes in society that may view their activities as not relevant to its needs. For instance, during the 20th century, experimental biology in general, and more recently studies at the molecular level of organization, have eclipsed organismal biology and pushed natural history studies further into the background of the biological sciences. With increasing concerns about the environment, a renaissance of sorts came into play during the late 1980s and 1990s in the guise of biodiversity and environmental studies, and this was enhanced by the application of biomolecular techniques to the study of plant and animal genealogies, phylogenetics.

Thus, a burning question today is how can museums and other institutions of natural history remain relevant in the light of the changes that have taken place in the study of plant and animal relations and in the light of the public's perception of what it needs to know about the environment. We have gained insights from our retrospective review of museums. We now come to the prospective overview. To do this, we asked several people who have given much thought to these matters to give us the benefits of their insights.

John Farnum, museum consultant to the California Academy of Sciences, assisted the Academy's staff in developing plans for the new Academy facilities that are scheduled for construction in Golden Gate Park this next year. Farnum minces no words; museums of natural history are in danger of becoming irrelevant unless they adapt to the changing needs of society. He lays out what he believes are the problems and offers suggestions for addressing them. He stresses that museums should work together as a networked community of information/experience providers to take advantage of the multiple channels for communication that can emphasize both actual and virtual experiences to attract attention and better inform and educate the public.

Museum directors and their colleagues in their respective institutions are attempting to address many of the concerns raised by Farnum, at different levels, depending on their situation. Drs. Scott Sampson and Sarah George, chair of the Department of Paleontology and Director of the Utah Museum of Natural History respectively, talk about a State University-based natural history museum and how it plans to meet the needs of the 21st century in the design of its new facility in Salt Lake City. In a like manner, Dr. Warren Allmon, Director of the Paleontological Research Institution in Ithaca, New York, a regional museum that has both public and research facilities, reveals much about how he and his colleagues went about planning for their newly constructed Museum of the Earth, which opened to the public in late 2003.

Dr. Peter Raven, Director of the Missouri Botanical Gardens in St. Louis, Missouri, offers thoughts about another kind of natural history museum, one that maintains large numbers of living plants, both native and exotic, in both large outdoor gardens and in glass-enclosed hothouses, as well as a large research herbarium, which stores hundreds of thousands of carefully dried plants that are mounted on sheets of paper and kept for study by scientists and students. He uses this as a point of departure to address nagging questions of how to stay relevant in both the public eye and in the research community in the 21st century.

Following Raven, Dr. David Kavanaugh, Director of Research at the California Academy of Sciences, describes in some detail, how he and his colleagues went about planning for the research needs of the Academy in its "museum of the future." Lastly, Dr. J. Patrick Kociolek, Executive Director of the California Academy of Sciences, closed the symposium with a summary statement of how the Academy planned for its new facilities, how it engaged people, both internal and external to the institution, in the planning process, and what it expects to achieve as a result of the years of preparation that have gone into the design of its new museum.

Dr. Terrence Gosliner, Provost of the California Academy of Sciences, prepared a brief epilogue for the volume, which clearly shows that the response of institutions of natural history to meet the ever changing needs of society is as much an internal as it is an external desire inasmuch as science itself is an ever evolving intellectual endeavour.

Acknowledgments

We want to thank the speakers, now authors, for their thoughtful and perceptive contributions in addressing the most fundamental question before us, can museums of natural history sponsor programs in the natural sciences in the 21st century that are both relevant to society and relevant to the advancement of scientific knowledge. We also thank many of these same colleagues who went the extra mile and helped with the review of the submitted manuscripts. In this regard, we must single out Dr. J. Thomas Dutro, Jr., U.S. Geological Survey [ret.], Washington, D.C., who read and critiqued all of the manuscripts in their penultimate format. Those who kindly critiqued individual articles are acknowledged in each essay. Finally, we gratefully acknowledge the sponsoring role of the Pacific Division of the American Association for the Advancement of Science, especially its current Executive Director, Roger Christianson, and of the administration of the California Academy of Sciences for both encouragement and participation in the program.

Alan E. Leviton and Michele L. Aldrich
15 July 2004

Testing new concepts in museum displays: Live Ant Exhibit at the "temporary" quarters of the California Academy of Sciences' Natural History Museum in downtown San Francisco

An innovative exhibit, a fully self-contained colony of live Trinidad army ants, which integrates a broad range of biodiversity and phylogenetic concepts, including habitat utilization and resource partitioning, morphological adaptations, population survival, and communal behavior. The exhibit is supported by explanatory materials and minidisplays which are arranged around the central terrarium.

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Framing Nature: The Formative Years of Natural History Museum Development in the United States[1]

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FIGURE 1. Charles Willson Peale designed the tickets and his son Ruben managed the business end of the transaction.

By printing the then familiar phrase "book of nature" on his admission ticket (Fig. 1) for his Philadelphia Museum, Charles Willson Peale insisted that nature could be better understood by careful study of its artifacts arranged in coherent order. Eventually provided space in prominent public buildings, Peale found it a challenge to frame his displays so that they simultaneously intrigued and educated audiences by the familiar and not-so-familiar specimens that constituted his museum.[2] Linnaean nomenclature and narrative labels gave individual specimens particular significance even as their juxtaposition created opportunities for visitors to make discoveries about the relationships among them. In the early nineteenth-century, the objects were expected primarily to "speak for themselves"; or, as Steven Conn put it, the early natural history museums offered "naked eye" science to audiences presumed to be able interpret the objects before them.[3] A century later, museums would be more didactic in their presentations, selecting materials in carefully designed exhibits that showed greater self-consciousness about museum standards and with specific audiences in mind. Designing museum facilities, outside as well as inside, became part of the process of defining, indeed continuously redefining, museum identity as well. This account reveals that local influences were often paramount, even as an evident standardization of museum goals and functions reflected national and international influences as museums became ever more prominent civic and scientific facilities.

Only recently have scholars begun to investigate common themes, over time and in specific places, that constitute the phenomenon of modern museum development, particularly with regard to those institutions dedicated to natural history. Such research provides an essential backdrop for scholars and others who wish to understand particular institutions and to escape narrow, celebratory accounts that emphasize uniqueness and presumed "firsts."[4] As historians of science turned their attention to the history of museums just over two decades ago, they concentrated much of their attention on the scientific and cultural aspects of institution building, on the founders and administrators who articulated the purposes of the museums, and on the broad profile of collections acquired.[5] The physical location and facilities for early museums like Peale's were pragmatic choices, and, until recently, historians of science largely took these material settings for granted, with the exception of a recent book on Victorian museum building in Britain.[6]

Given the fact that the California Academy of Sciences is about to embark on a new building phase, this seemed an opportune time to look back historically, albeit briefly, at the ways museums framed their collections — quite literally in wood, brick, stone and mortar. This analysis is informed by the more detailed research that has been done on the architectural history of art museums whose history runs parallel to but is distinctive from those for natural history.[7] Certain questions motivated this research: How were practical necessities, symbolic virtues, and scientific ambitions balanced, especially as special-purpose buildings were designed as museums? What characteristics can we discern in museums built by early entrepreneurs and societies that continued into and through what many have called the "golden age" of museums, particularly the latter half of the nineteenth into the early twentieth centuries? To what extent were these fundamental elements in museum design self-consciously derived from an emerging architectural tradition and in what ways did local preferences and technical innovations play into museum design? This preliminary overview of museum architecture and planning can reveal something of the ideas that were in play and negotiated among patrons, architects, curators, and audiences. Ideas about museum design and construction were also deeply influenced by increasing leisure among the middle classes and reflect some of the cultural tendencies also found in botanical gardens, zoological parks, and intermittent expositions.

Establishing Early American Museum Enterprises

Peale's home on Lombard Street, like homes of many other artists, served as his art studio and display gallery in the 1780s. Large mastodon bones left in his studio garnered such attention that he began to add other natural objects and soon his incipient museum outgrew its space in his home.[8] Such domestic natural history had, as Paula Findlen's account of Italian museums points out, significant social and civic dimensions during the seventeenth and eighteenth centuries.[9] Wooden cabinets (Fig. 2) preserved valuable specimens and were integrated into larger rooms or wings of homes that could be shared with visitors as well as family. Naturalists and other collectors saved, described, and organized their materials in various symbolic and aesthetic ways for themselves and others who shared their inter-

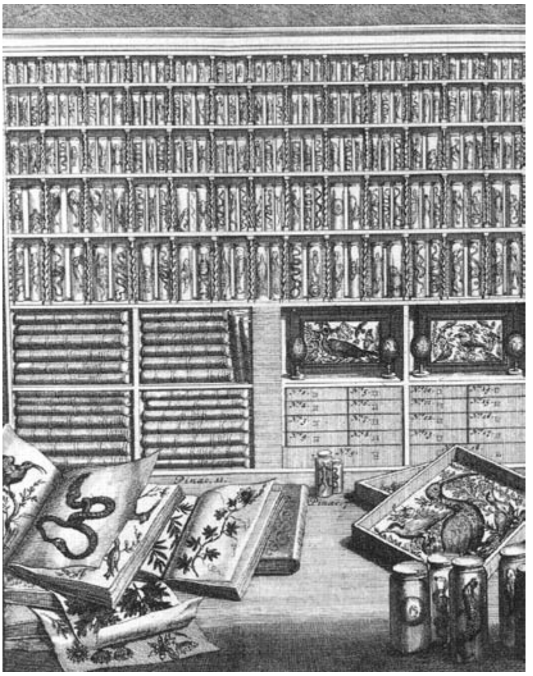


Figure 2. Wooden cabinets, with shelves and drawers that served to hold the collections of individuals whose specimens could thus be shared but also privately owned, remained a standard feature in natural history societies. These popular cabinets were steadily improved, with metal lining and other features that could protect the specimens from dirt and insects.

ests. These objects on display, however, also marked their owners' status, knowledge, and civic sensibility. As European intellectual practices and institutions were translated into colonial settings, small museum holdings became part of urban culture, and in some cases plantation culture, by the late eighteenth century in North America.[10]

FIGURE 3. The American Philosophical Society built a hall that served as its meeting place for members as well as its library and museum.

Most outstanding was Charles Willson Peale's collection which was growing, as its proprietor hoped, to be a museum destination worthy of the new republic. In 1794, he rented space in Philosophical Hall (Fig. 3), which had been built just six years earlier. The American Philosophical Society was re-energized by Peale's genuine enthusiasm for science, and his collection acquired intellectual panache by affiliation with local and visiting foreign naturalists. In 1811 he was granted space in perhaps the most prestigious building in Philadelphia, now known as Independence Hall (Fig. 4), which had housed the Congress of the United States before the capitol was relocated to Washington, D.C.[11] The old State House, shown here on election day in 1816, was by then being used for city court and office business in side wings. Peale

FIGURE 4. Philadelphia's Independence Hall had housed the first Congress of the United States before the capitol was relocated to Washington, D.C.

consistently argued, as in a public lecture published in 1800, that "Natural History is not only interesting to the individual, it ought to become a National Concern since it is a National Good."[12] The collections themselves were thus symbolically accommodated in spaces designed for civic purposes in the young republic. Peale's goals and experiences proved remarkably prescient about the public nature of science and the scientific role of natural objects.[13] In the early nineteenth century, the emphasis was on documenting the diversity of nature, putting newly discovered species into a taxonomy, and contemplating the pattern of an ordered universe. The mastodon was important for many reasons, not least of which were questions relating to extinction, to the nature of the Americas, and to its place in the natural order that might be discovered by comparison to the skeletons of living animals.[14] While the mere size certainly attracted the attention of many visitors, Peale encouraged the kind of intellectual curiosity that could be awakened by raising more scientific and philosophical questions.

When Peale began to develop a natural history collection, acquired by both chance and intentional acquisition, he was committed to making the materials in some way both reflect and invite participants into the new civic experiment.[15] Overhead costs of acquisition and maintenance required a relatively steep admission price (twenty-five cents) even as the entrepreneur needed to make his holdings as accessible as possible. The floor plans for Peale's space (Fig. 5) reveal his use of a long central corridor and adjoining rooms on the second floor. Several centuries of private collecting had resulted in standardized wooden cabinets (increasingly glass-fronted as that technology improved over the century) with rows of shelves along high-ceiling walls; the central corridor housed additional cases and over-sized specimens, often large skeletons. The Long Room of the old State House fit such practical requirements admirably. Peale's famous self-portrait (Fig. 6) with his most famous object, the mastodon, tantalizingly hidden just behind the curtain is undoubtedly

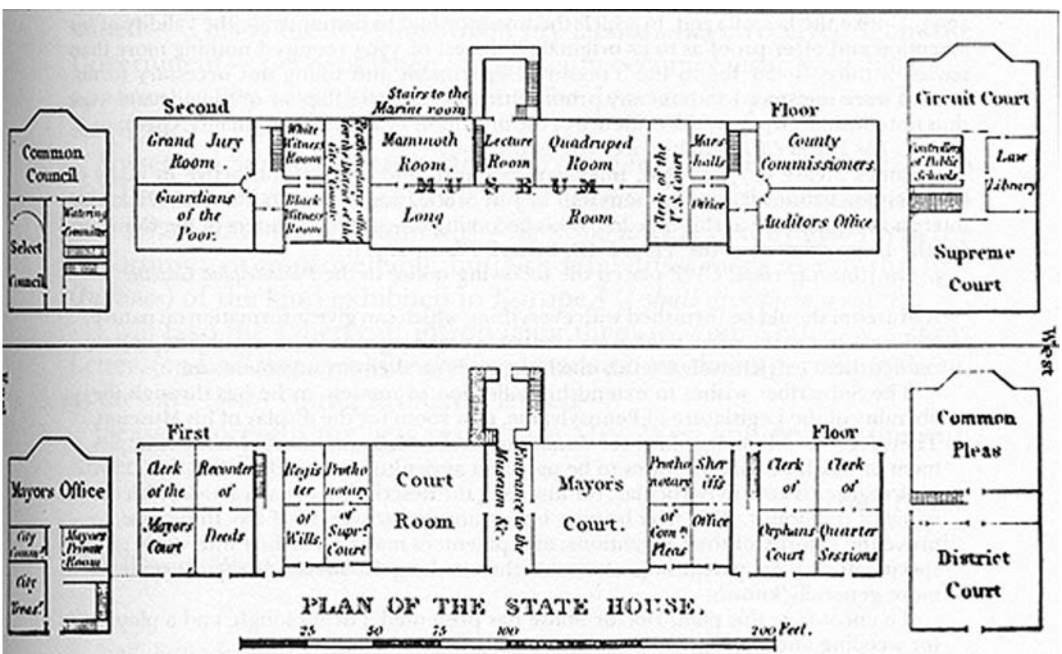


FIGURE 5. Charles Willson Peale was granted most of the second floor of Independence Hall, including the long central corridor, the lecture hall, and two side rooms, one of which housed specimens returned from the Lewis and Clark Expedition.

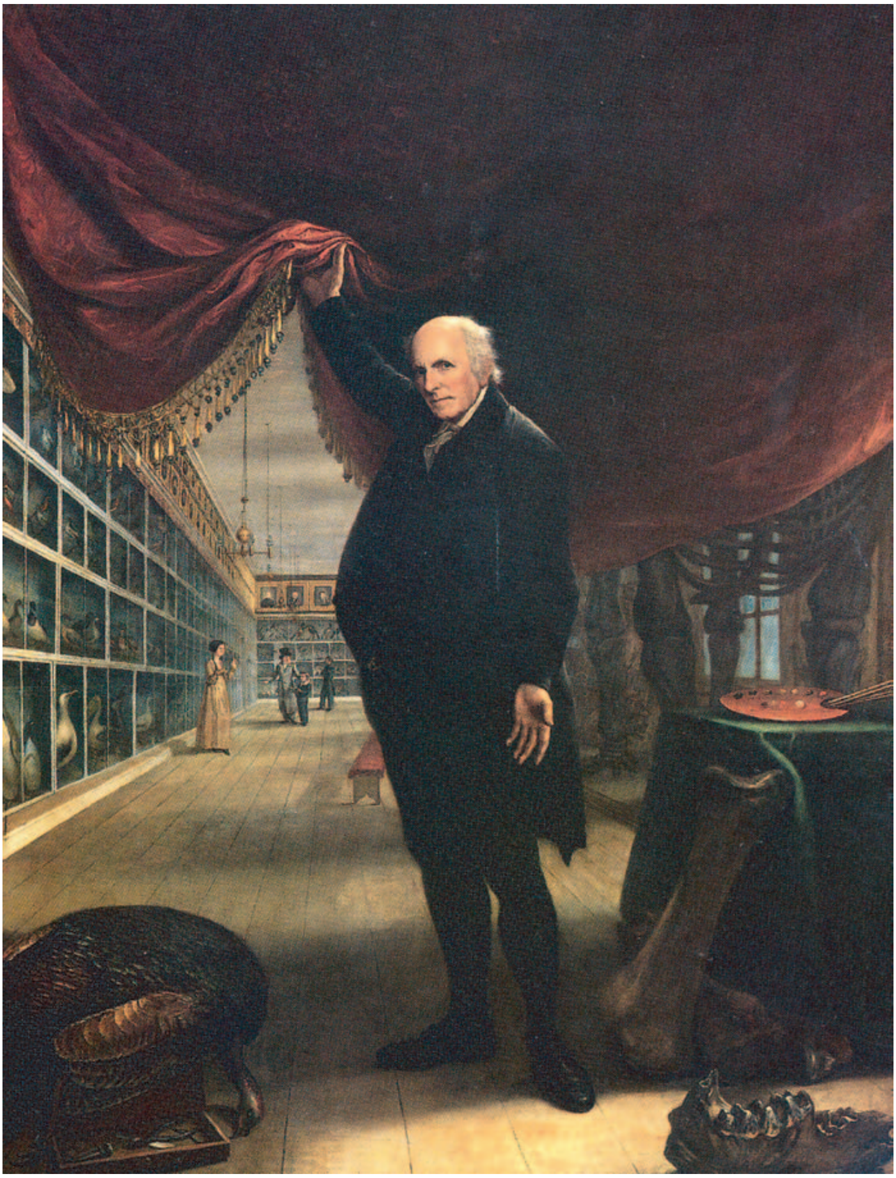


FIGURE 6. Charles Willson Peale's self-portrait is an idealized look at the museum interior, with art displayed above the natural history cabinets. Courtesy of the Philadelphia Academy of Fine Arts.

idealized and thus shows his ambitious plans for integrating art and science. High or vaulted ceilings with windows and the capacity for skylights in a period when interior lighting could be expensive and dirty meant that upper-storied rooms were typically used for displays. Scale and features that changed with cultural taste shaped distinctively styles of monumental architecture used for civic buildings in the ancient world and for churches in the Middle Ages. In the nineteenth century, American architects would revive elements of these earlier eras and use them for such other public facilities as museums. Use of Independence Hall early reinforced the presumption that these art and science materials held civic meaning, as did Thomas Jefferson's willingness to give Peale some of the zoological, geological and archeological specimens that came back with the Lewis and Clark Expedition.[16]

Leased facilities meant his design for the exhibits necessarily had to adapt to their assigned spaces. Perhaps for that reason, when Peale's son Rembrandt moved to Baltimore to establish his own museum, his was the first purpose-built museum in the young United States in 1814.[17] Designed by local architect Robert Carey Long, its "fashionable lounge" could accommodate daytime visitors and evening social events, particularly since another first was the use of experimental piped gas lighting (Fig. 7). The recently restored museum indicates something of a plain brick Federal style but with a hint of Colonial Revival in a style both more domestic and more modest than those of museum structures later in the century. Location mattered more than design, however, and when revenues were insufficient, Peale moved his museum materials nearer the commercial district on Baltimore Street, putting his museum and gallery of art above retail stores where traffic was constant. In an ironic twist, the city of Baltimore took over the original Baltimore Museum as its city hall during the economic depression of the late 1830s.[18] Museum development proved to be a risky business, and, although the Peales had several imitators, none lasted for more than a few years.[19]

FIGURE 7. Rembrandt Peale's Baltimore Museum was the first purpose built museum in the United States.

The limited success of museum entrepreneurs elsewhere can be explained in part by the fact that Philadelphia was the most cosmopolitan of North American cities in the early nineteenth century. Equally important, however, was the fact that other museum founders did not or could not match the facilities, either in terms of a striking public building or in the specimens, cases, and other material resources that could attract and maintain public interest; most of them were housed in commercial rental spaces or in sections of their private homes. Some of the efforts were heroic, including the short-lived Western Museum in frontier Cincinnati, under Dr. Daniel Drake.[20]

More successful were the American naturalists who began to combine resources by establishing natural history societies, and later state academies of science, where curators and semi-public display space would better insure the maintenance and accessibility of collections. The struggles of proprietors and societies from Boston to St. Louis during the ante-bellum period made it clear that acquiring rare specimens was often less expensive than arranging to secure them against dirt, insect infestations, and theft. Collectively, the societies of naturalists in Charleston, Philadelphia, Boston, New York City, and elsewhere arranged to rent or purchase rooms or even a building where each member might put a cabinet on display. Indeed the successful Philadelphia Academy of Natural Sciences moved three times in sixty years. For decades its members met and held their specimens in a private space. When the collections grew too large and they decided to hold public lectures, they built a combined lecture and exhibit hall on Samson and Broad Streets in 1840 (Fig. 8).[21]

FIGURE 8. The Academy of Natural Sciences in Philadelphia built a museum and lecture hall in 1840 to house what was then the largest and most important natural history collection in the nation.

Less than four decades later they built their current facility in time for Philadelphia's Centennial Exposition, and the Academy became one of the anchor institutions in Philadelphia's cultural district (Fig. 9). The Academy had substantial collections in several areas. At mid-century, member Joseph Leidy became actively involved in excavating and then mounting the *Hadrosaurus* that had been uncovered in New Jersey.[22] It enabled him to write extensively about Hadrosaur morphology and to create a new enthusiasm at the Academy much as Peale had used the mastodon skeleton. Indeed subsequent museum administrators would continue to anchor their public exhibitions with large mounted specimens. Over the last half century, issues in paleontology were changing, as they were in other natural sciences, as questions about chronological and geographical range required larger numbers of even partial specimens,[23] problems that would require additional secure storage space and increasingly sophisticated laboratory facilities and equipment like microscopes.

FIGURE 9. When the Academy of Natural Sciences built a new museum in 1876, it opened in time to gain attendance from visitors to the Centennial Exposition in Philadelphia.

The Academy's sister society, the Lyceum of Natural History in New York, raised subscriptions for a building in the 1830s, seeking a "safe receptacle for many scientific treasures" just before the Panic of 1837.[24] However, Lyceum members lost the building when they went bankrupt in 1844, another cautionary tale about the enormous expenses involved with building and maintaining a museum collection.[25] The Lyceum's subsequent search for space is a sad tale and, in 1866, after the collections had been destroyed by fire in a rented space, a member remarked, "What I once regarded as a crowning calamity, the destruction of Museum material, I now regard as a blessing. This may seem paradoxical, but I believe it to be true . . . . [The] erection and maintenance of a Museum ... now involves an enormous expenditure and never-ceasing labor, care, and anxiety. Happy are the students of nature who can enjoy the benefits of such a Museum without its costs and responsibility."[26] Nonetheless, the will to collect was strong and naturalists in moderately sized cities and on college campuses continued to create local museums.[27] Their specimens were critical to the taxonomic enterprise and were regularly referenced and displayed, in a way that paralleled similar experiences in British and European societies of the same period.[28] Society holdings were self-consciously differentiated from popular, typically transient displays of animals, fossils, minerals, and exotica at mid-century, undoubtedly in part in reaction to P. T. Barnum and others who promoted humbug alongside genuine natural history.[29] They particularly eschewed indiscriminate crowds and the kind of popular presentations that relied on sensation rather than serious natural history. Creating museums which stressed permanence through substantial, well-built facilities was a critical part of establishing the significance of museums.

By far the most specialized research museum at mid-century was that of Swiss émigré Louis Agassiz, namely the Museum of Comparative Zoology (Fig. 10), adjoining Harvard College, which was built in 1859 with monies provided by the Massachusetts's legislature as well as wealthy friends in Cambridge.[30] Agassiz articulated the benefits of scientific research but also the necessity of public funds, undoubtedly influenced by his knowledge of the sponsorship of important European museums in Munich, Paris, and London. The charismatic teacher and public speaker was, in fact, the catalyst for museum initiatives from Maine to Chicago to Charleston.[31]

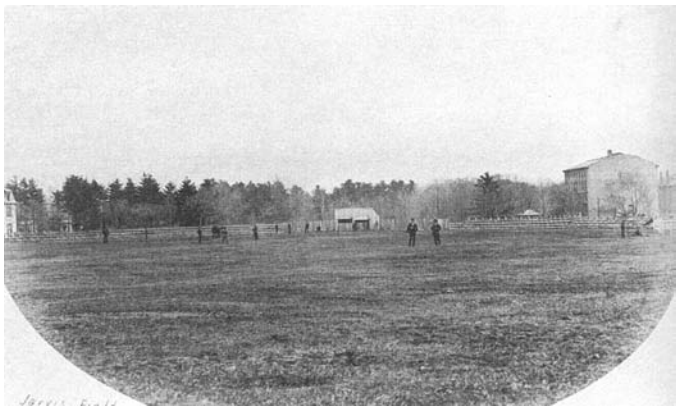


FIGURE 10 The allocation of land for the building of the Museum of Comparative Zoology reflected the aspiration of Louis Agassiz to create a museum comparable to those he had used in Europe.

His own MCZ was intended for serious study and destined for expansion. Its multi-storied facade announced its remarkably simple exterior and interior design. The MCZ plain style front façade faced the Harvard Divinity School across Divinity School Avenue, clearly intended to symbolize dialogue between science and religion. The museum's location at the edge of campus created potential for the ambitious expansion plans of Agassiz.[32] Although the MCZ initially had interior galleries around a central space in a configuration that was becoming standard in museums, this central space was soon floored over to make room for storing ever-growing collections. The elder Agassiz's concession to his local public was to commission a kind of stuffed petting zoo for young visitors, with farm animals like a cow and pig on display along with glass cases housing neat rows of specimens. Later, under Alexander Agassiz, would come the famous Blaschka glass models of plants.[33]

The specialized MCZ, with specimens organized taxonomically, was much like the European collections that were the domain of the botanical, geological, anatomical, or zoological societies. Few other highly focused research museums were attempted in the United States, and those on other college campuses were typically both smaller and more broadly inclusive, with a few exceptions, like the Museum of Vertebrate Zoology at the University of California at Berkeley, funded in the early twentieth century by Annie Alexander.[34] The emphasis on research functions would remain strong in such academic settings, but by the late 1850s, a movement to build larger civic facilities for music, art, and books found parallel expression among those promoting the possibilities for public education in zoology, geology, and related natural history subjects. The facilities, too, would look quite different and move toward very different arrangements of the displays.

Perhaps the most public museum of the mid-century, with goals similar to those of the earlier mechanics institutes and the Cooper Union for Art and Science in New York City, was the Wagner Free Institute of Science, founded by merchant and amateur naturalist William Wagner and built between 1859 and 1865. The building, designed by John McArthur, Jr., had the rather severe look of an abstracted classical temple, with arches and paired pilasters characteristic of public buildings at mid-century (Fig. 11). Inside were symmetrical galleries lit with skylights around a large central exhibition hall. Wagner intended his museum to be public, and indeed he himself gave public lectures on mineralogy in an auditorium modeled on that of the Smithsonian Institution that could hold fifteen hundred people. After his death in 1885 released additional funds, the museum underwent a renovation in which the glass-fronted display cases and collections were organized by Joseph Leidy into a systematic collection designed to portray earth's evolution. The cases were rearranged to show the course of the development of life from inorganic to organic matter and from simply organisms to the most complex.[35] By the time this project was complete, the arrangement was already out-of-date in terms of the trend toward habitat groups of particular species in settings that reflected their natural environment and limited the taxonomic descriptions found in the crowded cases of the Wagner.

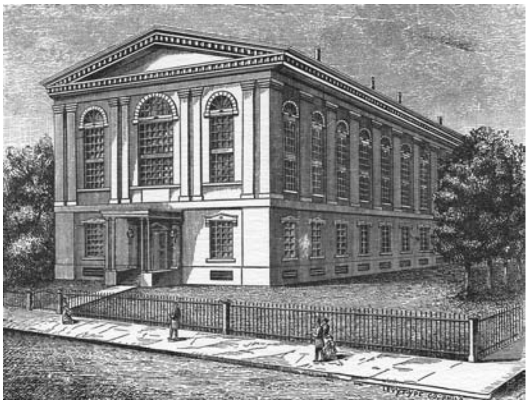


FIGURE 11. The Wagner Free Institute of Philadelphia, influenced by mechanics institutes, established a library and museum, and offered public lectures that were to benefit the entire public.

FRAMING PUBLIC MUSEUM COLLECTIONS

Particularly important as a model for a still Anglophile nation was the new British Museum (Natural History), designed with much fanfare in the 1860s, although not finally completed in London's South Kensington neighborhood until 1880 (Fig. 12).[36] This massive structure was

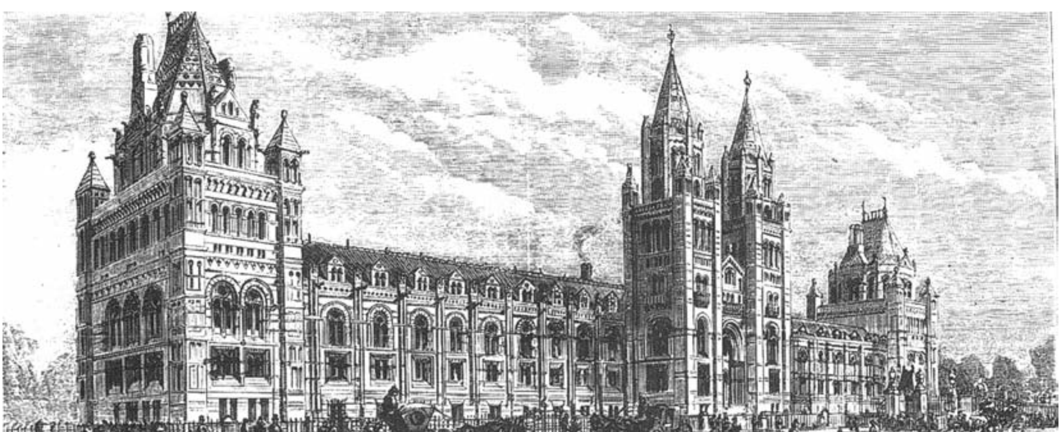


FIGURE 12. The British Museum (Natural History) opened in 1880 and was designed to have both substantial research and storage facilities as well as elegant public display space.

designed as a deliberate contrast with the popular and dramatic but commercial and ephemeral Crystal Palace of 1851.[37] In the meantime, the United States government's national collections of natural history, growing under the steady influx of specimens from expeditions, had begun to be housed at the Smithsonian Institution despite the caution of its Secretary, Joseph Henry, and under the direction of Assistant Secretary Spencer F. Baird (Fig. 13; also see the article by Pamela Henson in this volume).[38]

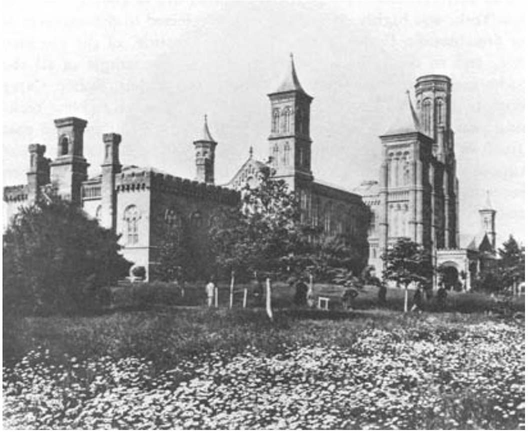


FIGURE 13. The Smithsonian Institution's distinctive façade on the mall reflected congressional aspirations to make its growing capital into a cultural center.

The Smithsonian castle of the 1850s, with its Norman gothic design and multiple turrets was not the modest building that Henry and other scientists had hoped might be built. Henry would have preferred economizing on the building and using the Smithson funds to support research. However, the building did not function badly as a museum. The towers allowed for staircases and ventilation shafts, leaving the interior spaces unencumbered and useful for public displays. Moreover, the medieval style allowed for numerous and large windows that supplied natural light for the displays arranged along the great hall, although less than that provided by the Wagner's skylights. While travelers to the United States commented with enthusiasm on the public display of extensive holdings, curators spent most of their time in the upper towers and the basement working with specimens and writing publications.[39]

It would be nearly three decades, in 1881, before the natural history collections of the Smithsonian Institution would move into a bold and eclectic Victorian building (Fig. 14) specifically designed for display under the auspices of the new Secretary, Spencer F. Baird, and his assistant George Brown Goode.[40] The United States National Museum (which is now named the Arts and Industries Building) was designed by Adolph Cluss and built under the civil engineer and former general Montgomery C. Meigs, who had visited European museums in anticipation of its con-

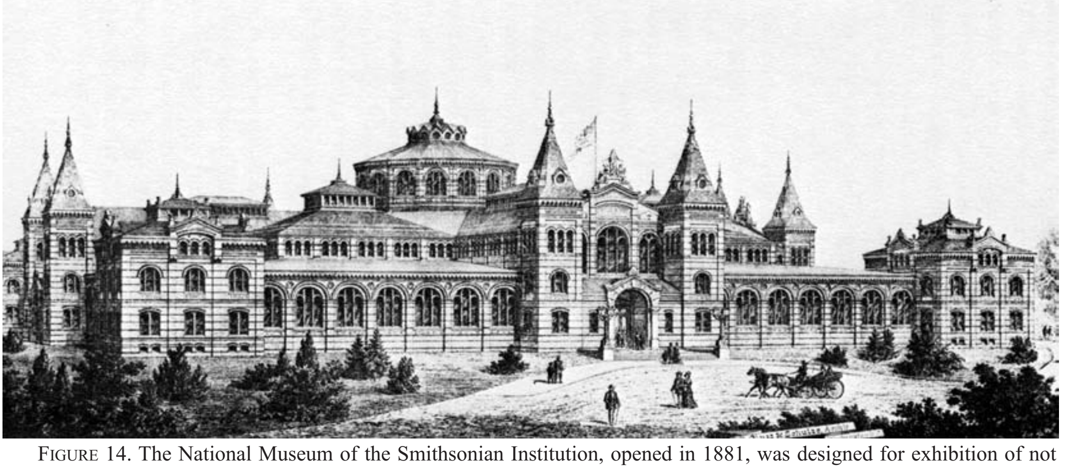


FIGURE 14. The National Museum of the Smithsonian Institution, opened in 1881, was designed for exhibition of not only natural history but also other art and history objects.

struction. It was intended to hold much of the material returned from the Philadelphia Centennial Exposition and, as Pam Henson has shown, was constructed remarkably cheaply but also with careful attention to technical matters, including fire safety.[41]

The interior organization (Fig. 15) built on increasingly common elements in museum design. Assistant director Goode, who had also spent considerable time in Europe visiting international expositions and museums, was very influential in creating the internal organization of the new museum. His published plans for this museum and his other writing made him America's foremost museum theorist at the end of the nineteenth century. Although there is no evidence of direct influence, the National Museum's interior organization seems to show at least familiarity with the plans of French architectural theorist Jean-Nicolas-Louis Durand on museum interiors (Fig. 16), perhaps because his formulation of space had already become common in European museums in the nine-

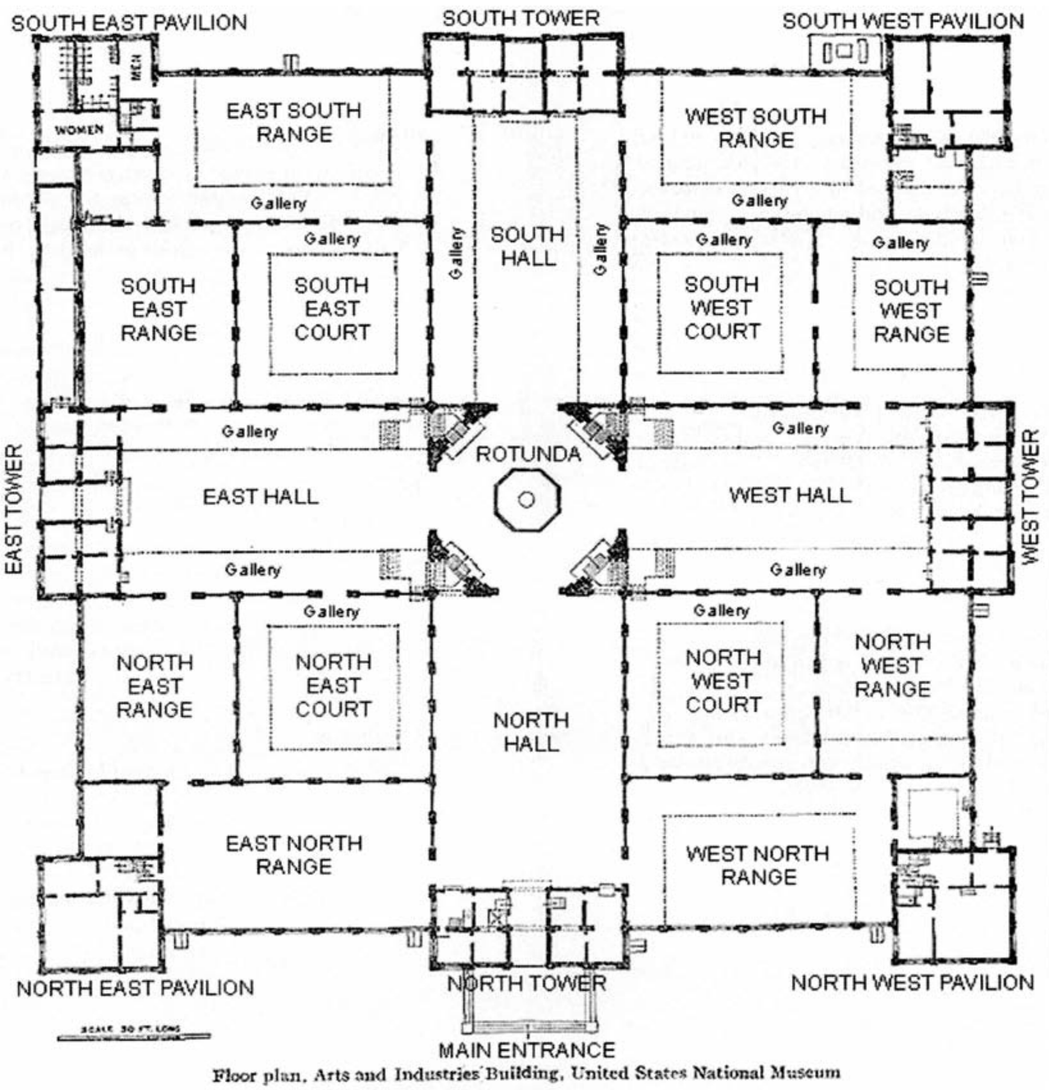


FIGURE 15. The National Museum's interior, with corridors, vestibules, and interior courtyards, was designed to provide maximum and effective display space.

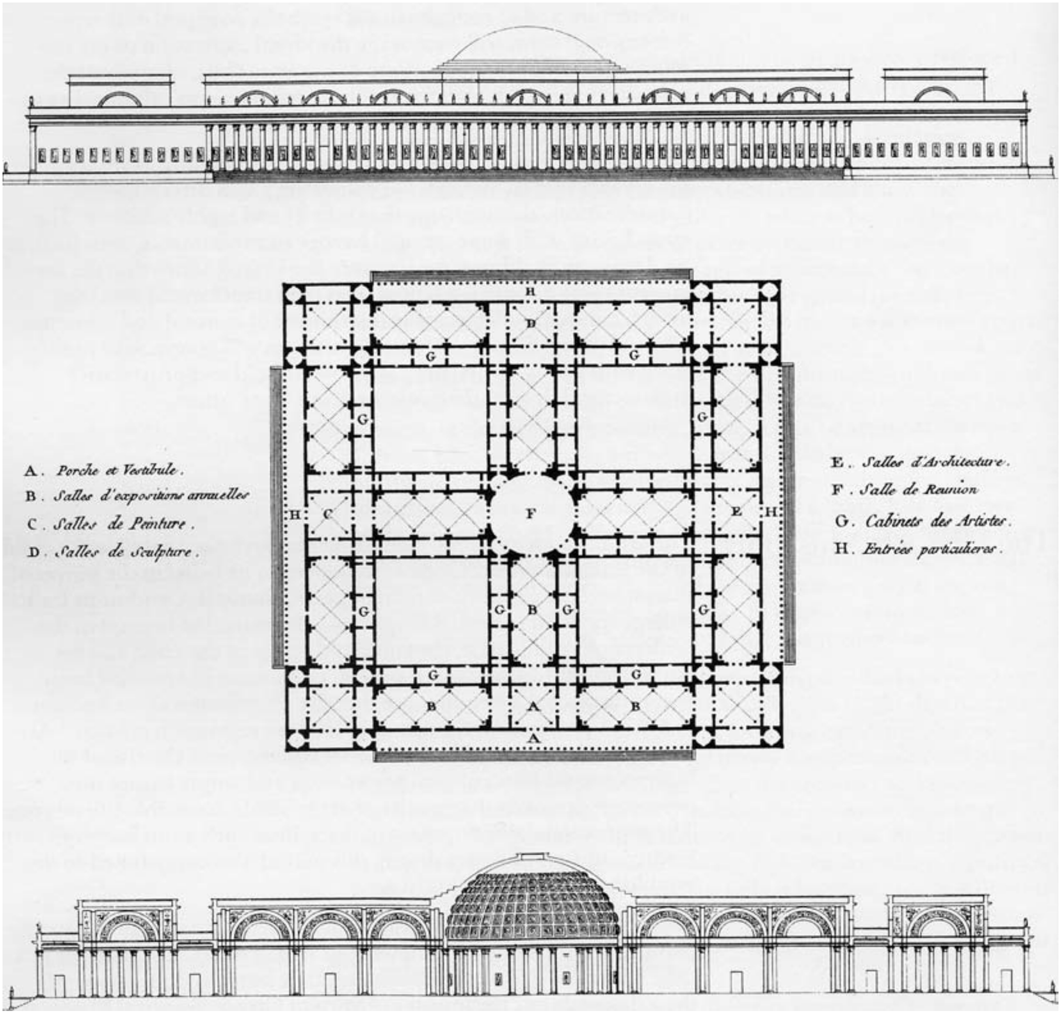


FIGURE 16. The elements emphasized by architect Jean-Nicolas-Louis Durand early in the nineteenth century became more evident in American museums after the Civil War.

teenth century. Durand's rationalist scheme for an art museum was sufficiently flexible that elements (including long corridors, impressive vestibules, interior courtyards with clerestories or other lighting) could be adopted and adapted for other kinds of public display.[42]

In the meantime, the Boston Society of Natural History built a distinctive museum on the western edge of the newly filled Back Bay (Fig. 17). Designed by William G. Preston, this

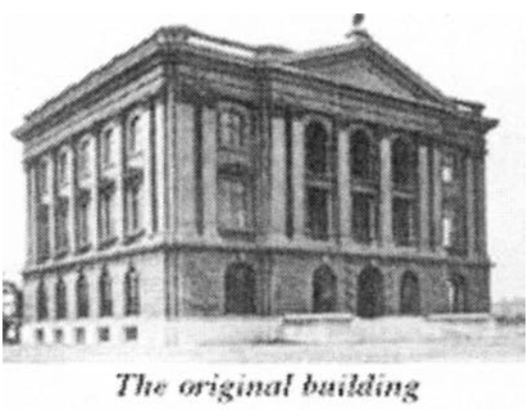


FIGURE 17. The Boston Society of Natural History built a distinctive public museum in 1864.

French academic style "temple of learning" was completed in 1864 and, although initially rather isolated from potential visitors, actually helped establish the area surrounding Commonwealth Avenue as an important residential and commercial district.[43]

The Society and its museum gained new momentum under the leadership of neo-Lamarckian Alpheus Hyatt, who became director in 1871. Hyatt had been part of the student "Salem secession" out of Agassiz's museum in the 1860s and worked in the Peabody Museum in Salem during the intervening years. His plan of 1871 (Fig. 18) clearly presented a public museum where essentially all the holdings were still to be on display or in neighboring drawers. The Society encouraged the students of Massachusetts Institute of Technology, who were then studying in a neighboring build-

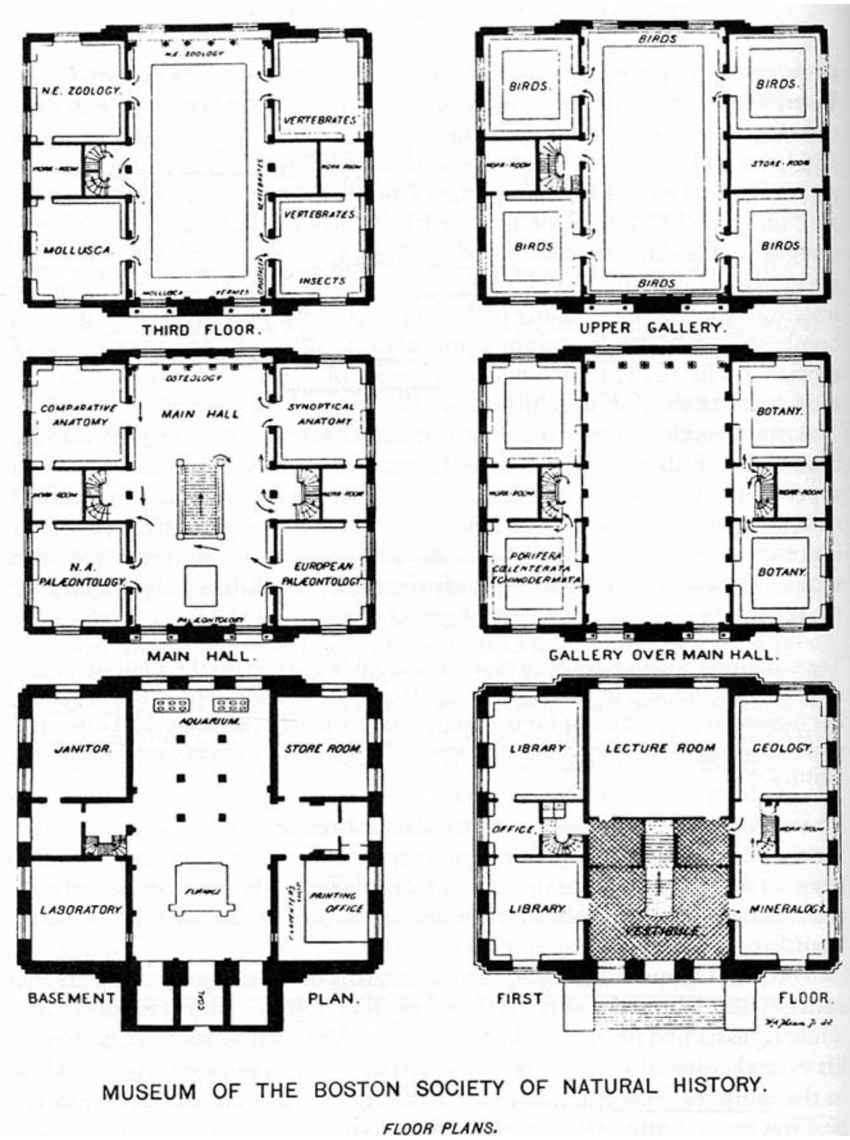


FIGURE 18. Alpheus Hyatt designed a plan for the Boston Society of Natural History that maintained the tradition of having the entire collection accessible.

ing, to use their specimens for study as well. During the 1870s the Society's curators encouraged participation of Boston area teachers and their students by designing displays for education as well as research. Like other mid-century collections, the Society featured large specimens in the central section of a high-ceilinged room, the largest sometimes suspended in space, with glass and wood cases arrayed along the walls and on surrounding mezzanines (Fig. 19).

As museums took on public functions, they attracted progressive civic leaders, like the German socialists in Milwaukee, who may have been the first to levy a mileage tax to support their public museum and library.[44] After viewing the submission of more than seventy architects, the trustees chose that of George Bowman Ferry and Alfred C. Clas (Fig. 20). The Milwaukee Public Museum and Library, featuring a central dome and a symmetrical, colonnaded front, opened in 1899. In other aspiring urban centers, like Pittsburgh, a major donor could provide the material means to create public facilities for natural science, art, and other purposes.[45] The palatial Carnegie Museum (Fig. 21) was an eclectic mix of architectural styles, dominated by elements of the Richardsonian Romanesque and classical styles that had become popular in the last quarter of the nineteenth century. Its interior, however, emphasized the interest of its patron and used a series of inter-connected rooms, the

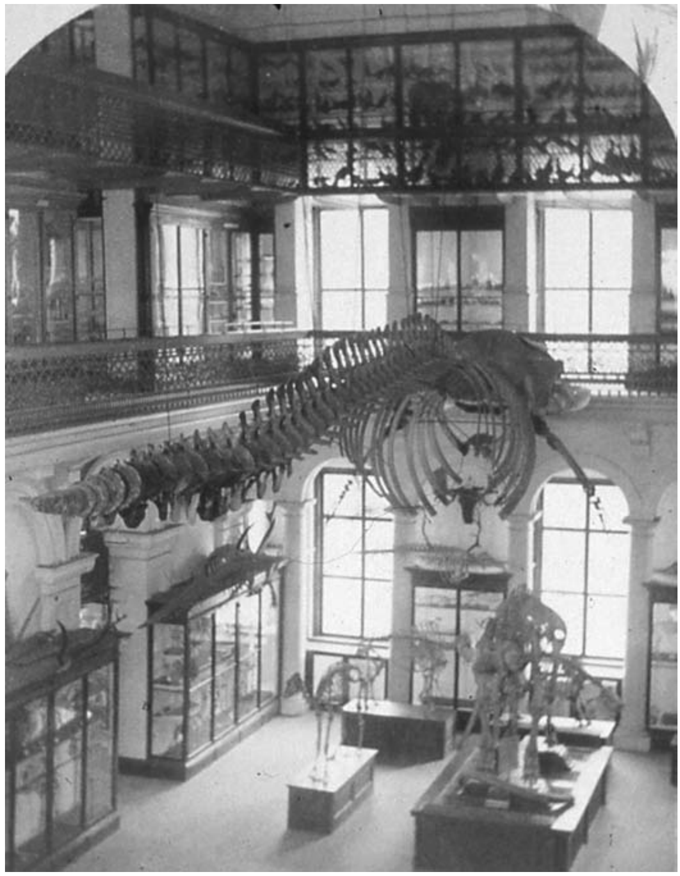


FIGURE 19. Large skeletons and other specimens were typically placed in the central section of museums, with the first floor and mezzanines used for glass fronted cabinets.

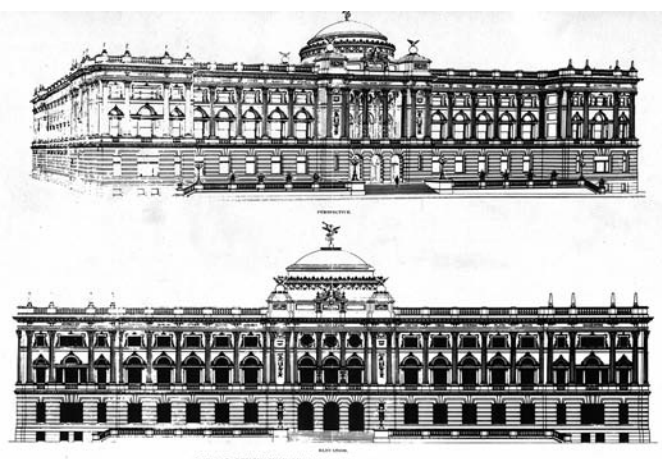


FIGURE 20. The Milwaukee Public Museum and Library presented the neoclassical style popular for public buildings at the turn of the century.

largest of which was devoted to dinosaurs (Fig. 22).[46]

By the late nineteenth century, there were building standards for museums that took into account lighting, ventilation, fire safety, and multiple entrances which all had some impact on design. North Americans were innovative in terms of both interior displays and functionality of building spaces, characteristics commented upon by European museum administrators who came in increasing numbers at the turn of the century.[47] They came, as well, to see the increasingly sophisticated presentation of natural history for public audiences, including habitat group displays and well-mounted paleontological specimens. Added to the museums as well were spaces for educational activity, some quite formal and connected to nature study programs in elementary schools or to graduate programs at nearby universities. Increasingly, museums provided informal education through printed brochures and trained volunteer museum guides to discuss the displays with visitors. These educational tasks meant that museums dedicated more space to classrooms, public lecture halls, and storage of educational materials to be sent on loan to public schools.[48]

FIGURE 21. Andrew Carnegie built an institution that was intended as an art gallery, a library, a natural history museum, and a public lecture hall.

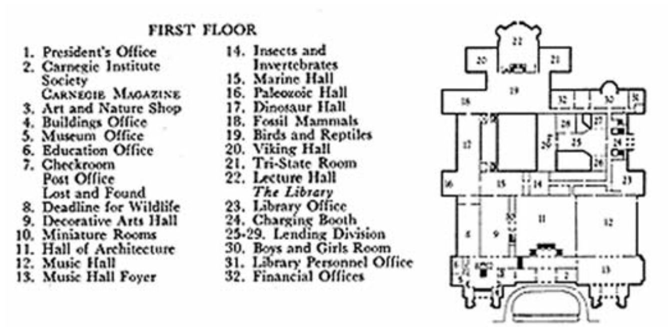


FIGURE 22. The Carnegie Institution in Pittsburgh was designed for display and did not show much architectural innovation.

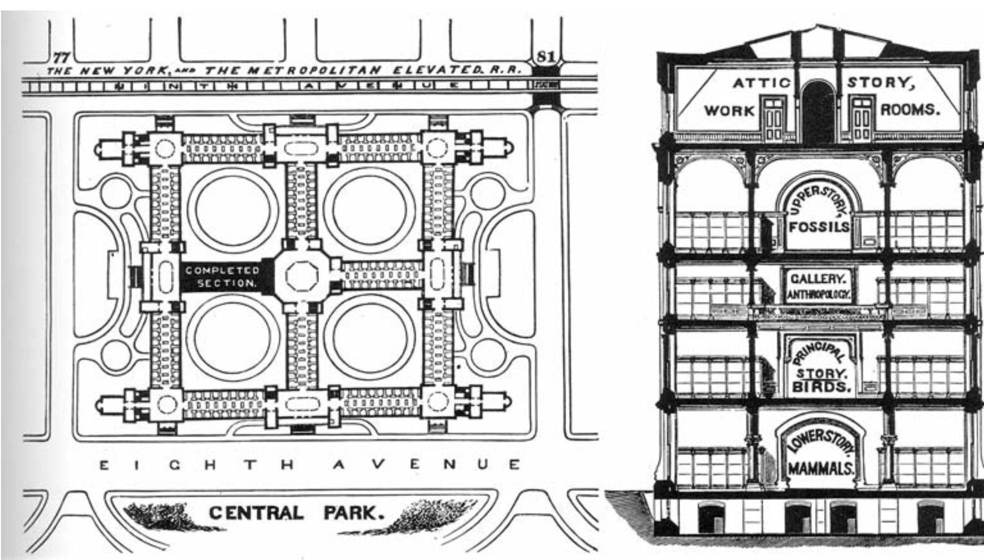
BUILDING URBAN MONUMENTS

In the last quarter of the nineteenth century, natural history museum building in America benefited from the explosive growth of private wealth and the rise of cultural philanthropy, much of it aimed toward rapidly growing cities.[49] While in the sixty years following Peale's Baltimore Museum only seven more natural history museums had been constructed, in the period from 1875 to 1900, seventeen would be built. (See Appendix A.) Wealthy individuals like Andrew Carnegie and Marshall Field, uncomfortable with charges of money but no taste, or wealth without culture, donated vast sums of money to establish natural history museums in the cities where they made their fortunes. These institutions were intended as a permanent testament to the philanthropists' wealth and generosity.[50]

Many were designed to be large, lavish and fashionable. Public museums were also intended to serve the larger community as an agent in educating and civilizing laborers, especially immigrants. An imposing exterior style and scale that inspired respect, and a lavish interior that reflected the rewards of New World civilization became the norm. With respect to museum design, new issues like central location and appropriate size and style became paramount. Two outstanding examples of urban natural history museums from the so-called golden age of museum building are the American Museum of Natural History, established in New York City in 1869, and the Field Museum, founded in Chicago in 1893.[51] Built in the two largest cities in the country by leading philanthropists with strong civic goals, these museums reflected the cultural pressures to provide entertainment, education, and research simultaneously.[52]

New York City had not had a highly visible or successful natural history enterprise and the Lyceum was in no position to provide leadership. Instead, it was Agassiz student Albert Bickmore who persuaded a number of prominent New Yorkers to envision an important natural history museum as part of the development of Central Park. Indeed, he persuaded an impressive list of moneyed locals to contribute to a museum project befitting the growing commercial city.[53] Teaming with the Metropolitan Museum of Art, American Museum officials successfully petitioned the state for land and funding for a fireproof building in 1871. The city council granted a remote, squalid 23-acre tract adjacent to Central Park. As pictured here (Fig. 23), the building was to be 850 feet long by 650 feet wide and included 18 acres of floor space — an area two thirds larger than the British Museum. Architect Calvert Vaux, who had collaborated with Frederick Law Olmsted on the design of Central Park, partnered with Jacob Wrey Mould for the initial design. They drafted a grand Victorian plan on a vast scale, with four quadrangles enclosed by twelve intersecting galleries and nine towering pavilions — the central one capped by a 120-foot diameter dome. But the first section built in 1877 was relatively modest (Fig. 24). As it turned out, the American Museum would be constructed with the help of government appropriations or individual donors, one section at a time.[54]

Much pomp and ceremony attended the beginning of construction on the first gallery in 1874. Joseph Henry in his dedication speech called the museum a "temple of nature" rightly constructed



American Museum of Natural History, Eighth to Ninth Avenue, West Seventy-seventh to West Eighty-first Street. Calvert Vaux and Jacob Wrey Mould, 1874–77. Master plan and section. AMNH.

FIGURE 23. The building planned by the aspiring founders of the American Museum of Natural History intended to surpass the British Museum in size.

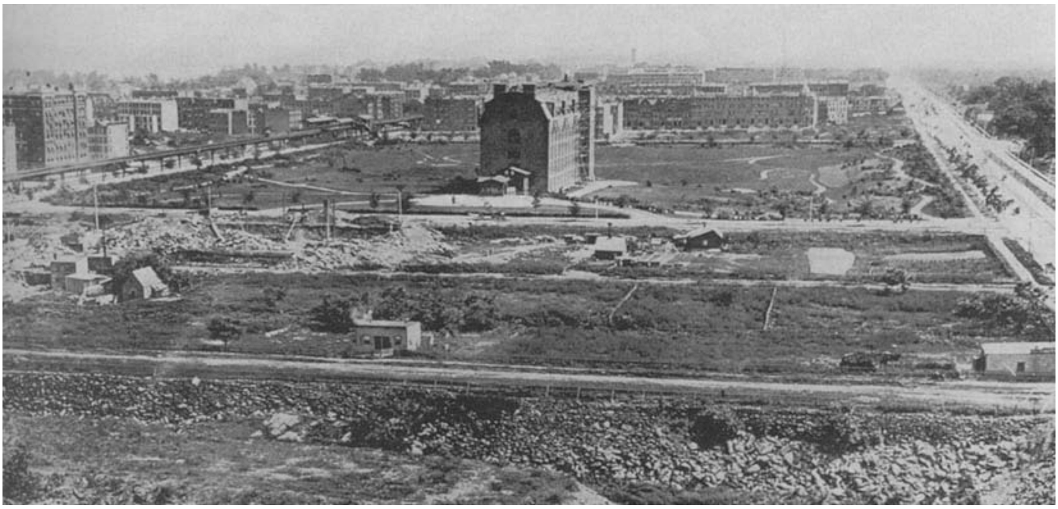


FIGURE 24. The section of the American Museum of Natural History that opened in 1877 quickly proved inadequate for the growing collections purchased by trustees.

to edify the urban masses. He also complained bitterly (and inappropriately) that a very large portion of the James Smithson bequest had been wrongly spent on the construction of a costly edifice in Washington.[55] Three years later, in December 1877, President Rutherford B. Hayes attended the opening of the first gallery, a gala affair for a cultivated audience.[56]

At the time, the museum's west side neighborhood was still underdeveloped, and the museum suffered for its remoteness. But a steady accumulation of collections, urban expansion, slowly increasing visitorship, and the determination of a handful of New York elites kept the museum going, and growing. Although Bickmore's vision of a museum that would invite the public was frustrated by its early isolation, the transit lines gradually extended to 79th Street, state subsidies allowed the museum to open one day a week with no admission fee, and teachers were allowed to borrow boxes of materials to use in their classrooms in addition to bringing an occasional class to the museum. Simultaneously, of course, the curators were adding to their collections. The demand for space meant that new wings and stories were required to accommodate large public audiences, dramatic exhibits, as well as storage and work space. In 1888, an appropriation was made to finance construction of the principal entrance pavilion on 77th Street. By then, Vaux and Mould had dissolved their partnership, and the trustees called for a revised master plan. The winning submission by J. Cleaveland Cady called for an imposing red granite Richardsonian Romanesque design — an architectural style then in vogue for large civic buildings (Fig. 25).[57] The Museum would continue to grow over in a similarly eclectic way through the next century, gradually filling in the massive block of land allocated to it in the 1870s.

In 1893, the success of the World's Columbian Exposition, whose "White City" would have a significant architectural impact well beyond Chicago, inspired local civic leaders to establish a permanent museum with exhibits acquired from the fair.[58] Museum advocates acquired the former Fine Arts Palace when the exposition closed in 1893 (Fig. 26).[59] A neoclassical masterpiece designed by Charles Atwood, the Palace was well-suited for exhibition purposes and was a favorite among Chicago fair goers. The fair had gained new status for the Windy City, previously better known for cattle than for culture. As the museum was originally intended to be a memorial of the fair — not just a natural history museum — the former Fine Arts Palace brought a certain nostal-

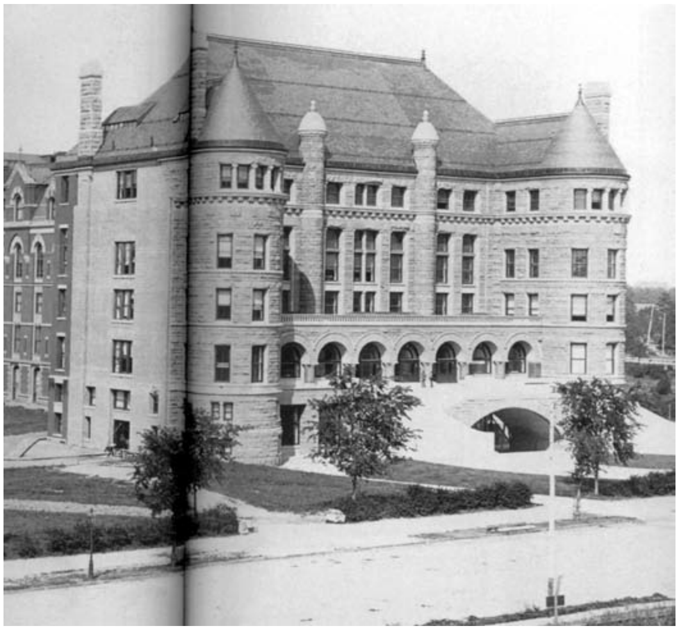


FIGURE 25. The trustees chose to place the grand entrance to the American Museum facing 77th Street rather than New York's Central Park.

gic appropriateness to the museum enterprise. With its brick understructure, it offered somewhat better fire protection than the other, less substantial buildings of the fair. It was conveniently located on the fairgrounds, close to the source of most of the museum's early acquisitions. Best of all was the price, as the abandoned Palace was given freely to museum developers.[60]

But as a permanent museum, the Palace had little to offer, and Field Museum founders were soon beset by problems. The Jackson Park location was quite distant from the city center. The building also had to be retrofitted for heat, which was never made adequate for Chicago winters.[61] The building's exterior details, cast in plaster and straw to look like stone, were extremely vulnerable to bad weather. Large sections of the decorative cornices and roof line would occasionally break free and fall, endangering visitors and specimens alike. Worst of all, museum developers, scarcely one generation removed from the Great Chicago Fire of 1871, lived in constant fear of conflagration. Lack of a permanent institutional home hampered the development of some sci-

FIGURE 26. The Palace of Fine Art had been a favorite among visitors to the Columbian Exposition in Chicago in 1893, but had not been designed for year-round use.

entific departments and was a constant cause of concern and lost time for museum staff and administrators.

In fact, the solution to this problem was under discussion even before the museum first opened its doors in June 1894. Marshall Field, the museum's namesake and chief benefactor, requested Ernest R. Graham to prepare a detailed estimate of the cost of re-making the Palace into a solid, permanent and incombustible building.[62] But the high cost of rebuilding, as well as the ongoing debate about the advisability of remaining in Jackson Park, delayed the effort. When Field died in 1906, he left money to finance a new structure. By this time, the museum had outgrown the original building, and a much larger one was commissioned under Daniel Burnham, chief architect of the fair. Burnham's plan called for an enormous neo-classical structure modeled closely on Atwood's design for the Fine Arts Palace, which Field apparently favored. Burnham's plan included a very large central pavilion, four large annexes, and a tall central dome.[63] Burnham believed the Grant Park location, and the dome, were both essential in making the Field Museum the most beautiful building in the world. But museum president Harlow Higinbotham passionately believed he was carrying out Marshall Field's mandate, and he argued that the building, without the dome, was more than adequate to the institution's needs. His feeling was that the dome would glorify the architect, but that the museum should be Field's monument, not Burnham's.

Also at issue was the museum's ultimate location. Would it go ideally in the center of Grant Park, near downtown, as most museum officials wanted? Would it be compelled to remain in its distant Jackson Park location? Or would some alternative site be found? Ultimately, the issue was over control of the institution after Marshall Field's death. By 1909, Higinbotham, former museum president Edward Ayer, the trustees, Burnham, Montgomery Ward, and members of the Field family were all involved in the controversy. Ayer wanted Stanley Field to replace Higinbotham as executive committee president — he thought that with Stanley Field as president, more money could be had from the Field family, thus enabling the museum to build the annexes and keep the dome. Higinbotham thought a regime change would jeopardize the museum's litigation with Ward over the proposed Grant Park location. Ward, who had made his fortune as a mail-order retailer, claimed that the museum would make Grant Park into a playground for millionaires, rather than ordinary citizens.[64]

In the end, Stanley Field was made museum president. The museum lost its court battle with Ward, but was given a compromise site on landfill added to the south end of Grant Park. Field's bequest was not enough to build the entire building, so Burnham's dome and the annexes were

FIGURE 27. When the new Field Museum opened in Chicago in 1921, it anchored a public park along Lake Michigan.

scuttled. The result was a symmetrical, marble-clad, neo-classical museum that became a focal point along Lake Shore Drive (Fig. 27).[65] Designed to accommodate anticipated growth, the museum was built on a scale that could be almost overwhelming, even exhausting for visitors and staff. Two entire floors were designated for exhibit space. The floor plan was arranged around a great central hall, 300 feet long, 70 feet wide, and 75 feet tall, named for Stanley Field. Long exhibit corridors intersected the main hall and extended out to exterior halls that run parallel to the main hall, to which visitors necessarily returned.[66]

The California Academy of Sciences, discussed elsewhere in this volume, represented a distinctive way of establishing a museum in the late nineteenth century. Founded as a society in 1853 in San Francisco, the Academy gained a commercial property from James Lick in the 1870s and its accruing rental income allowed Academy members to build their own facility in 1891.[67] Its façade was distinguished business on Market Street (Fig. 28), and the museum was in a building immediately behind it, again allowing rental revenues to recover at least some museum costs.

FIGURE 28. The California Academy of Sciences collections were held in a museum facility behind this specially constructed commercial building from which the Academy was able to derive sustaining income. Courtesy Archives, California Academy of Sciences.

Unfortunately, this building was destroyed by the 1906 earthquake and its replacement was wholly commercial in an effort to rebuild its capital. The Academy moved to Golden Gate Park, where it eventually built a modern museum facility.

Conclusion

The imposing natural history museum structures and their often dramatic interior displays were a product of nineteenth-century enthusiasm for natural history. Indeed, many of them acquired "great swaths of land" beyond immediate building needs and required of their sponsors significant "leaps of imagination" about the scale of the final institution – and it would take decades for some to fulfill the promissory notes of public service.[68] Natural history museums had become at once a location for pursuing research and an expression of the civic virtues assigned to education about the natural world.[69]

National rivalries with respect to Europe, urban competition with respect to other cities, and increasingly progressive notions about the significance of knowledge and opportunity were common notes played in celebratory speeches when each new museum opened. Monumental buildings with massive exteriors and grand interiors seemed to imply civic significance. After the Columbian Exposition of 1893, the neo-classic became the fashionable style of natural history museums, as shown by the "new" United States National Museum of 1911 (Fig. 29).

FIGURE 29. The National Museum of Natural History of the Smithsonian Institution was designed to accommodate large crowds of visitors on its main floors while sequestering the basement and upper floors for storage, laboratories, and curatorial offices.

What of the questions about architecture and design posed at the beginning of this essay? There turns out to be no simple pattern or progression in museum design — but instead we have found considerable heterogeneity in their interlocking, repeating, and culturally situated features. Nonetheless, a certain formula began to signal the importance of these public museums with their imposing facades (often with turrets and domes) and their park-like locations. Changing styles that had taken museums' rather domestic or multi-purpose space to dramatic Romanesque and classical facades mirrored changing cultural trends, but personal tastes of patrons and political leaders meant that there was no simple or universal pattern. Infrastructure changes were less visible but equally important. The danger of fire, dramatically demonstrated by a disastrous one at the Smithsonian Institution in 1865 and others mentioned throughout this paper, made administrators determined to take advantages of important engineering advances that could limit such risks and take advantage of stronger materials, better lighting, and central heating. Attention to these kinds of detail was more possible as civic support supplanted the entrepreneurial motives and philanthropic contributions that had created the earliest natural history museums. It was possible not only to build larger structures but also to place them in public spaces intended for cultural activities rather than commercial districts. Here the audience, too, was a broader one, intended to encompass the "mechanic, the factory operator, the day laborer, the salesman, and the clerk, as much as those of the professional man and the man of leisure." Such audiences, in a "busy critical, and skeptical age," observed Goode in 1896, relied on visual information that could be conveyed by objects on display.[70]

Internal spaces of museums also changed during the long nineteenth century, reaching back to an architectural tradition of extended corridors and of open vestibules, even as museums took advantage of better and larger glass for cabinetry, experimented with lighting and traffic flow, and considered what would capture the imagination and more successfully teach an ever broader public audience. The demand for safe facilities in terms of fire, ventilation for clean air, and structural strength was important both for public audiences and for the rich and often unique collections. Physical holdings continued to grow rapidly at the turn of the century, fueled by the enthusiasms of sportsmen like Theodore Roosevelt and his friends at the Boone and Crockett Club as well as by the more complex kinds of research questions that required large collections.[71]

The museums built in the nineteenth century and its early twentieth-century shadow before World War I were, on the surface, strikingly different from the metallic and glass institutions being built in the late twentieth and early twenty-first centuries. Nonetheless many familiar design elements in the early twenty-first century that encourage curators to educate, store research materials, and display items that reveal current ecological concerns in science reflect the priorities that were established more than a century ago. While considerably different in detail, the museums of the nineteenth century established distinctive and significant facilities that framed nature for civic purposes.

Notes

1 The authors would like to thank Michele Aldrich, Ronald Rainger, Alan Leviton, and Pamela Henson for their thoughtful comments on an earlier version of this paper.

2 Peale's diary (volume 5 of *Selected Papers of Charles Willson Peale and His Family*), in five volumes, ed. Lillian B. Miller, vol. 2 (New Haven: Yale University Press, 1981–2001; hereafter *Papers of CWP*), makes clear his initiatives: "Although Peale has so much labour to go through in preparing subjects for filling up the several classes of Animals in his Museum, yet his disposition was such, that if an Idea struck his fancy on any kind of improvement, which he conceived had a chance of becoming advantageous to the Public...he instantly went to work on such invention (p. 235)." There is a rich scholarship on Charles Willson Peale as artist and museum developer (see n. 8 below).

3 Steven Conn, *Museums and American Intellectual Life*, 1876–1926 (Chicago: University of Chicago Press, 1998), chapter 2.

4 There is considerably more work on art museums, and see especially Helen Searing, *New American Art Museums* (New York: Whitney Museum of American Art, 1982).

5 For an overview of the growing literature on natural history museums see review essays by Ronald Rainger, "Recent Books on the History of Museums," *Biology and Philosophy* 10 (1995): 235–248; and Sally Gregory Kohlstedt, "Museums: Revisiting Sites in the History of the Natural Sciences," *Journal of the History of Biology* 28 (1995): 151–166. Other useful sources on museum history include Charlotte M. Porter, "The Natural History Museum," in *The Museum: A Reference Guide*, Michael Steven Shapiro, ed. (Westport, Connecticut: Greenwood Press, 1990), pp. 1–29; and Tony Bennett, *Birth of the Museum: History, Theory, Politics* (London: Routledge, 1995); also see Edward P. Alexander, *Museums in Motion: An Introduction to the History and Functions of Museums* (Nashville, Tenn.: American Association for State and Local History, 1941).

6 For a recent discussion of museum spaces specifically, see Carla Yanni, *Nature's Museums: Victorian Science and the Architecture of Display* (Baltimore: Johns Hopkins University Press, 1999); there is also close attention to the building of the Museum of Comparative Zoology in Mary P. Winsor, "Agassiz's Notion of a Museum: The Vision and the Myth," in *Cultures and Institutions of Natural History: Essays in the History and Philosophy of Science*, Michael T. Ghiselin and Alan E. Leviton, eds. (San Francisco: California Academy of Sciences, 2000), 249–272.

7 Jay Cantor, "Temples of the Arts: Museum Architecture in Nineteenth-Century," *Metropolitan Museum of Art Bulletin* 28 (April, 1970): 331–354, and the classic by Nathaniel Burt, *Palaces of the People: A Social History of the American Art Museum* (Boston: Little, Brown, and Co., 1977).

[8] The standard biography remains Charles Coleman Sellers, *Mr. Peale's Museum: Charles Willson Peale and the First Popular Museum of Natural Science and Art* (New York: W.W. Norton, 1980); also useful is the illustrated volume based on an exhibition at the National Portrait Gallery by Edgar Richardson, Brooke Hindle and Lillian R. Miller, *Charles Willson Peale and His World* (New York: Henry N. Abrams, 1982).

[9] Paula Findlen, *Possessing Nature: Museums, Collecting, and Scientific Culture in Early Modern Italy* (Berkeley: University of California Press, 1994); and "Masculine Prerogatives: Gender, Space, and Knowledge in the Early Museum," in *The Architecture of Science*, Peter Galison and Emily Thompson, eds. (Cambridge: MIT Press, 1999), pp. 29–58. Another important discussion of the meaning of objects in the 17th and 18th centuries is Lorraine Daston and Katherine Park, *Wonders and the Order of Nature* (New York: Zone Books, 1998).

[10] On the naturalist tradition in this period see Raymond P. Stearns, *Science in the British Colonies of North America* (Urbana: University of Illinois Press, 1970); John C. Greene, *American Science in the Age of Jefferson* (Ames: University of Iowa Press, 1984); and Charlotte Porter, *The Eagle's Nest: Natural History and American Ideas, 1812–1842* (Tuscaloosa: University of Alabama Press, 1986).

[11] This use of public space for projects presumed to have public benefits had precedent in Europe and even in the colonies. The old State House in Charleston was given to the Library Society for their books and specimens as early as 1773 and has led some scholar to thus suggest it is North America's first public museum, as in Albert E. Sanders, *Natural History Investigations in South Carolina from Colonial Times to the Present* (Columbia: University of South Carolina Press, 1999); see *Charleston Library Society Journal*, 7 and 12 July, Charleston Library Society, South Carolina. Gardiner Baker had been granted free space in the City Hall by New York City's Common Council in 1793; see Robert M. McClung and Gale S. McClung, "Tammany's Remarkable Gardiner Baker," *New York Historical Society* 42 (1958):143–169.

[12] Charles W. Peale, *Introduction to a Course of Lectures on Natural History* (Philadelphia, 1800), p. 12.

[13] David Brigham, *Public Culture in the Early Republic: Peale's Museum and Its Audience* (Washington: Smithsonian Institution Press, 1995) discusses the importance of the museum for particular locals and for national visibility.

[14] Peale was fascinated by Georges Cuvier's research on comparative anatomy and particularly on the mastodon, encouraging Rembrandt to visit Cuvier and produce a portrait for the Philadelphia museum. See Miller, *Charles Willson Peale*, 2:1189–1191.

[15] George Brown Goode emphasizes this chance development of early museums in his "Museum-History and Museums of History" reprinted in Sally Gregory Kohlstedt, ed., *The Origins of Natural Science in America: The Essays of George Brown Goode* (Washington: Smithsonian Institution Press, 1991), pp. 297–321.

[16] Greene, *American Science*, pp. 195–217.

[17] Peale's Baltimore Museum was reconstituted in the 1990s as an historical exemplar of these early museums and aspects of their history are found in William T. Alderson, ed., *Mermaids, Mummies and Mastodons: The Emergence of the American Museum* (Washington: Association of American Museums, 1992). In London, the Museum of Practical Geology was among the first to be deliberately didactic in both its own construction and its holdings; see Sophie Forgan, "Bricks and Bones: Architecture and Science in Victorian Britain," in Galison and Thompson, *Architecture*, pp. 193–200. There is little to indicate how the interior was organized, and the younger Peale was most concerned to have a studio where he might attract art students.

[18] Wilbur Harvey Hunter, Jr., *The Story of America's Oldest Museum Building* (Baltimore: The Peale Museum, 1952).

[19] The building housed a cabinet of curiosities, a two-story gallery of art in the rear, a lecture hall, and a third floor space that Rembrandt Peale intended as a teaching studio. The Baltimore Museum building was transferred in the early 1820s to Rubens, who added more music, panoramas, and evening entertainment while Rembrandt returned to full-time painting. Later, Rubens moved to New York City where he opened his New York Museum on July 4, 1825, the same day as the official opening of the Erie Canal.

[20] Henry D. Shapiro, "The Western Academy of Natural Sciences of Cincinnati and the Structure of Science in the Ohio Valley, 1810–1850," in *The Pursuit of Knowledge in the Early American Republic: American Scientific and Learned Societies from Colonial Times to the Civil War*, Alexandra Oleson and Sanborn C. Brown, eds. (Baltimore: Johns Hopkins Press, 1976), pp. 219–247. On Drake see the biographical sketch in Charles D. Aring, *Daniel Drake: Frontiersman of the Mind* (Cincinnati: Crossroads Books, 1985). For a useful overview of the museums enterprises of this period see Joel Orosz, *Curators and Culture: The Museum Movement in America*, 1740–1870 (Tuscaloosa: University of Alabama Press, 1990).

[21] The best overview is Patsy A. Gerstner, "The Academy of Natural Sciences of Philadelphia, 1812–1850," in Oleson and Brown, *Pursuit of Knowledge*, pp. 174–193. Records of the Academy, founded in 1912, are available on microfilm and summarized in *Minutes and Correspondence of the Academy of Natural Sciences of Philadelphia, 1812–1924* (Philadelphia: Academy of Natural Sciences, 1967). The Academy figures throughout the discussions of natural science in Philadelphia in Porter, *Eagle's Nest*.

[22] Leonard Warren, Joseph Leidy: *The Last Man Who Knew Everything* (New Haven, CT: Yale University Press, 1998).

[23] See Juan Ilerbaig, “Pride in Place: Fieldwork, Geography, and American Field Zoology, 1850–1920” (Ph.D. diss., University of Minnesota, 2002).

[24] See undated pamphlet simply entitled *Lyceum of Natural History*, p. 3, that had evidently been self-published as part of an appeal for funds.

[25] Evidence that the Panic of 1837 left many subscribers unable to meet their commitments is evident in the account book; for the bankruptcy see *Minute Book*, February 26, 1844, New York Academy of Sciences Library. Also see Simon Baatz, *Knowledge, Culture and Science in the Metropolis: The New York Academy of Sciences, 1817–1970*, published as *NYA Annals*, vol. 584 (New York: Academy of Sciences, 1990), and H.L. Fairchild, *A History of the New York Academy of Sciences* (New York: The Academy, 1887), p.

[26] Quoted in Fairchild, *History of the Academy*, p. 81.

[27] Sally Gregory Kohlstedt, “Museums on Campus: A Tradition of Inquiry and Teaching,” in Ronald Rainger, Keith Benson, and Jane Maienschein, eds., *The American Development of Biology* (Philadelphia: University of Pennsylvania Press, 1988): 15–47.

28. See, for examples, N. Jardine, J.A. Secord, and E.C. Spary, eds., *Cultures of Natural History* (Cambridge: Cambridge University Press, 1996); and Andreas W. Daum, *Wissenschafts-popularisierung im 19. Jahrhundert: Burgerliche Kultur, naturwissenschaftliche Bildung und die deutsche Offentlichkkeit, 1848–1914* (Munich: Oldenbourg Verlag, 1998).

29. Various accounts of a mermaid (apparently constructed from a monkey and a fish) suggest that Barnum deliberately tweaked the naturalists, most particularly Neil Harris’s *Humbug: The Art of P.T. Barnum* (Boston: Little, Brown, and Co., 1973).

30. Winsor, “Agassiz’s Notion of a Museum,” pp. 249–272.

[31] Edward Lurie, *Louis Agassiz, a Life in Science* (Baltimore: Johns Hopkins Press, 1988 [1960]).

[32] Mary P. Winsor, *Reading the Shape of Nature: Comparative Zoology at the Agassiz Museum* (Chicago: University of Chicago Press, 1991), esp. pp. 174–176.

[33] Sally Gregory Kohlstedt, “Henry A. Ward: The Merchant Naturalist and American Museum Development,” *Journal of the Society for the Bibliography of Natural History*, 9 (l980): 647–66l discusses the limits of Agassiz’s interest in public display. On the glass models, see R.E. Shultes and W.A. Davis, *The Glass Flowers at Harvard* (New York: E.P. Dutton, 1982).

[34] Barbara R. Stein, *On Her Own Terms: Annie Montague Alexander and the Rise of Science in the American West* (California: University of California Press, 2001).

[35] Lynn Dewald of the Wagner Free Institute kindly provided a copy of their National Register of Historic Places and National Landmark registration forms, compiled by Eugene Bolt and Susan Glassman, with its detailed discussion of architecture and history. On William Wagner’s own assessment of the work that included 476 free lectures, a library of 7000 volumes, and chemical laboratory, and a cabinet of geology, mineralogy and conchology as well as his goals, see his letter to Spencer F. Baird at the Smithsonian Institution, n.d. [c. 1856], Baird Incoming Correspondence, Smithsonian Institution Archives.

[36] Coleman makes the provocative suggestion that abandoned castles were being converted into museums in Europe and that may have influenced Renaissance styles that became popular at mid-century; Laurence Vail Coleman, *The Museum in America: A Critical Study* (Washington: Association of American Museums, 1939), p. 199.

[37] Yanni, *Nature’s Museums*, p. 111. The contrasts were deliberate on both sides; see Henry R. Hitchcock, *The Crystal Palace: The Structure, Its Antecedents, and Its Immediate Progeny* (Northampton, Massachusetts, 1951).

[38] For a particularly close look at the architectural decisions involved see Kenneth Hafertepe, *America’s Castle*: *The Evolution of the Smithsonian Building, 1840–1878* (Washington: Smithsonian Institution, 1984). A number of architectural plans were submitted and, including two, one Gothic and the other the winning Norman style by the young James Renwick. Henry fretted that it would be “impossible for me to prevent a large expenditure in the way of a building” (p. 56) without arousing an already skittish Congress. Alexander Dallas Bache found a compromise by putting a cap at $100,000 and suggesting that only interest be used for the building itself.

[39] Despite or perhaps because there is an extensive correspondence of Baird at the Smithsonian Institution, there is still no definitive biography of this leading naturalist who orchestrated much of the collecting and publication at the Smithsonian for more than three decades; the best account of one aspect of his life and career is Dean C. Allard Jr., “Spencer F. Baird and the United States Fish Commission” (Ph.D. diss., George Washington University, 1972).

[40] The ornate Victorian red brick structure with polychromatic trim was nonetheless built with attention to public spaces that needed to be fireproof and well ventilated. In 2003 there is serious discussion about taking down this building, which is now in poor condition.

[41] Pamela M. Henson, “Spencer Baird’s Dream: A U. S. National Museum,” in Ghiselin and Leviton, *Cultures and Institutions*, pp. 101–126.

42 Helen Sterling suggests that the French teacher and author Jean-Nicolas-Louis Durand, who also had produced generalized plans for churches and other public buildings, found his inspiration for this museum design from Roman baths. See Sterling, *Art Museums*, pp. 14–20.

43 [Percy R. Creed, ed.], *The Boston Society of Natural History, 1830–1930* (Boston: The Society, 1930).

44 The museum was built together with a public library, see Nancy Oestreich Lurie, *A Special Style: The Milwaukee Public Museum, 1882–1982* (Milwaukee: Milwaukee Public Museum, 1983). Also see Sally Gregory Kohlstedt, "German Ideas and Practice in American Natural History Museums," in Henry Geitz, Jurgen Heideking, and Jurgen Herbst, eds., *German Influences on Education in the United States to 1917* (Cambridge: Cambridge University Press, 1995), pp. 103–114.

45 On the design competition see Ingrid A. Steffensen-Bruce, *Marble Palaces, Temples of Art: Art Museums, Architecture, and American Culture, 1890–1930* (Lewisburg: Bucknell University Press, 1998), pp. 168–176.

46 A pictorial retrospective is found in James D. Van Trump, *An American Palace of Culture: The Carnegie Institute and Carnegie Library of Pittsburgh* (Pittsburgh: Carnegie Institute, 1970). The architects were Longfellow, Alden and Harlow, who had a firm in Boston and in Pittsburgh; Alden had worked with Richardson before going to Pittsburgh in 1885.

47 Sally Gregory Kohlstedt, "International Exchange and National Style: A View of Natural History Museums in the United States, 1850–1900," in Nathan Reingold and Marc Rothenberg, eds., *Scientific Colonialism: A Cross-Cultural Comparison* (Washington: Smithsonian Institution Press, 1987), pp. 167–190.

48 Kohlstedt, "Museums on Campus," 15–47.

49 Museum philanthropy in this period has not received focused attention, but on early philanthropy see Howard S. Miller, *Dollars for Research: Science and Its Patrons in Nineteenth-Century America* (Seattle: University of Washington Press, 1970) and, although it sidesteps museums, also see Robert E. Kohler, *Partners in Science, Foundations and the Natural Scientists, 1900–1945* (Chicago: University of Chicago Press, 1991).

50 Kathleen D. McCarty, *Noblesse Oblige: Charity and Cultural Philanthropy in Chicago, 1849–1929* (Chicago and London, University of Chicago Press, 1982); and Helen Lefkowitz Horowitz, *Cultural Philanthropy in Chicago from the 1880s to 1917* (Lexington: University of Kentucky Press, 1976), pp. 107–125, passim.

51 In both instances, the founding date was to create a formal institutional base, although the actual facilities were in acknowledged temporary quarters, with the American Museum in the New York Armory and the Field Museum on the Columbian Exposition site.

52 These multiple goals were articulated by Alexander Winchell, a geologist who had established the museum at the University of Minnesota and had hopes of creating a larger public museum in St. Paul, Minnesota in "Museums and their Purposes" in *Science*, n.s. 18 (July 24, 1891):40–46.

53 John M. Kennedy, "Philanthropy and Science in New York City: The American Museum of Natural History, 1868–1968" (Ph.D. diss., Yale University, 1968).

54 Robert A. M. Stern, Thomas Mellins, and David Fishman, *New York, 1880: Architecture and Urbanism in the Gilded Age* (New York: Monacelli Press, 1999), pp. 182–189. The master plan was violated subsequently by the building of an immense, temple-like memorial to Theodore Roosevelt on the eastern facade in 1936, by the Hayden Planetarium addition, and more recently by the building of the Rose Center, which has been described as a "cosmic cathedral." See also Geoffrey Hellman, *Bankers, Bones and Beetles: The First Century of the American Museum of Natural History* (Garden City, New York: The Natural History Press, 1969), pp. 1–3 and 9–23; and Douglas J. Preston, *Dinosaurs in the Attic: An Excursion into the American Museum of Natural History* (New York: St. Martin's Press, 1994 [1986]), pp. 13–20.

55 While scores of dignitaries and displaced squatters looked on, President Ulysses S. Grant laid the cornerstone with a silver trowel supplied by Tiffany's – and later stolen. Several prominent speakers, including New York Governor John A. Dix, alluded to the civic virtue and accomplishment implied by the building of a great cultural institution. See Hellman, *Bankers*, pp. 24–25.

56 Karen Wonders, *Habitat Dioramas: Illustrations of Wilderness in Museums of Natural History* (Uppsala: Almqvist and Wiksell, 1993).

57 Stern, Mellins, and Fishman, *New York 1880*, p. 186. The present structure departs widely from the original plan, and the final result is somewhat ambiguous. Architecturally disharmonious on the exterior, and hopelessly confusing on the interior, the museum building nevertheless suits its purposes as a place for the accumulation and display of specimens. More importantly, the museum is loved by millions of New Yorkers and international visitors who come to marvel at the objects it houses.

58 For a detailed discussion of the influence of international fairs on architecture see Steffensen-Bruce, *Marble Palaces*, chapter 2: "The Art Museum as Fair Spectacle"

59 As in New York, the Chicago leaders completely ignored the expertise of less prominent local men who had a serious interest in natural history. The Chicago Academy of Sciences had struggled over the years to recreate its collections and was itself building a facility further north in the early 1890s, and near the lakeshore in Lincoln Park. Edward Timothy

Klunk, “The Chicago Academy of Sciences: The Development and Method of Educational Work in Natural History” (Ph.D. diss., Loyola University, Chicago, 1996)

60 No book-length, comprehensive, scholarly history of the Field Museum has ever been published. Essential data about its establishment can be found in [Frederick J.V. Skiff], “An Historical and Descriptive Account of the Field Columbian Museum” *Field Columbian Museum Publications, Historical Series*, 1 (1) (December, 1894): 1–91. There are also two incomplete manuscripts on the history of the museum housed in the Field Museum Archives (FMA), one by Frederick J.V. Skiff written in 1916, and one by J. Christian Bay written in 1929.

61 Lighted naturally through abundant skylights, the museum could be dim on cloudy days and had to keep limited hours during the shortest days of winter. Water closets had to be added. So did offices and laboratory spaces. The wood floors sagged and warped. Infestations and mysterious smells were frequent complaints. The glass skylights threatened to break. The roof leaked, and sections of tin used to repair the leaks would blow away in the stiff Chicago wind. Detailed information about the troubles museum administrators had with the Fine Arts Palace can be found in dozens of letters in the Director’s Correspondence, FMA.

62 Letter (copy), O.F. Aldis to M. Field, 10 May 1894, FMA; [E.R. Graham] document entitled: “Estimates of Cost of Rebuilding the Field Columbian Museum, in Jackson Park” (copy) 7 May 1894, FMA.

63 Burnham envisioned the museum as a key element in his grand Plan of Chicago, second in the urban hierarchy only to the main Civic Center, which would have an even higher dome. See Sally A. Kitt Chappel, *Architecture and Planning of Graham, Anderson, Probst and White, 1912–1936* (Chicago: University of Chicago Press, 1922), p. 3.

64 See Letter (copy), H.N. Higinbotham to E. Walker, 30 December 1908, FMA; Lois Wille, *Forever Open, Clear and Free* (Chicago, Henry Regnery Company, 1972), pp. 77–81.

65 Chappel, *Architecture and Planning*, pp. 86–88.

66 By this time essentially all major museums followed the advice of George Brown Goode and kept most of their materials in storage and maintained separate office, lab and library space. The Field Museum put these facilities on the third floor. New storage space has been created by filling in lightwells and commandeering exhibit space. The museum is currently building new storage space underground.

67 Michele Aldrich and Alan E. Leviton, “West and East: The California Academy of Sciences and the Smithsonian Institution, 1852–1906,” in Ghiselin and Leviton, *Cultures and Institutions*, pp. 183–202; and *Theodore Henry Hittell’s, The California Academy of Science: A Narrative History, 1853–1906*, Alan E. Leviton and Michele L. Aldrich, eds. (San Francisco: The Academy, 1997).

68 See Steffensen-Bruce, *Marble Palaces*, p. 176.

69 For a discussion of “civic science” on an international level, see Lynn Nyhart and Thomas Broman, eds., *Science and Civil Society* (Chicago: University of Chicago Press, 2002).

70 He observed that “The eye is used more and more, the ear less and less, and in the use of the dye, descriptive writing is set aside for picture, and pictures are in turn replaced by actual objects. In the schoolroom the diagram, the blackboard, and the object lesson, unknown thirty years ago, are universally employed. . . Amid such tendencies the museum if would seem, should find congenial place, or it is the most powerful and useful auxiliary of all systems of teaching by means of object lessons.” Quoted in “The Museums of the Future,” *Writings of George Brown Goode*, p. 321.

71 Not only did questions of variation and population have an effect on the size of collections, but the systematic attention to relatively new areas of study, particularly anthropology, also expanded the scope of museums. See, for example, Curtis M. Hinsley, Jr., *Savages and Scientists: The Smithsonian Institution and the Development of American Anthropology, 1846–1910* (Washington: Smithsonian Institution Press, 1981).

72 This list, which contains only public natural history museums and not those of colleges, is based in large part on Appendix Y, a list of all museums with their own buildings, found in Coleman, ***The Museum in America: A Critical Study*****,** n. p., 1939.

Appendix A: List of Natural History Museum Buildings, Not Including Those on College Campuses, to 1930[72]

To 1870

1814	Peale's Museum, Baltimore (1814–1830)
1840	Academy of Natural Sciences, Philadelphia (2nd story added in 1847; new bldg. 1876)
1855	Smithsonian Institution, Washington, D.C.

1860s

1860	Museum of Comparative Zoology, Cambridge (additions in 1889, 1902)
1864	Boston Society of Natural History
1864	Wagner Free Institute of Science, Philadelphia
1868	Chicago Academy of Sciences (destroyed by fire in 1871)

1870s

1874	California Academy of Sciences, San Francisco (relocated to new building in 1891)
1876	Academy of Natural Sciences, Philadelphia
1877	American Museum of Natural History, New York
1878	Davenport Public Museum (additions 1879, 1930)
1879	Portland Society of Natural History

1880s

1881	United States National Museum, Washington, D.C.
1885	Academy Hall, Peabody Academy of Science

1890s

1891	Fairbanks Museum of Natural Science, St. Johnsbury, Vermont
1891	California Academy of Sciences, San Francisco (destroyed by earthquake and fire in 1906)
1893	Field Museum of Natural History takes over Fine Arts Building, Chicago (new building 1921)
1893	Wistar Institute of Anatomy and Biology, Philadelphia
1895	Brooklyn Museum, Brooklyn Institute of Arts and Sciences (additions, 1905, 1907, 1927)
1895	Carnegie Institute, Pittsburgh
1898	Milwaukee Public Museum
1899	Museum of Natural History, Springfield, Massachusetts
1899	Barnum Institute, Bridgeport Scientific and Historical Society, Connecticut

1900s

1906	Colorado Museum of Natural History, Denver
1908	Everhart Museum of Natural History, Science and Art (addition 1929)

1910s

1911	United States National Museum (new building), Washington, D.C.
1913	Los Angeles County Museum of History, Science and Art (additions 1926, 1929)
1915	Natural History Museum, San Diego Society of Natural History
1916	California Academy of Sciences, San Francisco (new buildings; completed in 1913 but not opened to the public until 1916; addition 1923)
1916	New York State Museum, Albany
1918	Public Museum, Staten Island Institute of Arts and Sciences, New York

1920s

1920	Buffalo Society of Natural History (new building 1929)
1920	Knox Museum, Knox Academy of Arts and Sciences, Thomaston, Maine (addition 1929)
1921	Field Museum of Natural History, Chicago
1922	Santa Barbara Museum of Natural History (additions 1926, 1927, 1929), California
1923	Illinois State Museum, Springfield
1924	Reading Public Museum and Art Gallery, Reading, Pennsylvania
1924	Webb Memorial Library and Museum, St. Augustine, Florida
1926	Newark Museum, New Jersey
1929	Buffalo Museum of Science

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A National Science and a National Museum

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In 1881, the United States National Museum building opened in Washington, D.C., to display the flora, fauna, minerals, ethnology, history and arts of the United States to all the citizens of a democracy. It also served as a scientific and economic resource for studying the natural world and advancing the American economy. It had taken over a century after the Revolution for the young nation to build a national museum on par with those of European capitals, and that also met the demands of a rapidly growing and industrializing democratic society. This essay will trace some of the roots, forces, and stresses that shaped American science and the first distinctly American National Museum.

The Colonial Era

Interest in systematically collecting and describing the flora, fauna, and minerals of North America began with discovery and exploration of the continent by Europeans. Tales of the many curious animals and plants, from corn to tobacco, opossums to bison, fascinated Continental scientists. Colonists brought European, and especially English, scientific traditions with them and soon began collecting specimens for scientific study. Initially colonial naturalists sent their specimens, notes, and drawings back to England to be compared with the large collections there and to be described by leading scientists in British scientific journals.[1] Sir Hans Sloane (1660–1753), president of the Royal College of Physicians and the Royal Society of London, actively encouraged science in the colonies of North America. He sought specimens from correspondents for his growing natural history collection that formed the core of the British Museum in 1853. His correspondents included Cadwallader Colden (1689–1776), the lieutenant governor of New York who was also a fine naturalist, interested particularly in botany. Colden maintained a correspondence with Carl von Linné (1707–1778) and shipped many specimens to him and to British naturalists for study. He also published in England an interesting study of Native Americans, titled *The History of the Five Indian Nations Depending on the Province of New York in 1727*.[2]

Sloane's collections were augmented by quite a few colonists. Further south, William Byrd II (1674–1744) of Virginia in 1697 presented to the Royal Society of London a live rattlesnake and a live opossum, the latter creature causing a great debate about its proper classification. Like Colden, Byrd maintained a correspondence with British savants and provided them with exciting new materials to study. He also patronized young American scientists, such as Mark Catesby, and maintained an extensive garden, but did not pursue the serious study that characterized some of the colonial naturalists.[3]

In Massachusetts, Cotton Mather (1663–1728) initiated a correspondence with the Royal Society in 1712, known as his *Curiosa Americana*, a series of some 82 letters spanning twelve years in which he described the natural history of his region, accompanied by specimens for the

Society's collections. Occasionally these letters were published in the *Philosophical Transactions* of the Society, and the topics spanned botany, entomology, ornithology, zoology, anthropology, astronomy, geology, and meteorology, as well as philosophy, psychology, mathematics, and medicine. Included among Mather's accomplishments is the first account of hybridization of Indian corn and squash. But Mather's contributions, like his fellow colonials, were received diffidently by the Royal Society members in London, who appreciated descriptions and drawings, but wanted the theorizing left to the real scholars in London.[4]

Colden, Byrd, Mather, and their colleagues were well-educated men of means, and they were usually named corresponding members of the Royal Society of London. Their letters were read and occasionally published; however, they lacked the training and stature of London's scientific elite. They did not have access to great libraries or the specimen collections they needed to study to compare their new specimens. Thus most of these colonial naturalists were relegated to the status of collector, rather than published scientist. Nevertheless, through their collections and observations, they made substantial contributions to the natural history of North America and to the great natural history cabinets at the Royal Society, Jardin des Plantes and other European collections.[5]

In the following decades, several noted collectors traveled through the colonies, preparing notes and drawings of the exciting new plants and animals. Well-known among these are Mark Catesby (1683–1749), and John (1699–1777) and William (1739–1823) Bartram. Catesby immigrated to Virginia from Essex, England, in 1712 and soon became interested in natural history. Initially focusing on botany, he collected plants for English correspondents. He spent three years traveling around the Carolinas, collecting specimens, compiling notes, and preparing drawings and watercolors. He returned to London in 1726 where he struggled to produce his magisterial work, *Natural History of Carolina, Florida, and the Bahama Islands*, that was completed in 1743. This publication was the first major illustrated study of American natural history. Catesby bridged the gap between London and the colonies, but ultimately his collections and notes were deposited in London, maintaining the center of science there.[6]

John Bartram, a Pennsylvania Quaker farmer, was known for the botanical specimens he collected for the merchant-naturalist Peter Collinson (1694–1768) and Hans Sloane in London in the 1730s. Bartram soon developed a career as a collector of fossils, insects, animals, and minerals as well, filling out the collections of British scientists. His son William's journals of his travels through the colonies are among our best descriptions of colonial natural history. John Bartram also established a botanic garden at his farm that was maintained by his sons after his death in 1777.[7]

As productive as these networks were, there were stresses in these scientific relationships. Colonists struggled to have their intellectual contributions taken seriously across the Atlantic. Indeed, they had to prove that their native plants and animals were worth serious scientific study. Continental scientists, such as George Louis Leclerc, compte de Buffon (1707–1778) of the Jardin des Plantes in Paris, claimed that the flora and fauna of the New World were biologically inferior to European species. They argued that American plants and animals were smaller and not as vigorous because of the more recent origin of the New World, giving it an inferior climate, soil and topography. American species were viewed as migrants from the Old World that had degenerated in the substandard or lesser environment. The claim drew an immediate and sharp refutation.[8]

In the fractious decades before the revolution, as ties to England weakened and murmurings of political independence were heard, American naturalists began to think more in terms of scientific independence as well. Colonial savants began to form their own organizations to support their interest in science. Benjamin Franklin (1706–1790) (Fig. 1) first founded a philosophical society in Philadelphia in 1743, and it became the American Philosophical Society in 1769. This society was broad in scope, spanning natural history, astronomy, mathematics, chemistry, agriculture, and the useful arts. The Philosophical Society stimulated much activity in American science, presenting original papers and publishing American works. It also amassed a fine library and a museum collection for use by its members.[9]

This level of activity in Philadelphia spurred the New Englanders to action and, in 1779, John Adams (1735–1826) founded the American Academy of Arts and Sciences to assert the preeminence of Boston in the intellectual life of the nation. Most of its members were on the Harvard College faculty, giving it a strong and stable core. The Academy sponsored lectures and formed a library. The American Academy never, however, created a museum collection, and it would be some years before that gap would be filled in the Massachusetts Bay Colony.[10]

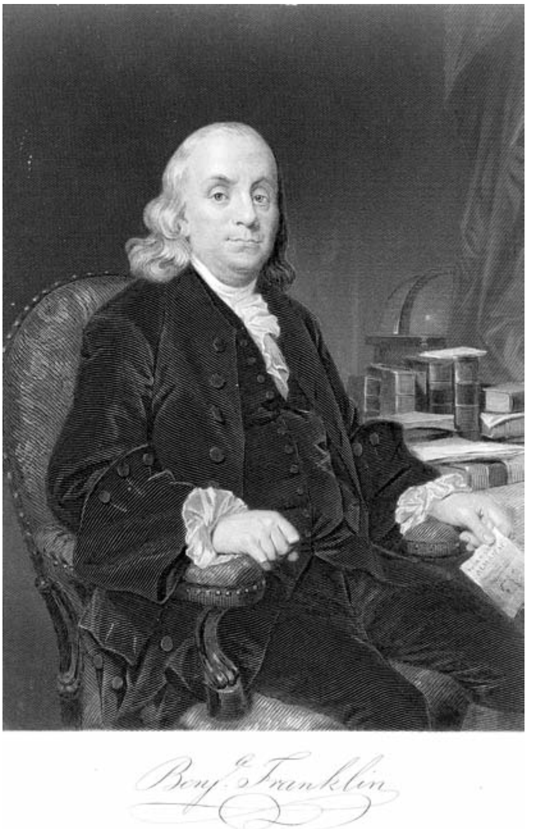

FIGURE 1. Benjamin Franklin, founder of the American Philosophical Society. Smithsonian Institution Archives.

The Early Republic

In the early years of the new republic, more voices could be heard calling for a national science and less dependence on Europe. After the Revolution, Philadelphia continued to serve as a center for naturalists. In 1802, Alexander Wilson (1766–1813) moved to a property near the Bartram gardens and was given access to the Bartrams' excellent natural history library. Inspired by these works, Wilson determined to prepare his own *American Ornithology*. Encouraged by William Bartram, he traveled on foot through the colonies compiling notes, drawings, and specimens. When his work was published by the Philadelphia printer Samuel Bradford, Wilson wrote in his preface that he compiled the *American Ornithology* to free the colonies from "that transatlantic and humiliating reproach of being obliged to apply to Europe for an account and description of the production of our own country." Self-taught and self-financed, Wilson produced the first comprehensive lists, drawings and scientific descriptions of North American birds. And it was the first American bird book with the color plates actually prepared in the United States. By the opening of the nineteenth century, then, naturalists were taking concrete steps to free themselves from dependence on both Britain and the Continent.[11]

This independence was encouraged by and epitomized by their president, Thomas Jefferson (1743–1826). Interested in science himself, Jefferson had dabbled in natural history for many years. He was among the American naturalists who responded to Buffon's claim of inferiority of American species, producing "A Comparative View of the Quadrupeds," in his *Notes on the State of Virginia*, and delivering it personally to Buffon with specimens of moose and panthers. Two hundred years ago, Jefferson commissioned the Corps of Discovery, the transcontinental expedition of Lewis and Clark, that searched for an easy route to the Pacific from 1803 to 1806.[12]

Meriwether Lewis (1774–1809) and William Clark (1770–1838) shipped many live and dead specimens back to the East Coast as they traveled, and they greatly increased the knowledge of North American geology, topography, flora and fauna. However, their collections were, for the most part, dispersed. There was no organization like the Royal Society or French Academy to take responsibility for the description and preservation of these collections, which included numerous type specimens because the species were unknown to western science. Lewis and Clark sent many of the specimens to Jefferson in Monticello, where Jefferson created a small museum in the foyer of his home. All that survives today is a set of elk antlers. Other specimens were sent to interested naturalists for identification, and the collection was thus scattered.[13]

Fortunately, a significant portion of the plant specimens was deposited in the herbarium at a new Academy of Natural Sciences in Philadelphia. Other specimens and fossils were donated to the American Philosophical Society, eventually joining the plants at the Academy. Descriptions of the plants, animals, and fossils appeared in Wilson's *American Ornithology* and other works on American natural history of the period. Many other live animals and specimens from the Lewis and Clark expedition went to a new public museum in Philadelphia. But the bulk of the materials were lost to science.[14]

The new public museum was the handiwork of Charles Willson Peale (1742–1827), an eighteenth century polymath interested in the arts and sciences, and strong supporter of the American Revolution. A noted portrait painter, Peale initially created an art gallery. He then began to amass a fine collection of natural history specimens in the second half of the 1700s. In 1786, he placed his collection on view for the public in his home in Philadelphia, and it generated a great deal of public interest. Indeed, the following year, George Washington (1732–1799) donated a pair of Chinese pheasants to the growing collection (Fig. 2). Peale believed that a museum could provide "rational amusement" and education to the general public. Such a museum created a world in miniature that would educate the citizens of a democracy and develop their virtue. Wealthy Philadelphians could purchase annual subscriptions to the museum and donate artifacts to its collections, establishing their role in the city's intellectual elite. Peale was one of the first American naturalists to envision a national museum, and so in 1792 he created a Society of Inspectors for his

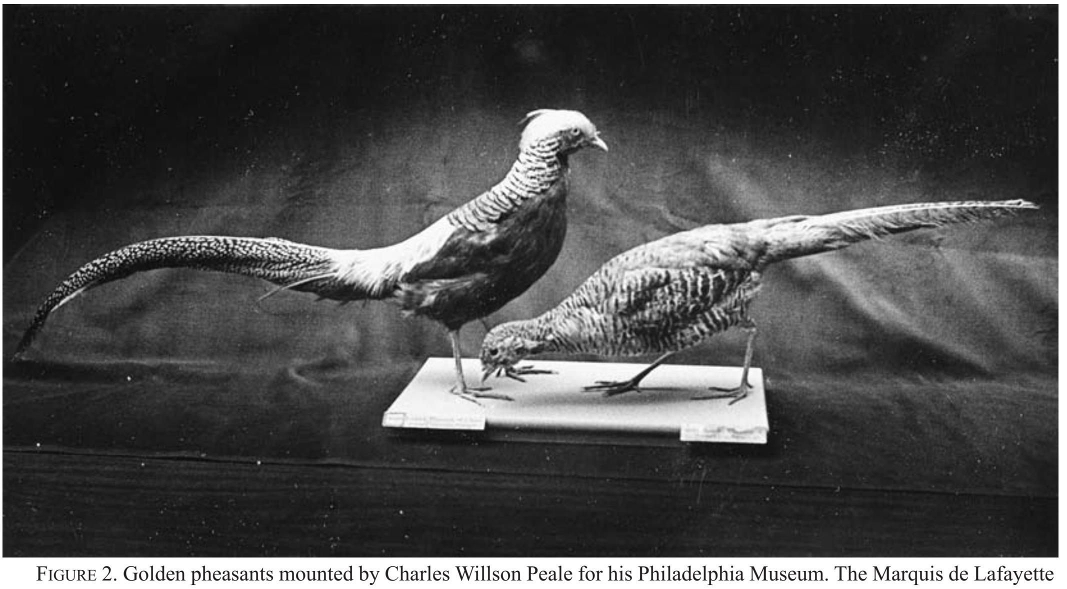

FIGURE 2. Golden pheasants mounted by Charles Willson Peale for his Philadelphia Museum. The Marquis de Lafayette gave the birds to George Washington. Smithsonian Institution Archives.

museum that included such political luminaries as Thomas Jefferson and Edmund Randolph (1753–1813). He counted among his friends such figures as Jefferson, Benjamin Franklin and David Rittenhouse (1732–1796). Through the society, Peale hoped to attract both private support and government funding; however, this support never materialized. In 1794, he obtained a ten-year lease to lodge his collections at the American Philosophical Society building on State House Square.[15]

The Peale Museum was perhaps best known for the giant mastodon skeleton that Peale placed on display on Christmas Eve in 1801. Found on a farm in the Hudson Valley of New York, Peale had overseen the massive excavation project of this spectacular specimen, the first complete fossil specimen placed on display in the United States. Peale paid the farmer, John Masten, $300 and a fine shotgun for the bones that he had discovered three years earlier. Peale had to devise machinery to drain the bog and scaffolds to lift the massive bones out, but by the end of the summer, he had a largely complete skeleton. Peale, his sons, and servant Moses Williams labored for three months to reconstruct the creature from its many parts, attaching vertebrae to an iron rod and filling in missing parts of the skull with papier-mâché. Only one fossil skeleton, of a megatherium, had been reconstructed earlier, that one in Spain. This was indeed a spectacular sight. Through the long winter of 1802, Philadelphians lined up until 10 pm every day and paid fifty cents apiece to view this monster of times long past, as fossil frenzy gripped the country, long before *Jurassic Park*. The Peale Museum was soon a mandatory stop for visitors to the City of Brotherly Love. In 1802, the Pennsylvania legislature authorized the museum to occupy quarters in the State House itself, although the mastodon stayed for many years at the Philosophical Society. Peale's son, Rembrandt, took a second mastodon skeleton on a tour of Europe.[16]

Peale's Museum became perhaps too popular and soon he was subject to criticism for the way he and his sons promoted his displays to attract large audiences. Thus, the tension between commercial popularization and serious education and research in museums was established in the early days of the Republic.[17]

His sons, Rembrandt (1778–1860) in Baltimore and Linnaeus (1794–1832) and Rubens (1784–1865) in New York, attempted spin-off museums but these failed. In 1821, the Philadelphia Museum Company was incorporated to provide a structure for Peale's collection. After his death in 1827, his sons, especially Rubens and Franklin (1795–1870), continued to run the museum in the Philadelphia Arcade. In 1836, they built a new building for the museum, but the museum gradually declined as it failed to chart a course between an emerging scientific professionalism and the circus showmanship of P.T. Barnum. The museum was disbanded in the 1840s and its collections were sold. Ironically, many of the specimens were purchased by none other than Phineas T. Barnum (1810–1891), a showman who lacked Peale's commitment to science and public education. The collections were burned in a warehouse fire the following year, although the mastodon skeleton survived at a German museum.[18]

As Peale's Museum fueled a popular interest in natural history, another naturalist's books fed the flames. In his travels in search of birds, Alexander Wilson had gone as far West as Louisville, Kentucky, where he visited another ardent naturalist in his general store. John James Audubon (1785–1851) (Fig. 3) would take up where Wilson left off, producing a magnificent view of the flora and fauna of the New World. A remarkably poor businessman, Audubon was entranced by natural history for his entire life. The dashing Frenchman styled himself as an American woodsman, selling his image as well as his magnificent drawings. Audubon could not find a publisher in the United States, thus, he turned to British publishers and engravers to produce *The Birds of America*, which first appeared in 1838 and became the standard against which all other publications would be judged. Audubon's stunning images stimulated public interest in natural history and created a new visual iconography for the New World.[19]

FIGURE 3. John James Audubon, artist and naturalist. Smithsonian Institution Archives.

The Early Nineteenth Century

In the United States, the nineteenth century was the era of the self-culture movement. Citizens of the democracy banded together in voluntary associations to advance their knowledge and moral fibre, in lyceums, academies and local societies. Many of these local academies attempted to develop libraries and natural history cabinets for the use of their members. They modeled these on the British and Continental organizations with which they had ties. Leaders in the lyceum movement urged that natural history collections be created to spur the economic development of the nation. One argued that if placed "before legislators and others, specimens of their own productions and a knowledge of their own resources in the mineral kingdom, by which industry would be encouraged and individual and public wealth and prosperity increased, they would support the creation of museums." Knowledge of North American natural resources was seen as key to national development.[20]

In the early nineteenth century, Boston's elite American Academy of Arts and Sciences, founded by John Adams, was challenged by several energetic new natural history societies. In 1814, the New England Society for Natural History was established to encourage naturalists in the region. The following year, the group changed its name to the Linnaean Society of New England, reflecting its focus on modern classification. It received mixed reviews for its 1817 report on a sea serpent seen near Cape Anne, with plates showing dissection of its young. The group began to develop a natural history cabinet but did not thrive and in 1822 the society dissolved. However, a new organization, formed a few years later, took in the natural history collection. The Boston Society of Natural History was created in 1830 by a group of gentlemen of scientific attainments for the promotion of natural history. This remarkably successful organization soon established an impressive library and museum, and began publication of its *Boston Journal of Natural History*. Members of the society participated in the first botanical and geological surveys of Massachusetts.[21]

In New York, a dynamic physician interested in a wide range of scientific topics brought together local natural philosophers for discussion and mutual enrichment. The Lyceum of Natural History of New York was formed in 1817 to recall the school founded by Aristotle, and its members were to be peripatetics who explored the natural world around them. This group also amassed an impressive library and natural history collection of botanical, zoological and mineralogical specimens. In 1876, its name was changed to the New York Academy of Sciences. Samuel L. Mitchill (1764–1831), its first president, was professor of chemistry and natural philosophy at Columbia College but had broad interests in geology and natural history.[22]

The Academy of Natural Sciences of Philadelphia was created in 1812, and it also challenged and competed with the more elite American Philosophical Society. Its dynamic membership included William Maclure (1763–1840), considered the father of American geology, who served as president from 1817 to 1840 and who bankrolled many of its operations. Maclure and several other members of the Academy, including Isaac Lea (1792–1886), a mollusk specialist, and Thomas Say (1787–1834), a conchologist, were founding members of the short-lived Utopian community at New Harmony, in Indiana. The Philadelphia Academy building soon housed a laboratory, library, meeting rooms and a museum.[23]

The City of Washington

Although these local academies and societies accomplished a great deal, their collections were, for the most part, private resources for their members. When societies fell on hard times, so did their collections; many promising collections found their ultimate homes decaying in members' attics. Most collections were not displayed for public view and education. Some citizens felt that a national organization was needed to collect the natural resources, art and history of the young nation for the edification of its citizens. Issues of nationalism and Yankee utilitarianism were on the minds of a group of earnest citizens of the City of Washington in 1816 when they formed a group called the Metropolitan Society. This association was organized to reduce the United States' dependence on purely European cultural and scientific heritage. It listed as its goals to 1) develop a botanic collection and garden that could be used to further agriculture; 2) amass a mineral collection for study and economic use; 3) compile information on the mineral waters of the U.S.; 4) publish papers on agricultural topics; 5) conduct surveys of the various districts of the U.S.; and 6) publish research of value to the nation. Thomas Law (1756–1834), a leading figure in the young city, helped guide it into existence. Law, who had married into the influential Custis family and invested heavily in Washington, D.C., real estate, had been a member of philosophical societies earlier in England and India.[24]

On April 20, 1818, the Congress gave the Metropolitan Society a twenty-year charter and renamed it the Columbian Institute for the Promotion of Arts and Sciences; its charter included provisions for a museum and a botanic garden. The President of the United States was to become an honorary member and its patron. The Columbian Institute established programs for correspondence between members and other scientists, publication, and specimen exchange. Led by the naval surgeon Edward Cutbush (1772–1843), the Institute established a 200-acre botanical garden on the Mall in Washington and formed a small library and a natural history cabinet. The small natural history museum contained some 60 separate accessions containing primarily minerals, but also plants and animals. The museum was not open to the public, since an attendant was only present during meetings.[25]

In 1819, Dr. William Darlington (1782–1863), a member of the Institute as well as a member of Congress, put forth a plan to create a National Herbarium at the Institute that identified the native and naturalized plants of the United States. He contributed part of the core collection of this national herbarium. A physician, Darlington had become interested in botany as a young man through the influence of the physician and botanist Benjamin Smith Barton (1766–1815). In 1826, he founded the Chester County, Pennsylvania, Cabinet of Natural Sciences, which was one of the most successful of the provincial natural history societies in that era.[26]

Members of the Columbian Institute also actively sought zoological collections. In 1827, the Institute issued a circular soliciting natural history specimens and providing instructions for collecting, documenting and shipping specimens. The circular was sent to all Congressmen and Senators, U.S. Post Offices, customs houses, diplomatic posts, army posts, and naval ships. With their official positions as head of the Naval Hospital and as a Member of Congress, Cutbush and Darlington were able to call on colleagues to send specimens and artifacts to the new cabinet. Soon there were ethnographic collections from around the world, and art works including paintings and sculpture. One of its more popular items was "a suit of regimental worn by George Washington as commander in chief during the Revolutionary War"; indeed, it was said to be the suit that Washington wore when he resigned his commission in Annapolis.[27]

But the group was always on the lookout for additional collections. In 1821, the Columbian Institute attempted to secure Congressional appropriations, organize a lottery, and solicit contributions so that they could purchase the Peale Museum in Philadelphia, which had been offered to the government for $100,000. These plans, however, never came to fruition. When the United States Exploring Expedition was being planned in the 1830s, however, officials turned to Institute members to establish guidelines for amassing national collections in the course of the expedition.[28]

In addition to presidential sponsorship, other members included the printer Peter Force (1790–1868), the philologist Peter S. Du Ponceau (1760–1844), mathematician William Elliot (1773?–1837), and Dr. Alexander McWilliams (1774–1850). But its membership was never very active and it struggled to continue operations. Most of its members were amateurs with enthusiasm for science but little commitment to actually carrying out research. Most were politicians or government employees. Indeed, the group could rarely assemble a quorum at its meetings and few members paid their $5 annual dues. The Columbian Institute limped along in constant financial crisis and failed to ever build a permanent building. In 1838, when its original charter expired, it ceased activity. In 1841, a group called the National Institute formally absorbed it.[29]

As the Columbian Institute went into decline, the American Historical Society was founded in Washington in 1835 to "discover, procure, and preserve, whatever may relate to the natural, civil, literary, and ecclesiastical history of America in general, and the United States in particular." The American Historical Society was led by Peter Force, who had also been active with the Columbian Institute. Like many other small societies, it had difficulties maintaining itself in the harsh economic climate after the Panic of 1837. On June 18, 1840, the American Historical Society members considered and approved a proposition to dissolve and become the Department of American History and Antiquities of the National Institution for the Promotion of Science. The Society transferred its membership and collections to the National Institute that same year. As part of the transfer, the new Department of American History and Antiquities dropped the natural history component from their areas of interest, continuing to study and collect American history; biographies; lives and cultures of Indian tribes; Indian place names; statistics of agriculture, commerce, and population; topography of the country; roads and canals; religious and literary institutions; as well as laws and records.[30]

Washington was the home to several other small museums in the early nineteenth century. A Mr. Caleb Boyle (1750–1850), a Baltimore painter, had assembled a small natural history museum in his Washington studio. The Secretary of War installed a gallery of Native American portraits, many by Charles Bird King (1785–1862), as well as Native American clothing and household artifacts. Georgetown University, founded in 1778, also housed a small natural history museum for its students. Best known was the Washington Museum, which housed the collections of John Varden (?–1864). Begun in 1829, it opened to the public in 1836 with displays of natural history specimens, curiosities, and art works. Eventually Varden's museum was also absorbed by the National Institute, the same group that absorbed the Columbian Institute and American Historical Society.[31]

The National Institute

On May 15, 1840, the National Institution for the Promotion of Science was organized "to promote science and the useful arts, and to establish a national museum of natural history." Joel

Roberts Poinsett (1779–1851) (Fig. 4) was a pivotal figure in this effort. A politician with an avocational interest in science, Poinsett was involved in many of the amateur scientific activities in the capital and is known for having the poinsettia named for him. A Jacksonian, he was a member of Congress and minister to Mexico. As Secretary of War under President Martin van Buren (1782–1862), Poinsett oversaw numerous exploring expeditions, including the Nicollet expedition of 1838 and Fremont expedition of 1842, as well as the United States Exploring Expedition as it circumnavigated the globe from 1838 to 1842. Poinsett feared that the fabulous collections being sent back to Washington would suffer a fate similar to that of the Lewis and Clark Expedition. He was determined to create a national museum in Washington that would place the capital city of the United States on par as a cultural center with the great capitals of Europe. When the bequest of Englishman James Smithson (c.1765–1829) to the United States was announced, Poinsett saw a way to finance such an ambitious program. He hoped that his National Institute would gain control of the Smithson bequest and become the national museum of the United States. He worked quickly to amass a natural history cabinet. With intervention from Daniel Webster (1782–1852), he was able to secure space for the Institute's collections in the Patent Office Building, first in its damp basement and later in its exhibit gallery. But he also earned the resentment of the various Commissioners of Patents, notably Thomas Ewbank (1792–1870) and Henry L. Ellsworth (1791–1858), who then worked to undermine the Institute. But when the Exploring Expedition collections arrived in Washington, they were sent to the Institute's gallery to be arranged and displayed, and to prepare scientific publications based on them. This control of the USEE collections was greatly resented by Charles Wilkes (1789–1877), who led the expedition and wanted control over the collections and publications himself. He also worked to undermine the Institute in its early years. In 1841, the art collections of the defunct Columbian Institute, as well as John Varden's collections, were transferred to the National Institute. On July 12, 1841, James Smithson's personal effects and collections, including a library, mineral collections, and manuscripts, were deposited with the National Institute by the Secretary of the Treasury, who had accepted the Smithson bequest and placed its proceeds in the U.S. Treasury, pending creation of Smithson's institution.[32]

FIGURE 4. Joel Roberts Poinsett, founder of the National Institute. Smithsonian Institution Archives.

The National Institute published a guide to its collections and exhibits, titled *A Popular Catalogue of the Extraordinary Curiosities in the National Institute, Arranged in the Building Belonging to the Patent Office. Curiosities Collected from All Parts of the World, by the Officers* *of the Army and Navy of the United States. Curious and Strange Articles, Presented by Private Individuals. Revolutionary Relics of Extraordinary Interest. Articles of Immense Value, Presented to the United States Government and Its Officers, Deposited Here According to Law*. As the *Popular Catalog of the Extraordinary Curiosities of the National Institute* reveals, the Institute's collections were an odd mix of the scientific, hoaxes, art and historical displays. Descriptions of displays reveal an almost whimsical juxtaposition of artifacts and specimens, such as the articles near the window opposite Case 38, "Specimens of Fruit; Portrait of William Wheelwright, presented by Com. Aulick; Engraving of the clemency of Napoleon; Relics from the tomb of Mrs. Washington, near Fredericksburg, Va.; and Lines to her grave, transcribed by Miss M. E. Summers." Nearby were a fragment of Plymouth Rock; a piece of the tree under which Penn treated with the Indians for Pennsylvania; Hair of General Bolivar; pieces of the charter oak; a piece from George Washington's coffin; as well as forty boxes of beetles, "all very beautiful specimens, and of natural and vivid colors." Members were not above adding statues and paintings of themselves for the public to contemplate.[33]

In 1842, the United States Congress formally chartered the group as the National Institute for the Promotion of Sciences, lending it a great deal of credibility. By 1842, the Institute had 287 resident members, 20 honorary members, 32 paying corresponding members, and 754 corresponding members; it also maintained correspondence with 17 American societies and 141 foreign ones. Poinsett and his National Institute seemed on the way to securing control of the Smithson bequest and creating the national museum of the United States. His colleague, the lawyer John Carroll Brent (1814–1876), prepared a series of letters for the *National Intelligencer* in which he presented plans for absorbing the Smithson estate. Brent called for building a "National Temple" on the Mall that would house works of art, natural history, and history. Brent also argued for the inclusion of an agricultural school to teach practical agriculture.[34]

As Kohlstedt has demonstrated, by mid-century American colleges were also developing natural history museums that both spurred and reflected a new emphasis on learning from natural objects, rather than ancient texts. At Harvard, Yale, and other colleges, natural history cabinets became essential teaching tools. Colleges provided good employment opportunities for dedicated naturalists, allowing them to establish natural history cabinets and publish their descriptions and classifications. Natural history societies on campuses organized field-collecting parties and stimulated interest in natural history. However, these cabinets were often the personal property of faculty and could move or fall on hard times when the natural history professor left or died.[35]

Despite these efforts of scientific enthusiasts, local academies and societies, and a growing core of natural history faculty at colleges, Americans retained a nagging sense of inferiority about their scientific contributions. They had rejected the European notion that New World species were inferior and less vigorous. They had formed societies, colleges, and museums that copied the professional standards in Europe. And they even published their research in the United States and, occasionally, abroad. But their work was rarely cited or taken seriously. This insecurity was heightened in 1835 by publication of Alexis de Tocqueville's *Democracy in America*. While greatly admiring Yankee energy and ingenuity, de Tocqueville (1805–1859) observed that American scientists were more interested in practical advances than the pure theoretical research of the academy. Although it is debatable whether this is true, the claim hit a raw nerve and galvanized a group of concerned scientists who sought government support for serious scientific research. Calling themselves the Scientific Lazzaroni, after Neapolitan beggars, they self-consciously attempted to secure funding for and control of government scientific positions, and then to create a gap between amateurs and professional researchers, between practical applications and pure research, between research collections and popular displays.[36]

The United States National Museum at the Smithsonian Institution

Echoes of all of these debates could be heard in the discussions concerning how to utilize the bequest of James Smithson (Fig. 5) to the United States. Smithson was an English scientist who, upon his death in 1829, had left a curious will that would shape the history of museums in America. Smithson left his estate to his young nephew, but noted that if his nephew were to die without heir, illegitimate or legitimate, his estate was to go to the United States of America to found in the City of Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men. Smithson's nephew died without heir in 1835, leaving this vague gift to a nation Smithson had never visited. The illegitimate son of Hugh Smithson, the Duke of Northumberland, (1715–1786), and Elizabeth Hungerford Keate Macie (1732–1800), Smithson had inherited the Hungerford family fortune from his mother and was free to devote his life to science. He spent much of his adult life on the Continent, conducting research in chemistry and mineralogy, and amassed a cabinet of minerals. He left no detailed instructions as to how his bequest was to be carried out.[37]

FIGURE 5. James Smithson, founding donor of the Smithsonian Institution, portrait by Henri Johns, 1816. Smithsonian Institution Archives.

For a decade, from 1836 to 1846, proposals were put forward and the U.S. Congress debated how to best use Smithson's largess. It was initially assumed that Smithson intended to found an educational institution, so proposals were put forward to create various schools: a college devoted to the classics, a college devoted to science, a graduate school, a teachers' training institute, an agricultural school, a women's seminary, a mechanics institute, among others. John Quincy Adams (1767–1848) proposed an astronomical observatory; Alexander Dallas Bache (1806–1867) argued for a scientific research institute; Congressmen Rufus Choate (1799–1859) and George Perkins Marsh (1801–1882) advocated creating a national library, while Poinsett continued to champion the cause of a national museum. On August 10, 1846, the Smithsonian's enabling act, 9 Stat. 102, was passed by the U.S. Congress, creating a Smithsonian Institution that was a quintessential American political compromise. While the concept of an educational institution was eliminated, the final bill included all of the other suggestions, creating an institution with a broad mandate to carry out a vague will. The new institution would be shaped by its governing board, the Board of Regents, and its chief operating officer, the "Secretary."[38]

The National Institute failed to gain control of the Smithson bequest, largely because it was viewed as a group of amateurs unable to manage a professional scientific enterprise. The Smithsonian's first Secretary, Joseph Henry (1797–1878) (Fig. 6), was a physicist noted for his work on electromagnetic induction and professor at the College of New Jersey. He was also a member of the Scientific Lazzaroni who advocated separating amateur from professional science. Henry formulated a "Programme of Organization" that focused on supporting basic research, gaining access to scholarly publications, and providing professional outlets for American scientists to publish their research. He discouraged public lectures in the Castle, worried about the expense of caring for a national library and museum, and deplored the popular exhibit halls that the Board of Regents insisted on. How then was the National Museum established at the Smithsonian? The Board of Regents guiding the new institution had a broader vision than the first Secretary. They insisted on constructing an elaborate building on the National Mall in Washington and encouraged the donation of art works, books, artifacts, and specimens. And the donations poured in. As the National Institute had found, the young nation needed a temple of national identity where citizens could place icons of American history, inspiring art works, artifacts of exotic cultures, and evidence of the natural environment. As the generation of founding fathers passed away, their possessions gained iconic status and were collected and preserved by the next generation. National heroes were captured in portraits by American painters. Believing that the Native American tribes would soon vanish, explorers and settlers collected artifacts of these cultures. Travelers and settlers sent back specimens of curious plants, unusual minerals, and unknown animals. The young nation simply needed a national museum.[39]

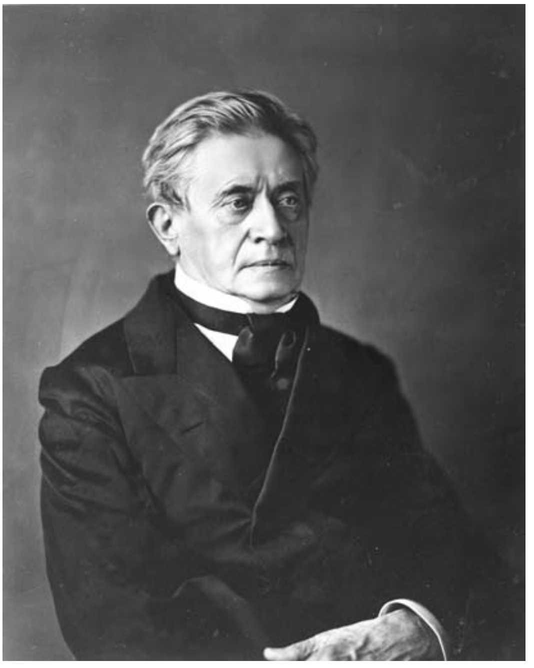

FIGURE 6. Joseph Henry, first Secretary of the Smithsonian Institution, by Thomas W. Smillie. Smithsonian Institution Archives.

Although the National Institute had failed to gain control of the Smithson bequest, it had significantly influenced the direction of the new Smithsonian Institution, since its efforts led to a provision for a national museum as part of the Smithsonian's enabling act. The nineteenth century was the era of creation of the great public museum in England and in the United States. In England, upon the death of Sir Hans Sloane, the British government accepted responsibility for the maintenance of his collection, forming the British Museum of Natural History in 1853. Newfound leisure time, higher levels of education and higher standards of living allowed a broad segment of the public to collect and study specimens and artifacts themselves. Museums became a popular public venue for useful, even educational, recreation.[40]

At the urging of scholar, collector, Smithsonian Regent, and Congressman George Perkins Marsh, in 1850 Henry hired as his assistant and curator, Spencer Fullerton Baird (1823–1887) (Fig. 7) of Pennsylvania. Baird was a naturalist and energetic collector who brought two boxcars of specimens with him to Washington. Coming from the Philadelphia intellectual aristocracy, Baird did not feel the need to establish his professional stature that Henry and other self-made men felt. Baird had but one goal in life, he wrote to Marsh, to become the director of a great national museum. But what did a great national museum for a democracy mean? Baird knew he needed to collect a rep-

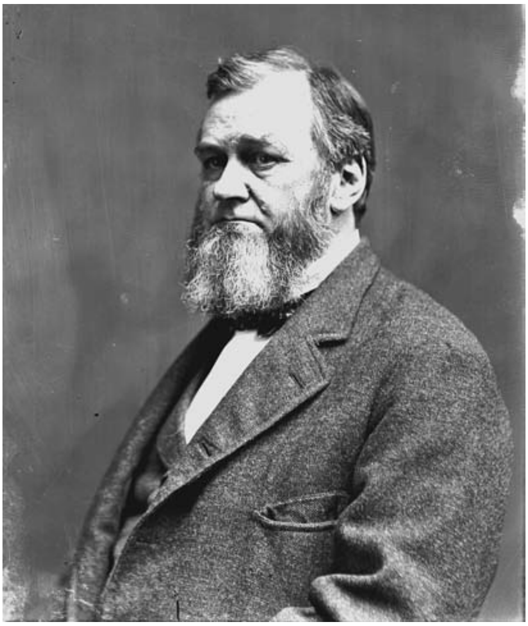
FIGURE 7. Spencer Fullerton Baird, first curator and second Secretary of the Smithsonian Institution, c. 1880s. Smithsonian Institution Archives.

resentative natural history cabinet, a national voucher collection that covered the continent, indeed the globe, since specimens needed to be compared, identified, and classified. Baird enthusiastically turned to amateurs, developing a national and even global correspondence and specimen exchange network. He built on the network Henry had created to collect weather observations. Settlers on the western frontier could retain some ties to eastern culture by sending observations on the weather, topography, plants, insects, animals and minerals of their region. Baird's creation of a national network of observers and collectors was a Baconian enterprise — as defined in his Solomon's House — a vast team of organized collectors to inventory natural phenomena.[41]

Secretary Henry still dreaded the responsibility of the national collections. He believed that the demands of a national library and a national museum would cost more than the Smithson bequest could afford. He would then be obliged to go to the Congress for federal funding to underwrite these projects, and this would subject the Institution to the control of the politicians on Capitol Hill — who, Henry believed, did not understand science or research. He wrote, "it would annually bring the institution before Congress as a supplicant for government patronage, and ultimately subject it to political influence and control" and that the best course was "to ask nothing from Congress. . .to mingle its operations as little as possible with those of the general government. . . ." [42]

Even Baird admitted that the collections were growing at such a rapid pace that it made him feel "somewhat like the magicians apprentice who knew the word to cause the broom to bring buckets of water, but could not stop it." Why, then, did Henry accept the collections? Henry had been subject to severe public criticism and a Congressional investigation as he sought to shape the young institution by divesting it of the responsibility for the national library. He had also been criticized for his focus on a meteorological research program for which he needed financial support to analyze the large quantity of data he had collected. The Commissioner of Patents, Charles Mason (1804–1882), had the funds in his agriculture budget to support reducing the meteorological data, but he wanted something from Henry in return — for the Smithsonian to take the National Institute's collections off his hands, since the collections were still on display in the Patent Office Building. Henry reluctantly agreed. When the first set of collections was transferred in 1858, they also brought with them an annual federal appropriation for their care. Henry hoped that ultimately, with federal funds paying for the national collections now, the Congress would establish a separate national museum. But the foundation of the U.S. National Museum was now firmly laid at the Smithsonian. Indeed, in the appropriation bills passed by the Congress, the Smithsonian's collections were officially designated "the United States National Museum."[43]

On July 27, 1862, the charter of the National Institute expired and, in accordance with its act of incorporation, its library and museum were delivered by the Secretary of the Interior to the

Smithsonian Institution. The transfer included the objects from John Varden's museum. The formal relationship of the National Institute to the Smithsonian ended completely on January 10, 1865, when the membership of the Board of Regents was changed to eliminate the requirement that two Regents be members of the National Institute. Over the next two decades, all of its collections were gradually transferred to the Smithsonian and received eagerly by its young curator.[44]

Baird encouraged his amateur and professional collectors and sent them Smithsonian and other publications. Baird knew he could not amass a great natural history museum alone; he needed a small army of enthusiastic collectors to participate in his great enterprise. He established ties with all of the existing scientific academies and societies, building upon that solid base. He exchanged specimens with their museums and the small museums on college campuses. For the amateurs, Baird printed a circular that taught how to collect and ship specimens. He wrote, on average, 3500 to 5000 letters per year, maintaining an enormous correspondence network that carried out his museum collection program. He cajoled the railroads into providing free shipments of artifacts and specimens. He convinced the Army to send naturalists on its topographic surveys of the American West. Artifacts and specimens soon flooded into the Castle, much to Henry's dismay. To mollify Henry, Baird ensured that competent naturalists described the specimens. But he created and maintained a niche for the amateur in his grand enterprise that would last until the late nineteenth century.[45]

During the 1850s, 1860s and 1870s, as the United States gradually expanded westward, the U.S. Army and commercial interests such as railroads sent out successive waves of explorers to survey and map the new lands. Baird's father-in-law, Bvt. Brig. Gen. Sylvester Churchill (1783–1862), was Inspector General of the Army, and through his influence, Baird equipped each expedition with instructions, supplies and equipment for collecting and shipping back representative samples of all the aspects of the natural environment. Indeed, Baird counted among his collectors such military luminaries as Commodore Matthew C. Perry (1794–1858), General George B. McClellan (1826–1885), and Captain David G. Farragut (1801–1870). Explorers such as Ferdinand Vandeveer Hayden (1829–1887) (Fig. 8) and John Wesley Powell (1834–1902), who led many of these expeditions, were interested primarily in the economic potential of the regions they surveyed and their potential for settlement. Baird supported their goals and highlighted the value of museum specimens in economic development.[46]

Thus Baird embraced the practical applications described by de Tocqueville and eschewed by Henry in his own work on electromagnetism. Indeed, the distinction was an artificial one, even in Europe. Many of the great natural history cabinets and botanic gardens of Europe were products of colonial expansion that was largely economic in purpose. The botanic gardens in London and Paris were known for their experimentation with exotic plants that might provide new crops and medicines. Baird insisted on meeting professional standards for scientific research, but he was comfortable with the practical applications of his work. During his career at the Smithsonian, Baird also served as Commissioner of Fish and Fisheries, establishing a government research program in Woods Hole, Massachusetts, and Washington, that addressed the practical problems of declining fish catches in the north Atlantic and western salmon rivers. He argued that it was necessary to study the entire oceanic flora and fauna in order to determine the cause of the fisheries crisis and used this government funding to support basic research on the classification and life histories of a broad range of marine species. Baird was also able to use the knowledge gained from his natural history surveys of the continent to encourage Secretary of State William Henry Seward (1801–1872) to pursue the purchase of Russian America — now Alaska — in the 1860s, since Baird could demonstrate that it contained a wealth of natural resources.[47]

Baird was also intrigued by the potential for popular education in museums (Fig. 9). He

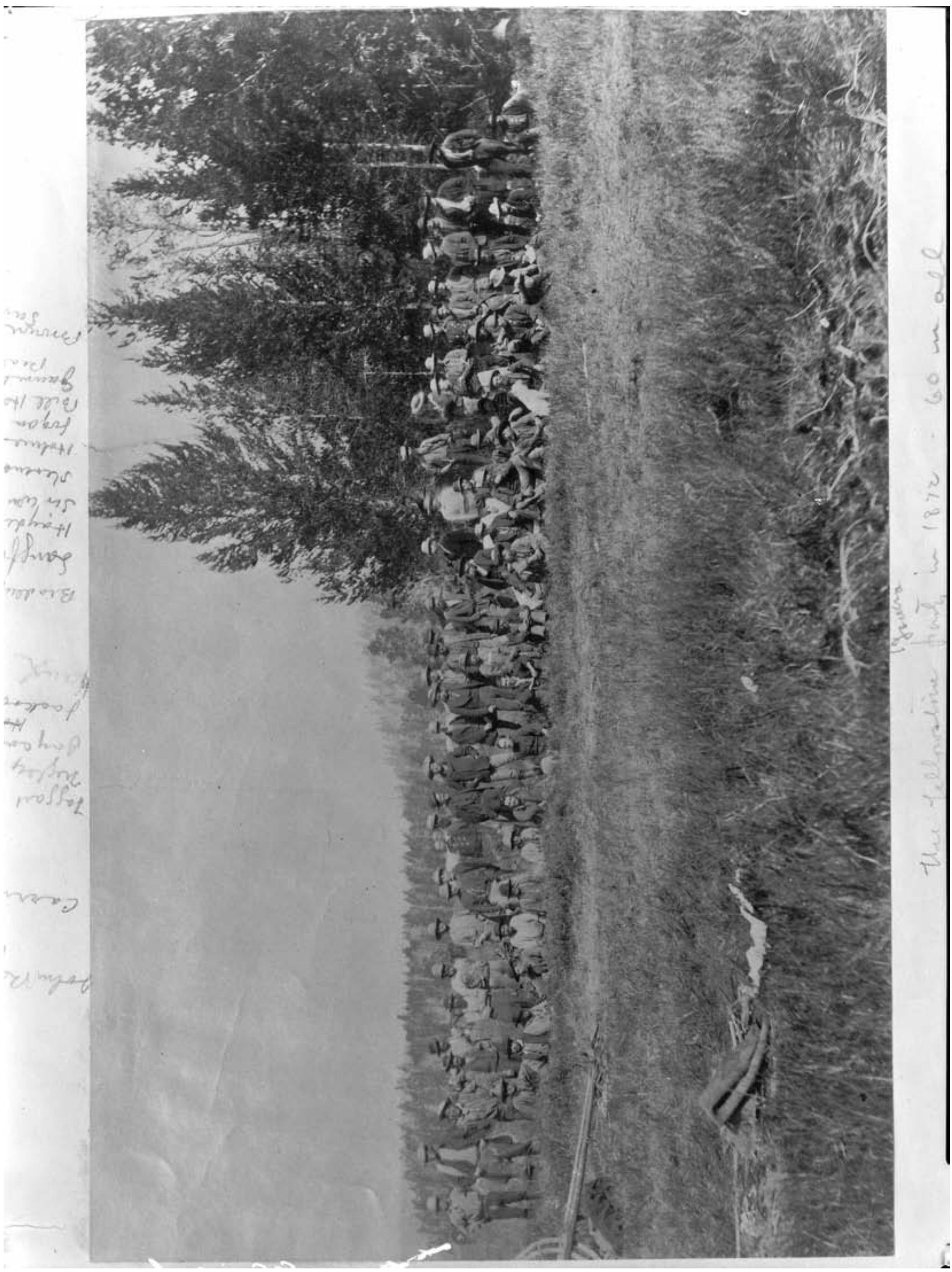

FIGURE 9. Visitors to the museum gallery in the Smithsonian Institution Building, 1867. Smithsonian Institution Archives.

FIGURE 8. United States Geological and Geographical Survey of the Territories, 1872, at Yellowstone, led by Ferdinand Vandeveer Hayden. Smithsonian Institution Archives.

encouraged his young assistant, George Brown Goode (1851–1896) (Fig. 10), to develop a systematic approach to museum exhibits. Goode studied the organization of European museums, applied his own training in biological systematics, and developed an overall schema for the National Museum. He wrote on the role of museums in research and education and became the leading theorist in museum practice in the United States. Goode argued that a museum had two functions, as a museum of research but also as a museum of education. One museum could serve both functions, as long as the goals and resources were clearly delineated.[48]

FIGURE 10. George Brown Goode, Smithsonian curator and leading museum theorist. Smithsonian Institution Archives.

Baird and Goode's approach reached its apogee at the Centennial Exposition in Philadelphia in 1876 where Baird and Goode produced the government's exhibits (Fig. 11). Their displays were very popular with visitors to the fair and garnered positive reviews for the nascent museum in Washington. Immensely popular with the general public, Baird and Goode had created a formula for public education in a democracy. In the ensuing decades, Baird and Goode produced award-winning exhibitions for a succession of national and international expositions, creating an international audience for their work and setting new standards for museum displays.[49]

Upon Henry's death in 1878, Baird succeeded him as the second Secretary of the Smithsonian. Two years after the Centennial, Baird secured the Congressional appropriation he had sought for so long to build a national museum building in the nation's capital. For the next decade, Baird focused his energies on developing the National Museum at the Smithsonian and shared none of Henry's concerns over accepting federal appropriations for its care. Baird and his assistant, Goode, encouraged the donation of a wide range of artifacts and specimens and experimented with new formats for display. When Baird arrived at the Smithsonian in 1850, the new museum had some 6,000 objects. At the time of his death in 1887, the USNM held over 2.5 million "lots" or sets of artifacts and specimens. The sheer volume of specimens and artifacts necessitated specialization, as well as professionalization. Baird was a naturalist who studied a range of taxonomic groups, including birds, mammals and fish (Fig. 12). The young curators he trained were specialists in such emerging fields as ornithology, ichthyology, conchology, and entomology, indeed, even focusing on smaller groups such as Lepidoptera or Cetacea. By 1887, the National Museum had thirty-one departments (Fig. 13) under the care of twenty-six curators, only seven of whom were paid by Museum funds. Unpaid honorary curators volunteered their time and expertise. In addition, researchers from the U.S. Fish Commission, U.S. Geological Survey, U.S. Army and U.S. Navy curated the collections of economic and medical importance. Baird utilized all available resources in his quest to create a comprehensive national collection.[50]

FIGURE 11. Mammal Exhibit at the Centennial Exhibition in Philadelphia, 1876. Smithsonian Institution Archives.

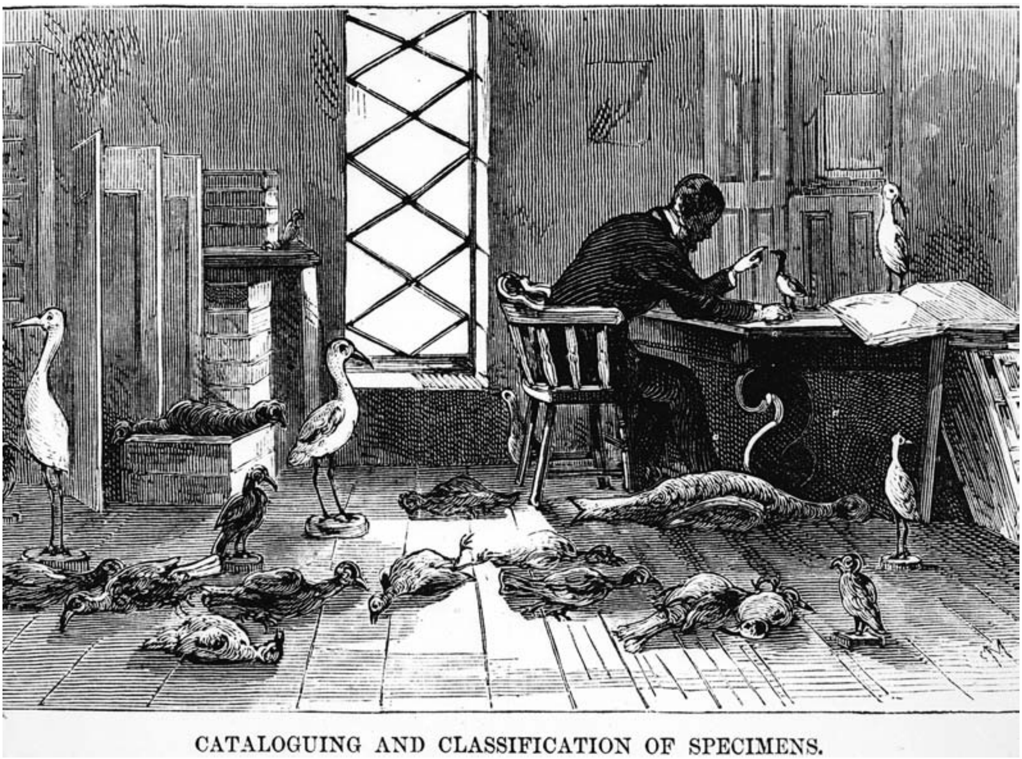

FIGURE 12. Ornithologist cataloging and classifying specimens of birds in the Smithsonian Institution Building, 1878. Smithsonian Institution Archives.

CONCLUSION

When the National Museum opened in 1881, it was free of charge and open to all of the nation's citizens. In its first year of operation, 167,455 visitors viewed the national collections in their modern displays.[51] Unlike the academies and societies in Boston, Philadelphia, and New York, it served all the citizens of the nation. Early museums, such as Peale's, had whetted the public's appetite for displays of mastodons and dinosaurs. The National Museum was a product of cultural forces and individual initiatives: a cultural need for a temple of national identity, a desire for scientific independence from Europe, the growth of leisure time and popular education, a new public interest in object collections and museums, and the initiatives of individuals such as philanthropist Smithson, Secretary of War Poinsett, Smithsonian Regent Marsh, curator Goode, and, most importantly, Secretary Baird. Baird formulated a vision for a great national museum that could meet a range of needs and demands. Baird simply did not see the need for the dichotomies between the practical and pure research, between the popular and academic. With collections for scientific study and practical applications, exhibits for popular education and publications for research professionals, Baird synthesized the competing strands of American natural history. The United States National Museum was a distinctly American institution because it married a commitment to basic research with responsibilities to advance the nation's economy, a commitment to professional standards for scholarly research to encouragement of the contributions of amateurs, a commitment to academic publication with exhibits that met American's thirst for public education (Fig. 14). At

FIGURE 13. Mammal Laboratory in the United States National Museum, 1886. Smithsonian Institution Archives.

least for a time, Baird resolved professionalization issues with the need to serve the public in a democracy. In doing so, he created a distinctly American museum that was built on a distinctly American science.

NOTES

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FIGURE 14. Natural History exhibit in the southeast range of the United States National Museum, 1886. Smithsonian Institution Archives.

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48 Goode's essays have been reprinted in G. Brown Goode, *The Origins of Natural Science in America: essays of George Brown Goode*, Sally G. Kohlstedt, ed. (Washington, D.C.: Smithsonian Institution Press, 1991); Edward P. Alexander, "George Brown Goode and the Smithsonian Museums: A National Museum of Cultural History," in *Museum Masters*, pp. 277–309; Sally Gregory Kohlstedt, "History in a Natural History Museum: George Brown Goode and the Smithsonian Institution," *The Public Historian* 10, 2 (Spring 1988): 7–14.

49 Pamela M. Henson, "'Objects of Curious Research': The History of Science and Technology at the Smithsonian," *Isis* 90 (1999): S249-S269; Kohlstedt, "Goode and Smithsonian," pp. 7–14; Robert W. Rydell, *All the World's A Fair: Visions of Empire at American International Expositions, 1876–1916* (Chicago: University of Chicago Press, 1984), passim.

50 *A Handbook to the National Museum at the Smithsonian Institution, Washington* (New York: Brentano, 1886); *Annual Report of the Board of Regents of the Smithsonian Institution for 1887* (Washington: Government Printing Office, 1889), pp. 17–18; Dall, *Spencer Fullerton Baird*, p. 408; Henson, "Baird's Dream," pp. 115–119; Oehser, *Smithsonian*, pp. 44–47.

51 *Annual Report of the Board of Regents of the Smithsonian Institution for 1882* (Washington: Government Printing Office, 1884), pp. 119–120, 124–126.

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The Flowering of Natural History Institutions in California

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The genesis and early years of a diversity of natural history institutions in California are presented as a single intertwined narrative, focusing on interactions among a selection of key individuals (mostly botanists) who played multiple roles. The California Academy of Sciences was founded in 1853 by a group of gentleman scholars, represented by Albert Kellogg. Hans Hermann Behr provided an input of professional training the following year. The establishment of the California Geological Survey in 1860 provided a further shot in the arm, with Josiah Dwight Whitney, William Henry Brewer, and Henry Nicholas Bolander having active roles in both the Survey and the Academy. When the Survey foundered, Whitney diverted his efforts towards ensuring a place for the Survey collections within the fledgling University of California. The collections became the responsibility of Joseph LeConte, one of the newly recruited faculty. LeConte developed a shared passion for Yosemite Valley with John Muir, who he met through Ezra and Jeanne Carr. Muir also developed a friendship with Kellogg, who became estranged from the Academy following the contentious election of 1887, which was purportedly instigated by Mary Katherine Curran. Curran, as Katharine Brandegee, subsequently crossed philosophical swords with Edward Lee Greene, a confirmed splitter who became professor of botany at the University where he inspired Willis Linn Jepson. Brandegee, who had been mentored by Behr, may have in turn influenced Harvey Monroe Hall, who laid the foundation for experimental plant taxonomy at the Plant Biology Department of the Carnegie Institution of Washington at Stanford University. Hall's presence at Stanford University followed President David Starr Jordan's previous support of Luther Burbank. Also at Stanford was William Russel Dudley, who became active in various forestry-related issues, including the founding of the Sempervirens Club and Big Basin Redwoods Park. Muir, Jordan, Dudley, and Jepson all were involved in the founding and early years of the Sierra Club. They also advocated for Yosemite National Park, the establishment of a forestry school in California, and the re-establishment of the State Board of Forestry. The previous Board, with Kellogg as a commissioner and John Gill Lemmon as Botanist, had been disbanded in 1893. Sara Plummer Lemmon, a member of the Academy with her husband, rallied the California Federation of Women's Clubs in support of forestry issues as well. Many of these goals reached fruition during the governorship of George Cooper Pardee.

In a previous paper (Ertter 2000), I explored the intertwined origin and early years of the various institutions of natural history in California, notably the California Academy of Sciences, the California Geological Survey, the University of California, and Stanford University. In many instances the same cast of characters (e.g., Josiah Dwight Whitney and Katharine Brandegee) played significant roles in multiple institutions. The present paper, in addition to recapitulating the core of the previous paper, expands the concept of "institutions of natural history" beyond academic and research institutions and/or those that collect and house natural history collections *per se*. In particular, I took this opportunity to analyze the genesis of land management agencies that are now an integral part of natural history activities, and whose controversial embryonic years overlapped those of the academic institutions. Foremost are the newly established park and forest management agencies at both state and federal levels. Coupled with the rise of the resultant government agencies was the appearance of non-governmental organizations, when the citizen groups whose active advocacy was instrumental in getting the governmental agencies established opted to become formally organized with the dual goals of outdoor enjoyment and watchdog oversight. As a result, these non-profit groups also serve as active participants in current natural history research and management,

The logic for an expanded definition of "institution" derives from the degree to which the same cadre of influential individuals play significant multiple roles, weaving a single story out of what has generally been treated as independent institutional histories. As a disclaimer, the individuals highlighted in the current paper are not necessarily the most significant in the history of each institution and, in fact, are only peripheral to the founding of the various land-management agencies. My choice of individuals to highlight is accordingly not always proportional to their influence in each institution, but rather represents the extent to which the same names keep showing up in multiple contexts, many of which I had previously never suspected. And, being a botanist myself, I am most familiar with those individuals with at least some botanical connection, even if their primary research focus lay elsewhere. Likewise, the land-management and conservation institutions highlighted are not necessarily those with the greatest present-day impact on natural history resources, but rather they are those whose origins fall within the covered time-frame and within which the highlighted individuals played at least some role. These institutions, nevertheless, stand as representatives of our current panoply of governmental agencies and non-governmental organizations whose collective efforts increasingly affect the future of our natural history legacy.

California Academy of Sciences: The Early Years

The development of institutions of natural history in California begins in 1853 with the founding of the California Academy of Natural Sciences (shortened to the California Academy of Sciences in 1868). The seven founders were all gentlemen-scholars, as was the norm for scientific practitioners in the 19th century. Dr. Albert Kellogg (Fig. 1), the founder with the strongest botanical inclination, exemplified the gentleman-scholar tradition to the extreme, to the extent of sacrificing his professional career as a physician-pharmacist to focus on the wealth of undescribed plant species by which he was surrounded (Greene 1887). Kellogg's botanical efforts took the form of beautifully rendered sketches of many of the plants he thought were new to science, accompanied by a Latin name and formal description. Having no formal training, however, "his terminology was somewhat original and his way of making Latin adjectives even more so" (Greene 1887:149).

A component of professional training was introduced into the fledgling Academy with the arrival of Hans Hermann Behr (Fig. 2) in 1854. Trained in medicine and natural science at the universities of Halle, Würzburg, and Berlin, Behr represents the group of educated refugees from the tumultuous birth-pangs of the modern German nation who infused the American frontier with a dose of solid Continental science in the mid 1800s (Gutzkow et al. 1905; Ertter 2003). His high standards also set him apart from many of his fellow medical practitioners in San Francisco, resulting in the loss of many patients when the "scientific humbugs and professional quacks" he scorned retaliated by accusing Behr of being in league with Jesuits "of the most sinister designs" (Leviton and Aldrich 1997:428).

Behr's credentials and Teutonic self-assuredness might have also served to encourage the gen-

FIGURE 1. Albert Kellogg

FIGURE 2. Hans Hermann Behr

tlemen-scholars in the Academy to publish new species presented at the weekly membership meetings. The *Proceedings* from these meetings were first published in *The Pacific,* a local Christian weekly newspaper, and only after several years reprinted as a unit for distribution to other institutions (Curran 1885; Leviton and Aldrich 1997). Other local periodicals were also used as an outlet for publishing new species, including *The Hesperian* and *Pacific Rural Press.* The nearly complete lack of comparative material and critical literature inevitably resulted in the superfluous description of species already named elsewhere, which, combined with the aberrant publication format, led scientists at established institutions in the eastern United States and Europe largely to ignore species published by the Academy. In response, the Academy passed a resolution in 1854 that "we will regard every publication of new species, which has been or which may be made through the daily papers of this city, as substantial evidence of priority of discovery."

Eventually the Academy's stand on priority was accepted by Eastern scientists, such that Academy member John Gill Lemmon (Fig. 3) stated that he had been encouraged to describe new species by no less an esteemed botanist than Asa Gray at Harvard, who represented the voice of botanical authority in the United States at that time. Lemmon further castigated "the custom of some Eastern men to describe all sorts of California plants from any kind of specimens, without ever having seen them grow, and take the chances as to their being new and the descriptions accurate" (quoted in Leviton and Aldrich 1997:239). In these early years one accordingly already sees the lines being drawn between "herbarium botanists," who depend entirely on dried material, and the incipient effort to understand species within a living ecological context.

Lemmon also serves to represent the many members elected to the Academy during the first few decades following its founding. A survivor of the infamous Andersonville Confederate prison, in 1866 Lemmon came to his brother's ranch in Sierra Valley to recuperate. After a year of "liberal diet" that increased his weight to a full 90 pounds, Lemmon was able to walk a little way alone,

FIGURE 3. John Gill Lemmon

FIGURE 4. Sara Allen Plummer Lemmon

"being greatly stimulated by handfuls of unrecognizable plants" (Lemmon 1908:18). This botanical incentive led to a career as a multi-faceted freelance botanist, among the first in California, in partnership with his wife, Sara Allen Plummer Lemmon (Fig. 4). Sara, who established Santa Barbara's first library, was among the first group of women accepted into the Academy in 1878, thereby fulfilling an early resolution proposed by Kellogg: "Be it resolved that we highly approve the aid of females in every department of natural history, and that we earnestly invite their cooperation" (quoted in Leviton and Aldrich 1997:21).

California Geological Survey

In spite of early accomplishments, it is unlikely that the California Academy of Sciences would have survived its first decade had it not been for the shot in the arm provided by California's second significant institution of natural history, the California Geological Survey. The Academy's near-demise prior to the establishment of the Survey in 1860 is documented in several sources, such as a letter from Behr to a fellow German expatriate, George Engelmann, who provided botanical expertise in St. Louis, Gateway to the American West:

> I haven't heard for a long time from the [Academy] and it seems that there are not too many signs of life. There are several things amiss, primarily the necessary funds. From this follows that neither collections can be wisely planned and carried out, nor that the needed literary support can be acquired. Much gets lost in the collections, and scientific descriptions and works lack all overview, because the few members who work can only refer to study-type monographs, travel reports, and natural history picture books. And thus it happens that the Society in the 7th year of its existence has really not achieved anything despite the grueling labors of one or two of its members. By the way, I must confess that I am only incompletely aware of the goals of the Society during the last

> years and as an outsider I can only judge the results. (Letter of 10 November 1860, archives of Missouri Botanical Garden, translated by Edgar Deniscon; quoted in Ertter 2003:21)

In addition to serving as a centerpiece for state pride, the Survey was intended to locate new geological deposits and other natural resources that could be exploited for economic development, especially important given the near-exhaustion of known gold reserves (Goetzmann 1966). The California government accordingly approved a Geological Survey of the State in April 1860, headed by Josiah Dwight Whitney as State Geologist. The legislated mandate of the Survey was to map California and to prepare "a full and scientific description of its rocks, fossils, soils, and minerals, and of its botanical and zoological productions, together with specimens of the same, which specimens shall be properly labeled and arranged, and deposited in such place as shall be hereafter provided for that purpose by the legislature." Whitney selected William H. Brewer, an agricultural chemistry professor from Pennsylvania, as his right-hand man. Brewer also served as primary botanist, supplemented by collections from the Survey's surgeon-naturalist James G. Cooper.

The heavy winter rains of 1861–1862, while disastrous for the state economy and a serious setback for the Survey, proved to be an immense boon to the Academy. Unable to conduct fieldwork due to washed out roads and bridges, the members of the Survey became active in the Academy and soon filled most of the officer positions. Whitney served as Academy president for many years, while Brewer became corresponding secretary and Cooper curator of zoology. At the same time Kellogg and other members of the Academy served as an additional source of specimens for the Survey.

When Brewer left the Survey after four years to accept a position at Yale, his botanical duties were taken over by Henry Nicholas Bolander (Fig. 5), an expatriate German school teacher who had joined the Academy in 1862 (Jepson 1898). Unfortunately, the Survey's increasingly dire financial situation allowed Bolander to be hired only periodically, apparently on a contract basis. Bolander's total collections nevertheless exceeded those of Brewer, with a special focus on previously overlooked graminoids and bryophytes. Bolander also played an active role in Academy affairs, and was credited by Lemmon with encouraging the recovering veteran's botanical interest (Lemmon 1908).

FIGURE 5. Henry Nicolas Bolander

All of the botanical collections for the Survey, from whatever source, were incorporated into a single numbering sequence. These were sent to Harvard, where America's foremost botanist, Asa Gray, was preparing a synoptical flora of North America. Gray was accordingly not only eminently suited to work up the Survey's collection, but he needed to see the new material for incorporation into this magnum opus. After Brewer moved to Yale, he periodically traveled to Harvard to work with Gray on preparing the botanical report of the Survey. This was at considerable personal expense to Brewer, since no State funds were made available in spite of a legislative mandate to produce the report (Farquhar 1930). It was accordingly only when a group of

California's wealthier citizens, spearheaded by railroad magnate and former governor Leland Stanford, donated the necessary funds to cover publication costs, including the hiring of Sereno Watson as an assistant to Gray and Brewer, that the botanical report for the Survey was completed. The resultant two-volume *Botany of California* (Brewer et al. 1876; Watson 1880) stands as the first flora of California. It incorporates not only collections made by the Survey team but by all botanists who had collected in California, including Kellogg, Behr, Lemmon, and the latter's soon-to-be-wife Sara Plummer.

The infusion of fresh blood had rejuvenated the Academy, but the Survey itself had fallen on hard times. Initial enthusiasm from the state legislature had rapidly waned when lucrative new mineral deposits were not immediately forthcoming, forcing Whitney to spend most of his time justifying continued support for the Survey from "the jackasses in Sacramento" whose "votes can only be had this year by purchase" (quoted in Brewster 1909:264). The nail in the coffin was a speculation boom involving Santa Barbara's vast petroleum reserves, which the Survey was accused of having overlooked. Although it was later shown that the speculation was probably driven by a scam in which a sample of refined Pennsylvania oil had been used in place of the thick Santa Barbara crude (which was in fact of little value using technology available at the time), the damage to the Survey's reputation had already been done (Goetzmann 1966). As summarized by Whitney, "'Petroleum' is what has killed us. By the word 'petroleum,' understand the desire to sell worthless property for large sums and the impolicy of having anybody around to interfere with the little game" (quoted in Brewster 1909:267).

University of California: Early Years

In that the botanical specimens had been sent to Harvard for processing (sans funds), Whitney was also accused of running the Survey for the benefit of Harvard University (Brewster 1909). In actuality, Whitney lobbied hard to obtain state funds for housing the collections resulting from the Survey in California, divided between the Academy and the State Agricultural Society in Sacramento (Appendix E *in* Leviton and Aldrich 1997). When this attempt failed, he turned his efforts instead into assuring a place for the collections within the newly proposed University of California. Serving as the chair of the commission charged with drafting plans for the University, Whitney maintained that "the establishment of the Geological Survey was in fact the first step towards the production of a State University. Without the information to be obtained by that Survey, no thorough instruction was possible on this coast, either in geography, geology, or natural history; for the student of these branches requires to be taught in that which is about him, and with which he is brought into daily contact, as well as that which is distant and only theoretically important." (quoted in Stadtman 1970:27).

Whitney's efforts evidently paid off (probably aided by rivalry with Harvard!) Of the 28 sections of California Assembly Bill 583 that brought the University of California into being in 1868, Section 24 deals exclusively with accommodations for the Survey collections, which "shall belong to the University, and . . . be arranged by the resident Professors of the University in a building by themselves, which shall be denominated the 'Museum of the University'." Although it is unclear exactly when a set of the Survey's botanical collections were deposited in the fledgling University, other collections were apparently housed in South Hall, one of the first two buildings constructed when the Berkeley campus opened in 1873.

Subsequent references to the mandated "Museum of the University" are few and far between, with one of the more intriguing being an 1875 "Report of the Results of Excursion of the Scientific Party of the University" submitted by Joseph LeConte, the first Professor of Geology, Natural History, and Botany:

> In accordance with my promise I hereby make a brief report of the results of the recent excursion made by the University Scientific Party. The party as you know was organized for the purpose of utilizing the Spring recess of a week, in giving some practical instruction in Geology, Lithology, and Surveying; but expected also to make some collections of plants, rocks, fossils, etc., for the Museum. . . . We started on the 25th March. Our route passed through San Pablo, Martinez, Pacheco, to Nortonville; thence to Mt. Diablo Summit through Pine Cañon and return by Walnut Creek, Lafayette, Summit House to Berkeley. As our time was very limited we stopped but little until our objective points were reached. We gathered, however, on the first day, some cretaceous fossils near Martinez, and Mr. McLean, our young botanist a large number of plants. (LeConte 1875.)

LeConte apparently did not collect plants himself, but the several hundred collections from throughout California by Franklin P. McLean (aka Maclean), a graduate of the College of Pharmacy, are apparently the earliest extant herbarium specimens prepared under the University aegis.

Joseph and his brother John LeConte were among the initial faculty recruited after the University was formally established in 1868 by the merger of a pre-existing private College of California (where Brewer had served as Professor of Natural Sciences in 1863) and the proposed State Agricultural, Mining, and Mechanical Arts College. The LeConte brothers were among several newly recruited faculty who were fleeing the deprivations of Reconstructionist South, leading to James Cooper's slur about "that Asylum for rebel Professors" (quoted in Leviton & Aldrich 1997:123). Although Cooper, zoologist for the Survey who was also active in the Academy, apparently had little respect for the new University, other Academy members taught courses during the early years, including Bolander and Kellogg (Constance 1978).

Another initial faculty recruit who played a significant role in California's natural history, albeit indirect, is Ezra Slocum Carr. Carr was recruited as Professor of Agriculture, Chemistry, and Horticulture at UC after having parted ways with the University of Wisconsin over a variety of academic controversies. His primary claim to fame at UC was a continuation of this combative tradition, when he found himself on the losing side of one of the seminal battles that would dramatically shape the University's future. The specific issue was to what extent the University would model itself according to the provisions of the 1862 Morrill Act that provided the funding for its establishment. Also called the Agricultural College Land Grant Act, the federal legislation mandated a focus on "such branches of learning as are related to agriculture and the mechanical arts . . . in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life" (quoted in Stadtman 1970:25). Carr staunchly supported a close adherence to this applied focus, carrying the banner for "farmers and workingmen [who] were challenging established wealth, established authority, and established intellectual values, [and who] found the University, even as it then existed, too rich for the needs of the common man" (Stadtman 1970: 69).

Carr was opposed by University President Daniel Coit Gilman, who advocated a broader liberal arts curriculum. Whitney sympathized with Gilman, who he described as "engaged in a hard fight to save the University from the claws of the grangers [farmers] who want to make a manual-labor school of it" (quoted in Brewster 1909:288). Gilman's camp carried the day, and Carr was dismissed in 1875 after refusing to resign. Not unscathed, Gilman also departed the arena, accepting the presidency of the newly established John Hopkins University in 1876. Here he was able to pursue his vision unfettered, pioneering the combination of research and teaching that helped revolutionize higher education in the United States (*http://www.jhu.edu/*).

Carr's primary connection to the current narrative, however, is the friendship he and his wife Jeanne had with a young Scotsman who had preceded them to California from Wisconsin the previous year, by name of John Muir (Fig. 6). As analyzed by Gisel (2001), Jeanne Carr played a pivotal role as mentor and de facto agent for Muir, convincing him to convert his astute observations and insights into print. Although best known for his lilting essays in praise and defense of his beloved Yosemite Valley and the natural world in general, Muir was also an accomplished botanist who contributed specimens to Gray at Harvard, resulting in the discovery of several new species. Muir's primary scientific contribution, however, was to correctly interpret the glacial origin of Yosemite Valley, contradicting the cataclysmic explanation put forth by Whitney.

Through the Carrs, Muir made the acquaintance of Joseph LeConte (Brentano 2000; Gisel 2001). The two men first met when LeConte was on a camping trip to Yosemite in 1870, having joined several students on a "university excursion party" only months after his arrival in California. This was prior to Muir's literary efforts (encouraged by Carr), when he was working for a sawmill in Yosemite Valley itself. The meeting occurred as the excursion was on its way to Yosemite Falls:

FIGURE 6. John Muir

> Stopped a moment at the foot of the falls, at a saw-mill, to make inquiries. Here found a man in rough miller's garb, whose intelligent face and earnest, clear blue eye excited my interest. After some conversation, discovered that it was Mr. Muir, a gentleman of whom I had heard much from Mrs. Professor Carr and others. He had also received a letter from Mrs. Carr concerning our party, and was looking for us. . . . Mr. Muir is a gentleman of rare intelligence, of much knowledge of science, particularly of botany, which he has made a specialty. He has lived several years in the valley, and is thoroughly acquainted with the mountains in the vicinity. A man of so much intelligence tending a sawmill! (LeConte 1960:56, 59.)

The resultant friendship and mutual respect, anchored in a shared passion for both the beauty and the geology of of the Sierra Nevada, was sufficient to weather some resentment about LeConte getting credit for Muir's insights on Yosemite glaciation (Gisel 2001). Muir also regretted that LeConte "had allowed himself to be caught and put in professional harness so early" (quoted in Brentano 2000:82), reflecting the contrast that existed between Muir's and LeConte's approach to nature's beauty. The 1870 excursion was only the first of several trips by LeConte to Yosemite and the surrounding Sierra Nevada, establishing his connection with the area to the extent that a memorial lodge was built in the Valley by the Sierra Club after his death in 1901, on LeConte's final expedition to his beloved Yosemite (Figs. 7–8).

Political Upheaval at the Academy

Muir and Jeanne Carr also developed a close friendship with Kellogg, who shared their poetic affinity for nature, resulting in a joint camping trip to Yosemite in 1873. This was the same year that Toland Medical College and the affiliated College of Pharmacy were absorbed as the

FIGURES 7 (above) and 8 (right). Sierra Club memorial to Joseph LeConte in Yosemite National Park. Photos by the author.

University's medical school, setting into play a chain of events that would ultimately result in Kellogg's falling out with the institution that he had helped found, and in which he had long been revered.

Among the first female students in the new medical school was a young widow, Mary Katharine Layne Curran (Fig. 9), who earned her M.D. in 1878. Strong-willed and uncompromising, Curran found a kindred spirit and mentor in Behr, who taught botany at the College of Pharmacy as the core of the available pharmacopoeia. As described by a fellow student:

> We were all much interested in Materia Medica. Our professor was a very busy man and could not always give the time he wished to give to the subject: Therefore Mrs. Curran with a number of us who were members of the Academy of Sciences decided to go out with the Pharmaceutical Class — Dr. Herman Behr our instructor — and study the flora and plant life of the bay region usually Marin, Contra Costa and San Mateo Counties. Whatever was collected of

FIGURE 9. Mary Katharine Layne Curran

> value or of special interest was taken or given to the Academy of Sciences. Mrs. Curran was a very close student and observer—so also was Dr. Behr and his deep interest in the Academy and the flora and plant life of California had a charm for the entire class. (L. Wanzer to E. Stockton, 1925, in University Herbarium archives)

With Behr's backing, Curran became active in the Academy, initially sharing her mentor's primary interest in entomology. However, after failing to establish a medical practice, she accepted the position of joint curator of botany at the Academy in 1883. In addition to overhauling curation of the herbarium, which she described as "in a shocking condition" (quoted in Setchell 1926:167), Curran began her life-long editorial activities by establishing the *Bulletin of the California Academy of Sciences.* Published therein is a little-known paper (Curran 1885) in which she evaluated all the plant species described at the Academy by Kellogg, Behr, and Bolander according to the recently published *Botany of California,* a paper that has gained tremendous significance following the destruction of many of the type specimens in 1906. The article was accompanied by reprints of detailed drawings, several of them exquisitely colored (Fig. 10), of species that Kellogg had published in *The Hesperian,* a by-then-defunct local monthly magazine.

At some point Curran also became active in Academy politics, culminating in the hotly contested election of 1887 that resulted in a wholesale replacement of incumbents with a new slate of officers. The specific issues have faded with time but probably involved disagreements over the windfall resulting from the magnanimous bequest of James Lick, "the eccentric cabinetmaker whose investments had made him a millionaire" (Stadtman 1970:108). Although Lick's gift was ultimately responsible for converting the Academy from a scholarly club to a premier research institute, the initial impact was one of extreme financial straits while the will was being contested by a dispossessed son, during which time the Academy was strained to pay taxes on land donated by Lick just prior to his death. When the unbelievable largess of well over half a million dollars was finally available to the Academy, disagreement then erupted over how it would be best directed. The most contentious question was whether the bequested prime real estate on Market Street should be used as the site of badly needed new quarters for the Academy's collections, as intended by Lick, or if it made better economic sense to construct a commercial building on the site that would generate income to maintain a new museum facility built elsewhere. The eventual structure was an innovative compromise, with commercial space in front and the Academy museum and offices in the rear, accessed through a prominent portal.

Disagreement over the Market Street lot was, however, apparently only one facet of opposition to incumbent George Davidson, a member of the United States Coast Survey who had served as president of the Academy for the preceding 16 years. The extent of disfavor is evidenced in the Reform Ticket of 1887 (copy in UC Herbarium archives), which proposes "To advance the cause of Science instead of the aggrandizement or profit of individuals" and "To put the Society in a position of respectability before the world, such as to deserve the large Bequests and Donations which are being withheld for the want of confidence in its management." It is quite likely that this Reform Ticket was printed by Curran, given her editorial activities and firm support of opposition candidate Harvey Willson Harkness. Indeed, Jepson (1933) goes so far as to claim that "the first political upheaval of the Academy [was] largely engineered by Mrs. Mary K. Curran." The end result was the replacement not only of Davidson by Harkness as Academy president, but also a nearly complete turn-over in the other elected positions and a deep resentment against the new administration by allies of Davidson and other former officers. A contemporary letter encapsulates the tenor: "Acad[em]y affairs as you will infer are run *a la Curran* and nobody else has anything to say in the matter — Greene draws off to Berkeley—how long this state of things may last *quien*


D. D. Neal Del.
L. Nagel Print.
LEOPARD LILY
(Lilium Pardalium – Kellogg.)
Drawn from Nature Expressly for the "HESPERIAN."

sabe. I enclose Harkness's inaugural written as I understand by Curran." (C.C. Parry to S.B. Parish, quoted in Ewan 1955:32).

The University may have acted as a stronghold for resistance to the new Academy administration in general, as evidenced by the appearance of Joseph LeConte as candidate for Academy president on an unsuccessful opposition ticket in the 1890 election (Leviton and Aldrich 1997). LeConte's disdain for Academy politics is clearly stated: "Under the presidency of J.D. Whitney the Academy was prosperous and held a high position among the scientific institutions of our country; but from that time, because of internal dissensions, it dropped lower and lower" (quoted in Ewan 1955:32). Edward Lee Greene, referred to in the letter from Parry to Parish, left his position as joint curator of botany with Curran to accept the newly established position of Professor of Botany at Berkeley. Malacologist William G.W. Harford, ousted from his post as Director of the Museum at the Academy, also relocated to the University, serving as assistant curator of the "Museum of the University of California" (Jepson 1933).

Kellogg also became embittered with the new administration, presumably out of loyalty to Davidson and Harford. His ties to Harford, whom Davidson referred to as Kellogg's "other-self" (in Greene 1889–1890:vi), were particularly strong, with Kellogg becoming a member of the Harford household in Alameda in his later years. Kellogg's estrangement from the Academy that he had helped found continued beyond his death (which occurred less than a year after the election), such that his botanical drawings were not willed to the Academy "while the present administration was in power." This led to further acrimonious debate and "a great many desultory remarks" over the status of Kellogg's work that had been accomplished during his paid tenure at the Academy (minutes of 3 Dec 1888, in Leviton and Aldrich 1997). The debate came to a head with the posthumous publication of a book containing Kellogg's illustrations and other material, separate from the Academy's purview (Greene 1889–1890). Davidson provided the introductory eulogy to the book, extolling how:

> [Kellogg worked for the Academy] and believed in its success when the number of members could have been counted on one's fingers, and when the means of supporting such an institution and publishing its results came wholly from their professional earnings. . . . Dr. Kellogg did his full quota of work among workers, and bore his share of the trials; he never lost hope, he inspired others with his enthusiasm, he quieted dissension; he was confident there would spread among our people a desire for that scientific knowledge which is the foundation of the practical. Beyond the wild rush for wealth and the unsettledness of that period he foresaw the growth of schools, colleges, universities and societies for every branch of scientific research. . . . In fact, the California Academy of Sciences owes its present standing in science and wealth to the labors of Dr. Kellogg and his fellow workers. (Greene 1889–90:v–vi).

The Greene Era at Berkeley

The publication of Kellogg's final opus was spearheaded by Davidson, William P. Gibbons (another disenfranchised Academy member of long standing), and Edward Lee Greene (Fig. 11), mentioned previously as "drawing off" to Berkeley. Greene apparently retained a deep loyalty to Kellogg, who probably served as a mentor and role model following Greene's arrival in 1881 as pastor of St. Mark's Episcopal church in Berkeley. Greene obviously had reasons beyond Academy politics to accept the first strictly botanical appointment at the University in 1885, given that his conversion to Catholicism in 1884 left him unqualified to continue as an Episcopalian pastor (McIntosh 1983).

← FIGURE 10. Color lithograph of the leopard lily by Albert Kellogg that first appeared in *The Hesperian* and then was reproduced by Katharine Curran [Brandegee] in 1885

FIGURE 11. Edward Lee Greene

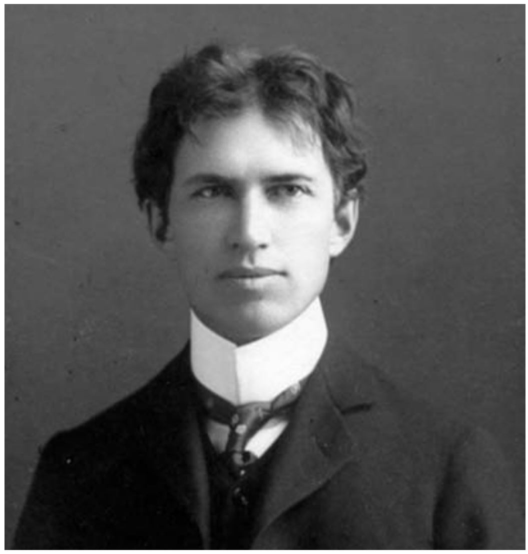
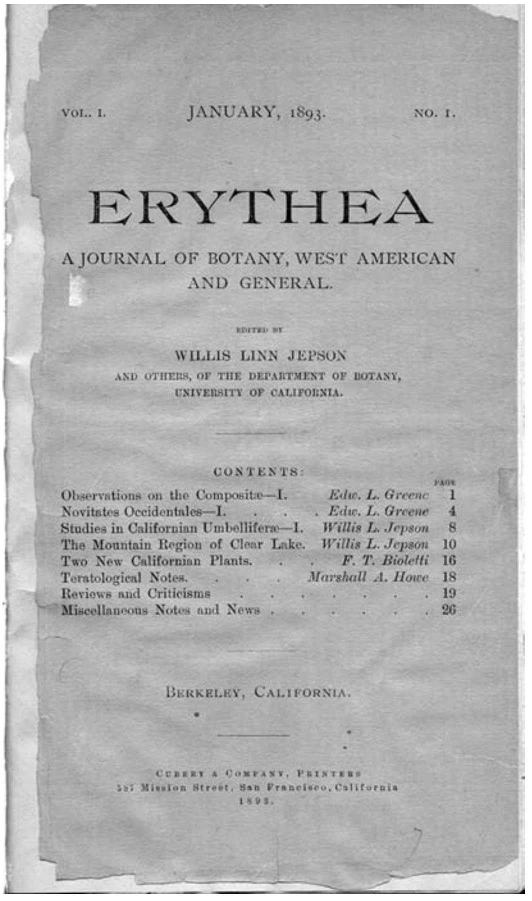


FIGURE 12. Willis Linn Jepson

Greene's ten years at Berkeley coincided with a flowering of botanical activity, with numerous energetic colleagues. His position had been lobbied for by Eugene W. Hilgard, who had replaced Ezra Carr when the unfortunate latter lost his political battle with President Gilman in 1875. Hilgard's appointment launched the University's College of Agriculture and Agricultural Experiment Station, followed by the establishment of a garden of economic plants in 1879. By 1890 a College of Natural Sciences had been established, containing a Department of Botany. Newly appointed faculty within the fledgling department included Joseph Burtt-Davy, with seminal interests in agronomy and economic botany, and Marshall Avery Howe, who taught morphology and cryptogamic botany (Constance 1978). Several students also played active roles in the department, notably Willis Linn Jepson (Fig. 12) who arrived in 1885. In 1891 the instructors and students of the botany department founded the journal *Erythea* (Fig. 13) and the Chamisso Botanical Club, which had as a primary goal "the collection of materials upon which to found local plant-lists" (Jepson 1894:171).

Greene also established his own journal, *Pittonia,* in 1887, primarily as a personal outlet where he could publish new species and philosophies independent of critical review. This gained importance as Greene's views became increasingly marginalized, especially in the matter of ultimate priority (i.e., not accepting Linnaeus' *Species Plantarum* as a starting point). Greene also earned notoriety as a hardcore splitter, with the philosophy "that many species exist in nature, for which no specific characters can easily, or even by any known criterion, be found at all" (Greene 1889:298). His reputation has been further tarnished by the claim that this philosophy was rooted in creationist leanings: "The underlying reasons of Mr. Greene's devotion to 'new species' are not far to seek. He openly contemns [*sic*], as inconsistent with the Mosaic record, the theory of evolution held in greater or lesser degree by almost all biologists, and proclaims his belief in the special creation and the fixity of species" (Brandegee 1893:64).

There is little evidence that Greene's idiosyncratic philosophies left much of an imprint in Berkeley at the time. Even Jepson, one of Greene's most devoted disciples, parted ways with his mentor in fundamental aspects of taxonomic philosophy. Ironically, although Greene continues to be invoked as the quintessentially subjective descriptive taxonomist, a denigration all the more damning because of the purported creationist bent, his track record has actually been remarkably successful. In contrast to predictions that "It is safe to say that not more than one in ten of [Greene's] species is tenable, and probably one in fifteen or twenty would be nearer the mark" (Brandegee 1893:64), a respectable 70% of those species described by Greene while he was residing in California have stood the test of time (McVaugh 1983). It has also been argued (e.g., Ornduff 2000) that Greene's anti-evolutionary stance has been overstated, as evidenced by Greene's attribution of evolutionary views to Linnaeus (Greene 1909).


VOL. I. JANUARY, 1893. NO. I.

ERYTHEA

A JOURNAL OF BOTANY, WEST AMERICAN AND GENERAL.

EDITED BY

WILLIS LINN JEPSON

AND OTHERS, OF THE DEPARTMENT OF BOTANY, UNIVERSITY OF CALIFORNIA.

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BERKELEY, CALIFORNIA.

CUBERY & COMPANY, PRINTERS
527 Mission Street, San Francisco, California
1893.

FIGURE 13. Title page of volume 1, number 1 of *Erythea* dated January 1891.

Greene nevertheless served as the foil for local supporters of Darwin's revolutionary ideas and a more overtly experimental approach to taxonomy. Coinciding with Greene's transit to the University, Behr (1884) was propounding that "the theory of evolution will be the most successful in explaining the resemblances and differences of organized life" and that the resultant "divergences and their ramifications may be compared to the branches of a pedigree." He furthermore looked forward to the time when California would possess "a botanical garden or experimental grounds" where the potential role of hybridization could be evaluated, as the probable explanation (in Behr's understanding) of "why several species described and characterized by different authors have not been found again" (Behr 1888). These beliefs were echoed by Curran (who, as previously noted, had Behr as a mentor) in such phrases as "The life history of a single species, its limit of variation, and its hybrids, if any, would be far more useful than a dozen 'decades' of new violets or Senecios." (Brandegee 1901:96).

This last quote contains a scarcely veiled gibe at Greene and his splitter philosophy, only one in a long series heaped on Greene. Curran's relationship with Greene was amicable enough during their overlapping years at the Academy, which included a stint as joint curator of botany (1884–1887) when Greene aided Curran's early botanical development. This early friendship quickly crumbled, however, following the bitter fall-out from the 1887 political battle at the Academy, in which Curran and Greene took sides in opposing camps (Ertter 2000). It is also conceivable that an element of "unrequited love" was involved, as suggested by Ewan (1942) and supported by a cryptic "Hell hath no fury" comment in one of Jepson's notebooks. It is accordingly intriguing, at the very least, to wonder to what extent a failed love affair may have influenced the subsequent rise of biosystematics in California, as outlined later.

As additional evidence for the "unrequited love" hypothesis, two years after the falling out with Greene saw Curran remarried and known henceforth as Katharine (Kate) Brandegee. Townshend Stith Brandegee, who had served as botanist for several territorial surveys, had sufficient inheritance to allow financial independence for the blissful couple. Combined with initial funds from Harkness, the inheritance also allowed the founding of a new journal, *Zoe,* which gave Katharine an outlet for her outspoken analyses of Greene's publications and others with whom she took issue (Setchell 1926).

The financial independence also allowed the Brandegees to leave the Academy and move to San Diego in 1894, bringing them closer to Townshend's research focus of Baja California and the off-shore islands. The decision was perhaps influenced as well by fall-out from the political battles, which may have taken a toll on Katharine. Leaving the Academy herbarium in charge of Alice Eastwood, who had been recruited as assistant curator in 1892, the Brandegees took their personal library and herbarium to an idyllic mesa overlooking San Diego, at First and Redwood Streets. The large garden surrounding the brick herbarium would have given Katharine ample opportunity to initiate experimental studies, as implied in her comment that "The field investigation of hybrids is a most interesting and useful employment for botanists who do not have access to large herbaria and libraries" (Brandegee 1901:96).

It was presumably while in San Diego that the Brandegees became acquainted with the young Harvey Monroe Hall (Fig. 14), who taught school in Riverside before matriculating at the University of California in 1898. No mention is made in Hall's biography (Babcock 1934) of a Brandegee influence, but it is evident from letters and other sources (e.g., Setchell 1926) that Hall and Katharine developed a warm friendship with a shared taxonomic philosophy. Excerpts such as "if one has not a bunch of new things at least once a month he is in danger of being called slow and will surely fail to cut much of a figure alongside of the 'progressive botanists'" (Hall to K.

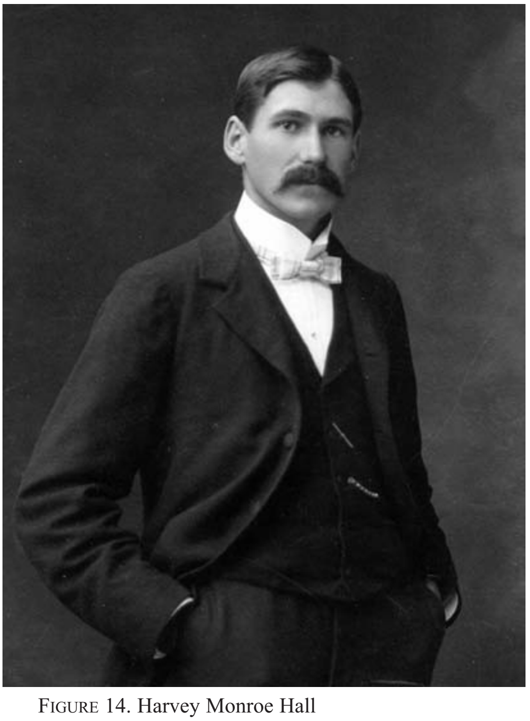


FIGURE 14. Harvey Monroe Hall

FIGURE 15. William Albert Setchell

Brandegee, letter of 26 Nov. 1905, UC Herbarium archives) and a call to "preserve the dignity of the species as you and I know them" (Hall to K. Brandegee, letter of 26 July 1918, UC Herbarium archives) give evidence of long conversations on taxonomic theory, and suggest that Hall accordingly also partook of Behr's philosophical legacy.

Greene had departed Berkeley before Hall's arrival, leaving the University of California one year after the Brandegees' move to San Diego to accept a position at Catholic University in Washington in 1895. Contrary to his hopes of finding himself in a more centrally located and influential position, Greene's views made him increasingly isolated, and embittered, in the battles that shaped the future of botanical nomenclature in the subsequent decades. Back in Berkeley, phycologist William Albert Setchell (Fig. 15) was recruited to fill Greene's vacated position, beginning a long reign as chair of the department of botany. Jepson, who had already been serving as an instructor, was promoted to assistant professor after receiving the first Ph.D. in the department in 1898. When Burtt-Davy resigned in 1902 to pursue a prestigious career in South Africa, he was replaced by Hall, who finished his Ph.D. in 1906.

Hall is given credit for the Brandegees' decision to move to Berkeley in 1906, when the San Diego climate proved incompatible with Katharine's failing health (Babcock 1934). Negotiations with Setchell resulted in the donation of the Brandegees' superb botanical library and herbarium to the University of California, effectively doubling the size of the existing herbarium and establishing the botany department as a world-class facility. In exchange, the Brandegees were provided with permanent research space, and, for Townshend, an Honorary Curator appointment (Setchell 1926; Ertter 2000).

Stanford University and the Carnegie Institution

An 1893 note in *Zoe*, prior to Greene's departure from Berkeley and probably penned by Katharine, heralded the appearance of what would become the third major institution of natural history in the San Francisco Bay Area, Stanford University:

> Prof. W[illiam] R[ussel] Dudley, late of Cornell, has taken the chair of systematic botany at Stanford University. With such men as he and Prof. Douglas H. Campbell in charge of the botanical work at Stanford University, where botany is taught according to modern methods, we may expect to have in time, a body of resident botanists whose entire stock of botanical knowledge is not confined to the possession of a limited terminology and a large capacity for discovering new species that do not exist. (*Zoe* 3:378, 1893)

The new university, which opened its doors in 1891, was founded by Leland and Jane Stanford in memory of their son Leland Stanford, Jr., who died in 1884 from typhoid fever. Leland Stanford, who has been previously mentioned as having helped fund the botanical report resulting from the Geological Survey, recruited David Starr Jordan to serve as president, a post held by Jordan for 22 years. Jordan in turn recruited William Russel Dudley as professor of botany, Dudley having taken his first botany course from Jordan at Cornell University (Jordan 1911). Leland Stanford's death in 1893, only two years after the university's opening, led to an extremely trying period when his estate was in probate. Of the subsequent long six years, Jordan later stated that "the future of a university hung by a single thread, the love of a good woman," as Jane Stanford kept the dream alive (*www.stanford.edu/home/stanford/history/begin.html*).

Jordan, a practicing ichthyologist, also took an active role in the Academy. His election as president of the Academy in 1896 ended the Harkness administration and served, finally, to heal the rift between the feuding factions. It also initiated the seven-year "University Regime of the Academy," during which the presidents of Stanford University and the University of California took turns as primary officers of the Academy. Dudley also became involved with the Academy, serving with Setchell on the editorial committee for botany (Leviton and Aldrich 1997).

Jordan had a strong desire to have the new field of plant evolution represented at Stanford University, which eventually led to a close connection with the Carnegie Institution of Washington. The Institution was incorporated in 1902 after steel magnate Andrew Carnegie decided to establish a scientific institution with the mission "to encourage, in the broadest and most liberal manner, investigation, research, and discovery, and the application of knowledge to the improvement of mankind." Selected as first director was Daniel Coit Gilman, former president of the University of California who was now approaching retirement as president of John Hopkins University. In contrast to his success at the latter university, power struggles at the Carnegie Institution led to Gilman's resignation by the end of 1904 (Yochelson 1994).

The botanical connection between Stanford University and the Carnegie Institution goes back at least to 1904, when Jordan and entomologist Vernon Kellogg added their support to obtain Institution funding for well-known plant breeder Luther Burbank (Largent mss.). The California Academy of Sciences also passed a resolution endorsing the request, "in full confidence that such a grant will yield most valuable returns to science" (Leviton and Aldrich 1997:420). The Academy furthermore chose Burbank as the recipient of a gold medal presented as part of its Semi-Centennial Anniversary, designated "to be awarded to the person who, in the judgment of the Academy, has most advanced the interests of agriculture by his investigations and by the application of scientific principles to plant life" (quoted in Leviton and Aldrich 1997:419). The result was a hefty $10,000 grant from the Carnegie Institution to Burbank "for Investigations in the Evolution of Plants," renewed over a five-year period to support his plant breeding experiments in Santa Rosa. Jordan also gave Burbank a position in Stanford's Bionomics department as "Special Lecturer in Evolution," which came with a $300 salary for two lectures per year (Largent mss.).

To the disappointment of Jordan and other scientific supporters, however, Burbank's idiosyncratic methodology did not prove compatible with the expectations of an increasingly professionalized field. When the initial five-year agreement with the Carnegie Institution ended in 1909, the grant was accordingly not renewed. Stanford University and Burbank parted ways, but Jordan's desire to have plant evolution represented at Stanford continued. It is accordingly reasonable to assume that the Burbank episode laid the foundation for Harvey Monroe Hall's receipt of Carnegie Institution support beginning in 1919 and the eventual establishment of the Institution's Plant Biology Department at Stanford in 1929.[1]

Across the Bay at Berkeley, Hall had worked his way up from instructor at the University of California in 1903 to associate professor in 1916. He also served as curator of the herbarium and of the botanical garden, which had been initiated in 1879 by Eugene Hilgard as a garden of economic plants (Constance 1978). An expanded botanical garden, established by Greene in 1890, was situated on the north fork of Strawberry Creek. It eventually included as many as 1,500 species, some housed in an elegant glass conservatory that was completed in 1894 (Roberts 2000). These facilities were, however, apparently inadequate for the experimental taxonomy envisioned by Hall:

> It was while he was connected with the University that Hall became keenly interested in botanical gardens and came to think of them as an important part of the working equipment of every botanical institution. . . . in 1911, when he wrote to President Wheeler about the proposed garden in Strawberry Cañon, he was thinking in broader terms than a garden, for he dwelt on "the importance

[1] The establishment of the Institution's Department of Plant Biology at Stanford is actually somewhat ironic, in that Carnegie himself had spoken scornfully of Stanford University, stating in a letter to Andrew D. White that "Gov. Stanford made a useless rival as you and I saw in San Francisco to the State University. I could be no party to such a thing." (quoted in Madsen 1969:158)

of looking forward to a time when a botanical garden operated in connection with botanical laboratories, libraries, and herbaria, where far-reaching studies in plant genetics, systematic botany, dendrology, plant pathology and physiology may be pursued." (Babcock 1934:356, 363.)

By the time that the University's botanical garden was finally relocated to Strawberry Canyon in the 1920s, Hall had already resigned to accept a position with the Carnegie Institution of Washington in 1919. He continued to reside in Berkeley until the Institution's Department of Plant Biology was established at Stanford University in 1929, providing Hall with the experimental growing facilities that he desired (Babcock 1934). Hall was appointed acting professor of botany at Stanford University the same year, while retaining the position of honorary curator at the University of California (Babcock 1934). Before his untimely death four years later, he also laid the groundwork for the transplant experiments of Jens Clausen, David Keck, and William Hiesey, which would ultimately revolutionize plant taxonomy and establish the rigorously experimental discipline of biosystematics.

As a side-note to this condensed synopsis of the advent of experimental plant taxonomy, it is worth contrasting early expectations and beliefs with eventual outcomes. As noted previously, Greene's reputation as a splitter served as a foil for his detractors who were early proponents of a more overtly experimental approach to plant taxonomy. However, not only have Greene's species been vindicated beyond these predictions (McVaugh 1983), but other beliefs of his contemporary opponents have suffered as well. Since most of us would now automatically identify with the "evolutionists" over someone who subscribes to the "Mosaic record," it comes as a surprise to realize that these pre-Synthesis proponents firmly believed that environmental influences and hybridization, not suspect Mendelian genetics, were the primary explanations for diversity. This philosophy underlies Greene's rebuttal about "our friends the evolutionists" who invoke "soil, climate, or in one oft-repeated word, environment" (quoted in Brandegee 1893:64) to explain the genesis of species, and even genera, as well as claims such as:

> If mutations prove to be but major variations in which the environic stimulus is hidden or indirect, it will become possible to study the origin of all new features or forms ecologically, since hybrids are to be regarded as new expressions of old forms. It appears probable that this method can be successfully applied to retracing the origin of existing species or stocks, and with increasing knowledge and skill in experimental manipulation, to repeating the change from a genus into a related one. (Hall and Clements 1923:3.)

In this light, Burbank's inclusion in the current narrative makes perfect sense, as further evidenced by Brandegee's admiration for Burbank's experiments on *Zauschneria* as a means to "rid us of a host of species" (Brandegee 1901:96). At the same time, however, none of this should detract from the credit that these early proponents of experimental taxonomy fully deserve, even if the results of the experimental methodologies they laid the foundations for ultimately disproved their expectations. As clearly acknowledged by Clausen, Keck, and Hiesey in the introduction to one of their landmark publications (Fig. 16), based on research done at the Carnegie Institution:

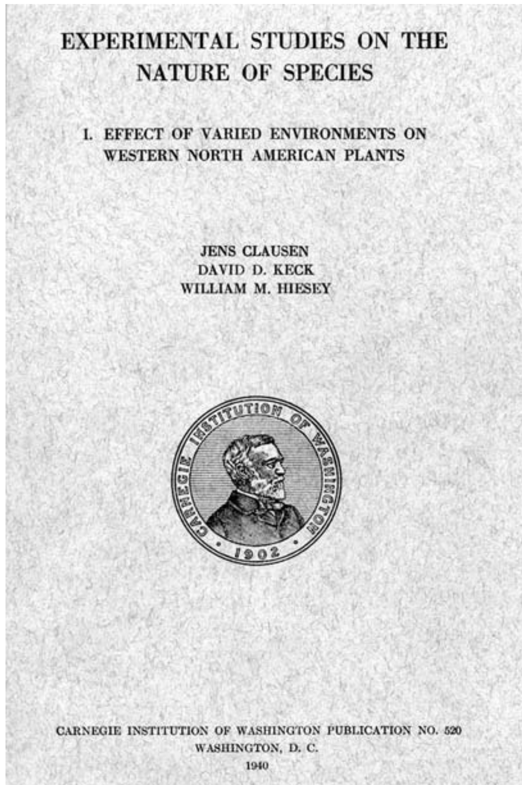
> Dr. Harvey Monroe Hall . . . was a pioneer in endeavoring to improve existing methods of plant taxonomy. He was led to recognize the need for a better understanding of relationships through his work on large, polymorphic species. A knowledge of the capacities of a plant to adjust itself to varying environments was especially desirable in species with intergrading forms occupying a series of habitats. This led Hall to undertake a series of experiments in which plants were transferred from one environment to another in order to test their capacity for modification. The investigations of the present report have emanated from the program that Hall carried on for a decade until his untimely death. Many of the plants discussed in this volume were collected and studied by him, and the transplant stations at which these experiments have been conducted were established through his initia-

tive. It is a matter of deep regret that Hall was unable to see the completion of the investigations which he inaugurated. (Clausen, Keck, and Hiesey 1940:iii.)

Land Management and Conservation Organizations

Of course, much more than the development of experimental systematics was taking place at the existing institutions of natural history. The most significant single event was the destruction of the Academy's magnificent new building in the firestorm that resulted from the Great Earthquake of 1906. Alice Eastwood (Fig. 17), who gained fame as a result of her efforts to save the botanical type specimens, spent the next decade working at Berkeley, Harvard, and other institutions before new facilities became available in Golden Gate Park in 1915 (Leviton and Aldrich 1997). During this same period, Willis Linn Jepson was establishing his reputation in California floristics at Berkeley, and William Russel Dudley quietly pursued his own taxonomic interests at Stanford University.

Jepson, Dudley, and Eastwood, along with most of the other individuals highlighted thus far, played various roles in the genesis of the final "institution" that the current narrative addresses; specifically, the land management agencies whose collective activities now dominate our natural resource legacy. As superbly analyzed by Clar's (1959) history of the California Board of Forestry, this genesis was a prolonged, convoluted process, with many setbacks along the way. Clar makes the critical point that the initial situation involved essentially no provision for a large timber operator to harvest mature timber from a sizeable area of federally owned land. Instead, much of the timber needed for early development was harvested from land that was transferred to private ownership with a single down-payment and then abandoned after the trees were removed, resulting in an increasing amount of ecologically ravaged tax-delinquent lands (Fig. 18).


EXPERIMENTAL STUDIES ON THE NATURE OF SPECIES

I. EFFECT OF VARIED ENVIRONMENTS ON WESTERN NORTH AMERICAN PLANTS

JENS CLAUSEN
DAVID D. KECK
WILLIAM M. HIESEY

CARNEGIE INSTITUTION OF WASHINGTON 1902

CARNEGIE INSTITUTION OF WASHINGTON PUBLICATION NO. 520
WASHINGTON, D. C.
1940

FIGURE 16. Title page of landmark 1940 publication by Clausen, Keck, and Hiesey on *Experimental Studies on the Nature of Species. I. Effect of Varied Environments on Western North American Plants.*

FIGURE 17. Alice Eastwood

FIGURE 18. Trees were removed, resulting in an increasing amount of ecologically ravaged tax-delinquent lands

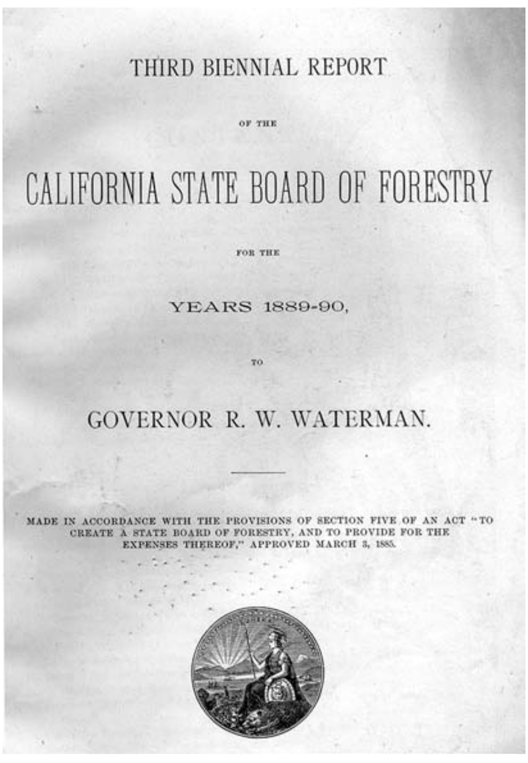
The long-term consequences of such destruction were realized as early as the 1860s. Leland Stanford, in his 1862 inaugural address as governor, noted that "It cannot have escaped the attention of those familiar with the timber regions of this State, that there is a great and unnecessary waste of our stately forests" (quoted in Clar 1959:65). Bolander, erstwhile botanist for the California Geological Survey who was currently serving as Superintendent of Public Instruction and President of the State Horticultural Society, likewise stated in 1872 that "It is my firm conviction that if the redwoods are destroyed and they necessarily will be if not protected by a wise action of our government — California will become a desert in the true sense of the word. On their safety depends the future welfare of the State" (quoted in Clar 1959:77–78). This concern paralleled a counterpart movement at the national level, including the 1873 creation of a committee within the American Association for the Advancement of Science to address the need for legislation leading to forest preservation. Appointed to the committee were Whitney, then still acting as State Geologist, and Eugene Hilgard, prior to his arrival at the University of California (Clar 1959).

Admittedly, Bolander's claim was rooted in the belief accepted at the time that the forests themselves created the climate, to a greater extent than is currently understood. Brewer, making an encore appearance at the Academy in 1875, asserted his belief in this theory, in spite of the lack of instrumental evidence that the destruction of forests had reduced rainfall anywhere in the United

States (Leviton and Aldrich 1997:182). The net result was that the constituency most concerned with the loss of forest coverage was the agricultural industry in southern California, which was completely dependent on rainfall in adjacent mountains. After several failed attempts, pressure from agricultural interests and allies finally resulted in the establishment of a California State Board of Forestry in 1885.

Prior to his death in 1887, Albert Kellogg served as one of three commissioners for the newly established Board, and probably arranged for the first meeting to be held in the California Academy of Sciences. In this capacity, Kellogg contributed information on vegetation to the First Biennial Report, which totaled 230 pages of fine print (Clar 1959). Subsequent reports (Fig. 19) were produced by a staff of hired specialists, led by a State Forester. Second in importance was John Gill Lemmon, hired as State Botanist in 1887. Lemmon's focus at the time was accordingly the forest trees of California, about which he wrote several books (Fig. 20), reports, and other articles, several bearing beautifully rendered illustrations prepared by Sara Lemmon (e.g., Lemmon 1890, 1900).

In addition to evaluating the existing forest resources of California, the early State Board of Forestry aggressively pursued a program to increase forested acreage, especially in grasslands and chaparral zones, tied to the aforementioned belief that doing so would increase rainfall. Experimental planting stations were established at Santa Monica, Chico, Merced, Hesperia, Livermore, and San Jacinto, with various species of *Eucalyptus* quickly becoming the favored choice (Figs. 21–22). As early as 1869, Bolander (among others) had recommended *Eucalyptus* (and, as a side note, opium poppy) for cultivation in California (Leviton and Aldrich 1997:108). Kellogg (1875) prepared a summation of *Eucalyptus* species and their useful characteristics, and



THIRD BIENNIAL REPORT

OF THE

CALIFORNIA STATE BOARD OF FORESTRY

FOR THE

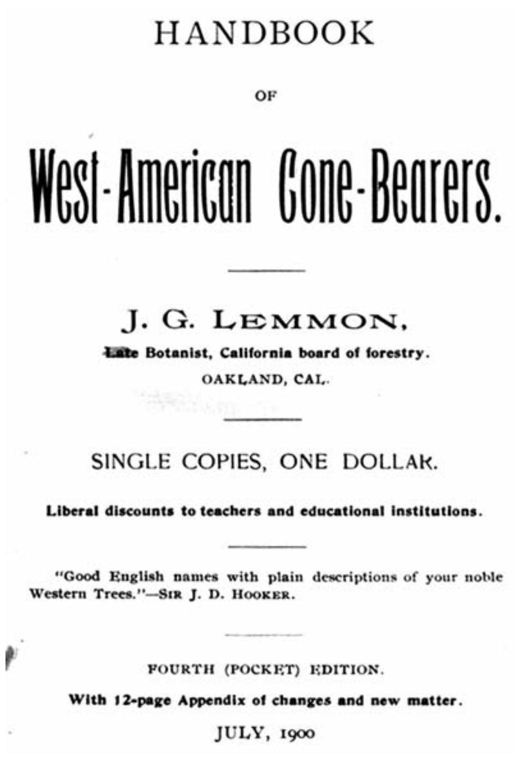
YEARS 1889-90,

TO

GOVERNOR R. W. WATERMAN.

MADE IN ACCORDANCE WITH THE PROVISIONS OF SECTION FIVE OF AN ACT "TO CREATE A STATE BOARD OF FORESTRY, AND TO PROVIDE FOR THE EXPENSES THEREOF," APPROVED MARCH 3, 1885.

FIGURE 19. Title page of a biennial report of the California State Board of Forestry.



HANDBOOK

OF

West-American Cone-Bearers.

J. G. LEMMON,

Late Botanist, California board of forestry.

OAKLAND, CAL.

SINGLE COPIES, ONE DOLLAR.

Liberal discounts to teachers and educational institutions.

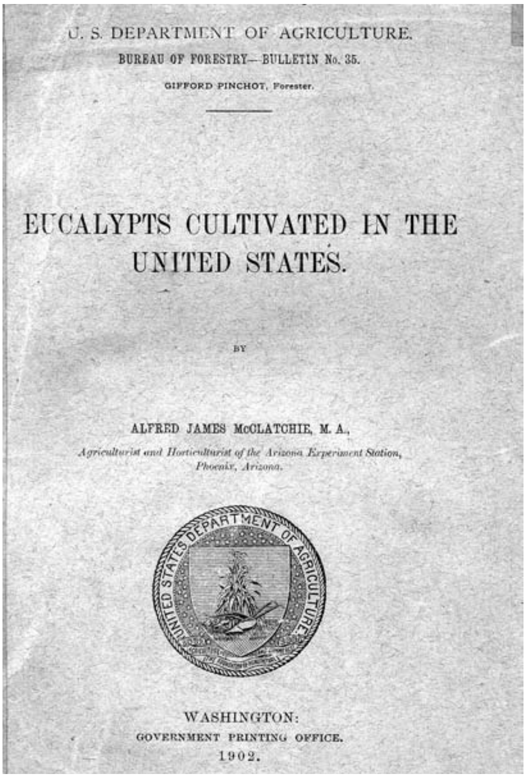
"Good English names with plain descriptions of your noble Western Trees."—SIR J. D. HOOKER.

FOURTH (POCKET) EDITION.

With 12-page Appendix of changes and new matter.

JULY, 1900

FIGURE 20. Title page of John Gill Lemmon's *Handbook of West-American Cone-bearers* (1900).



U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF FORESTRY—BULLETIN No. 35.
GIFFORD PINCHOT, Forester.

EUCALYPTS CULTIVATED IN THE UNITED STATES.

BY

ALFRED JAMES McCLATCHIE, M. A.,
Agriculturist and Horticulturist of the Arizona Experiment Station, Phoenix, Arizona.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1902.

FIGURE 21. A.J. McClatchie on *Eucalyptus* cultivated in the United States (1875).

FIGURE 22. *Eucalyptus* grove in California, a remnant of the heady days of the *Eucalyptus* boom of the late 19th century.

Behr added his voice as well (ironically promoting *Eucalyptus* shingles for their alleged fire-resistant properties! [Leviton and Aldrich 1997:206]). The net result was a speculation boom in *Eucalyptus,* which eventually collapsed in the 1910s, not long after the then-State Forester resigned to take a position in the *Eucalyptus* industry (Clar 1959). A whiff of scandal associated with the latter is addressed by Clar (p. 301 ff.): "It would be improper to debate at the present date that certain persons in an official capacity were deliberately deceitful in overselling the commercial value of eucalyptus. The same can not be said for a few high pressure business men (of the type which are likely to be with us always)."

These early efforts of the California State Board of Forestry were soon curtailed, however, when the Board was disbanded in 1893, with the experiment stations transferred to the University of California (Clar 1959). Support for the Board had waned at least in part as backlash against steps toward forest protection taking place at the national level. The landmark Forest Reserve Act of 1891 gave the President the authority to designate forested reserves from among the public domain. Because no provision was made initially for legally harvesting timber from or grazing livestock in the new reserves, resentment began to swell against the "lock-up" of resources that had previously been widely exploited. Part of the backlash took the form of an effort to reduce the size of the forest reserves, which led the Academy to weigh in with an 1894 resolution in which "the Academy respectfully and most earnestly protests against any such reductions and encroachments, it being a trespass or spoilation of an inheritance which should by every legitimate means be preserved by this generation for those who are to come after us" (quoted in Leviton and Aldrich 1997:347). Suspicion and resentment lingered even after a resource extraction policy developed, with most reserves becoming National Forests in 1907.

In addition to Forest Reserves, several national parks had also been established, starting with Yellowstone Park in 1872. The precedent for lands set aside "to be held for public use, resort, and recreation . . . inalienable for all time" actually occurred eight years earlier in 1864, when President Lincoln granted Yosemite Valley and Mariposa Big Trees to the state of California for public recreation. Yosemite (Fig. 23), accordingly, not only became the first state park in California, but the first such dedication of land in the world. Whitney served on the eight-person commission charged with overseeing the new state park, chaired by well-known landscape architect Frederick Olmsted. Other members of the California Geological Survey did some mapping of the boundaries and potential roads, personally funded by Olmsted. Whitney's main recorded action on the commission, however, was scuttling Olmsted's recommendation for a much-needed access road, which Whitney felt represented competition to his uphill battle to keep the Survey funded (Ranney 1952).

In 1890, just prior to the Forest Reserve Act, additional federal lands surrounding Yosemite state park were set aside as "reserved forest lands" to be managed along park lines (Mackintosh 2000). As with other national parks at the time, the resultant Yosemite and Sequoia National Parks were managed by the U.S. Army (a seemingly incongruous arrangement superbly illuminated by Meyerson [2001]).[2] Yosemite Valley itself remained a state park, but pressure began to develop for "recession," the return of State lands to federal control. This was in large part driven by the poor custodial track record the State had thus far shown, including an 1868 bill to open the valley to 160-acre settlements (leaving Whitney "so disgusted with California that I can hardly stand it much longer" [quoted in Brewster 1909:264]).

John Muir is unquestionably the best known advocate for Yosemite Valley's recession and protection in general, but he by no means acted alone. Several other persons who have played multiple roles in the current narrative were also closely involved, notably Joseph LeConte, David Starr Jordan, Willis Linn Jepson, and William Russel Dudley. In 1892, they joined together with other like-minded advocates to found the Sierra Club,[3] incorporated "to explore, enjoy, and render accessible the mountain regions of the Pacific Coast; to publish authentic information concerning them" and "to enlist the support and cooperation of the people and government in preserving the forests and other natural features of the Sierra Nevada." The Sierra Club was one of multiple citizen groups that formed during the late 1800s which, in the words of Clar (1959:167), "largely substituted through voluntary effort the leadership which government declined to exert."

The first headquarters of the Sierra Club, until 1898, were in the Academy's fine new building on Market Street, perhaps in one of the commercial rooms that had been "offered to scientific societies at moderate rent in accordance with the purposes of Mr. Lick" (Leviton and Aldrich 1997:326). The annual general meeting was held in the Academy's auditorium, with around 250 "members and friends" attending the first general meeting in 1892 (*Sierra Club Bulletin* 1:23). The

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[2] According to Carl Albert Purpus, one of the Brandegee's correspondents, the Army was not always welcoming to botanists: "I had a very bad experience with Capt. Gale who is superintendent of [Sequoia] Park, as he was about ready to turn me and my man, who helps me collecting out of the park, although I had a letter of introduction to him by the General from last year." (letter of 8 Sep 1897, Purpus to K. Brandegee; http://ucjeps.berkeley.edu/Purpus/letters1897.html).

[3] Muir was president of the Club until his death in 1914; LeConte served as a director until 1898 and as co-vice president 1892–1898; Jordan was a director 1892–1903 and honorary vice president 1905–1931; Dudley served as corresponding secretary 1898–1905 and as a director 1898–1909; and Jepson, in addition to being one of the signers of the Articles of Incorporation, was an honorary vice president 1942–1946 (Brower 1951). Whitney was made an honorary member in 1892, Sara Lemmon is listed among the early members, and J.G. Lemmon's lengthy analysis of native conifers was printed in the *Sierra Club Bulletin* (Lemmon 1897).

FIGURE 23. Yosemite Valley looking east toward Half Dome. Photo by the author.

general meeting in 1895 focused on the topic of "The National Parks and Forest Reservations" (*Sierra Club Bulletin* 1:268-269). LeConte presided over the meeting, noting that "The timber of our country is disappearing at a rate which is simply unparalleled in the history of the world" (p. 269). Muir and Dudley (1896) both gave impassioned presentations, praising the efforts of "Uncle Sam's blue-coats" in protecting the national parks (p. 273) in contrast to the destruction still occurring in the state park and the Sierra Reservation. Dudley subsequently prepared a series of "Forestry Notes" for the Club, including a depressing description of devastion wrought by unregulated grazing in the drought year of 1898, coinciding with the redeployment of the army to the

Philippines "leaving the parks to their enemies during the year they needed protection most" (Dudley 1899:292).

Dudley concluded his presentation at the1895 meeting with a call for attention to "the urgent need of a redwood reservation in our Coast Range mountains" (*Sierra Club Bulletin* 1:285). Putting words into action, he subsequently played a founding and leadership role in the Sempervirens Club (Campbell 1913), which was established in 1900 to advocate for the protection of the Big Basin redwoods in San Mateo County. Protection for these magnificent trees had been proposed as early as 1887, in a petition to the State Board of Forestry (Clar 1959). Success was finally achieved in 1902, when Big Basin Redwoods joined Yosemite Valley as a state park.

Dudley was also active in the parallel effort to establish a formal school of forestry in California. His hopes to have such a program at Stanford University were, however, stymied by a "gentleman's agreement" between Stanford president Jordan and the president of the University of California, Benjamin Ide Wheeler, which ceded the right to a forestry department to Berkeley (Wieslander 1965). The call for a forestry program at the University of California goes back to an 1873 address by University president Daniel Coit Gilman, backed by subsequent efforts of Eugene Hilgard as dean of agriculture. The 1891–1892 Biennial Report of the State Board of Forestry had also called for the establishment of a school of forestry in California, but efforts to obtain funding failed in the two subsequent legislative terms. Opposition took the form of such statements as "The school of forestry connected with the State University will accomplish nothing practical. It is not to be trusted with a fund of this kind" (quoted in Wieslander 1965:12). Even without a formal program at Berkeley, the first forestry courses began in 1903, when Jepson teamed up with another professor, Arnold V. Stubenrauch, to offer summer lectures at Idyllwild in the San Jacinto Mountains (Fig. 24).

The preceding efforts combined with others to form an increasing ground-swell promoting the reestablishment of a state board of forestry, both to regulate harvest and to curtail destructive fires. An 1899 meeting in San Francisco brought together delegates from 24 organizations, including the University of California, the Yosemite State Park Commission, the Sierra Club, and various commercial interests such as the Miner's Association. The outcome was the establishment of the California Society for Conserving Waters and Protecting Forests, which, although not immediately successful in re-establishing state protection of forested lands and a school of forestry at Berkeley, provided strong impetus for a growing snowball. The California Federation of Women's Clubs also carried the banner, spearheaded by Sara Lemmon as Chairman of the Committee of Forestry, calling for "the Promotion of Education in General, and the Special Promotion of Forestry" (S. Lemmon 1900).

The dam of opposition finally broke in the 1900s. One contributing factor was the acreage lost to devastating forest fires in 1903 and 1904, evidence that "Public calamity is always more effective in shaping public opinion than stuffy plans" (Clar 1959:183). Equally important was the 1902 election of George Cooper Pardee as governor of California. Often referred to as "the father of natural resource conservation in California" (Clar 1959:185), Pardee stands as California's counterpart to the progressive presidency of Theodore Roosevelt. Unfortunately, Pardee's support of conservation was also a contributing factor to his failure to be nominated for a second term. His relatively brief administration nevertheless saw the re-establishment of a California State Board of Forestry, albeit this time without a botanist. The close ties between state and federal forestry were particularly evident at this time, with Pardee soliciting a recommendation from Gifford Pinchot, first Chief of the National Forest Service (and an "intimate friend" of Dudley [Campbell 1913]), for the reconstituted State Forester position. Pinchot nominated one of his assistants, E.T. Allen, who continued to serve as chief inspector of the National Forest Reserves in California simultane-

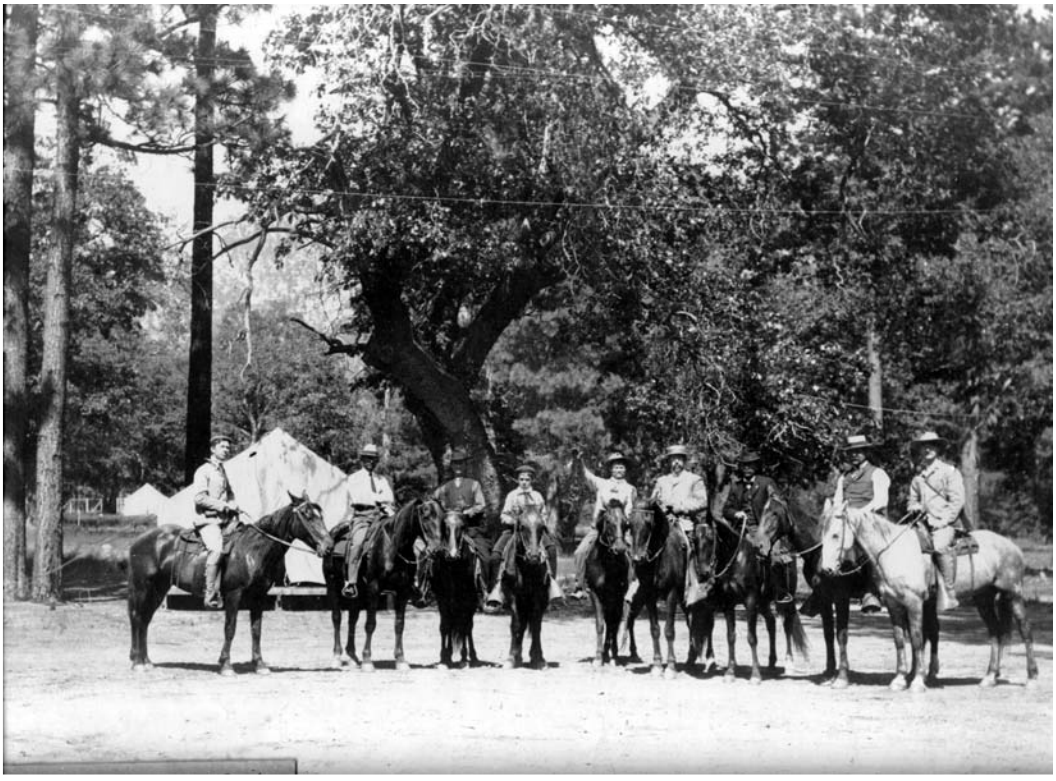

FIGURE 24. Students and faculty at the University of California's forest camp in the San Jacinto Mountains. Jepson is on the far left. Courtesy Jepson Herbarium Archives.

ously with his brief tenure as State Forester (Clar 1959).

The Yosemite Valley question was also settled during Pardee's tenure, aided by a whistle-stop tour to California in 1903 by President Theodore Roosevelt. Benjamin Ide Wheeler, president of the University of California and an active supporter of forest policies in California, was a friend of Roosevelt's from the days when Wheeler taught at Cornell University while Roosevelt was governor of New York. After Roosevelt delivered the commencement address at the University of California, he and Wheeler traveled to Yosemite Valley, there to be regaled by Muir and treated to a night under the towering Mariposa Grove (Finacom 2003). Roosevelt was won over, and Yosemite Valley and the Mariposa Grove were added to Yosemite National Park in 1906. The University's connection to Yosemite was further strengthened when the National Park Service coalesced in 1916, with a UC graduate, Stephen T. Mather, as the first Director.

EPILOGUE

The preceding narrative obviously covers only a subset of the institutions involved in California's natural history, the events that shaped them, and the individuals who played pivotal roles in this shaping. Nor, of course, does the story have an end, though the stopping place chosen here represents a satisfactory hiatus in major developments. A few additional related threads are nevertheless worth summarizing briefly. Sara Lemmon, backed by the California Federation of Women's Clubs, successfully lobbied for the designation of the California Poppy as official state flower, signed into law by Governor Pardee in 1903. Harvey Monroe Hall included Yosemite

National Park within his sphere of interest, producing the first complete flora of the park in collaboration with his wife, the pteridologist Carlotta Case Hall (Hall and Hall 1912). He was also instrumental in establishing a permanent natural area for scientific research, subsequently named in his honor, in the higher regions of Yosemite National Park and adjacent forest land (Babcock 1934). A Division of Forestry was finally established at the University of California in 1914, following heavy pressure by a Forestry Club that Willis Linn Jepson had helped organize (Wieslander 1965). Jepson was also heavily involved in the Save-the-Redwoods League following its establishment in 1919, and his wide-ranging speaking tours were instrumental in obtaining protection for northern California's magnificent redwoods (Beidleman 2000). Alice Eastwood was also a prime mover in the Save-the-Redwoods League, but it was her commitment to Mount Tamalpais that resulted in the honor she most deeply appreciated, in the form of Camp Alice Eastwood (Howell 1954). The Sierra Club's current high profile advocacy tends to overshadow its equally strong tradition of outdoor recreation and education, which in the early days took the form of several-week-long group outings with over a hundred participants. In the 1940s and 1950s these outings served as the setting for a series of Base Camp Botany floristic surveys organized by the California Academy of Sciences. The first ten Base Camp Botany surveys were compiled by John Thomas Howell, Eastwood's assistant and eventual successor, but in 1950 Howell had other commitments. Instead, this function was ably handled by a precocious 14-year-old, Peter Raven, who went on to make his own modest contribution to a diversity of natural history institutions around the world (brief synopsis in Carlquist 1997).

In summary, the present narrative illustrates profusely the extent to which committed individuals, working cooperatively in multiple arenas, are ultimately responsible for creating and shaping the institutions that are subsequently taken for granted. This fundamental reality was well captured by Clar (1959:262) with his statement "It has been observed that the great movement toward the conservation of forest and water resources in California had been pushed along under the goading of a relatively few but nonetheless determined citizens," and more recently by the late Galen Rowell (1997): "One citizen powered by passion tempered with common sense can overcome the complacency of millions."

Acknowledgments

Of the many people who contributed in various ways to the current missive, special acknowledgments are due to Dick Beidleman, for his historical interest in general; Bonnie Gisel, for long discussion on Muir, the Carrs, and LeConte; Joanne Kerbavaz, for background on the California state parks; Mark Largent, for providing access to his valuable manuscript on Burbank, Jordan, and Vernon Kellogg; Edward Martin, for introducing me to C. Raymond Clar's detailed history of the California State Board of Forestry; David Nicolai, Director of the Pardee Home Museum; and George Rushton, for painstakingly tracking down critical records on Kellogg and Harford; Jim Shevock, for the background on Yosemite National Park; Vassiliki Smocovitis, for insights on early biosystematics; Dean Taylor, for discussions on the California Geological Survey; Alan Whittemore, for insights on protobiosystematic developments; and Ellis Yochelson, for much-needed information on Gilman's connection to the Carnegie Institution.

Images, other than those attributed to the author, are from the University and Jepson Herbaria Archives and the Archives of the California Academy of Sciences.

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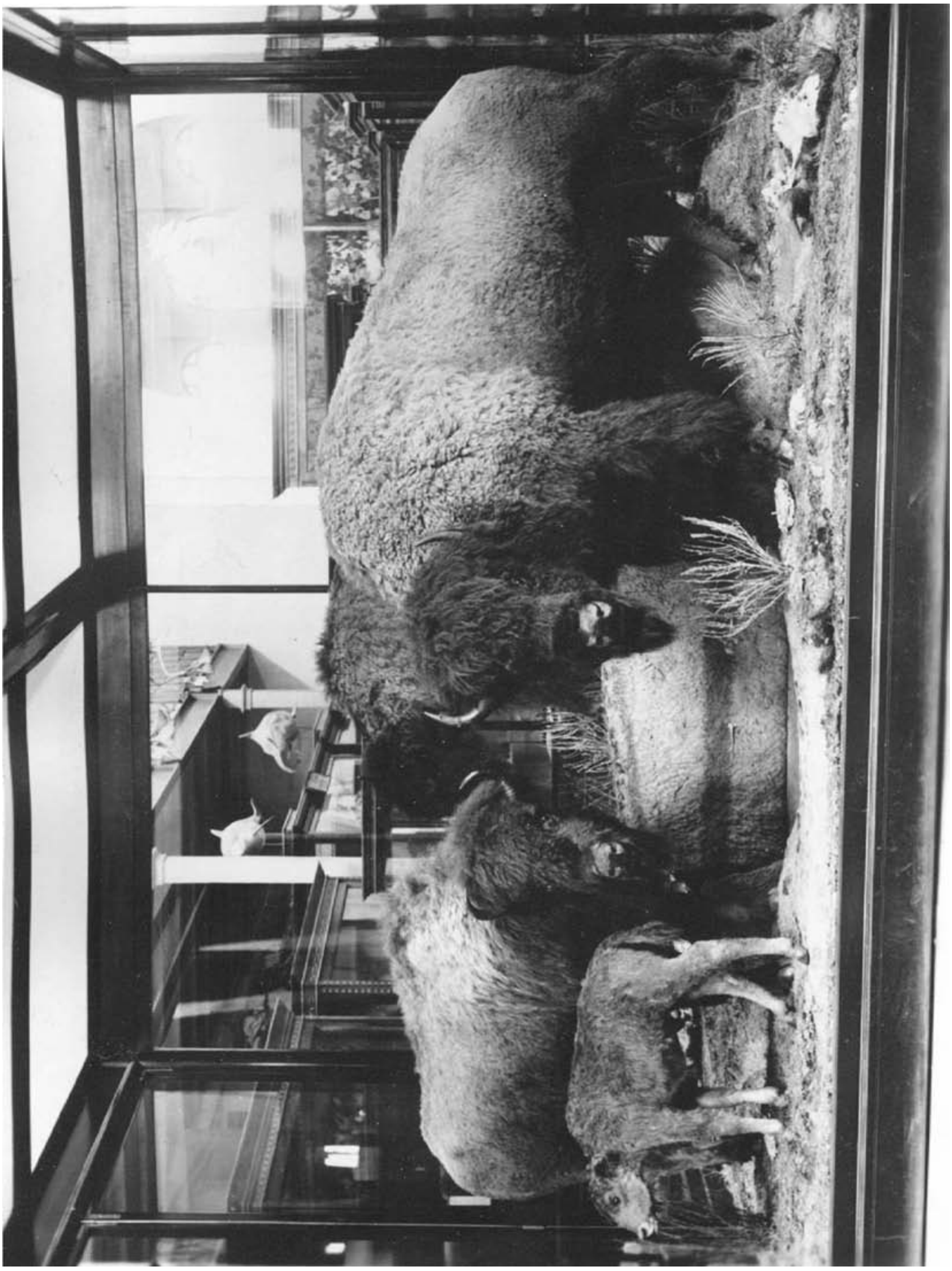

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Skin Deep
Taxidermy, Embodiment, and Extinction in W. T. Hornaday's Buffalo Group

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Perhaps you think a wild animal has no soul,
But let me tell you that it has.
Its skin is its soul; and when mounted by skillful hands,
it becomes comparatively immortal.[1]
— William T. Hornaday, 1887

Prologue: Into the Case

One day in 1957, while working on an exhibit renovation project, curatorial staff at the Smithsonian Museum of Natural History discovered a small metal box embedded inside the floorboards of the so-called Buffalo Group, an eighty-year-old display of American bison slated for destruction later that day (Plate 1). Inside the taxidermic time capsule, the curatorial team discovered a note dated March 7, 1888. The message — signed by William Temple Hornaday (1854-1937), creator of the Buffalo Group and chief museum taxidermist for the Smithsonian Institution between 1882 and 1891 — read as follows:

> To my illustrious successor:
>
> The old bull, the young cow and the yearling calf you find here were killed by yours truly. When I am dust and ashes, I beg you to protect these specimens from deterioration and destruction as they are among the last of their kind. Of course they are crude productions in comparison with what you must now produce, but you must remember that at this time, the American School of Taxidermy has only just been recognized. Therefore give the devil his due, and revile not.[2]

Smithsonian curators savored and saved this note, memorabilia fit for the museum's archives, before dismantling the rest of the buffalo display. But what lay behind the Buffalo Group's taxidermied scenes, and vested within its historical seams, to have motivated its creator's somber mes-

← PLATE 1. The Buffalo Group: Completed in 1888, at the U.S. National Museum, Washington DC. Source: Hornaday, *Taxidermy and Zoological Collecting*, 246.

* This article is based on my manuscript "The Soul in the Skin: William Temple Hornaday and the Construction of the Buffalo Group, 1886–1996." Relevant research was conducted during 1997 and 1998 at the *Office of Smithsonian Institution Archives* (*SIA*), *The Library of Congress Manuscript Division*, *The Library of Congress Photographic and Prints Collections*, and *The New York Zoological Park Archives and Wildlife Conservation Library*. I am grateful for the assistance of staff at these institutions, as well as for funding from *The Charles Warren Center for American History* and *The Alpha Iota Chapter of The Phi Beta Kappa Foundation*. For their comments, criticisms and support, I thank Doug Coffman, Pamela Henson, Katharine Park, and Alan Trachtenberg.

sage? This quandary is the impetus behind "Skin Deep: Taxidermy, Embodiment and Extinction in W.T. Hornaday's Buffalo Group," a case study in the nature and nurture of museum taxidermy and the conservation movement in America.[3]

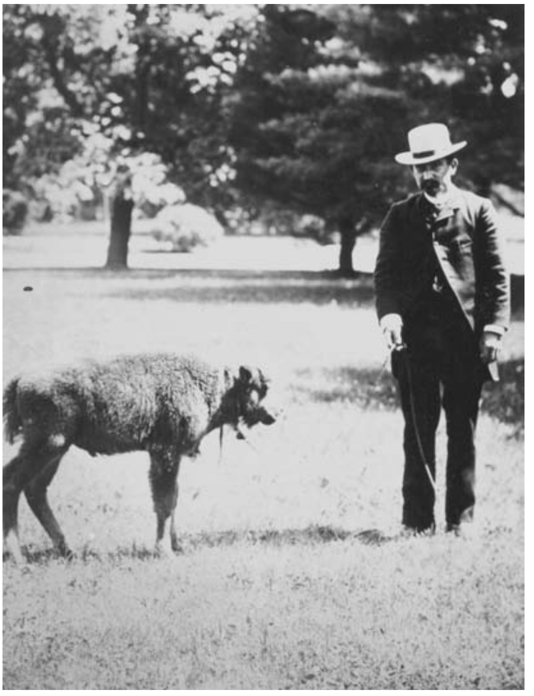

FIGURE 1. William Hornaday and calf at the Castle. Source: Smithsonian Institution Archives (Neg. #74-12338).

Introduction: The Look of Life

In 1899, the United States Government Printing Office published an unusual report. Robert W. Shufeldt's *Scientific Taxidermy for Museums* was the first — and the last — comprehensive survey of American taxidermy.[4] By providing a survey of natural history displays in the nation's museums, simultaneously commenting on the merits and faults of particular styles and artists, Shufeldt sought to elevate the status of the art of preparing, stuffing and mounting animal skins. According to Shufeldt, it should be "the business of the museum to bring whole living sections of nature within its walls."[5] Thus, the reanimation of the museum would require the reinvigoration of its taxidermists and their craft, through which dead creatures might be preserved and turned into appealing exhibits.[6] In Shufeldt's view, traditional museum displays — generally single taxidermied animals placed by curators in sterile white cases — should be replaced by so-called "habitat groups" in which taxidermied animals and simulated habitats were enclosed within four-sided glass cases.[7] Such displays would enliven the turn-of-the-century museum by filling its halls with "the look of life."

One habitat group in particular exemplified what Shufeldt hoped for the future of taxidermy and the American museum. Singling out Hornaday's Buffalo Group, completed eleven years earlier, Shufeldt reported to his readership:

> We have now to notice one of the very finest accomplishments that the art of taxidermy has yet produced in this country. I refer to the case containing the several specimens of our now nearly extinct bison or American buffalo.[8]

Between 1886 and 1888, Hornaday had planned, collected specimens for, and constructed this arrangement of six taxidermied American bison (commonly known, and referred to hereafter, as "buffalo") arranged behind glass amidst a reconstructed piece of the Montana buttes landscape. Drawn to the buffalo as an endangered American hunting target, Hornaday had made a bold move in the Buffalo Group project, turning from exotic fauna (long the mainstay of museum displays) towards native wildlife. In January 1886, concerned about what seemed like the species' imminent extinction, he had presented to the directors of the National Museum the idea of a habitat group to be installed on the ground floor. Unveiled to the public just over two years later, the Buffalo Group exemplified the so-called "New School of Taxidermy" that developed in the 1880s and 1890s.[9] At the same time, his habitat group achieved acclaim for its symbolic role in the buffalo preservation movement, with which Hornaday too would remain involved well into the twentieth century.

The Buffalo Group served as a "taxidermic memorial," both progressive and nostalgic in its simultaneous inscription and erasure of the American wilderness it represented. In this essay, I analyze the late nineteenth-century habitat group's significance through close attention to this particular display's construction, reception and ensuing "life history." As I show, Hornaday's exhibit came to embody attitudes towards material culture and animal conservation characteristic of its author and its era. Thus, I argue that the story of Hornaday's Buffalo Group exemplifies what I develop (here and elsewhere in my work) as the "taxidermic model" of natural and cultural preservation. The "taxidermic model" underlying the Buffalo Group and other habitat groups, lies poised between two meanings of the very word "preservation" — chemical preservation of a single dead specimen and wildlife preservation of an entire living species.

William T. Hornaday: Taxidermist-Conservationist

William Temple Hornaday's early employment as museum taxidermist initiated his interest in the threatened American animal-scapes of the late nineteenth century. Which is to say: his later and enduring passion for saving American wildlife — and for the cause of preservation itself, in museums and later zoos and wildlife refuges — developed out of his background as a museum taxidermist trained to literally "preserve" animal skins.

Though a fulltime taxidermist at the time of the Buffalo Group project, Hornaday was also a lifelong hunter, collector and wildlife lover. In addition, later in life, he would go on to become a zoological park director, environmental activist and prolific author.[10] Born in Indiana in 1854, Hornaday developed a love for animals and hunting at an early age. After working for a small taxidermy establishment in Iowa, he decided to train as a professional taxidermist at the prestigious "Ward's Natural Science Establishment" in Rochester, New York (Fig. 2).[11] Animal preservation — not yet of endangered species but rather of dead individual animal bodies — became his driving passion. This ambiguity — preservation in the senses of both preserving a hunted specimen from decay, and saving a threatened species from extinction, was at the heart of Hornaday's varied career. This ambiguity is also at the heart of the Buffalo Group's story.

During the 1880s, Hornaday developed a strong interest in both the accumulation of exotic animal specimens and these same animals' manipulation through taxidermy. By the early 1880s, Hornaday had undertaken several large-scale collection expeditions to Africa, Asia and South America. At the same time, he created inventive displays of his own design; he constructed habitat groups in which he incorporated taxidermied animals and simulated environments within four-sided glass cases. In his first such display, called "A Fight in the Treetops," Hornaday presented a group of orangutans in a representative Borneo forest canopy (Fig. 3). Such museum displays were innovative since, up to that point, American natural history museums had generally placed a single taxidermied specimen against a solid background, behind only one pane of glass.

By the early 1880s, Hornaday had also helped establish the Society of American Taxidermists (1881–1883), for which he served as both secretary and president. This organization was founded to raise the stature of taxidermy from secretive craft to prominent profession. Members of the short-lived society dedicated themselves to the perfection of taxidermic technique. At the same time, they promoted this uniquely "skin-deep" representational medium as an exemplary fusion of art, craft and science.[12]

By 1882, Hornaday had become a bright name in the growing American taxidermy profession. Later in the same year, the National Museum hired him as its chief taxidermist. To Washington D.C., Hornaday brought an agenda — the incorporation of his new-fangled habitat group concept into the country's institutional showcase for natural and cultural resources.

FIGURE 2. Ward's Natural Science Establishment, Rochester NY, c. 1875. Source: *Ward's Natural Science Bulletin*.

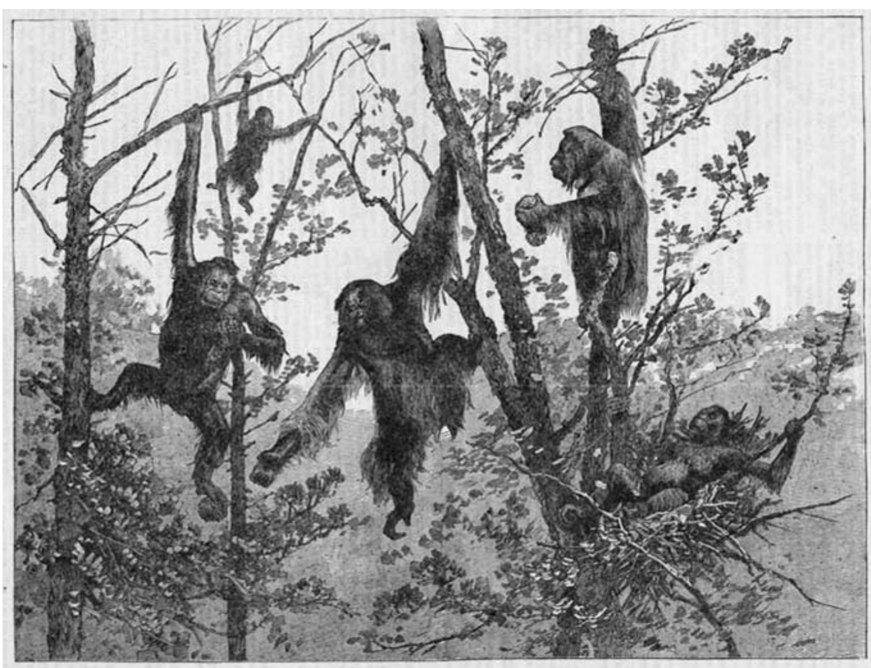

FIGURE 3. "A Fight in the Treetops" by W.T. Hornaday. Source: *Ward's Natural Science Bulletin*.

Where the Buffalo Roam

As Hornaday was well aware, by 1886 — the year he began work on the Buffalo Group project — the previous quarter of the nineteenth century had been marked by rapid change throughout the American West. During these decades, railroad expansion, western migration and military pressures permanently changed the Great Plains (Fig. 4). Once remote areas became easily accessible to sportsmen, commercial hunters and settlers — causing increased hunting, industrialization, and ecological change.[13] Such conditions, among others, wreaked havoc on the North American buffalo population, once numbering thirty million or more.[14] Thus, in the 1870s and early 1880s, buffalo hides filled eastern-bound freight trains throughout the Great Plains. Rotting carcasses and bleaching skeletons covered the buttes and grasslands of Montana, North Dakota and Wyoming. By 1886, some east-coast newspapers reported that the wild buffalo population was down to only eight hundred animals. Others reported a mere handful left (Fig. 5).

During these same years, many Americans — especially urban Northeasterners — grew concerned about the place of both wilderness and national memory in relation to a booming economy and an industrializing landscape. Such individuals felt ambivalent about America's recent rapid expansion. On the one hand, they supported what seemed to be an inevitable march of national "progress," which included the steady conquest — and quite often destruction — of the continent's land and peoples. On the other hand, they longed for the perpetuation of wild spaces available for their own real or imagined use.[15] Theodore Roosevelt, still sixteen years from the American presidency, voiced this nostalgic anxiety in his *Hunting Trips of a Ranchman* (1885). As Roosevelt lamented:

> Gone forever are the mighty herds of the lordly buffalo . . . Now no sight is more common on the plains that that of a bleached buffalo skull; their countless numbers attest to the abundance of the animal at a time not so very long ago.[16]

FIGURE 4. Slaughter of the Bufffalo Along the Kansas-Pacific Railroad. Source: Hornaday, *Extermination*, 392.

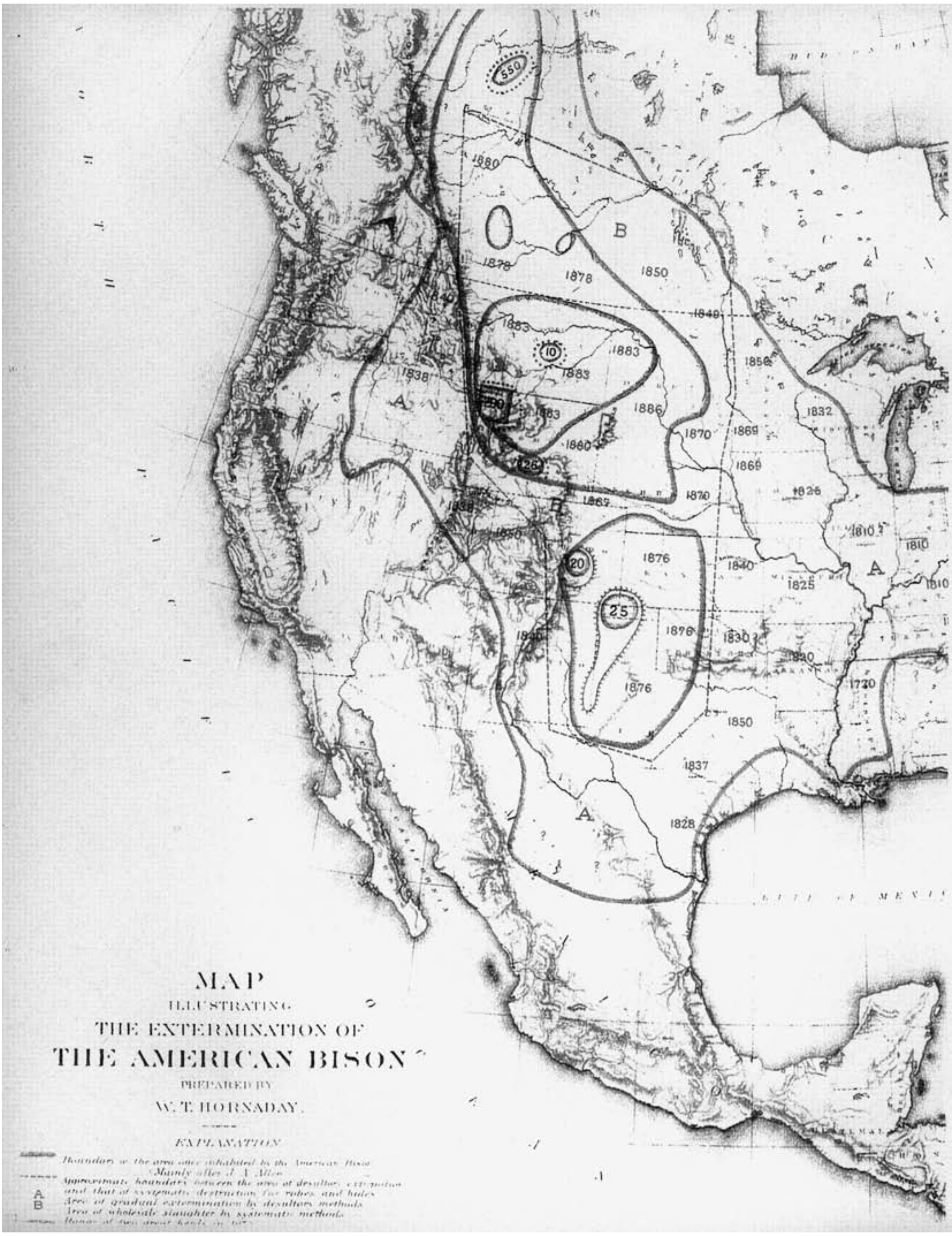

FIGURE 5. Map of the Extermination of the American Buffalo, 1720–1890. Source: Hornaday, *Extermination*, back cover.

In such a cultural climate, the buffalo came to symbolize a particularly American state of wilderness. Sportsmen, naturalists and museum professionals — here Hornaday is a historical case in point — suddenly worried that the buffalo, an animal long considered too ordinary to mount as a museum trophy, would soon no longer exist as a living component of the landscape.

As might be expected, increasing scarcity made the buffalo especially desirable game among trophy and market hunters. Hornaday himself felt certain that the buffalo — at least in its wild state — had reached the eve of its final annihilation. As Hornaday's described the situation at the time: "A buffalo is now so great a prize that extraordinary exertions will be made to find, and shoot down without mercy, the last buffalo."[17] In early 1886, prompted by such anxieties, Hornaday asked the Secretary of the Smithsonian Institution to fund a buffalo collection expedition. In connection with the expedition, Hornaday would compose both a habitat group and a written report for museum publication.[18] As the taxidermist argued: the ongoing slaughter of the buffalo would soon make it quite impossible for the museum to acquire first-rate specimens.[19] Thus Hornaday embraced the notion that he himself, on behalf of the National Museum, should kill some of the last wild buffalo in order to save, which is to say embody, its memory in corporeal form.

In 1886, with Smithsonian financial and institutional support, Hornaday organized two buffalo collection expeditions to Montana — in his estimation, among the last areas containing a sizable population of wild buffalo. In the spring and fall of that year, he and a small crew traveled around the Buttes in the eastern part of the state (Fig. 6), collecting specimens and props for the Buffalo Group. The expedition took back twenty-five buffalo in all — twenty-four dead and one live calf named Sandy. The team also collected Montana sod, grasses, rocks and fossils.

Back at the museum, Hornaday scrutinized the animal specimens, alongside his field measurements and sketches, in order to determine those ideal for museum encapsulation. He finally chose six exemplary specimens — a massive bull, a hefty cow, a smaller cow, a young spike bull, a yearling, and a suckling calf.

By the end of 1887, Hornaday had begun the yearlong process of design, construction and installation of the Buffalo Group. To this end, he mounted the six chosen buffalo and placed them in a quasi-realistic environment, complete with the accessories imported from Montana. Hornaday then arranged the animals around a pond rendered in glass and wax. Finally, he enclosed the ecological unit thus formed within a four-sided sixteen-by-twelve-by eleven-foot glass and mahogany case (Plate 1).

Although Hornaday kept the construction of the Buffalo Group from public view, interest never waned along the way. Throughout the winter of 1888, guides led curious visitors

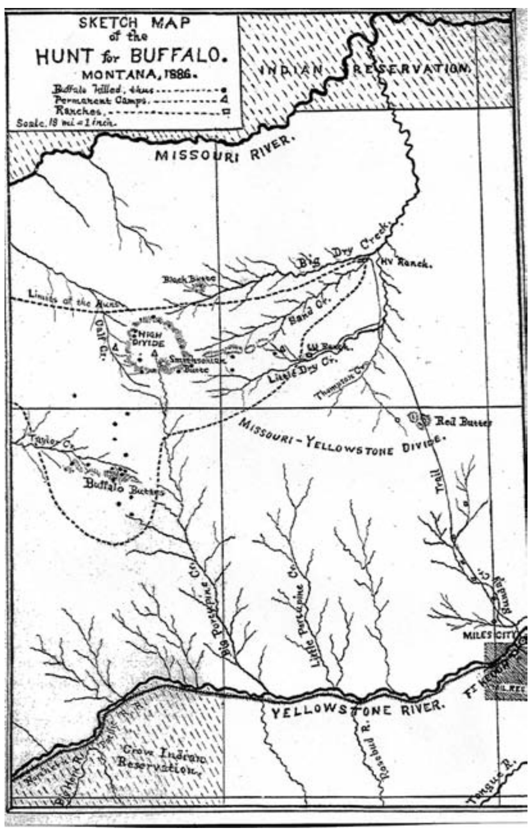

FIGURE 6. Sketch Map of the Hunt for the Buffalo, 1886. Source: Hornaday, *Extermination*, 534.

around the curtained outskirts of the construction. Finally, in March 1888, before a delighted public, the National Museum lifted the screen surrounding the completed Buffalo Group. On the same day, a popular Washington newspaper ran a photograph with the following caption:

> A scene from Montana — Six of Mr. Hornaday's Buffaloes form a perfectly picturesque group — a bit of the Wild West reproduced at the National Museum — something novel in the way of taxidermy — Real buffalo-grass, real Montana dirt, and real Buffaloes — All carefully cut out and brought to the museum.[20]

Scientists as well as lay people recognized that the Buffalo Group was innovative in both design and effect. Before Hornaday's work developing habitat groups, scientists and museum affiliates had tended to reject such environment-inclusive taxidermy displays. But the Buffalo Group project brought the habitat group idea into a scientific and educational context, thereby replacing the traditional taxidermy museum mount with a naturalized mîse-en-scene. Indeed, even before the first public viewing, curators at the rival American Museum of Natural History had already begun rallying for funds to build his own buffalo habitat group in New York City.[21] Meanwhile, the National Museum's director hailed the Buffalo Group as a "true triumph of the taxidermist's art."[22]

Embodying Extinction

To the casual museum visitor, as well as the journalist quoted above, the Buffalo Group might have appeared to be a straightforward reproduction of American wildlife, what the *Washington Star* called a "bit of the Wild West." But the Buffalo Group was certainly not *literally* a genuine piece of the prairie. Hornaday's design had to be both exquisitely crafted and carefully executed to make the dead buffalo in a glass box evoke living buffalo in the wild. And to this end, the Buffalo Group's realization required a complicated set of technical, scientific and philosophical decisions by the taxidermist. Complex material and intellectual processes led up to the exhibit's realization. Meanwhile, specific notions of idealization, preservation and conservation became embedded in the material and discursive interstices of the Buffalo Group.

In the Buffalo Group, Hornaday designed and fabricated an ideal section of representational ground.[23] The taxidermist's aim: to condense the essence of the buffalo's once expansive range into the area of a glass museum case.

In *Taxidermy and Zoological Collecting* (1891), Hornaday described the Buffalo Group's construction in order to elaborate his general principals of taxidermy and museum display.[24] In a chapter entitled "General Principles of Group Making," Hornaday supported the careful choice and arrangement of accessories "for the best artistic effect."[25] Mounting and posing of animal specimens should begin only after basic design issues has been settled.

To convey the buffalo's perfected habitat, Hornaday took everything from the buffalo specimens to sod pieces out of their original locations in space and time. However, since — at least in Hornaday's opinion — typical plots of land in the Montana Buttes territory were aesthetically bland, he collected animate and inanimate specimens from a variety of sites throughout Montana. Eventually he would alter the various found objects and insert them into an idealized space that corresponded to no actual location in the American West.[26]

Not all taxidermists of the period shared Hornaday's idealizing approach to museum display construction. Some struggled to recreate as exactly as possible a particular plot of nature's geography. One example was Jesse Richardson, Hornaday's contemporary and a taxidermist at the American Museum of Natural History in New York. As described in *Scientific Taxidermy for Museums* (1899), Richardson, as opposed to Hornaday, chose to:

> select a given spot of wilderness ground of precisely the same area [as the exhibit space will be] . . . and reproduce only such materials as are found on that particular square of mother earth.[27]

Thus in his version of the habitat group, Richardson aimed to faithfully reproduce the appearance of a specific plot that he had surveyed, recording its exact perimeter and contents in field photographs. Hornaday, by contrast, demanded the careful construction of an ideal space that was entirely outside any "particular square of mother earth." Found nature would be subordinated to an idealized "look of life," the goal, according to Hornaday, of all great taxidermists.[28]

Of course, the Buffalo Group's overall "look of life" would depend most of all on the dynamic qualities of its six animal inhabitants. In planning for the Buffalo Group, Hornaday first killed a small herd's worth of Montana buffalos and then proceeded to hollow out their bodies. His purpose was to make room for his version of idyllic American buffalo-hood.

Hornaday mounted the chosen six specimens using his so-called "clay manikin process." This process, unlike the more primitive taxidermic techniques of the eighteenth and nineteenth centuries (the "rag and stuff method"), did not use the animal skeleton for structural support.[29] Instead, in line with the new taxidermy, Hornaday eliminated the vast majority of the actual animal body in his finished work.

Hornaday's manikin method not only limited the technical difficulties of the mounting, but also made taxidermy almost entirely a matter of what Hornaday called "artistic sense" and anatomical re-creation. After disposing of the specimen's bones and innards, Hornaday then removed and preserved the fur-coated skins. While treating the pelts, he was careful to either clean, or else cut around, bullet holes and bloodstains, thereby wiping away any visual traces of violent slaughter. Next, Hornaday set to work on the construction of the form itself. To this end, he created a plaster cast of the idealized buffalo body shape, using a wooden frame wrapped in rope as a foundation (Fig. 7). This cast, called the manikin, was then coated with textured clay (Fig. 8). According to Hornaday, the successful manikin would always surpass the original, organic, animal body in both appearance and endurance. He explained in his manual that:

> It is impossible for any taxidermist to stuff a buffalo skin with loose materials and produce a specimen which fitly represents the species. The proper height and form of the animal can be secured and retained only by the construction of a statue to carry the skin . . . The term manikin is this made-up figure of an animal over which a skin is to be adjusted; [it is] made to counterfeit the actual form and size of a living animal.[30]

Ironically enough, in the construction of the Buffalo Group, the "real" Montana animal was hollowed out to "secure the precise artistic effect that was intended in the design" for the artificial ideal.[31] The manikin thus became a "counterfeit" form, "made-up" — through care and skillful craftsmanship — to surpass the original.

Idealization in the habitat group, according to Hornaday, extended from the calculated fiction of the counterfeit bodies, to the pelts that would drape them. After completing the manikins, Hornaday attached authentic buffalo skins to the sculptural pieces he had created. Each of the six buffalo whose skins appeared in the Buffalo Group should, he thought, stand as perfect representatives for every buffalo of their type that had ever lived. Assembled together, they should represent far more than just a single cluster of dead buffalos. Rather, these buffalo should constitute a perfected vision of the species as a whole — the "spirit" of the buffalo in the wild.

During his expedition to Montana in 1886, Hornaday and his team had collected twenty-five buffalo specimens of varying sexes, ages and statures. Upon returning from the 1886 Smithsonian collection expedition, Hornaday was very proud to report: "It may be fairly represented that the

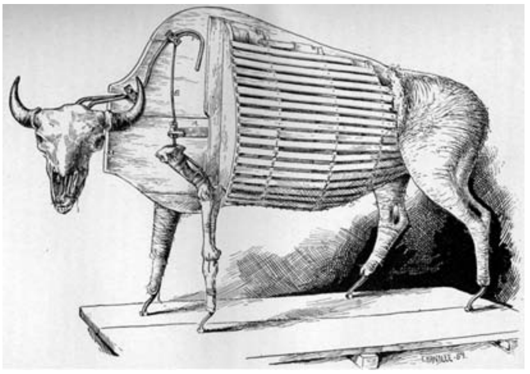

FIGURE 7. Manikin for Male American Buffalo: In Process. Source: Hornaday, *Taxidermy and Zoological Collecting*, 152.

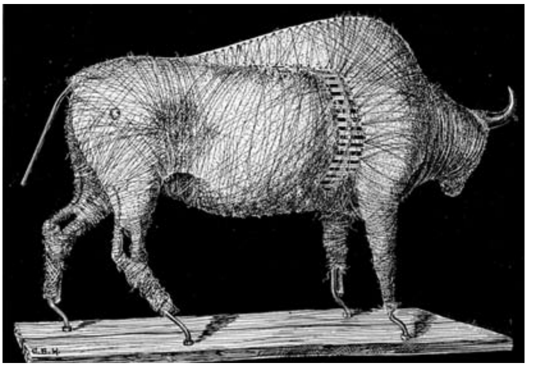

FIGURE 8. Manikin for Male American Buffalo: Completed. Source: Hornaday, *Taxidermy and Zoological Collecting*, 156.

specimens taken by the expedition were in every way perfect representatives of the species."[32] When Hornaday was back at the National Museum, he scrutinized these twenty-five specimens alongside the measurements and sketches that had been produced at the site of their individual deaths in order to determine the most perfect of the "perfect representatives." Hornaday chose a massive bull, a hefty cow, a smaller cow, a young spike bull, a yearling and a suckling calf.

Of the six chosen exemplars, Hornaday considered the large male buffalo specimen the most perfect of all (Fig. 9). The large male buffalo specimen would stand at the center of this vision. According to Hornaday, the bull's perfection inhered in his massive size and strength. Hornaday described him as "the giant of his race . . . believed to be the absolute largest specimen of which there is an authentic record."[33]

FIGURE 9. The Perfect Representative: Head of the Buffalo Bull, Model for the National Park Service Seal. Source: Hornaday, *Extermination*, 382.

The other five specimens, all females and youths, flanked the big bull, positioned so as to accent the bull's size and power.[34] To be sure, the bull buffalo did eventually acquire the sort of iconicity for which Hornaday had hoped. Indeed, in the 115 years since the Buffalo Group's unveiling, portraits of this same bull have adorned buffalo nickels, buffalo bills and buffalo postal stamps; his silhouette graces the current seal of the National Park Service.

Hornaday posed his buffalo posse around an artificial alkaline pool of his own construction. As in his design of the Buffalo Group overall, in creating the artificial alkaline pool, Hornaday manipulated the viewer's perception of the display's material dimensions. He recounted proudly in *The Extermination of the American Bison* that "the pool is a glassy delusion, and very perfect in its way."[35] By using several layers of glazed glass and coated wax, he created an effect of depth far greater than the model's actual dimensions (see Plate 1). In the result,

> one sees a plant growing beneath the water and in the soft, oozy bottom near the edge, are the deep prints made by the fore feet of a big buffalo bull.[36]

After creating the interior of the ideal outdoor scene, Hornaday provided his buffalo with a protective enclosure, a four-sided glass and mahogany case. Early museum display cases (those in general use before the 1880s), had only one or two transparent walls.[37] Hornaday's introduction of the four-sided glass case for the Buffalo Group created an additional compositional requirement; the animals must come to life from all possible perspectives, and not only from one side.

Once the case was in place, the glass panes locked the animals in and the observers out. The glass partition created a spatial boundary between the viewer and the viewed. This break between observer and observed strengthened the resulting sense of two separate realms — of lay-reality and pristine nature. Within the interior realm, Hornaday positioned the animals so that their expressions — the sparkling alert eyes of the mother and father especially — would lure the observer into the quiet drama of the scenic moment (see Plate 1).

The glass partition of the vitrine created not only a spatial, but also a temporal barrier between the viewer and the viewed. Holden Caulfield, of J.D. Salinger's *The Catcher in the Rye*, pointed out that the passage of time that occurs for the museum visitor is entirely out of sync with the time understood to be operative inside the display case. For the adolescent Caulfield,

> The best thing about the museum . . . [is that] everything'd stay right where it was. Nobody'd move . . . The only thing that would be different was you.[38]

As Salinger's character articulates, the everyday life of the museum visitor passes moment by moment. Spatial and material changes mark temporal progression. The six buffalo of Hornaday's group, by contrast, are caught forever in an imaginary moment of time on the Montana prairie. A single moment is eternalized behind the glass — illustrating an impossible but convincing version of the exterior world.

In Hornaday's Buffalo Group, the temporal fantasy ultimately extended further and deeper — to embrace not only idealized stasis but also the unrealistic — and specifically anachronistic — relations between the objects within the case. In *Taxidermy and Zoological Collecting,* Hornaday admitted that the six buffalo specimens on display, aside from being collected at different sites, were shot at different times of year and therefore appeared in seasonally incongruous fur phases.[39] Although the buffalo calf and yearling specimens obtained in the spring of 1886 were in perfect condition, according to Hornaday, the adult specimens had begun to shed their winter pelage; consequently the adults' skins were "unfit" to mount.[40] As a result, Hornaday had to return to the field in the fall to collect adults in the finest and firmest period of their fur. Hornaday strongly defended this choice, contending that:

> No matter what hypocrites may say, do not hesitate to perpetrate an anachronism by taking adult specimens later in the season, when their fur is at its best.[41]

Thus, Hornaday constructed a group of animals that could never have existed simultaneously in their current forms, displacing them from seasonal and spatial origins.

Notably, throughout his taxidermic process, Hornaday vehemently rejected the use of photography. He argued that photographs taken in the wild, whether of live or dead animals, were of minimal use to the taxidermist precisely because photographs were too tightly bound to an actual place and time. In Hornaday's view (disputed by some of his colleagues), the photograph would always fail to elucidate the very points which taxidermists considered to be important.[42]

In contrast, to the photographer, the taxidermist was not trying to represent, or even memorialize, the dead animal as it actually was. The taxidermist aimed to present the living animal in an idealized setting. In contrast, instantaneous photography, developed in the late nineteenth century, did exactly the opposite, capturing only a single moment and locale. Instead of making photographs, Hornaday recommended field sketches, which would allow taxidermists to pick and choose exactly the sort of reality they wanted to transport back to the studio for transformation into a taxidermic moment. As a local newspaper would report just days before the Buffalo Group was unveiled for public viewing:

> It is as though a little group of buffalo that have come to drink at a pool has suddenly been struck motionless by some magic spell, each in a natural attitude and then the section of prairie, pool, buffalo and all had been carefully cut out and brought to the National Museum.[43]

The "magic spell" had been cast by the crafty hand of the illusionistic taxidermist.

The Whole Story

Hornaday's habitat groups, and the Buffalo Group in particular, situated themselves between scientific "critical scrutiny" and mass appeal through the telling of a particular kind of "story." As *The Washington Star* would report:

> The [Buffalo] group with its accessories has been prepared to tell in an attractive way to the general visitor to the museum the story of the buffalo, but . . . at the same time to secure an accuracy of detail that will satisfy critical scrutiny.[44]

Hornaday's colleagues and followers also used the word "story" to describe their constructions. In the *Story of Museum Groups* (1922), an informational pamphlet for visitors, Frederic Lucas, director of the American Museum of Natural History in the 1910s and 1920s, described the construction of Hornaday's Buffalo Group in just such terms. Lucas, like Hornaday, approved of anachronistic depictions of nature for the sake of the story. As Lucas wrote:

> The habitat group thus involves a slight departure from nature . . . May we combine animals from different localities, or show together those taken at different seasons? Personally the writer believes that all these things are permissible . . . in no other way can you complete the life-cycle and tell the whole story of the buffalo.[45]

But what kind of "whole story" was this?

When Hornaday and his colleagues referred to such stories, they do not refer to a linear narrative containing a beginning, middle and end; after all, such a structure would defy the habitat group's quality of cyclicality. Nor is the habitat group story a baseless tall-tale. Rather, the taxidermists' allusion to "story" refers to a molding of shape, narrative and moral design. The prominence of the "story" concept also underscores their celebration of taxidermic artistry and craftsmanship.[46]

Hornaday claimed that each taxidermy display should teach "a number of little facts" to the viewer about the displayed species — for example its characteristic appearance, habitat and social structure.[47] The Buffalo Group's story was the result of such conscious distillation and presentation of idealized habitat and pedagogical message. In his opinion, the Buffalo Group taught specific facts regarding the buffalo's ideal size and presented typical elements of the Montana Buttes in a condensed landscape.

But these pieces of specific information did not exhaust the factual content of the habitat groups in general. In his *Taxidermy and Zoological Collecting,* Hornaday described many of the general facts he had embedded in his "Squirrel Triptych," a three part habitat group completed at the Smithsonian just after the unveiling of the Buffalo Group. The Squirrel Triptych display presented the squirrel in three distinct incarnations. Representations of the squirrel's fall, winter and spring habitats were separated by panes of tinted glass. According to Hornaday:

> Besides teaching what the nesting habits of the gray squirrel are, [the Squirrel Group] also impresses upon the observer the very important fact that the habits of different individuals are capable of very wide variation. It shows how dangerous it is for a student or scientific investigator to generalize too freely from one or two facts, and that it is dangerous for anyone to say what an animal will NOT do![48]

In another passage, Hornaday instructs taxidermists that habitat groups should convey lessons about scientific method and appropriate field observation techniques. He specifies that "the design [of the habitat group] must be dominated by one central idea of purpose, which should never be lost sight of in the construction of the group."[49]

According to Hornaday, the habitat group should teach not only about natural history and scientific observation, but also about aesthetics, morality and gender roles; it should teach lessons about human, as well as animal, behavior. Hornaday contended that in any large mammal habitat group, animal poses should be perfectly timeless and peaceful. Taxidermists should not sculpt eternal moments that depict climaxes of violence or love-making; instead they should present the complacently domestic within the museum case. Hornaday suggests in *Taxidermy and Zoological Collecting* to "represent every-day, peaceful home scenes in the lives of your animals . . . . anything but fighting, leaping and running."[50] He later compares the tranquility that should be created in the mount, with the peace that should be cultivated in the museum itself, asserting that "in a well regulated museum, no fighting is allowed."[51] Hornaday's statement presents a critical double meaning. The actions that Hornaday prohibits in his taxidermied specimens are the very same actions that would be prohibited outside the glass fantasy — in the realm of the museum itself.

In the Buffalo Group, then, Hornaday crafted a moral education as much as an education in natural history. His exhibit might be interpreted as, among other things, a moral lesson in the naturalness of patriarchy. Although the male and female are both central in the Buffalo Group, the male specimen is the focus of the display, as well as of the overall project. Hornaday posed the six buffalo specimens so as to create a buffalo family portrait in which the male would occupy the highest and most prominent position. He posed the dominant bull so as to exaggerate his size and girth in comparison to the other specimens. Thus, *The Washington Star* would report, "it is around this great bull that the romance of the group centers."[52] Modeling the habitat group after an ideal Victorian American family, Hornaday reinforced the very conventions upon which he drew, thereby naturalizing the patriarchal structure of the idealized nuclear family.[53]

Hornaday and his colleagues also inserted a morality of "fairness and justice" into the rhetoric of taxidermy. In their opinion, to create a display that does justice to a notable species, the taxidermist must conceal the peculiarities of a particular specimen.

> Unless the individuals of a given species are always scrawny, I pray you for the sake of truth and justice, do not make your solitary representative of that species look like a candidate for special honors at a bone-yard.[54]

Hornaday claims that his artificial manipulations of actual organic form are "for the sake of truth and justice." If the last buffalo looked dead, then ultimate "truth" would be lost; violence and mortality would triumph.

The habitat group's lessons were aesthetic as well as moral. Hornaday contended that the form, composition and construction of the habitat group's specimens and accessories must be exquisitely balanced. As he wrote:

> It is unnecessary to say that each group should form a perfect picture, compact, well rounded . . . so clearly defined as to leave no room for the suggestion that the specimens have been mounted independently and simply placed together.[55]

Successful taxidermy should seamlessly create the natural rather than reproduce the actual. Nature should be perfected through deliberate modification of particular observations. As Hornaday advised his students:

> Do not make the mistake of concluding that because you have seen a particular animal assume a particular attitude, it is "natural" and that therefore you can do no better than reproduce that attitude. This mistake will lead to the reproduction of many an ugly attitude even though like life itself.[56]

Hornaday thus concludes, definitively, that nature should not be seen when it is ugly. Rather, the taxidermist should select from beautiful poses, even if drawn from the imagination. In the end,

> the choice of an attitude depends wholly on your artistic instincts, "on your eye" so to speak . . . Choose [the pose] which is most graceful or grand and is at the same time truly characteristic of the subject.[57]

The stuffed specimen in the habitat group must be at the same time "most characteristic" and perfect. Natural anomalies and asymmetries would thereby be wiped out resulting in a story of tranquil normalcy.

Hornaday thereby sanctified the natural and domestic human orders, as well as the museum space in conceiving and implementing details of the Buffalo Group. "Seek not to startle and appall the beholder, but rather to interest and instruct him."[58] "Beholding" rather than simply seeing, the museum-goer becomes a participant in a spiritually uplifting experience — the observation of nature distilled and preserved in compressed form.

History, Memory, Animal Reliquary

To create a successful model of the buffalo species for future generations, Hornaday had to fabricate the buffalo's recent history as well as its interiority. As part of this process, this taxidermist-conservationist consciously hid away the real mortality, violence, and space that constituted the buffalo's Great Plains habitat.

Recent scholarship on the relationship between history and memory proposes that in building monuments, human society seeks to rid itself of its obligation to remember the past. Much of this scholarship has tended to address war memorials and commemorative outdoor statuary, and has argued that the reality of the past often becomes buried beneath complex veneers of myth and artifice. As James Young has written, "In effect, the initial impulse to memorialize events . . . may actually spring from an opposite and equal desire to forget them."[59] French historian Pierre Nora made a foundational argument about *lieux de mémoire* (sites of memory), contending that "the less memory is experienced from the inside, the more it exists through its exterior scaffolding and outward signs."[60]

Such lines of inquiry can well be brought to interpretation of natural history exhibition space. Indeed, Nora's words bear profoundly on the "exterior scaffolding" of the Buffalo Group. For in mounting each of the six buffalo specimens, Hornaday turned a dead animal — a body whose liveliness had been destroyed by the violence of extermination — into a simultaneously literal and figurative veneer. The Buffalo Group's literal veneer consisted in preserved dead skin laid over plaster manikins. But the figurative creation went far deeper into the object itself, becoming an antidote to both memory and the reality of incipient species extinction.

In constructing the Buffalo Group, I contend that Hornaday aimed to atone for the physical reality of the buffalo extermination he had witnessed (and participated in) on the Montana plains by simultaneously acknowledging and denying it; he wanted to make people forget mortality and violence. The real time and space of the late nineteenth century should be scrubbed clean, supplanted by the glassy perfection of the Buffalo Group.

In 1886 Hornaday and his expedition crew traveled across the Montana Buttes territory, encountering the animal genocide-in-progress. In his 1888 article for *Cosmopolitan Magazine,* he described the actual remains of the extermination; mile after mile of dead carcasses littered the landscape of the West (Fig. 10).

> The bleaching skeletons lie scattered thickly all along the trail. Like ghastly monuments of slaughter, these ugly excrescences stand out in bold relief on the smooth hard surface of the prairie, from the huge bull skeletons lying close beside the wagon trail to those far back in the bad-lands, where they are merely dark specks in the distance . . . They are the only monuments that remain to the American bison.[61]

Hornaday's words here describe a horrific diorama — what he calls a "bold relief." His vivid observations might have inspired a different kind of museum display — one that more accurately captured the habitat he had witnessed. But such found images — snatched out of Hornaday's actual experience — evoked cruelty and extinction rather than livelihood and perfected nature. Indeed, the buffalo bones and rotting carcasses exposed the ugly interior of the slaughtered animals. And to be sure, such untreated corporeal remains — the "only that remain[ed]" before Hornaday's project, were transient as well as sinister. Unlike the well-preserved taxidermic sculptures of the Buffalo Group, buffalo carcasses in the wild would soon decompose. The real, albeit ghastly, monuments would rot, smell and then disintegrate into nothing. Hornaday asserted that "in a short time, even the bones will all be gathered and nothing whatever will remain save what can be found in the museums, the zoological gardens or the tertiary deposits of the earth itself."[62]

Hornaday thus decided to supplant these natural remains with a work of human art. Through his work as taxidermist, he replaced the natural memorials of the carcasses with the construction of artful relics.[63]

The Buffalo Group then, Hornaday's first major preservation project, required a killing that denied itself. Rather than collecting any of the buffalo corpses lining the railroad tracks, Hornaday's team hunted and killed each and every specimen. In this way, they ensured that the carcasses would bear no visible signs of violence, unlike the "ghastly specimens" already scattered over the fields. Hornaday was most proud of his ability to kill the massive bull. With a shot aimed "squarely through the backbone," he granted his own "wish to bring down a buffalo with a single shot."[64] Hitting this target assured the perfection of the bull's hide; the killing would leave no trace of blood. Only thus could violence be negated in the fantastical world of the glass case.

The perceived importance of national memorialization justified Hornaday's purposeful slaughter. According to one journalist reporting on the expedition: "Bullets found in the Great Bull's body showed that he had been chased and hunted before, but Fate had long preserved him for the immortality of the Museum exhibit."

After the slaughter of the six specimens, Hornaday and his crew collected several dessicated skeletons from the Plains that they later hid within the museum's storage rooms. As Hornaday described, the bones were "cached. . . against the great famine for bison that will soon set in."[65] Eventually these skeletons would either be used by Smithsonian scientists for comparative morphological studies or sent to other museums' research facilities. Next, Hornaday's crew turned to the carcasses of the animals that they themselves had hunted down and collected. Hidden away behind the screens that veiled the construction and installation of the Buffalo Group, taxidermists peeled back, and scrubbed away, all traces of flesh and blood on the skins.[66] Hornaday (and an assistant) flanked the skin-covered manikin with carefully-chosen accessories of its imagined envi-

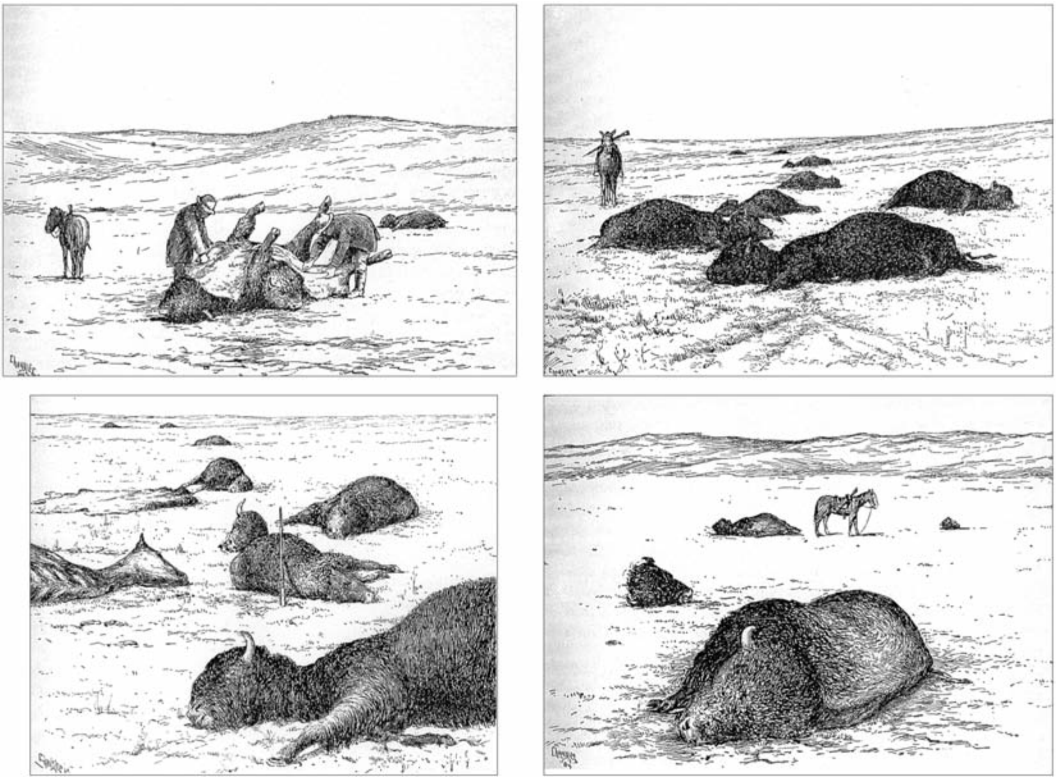

FIGURE 10. Ghastly Monuments: Scenes on the Northern Buffalo Range, c. 1875, after photographs by L.A. Huffman. Source: Hornaday, *Extermination*, 534.

ronment. Nascent memories of extermination having been swept away, finally all was encased in a world of glassy fantasy. As Nora suggests in his discussion of French public monuments:

> Memory had been wholly absorbed by its meticulous reconstruction. Its new vocation is to record . . . it sheds its signs upon depositing them there, as a snake sheds its skin.[67]

Taxidermy literalizes Nora's metaphor of the shedding of the skin. In the Buffalo Group, as it appeared in 1888 at the National Museum, the horrors of the hunt had been well-hidden. Instead of displaying the relics of the actual slaughter — these being the bones and innards of dead animals — Hornaday's killing of the buffalo specimens became an affirmation of life itself. Through the buffalo's meticulous, taxidermic reconstruction, death was transformed — nature rendered in glassy perpetuity.

As a concerned sports-hunter and museum professional, Hornaday reacted to the depletion of the buffalo — which he himself attributed to excessive hunting — by deciding to seek out and kill several of its remaining specimens. The notion of killing a species to save it, today seems quite puzzling — even ironic. Yet the practice made sense within Hornaday and the Buffalo Group's milieu. The drive to memorialize threatened natural resources justified — and indeed necessitated — the killing of specimens.

Thus, by constructing the Buffalo Group, Hornaday saw himself — as others saw him — as atoning in small part for the devastating slaughter of the buffalo that had occurred over the preceding century. This notion of atonement, central to his and his peers' later conservation efforts, and detailed elsewhere in my work, emerged from the same tenets he propounded as professional taxidermist.[68] In his 1891 treatise on the art of taxidermy, Hornaday counseled his readership: “if you really must kill all the large mammalia from off the face of the earth, do at least preserve the heads that are brought low by your skill and powers.” And as he reiterates: “If you must go and kill things, saves their heads and mount them, as atonement for your deeds of blood.”[69]

Like other prominent naturalists and taxidermists of the late nineteenth century, Hornaday felt strongly that taxidermy might preserve a representative remnant of a vanishing species for posterity. Losses effected through conquests of native nature and culture could be replaced by convincing taxidermied specimens. Evanescent creatures might thereby remain safe for years to come, memorialized in a visually accessible form. Hornaday expressed this sentiment when he addressed his readers later on in his taxidermy treatise. As he wrote:

> Perhaps you think a wild animal has no soul. But let me tell you that it has. Its skin is its soul. And when mounted by skillful hands, it becomes comparatively immortal.[70]

However, to be effective, taxidermic preservation must be exquisitely designed and crafted for endurance.[71] As Hornaday advised in *Taxidermy and Zoological Collecting*:

> A preserved and mounted animal that has not enough solidity and stability to stand the test of time is unworthy of a place in any museum, for its existence is sure to terminate speedily — in disappointment, disgust and loss.[72]

Deterioration of the habitat group would disable its function as a permanent embodiment of space, time, and species. Years would wash over the finished specimen; cracks and seams would begin to show through the skin. Without proper care, he suggests:

> its sides will be a succession of hills and hollows, its seams will be ripped and gaping wide open, its nose will be shriveled up and shapeless, its ears will look like dry autumn leaves. It will lean over to one side and will also have settled down upon its feet until they are shapeless deformities.[73]

The mistreated specimen returns from a state of glassy perpetuity to one of tragic mortality; perceived as “ripped,” its component parts “gape wide open.” In his manual, Hornaday warned that “dishonest or careless taxidermy work [is] like murder.”[74] Without the taxidermist-given (rather than God-given) gift of incorruption, taxidermied form “shrivels” and evolves into formlessness. Sculpted perfection becomes “ripped. . . . gap[ing] . . helpless and disordered.”

Conclusion and Epilogue: Old Skins and Fresh Meanings

Thus, in the eyes of many late-nineteenth-century taxidermists and museum-goers, the Buffalo Group, once properly assembled and installed, would present an arrested version of wild nature — of the wild animal in its purest form, simultaneously idealized and immortalized. Thus did killing and stuffing animals seem to provide a virtual salvation.

To be sure, in the decades following1888 and indeed well into the twentieth century, Hornaday brought this taxidermic model of preservation to bear on the development of displays and enclosures at various zoological parks and wildlife refuges the world over. He applied ideas generated during the Buffalo Group project, to his work for the National Zoo, the New York Zoological Park, the American Bison Society, and both the Wichita and National Bison Ranges. And more broadly as well, taxidermic production and discourse in the late-nineteenth century influenced the development of the American conservation and environmental movements. In particular, as I show elsewhere, Hornaday’s taxidermy work impacted profoundly his development of zoological parks and wildlife refuges in the twentieth century.[75]

Like Hornaday's own career, and like the live buffalo population (which, after recovering by the 1930s, continues to skyrocket into the twenty-first century [Fig. 11]), the Buffalo Group itself did not stand still in the twentieth century. Its journey through space and time has continued into the present day.[76] Hornaday's Buffalo Group remained on display at the Smithsonian for sixty-five years after its first unveiling in 1888. From 1911 until 1955, the Buffalo Group occupied a central position on the ground floor of the National Museum of Natural History, across the Smithsonian Mall from its original location at the Arts and Industries Building. For these forty-four years, the Buffalo Group's massive mahogany case rested to the left of the Museum's ground-floor entryway. Its six taxidermied buffalo inhabitants gazed out through glass eyes at arriving museum visitors. All the while, their living, breathing counterparts — that is, buffalo in the flesh — made a remarkable comeback, repopulating wildlife refuges, zoological parks and private ranches throughout the nation.

But, in 1955, the natural history museum's Mammal Division began a large-scale mid-century modernization project. Curators hoped to update the displays of the larger North American quadrupeds. As part of this project, the Hornaday display would have to be removed — "perfect representatives" and all. On the one hand, the Buffalo Group seemed old-fashioned in style as compared to more contemporary dioramas that incorporated painted composite backgrounds. On the other hand, the skins it contained — its real soul, according to its maker — had not been mounted up to the standards of the 1950s taxidermists. Curators, therefore, replaced the Buffalo Group with a new buffalo diorama, for which they used the fresh pelts of animals recently killed from the National Bison Range, which Hornaday had himself helped establish in 1908.

While workmen were dismantling the great mahogany case, they discovered the metal box, Hornaday's time capsule, buried in the floorboards. Within was his handwritten plea — "When I am dust and ashes, I beg you to protect these specimens from deterioration and destruction, as they

FIGURE 11. National Bison Range Montana. Source: Author's photograph, June 2001.

are among the last of their kind." The curatorial team saved the note, along with the attached sketches and news clippings. They treasured it with the same fondness they held for its now-deceased author. But they chose not to heed its advice. Preferring new buffalo skins and new ideas, they moved the Hornaday buffalo to the basement and disposed of the case.

Yet these buffalo did not last long in the dusty Washington D.C. basement. Rather they enjoyed a brief hibernation, followed by a major buffalo migration.

In 1958, the National Museum of Natural History shipped the six specimens back to Montana by request of the University of Montana at Missoula, which — after a few years — in turn donated these specimens to various sites in the region. The calf and mother cow were soon relegated to a nearby basement storage facility. The Great Bull was sent to the Montana Department of Fish, Wildlife and Parks. Meanwhile, the younger cow ended up underground — in a converted old army bunker in Fort Ellis, just outside of Bozeman.

The monument was in pieces — sent across the country, dispersed throughout the state of Montana. Time and the twentieth century had shattered the idealized material, space and moment of the original Buffalo Group. But in the late nineteen-eighties, an Oregon writer and naturalist named Doug Coffman decided to track down the Buffalo Group's dispersed pieces; his goal was reunification. Coffman had fixated on Hornaday's lost display as a symbol of both the recovery of American buffalo — already numbering in the hundreds of thousands — and the birth of the conservation movement. Over the next four years, he located all six specimens. Coffman began to plan for their reassembly at the Montana Agricultural Museum in Fort Benton, just miles from the Buttes where Hornaday had collected the same buffalo over a century earlier.

To pay for the planned restoration and homecoming, Coffman and the Fort Benton museum commissioned bronze miniature casts of the once-unified Buffalo Group. Using funds from their sale, the team hired a crew of taxidermists to "restuff" the six old buffalo, using new manikins and restored glass eyes. The Buffalo Group's original accessories, long since lost, were matched to similar rocks, shrubs and sod collected in and around the Buttes.

In June of 1996, the ribbon-cutting ceremony took place in Fort Benton. The resurrected taxidermy group stands today in a special new wing of the small museum (Figs. 12–13). The exhibit hall is heated year-round for the comfort and longevity of the Buffalo Group, whose specimen and accessory arrangement almost perfectly match those in the 1888 photographs and description. Unlike the original Buffalo Group, the resurrected version is in open air; the glass of Hornaday's case has completely disappeared. The six buffalo specimens rest on an eight-sided pedestal. Steel guard-rails, rather than glass walls, prevent collisions between human and animal.

No longer a national monument to loss, the Buffalo Group has become a regional monument to recovery. Thus do taxidermied landscapes and life-scapes come to be refigured in space and time. Old skins are refitted with fresh meaning.

FIGURE 12. Renunited Buffalo Group: Museum of the Northern Great Plains and Montana Agricultural Center. Source: Author's photograph, June 2001.

FIGURE 13. Details of Hornaday's Buffalo Group. Source: Author's photographs, June 2001.

Notes

[1] William T. Hornaday, "The Passing of the Buffalo," *Cosmopolitan* 4 (October 1887):51–89, 85.

[2] Letter reproduced in Doug Coffman, "William Hornaday's Bitter Mission: The Mysterious Journey of the Last Wild Bison," *Montana Magazine* (February 1991):59–71, 63.

[3] Some of the cultural histories and meanings of twentieth-century taxidermic production have been explored in Donna Haraway's "Teddy Bear Patriarchy," in *Primate Visions: Gender, Race and Nature in the World of Modern Science* (New York: Routledge Press, 1989): 26–58; also Susan L. Star's "Craft vs. Commodity, Mess vs. Transcendence: How the Right Tool Became the Wrong One in the Case of Taxidermy and Natural History," in *The Right Tools for the Job: At Work in Twentieth Century Life-Sciences,* ed. Adele Clarke and Joan H. Fujimura (Princeton, NJ: Princeton University Press, 1992): 257–287; and Marc Simpson, "Immaculate Trophies" *Essays on Canadian Writing 68* (Summer 1999):77–106.

[4] Robert W. Shufeldt, *Scientific Taxidermy for Museums: A Report Based on a Study of the United States Government Collections* (Washington D.C.: Government Printing Office, 1899).

[5] *Ibid.,* 430.

[6] Traditional museum taxidermy, according to Shufeldt, was entirely incapable of such a feat. American museum taxidermists in the early nineteenth century produced drab and lifeless specimens. For a concise and informative discussion of the development of taxidermy in England see *Encyclopedia Britannica*, 11th ed., s.v. "Taxidermy."

[7] Karen Wonders, "Bird Taxidermy and the Origin of the Habitat Diorama," in *Non-Verbal Communication in Science Prior to 1900*, ed. Renato G. Mazzolini (Firenze, Italy: Leo S. Olschki Press, 1986), 446.

[8] *Scientific Taxidermy,* 422.

[9] In the late nineteenth century, university and public natural history museums strengthened their ties with the non-academic groups and interests including entertainment as well as eduction, as natural history museums' mission became less and less exclusively tied to scientific research *per se*, with the increasing importance of experimentalism and the industrialization of science. (See Keith R. Benson "From Museum Research to Laboratory Research: The Transformation of Natural History into Academic Biology" and Sally Kohlstedt, "Museums on Campus: A Tradition of Inquiry and Teaching" in *The American Development of Biology,* ed. Ronald Ranger, Keith R. Benson and Jane Maienschein (Philadelphia: University of Pennsylvania Press, 1988), 49–83, 15–47. On the "New School of Taxidermy," Christopher Stoate, *Taxidermy: The Revival of a Natural Art* (London: The Sportsman's Press, 1987), 6.

[10] Literature on W.T. Hornaday's life and career remains quite limited, but includes: James A. Dolph, "Bringing Wild-Life to the Millions: William Temple Hornaday, The Early Years: 1854–1896" (Ph.D. diss., University of Massachusetts at Amherst, 1975); and Hanna Rose Shell, "Finding the Soul in the Skin," critical introduction to Hornaday's *The Extermination of the American Bison* (Washington D.C.: Smithsonian Institution Press, 2002 [Washington D.C.: Government Printing Office, 1889]): viii–xxiii. Also of note is William Bridges' A *Gathering of Animals: An Unconventional History of the New York Zoological Society* (New York: Harper and Row, 1974).

[11] Sally Gregory Kohlstedt, "Henry A. Ward: The Merchant Naturalist and American Museum Development" *Journal of the Society for the Bibliography of Natural History* 9 (1980):647–661.

[12] Frederic S. Webster, "Address," *Annual Report of the Society of American Taxidermists* 1 (1881):31–36.

[13] Andrew Isenberg, *The Destruction of the American Bison: An Environmental History, 1750–1920* (Cambridge: Cambridge University Press, 2000).

[14] Dale F. Lott, *American Bison: A Natural History* (Berkeley, CA: University of California Press, 2002), 69–76.

[15] T. J. Lears, *No Place of Grace: Antimodernism and the Transformation of American Culture, 1880–1920* (New York: Pantheon Books, 1981). Also Leo Marx, *The Machine in the Garden, with a New Preface* (Chicago: University of Chicago Press, 1994).

[16] Theodore Roosevelt, *Hunting Trips of a Ranchman: An Account of the Big Game of the United States and its Chase with Horse, Hand and Rifle* (New York: Putnam and Sons, 1885), 241–243.

[17] William T. Hornaday, *The Extermination of the American Bison* (Washington D.C.: U.S. Government Printing Office, 1889), 376.

[18] Ibid., 376.

[19] Ibid., 531.

[20] Ibid., 546–547.

[21] Karen Wonders, *Habitat Dioramas: Illusions of Wilderness in Museum's of Natural History* (Upsalla, Sweden: University of Upsalla Press, 1993), 125.

[22] Shufeldt, *Scientific Taxidermy*, 153.

[23] Hornaday created the Buffalo Group exactly along these ideal taxidermic lines laid out by himself and his peers in the closing decades of the nineteenth century. Using his skills as museological craftsman, Hornaday altered the buffalo spec-

imens and accessories he collected, creating an ideal section of representational ground. Rather than reproducing any specific geographic site in Montana, Hornaday aimed to condense the buffalo's formerly expansive habitat into the small area of a Washington D.C. museum case. — six buffalo in glass box assembled so as to conjure up the Great Plains.

24 William T. Hornaday, *Taxidermy and Zoological Collecting*, (New York: Scribner's Sons, 1891), 229–247.

25 *Ibid*., 233.

26 Frederic A. Lucas, *The Story of Museum Groups: Guide Leaflet Series No. 53* (New York: American Museum of Natural History, 1921), 32.

27 Shufeldt, *Scientific Taxidermy*, 238.

28 William T. Hornaday, "Common Faults in the Mounting of Quadrupeds," *Annual Report of the Society of American Taxidermists* 3 (1883):67–71, 67.

29 This earlier method — variations of which were standard practice throughout the eighteenth and nineteenth centuries — consisted of "stuffing" the chemically-treated animal pelt with fibrous material (rag and hemp). (C.J. Maynard, *The Naturalist's Guide in Collecting and Preserving Objects of Natural History* [Boston: Fields, Osgood and Co., 1870], 50–51. Also, *Encyclopedia Britannica 11th Edition*, s.v. "Taxidermy" and P.L. Farber, "The Development of Taxidermy and the History of Ornithology" *Isis* 68 [1977]:550–566.)

30 *Taxidermy and Zoological Collecting*, 140.

31 *Ibid.,* 245.

32 *Extermination,* 395.

33 *Extermination*, 547.

34 A *Washington Star* journalist pointed out that the larger cow complemented but did not excel the mighty male; the journalist described the cow as "a creature that would be considered of great dimensions in any other company than that of the great bull." (Reproduced in Hornaday, *Extermination,* 547).

35 *Ibid*., 547.

36 *Ibid*., 547.

37 Karen Wonders, *Habitat Dioramas: Illusions of Wilderness in Natural History Museums* (Sweden: Upsalla University Press, 1993).

38 J. D. Salinger, *The Catcher in the Rye* (Boston: Little Brown, 1951), 121.

39 Hornaday, *Taxidermy and Zoological Collecting,* 243.

40 Hornaday, "The Passing of the Buffalo," 87.

41 *Ibid.,* 243.

42 Robert Shufeldt, "Taxidermy and Photography," in *The American Annual of Photography and Photographic Almanac* (January 1899):72–4.

43 *Extermination,* 546.

44 *Extermination*, 546.

45 Frederic A. Lucas, *The Story of Museum Groups,* Guide Leaflet Series, no. 53, (New York: American Museum of Natural History, 1921), 26–27.

46 Star, "Craft vs. Commodity," *Op. Cit.*

47 *Taxidermy and Zoological Collecting*, 241.

48 *Ibid.,* 242.

49 *Ibid.,* 237.

50 *Ibid*., 141.

51 *Ibid*., 142.

52 *Extermination*, 547.

53 Notably, buffalo are, in reality, a matriarchal species.

54 *Taxidermy and Zoological Collecting,* 112.

55 *Ibid.,* 143.

56 *Ibid*., 111.

57 *Ibid*., 112.

58 *Taxidermy and Zoological Collecting,* 140.

59 James E. Young, *The Texture of Memory* (Yale University Press: New Haven, 1993), 5.

60 Pierre Nora, "Between History and Memory: Les Lieux de Mémoire [1984]," *Representations 25* (Spring 1989): 7–25.

[61] "The Passing of the Buffalo," 88.

[62] *Ibid.,* 88.

[63] See Leo Marx, *The Machine in the Garden: Technology and the Pastoral Ideal in America* (Oxford: Oxford University Press, 1964).

[64] "The Passing of the Buffalo," 95.

[65] *Ibid.,* 88.

[66] *Ibid*., 88.

[67] "Between History and Memory," 13.

[68] Hanna Rose Shell, "Vital Sparks: Taxidermy at the Zoo, 1890–1930," (forthcoming article).

[69] *Taxidermy and Zoological Collecting*, 157–158.

[70] "The Passing of the Buffalo," 85.

[71] *Ibid.,* 235.

[72] *Taxidermy and Zoological Collecting,* 109.

[73] *Ibid*., 109.

[74] *Ibid.,* 110.

[75] As I argue in "Vital Sparks: Taxidermy at the Zoo, 1890–1930," Hornaday modeled his innovative "zoological park idea" on a taxidermic model, employing photography and painting as media to compensate for the inadequacies encountered in orchestrating live animal displays.

[76] Doug Coffman, "Bitter Mission"; also Hanna Rose Shell, "The Last Wild Buffalo" *Smithsonian Magazine* (February 2000):26–30.

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More than 150 years of Administrative Ups and Downs for Natural History in Washington

Smithsonian Institution, United States National Museum, National Museum of Natural History

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From its inception, the Smithsonian Institution has had interests in natural history with a modest start during the early days of Joseph Henry, the first Secretary. The United States National Museum came into being in a sense when 1858 brought Federally-owned specimens from the Wilkes Expedition and Federal money to the "Castle." S. F. Baird, eventually to become second Secretary, encouraged the study of natural history and effectively changed the course of the Institution; he was able to obtain a museum building. S.P. Langley, next in line, cared little for the subject but was at least indirectly responsible for starting construction of the "new National Museum" on the north side of the Mall. The fourth Secretary, C.D. Walcott strongly supported the museum and its staff, but following World War I obtaining appropriate levels of Federal funding became more complex. Fifth Secretary C.G. Abbot did his best to hold the Smithsonian and museum together during the great depression and the start of World War II — no mean feat. Following him, Alexander Wetmore refurbished the place to its prewar strength. The seventh Secretary, Leonard Carmichael, a psychologist, obtained money for new major exhibits and wings on the building, and the staff began to grow. Under the eighth Secretary, S. Dillon Ripley, there was dramatic expansion of the Smithsonian Institution and the newly named National Museum of Natural History. Under the three living Secretaries, Adams, Heyman, and Small, natural history has declined for both internal and external reasons. The role of the Director of the National Museum of Natural History has changed, and his power within the Smithsonian complex has diminished.

In considering the entity as a museum of education, it has been adequate, but never outstanding; currently, about one-third of former exhibit space is closed to the public. As a museum of record, it has performed yeoman service and the collections are immense and fairly well catalogued; how much the collections contribute to the nation is a difficult subject to quantify, but at times they have yielded critical data. As a museum of research, the organization has been superb, and it is the last major bastion of systematics and taxonomy in America, even though the number of staff members has declined about 20% during the last two decades. Predictions are always uncertain, but there is no reason to assume that increased funding will come about to correct current difficulties. The most optimistic view of the future of National Museum of Natural History is that it is hazy; a realistic view is that it is cloudy, although actions of a new director provide hope.

As the title correctly suggests, this paper is, sadly, only a study of administration of natural history in Washington, not a more useful study of the study of natural history. Still, no one involved with natural history works in a vacuum and there must be some surrounding support structure. For examples, Linnaeus was on a university faculty, and Darwin and Lord Rothschild had the advantage of rich parents. This work does not document all places in Washington, D.C., that have supported natural history investigations but only those under that peculiar entity, the Smithsonian Institution (SI). The SI is a public trust to the American people — a term seldom used today — and it gave rise to the United States National Museum (USNM) which, when it disappeared, gave rise to several entities including the National Museum of Natural History (NMNH). As one aspect of continuity, the USNM prefix is still used with catalogue numbers for the specimens.

History is a safe subject to wallow in, what with facts, figures, and dates to quote; Henry Ford commented, "History is bunk." In preparing an historical manuscript, a writer conventionally puts a slightly different spin on what has been written previously and no one is deeply concerned, other than the next person to consider the subject. Commonly, one begins prolix and, in moving forward through time, events become increasingly complex but concurrently increasingly compressed. Once a chronology is established, events can be rehashed from various aspects, sometimes to emphasize particular points, but sometimes only to provide a patina or illusion of scholarship.

In discussing events from past to present, at some point one crosses a vaguely placed line, clear only in retrospect, between history and current events. Discussing the present differs from considering history, for events and interpretations are tightly bound, reputations and egos are at stake, and each observer brings his/her prejudices/observations/agendas to the subject. Writing about a spouse is quite different from discussing a long dead ancestor. Once past the present, pontificating on the future is even less troublesome than writing about the past. Unless one actually controls the course of events by controlling the funding sources — "He who has the gold, rules" — only speculation is involved and the further into the future one projects, the safer it is to speculate. This constitutes the theoretical basis to pursue the past, present, and future of the nation's natural history museum.

Illustrations are supposed to illuminate a discussion. Despite the wonders of digital cameras and other cutting edge technology, one cannot illustrate the future, except in a metaphorical sense. The present is an era of color pictures, still expensive to print, and the recent past had more snapshots than documentary-type photographs. Thus, the last half-century is not so easy to portrait in pictures. Museum photographers, past and present, concentrate on the exhibits and the organizational leaders. It is rare to find a photograph of mundane day-to-day life in the "good old days."

Though the subject is a museum, that entity is one way or another bound to the SI. There are a number of books on SI history, for example Goode (1897), True (1950), and Conaway (1995), which consider the entity during 50 years intervals. For a century, natural history and Smithsonian were nearly synonymous. In a shorthand way, the title "The Smithsonian: Octopus on the Mall," (Hellman 1967) pinpoints a dramatic time during which the Institution changed and the museum grew. Both SI and NMNH are now undergoing changes that some observers might characterize as decline. This interpretation may be partly the result of factors outside the control of the SI, partly it may be due to changing internal priorities, and partly it may be due to a change in the nature of biological investigations.

Before becoming mired in the past, it may be useful to contrast engineering and art museums with natural history museums; museums catering to human history are intermediate, but may have more in common with natural history than with art. Engineering and art deal with a severely limited number of objects. The first steam turbine may be on exhibit along with the first and five millionth personal computers, but few later turbines are needed make the point of size and operation, and to illustrate box after box of computers, even if they show trends in size and styling, is not particularly instructive. In art museums, the size of individual collections is obviously limited, for each dead artist supplied only a finite number of pieces. A more fundamental difference, noted by an art curator colleague, is that the objects themselves carry an aura and this aura may be as important as the quality of the object itself. The first heavier than air aircraft has great significance, as does a pencil sketch — if it was signed by Renoir.

Once one gets beyond the largest elephant or *Tyrannosaurus rex*, natural history specimens convey no aura to the public. But natural history is far more complex than its largest cultural artifacts. And large collections are needed to document some of the complexity, both in terms of display and research. Consider the term "can of worms" and compare the dozen or so people in the world who would delight in opening such a can to the millions who prefer to avoid the prospect, either real or metaphorical.

Finally, despite similarity in the history, problems, and prospects of all natural history museums, application of "He who has the gold, rules" may vary widely. State, county, local, and, especially, private funds are not controlled in the same way as are Federal funds. To cite a specific example, for several decades, the Congress has authorized pay raises for Federal employees, but it rarely increases the size of the appropriations to cover the added cost. This is akin to the peddler who improves his profit margin by feeding the horse less and less hay each day. He was able to train the horse to pull the wagon with no overhead costs, just before the animal died. The example cited is not humorous; it is a pernicious way to operate and one cause of present difficulties, not only specifically for the museum, but, in general, for science conducted by Federal employees.

Joseph Henry and The Smithsonian Institution

Twelve decades after Smithson wrote his will, one interpretation of the SI by Joseph Henry was still accepted. "No local or even national interests limited the scope. Knowledge was to be promoted by original research, and it was to be diffused as widely as possible" (Abbot 1946:326). This is well-plowed ground and it is sufficient to note that "increase and diffusion of knowledge among men" is not a crystal clear directive.

Just what constitutes appropriate limits in connection with a donation has been a problem from the start (L. Small, oral commun., 2002). Those who insisted that Smithson's money should be refused may have had a point, but accepted it was, and a decade of congressional wrangling ensued. At the SI founding, August 10, 1846, the enabling legislation mentioned that among other assignments the secretary, yet to be designated, "shall also discharge the duties of librarian and of keeper of the museum . . . ." This bill covered a wide spectrum of possibilities for the SI, including that of a museum for "all objects of natural history, plants, and geological and mineralogical specimens, belonging to, or hereafter to belong to the United States . . . ." (Rhees 1901:435.) The legislation further specified ". . . a suitable building, of plain and durable construction materials and construction . . ." If one has ever seen the Smithsonian "Castle," no more comment needed. As regards the function of a museum staff, one may also ponder use of the British usage of "keeper" versus the traditional American term "curator."

Prior to the election of Secretary Joseph Henry, meeting minutes of the Board of Regents mention a national museum. In his inaugural plan for the SI, Henry indicated that ethnographic investigations might be supported financially by the Smithsonian, but. "(9.) It is believed that the collections of natural history will increase by donation as rapidly as the income of the institution can make provision for their reception, and, therefore it will seldom be necessary to purchase any articles of this kind. . . . . (17.) When the building is completed, and when, in accord with the act of Congress, the charge of the National Museum is given to the Smithsonian Institution, other assistants will be required" (Henry 1847: 4). For whatever it signifies, in 1846, the Regents did not capitalize *museum* whereas Henry did in the above quote.

"In his 1849 Annual Report, Henry wrote 'It could not be the intention of Congress that an Institution founded by the liberality of a foreigner, and to which he affixed his name, should be charged with the keeping of a separate museum, the property of the United States.' But Henry was wrong, Congress did so intend . . . ." (Oehser 1970:73). In my view, Secretary Henry was the outstanding Secretary, not simply because he was the first, but because of his vision. Lest one get the wrong idea, he was by no means opposed to investigations in natural history as such and instituted public lectures that included this subject long before he was saddled with the Smithsonian Castle (Hafertepe 1984). The first volume of *Smithsonian Contributions to Knowledge* was concerned with anthropology.

Objects, private and public, were given to the Institution and a few were purchased. Once the Castle opened to the public, the SI was in the museum business. In 1856, when construction of the Castle was finally completed, Henry recruited a paleontologist, F.B. Meek, for the SI. Meek was unsalaried, but allowed to live in his office. Like Henry, he was literally a scholar in residence.

It is well known that in the fall of 1850, Henry hired a junior Assistant Secretary, Spencer F. Baird, who brought a dowry of two freight cars of natural history specimens (Rivinus and Youssef 1992). Henry had plenty for Baird to do, with handling official correspondence and editing, and, after Assistant Secretary W.C. Jewett was fired as librarian and the SI investigated by Congress, Baird was also placed in charge of the library and of exchanges. The young man still found time to pursue natural history with a vengeance and collections accumulated. In particular, the western railroad surveys of the late 1850s contributed material, mainly biological specimens. There may have been earlier formal listings of titles, but in a March 3, 1855, Congressional document one finds "Spencer F. Baird, Assistant Secretary, in charge of the Museum." Even so, it was not until 1872 that Baird was given full administrative responsibility for the museum.

In his annual report for 1856, Henry suggested, in part, that the SI might sell, or even give away the Castle "for no other consideration than that of being relieved from the costly charge of the collections" (Hafertepe 1984:129). The standard story is that Henry reluctantly agreed to accept custodianship of the Wilkes Expedition collections, which were in the Patent Office building (Stanton 1975), and that these led to founding of the United States National Museum. (Viola and Margolis 1985). The SI had a large number of natural history specimens at that time; the Wilkes material accounted for only about 20% of the total holdings (M. Rothenberg, oral commun., 2002). After several years of refusing to take custody of these specimens, when Henry finally agreed he insisted the collection be accompanied by money for transport and display cases, plus an annual sum to support the material. The latest interpretation is that Henry was short of funds for his meteorological program and needed more income. "Those few thousand dollars from the Patent Office helped restore the good name of the Smithsonian meteorological program, but they destroyed Henry's vision of a Smithsonian free of political control through the annual appropriations process" (Rothenberg 2000:3). It was not until 1871, after several failed attempts, that Henry was able to persuade Congress to raise the annual appropriation from $4,000 to $10,000.

The rhetoric in 1860 over collections in particular and the Smithsonian in general provides fascinating reading (Rhees 1901:611–627) and only a smidgen can be inserted here: "Mr. Mason. Mr. President, I have been for many years one of the Regents of this Institution; under the appointment of the Senate, in connection with my friend from Maryland. We know that it is a public trust; one, we think of a sacred character. We know as a fact, and it appears in the records of that Institution, that these specimens of natural history sent from the Patent Office to the Smithsonian Institution, were sent there against the remonstrances, repeated from year to year, of the Institution, and if

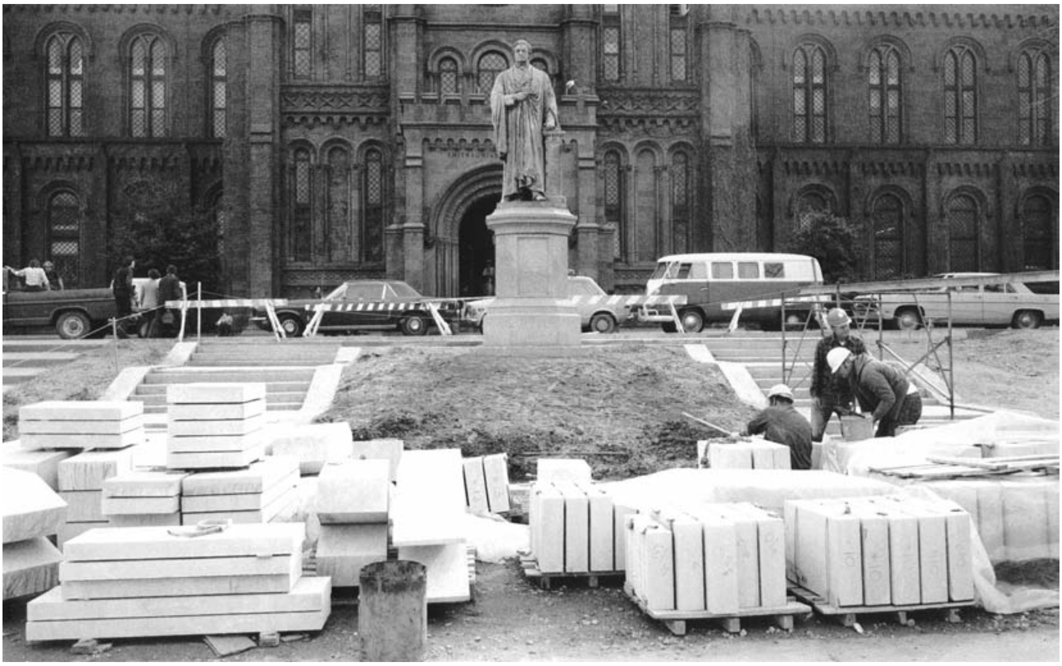
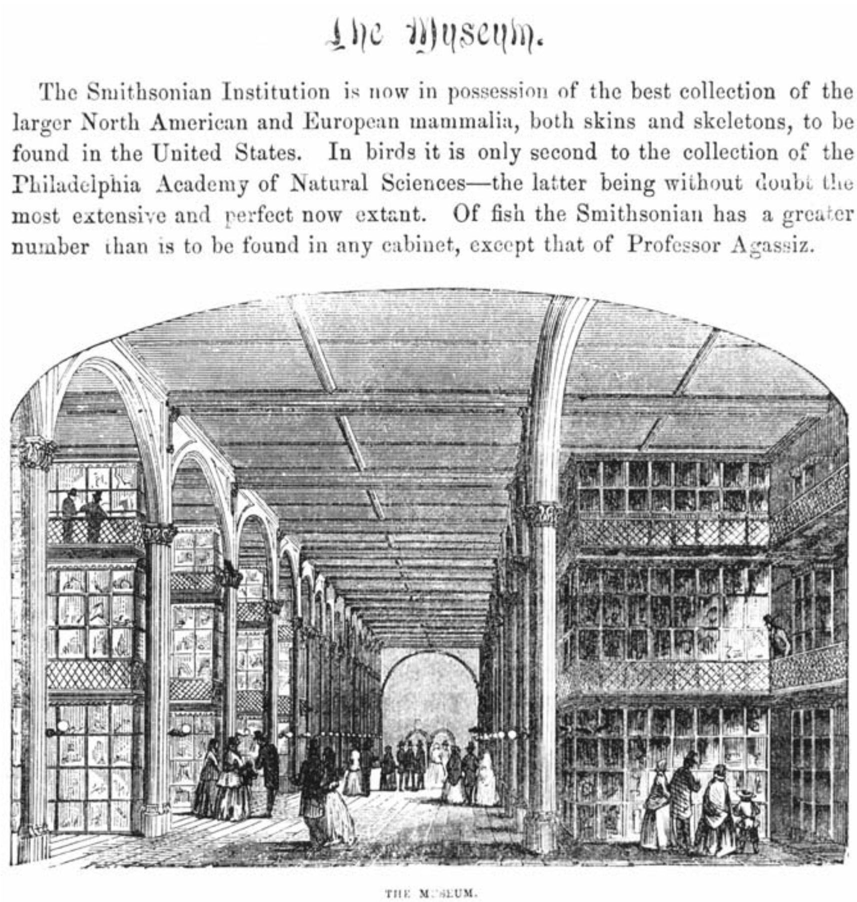


FIGURE 1. The statue of Joseph Henry in front of the "Castle." After Henry's death this sculpture was authorized by Congress, June 1, 1880. The statue by W.W. Story was unveiled April 19, 1883, and was moved several times before settling at the north portico. One of Secretary S. Dillon Ripley's first acts was to turn the statue to face the Mall, symbolically opening the museums to all. Courtesy Smithsonian Institution Archives. (SIA Negative number 76-3110-36.)

either the Senator from New Hampshire, or any gentleman who thinks with them, would introduce an amendment to this bill directing the Institution to throw what they have received from the Government out of doors — just put it out of doors and let it rot — I will vote for it. It belongs to the Government. It does not belong to the Institution. It has no business there within the terms of the trust, none whatsoever. It was forced upon them against their will; as they believe, in violation of the trust left by Smithson; and if these gentlemen will devise any mode to take away all these specimens of natural history sent there by the Government I will vote for it cheerfully. I do not know that I would not consider it incumbent upon me, for purposes of getting rid of them, if the Government will not bear the expenses of getting rid of them, if the Government will not bear the expense of throwing them out of doors, to vote it out of the funds of the Institution" (Rhees 1901:624-625). Baird would have been very depressed by this statement, but Henry would have cheered.

Accordingly, the USNM had no formal beginning and simply came about serendipitously. On a previous occasion, I had suggested that the trickle of Federal funds, first appropriated in 1858, could be considered as logical a starting place as any (Yochelson 1985:15). Should anyone wish to pursue the subject further, there are several studies of interest of the early history written by Goode (Walcott 1899:83–192).

Henry did his best to make it perfectly clear that the collections were the responsibility of the Federal government and had simply been moved from one place to another. As one who was responsible to the Board of Regents rather than to the Federal government, in Henry's judgment he was not empowered to receive funds directly from Congress. Federal money was appropriated to


The Museum.

The Smithsonian Institution is now in possession of the best collection of the larger North American and European mammalia, both skins and skeletons, to be found in the United States. In birds it is only second to the collection of the Philadelphia Academy of Natural Sciences—the latter being without doubt the most extensive and perfect now extant. Of fish the Smithsonian has a greater number than is to be found in any cabinet, except that of Professor Agassiz.

THE MUSEUM.

FIGURE 2 The Great Hall of the Castle somewhat idealized, for the third story exhibit gallery shown in the drawing was never installed. From the 1859 SI guidebook assembled by W.J. Rhees. (MAH-43804-H.)

the Department of Interior and, in turn, some was doled out to the Smithsonian. The methodical Rhees, who chronicled Congressional documents relative to the SI, has no index listing for "founding of" under National Museum and his "Appropriations, history of" (Rhees 1901:1250–1251) is an 1889 action of Langley to have the Federal appropriation come directly to the SI. The first use by Congress of the full title of United States National Museum was March 3, 1875, in connection with postage stamps.

One example in February 1873 shows Henry's wisdom in trying to keep the Smithsonian focused and shielded from requests for Federal funds. "Mr. John W. Stevenson. Professor Baird, in a letter before me, says he made this estimate of $15,000 which is the usual estimate, before the transfer was made from the Land Office of all these specimens, and the additional appropriation is required to prepare for the large increase of these specimens, and also to prepare duplicates for distribution. The amendment simply proposes an appropriation of $20,000 instead of $15,000. I hope the Senate will agree to it.

"Mr. Cornelius Cole. I think $20,000 is probably more than the whole thing is worth" (Rhees 1901:693).

FIGURE 3. An 1867 stereo-pair of a meteorite acquired in 1863 and placed on display in the Great Hall of the Castle; exhibits on the balcony and in the cases below are in the background. This "wedding ring" of iron, moved to the new USNM building next door, and then across the Mall to the next new set of displays, and it was again recycled when further new geological exhibits were installed. (SIA Negative number 87-5252-3)

Henry met with Louis Agassiz of the Museum of Comparative Zoology in 1860 and in December, Agassiz wrote Baird reporting on their discussion. "I believe Prof. Henry is right in considering the collections as superfetation[1] of the Smithsonian Institution as long as Congress does not make an appropriation for a National Museum" (Herber 1963:161.).

About six weeks later, Baird responded to Agassiz with a statement of loyalty that will still bring a tear to one's eye. "I am sorry you think there is a difference of sentiment between Professor Henry and myself in regard to the Smithsonian Museum. On the contrary, I consider it my duty to maintain his policy as far as I understand it and I shall always endeavor to do so. If he were to forbid the entrance of a single additional specimen of Natural History into the building and give me orders to that effect I would unhesitatingly obey him and act accordingly. I am well aware that the present means and space of the building do not admit a vast and unlimited addition of materials such as you have at Cambridge [Museum of Comparative Zoology]. All I do care for is to do full justice to materials we are obliged by law of Congress to receive and keep in order, but I have no desire to make a show with these. I am much interested in the development and exploration of any new regions of North America but will not restrict my views to Natural History and feel as much gratified when we get a batch of important Meteorological reports from a new arctic station, as with the birds and beasts accompanying them" (Herber 1963:162–163.)

Although the Civil War caused disruption, and the 1865 fire in the Castle more disruption, despite his pious awareness of physical limitations of the building and of finances, Baird continued to encourage collectors and the collections rolled in. Henry rearranged the building's interior so that SI activities *per se* were in the east wing and the museum took over the west wing and much of the central part of the building. Balconies in the great hall became crowded with specimens and youthful natural historians. The Secretary occasionally went on a rampage when the specimens

[1] The first meaning of this word is conception during pregnancy, surely an atypical occurrence, but, as used in the quotation, it probably implies the piling of one growth or overgrowth upon another, or, somewhat less likely, the idea of overproduction.

CATALOGUING AND CLASSIFICATION OF SPECIMENS.

FIGURE 4. The caption on this drawing does not identify the ornithologist, but the shape of the window suggests that the office may have been in one of the towers of the Castle. (MAH-43754A.)

FIGURE 5. The Castle on January 24, 1865, after the fire. The roofs over the main part of the building and the middle north tower, to the left of the highest "clock" tower are missing. A century later for the Smithson bicentennial the north tower roof was restored and in 1996 for the Smithsonian sesquicentennial a bell was added to the to toll the hours. (SIA Negative number 30792-a.)

FIGURE 6. Photograph of Great Hall, probably looking west and probably in 1867 after a temporary roof was installed. The stove in the foreground provided what heat there was for the tourists. (SIA Negative number 72-1973.)

intruded on his space or their smells became intolerable. Henry insisted that "duplicates" be distributed to cut down on the bulk, but like the water of the sorcerer's apprentice, the flow of material could not be stemmed. The territorial surveys in the west of the 1870s contributed specimens, but probably more came from Baird's network of private and Army collectors.

Baird began to wiggle out from under Henry's control when the Fish Commission was founded in 1871. As a partial consequence, the museum probably has the world's largest fish collection. Baird was also able to find Federal money for publication and convince Henry to start another series. *United States National Museum Bulletin 1* was published in 1875; as might be expected, it was for long papers and nearly 100% of them were on natural history subjects.

By January 1876, Henry, though enfeebled, was seriously concerned that even the SI display at the Philadelphia Centennial could not be accommodated in the Castle when the exposition ended. "He was becoming more and more convinced of the advisability of separating the Smithsonian from the National Museum, in light of the latter's stupendous growth and subsequent dependence on federal appropriations, which in turn required extensive lobbying" (Hafertepe 1984:146). At Philadelphia, Baird solicited donations from commercial businesses and foreign countries, pointing out that it was cheaper to send the material to Washington to than pay the freight costs of returning their own exhibit material. Baird collected fifty boxcars of miscellanea donated by foreign countries. Private firms and government agencies also shipped former exhibits to the city, so the conventional report of 60 freight cars of material is probably correct.

Marc Rothenberg (oral commun., 2003) has noted that in the Annual Reports for 1875 and 1876, Henry defined his concept of a national museum and questioned whether such a museum was properly part of the function of the Smithsonian. In his efforts to rescue the Smithsonian from dissipation of resources and to shape it into an Institution for the pursuit of knowledge, Henry effec-

FIGURE 7. “The Ornithological Laboratory in the Smithsonian Building.” An 1884 photograph of the south balcony of the Great Hall. (SIA Negative number 6063.)

tively disposed of the library and art functions, but he could not shake off the museum. “When Joseph Henry breathed his last [May 13, 1878], his Smithsonian Institution died with him” (Hafertepe 1984:153). Four days later, the Regents elected Assistant Secretary Baird as the second Secretary.

Spencer Fullerton Baird and the United States National Museum

To backtrack a little, the Philadelphia Exposition is important for at least two aspects. First, it began a long series of regional, national, and international exhibits in which the SI figured prominently for nearly half a century. The heart of all of these displays was natural history. For most of this interval, these expositions were pre-automobile occurrences and they had a remarkable impact on the public. It is virtually impossible to explain to the current generation the concept of a pre-television world, let alone the significance of these expositions.

Second, George Brown Goode, born in 1851, came into the natural history story. He began as a volunteer with the Fish Commission and is given credit for the fisheries display at Philadelphia, though he did a good deal more. As Baird took over more duties when he became Secretary, along with greater activities of the Fish Commission, Goode became the *de facto* head of the museum. As late as June 1886, Baird was still listed as both Secretary and Director, though at that time he did formally delegate essentially all responsibility to Goode.

FIGURE 8. The United States National Museum under construction; the entrance, flanked on either side by a modest spire, is partially shown at the right. (SIA Negative number 2003-36480.)

In the regional, national, and international expositions in which the SI participated, Goode was responsible for the temporary displays, in addition to all his efforts in Washington. The final item of overwork, which killed him, was a massive book detailing the first fifty years of the Institution. In my opinion, and one shared by others, Goode was the outstanding museum man in North America of all time and worldwide may have been the best of his era.

Henry's body was hardly cold when The *Proceedings of the United States National Museum* began publication. The first volume for 1878 came out in 1879. Like the *Bulletins*, Federal money was involved, but this series differed in containing shorter papers. 1879 was an excellent year and, in particular, March 3 deserves the title of a red-letter day for Baird and many of his cronies, even if that antique phrase has lost most of it meaning. The sundry civil act for 1880 contained an appropriation of $250,000 to construct a building 300 feet square (Rhees 1901:778). Likewise, the Bureau of Ethnology was founded, again more or less by happenstance, and placed under the direction of the SI, with John Wesley Powell in charge. Finally, in the same act, establishment of the U. S. Geological Survey included one major general provision; almost certainly Baird had a part in its framing. "And all collections of rocks, minerals, soils, fossils, and objects of natural history, archaeology, and ethnology, made by the Coast and Interior Survey, the Geological Survey, or by any other parties for the Government of the United States, when no longer needed for investigations in progress, shall be deposited in the National Museum" (King 1880:1).

An original inhabitant provided a vivid description of the USNM building. "It was a square squatty affair of red, blue, and yellow brick, exteriorly an architectural horror, internally a barren waste. It presented one redeeming feature — space; and as it was space that Baird was after, I presume it may at first thought to have been considered a success" (Yochelson 1985:24). After displays were installed, a few years later the term "Nation's attic" began to be bruited about, and it

FIGURE 9. Installing whale skeletons before the opening of the United State National Museum building. (SIA Negative number 11254.)

FIGURE 10. Secretary S. F. Baird, with wife and daughter, a man utterly devoted to promotion of natural history who laid the foundation for the extensive collections. (SIA Negative number 10714.)

FIGURE 11. Constructing a full-size model of a whale jaw for exhibit in the United States National Museum during the early 1900s. The temporary shed was probably behind the Castle. (SIA Negative number 83-3373.)

was used in a pejorative sense. Even with the new building, natural history collections and offices were still crowded into a significant part of the Castle. The balconies in the Great Hall were converted from exhibits to office space and remained until 1914 (Field, Stamm, and Ewing 1993).

Goode oversaw details and set standards in the museum. For example, he required curators to have two kinds of ink for writing labels and indicated what data should be included, as well as the size of labels for different purposes. The specifications developed for wooden cases and drawers run to more than two pages. In many of the behind-the-scene operations, Goode provided standards, innovation and leadership for American museums.

From 1881 though 1886, the most illustrious title that Baird allowed him was that of Assistant Director. Not until January 12, 1887, was George Brown Goode finally appointed by Baird as Assistant Secretary, a position he richly deserved. Simultaneously, Samuel Pierpont Langley was brought in from the outside and also appointed as an Assistant Secretary. Probably the Regents recognized the mortality of Baird and insisted on bringing in an outside scientist to administer the other SI functions. A few months before Baird's death, the Director of the USNM was directed to report annually to Congress. "When Baird died, on August 19, 1887, following a long period of overwork and heart strain, America lost what many thought was its greatest naturalist" (Oehser 1949:91). Within three months, Langley was appointed Secretary.

Secretary Baird was personally one of nicest of men, but he had a complex character. How one in retrospect reads his character depends on what one reads (Dall 1915; Rivinus and Youssef 1992). The traditional interpretation that Baird changed the course of the Smithsonian is rock solid. “The average annual expenditure for original research for 1850 to 1877 was a little over $2000 a year. After Professor Baird took charge, in 1878, it fell to $802.80 for each of the next three years, and then ceased entirely” (Rivinus and Youssef 1992:130). Funding went mainly to the collecting of natural history specimens and their curation. Considering the size of the SI, Professor Baird developed an enormous tail to wag an exceedingly small dog.

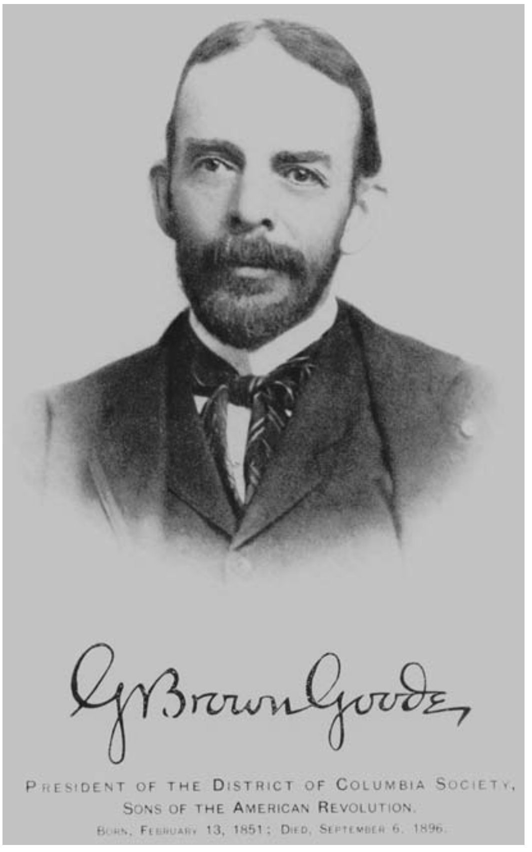


FIGURE 12. George Brown Goode, the best museum man of his time, who should have been appointed Secretary. (SIA Negative number 2003-36479.)

Samuel Pierpont Langley

The astronomer Langley was secretary for 18 years. It is a fair statement that at his very best, he was little interested in natural history. He did study the flying of buzzards, but it was the flying, not the birds, that was of interest. As late as the early l950s, occasionally old-timers still told Langley stories and most anecdotes concerning his tenure are not particularly flattering (Abbot, 1958). His founding of the Astrophysical Observatory and his experiments in aeronautics were important, but did not impinge on natural history.

Baird's death prompted a series of events in Congress. First was whether his estate should be compensated for his efforts as Fish Commissioner. Baird had purchased a large house, 1445 Massachusetts Avenue NW, and devoted it mainly to Commission offices. He charged no rent and received no salary as Commissioner. A bill was introduced to pay his widow $50,000. After much discussion of whether this was a legal claim, moral responsibility, or whatever (Rhees 1901:1045–1104) widow Baird received $25,000.

Goode temporarily took charge of Fish Commission, but when Marshall McDonald was appointed Commissioner of Fish and Fisheries, new quarters were needed. A building on the Mall, originally designed as an armory, occupied part of the site of the present National Air & Space Museum. For years, it had served as storage area and extra office space for both USNM and Fish Commission. After congressional wrangling, including returning the place to its original purpose, the SI effectively lost all this space, which led to further crowding within the USNM building.

As a next major step in natural history studies, 1888 saw the first formal attempt to form a zoological park (Rhees 1901:1149). William Hornaday, an outstanding taxidermist, developed within the USNM a Department of Living Animals so that their movements could be studied and taxidermy made more realistic. The animals behind the Castle became a tourist attraction. (During the

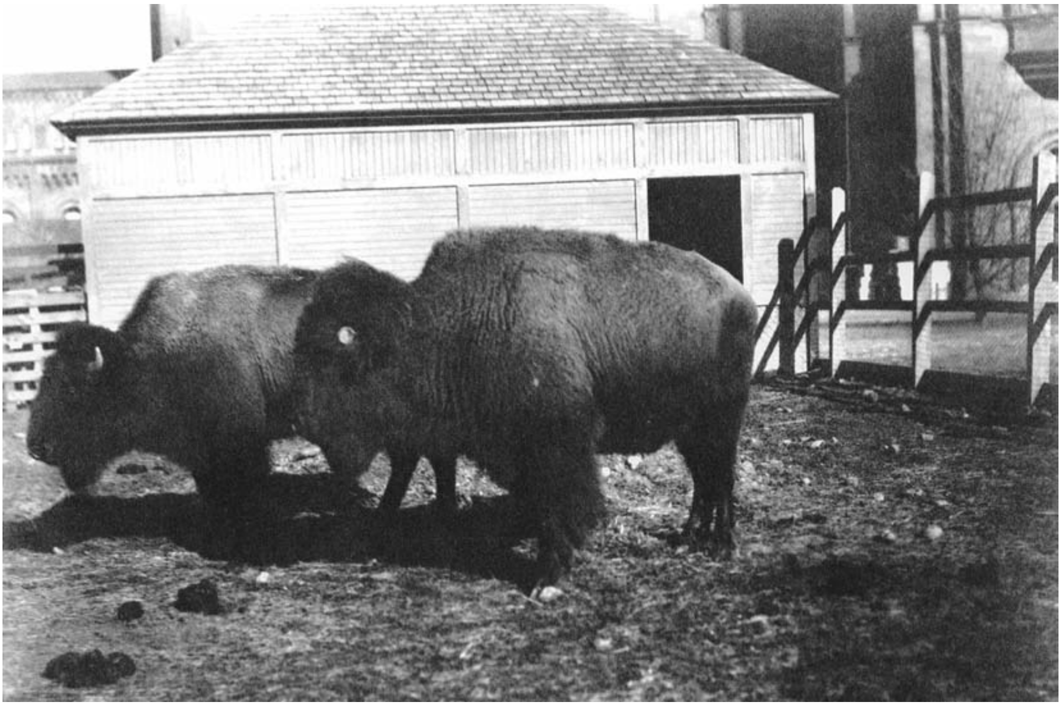


FIGURE 13. American buffalo south of the Mall, behind the Castle. These were donated shortly after a variety of other small live American animals and birds had been collected and donated. Buffalo returned briefly to the Mall during one of the summer Folk Festivals. (SIA Negative number 9730.)

Smithsonian Sesquicentennial, in commemoration, gardeners grew several topiary "buffalo" on the site.) Hornaday had shot the last group of wild buffalo garnered for a museum display. Preservation of vanishing American species, especially the buffalo, was a prime consideration for him and Hornaday was the leading force in the push for a zoo.

Congressional remarks wandered between a zoological park and a major city green space, eventually to become Rock Creek Park. It is surprising what remarks some congressmen are willing to leave for posterity. "Next year we will be called upon to appropriate $200,000 to buy buffaloes, tigers, lions, monkeys, and other animals to put in there. The next year after that we will have to appropriate another $200,000, because we will have to buy reptiles, snakes, and things of that kind." (Rhees 1901:1159). On the other hand "The study of life always has, and always will have, a fascinating interest for the human mind, and where can lower forms of life be better studied than in zoological gardens? . . . . Therefore I say Mr. Speaker, that the expenditure of this money will be productive of great and lasting benefit to science" (Rhees 1901:1163). On yet another hand, "Why, Mr. Speaker, if gentlemen want to study this science, and the habits of monkeys, bears, and elephants, I suppose it would be better to go into the country where they are grown and reared and study their habits in their native land. But to bring them here for 'scientific' purposes is not a proper use of the word. . . . . if this circus is to inaugurated . . . it should be put on wheels." (Rhees 1901:1164).

After an incredible amount of discussion, Congress acted and the Department of Living Animals segued into the National Zoological Park (Mann, 1946). Langley refused to appoint Hornaday to head up this new organization, and he left the Smithsonian for a long and distinguished career in New York. There are many good reasons why historians may not rank Langley as one of the outstanding SI Secretaries, but his discarding of Hornaday has to rank high among his various poor decisions.

Had Hornaday had been in charge, perhaps the zoo would have become more of a force in classical natural history studies, but perhaps not. When the legislation was finally passed, half the annual appropriation was to come from the District of Columbia budget. As a consequence, the facility was perpetually short of funds. It was not until the 1950s, following the death of a child mauled by a lion, that the physical plant began to receive proper attention, and it was not until a quarter century later with the acquisition of the Conservation & Resource Center at Front Royal, Virginia, that scientific studies of animals there and in Rock Creek Park became significant. The outgrowth of the National Zoological Park from the USNM is a SI milestone, but a zoo is not a museum and details of its history will not be pursued here.

In 1888, John Wesley Powell, then second Director of the U.S. Geological Survey, as well as head of the Bureau of Ethnology, failed in his effort to obtain funding for a new building adjacent to the National Museum. As part of his campaign he made a few points of interest to museology. "There are certain collections . . . which are of intrinsic value and are readily marketable; and there are certain other materials . . . fossils, typical rocks . . . for which there is a demand for educational and museum purposes. . . . and a trade in such material has sprung up. . . . . But there is another class of material collected by the investigator, comprising rocks, soils, ... ill-preserved fossils, which have no money value, would be worthless in a museum . . . . It would manifestly be unwise to preserve such material in the National Museum, and it is accordingly destroyed" (Rhees 1901:1113). Thus, there was some discussion concerning what was to be stored in the Nation's attic.

Funding for the USNM was anemic and there was essentially no scientific staff to support the collections. Goode honed the concept of appointing honorary curators, that is not paid by the USNM, to a fine art and if needed to salve an ego or snare a prize, he would designate a new department for the non-paid curator. Eventually there were more than 20 USNM departments, nearly all concerned with natural history. Feeble attempts were made to improve the place; digging a full basement was not deemed feasible. Congress was in no mood to provide funds for a new building, but after years of effort, the floors were fixed and in the early 1890s balconies were added; to fund them took two separate appropriations. Conditions prior to the adding of the balconies are best described in the unpublished manuscript of G.P. Merrill, previously quoted.

"The building was flat upon the ground with no basements except at the four corners. Within were no partitions, no ceiling, nothing but acres of space interrupted by vertical columns and over head a network of iron rods to support the roof. Light streamed in from high windows producing shadows and reflections everywhere but where wanted. The quadrennial period of silliness for which Washington was noted came on early in 1881. A place must be found for the inaugural ball on March 4 [presidential inaugurations were later changed to January], and as there was no other place the museum building was selected. All begun and unfinished projects were pushed aside and preparations for the ball begun.

"The available time not being sufficient for laying tiles, a board floor was hastily laid on joints laid in grooves dug in the soft black earth. On these boards were nailed, with the same spirit of governmental economy that permits the continual repairing on the lath and plaster [Civil] wartime structures in South Washington. These shoddy floors were allowed to remain until the occasional breaking thru by rotting necessitated their replacement. The down pipes carrying water from the roof proved insufficient for our torrential rains and they burst, locally flooding interior, the broad iron roof also sprang periodically a leak and one early summer I recall such a host of newborn ter-

FIGURE 14. South Hall of the United States National Museum looking north. The Hornaday Buffalo group is in the foreground. (SIA Negative number 16247.)

mites bored their way through rotting floors and attacking the woodwork of the cases as to threaten . . . .

"Yet thru it an energetic body of inexperienced and untried men labored conscientiously and courageously, for the love of G.B. Goode and his cause, inspired by the silent approval of Baird and Goode for order. Baird did not live to see it, and Goode broke under the strain. Those of us only who were young, tough and irresponsible lived to tell the tale."

Quite apart from his manifold works in ichthyology, Goode distilled his philosophy of museums into three significant papers. Perhaps the most significant of his concepts was a three-fold classification of museum functions, and one year Goode even tried to explain this idea to Congress. He divided the history of the USNM into three periods. In his view, until 1857 specimens were collected purely for research, from 1858 to 1879, the museum acted as a deposit for government objects, and from 1879 the museum actively collected and exhibited specimens. "The three ideas, record, research, and education, cooperative and mutually helpful as they are, are essential to the development of every great museum. The National Museum endeavors to promote them all." (Rhees 1901:1713–1714).

A letter to Congress, four months before his death, gives some notion of his method of operation. Goode pointed out that the National Herbarium was nominally under the control of the Smithsonian, but for years have been curated by Department of Agriculture employees. Two years

FIGURE 15. Office and storage space for anthropology on a balcony of the United States National Museum building, a powerful argument for another building. (SIA Negative number MNH-3680.)

earlier an agreement was reached to move it physically to the Castle. To maintain the herbarium would require $10,000 annually for assistants, clerks, preparators, postage for exchanges and so forth. "Should the desired sum be granted, it will be possible to maintain this vast collection, which is of much importance to botanical science, in a manner befitting the dignity of the nation" (Rhees 1901:1733). This letter was accompanied by one from the Assistant Secretary of Agriculture. If the transfer was made: the collection would be in a fireproof building; more space would be available in the Agriculture building; there would be no request for new positions to fill those of the men transferred to the Smithsonian; and the Department appropriation could be cut by the amount transferred to the Museum. Since everyone would seem to gain, Congress agreed and the annual museum appropriation went from $40, 000 to $50,000.

Goode died September 6, 1896, and as a tribute his papers on history of natural history and on museums were reprinted (Walcott 1899). They are well worth studying in detail. A later book (Kohlstedt 1991) reprinted some of his papers, though not the key ones on museology. Sir William Flower of the British Museum, Natural History, a star in the history of museums, noted his death. "Here I cannot refrain from expressing my deep sense of loss this cause [dissemination of knowledge though the development of museums] has recently sustained by premature death of Dr. Brown Goode, Director, United States National Museum" (Flower 1898:vii). He went on to laud "The

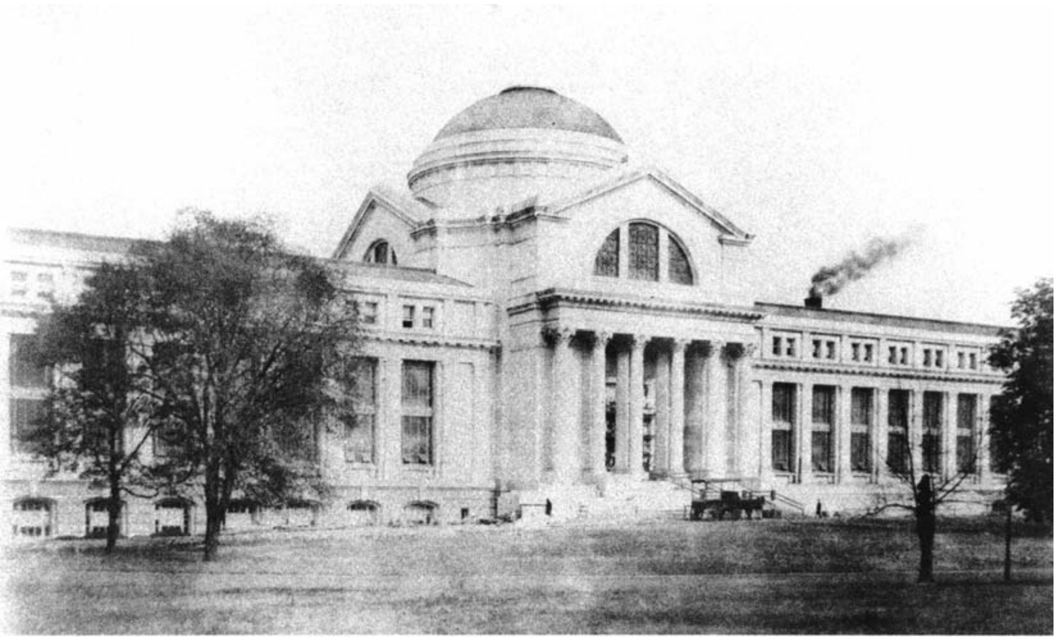


FIGURE 16. The new natural history building in 1909, looking northeast, with a wagon in front and with work continuing on the roof. For several generations this was almost always referred to as the New National Museum. (SIA Negative number 87-4899-20.)

principles of museum administration" (Goode 1895). Goode deserves a book length biography, but so far he has only received a chapter (Oehser 1949).

Langley now faced a serious problem. Some Regents were less than enthusiastic toward the Secretary and others were downright hostile. Names of several candidates for Goode's position were floated in the local papers. Langley surprised everyone by suggesting Charles Doolittle Walcott, who had been director of the U.S. Geological Survey for two years, salary, $5,000. Prior to that Walcott had spent a decade working in the USNM building and was also an honorary curator; he knew both the SI and his way around Washington. Walcott agreed, but insisted on a title to indicate the appointment was temporary (Yochelson 1998). During 1897 and part of 1898, while Walcott was Acting Assistant Secretary in Charge of the United States National Museum, the Regents paid him $1,000 annually.

In less than six months, Walcott reorganized the chaotic museum structure into three departments and the heads of each are still remembered as prominent in their fields. Anthropology was under William Henry Holmes, who was a geologist-ethnologist-artist, and he served until Powell's death, whereupon in 1902 he became Chief of the Bureau of American Ethnology; Otis T. Mason replaced him. Biology was under the distinguished mammalogist, Frederick W. True. Geology was headed by George P. Merrill, known for his study of building stones and their weathering, meteoritics and history of geology.

It is difficult to convey one feature of a century ago, namely just how tiny was the staff. If one excludes the aides and honorary positions and counts only paid curatorial positions, including the head curators, for the fiscal year 1905, when the museum annual report was first bound separately, Anthropology and Geology each had five positions and Biology may have had at most 15.

The annual reports Goode prepared were always optimistic. Walcott was realistic. "Curators and assistants are hampered for want of room to lay out, arrange, classify, mount, and label speci-

FIGURE 17. Secretary Charles Doolittle Walcott sitting on rocks in the Canadian Rockies with his famous panorama camera. (SIA Negative number 2003-36478.)

mens . . . . Owing to the pressure for space, courts, halls, and galleries intended for exhibition purposes, both in the Smithsonian building and the Museum building, are unavoidably occupied to a considerable extent as laboratories and storerooms, . . ." (Walcott, 1900:9). He presented considerably more detail on what was wrong, and what was needed.

Besides reorganizing the USNM, Walcott saw need for other changes within the SI, but Langley was not interested. When Walcott saw a problem, he attempted to solve it, and before leaving his acting position, he performed one signal service. "During his administration 'Uncle Joe' Cannon was Speaker of the House and it was his habit after a fatiguing session to walk up Pennsylvania Avenue. Walcott, as if by chance, would draw up beside the curb with a fast-stepping bay and a light buggy and suggest a drive to Rock Creek Park, but during these rides he never mentioned business. On one occasion 'Uncle Joe' paused, his foot on the step, and said: 'Walcott, you may have a building for the [U.S. Geological] Survey or one for the National Museum, but you can't have both.' And Walcott took the Museum" (Willis 1947:32). It was not until 1974, that the new John Wesley Powell building in Reston, Virginia, became U.S. Geological Survey headquarters.

After Walcott left, Richard Rathbun, like Goode another who started with the Fish Commission, took over without the Acting in his title. He steered a course through Congress toward a new building, once Walcott had laid the financial foundation of planning money. Construction began June 14, 1902, with Langley digging a shovelfull of dirt in a plot directly across the Mall from the Castle. As the Secretary at the time, technically Langley deserves credit for the building, but his head was elsewhere. To be fair, one must note that the architects Hornblower & Marshall had plans for an incredibly elaborate dome (Yochelson 1985:25), and Langley did bring in another architect to correct that flaw (Field, oral commun., 1990). Langley died February 27, 1906, slightly more than two years after his aerodrome failed and the Wright brothers flew.

Charles Doolittle Walcott

In December, 1906, the Regents offered the Secretaryship to Henry Fairfield Osborn, the great Pooh-Bah of the American Museum of Natural History. Osborn could tell a well-running organization from one with difficulties and he promptly declined. On January 31, 1907, Walcott was appointed Secretary and served twenty years; he was the last SI Secretary to die in office (Yochelson 2001). Nineteen of his twenty years, he conducted a strenuous field season collecting fossils and studying rocks.

By 1909, the museum building was complete enough so that collections could be transferred. All items of the new structure were described in loving detail (Rathbun 1913). Thanks to the planning by Rathbun, the move across the Mall was executed with efficiency (Yochelson 1985). Except for the botanists who had their herbarium in the Castle, those involved with natural history relocated on either the ground or third floors. There was storage space for arranging collections and vast exhibit halls to fill. (Actually, the first hall to open, March 17, 1910, was devoted to art rather than natural history, for the SI had no other place to display these objects). Federal funds were always in short supply, but the scientists had a new facility and they were a happy staff. As an indication of good feelings, occasionally Walcott would write from the field to "Sir Richard."

About the time of the move, Holmes returned to the museum staff — not that he had ever really left — as Head Curator of Anthropology. In 1911, F.W. True moved up to Assistant Secretary and Leonhard Stejneger became Head Curator of Biology. Stejneger held the position for decades because he began government service as a presidential appointee to study the fur seal industry, and Civil Service regulations could not be applied to him. Stejneger is typical of the grand old men who spent their entire life in the building. When he was in his 80s, his doctor insisted the zoologist give up waltzing.

To recount the various heads of the departments through time would add to the tedium, but some of the staff who had begun as aides in the old building or the new ended up as curators; for example, Waldo Schmitt later was Head Curator of Biology (Blackwelder 1979). One name on the staff list from 1912 that must be mentioned in any history is that of C.W. Stiles, honorary curator of the helminthological collection and a career member of the Department of Agriculture. Stiles was in at the beginning of modern codification of zoological nomenclature. He was one of the original members of the International Commission on Zoological Nomenclature and served from 1895 until 1941; he was the secretary of the Commission from 1897–1936 (Melville 1995:25). Anyone who studies the systematics of living or fossil animals can recognize his significance.

The new building, second in size only to the Capitol (Rathbun 1913), was the Natural History Building of the United States National Museum, but was immediately dubbed the "new national museum." The brick monstrosity became the Arts & Industries Building, and for completeness, two tangential comments concerning it are inserted. First, a curator of Ethnology recalled visiting the building as a young child and seeing a case of a few lamps resting on crumpled newspaper. When he joined the staff in the 1950s, he opened the case and removed the 1910 paper. Second, the old building had its moment of glory in 1976 when the four remaining exhibit halls were developed as a simulacrum of the 1876 Philadelphia Exposition. One of the halls was devoted to the Government exhibits and included a replica of the Smithsonian display; eventually all this display was dismantled, to be replaced by brief temporary exhibits and now a coffee bar. The roof continued to leak. Indeed, in 2003 the rains associated with Hurricane Isabelle caused so much damage, that in

FIGURE 18. The lion family group collected by Theodore Roosevelt, shortly after installation in the first floor of the new museum; because of strong sunlight coming though the windows in the afternoon, one duty of the guards was to draw the curtains. The group was moved when the Hall of Mammals was first revised and installed as a diorama, only to be lost when the new hall opened in 2003. (SIA Negative number 24881.)

January, 2004, the building was closed to the public and the staff is gradually being moved out. What happens next to the building is quite uncertain for, wreck though it is, the place is designated as historic landmark.

Walcott aided natural history in subtle ways. *Smithsonian Contributions to Knowledge* ended in 1916, but earlier he revamped *Smithsonian Miscellaneous Collections*, making it faster and easier to publish in this series, and the *Annual Report* began to include for more original papers rather than almost entirely reprinting of published papers. These publication outlets helped supplement the *Proceedings of the United States National Museum*.

Walcott also started a report of "Explorations and Research" to provide publicity for annual fieldwork and activities; he had a section every year on his paleontological investigations and used it to publish magnificent panorama photographs of the Canadian Rockies. He raised private funds for Roosevelt's African expedition and occasionally obtained money for fieldwork by the staff. Walcott announced publications by issuing press releases, a perfectly obvious action, except no one else had thought to do so. More importantly than any other item, Walcott was an actively working scientist, who set an example for the scientists under him in the Bairdian tradition. Among his other collections were the world famous ancient Burgess Shale fossils.

Once after Walcott consulted with Schmitt comparing some living Crustacea to his fossils, the

FIGURE 19. An Anthropology display on the second floor; the figures of native Americans may have been sculpted and arranged by W.H. Holmes, originally for the 1893 Chicago Exposition.. Note the ceiling lights and the enormous amount of glass to be cleaned each morning. (SIA Negative number 2003-36481.)

young curator mentioned that the museum did not own a Camera Lucida. This is a simple device to reflect a microscope image onto a sheet of paper so an accurate drawing can be made. Walcott found the money for one, but it is an indication that, despite the new building, the museum suffered from inadequate funding for even basic equipment.

The First World War began to bring global problems, and from 1916 Walcott, as President of the National Academy of Sciences, tried to make American science part of the war effort. When America finally went to war, President Wilson requested a bit of office space in the new building for the Bureau of War Risk Insurance. The Bureau kept requiring more space, and in July, 1918 took the entire building, apart from staff offices. As one of the ironies of fate, Rathbun died the day the museum building was closed to the public.

When the conflict ended, Walcott got the museum reopened and even persuaded the Army to pay for the damage done. Rather than appoint a new Assistant Secretary or a Director, Walcott anointed William de C. Ravenel as an Administrative Assistant to run day-to day affairs at the natural history building. The staff eventually came back to the prewar level, but Federal funding could not keep up with basic requirements. A few years after the wartime dramatic growth of the Federal government, the Bureau of the Budget was established. Requests for an annual appropriation now had to be filtered through another set of offices before reaching any Congressional appropriations hearing.

November 1924, the director of the zoo died, and Walcott arranged for Alexander Wetmore to transfer from the Biological Survey to that position. Within three months, however, Wetmore was

FIGURE 20. A ground floor office in the new museum. The woman at the desk is probably Mary Jane Rathbun, sister of the Assistant Secretary, an expert on crabs and one of a small handful of woman curators in the first six decades of the building. (SIA Negative number MNH-26552.)

appointed Assistant Secretary in charge of the National Museum. Meanwhile, Walcott recognized how much the SI endowment had declined in yield relative to need and he began to develop plans for a major SI endowment drive. Walcott died February 9, 1927, and at his insistence while he was failing, on the 10th the kickoff conference for the drive convened; his funeral was held on the 11th.

Charles Greeley Abbot

The astrophysicist Abbot came on the Smithsonian scene during 1895 as an assistant to Langley (Abbot, 1958) and died in 1973 at the age of 102. In 1916, Walcott had appointed him Assistant Secretary. Early in 1928, he became the fifth secretary and he continued his research on the sun, sunspots, and weather cycles.

With still lots of space remaining in the new building and fairly new displays, plus the prospects of an endowment drive, Abbot should have had an easy time. The endowment drive stalled before it started, and collapsed as a result of the great depression. The Abbot interval might be characterized as a "do nothing" time, but that is an unfair assessment, for he and the country were in the grip of something new and terrible. There were reports of rats seen in the stairwells .and probably these are true, for the physical plant deteriorated. The staff was still employed and that alone was a tremendous administrative feat during the 1930s. Federal programs of WPA and PWA

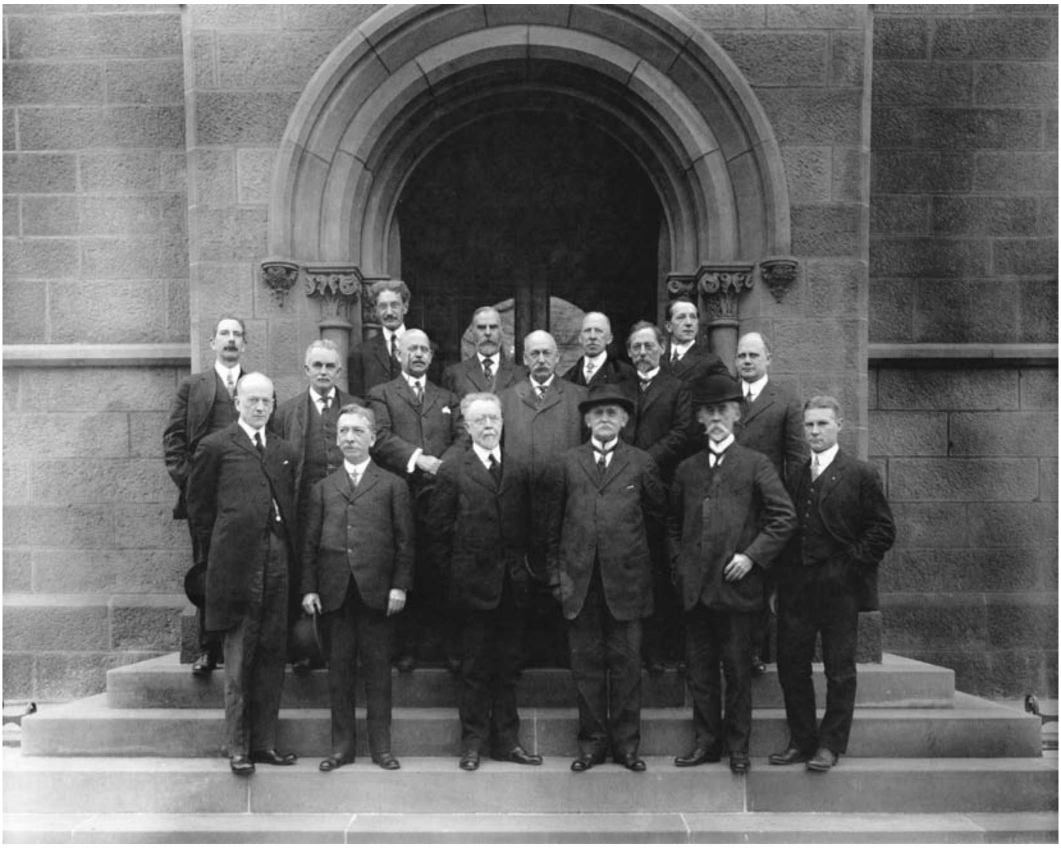


FIGURE 21. A photo of the “brass” on the east of the Castle, January 11, 1915. Secretary Walcott is the far left, and left to right Assistant Secretary R. Rathbun in charge of the National Museum, G.P. Merrill, Head Curator of Geology, Frank Baker, Superintendent of the Zoological Park, W.H. Holmes, Head Curator of Anthropology, and at the end of the row, Chief Clerk Harry Dorsey, who ran everything. On the next row, Assistant Secretary C.G. Abbot is behind Walcott, and second from the right is Leonhard Stejneger,. Head Curator of Biology. (SIA Negative number 82-3221.)

brought help into the museum, as essentially unskilled labor making card catalogues and writing labels. There is more routine work on collection curation than those who are not involved with museums realize and more than the staff can handle. As a result of this help, the backlog of specimens to record and number was reduced considerably.

One natural history effort of Abbot's time was a Division of Radiation and Organisms (Johnston 1946). Research included growing plants under controlled environmental conditions in the “Castle” basement. Abbot began the effort in 1929 and kept it going for a dozen years on “outside” money, quite a trick during those years. He started SI radio broadcasts devoted to science. Abbot wrote several volumes and pushed the completion of the twelve volumes of the popular “Smithsonian Scientific Series” which brought in funds when the days were especially grim. Again, these items sound trivial in the information age, but they were groundbreaking in the context of the times.

Abbot recognized the coming second World War and had committees in place to deliver information on such items as harmful plants and animals in obscure regions. A few of the staff had collected in areas that were essentially unvisited by the military and they had priceless life-saving

FIGURE 22. One of the dioramas installed during the 1930s in the Hall of North American Mammals, and closed during the late 1990s. The Rocky Mountain sheep were collected by Secretary Walcott and hunters, and the background painting was paid for by his widow Mary Vaux Walcott. (SIA Negative number 85057E.)

information. Washington was so poorly organized during the early days of the war that a request of an employee for a map of the Solomon Islands resulted in a map of Solomons Island, Maryland. Those servicemen with interests in natural history who were assigned to far away places, sent specimens back to Washington (Walker 1946).

The Natural History Museum was not closed during this war, for the argument was made — and accepted — that visiting the exhibits would provide innocent recreation for the young soldiers far from home. It is not generally known that because there was such concern over possible bombing of Washington, that type specimens were wrapped and moved out of the city. In mid-June 1994, Abbot officially retired, but continued investigations into his late 90s.

Alexander Wetmore

At the January, 1945, Regents meeting, Assistant Secretary Wetmore was appointed the sixth Secretary. After a century, the SI was finally in charge of a scientist with a Ph.D. Wetmore's primary research activity was ornithology and his studies are still treasured. Following the close of the war, staff members came back from the military, a few new positions opened and collections began to accrue at an increasing rate. Wetmore had little time to prepare for a major event, so the SI Centennial in 1946 was commemorated by the issuance of a small booklet, articles in a few scientific journals, a postage stamp, and a modest local celebration.

During the years when USNM Director Wetmore reported to SI Secretary Wetmore, the administration ran smoothly, which is just as well, for there were difficulties of rebuilding after the war. In 1947, the basic departmental structure began to change when Director Wetmore divided the department of Biology into Zoology and Botany, and a few new staff positions were available.

In 1948, Remington Kellogg was appointed USNM Director. He is remembered as an expert

FIGURE 23. Seventh Secretary Leonard Carmichael to the left of former Secretaries Abbot , and Wetmore. Dr. Carmichael obtained funding to replace the aged displays in the natural history building. (SIA Negative number 42377-C.)

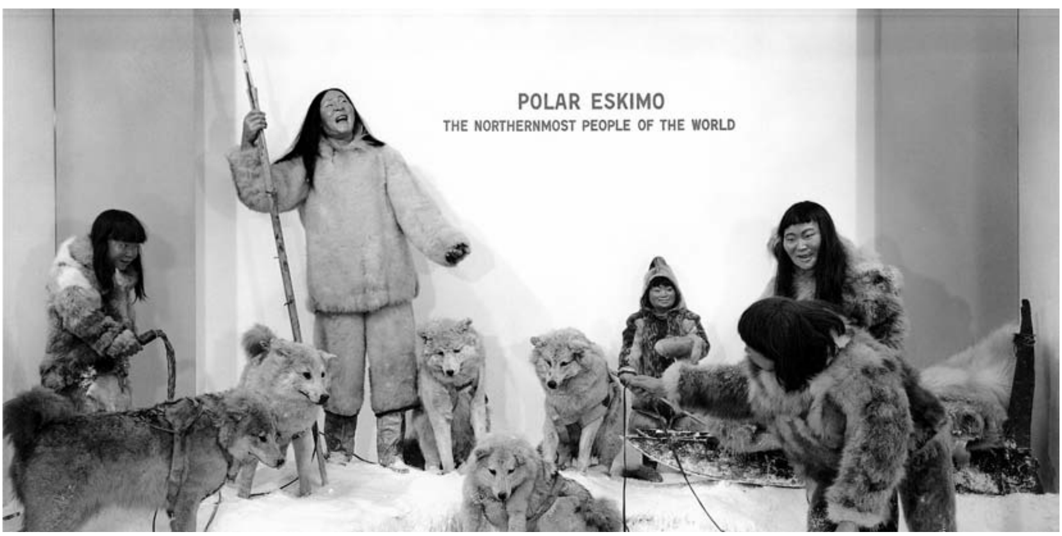


FIGURE 24. The" Polar Eskimo" as an example of an old displays refurbished. It is one of the few remaining dioramas in the building. (SIA Negative number MNH-035.)

on both living and fossil whales and he fought for years to slow the slaughter of whales. In keeping with rumors at the time of primates in the Himalayas, because of his administrative style Kellogg was known as the "abominable no man." When Wetmore retired in December, 1952, he returned to full-time research in the Division of Birds until he was in his 90s. Dr. Wetmore, who died in 1979, was a cautious, gentle man.

One opinion Wetmore voiced summarizes the tenor of the SI and the USNM just after World War II. Because the museum was a Federal establishment, no sales tax was paid on any purchases. If a shop was opened in the museum to sell items to the tourists, his dual concerns were that this would be unfair competition with the local merchants and, further, might result in adverse publicity and the wrath of Congress.

Leonard Carmichael

The first six secretaries had alternated between physical sciences and natural history in their own research interests, but almost certainly this was happenstance, not any inherent pattern. If there was a pattern, it was broken by the appointment immediately after New Year's Day, 1953, of a Secretary from the outside world with no personal experience in either natural science or museums. Leonard Carmichael was a psychologist who had an academic background, but had been extremely active in Washington during the war marshaling scientific manpower.

Administrative actions in the "Castle" were to have an effect on the organization. Within four years, the USNM was subdivided into a Museum of History and Technology and a Museum of Natural History. During 1958, after Kellogg moved on as Assistant Secretary in overall charge of the museums, A.C. Smith became the Director of Natural History. Smith was a botanist who had worked briefly at the museum before transferring to the new National Science Foundation. Under Smith, an Office of Oceanography was installed in the museum and it tapped funds that resulted in an almost explosive growth in the staff. After four years, Smith left and T. Dale Stewart, a physical anthropologist, became Director.

In 1957, the Russian Sputnik focused attention on America's seemingly second-class position in science. Suddenly money for research was no longer in short supply. Along with his concern that research be properly supported, Carmichael was able to persuade Congress to grant money to improve the exhibits in the natural history building, nearly unchanged since the 1910s. The first cycle of more modern exhibits began to appear in halls of natural history (Yochelson 1985). However, the first hall to be modernized, devoted to Latin American archeology opened April 14, 1954, due entirely to the single-handed efforts of Clifford Evans and Betty Megers.

The affiliated agencies, which had offices in the museum, grew relatively rapidly in new staff. Until "oceanography" provided new funding, the museum staff itself had only modest growth and money was still short. On the other hand, morale was high, hope was in the air and a few people were able to travel overseas for collecting and study. It is useful to note that in March, 1959, Secretary Carmichael dedicated the Fénykövi elephant. This is the largest Recent land animal on display in any museum. It was placed in the Rotunda and for the first time the Natural History Building had a symbol.

Even more significantly, Carmichael obtained funding for the wings on the museum building. This is a great Washington story of one administrator outwitting another (Yochelson 1985:104-105). In 1928, Congress passed a bill authorizing wings on the building but never followed with an appropriation. A special SI assistant determined that the authorization was still in force and asked the head of the Bureau of the Budget for money for two wings. This was refused, but a request to Congress for money to construct one wing was approved. With an appropriation in hand, construction on the east wing began in 1960. Any Congressman could see that the building was asymmetrical, and three years later the west wing was under construction.

Along with the wings came air conditioning. One is hard pressed imagine living anywhere in Washington without this convenience, but the building was particularly grim. It began to soak up heat in March and continued to get increasingly hotter until October when outside temperatures dropped and it then became increasingly colder. There were other amenities installed. One old-timer considered that the two greatest advances in systematics during his time were fluorescent lights so that one could see the specimens, and closer bathrooms; the main museum building had only one set of toilets on the third floor and another set in the foyer.

Before Carmichael retired, the Department of Entomology had been created and Geology was divided into departments of Paleobiology and Mineral Sciences. The transfer of some of the staff and collections to the east wing was more or less concurrent with the end of the concept of lifetime appointments for departmental heads and the start of departmental chairmen serving for a fixed term; the change in title may have been deliberate, for chairmen had far less power. As an example of the weird comments, which might pass for humor in a museum, T. Dale Stewart, whose forte in physical anatomy was skulls, was a curator of heads and, therefore, when the title of chairman came into vogue, he became known as the last head curator in the museum.

The end of January, 1964, the National Museum of History and Technology — now American History — was dedicated by Secretary Carmichael. The following day, the Ripley era began. The

FIGURE 25. The one-winged museum looking northeast. Years after the west wing was added, a building was constructed in the west courtyard and then another in the east courtyard. (SIA Negative number P63361-B.)

time of Secretaries Carmichael and Ripley were a golden era for the study of natural history in Washington, and its like may never be seen again.

S. Dillon Ripley and the National Museum of Natural History

The patrician ornithologist Ripley had been employed briefly in the Division of Birds at the museum during his graduate student days. Following World War II, he went to the Peabody Museum of Natural History at Yale University and became its Director. When Ripley moved to Washington, he had definite notions of what he wanted to accomplish and ". . . he had both class and stature . . . ." (Challinor 2003:301). The two secretaries who significantly changed the course of the Smithsonian were Baird and Ripley. The former forced change by steadily increasing pressure over decades. The latter did it with a dramatic commemoration of the 200th birthday of James Smithson in 1965. In the most positive sense, it shook to the rafters what had been a staid, gray institution. "Examples abound of Ripley's willingness to confront the executive branch to protect the independence of the Institution" (Challinor 2003:300).

As he wrote a few years later "These are excited times. . . . The Smithsonian Institution is in a fortuitous position to focus on the problem of change" (Ripley, 1970:v). A great deal happened, in a short time, but how, let alone why, is difficult to catalogue. The last Annual Report was for the fiscal year 1964. When Smithsonian Year began a few years later, it was an entirely different kind of document. During this gap, the last *Bulletin*, number 293, came off the press in 1969. The last *Proceedings*, volume 125, was published in 1968.

The two museums of History and Technology and of Natural History were under one Director-General for several years and under a second for even a shorter time. Then the name of the United

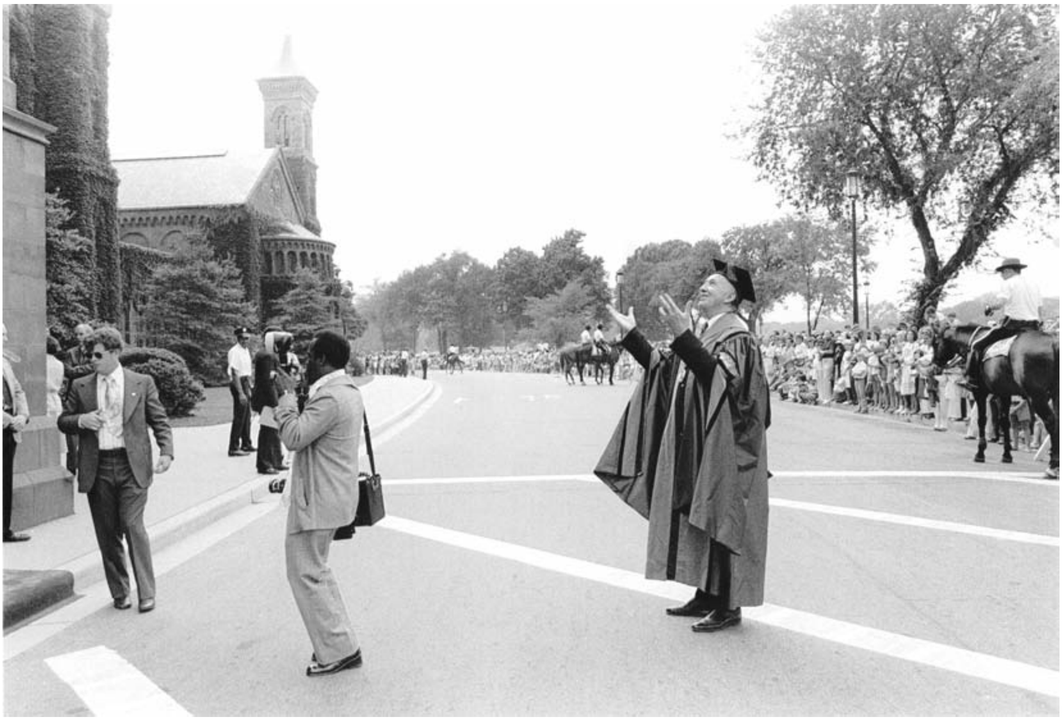


FIGURE 26. Eighth Secretary S. Dillon Ripley, a happy man, in front of the castle in 1965 at the celebration of the 200th anniversary of the birth of James Smithson. (SIA Negative number 76-8525-90.)

States National Museum vanished as mysteriously as it had appeared. A National Museums Act laid out some duties, but little funding, followed by no funding, effectively ended any semblance of an overall museum. On March 24, 1969, the official name of the place of interest here became the National Museum of Natural History. For those interested in administration, the various museums and research organizations were considered by the SI staff in the Castle as bureaus under the Institution. In theory, the head of each had an equal voice, regardless of the size of the facility or the number of staff he directed.

At some uncertain point in time, probably during the early days of the Ripley era, a Museum of Man came into being and was somehow affiliated with, or is part of, Natural History. The name appears on one or two door plaques of the natural history building and was occasionally mentioned in official reports. It is not clear what its staff and function were supposed to be. As the Museum of Man exists today, it is in the form of letterheads and it was never a paper tiger or even a house cat. Another stray item of interest is an unpublished 1972 marketing study of the potential of the SI to increase private monies. Thereafter, the shops and business enterprises began to slowly appear.

In the last year that Stewart was Director, the west wing was completed. With more space, the Department of Botany was moved from the Castle and for the first time, all natural history was under one very large roof. At the start of the fiscal year in 1965, the department of zoology was divided into two departments for vertebrates and invertebrates, respectively. An Office of Ecology and an Office of Systematics were emplaced in the office of the director, though neither had the impact brought to the museum by the Office of Oceanography. At about this time a new series of Smithsonian Contributions to . . . began to appear from each department to replace the two defunct publication series.

Prior to 1964 — the records are a little fuzzy — some of the curatorial staff organized a "Senate of Scientists." The officers met occasionally with the director, as a group distinct from the chairmen with different concerns. Among their few activities, they arranged informal gatherings with various members of the secretariat in an attempt at mutual understanding. One action that did not endear them was to set up a paper Smithsonian investment committee that in a few years of stock picks would have yielded a substantially higher return.

During March 1966, Richard S. Cowan became Director, moving up from Assistant Director. Like A.C. Smith, he was a botanist who had worked briefly in the Division of Botany before transferring to the National Science Foundation. The times of both Smith and Cowan were characterized by growth in the staff and relatively high levels of funding for research. "In 1967, the office [of systematics] staged the first annual summer institute in systematics in collaboration with a number of outside agencies" (Oehser 1970:222). This three-week, three-ring activity continued for four more years and greatly aided the careers of scores of young systematists. (I was in charge of the first one and am pleased to have that fact on my résmué.) Cowan also suggested that the staff and collections might be moved to new quarters on the Department of Agriculture experimental farm at Beltsville, Maryland, but there was too much resistance to this plan and it died. Cowan stepped down late in 1972 and returned to his plant investigations.

Another far-reaching development was the nomenclatural activity of Curtis Sabrosky, an entomologist paid by the Department of Agriculture to work at the museum. For many years, beginning in 1963, he was a long-time member of the International Commission on Zoological Nomenclature; Sabrosky assisted with two revisions of the Zoological Code. In the Department of Botany, Daniel Nicolson played a comparable international role as regards botanical nomenclature and was involved with four revisions of that nomenclatural code.

In mid-January 1973, Porter M. Kier took over as Director, after Cowan returned to the

FIGURE 27. The staff of the newly created Department of Invertebrate Zoology in 1965, as representative of staff increase. In the second row, far left, is Waldo Schmitt, the last Head Curator of Zoology. Three of the curatorial staff hired in 1964 are still active. (SIA Negative number MNH-1536.)

Department of Botany as a curator. Kier was a paleontologist specializing in fossil echinoderms, especially sea urchins. To consider physical structure first, the original natural history building was built around two hollow courtyards. During Kier's tenure, a substantial structure was built in the west courtyard, after a few temporary buildings, which had been used to fabricate the new exhibits that Secretary Carmichael had funded, were dismantled. The lower floor contained a few classrooms and a cafeteria, the first place to buy a meal in the history of the building. The second floor was a naturalist center where interested amateurs could identify specimens and learn more concerning natural history. Some of the activities formerly in the west court were transferred to temporary structures in the east courtyard. Kier is also to be credited with installation of an escalator from the foyer to the rotunda. The staff was certain that he was wrong in his view that hoards of people would visit the museum during America's bicentennial. But Kier was right!

Although the growth of the scientific staff slowed, the scientists had a feeling that they were well represented in the necessary dealings across the Mall. Several people who had come to the museum earlier and still remain judge Kier to be the finest director in their memory for he circulated among the staff and seemed to know what almost everyone was doing. Kier agreed to serve for five years. At the end of that time he had a vote by the staff and with their support stayed in office for another year, until mid-1979. Kier spent a short time back in the Department of Paleobiology. Then, having seen almost all of the collections in the world of echinoids which interested him, and having studied the group to his satisfaction, he retired.

After an interim with an acting director, James F. Mello, Secretary Ripley let it be known that he wanted Richard S. Fiske to apply. Fiske applied in November and was appointed director in January, 1980. He had been a member of the U.S. Geological Survey and had transferred to the Department of Mineral Sciences a few years earlier. Funds were still sufficiently fluid so that when a staff member was lost to a department, a replacement could be hired for that department. Fiske was even able to obtain new congressional funding to build an outstanding group for the study of volcanology and rapid dissemination of information on eruptions, and a Caribbean reef initiative. Near the end of his time, the foundation was also laid for new Federal money to support Arctic anthropology. When Fiske returned to research, he could note that the Museum Support Center had opened and the ground floor of the NMNH boasted a fine gallery for temporary exhibits in the foyer.

To return to more general matters that impinged on the NMNH, Dr. Ripley died March 12, 2001, and received, appropriately, a memorial tribute on the Mall in front of the Castle. He had created out of the old SI a very large dog to match in size the tail of the USNM, which Baird had formed. Indeed, considering relative size and importance of its function, this "tail" of natural history may have been a little small to be in the correct proportion. It should also be noted that during his time, the NMNH was not engaged in any fund raising.

To quote an older work "I have a feeling that the Smithsonian, with it phenomenal growth, has not been entirely successful, probably inevitably so, in escaping the pitfalls of overorganization and overmanagement. . . . . I have portrayed the Smithsonian - a great though not perfect institution — as I see it and in historical perspective" (Oehser 1970:x-xi). Even with this earlier expression of disquiet, it may be too soon to evaluate Secretary Ripley's manifold accomplishments, which resulted in opening eight museums and doubling the number of visitors, along with significant new initiatives.

Still, since "fools rush in," I must now play the devil's advocate. Near the end of his tenure, I think Ripley reached too far in creating new entities. When told by Congress that there were to be no new buildings on the Mall, the tenor of his response was that the area behind the Castle would be the first building under the Mall. As his final major project, funding was secured for the Quadrangle complex, but relations with Congress, which had been mutually congratulatory for years, were certainly cooled. No one intentionally overextends, but by 1984, the Smithsonian may have been overextended.

To continue in this vein, it is difficult to define certain general terms to the satisfaction of all. Even so, it is my view that during the two decades when Ripley was in charge, the Smithsonian Institution moved away from the field of "knowledge" and into the sphere of "culture." One of the keys to the dramatic growth of the Smithsonian was that the rigid line between public and private funds was breached. Everyone became confused as to which monies were involved where to do what. This was surely not the intent, yet in my judgment the consequence is that this confusion of funds and purpose became the root causes of subsequent difficulties in obtaining appropriate Congressional appropriations.

The notion that the SI, and especially the museum, was in some aspects a sort of a university was bruited about during this era and at least a few staff members with hubris viewed themselves as more than mere civil service employees. Yet, how can one decry the vision of this extraordinary man. If he has one monument, apart from several buildings, it is the annual Folk Festival on the Mall (Kurin 1997).

FIGURE 28. A staff member at work with a Scanning Electron Microscope. Photo by Chip Clark.

Robert McCormick Adams

The ninth, tenth, and eleventh Secretaries are alive and active. As a typographical device to distinguish them from their forebearers, no pictures of them are included. To otherwise mark them distinctively might be taken as an indication of disrespect where none is intended. With that caveat, recall the introduction noted that current events and those that are immediately past differ from traditional history.

The domain of history was past after Secretary Ripley retired, or perhaps even during his tenure. Journalists can draw value judgments on the events they witness, but history requires time to marinate views. Notions on exhibits changed and "political correctness" became an issue (Henderson and Kaeppler 1997). It remains an issue for the new mammal hall brought up concern about trophy hunters and that old bugaboo evolution; shortly before the opening of the National Air & Space Museum where the "Enola Gay" is displayed, a group asked that labels contain information on how many were killed by the atomic bomb dropped on Hiroshima. Still, to continue the story one must at least touch on events of the last two decades. As a further difficulty in rendering judgments, all former directors from Kier onward are still very much alive and two are quite active in museum research; likewise acting and interim directors are equally active.

The decade following Secretary Ripley was presided over by Robert McCormick Adams, an anthropologist from academia interested in ancient irrigations systems. If a brief comment on this interval were necessary, the two words I would choose would be "financial decline." In regard to appropriations, relations with Congress did not begin well and from there went downhill. Several persons have indicated that Secretary Adams lacked "charm" and that he preferred detailed intellectual discussion of a subject to decision making.

If a holophrastic summary is wanted, probably "drifting" is realistic. Each part of the Smithsonian empire was effectively cut loose to succeed or fail without much overall direction, though the more elegant term "decentralization of functions" was used. In keeping with some of the other "bureaus," the museum organized its own office to solicit private funds. This may have been inevitable as pay raises authorized by Congress, but without increase in appropriations, began to take their toll. Increasingly, funds were used for salaries and most of what little money was left seemingly went into buying or upgrading computers. Old-fashioned Civil servants would have been shocked by the concept of fund raising, for Federal employees are forbidden to solicit money. Those in "development" were Smithsonian Trust employees and their activities were legally correct; the moral issue of whether any fund raising for a Federal establishment is appropriate or not, is not a legal point.

During March, 1985, the natural history building celebrated 75 years of its first public displays (Yochelson 1985). Among a few scientific activities, a grand party filled the rotunda; it may be that even the elephant did a little jig on his pedestal. Nine months after Secretary Adams was installed, with James Tyler serving as Acting Director to space them, in June 1988 Fiske was followed in the Director's Office by Robert S. Hoffmann, a mammalogist.

Hoffmann had spent a sabbatical at the Museum, but had no other ties to Washington. Still, for many years both at Montana and Kansas he had been in charge of the natural history museums and, accordingly, had knowledge of the kind of research that was appropriate for the building. Money was becoming tighter. Hoffmann was aware of difficulties and had an outside management make a report on the condition of the museum. As a result, low morale was recognized as a serious problem, and staff members were formed into a number of committees to advise on how to correct this and some of the other concerns.

Hoffman was not able to accomplist much of a change in direction. Unfortunately, Federal personnel ceilings and restricted funding are intractable hurdles for most any director. So, after only eighteen months in the museum building, he transferred across the Mall, leaving the museum Director's office to become Assistant Secretary of Research, for four years, and then Assistant Secretary for Science, for another two. The move of Hofmann across the Mall resulted in James Tyler again serving as Acting Director in the large southwest corner office before Frank Talbot was appointed. Talbot began life as a marine biologist primarily concerned with the systematics and ecology of marine fish, but his career was mainly that of an administrator running several different museums on several different continents.

Following Talbot's arrival, one small exhibit space became an elaborate director's conference room. The hall of physical anthropology simply vanished and was replaced by a series of offices. Halls for physical geology and for mineralogy were closed for major rebuilding before all the necessary funding was in hand. The Insect Zoo was rebuilt and renamed the O. Orkin Insect Zoo. The director's office saw nothing wrong in naming Federal public space after a donor and was quick to state that the name was, of course, that of an individual, not the name of company dedicated to killing insects. As another development, the number and size of shops in the building grew, further nibbling away public displays. All of this commercialization led to diminution of public exhibits and the foyer became the site of two large shops. Concomitant with these activities, there was an exponential growth in the office of director with four associate directors, each with a staff. Meanwhile, the numbers of the scientific staff continued to decline. Increasingly, each temporary exhibit had an associated shop.

Talbot was aggressive in seeking outside funding for exhibits and had some success. Like Cowan, Talbot seriously discussed moving the staff to the campus of the University of Maryland or the Department of Agriculture Beltsville Agricultural Research Station. The initiative actually

FIGURE 29. Entrance to the Hall of Geology, which emphasizes plate tectonics, meteorites, and volcanism. The original hall lasted for nearly 40 years, before being closed for office space; a new hall opened with this globe and when it was rebuilt, the globe was recycled. Photo by Chip Clark.

moved to the stage of examining several sites, before it foundered. Talbot retired and returned to his adopted home in Sydney, Australia, from whence he had come via a stint in San Francisco as Director of the California Academy of Sciences. In his place, Robert McCormick Adams was appointed Director.

In some sense, two events help define the Adams period. First, the Board of Regents deemed it proper to provide a house for the Secretary; this property was later sold. One may speculate that the action was based on the notion that universities provide presidential housing and therefore the SI should emulate them. At that time, the cost of this property was nearly the same sum as the Smithson bequest. Granted that the effects of more than a century of inflation make for a poor comparison, it is in symbolic of what was deemed important. Few of the natural history staff remarked on this event, but other actions or non-actions continued to lower morale. Second, after Secretary Adams retired to become an adjunct professor, the press release issued by the University of California, San Diego, listed his many honors and accomplishments, but did not include his ten years as Secretary of the Smithsonian.

During the latter part of Secretary Adams' tenure, the west court building was torn down and replaced with a far taller structure. The Naturalists' Center moved to suburban Virginia and seemingly there are no plans to return it to the museum. The new building contained a public cafeteria, an IMAX [Registered trademark] theater and an interactive computer theater facility on the upper floor. The new theater was to be the principal contribution of NMNH to the 150th anniversary celebration in 1996. Further, within three years, revenues were anticipated to pay for the equipment and running costs and thereafter provide scads of funding. The theater finally did open in the latter part of 1999; seemingly, the anticipated flow of money has not yet trickled down very far, for the debt has not yet been fully repaid.

In fact, during the second half of the Adams decade, some of the SI Trust employees were terminated with little notice. It was a graphic lesson in the difference between employees in the various museums who were on the Federal payroll and those dependent on Smithsonian trust funds.

Although it did not directly affect the NMNH, unfavorable criticism of an exhibit in the National Museum of American History which reinterpreted western history marred the earlier part of Adams tenure. His era ended with a flaming argument centered on an exhibit proposed for the National Air & Space Museum, but the smoke from it engulfed the entire institution. Never had the SI been subject to such unfavorable publicity.

I. Michael Heyman

The tenth Secretary, a former professor of environment law, at the University of California, Berkeley, took over in the midst of difficulties. He put out the major fire at the Air & Space Museum and few minor ones elsewhere within the SI. Likewise, with his greater concern for personal relations, he was able to improve relations with the Office of Budget and Management and with Congress though he was not an insider as the term is applied in Washington, and his efforts were accordingly limited. He was also able to bring in some private funds to augment the Smithsonian endowment. Even though all this considerable effort was useful overall, virtually none of this effort materially affected, let alone improved, the lot of the natural history museum, for decline in staff continued and research funds diminished.

In keeping with the “university” approach, a change from Assistant Secretary for Science to “Provost” occurred. Understandably, a new Secretary would want his own advisors and after as short period, Hoffmann returned to the museum building to continue studying mammals. With little in the way of a formal search and less fanfare, Dennis J. O'Connor, from the University of California, Los Angeles, became the second provost. His background was primarily in academic administration, though he had begun his career briefly in genetics and had no experience in museums. After a relatively short time, he was regarded by some members of the natural history staff who had dealing with him as a person who would say one thing in a conversation and then take an action quite different.

More or less at the start of Secretary Heyman's tenure, Talbot left as Director of the National Museum of Natural History, though the foundation for this change may have been laid earlier. He retired as a result of “ill-health,” with a year's salary so that he could resume his research at another location. Donald Ortner, a senior physical anthropologist took over as Acting Director for a stay of two years in the front office. With the title of “Acting,” there was little of a permanent change he could affect. One accomplishment was the first “bug day” on the Mall. This Saturday event now occurs every other year.

The sesquicentennial of the Smithsonian Institution occurred in 1996; there had been essentially no planning for it by the previous secretary. Some fine things were done to mark the year. On the other hand, by taking the advice of outside consultants who wanted a major traveling exhibit and not taking the advice of the SI organizing committee who saw problems, the net result was a major loss in trust funds were lost. Some accounts place the loss at 60 million, though this may include hoped for donations that never materialized As a result, the SI Trust funds which had helped to support post-doctoral investigators and bring in short-term scientific visitors for the NMNH and other parts of SI vanished.

Work began on a reconstruction of the heating and air conditioning in the museum building. This affected the third floor of the older building and the sixth floor of the wing. As a result, most of the Department of Anthropology and all of Division of Birds, respectively, moved into what had been exhibit space on the second floor. The halls full of former displays of Native American pots and arrowheads had already been closed for well more than a decade when the library was remodeled and had never been reopened for public exhibits. As might be expected, the construction scheduled for eighteen months took about twice as long. Independent of this disruption, because Federal funds for salaries were so short, the SI received authorization from the Office of Management and Budget for employee "buyout" and for early retirement. Some at the museum availed themselves of this opportunity to leave. These were particularly among the ranks of what might be termed scientific aides, a group always in short supply. As an indication of change in exhibits, the last taxidermist to help reconstruct the Fénykövi elephant retired.

Early in 1996, Robert Fri moved from the think tank "Resources for the Future, Inc." to become Director; previously he had been assistant director of the Environmental Protection Agency. Seemingly, there are neither strongly positive or strongly negative comments on his tenure, for the general view was that all power resided in the Castle and there was little a director could do to influence the course of events. The title of Director does not necessarily convey information concerning the person in charge. Fri was commonly viewed by the staff as an administrator rather than a leader.

When the disruption of the anthropologists finally stopped, the staff on the fifth and fourth floors of the east wing was displaced. Those who studied mollusks moved to the west wing, whereas the Department of Mineral Science moved to the vacated space on the second floor. That reconstruction took about two years. Along with this, work began on a building to be placed in the east courtyard. Earlier, the air conditioning plant was moved to the east parking lot and various buildings in the courtyard were demolished. All waste material moving out and all building material moving into this interior space had to be hoisted over the roof. This construction was not an inexpensive operation.

Lawrence Small

This now surely brings one to the time of current events, which from several different aspects brings considerable discomfort in writing a chronicle, let alone making an evaluation. As with all the secretaries, the eleventh Secretary was appointed by the Board of Regents, and reflected their immediate concerns. The appointment of L.M. Small was announced during September, 1999, and he was installed January 24, 2000. He was a former banker and money manager, and he has made no pretense of a scientific or academic background.

Secretary Small began on a high note by noting the deterioration of the buildings. He moved funds and changed priorities so that work on the heating and air conditioning in the east wing stopped with the job half completed, though this was no hardship for those in the Department of Paleobiology on the second and third floors who dreaded being displaced.

Meanwhile some work on the west wing and on the roof continued. He also took control of a variety of small funds which had accumulated from honoraria and book royalties; the Federal employees could not directly accept these monies, but they could be used to support travel and research. Their loss resulted in a view that this was a first attempt to remove natural history research from the Smithsonian.

Within the Castle a plan was developed to reorganize scientific activities and "focus on fewer than double digit numbers of research areas." There was so little consultation with those concerned that it became known as the stealth plan. While Secretary Heyman was still in office several committees were appointed to evaluate the various departments. Considerable uncertainty and unease was in the air as to what sort of reorganization might take place. Early in February, 2000, Director Fri announced a Department of Systematic Biology, formed by combining the four departments which dealt with living organisms:, Invertebrate Zoology, Vertebrate Zoology; Entomology: and Botany. It added another level of management, and partly as a consequence, two of the four fund managers involved, retired. Although about 35% of the NMNH curators are involved with marine organisms, there was now no longer any voice for marine biology when the chairmen meet with the Director.

The first week of April 2000, the Castle announced plans to abolish the Conservation & Research Center of the zoo, at Front Royal, Virginia, and the Conservation Analytical Laboratory, at Suitland, Maryland (Trescott 2000). Morale plummeted and dudgeon rose. Those who had earlier stated that things could not get worse apologized to their colleagues, for rightly or wrongly this was perceived as an all-out attack on science by the high level Smithsonian administration. *The* actions provoked comment from outside the Institution in many journal and newspapers, all of it adverse. Although for many newspapers, the problems at the SI were front-page news, The *Washington Post* invariably assigned SI events to the "Style" section. The storm of unfavorable views eventually reached Capitol Hill, and within a month the proposed abolition of these units stopped in its tracks.

In retrospect, there have been several different guesses as to the cause of the brouhaha. The most benign is that the budget shortfall was $5,000,000 and the budget of these two groups totaled that amount. One persistent rumor is that to retain his position, the Provost simply offered up these facilities without any consideration as to merit of the choice. More sinister scenarios have been suggested, but there was much gossiping and few facts.

The premise that funding was in critically short supply was absolutely correct and the corollary that not all current activities could be supported was equally correct. Notwithstanding these basic considerations, someone should have foreseen that the lack of explanation and the heavy-handed approach were bound to prompt major upset.

A few months later, additional unfavorable publicity ensued in connection with donations for halls at the National Museum of American History and the issue of how much control a donor, either private or corporate, should exert over an exhibit. This did not directly impact those in natural history, but sale of the "naming rights" for halls became an extremely sore subject, and adverse publicity affected everyone under the aegis of the SI. All in all, 2000 was not a good year!

During the late 1990s, a "Congress of Scholars" was initiated in part to see if the concept of the NMNH Senate of Scientists could be expanded to other parts of the Institution. For the first year or two little was accomplished by that group, but the attempt to close facilities energized almost everyone. One wag asked to comment on the early days of the Small regime, pondered and stated "Well, he has become a cohesive force." Others speculated that Ripley was 20 years in office, Adams 10, Heyman 5, and perhaps Small would only have 2½ years in the position. This is simply an example of scientific minds trying to interpret any area alien to their accustomed sphere.

However, 2001 was no improvement over 2000. The Director of the NMNH, Fri, announced his retirement in May of 2001, shortly after the plan to close the two facilities was blocked, announcing that he could not support the plans of the Secretary (Trescott 2001). The Provost, now retitled Under Secretary of Science, was then simultaneously appointed Director of the Museum. This did nothing whatsoever to improve morale and lower the level of gloom. To add to that, in December, the Office of Management and Budget announced a plan that would have effectively gutted the SI. In accordance with Harry Truman's desk sign "The buck stops here," those who have laid full blame on the Secretary for the debacle of 2000, should bestow full credit for thwarting the plans to cut funding (Trescott 2002).

By early 2002 most of the adverse public publicity had died down. More importantly, there was a feeling that perhaps the nadir had been reached. After a relatively short stay wearing two hats, O'Connor left for Academia. Research then seemed to have gradually come to the fore both in Secretary Small's office and elsewhere in the Castle. The NMNH staff was pleasantly surprised when a sensible interim appointments of an Under Secretary was made from the Smithsonian Astrophysical Laboratory. He in turn interviewed members of the museum staff, especially the newer ones and selected an Interim Director. Douglas H. Erwin, a paleontologist assumed the role. The relatively rapid appointment of a new Under Secretary, David Evans, who had been a Federal employee, a scientist and an administrator of scientists, was a positive development.

The search for a new director seems to have been conducted in a thorough manner and on April 1, 2003, Cristián Samper assumed office. From then to submission of the manuscript is too short a time to evaluate the impact of a director, unless he is incredibly bad. That is certainly not the case with Dr. Samper! One of his first actions was to become affiliated with the Section — formerly Department — of Botany. He has been seen around the building more in these few months than his predecessor was in years. The new Director has been frank that the funding situation for at least a year, and perhaps longer, is grim. Nevertheless, he has projected an aura of caring about the museum in general and research in particular. Morale has improved though a stage of hopeful waiting to hope; there is a feeling that for the first time in over a decade positive actions might occur.

Meanwhile, Secretary Small has had his interest in science sparked and during the spring of 2003 had a meeting with scientists from the affiliated agencies, a first for the Castle administration, and agreed by all as a good event. Early in November, 2003, Director Samper dissolved the Department of Systematic Biology, and reinstated the Departments of Botany and Entomology; the remainder constituted a Department of Zoology. The new Hall of Mammals (Fig. 30) opened on schedule in mid- November, providing another boost to the Samper regime. It is architecturally spectacular; the cost was $31,000,000.

In the wake of the attempts to close the facilities mentioned above, an SI Science Commission was appointed in 2000 by the Regents. Its charge extended beyond natural history, though this was a significant factor in its conclusions. The commission consulted with a variety of staff members during the process and submitted a long report to the Regents January 7, 2003. An hour before noon the full report was placed on a web site (Sabloff et al. 2003). The next morning this effort resulted in a front-page article in *The Washington Post*.

The report provides an opportunity to document the current speed of dissemination of information. Within an hour, a colleague in Indiana received a phone call from a former student currently at the museum. Shortly thereafter, he noted on the Sigma Xi website, a summary of the newspaper article and reference to the website containing the full text. When he next consulted the electronic *Chronicles of Higher Education*, the same information was present. For better or for worse, the report must have been available worldwide in less than a few hours.

The Science Commission was not the only group that was active. As mentioned, over the last few decades, the line between government and private funds has been so confused that many can no longer make a distinction. Indeed, in 2002 the Office of Management and Budget suggested that Federal funding for research at the Smithsonian's Astrophysical Laboratory, the Tropical Research Institute, and the Environmental Research Center be transferred to the National Science Foundation, and that employees should compete for funding against their colleagues in academia. Fortunately, the NMNH was not included and one can surmise that the suggestion was based primarily on summing up the total funds involved without concern for their purpose. It has been a standing policy that Federal employees cannot be funded by the National Science Foundation.

Fortunately again, both the National Academy of Sciences and the National Academy of Public Administration were asked to comment and both responded with strong reports against such a specific idea. These appeared shortly before the Science Commission report. In my view, short-

FIGURE 30. A portion of the central part of the new Hall of Mammals, which opened in mid-November, 2003. The older mammal hall was to the left, life in the seas was in the center, and birds were to the right. Photo by Chip Clark.

term grants, which are the norm for the National Science Foundation, place a premium on short papers, whereas the works that are significant in natural history studies are monographic and of necessity are long-term projects. In contrast to the two reports mentioned above, the Science Commission recommended that the staff be allowed to apply for NSF grants. If that is put in effect, a possible short-term gain in research funds, may lead to a long-term decline in Federal funding. Current competition for NSF funding resembles a shark feeding frenzy and I doubt that this situation will improve, though one can always hope. As a result of this flurry of reports, a new arrangement between the SI and the National Science Foundation is in process and it may result in more funding.

Whereas the attempted closing of two facilities was front-page news for days in the Washington papers, the elimination of five persons who delivered mail around the various buildings of the Smithsonian was not. Whereas, each mail stop used to receive its mail and then sort it for the staff, now each day someone must take the outgoing mail to a central spot and bring back the incoming material. This appears to be a saving, on paper, but it is yet another way to use the time of assistants and to delay research. The bottom line always seems to overshadow the big picture.

The new east courtyard building opened in 2001 and the architects had done an excellent job. The upper floors were devoted to entomology, the best collection and research space the group has ever had. The lower floors were offices and several class rooms, along with a much improved day care center. A nice touch is a small playground in front of the east wing for the toddlers. It gives a little life to the place.

The SI again received some unfavorable publicity during the winter of 2003 with the death by poisoning of two animals of an endangered species, culminating a series of earlier animal deaths at the National Zoological Park. This led to an inquiry by a House of Representatives Committee, but fortunately once more, the committee was relatively sympathetic. The National Academy of Sciences has been asked to examine the zoo. No one at the NMNH has commented, but there seems to be unspoken agreement that the skinned, pickled, pinned, and rock-like specimens have some advantages over the living ones subject to dying unexpectedly.

Outposts

Although the National Museum of Natural History consists primarily of a large building on the Mall, it does have a presence elsewhere. Perhaps a more appropriate heading for the topic would be "field stations," but that is not quite accurate either. To begin, when the Panama Canal was flooded, Barro Colorado became an island in Lake Gatun. The potential for natural history study appealed to a few hardy souls and for three decades people came and went under limited administration. In 1946, the Canal Zone Biological Area was placed under the SI. Whether it was ever formally part of the United States National Museum, is not clear, but Washington natural historians did use its facilities. Under Secretary Ripley this facility became the Smithsonian Tropical Research Institute (STRI), and was administered as a separate entity from the museum.

Also under the Ripley regime, donation of a farm adjacent to Chesapeake Bay led to another facility. The aim was to concentrate on the ecology of the brackish bay and the adjacent land. After a few name changes, the place became the Smithsonian Environmental Research Center (SERC). Early in the history of SERC, the efforts of what had been the Division of Radiation and Organisms were partly folded into the place and partly dropped. Within the last few years, as a result of administrative shuffling, at the moment SERC is part of the NMNH.

During the heyday of the oceanographic push, a center to sort the specimens dredged from the oceans was established in southeast Washington. It spawned another center, or field station if you will, in India, which existed for about four years, and another in Tunisia, which lasted for more than a decade. All of these 1960s and 1970s places are gone, but a few alumni of the sorting centers joined the museum staff.

Off the coast of Belize in Central America is a major coral reef tract. For more than three decades this field station has served as a base of operations for many of the staff members and their colleagues. Somewhat later, the Harbor Branch Foundation in Ft. Pierce, Florida, provided space for museum employees. By the turn of the century a modest building at another site in the city was completed and in 2002, Mary Rice, the first director of the Smithsonian Marine Station, retired.

The Museum Support Center opened in Prince Georges County, Maryland during 1983. It is a curiosity of history that the two curators who were its strongest advocates left Washington for other museums before that date. According to listings in the telephone book, as of 1992, the center was at least nominally part of the office of the Director of the Natural History Museum. A few staff research activities are conducted there, including a modest molecular systematic laboratory, and mosquito identification for the Armed Forces.

Many stories, most of them true, have circulated concerning the support center. It began as a high security facility when such a concept was alien to Washington. Guard dogs and jack-booted guards armed with batons and revolvers were present. To insure that there were no "vermin," staff were forbidden to have plants, eat in their offices, or hang anything on a wall. When three groups vied for space in the three floors of the first pod, a huge cavernous building, the decision was made that each would get one-third of each of the floors.

The center is increasingly being filled with specimens transferred from the museum. There are now four pods and miscellaneous other buildings. In one respect the place has also taken on the aspect of the old USNM in that other kinds of objects are being stored there. For example, new space originally designated for the alcohol collection is needed by the Portrait Gallery and Museum of American Art; it is not clear how that particular turf war will play out. The place is not a black hole into which objects vanish forever, but it does make browsing of the collections extremely difficult. If you know precisely what you want to see, it can be retrieved more or less promptly. Congress has now given authorization for construction of a fifth pod, presumably mainly for the specimens in alcohol. One problem is that the museum staff has had virtually no input on the design and has essentially no way to change the plans. This is not an isolated event, but is more common than not when major construction or repair is contemplated.

When plans were made for the old west court building to be torn down, the naturalist center was lost. By perseverance, those involved with it found a place in Leesburg, Virginia. For more than a decade this center has continued to serve a smaller public, but how long the concept of supporting amateur effort in natural history will continue is extremely uncertain. There do not appear to be any plans to return this educational activity to the museum building or even to any place on the Mall.

Governance of the Museum

Congressional inquiries in 1888 in regard to the "classified service" provide a little data on the small size of the United States National Museum. The Assistant Secretary in charge received $4,000 and the combined curator and executive officer $3,000. Five curators each received $2,400 and five more received $2,100. Four assistant curators were paid $1,600 and four more junior assistants $1,400 annually. Four "aids" — that was the spelling — made $1,200 and six more made $1,000. Finally $4,000 in special services was contracted out, making a total of $56,300; this covered the entire span of the museum's holdings, not simply natural history. The cost of running the entire USNM in 1888 was $199,121. "The rates of pay indicated are in most cases considerably lower than are customarily allowed for similar services in the Executive Department" (Rhees 1901:1240). History teaches that low salaries for museum workers is nothing new.

Governance is an incredibly dull subject except to those near the bottom of the ladder, and when problems appear, the subject is retitled "employee morale." Henry kept Baird on a relatively short leash, but he had considerable latitude compared to that which Baird allowed his subordinates (Rivinus and Youssef 1992). Langley was neither interested in natural history nor very much in those beneath him, but fortunately Goode, Walcott, and Rathbun seemed to understand those whose interests were in natural history. In photographs, Ravenel looks like a typical bureaucrat, but there are no horror stories resulting from his regime. Wetmore, wearing two hats as both Director of USNM and Assistant Secretary of SI, and then later as Secretary, was favored by the staff; salaries continued to be low but morale was high.

If a quick summary of a century is in order, natural history fared far better under the leadership of the three secretaries who were specialists in the field than under the three who were not. This is not due to prejudice or preference, but was affected more by external events influencing Congress than any other factor. Baird was memorialized late in 1971 when the meeting room in the Natural History Building was designated as the Baird Auditorium. The contributions of Walcott and Wetmore to the Institution have never been properly recognized anywhere within the Smithsonian!

Secretary Carmichael was easy of access as was Secretary Ripley, especially in his early days; if an unexpected opportunity for a trip or a conference appeared, a staff member could write a note directly to the Secretary asking for a small sum and it would come back "OK SDR". Since then for those within NMNH, a subtle change ensued in that the secretary has become more remote and voice of the director became less significant. Some staff spoke of a "grass curtain" separating Castle and museum building, analogous to the "bamboo curtain" which surrounded China for decades.

Kier was the last director to come directly from the ranks of the staff without other employment on his record, and the last who apparently had direct and easy access to the Secretary, although Fiske could well be considered "in house." Since then, directors have come and gone; it is up to others to judge their relative capabilities and accomplishments. Meanwhile, paralleling the increasing complexity of administrative structure in the "Castle," the NMNH became more complicated and currently has four associate/deputy directors. Whereas four decades ago it was no problem for a staff member to reach the Secretary for a brief meeting, the route now for even a memorandum is through the Department Chairman, to Associate Director, to Director, to Assistant Secretary, as only the most obvious of the many steps which must be followed.

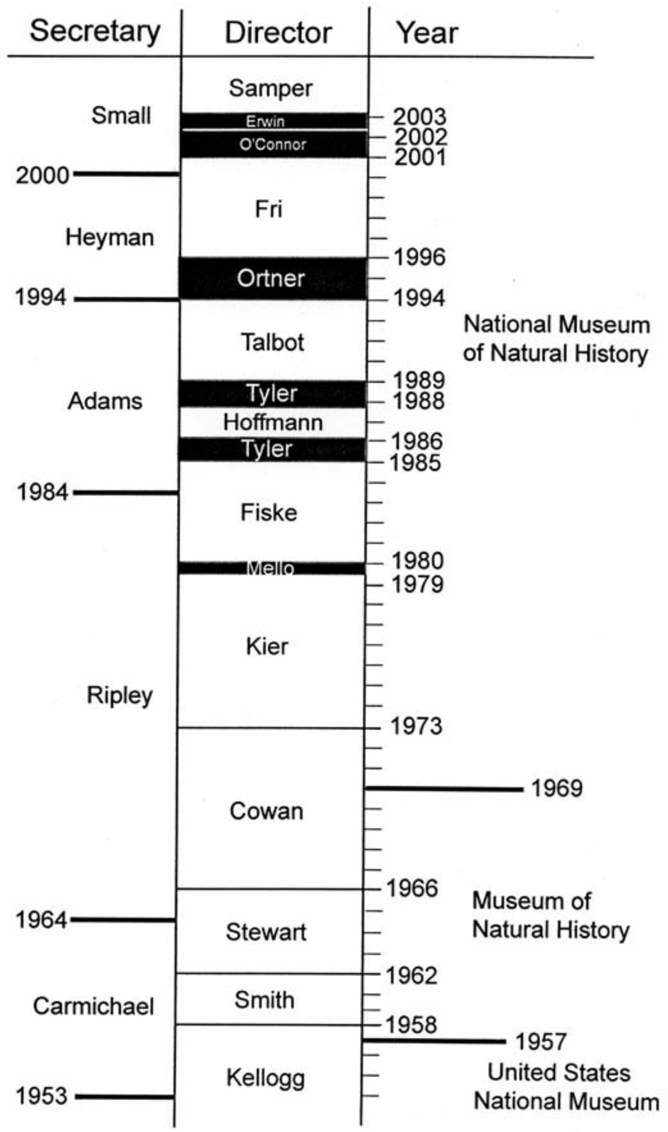


FIGURE 31. Leadership of the Smithsonian and the Museum during the last half century. The two names at the top are not to scale, in part to allow space for the names and in part as a hope of stability during the coming years.

On a lower level, after Walcott reorganized the USNM, there were effectively a director and three Head curators. These were lifetime appointments. Subordinates may have been under the thumb of the Head, but at least it was a consistent thumb. Likewise, when the Director was supported by three eminent scientists, he could make a strong case to the Secretary for a particular need.

According to one corollary of Murphy's Law, there are always unintended consequences of an action. Regardless of who was director, consultation with the heads of departments as a group was a regular, often weekly, activity. Notwithstanding that cooperation, the increase in the number of museum departments and the change from Head to Chairman with a stated term, in effect shifted any power from the offices of the scientists to the office of the Director.

In turn, during the last half century, the power of the director has increasingly been limited, both by the "Castle" and by events outside of their control. If there is a policy as to how long a director should remain in office, it is by no means public knowledge. Over the last four decades, not counting the "acting" appointments, most of the good, poor, and indifferent directors have been in office for four to six years.

When times were good there were no serious problems, but under worsening conditions, the staff tended to lay blame mainly at the door of the Director. As another generalization, with decreasing funds and limitations on staff positions, there develops less comradeship among the curatorial staff. From the beginning, a caste system was always in place, with the aides paid far less and working far harder than the curators. In that regard, the museum is no different from the business world. Nevertheless, until after the Second World War a diligent young man — and very rarely even a young lady — who wanted to learn might eventually become a curator. This rung of the ladder has long since been broken away.

Likewise the very top rung is gone. Directors used to come up though the ranks either from the museum itself or from affiliated agencies. Now they are brought from the outside. To me, this seems to present two distinct problems. First, is that there is a difference between museums and academia and those who come from an academic background with no experience in natural history museums will likely try to reinvent the wheel and in the process break some of the spokes.

Second, is that the office of the director of the NMNH and the heads of the other Federal bureaus under the SI no longer a Federal Civil Service position. The rationale is that to obtain an appropriate person, a higher salary must be paid and this can only be done from Smithsonian Trust funds. As a former member of the Department of Interior, this troubles me, though no one else seems to care about either the legality or propriety. There is resentment that about thirty of the Castle appointed earn more than $200,000 each and some of these considerably more.

A standard remark during the Ripley era was that 20% of the Smithsonian funding was private and 80% was Federal money. To save Trust funds for other purposes Ripley even arranged for one Assistant Secretary to be paid from public funds on the grounds that he was doing work of service to the government. This trend has now been reversed.

Currently it is stated that the Smithsonian operates on 70% Federal money. I do not believe this as a trend. A one-time large donation does not substitute for a steady amount appropriated annually, for there is always the hope — admittedly more often than not forlorn — that it might be increased. If the NMNH is part of the Federal government, it should be treated as such and funded as such. Public and private are distinct, but once the concept of a quasi-federal arrangement is introduced, it can rapidly degrade into quasi-private and move further into arguments that the activity, which is performed, is not a proper function of the government. There is a real fear that a consequence of soliciting private donations will result in diminished Federal appropriations.

To rephrase this point, a Smithsonian employee paid from Trust funds has no job security. When Secretary Adams reduced that group, he did give those affected two weeks notice. A Federal employee has more job security and for any scientist involved in a long time study, this is important. By law, Federal employees cannot speak out, except in their capacity as private citizens, and they are, therefore, an easy target. Because of the furor over "big gumment," it makes political capital to attack small groups whose work is not immediately obvious. The concept of the dedicated Civil Servant has been transmogrified into that of the bureaucrat swilling at the public trough. To attempt to explain that one is not a bureaucrat, but a specialist on the spiders of eastern North America and therefore assisting the general public will not enhance job security. A director who has no familiarity with government employees and their customs might not understand, let alone be able to explain the need of such efforts to those who hold the purse strings.

Under Talbot, a National Museum of Natural History Board was appointed to advise the director. It may have originally been conceived as a mechanism for fund raising, for its two dozen members included both businessmen and scientists. How much attention Talbot paid to the Board is for others to determine. When Fri became director, it was because he was a candidate suggested by the Board.

Even more tangential to the direct lines of governance is the Senate of Scientists, which has now been around for nearly fifty years. There are no unions for the professional staff anywhere within the SI and in some ways this organization hoped to be the equivalent of an academic faculty senate. The Senate of Scientists is a voluntary organization, and not all those within the building choose to join.

In its early days, the organization was of young turks full of vigor. In large measure, this group was responsible for blocking Cowan's plan to consider a move of the staff to the Beltsville Agricultural Research Center. Another action of the Senate was to set up a paper investment group and compare that yield for several years with that of the SI investments. That the financial advice of the scientists would have produced substantially more income than the course taken by the "Castle" was not appreciated and was ignored.

The influence of the Senate has never been great, and has waxed and waned with the various directors. For years to a large extent, Senate activities were mainly along the lines of having dinners with a speaker concerned with science or holding a "sherry seminar" to have a member of the secretariat meet staff members. The group played a negative role in being less than enthusiastic toward any of the candidate scientists to replace Talbot when he left the director's office.

One important action begun a few years earlier was developing a "Congressional night" to show members of the Congress, along with their staff and families, something of the inner workings of the museum. This became increasingly successful in terms of attendance, until it was then taken over by the Castle at the beginning of the tenure of the current Secretary, whereupon it was delayed until it was dropped.

During 2001 and 2002 the Senate played an extremely active role in opposing the closing of facilities, and attempts to reorganize SI science without consulting the scientists. Just what influence the group will have on policy in the future depends in part on the temperament of the new director, but it may provide some slight counterbalance in governance to high-level directives from those higher in authority who do not understand natural history.

What if?

Occasionally, a game is played by some purveyors of history that has the title used for this section. It is a fun game for there are no rules to follow, no serious considerations to ponder, and no consequences from what is written. Hindsight view is always perfect 20/20 vision. On rare occasions, such an exercise does highlight poor decisions and might prevent comparable ones in the future. Although one might make a fruitful historical study by an analysis of how the NMNH has fared when different political parties controlled its Congressional funding, that might impose a fact on unbridled speculation and delay the start of this foolishness.

To begin at the beginning, Henry started serious meteorological investigations, but once the efforts began to move from research to development, the activity was spun off to the Federal government. Baird did not actually spin off the Fish Commission, but he kept its activities separate from the Institution. Now what if Henry had been able to move the museum out of the Smithsonian or Baird had been inspired to do so? What a marvelous opportunity for unbridled speculation as to whether a museum devoted to natural history would have flourished, vanished, or developed as a place devoted to research and preserving collections.

What if Goode had become Secretary and Langley Assistant Secretary? The USNM might have prospered, for Goode was both passionate and persuasive. After his death, the Regents might have elected someone other than Langley, or at the least he would then have been a Secretary forced to have a broader vision. What if Acting Assistant Secretary Walcott had pressed for a new Geological Survey building and let the old brick structure collapse under he weight of its collections, leaving room for a decent facility?

In 1906, Congress passed the Antiquities Act which for much of the twentieth century governed collecting on public lands. One of Walcott's first acts as Secretary was to arrange with the Federal agencies that had jurisdiction over public lands to review applications for collecting permits as regard to their scientific merit. What if this function had continued? It would certainly have brought the museum staff and those from academic institutions into closer contact, to their mutual benefit. How many permits were reviewed and when the Smithsonian let this function slip through its fingers might make a reasonable thesis problem for someone.

When the National Science Foundation came into being, Federal funds were given to folk not connected with the national government. What if the enabling legislation had been tinkered with a bit, so that all natural history collections made with Federal funds eventually reverted to the National Museum? This would have been a tremendous boost to the museum as a national institution and would have required several large storage facilities. The positive side is that huge quantities of irreplaceable material would not be scattered or discarded.

By the 1950s, the USNM/NMNH was recognized as the outstanding repository for meteorites. When meteorites began to come out of Antarctica, those interested in them agreed that all collected by American scientists should be deposited in the Department of Mineral Sciences. Collecting in Antarctica is an exceedingly expensive endeavor. Apart from meteorites, much of material gathered by American scientists from that continent is dissipated and some has already been discarded by other organizations. What if everyone agreed that at least all Antarctic collections would come to the NMNH?

The several government agencies that are involved to some degree with natural history are part of their assigned mission have varied widely in their adherence to the 1879 law. The administration of the SI has paid no attention to this issue for decades and the later group of the NMNH Directors likely did not even have any detailed knowledge of its laissez faire enforcement. Because some of the scientists were preoccupied with their own research efforts, rather than with the function of the museum and because space for new material became increasingly short, the "shall" of this law has been transmogrified into a "may."

NASA developed its own storage program for moon rocks and controlled who did what research on which material. The NMNH certainly did not have the background or the funding to administer this program, but if a Federal agency is required to obey Federal law, the collections should have been given at least a metaphorical catalogue number and placed on indefinite loan to NASA with authorization for that agency to prepare and distribute specimens. What if the moon rocks were nominally part of the NMNH collection?

Perhaps this is a bad example, for NASA was a new agency not affiliated with any of the old-line departments. However, during the 1980s and 1990s, parts of the Interior Department, mainly the Bureau of Land Management and National Park Service embarked on collecting and storage programs. A logical and legal approach would have been to assign collections to the National Museum and the museum, in turn, place them on indefinite deposit at various localities. That way there would be no fear of the collections being discarded in the future when agency agendas and funding changed. That way there would have been proper and uniform standards for curation and storage. That way there would have been a clearer notion of what specimens existed where.

This never, never land inquiry then may be summed up in one last question. What if the national museum of natural history actually had functioned as THE NATIONAL MUSEUM of Natural History? Having has the fun of this game, it may be appropriate to summarize the past and current status of the NMNH using the perspective of Goode's classification of museums.

The Exhibits [Museum of Education]

Say the word "museum" to the average person and what comes to mind are displays and nothing else. The three-legged stool of disparate museum activities outlined by Goode is almost impossible to keep level. The public function of exhibits increasingly takes more resources, time, and money, than research. Occasionally, a bone is thrown to research, though funding for it is harder to justify than for displays. Historically, more often than not, the concept of a museum of record is intermixed with or subsumed under staff investigations, though at most of the Congressional budget hearings, officially preservation of collections was subordinated to research.

It is probably a fair generalization that from the time of Goode until after the Second World War, exhibit philosophy changed little. The USNM building is best described as showing the public a hodge-podge, though within the limits of space and what was available, the natural history displays were probably as good there as in any other place in America. The standard charge hurled in hindsight is that, for example, cases containing 10,000 arrowheads were displayed. This has an element of truth, and such displays are boring, but the concept of evolution was strongly in the air and to show individual variation among specimens and how stone technology had changed were worthy objectives.

Starting in 1909, the new natural history building provided remarkable opportunities and the staff rushed to fill the space. Theodore Roosevelt shot many African mammals for the displays and was accompanied in the field by museum taxidermists. By 1916, the exhibits were completed, and even allowing for the art on the first floor, at that point there were more natural history displays than any subsequent time. On the first floor, paleontology was on the east side and biology on the west with ethnology near the art. The second floor had more specialized halls on all three themes.

Following the First World War, some of the machines of war were crowded in, and when in the 1930s they were moved, a few collections from the Arts & Industries building were transferred to that space; a case of domestic chickens was adjacent to the lace display. During the mid-1930s a fine hall with eight large cases of North American mammals was installed, — it was destroyed during the 1990s — but otherwise almost nothing had changed on the first and second floors. The ground floor foyer mounted numerous temporary exhibits. During and after the Second World War, one or two exhibit halls were translated into office space.

In the 1950s, the exhibit halls were extensively revised and some of those closed for offices were opened to the public. The halls of the 1960s were enthusiastically summarized by one who knew how drab had become those original installations that predated the First World War and how little they had changed (Oehser 1970:92–93). Over the next decades some of the major halls even went through a second cycle of displays (Yochelson, 1985:91, 120).

The philosophy of displays has changed since Goode's day and a summary might be that a more ecological approach is now taken. More significantly, the later exhibits have been constructed with a gradual change more toward entertainment than didactic education. Since the advent of computers and elaborate video displays, this trend has accelerated. Virtual reality has not yet taken over display of the real objects, but it may well do so, if, as, and when, the current exhibit halls are again reconstructed.

Since the 1980s the story has been of more and more closing of halls and few openings.

By the end of 2002, at least one-third of the exhibit halls were closed. Emphasis has shifted to "tin cupping" in the private sector for funding rather than trying to increase Congressional appropriations. Whereas, in the old USNM building the collections encroached on the displays, this change is more pernicious. Shops with a diversity of items occupy what was major space for temporary exhibits in the foyer. Several halls where formerly permanent exhibits were present are now used for visiting ephemera, and more shops encroach on other display areas. Almost every temporary display is accompanied by a specialty shop. Buying by the visitors is now expected to be a significant part of the museum experience.

In the past, the museum has had some good exhibit halls. They have never been the finest in America; other museums can argue for that title. It seems to me unlikely that the natural history exhibits will ever rise to the first rank. In keeping with the current trends, there are far fewer specimens on display and more gadgets for "interaction" by the public, generally pushing buttons to get the right answer to simple questions. Despite the closed halls, the NMNH counts its visitors in millions. Indeed, it was the first of the Smithsonian museums to experience the summer event of filling to the point where the guards closed the building until some visitors left. Despite the uncertainty of the times, counts of visitors are still in the millions. For a few years it was the most attended museum in the world.

Traditionally, the number of visitors has been determined by a guard clicking a hand counter. When bored, the guard may simply click the counter for something to do. When overwhelmed by the security concerns causing a searching the bags of visitors, the count may lag. One unintended consequence of the installation in May, 2003, of metal detectors to screen tourists is that for the first time in history there will be an accurate number of how many people visit the exhibits.

A large private donation for NMNH was accepted by the Director Fri. Although there was some consultation with staff members concerned with mammals, no one on the curatorial staff expected that a new hall of mammals would result in the loss of both the hall of marine life and the bird hall, along with the loss of the hall of North American Mammals for use as a staging area. Even by being cushioned by several exhibit halls disappearing over the last decade, abruptly, it was a shock that 25 percent of the remaining halls were closed abruptly. Indeed, the bird hall was closed without any prior knowledge to the curator, who then had to arrange to move specimens and dismantle displays.

The Rotunda has been named in honor of the donor, and the donation covered part of the cost of the new halls on the west side of the building. Not only was the priority of exhibits jettisoned, the new halls encompass a total reversal of exhibit policy of the 1950s, which tried to make the exhibit space more intimate. The central hall opens to the skylight towering above, and the walls separating the two lateral halls have vanished. In keeping with commercial trends, a store for tourists has been part of the construction and opened six months prior to the hall itself.

The new mammal hall actually did open on time, despite the common formulation that everything takes longer. Despite that success, there is little likelihood that the lost halls now used for offices ever being reclaimed in the immediate future. A proper, though modest natural history display now costs in the $15,000,000–$20,000,000 range and to expect six or seven times that amount in public or private funds is in the realm of pipe dreams.

From time to time, suggestions have been put forth to charge admission, but fortunately these have all come to naught. Experience from other institutions indicates that at best, admissions collect less than half the cost of running museums. To take a family of five to a museum may well cost $50 or more. The taxpayers have supported the NMNH and they received good value for their money when they enter the doors without charge. Travel agents are well aware of the lure of free admission and tout it as one of the reasons to visit Washington. As a result of free admission, millions come to see the displays; how many might not have come if there was a cost cannot be answered, but likely it is a substantial percentage of the total. Perhaps in exposing many to the educational aspects of natural history who might not otherwise be inclined to enter the building, the NMNH performs its single most important function in education.

The Collections [Museum of Record]

According to one source, which I consulted many years ago and, of course, neglected to document, the galleries in the United States National Museum building added about 15% more space, whereas from 1881 to the time of Walcott's "Acting" the collections increased 20-fold in size; almost all this growth was in natural history specimens. Such a rate of increase cannot be sustained, but the present collections dwarf those that were present when the 1890s ended.

There are still a few reactionaries who would argue that specimens are the "be all, do all, and end all" of natural history museums. The third of these points is clearly wrong, and the second may be argued, but the first is basic. If a scientist has no interest whatsoever in collecting and collections, there is no reason for him/her be on the staff of a natural history museum; under such people the collections suffer and eventually may be discarded. The "be all" is the only reason for a balanced natural history museum. Without collections or those interested in them, the building might just as well be a gallery of things, real or virtual, to entertain the public. Differentiating them from theme parks may well be an issue for the 21st Century.

The USNM and its successor have the largest assemblage of natural history collections in America, and probably in the world. The bird collection of the American Museum of Natural History is larger with that in Washington a close second (Banks, oral commun., 2002). The mineral collection is the largest, the fossil collection is the largest, fish collection is the largest, as is the insect collection, etc., etc., etc. The fishes in alcohol occupy about 2500 square meters of shelving and it is estimated that the collection may grow by about 1.5% percent per year; 40% of the collection remains to be catalogued (Poss and Collette 1995:53). In every division the collections of natural history specimens are the first or second largest in the country and more often than not, the first in the world.

The material collected comes from donations, efforts by the staff and transfer from government agencies. Estimates vary but as a minimum, at least 50% of the collections in each museum department derive from the last source and it may be closer to 75% in some divisions. The Federal sources are many and varied and some no longer exist. The General Land Office, Fish Commission, Bureau of Ethnology, 10th Census and a few others are gone.

Donations from individuals are more limited than in the past and I predict will continue to decline. About two decades ago, lawyers determined that the NMNH must show clear title to all items that were accessioned. Whereas one could give a curator material with the appropriate locality data, now it must be accompanied by deed of gift certifying that the specimens were collected legally, that they are the property of the individual donating them, and so forth. The museum must then send a letter acknowledging the gift. More paper work for the sake of paper work.

Collection managers for fishes have been at the principal American museums for more than two decades (Parenti 1999:205). They have probably been associated with other groups in natural history for about that long, and the collection manager concept is a major change over the old ways. What problems there might have been between those concerned with research on specimens and those concerned with care of the specimens have more or less been resolved. For me, it is a reasonable assumption that if times continue to worsen and staffs are depleted, more of the research staff will disappear than that of the collection managers. At the same time, there will be more turnover and the collections group will have less and less experience.

Specimens still arrive in droves, but the days of huge new collections are over. Live specimens are becoming scarce as the inexhaustible resources of the sea are going the way of the vast inexhaustible forests of America. Environmental regulations, and laws protecting endangered species are inhibiting; acid etching of limestone to free silicified fossils (Yochelson 1969:599) is nearly a lost art, what with concerns over air pollution. While it is true that one cannot solve new problems directly with old collections, they have always provided a starting place for new investigations and in that sense are going to be of increasing importance in the future.

Despite that point, the future is not at all rosy. Coordinate with the development of the collections management concept is the arrangement of collections for the convenience of the computer inventory rather than the investigator. Rearrangement of collections to test a new concept is an increasingly complex operation, one that transcends mere physical labor of moving drawers. It may be that the items in some of the collections are on their way to become icons rather than specimens for study. That word is not chosen lightly.

Even more troubling is that the need for space has resulted in the transfer of collections to another location distant from the curators. This is a further disconnect between research and specimens. It is important to browse through collections. Just as in a library, in looking for the book one thinks that one needs, it is actually the associated books that become important.

Whereas in the old brick building, collections crowded exhibit space and in the 1950s crowded the halls of the research areas and were stacked nine feet high, there is now, to me, a feeling of loss or a degree of hollowness as more and more collections are transferred to the museum support center. The aura of the place has changed. A museum is supposed to be stuffed to overflowing with material on the assumption that even if it is not currently being studied, sooner or later someone will come along and make good scientific use of the specimens. That seems no longer to be case.

For a century and a half, alcoholics — that is the specimens in bottles of spirits, as distinguished from those who empty bottles of spirits — have been readily available for study. Suddenly, they are interpreted by outside authorities as a fire hazard and most must be moved; the few remaining collections are to be stored in small rooms. Interestingly enough, the Natural History Museum in London does not consider them to be a major hazard. Liquor stores are not noted for especially violent fires, yet the alcoholic collections of the museum must move out of downtown Washington; national security may be involved and once pronouncements are made in that field there is no recourse.

Even worse than assumptions of fire hazard, cost/benefit ratios are the bane of collections. It is easy enough for a bean counter to figure the cost of square feet in a building, the cost of cases, and the cost of heat and light, let alone staff. Those who study mollusks estimate that it costs $40.00 to accession a collection; at least half an hour is needed to enter data in a computer lists and print labels. One is forced to decide what is currently worth the money to preserve it and what may not be saved, and once the decision is made and material discarded, it cannot be recovered. Collection policies are established and policies have a tendency to lose flexibility the longer they are in place.

Although it is easy to assign cost, it is impossible to define benefit in regard to collections. Depending on the view one takes, such assemblages of specimens are either worthless or priceless and the latter cannot be assigned a dollar value regardless of how the bean counters calculate.

From time to time some efficiency expert suggests that exhibits be confined to American organisms or that the research collections be pruned of material from other continents. When analyzing bureaucratic ideas, it is impossible to determine when the most foolish proposal ever will come to fore, for someone will always underwit one's wildest assumption, but surely confining natural history specimens to the United States is shortsighted and just plain dumb. The global village concept insures that vermin from elsewhere will sooner or later descend on us. Alien predatory earthworms destroying the native species do not receive the press coverage of airplane crashes destroying buildings, but they may in the long run be a more serious threat to our country.

There are many examples of novel uses of the collections. The story of the Japanese fire balloons, or the mercury scare with swordfish, are well known, but I would like to add one more. In the fall of 2001, I received a phone call from a colleague on the U.S. Geological Survey. He in turn had heard from other colleagues who were assembling data on possible caves in Afghanistan. I was to go to the library, find a particular French periodical and see if I could find a paper on cave-dwelling oligochaete worms that contained a map. The library did not have that journal, but I remembered that the invertebrate zoology library included some boxes of reprints. A reprint of the paper was there and though it had no map, it listed the latitude and longitude of a number of caves. A half hour after the phone call, this request the information had been FAXed and moved up the line to the interested parties. Now how does one put a dollar value on this benefit?

Museum Staff/Associates [Museum of Research]

It may be helpful to start with a quotation. “I never knew exactly how Baird conducted his diplomacy; but he smoothed Bendire's ruffled plumes effectively, soon had him well in hand, and in due course thereafter the Bendire collection was in Baird's hands also, becoming the nucleus of the present unrivaled oological [bird egg] cabinet in the National Museum, of which Bendire was honorary curator until his death . . .” (Rivinus and Youssef 1992:172). Baird probably instituted the concept of honorary curatorship, which is a euphemism for volunteer, in turn a euphemism for unpaid worker. Goode honed the concept so that at the time of his death, the United States National Museum had more than 20 departments, mostly staffed by honorary curators, assistant curators, and investigators.

Some of the honorary appointments in the old days were to public-spirited folk, as in the example of the Army Captain in the quotation above. More were drawn from the ranks of those paid by other government agencies. To those on the outside, all curators were part of the museum staff, but there is a distinction between the paid staff in a strict sense, and the museum community. If the Museum began in 1858, then for at least the first century, more than 50% of the community were not paid by that organization; for much of that period the proportion was higher, but it would be tedious to determine who was paid out of which pocket.

The honorary title began to fade and as the Museum staff began to grow after World War II, the title of research associate took its place. Not all employees of government agencies who maintain a presence in the building are research associates, though the majority are. Not all research associates are employees of other government agencies, though again the majority are. As with any family, some members got on well and some not so well. From what one can gather, there were and are few formal agreements on space for those from affiliated agencies, yet somehow the system seems to work. During the last few decades, just as the staff had begun to shrink, the numbers of others in the museum community has also begun to decline. This is in the face of several official reports and pious comments over the importance of systematics.

The quality of research by the museum community has been excellent and continues at a high standard. This comment will have to be accepted at face value. Whereas a few museums have one or two stars, the Washington museum community has depth and those willing to do the basic work. Perhaps as a participant, I cannot be unbiased, but my impression is that this group has substance rather than flash. T. Dale Stewart, who died at the end of the last millennium, was, until one year ago, the last of the staff to be a member of the National Academy of Sciences. If that is the only measure of excellence, so be it, but it is my impression that the few members of the National Academy who are engaged in natural history study more often come to the museum to consult and examine the collections than their counterparts visit them.

What are perhaps remarkable historical features of the staff during long history outlined, are the remarkably low rate of turnover and the long tenures. Few curators left for other employment and several of those who left for teaching, returned. Most of the scientists had more than thirty years of Federal service, a number stayed for forty, and a few were active for sixty years.

For at least the first Century of natural history under the aegis of the Smithsonian, male WASP would be a fairly accurate shorthand description of the scientific staff. This has changed and seemingly the change has not affected the quality of research in any discernible way. The museum staff had Mary Jane Rathbun, and later, Doris Cochran, as token woman on the staff for the first half of the 20st Century. Currently, a significant number of women are in both scientific and administrative ranks; others can figure percentages and plot trends. There are a few handicapped — pardon, physically challenged — staff members and they are as productive as others. As to other aspects of politically correct hiring, the so-called minority groups are still very much in a minority on the scientific staff. Apparently, this is not for lack of trying as a few years ago Federal funds were directed toward minority scientists, but rather there is essentially no pool of minority groups interested in careers in natural history.

When one cites numbers, some readers mentally associate with this thoroughness and precision. On occasion, numbers do help to convey a concept of size, which cannot be derived by using words. For the 1985 diamond jubilee of the national history building a directory of those in the building and associated facilities was compiled in which 1243 names are listed. Of these, 25 were on the museum payroll at the Smithsonian Oceanographic Center in Washington, and 6 were at Ft. Pierce, Florida. It is fair to say that about 1200 people inhabited the main building and wings in Washington. Not all were on the museum staff in a restricted sense, for guards, librarians, painters, and so forth were included, as part of one big family. All of these persons are important to keep the machinery running. There is no current comparable comparison of ready access, and there have been shifts in priorities, but about 1200 still seems a reasonable figure for total building occupancy.

Thanks to summary listings, it is somewhat easier to gain an idea of size of the museum community than the larger building community. The 106 staff members of outside agencies were included in the count. The National Marine Fisheries Service counted eight people, the biosystematics unit of Walter Reed Army Hospital had five, 38 were in the Systematic Entomology Laboratory, paid by the Department of Agriculture, and the Department of Interior had 15 employees with the Fish & Wildlife Service and 40 with the U.S. Geological Survey. It is difficult to equate these with curators, but among this group 35–40 "professionals" may be accurate. The Army folk, much concerned with biting insects, are now at the museum support center in Suitland, Maryland. The fish and wildlife employees are now part of the U.S. Geological Survey, whether they like it or not, and the paleontologists of the U.S. Geological Survey are now represented only by a few retirees. Agriculture entomologists are still prominently present, as is the NOAA fisheries group. It is my sense that all have shrunk and my prediction is that the trend will continue. There is no easy way to count present numbers, but by my definition and guess, the current number of "professionals" may be between 20 and 25 with a few of these close to retirement.

In 1985, the listed staff of the seven departments was 455. though this may have included a few emeritus people, fellows, and research associates, not paid directly by the museum. Other figures below refer to those called curators of various rank, or comparable titles. With almost no exceptions, this now refers to those holding a Ph.D. Most emphatically that does not mean that they are more important or better scientists than some designated as aides. That understood , Yochelson (1985:140) compiled figures from various sources for most of the years in the 1974–1984 interval, and they average about 110 Federally funded “professionals” for each year.

Using my definition and the 1985 book, the “professionals” numbered 113. A simplistic dividing of numbers would suggest three support people for every research scientist, but that is a cruel illusion. The true figure for direct assistance is closer to one-half than it is to one. If there is any trend, it is that lower level positions associated with research have decreased and the number of outside volunteers in the departments has increased.

A Smithsonian-wide telephone book was printed late in 2002. Because there is a listing of departments and divisions one can summarize the “professionals,.” though not the total staff in the departments. I count 92 “professionals” being paid by the Federal government, supplemented by a sprinkling of emeritus members. Of these 13 were hired during the first half of the 1980s, 14 were hired during the 1970s, 20 during the 1960s and 2 during the 1950s. In other words, more than half have had at least 20 years in service and at least one-third are eligible to retire at any time. This is a dramatic graying of the staff. Considering the problems of hiring ceilings and the glacial pace of the employment procedure, even if more funds were immediately available, it is likely a number of the staff will be gone before there are replacements. Part of the value of the collections lies in who collected them and under what conditions. This kind of lore is oral tradition and without a younger understudy for an older staff member, some of the history is lost.

Prior to opening of the wings, in some parts of the building two persons to an office was not unusual. Now in some places the ratio is two offices per person. Collections which once lined the halls have been moved to the support center,, and a similar decline in the number of people is apparent to anyone who walks the research halls. For me, these observations bring the first stirring of a sense of major loss to science, one that may never be recovered.

The Present

If a summary of the last three decades is needed from the standpoint of natural history in Washington, it can be presented easily. Smithson's aim was for increase and diffusion of knowledge. Diffusion has been in the forefront, despite the point that increase was mentioned first by benefactor Smithson. It should be obvious even to administrators that the more the diffusion, the thinner becomes that which is being diffused. To further summarize, most of the staff could be characterized as in an interim state, carrying on for the moment with their research, but with no view of what the future may bring.

Two critical points were summarized by the Senate of Scientists during 2000 when, to some extent, research seemed to be under attack. The first was that from 1985 to 2000, the staff in the Directors office increased by 150%; much of this increase occurred under Frank Talbot. The second point is that during this same interval, the scientific staff decreased by 23%. This seems to be yet another graphic example of the famous law expounded by C.N Parkinson. It is much to early in the career of the new director to see whether any of these percentages will change.

An item touched upon by the Science Commission report is that of leadership. By the standards they used, there were eleven changes in the Office of the Director during twenty-two years. Those who were designated as “acting director” were skipped over the preceding short history. Even if those “acting,” maintained the previous status quo, there has been considerable turnover and no obvious direction for directors. Some of the staff might argue that conditions for uninterrupted research seem to have been a little better when the office was officially vacant.

The impact, if any, that the Science Commission report may have on the course of events cannot be evaluated for months, at best. It presented strong support for research within the Institution. Whether that will change the current emphasis on bricks and mortar is a real question. Mission statements, policy papers, evaluations, reports of special commissions and similar document contribute to the prime export of the District of Columbia, namely waste paper. Still, occasionally, there is impact and concomitant change and one can only hope.

One concern in regard to this report is the view that by retiring an older staff member, two younger persons could be employed. There is no question that the staff is gray, but this seems to be seen by some, especially the older geezers such as myself, as extremely shortsighted. People examining specimens are like wine, the longer they stay around the better they are, even if an occasional bottle or person goes sour. In the winter of 2003, the Office of Management and Budget granted the SI the right to offer "early retirement," but refused to grant authority to "buyout." A very few persons left before 30 years Federal Service, but had a money supplement been offered a fair number of senior persons might have left.

There is a real fear that when any older collection-oriented person retires, he will be replace by a hot-shot who thinks everything can be done by manipulating data by computer. The worst of all possible worlds is that retirement will be followed by loss of that staff position. Encouragement of staff to retire should be resisted tooth and nail. A classic remark some years ago from a member of the Director's entourage was "Of course, our word is only as good as our budget."

Most of the scientific staff in the National Museum of Natural History is concerned, in one way or another, with biological diversity. This is such a huge and complex field of knowledge that anyone who hopes to understand even a small part of it, must, despite all external appearances, be an optimist. Even allowing for the underlying attitude that "come hell or high water, my personal investigations will continue," there appears to be a general feeling that if the nadir of all current problems has not been reached, it is close and perhaps the remainder of the decade will be better.

Random inquiry as to why people stayed on the staff rather than fleeing occasionally touched on the paucity of outside opportunities, but these were exceptions. Characteristically, answers more or less centered on the view that with all it problems, the museum remained the best place in the world to pursue the kind of scientific inquiry the person wished to pursue. As to what is good about the museum, one succinct reply summed it up nicely, "Outstanding collections, excellent library, good people."

The collections deserve a little more comment. They are the starting point. As natural history efforts become more detailed, the precise identification of species is critical. It is important to obtain material, and one can still encounter a marine strand collector or a grizzled field geologist (Gladfelter 2002), but "dusty boot" botanists, or the man in pith helmet and shorts flailing a butterfly net, are anachronistic rare and endangered forms. Biology in the 19th century was different from biology of the 20th century and predictions have been made for more change in the future (Kress and Barrett 2001). The earth sciences and paleontology have likewise undergone dramatic change.

To move to another significant item of the present, seldom mentioned, but especially vital to those whose primary research efforts are in foreign counties is that the NMNH is linked to the SI. The name of the Institution carries a cachet like no other in the world and opens doors which otherwise would be impregnable. The point is particularly important to younger staff members. Many years ago, a senior staff member commented that the place reminded him of Harvard in that some features were incredibly good, some were incredibly bad, but all took themselves incredibly seriously. There is a kernel of truth in that observation, for the public does view the Smithsonian as the ultimate authority. Many institutions have been considered first class long after their day of glory passed. This is by no means the case with the NMNH, but it is a distinct possibility if staff positions and funding continue to diminish.

During the "old days," that is up through the 1970s, most of the scientists stayed on after official retirement, and commonly very long after. Despite the many attractions now offered by the outside, this tradition continues and a fair amount of the current strength resides in emeritus members of the natural history community. It has been the exception that a staff member retires and leaves the area. Indeed, a few who leave have taken a microscope with them and soldier on for a few years. There is no certainty that in the future many of staff will choose to stay by the museum when they finally retire. A few in mid-career are already making other plans for when they retire.

Museums seem to attract a very select and very strange group of people when compared to the general population. With few exceptions these people are driven by curiosity to examine specimens and tease out their relationships, life histories, and other details. They are bound and determined to do this, despite all obstacles placed in their path. America never directly suffered the horrors of World War II or subsequent smaller wars. Despite what was happening, those who were in museums in afflicted areas continued to pursue their objectives and there is no doubt in my mind that precisely the same spirit imbues those in Washington.

The academic community and the museum community have much in common, in that they are not part of the so-called "real world." Yet there are differences between universities and museums. In particular a presumed National Museum is quite different from any university. The distinctions may be traced in part to the source of funding, in part to Civil Service regulations, and in part to tradition. Good teachers are more flexible and more people-oriented, as a result of interaction with students. Those in museums are more solitary and focused. Whether Federal or privately funded, museums do not support basketball or football teams. Scientific talks presented by good academicians tend to be slightly less dry than those by curators.

This is not to say that the NMNH is not involved in education. The staff has supervised and instructed many students over the years. It is, in a way, tutorial rather than classroom-oriented, and both setting and goals are quite different. It is my sense that in recent years the number of students has diminished, and the number of American scientists examining the collections for a few days or weeks has also declined. A short-term visitors program, which brought foreign colleagues to the museum, vanished as funds declined, although more recently some limited funding for this program has been restored.

A vital point, in my view, is that important research is conducted in spite of administration, not because of administration. Years ago, government organizations were run by directors who set a tone for the scientific staff and had under their direction various clerks to aid the scientific work. Then more than half a century ago, directors gradually became administrators in function if not in title, and clerks became administrative assistants. There is an opinion in some quarters that natural history scientists are woolly headed and tend to know nothing of administration. In fact, they are acutely aware of administrators and can readily differentiate the bad from the not so bad. As a rule, the USNM has worked best when directed by a working scientist who delegated the nuts and bolts to a subordinate administrator. The minute any director felt his office space was more important than his research desk, morale began to go down.

To provide a general formulation, for at least the last one-third of the previous century in America there has been a shift in emphasis from product to process. This downhill slide continues, yet to the best of their ability the researchers in natural history do concentrate on the product. Not all publish at the same rate, yet all know that knowledge, which is not shared, is worthless. These people need only be given a metaphorical pencil stub and a scrap of paper and then be left alone. As perhaps illustrated by events in the last days of the Soviet Union, if allowed to continue to investigate, they would even forgo salary and provide their own pencil stubs.

This touches on the concept of team research. It works well when dozens of people are needed to service an expensive machine or be serviced by it. It works poorly with eccentric individuals who know that what they are doing is fundamental to them and far more important than the work of anyone else. It works well when one of these folk can persuade a colleague to cooperate such as “I'll look at the insects and you look at the plants they visit.” A worldwide survey of diversity is foolish in the extreme, not because of the magnitude of the objective, nor the paucity of personnel, but the reason for it. A rough map of human genome is now available, but it is not clear just what can be done with this information. The museum programs that involve several people and are successful are those that the scientists have conceived. Those that have been crafted by administrators typically do not live up to the presumed potential. The staff overall has developed the ability to somehow find the funds or team up with those who have the funds to carry on research.

A few people studying natural history at government expense require, in present-day spending, an exceedingly modest amount of money. An immediate short-term financial reward will not result from their efforts. The government spends billions on investigation of the cosmos, for example, with the Hubble Telescope. An immediate short-term financial reward, likewise will not result from this investigation. Why one part of science is starved and another is fattened has never been clear. What is clear is that big science tends to crowd out little science, so that there hardly ever even a crumb of support left for the little folk. Perhaps those who wrote the Bible knew human nature all too well. “To them that hath, it shall be given and to them that hath not, it shall be taken away.”

Again in a more general formulation, this is a time of great uncertainty. Even with a new museum director appointed, it will likely be a year before measurable change, either for better or for worse, can be observed. Even if the SI should miraculously provide the authorization for a new director to double the research staff and triple the funds for assistants, travel, collecting, and publication, current events in domestic and foreign policy may well thwart any change. Indeed, a few souls are of the view that in a decade or so, the first few years of the twenty-first Century may be referred to as the “good old days” of science in America.

The Future

The picture painted above is gloomy, but it is important to recognize that this is not a Washington phenomenon. Throughout America, current emphasis at museums has concentrated on raising money, but more than the dot.com bubble has burst and the day of large donations is over. Almost invariably when funds are raised, that money goes to public exhibits, to the detriment of other functions. This problem is actually worldwide as the expansion of the last century begins to contract. To be blunt, too much of the immediate future is uncertain and out of the control of any organization. Without attempting special pleading, it should be apparent that the generally poor prospects for museums might even worsen for the NMNH, a place dependent on government largess. Access to those who control funding is much further away than in either a private or academic museum. Not only are there more hoops to jump through in seeking money, there is less of a local constituency to support funding requests.

If national security and national defense continue to be prime governmental concerns, Federal natural history science will continue to decline. In the most unlikely event that the importance of such investigations to the economy can be demonstrated, there may be modest growth, but never to the extent of the 1960s and 1970s. It is an exceptionally large “if” that a connection can be made in the minds of political leaders as to the importance of natural history. Still, the spread of West Nile virus, the impact on agriculture of alien species, the decline of fisheries, and other comparable worldwide problems may work to the advantage of this old-fashioned scientific inquiry.

Assuming that all goes well, predictions can be made. As I shall not be around when they are subject to Popperian falsification, this cannot be a serious exercise. In appropriate scientific manner, I would add that not all the notions are mine, but equally I will take full credit herein for authorship of the opinions.

(1) The system of a collections manager with subordinates seems to be one of limited opportunity for anyone involved in that machinery to develop to the point where they may have a chance to advance knowledge of natural history though basic research, though there are some exceptions. Proper collection management requires a knowledge of organisms, not simply shuffling of data. People trained at the doctorate level are drifting into this discipline as typical curatorial positions become rarer, and they expect to do some research and publish. Two kinds of positions may eventually evolve, one for those concerned with specimens (Goode's museum of record), the second, for those concerned with problems and processes (Goode's museum of research).

(2) After the application of wads of money, if that ever happens, a few of the closed halls lost during the last two decades will be restored to their original use (Goode's museum of education). The hypothetical new exhibits will certainly be adequate, but public exhibits have never been a strong point of NMNH and, if history is any teacher, it is unlikely that they ever will be. To a large extent there is a disconnect between scientists and exhibit planners, and there is no reason to assume that gulf will be narrowed. Educational activities in a broad sense have already moved into cyberspace and those that remain will consist of hall tours and similar activities. The public is increasingly programmed toward virtual reality as distinguished from the genuine article. What effect this will have on design of exhibits and total number of visitors is too murky an area to discuss, but the roaring models of Dinorama, which fortunately was a financial bust at the NMNH, presage the theme-park prospects for future halls.

(3) For more than half a century taxonomy and systematics have been downgraded by other biologists, especially in academia. Will the model for the future be the departments of classical languages at many institutions? There are still a few strange people who translate useless Latin and Greek simply for the satisfaction of translating. There are fewer and stranger people who study fossil spiders for inexplicable reasons. If there is to be any knowledge of the diversity of the world to be transmitted from one generation to another, it will have be done by developing a program of term appointments for investigators comparable to medical residency. With considerable luck the point may sink in that the background acquired in the understanding of what constitutes a taxon, regardless of what level that term is applied, can be applied in good stead when the interns go off to other fields of endeavor. It may also be the glue that will make collection-oriented and problem-oriented folks cooperate is the recognition that starvation of one group will later lead to extinction of the other.

(4) The growth of collections will continue to slow down for a complex set of reasons, but mostly the facade will be “conservation.” In biology, those collections, which are assembled, will be oriented toward molecular research and will require refrigeration rather than paper trays and cabinet drawers. One consequence is that this new type of material will cost much more to collect and to maintain. Another consequence is that it may take a long time to educate those who hold the purse strings; the salvage of an irreplaceable collection of whale blubber a few years ago is an interesting case study.

(5) Fortunately, it is becoming evident to at least a few folk that if we knew the genetic code of every living organism, we still would not have all the answers to all the current concerns in biology. It might also become evident that the interrelationships of various groups of organisms worked out over the years in a low-cost, low-tech manner are remarkably similar to those obtained by

expensive genetic sequencing. Thus, there is some hope that some systematists will continue to be employed, if only because they will develop new ideas in fields such as the spread of invasive species to which, the real scientists (those requiring a high salary, expensive equipment, and many technicians) can then apply their expert talents.

(6) Considerable effort and money will be spent in digitizing images of type specimens. The rationale will be that this will make material readily available worldwide. It will be a spectacular failure, for no image can substitute for looking at the real object. Unfortunately, the tenor of American life is conditioning the public and some scientists to the view that anything that is not on the Internet is insignificant and can be ignored. If this attitude expands, it will mark the eventual end of natural history for as a consequence, a single classification, or a single illustration or an organism, or even a single interpretation will be continuously recycled through future generations.

(8). It is unlikely that Federal appropriations will increase significantly and it equally unlikely that the staff will ever increase to the level of the 1960s and 1970s. Coordinate with this prediction is that the work load on the staff will increase to the point where the days of the United States National Museum building will resemble living in Valhalla.

(9). More and more of the Natural History building and other parts of the Smithsonian complex will bear the name plaques of donors, but as the economy winds down outside money will become harder to raise and the donors will demand more exposure for less funding.

(10). Despite the prospects of nothing of major good coming in the foreseeable future, the museum will persist. In the unlikely event that administrators or bean counters concerned with the NMNH read this account, which because of my predilections and prejudices, is partially a diatribe, they should recall the famous quotation from G. Brown Goode. "A finished museum is a dead museum and a dead museum is a useless museum." It is better however, to end on the same note that gentle soul used in one of his other papers. "My prayer for the museum of the United States and for all other similar agencies of enlightenment is this -that they may never cease to increase" (Goode 1891:445).

Acknowledgments

Not counting occasional visits as a child, and a summer of volunteering during high school — most of which was spent pasting locality numbers on fossils — I have been around the natural history building of the SI for more than 50 years, a fact of interest to no one else. Despite aggravations, disappointments, and lost opportunities over the decades, there may be truth in the old shibboleth that time flies when you are having fun. To be honest, I have difficulty staying at one task for too long and my research in invertebrate paleontology has flitted around. Likewise, although I began shy, I found that I liked to lecture and to talk. I also found out that if you want to have an audience of even one person, you have to be prepared to listen when others talk.

Because I was a member of the U.S. Geological Survey for 32 years, and subsequently the Smithsonian authorities generously granted me an office, I have remained around for 19 more years; (I acknowledge with thanks being assigned the status of research associate in 1967 and having that honor renewed every three years). Thus, I have been in the building, but not directly of the building. This is a subtle distinction, but not a minor one, for I was an observer, and never a staff member affected by actions of the SI or the NMNH. As a result, many people in the community, including, a number of whom are no longer present, have conversed with me and shared views on the Institution and Museum. I have filed away their comments, but never passed them on to others. Much of that material is included in the above account. Thus, in one sense, although I have tried to present a consensus view of events, I confess they are likely much tempered by my own experiences.

I have never held an administrative post, nor had to raise funds, and admit that this lack of experience has colored my views of these subjects. Where I have expressed my personal opinion on other matters I have tried to be objective within the limits of an idiosyncratic writing style. I thank Brian Huber, head of Senate of Scientists during 2000, for reading an early draft and adding significant information. A later draft was read by David Pawson, again giving new insight. Finally, Michele Aldrich, Alan Leviton, and J. Thomas Dutro, Jr., applied their many skills to both text and illustration. As a result of these efforts, the prose is slightly less turgid and a few of my opinions on recent happenings have been modified or muted. Notwithstanding all this direct assistance, the text, containing both sins of commission and sins of omission, remains my full responsibility.

The woodcuts and some photographs are from the collections of the Smithsonian Archives; those concerned with historic preservation are from the Office of Architectural Preservation. More recent photographs are from Chip Clark, photographer for exhibits; they are as yet uncataloged. The Smithsonian Photographic Services performed yeoman service in printing old negatives. Mary Parrish, Department of Paleobiology, drafted the summary of administrative changes.

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Author's Note (added in proof)

In preparing for my participation in a symposium on museums being organized in celebration of the sesquecentennial of the California Academy of Sciences, I began work on this manuscript during the spring and fall of 2002, which was not a particularly good time for the Smithsonian Institution. As a consequence, any realistic view of developments was likely to be pessimistic. Shortly before the time of oral presentation of this study in the late spring of 2003, a new museum director, Dr. Christán Samper, had been appointed, but he had only just moved in to his new office. It is exciting to report that during slightly more than a year of his administration, morale of the staff of the National Museum of Natural History has improved dramatically.

Although Dr. Samper must be given considerable credit for this change, the visibility and overall morale of the Smithsonian Institution also improved. Tourist visitation has increased since its dramatic decline after September 11, 200l and figures for 2004 so far are more than 20% over those of 2003. A flurry of successful displays and new halls in several of the buildings are important, and a major new aircraft annex has attracted more than one million visitors in less than a year. This has had a positive effect on the various museum stores, and thus a modest increase in revenues, a portion of which are allocated to Natural History. The only unfavorable publicity concerns the National Zoological Park, and its difficulties seem to be on the way to resolution.

For the Natural History building itself, a key event was the opening of the new mammal exhibit. This occupies three former halls on the west side of the building. Interior walls on both sides of the central hall were broken out and the skylight above this main hall has been restored so that this central area now resembles the original configuration of 1910. The view into the hall is impressive and the work of taxidermists is aptly described as magnificent. On the negative side, two smaller exhibit halls in the west and north ranges of the building remain closed. Habitat groups, as such, of the animals have virtually disappeared and the tourist may learn less about mammals than was provided by the former smaller hall. The cost of the new display has been estimated at $15,000,000.

Despite the price, this new hall has received considerable favorable publicity and serves as the model for future major innovations in the exhibits. Planning is well underway for a major hall of the oceans, which will attempt to integrate physical oceanography, marine biology and paleontology. This will occupy the northern axis of the original building. Funding is in hand to start basic electrical work and construction, and it may already have started. A projected opening date is the fall of 2008.

Unfortunately, as a result of this new activity several more of the older halls have been closed. The direct consequence is that among the public displays, anthropology is now greatly underrepresented. If the east side of the building is used to emphasize fossils and geology in a manner comparable to that of mammals and the oceans, the only space left for anthropological exhibit will be on the second floor. The new National Museum of The American Indian opens in the fall of 2004, but that may not have significant impact on either the collections or directions of research within the department of anthropology.

Another point of public display has been refurbishing of the Rotunda. In part, this was by cleaning the walls, and, in part, by building a large pedestal surrounding the elephant and moving it away from the center of the Rotunda. Several video and small displays were installed in the pedestal, but there is minor discussion as to whether this has increased or diminished the impact of viewing the world largest (former) living land animal.

The former Associate Director for Research and Collections (ADRC) now heads the Smithsonian Environmental Research Center on Chesapeake Bay, south of Annapolis, Maryland. Although this facility is a division of the National Museum of Natural History, it is semi-independent, in large measure because of its physical separation from the main building. There are several areas where mutual interests overlap, one being an annual survey of bird life on the Mall conducted by the Center. Early in 2004, the vacancy in the office of ADRC was filled by a vertebrate paleontologist who previously had been at the museum for a decade.

Insofar as research collections are concerned, efforts to build a new "pod" at the Museum Support Center (MSC) to house specimens stored in alcohol are continuing. They continue to be housed in the west wing adjacent to the curators who study them. It is not entirely clear when this major displacement of fishes, amphibians and reptiles, and marine invertebrates will occur, but seemingly it will occur. The drawers of human skeletons, which lined the east side of the third floor since 1909, are being transported to the MSC.

It has been reported, informally, that when Christán Samper was appointed director, only one member of the curatorial staff was younger than him. Since then, there have been interviews for new staff in at least three departments and though the Federal personnel system moves at a glacial pace, new faces may soon appear. The staff continues to gray, and it will be a real race to find replacements so as to pass along accumulated tradition and wisdom to a next generation of curators. There are too many uncertainties to make predictions, but it will be a real feat to find replacements for all professional staff positions, and one can "bet the farm" that the curatorial staff will never again rise to the level of the 1960–1970 decade.

Within the structure, the transfer of mollusks to the third floor of the west wing and move of the entomologists to their former space and to the east courtyard building has been completed long enough now so that these new quarters are like home. This has left the sixth floor of the west wing empty for refurbishing. Who will move there when the contractors leave has not been announced. The installation of a new phone network with far too many features for some to comprehend has been enough immediate concern.

Several programs to support visiting scientists that had been cut have been partially restored, and a small increase in funding for research and collection maintenance has been obtained. These developments are all to the good. Indeed, there is enough expectation of continuity that at least a few persons are informally considering what might be planned in 2010 to commemorate the centennial of the "new" National Museum.

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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES

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A National Research Laboratory in the Late 20th Century: U.S. Geological Survey's Paleontology and Stratigraphy Branch as a Case Study

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Government agencies involved with natural history research play different roles from those of museums, academic departments, or industrial laboratories. They share similar interests in systematic biologic research and its application to problem-solving, but emphasis is placed on different aspects of the scientific enterprise. Traditionally, museums were mostly pure research laboratories and commercial labs were almost entirely applied, whereas organizations like the U.S. Geological Survey (USGS) fell somewhere in between.

This paper traces the post-World War II history of the Paleontology and Stratigraphy Branch (P & S) of the USGS from its phoenix-like revival in 1948 under Branch Chief Preston E. Cloud, Jr. (Fig. 1) to its elimination as a functioning unit in 1998, reorganized out of existence during Gordon Eaton's directorship of the Survey.

During the half-century that followed the end of the Second World War and to 1998, when the USGS was reorganized during the tenure of Gordon Eaton as Director, the Paleontology and Stratigraphy Branch (P & S) grew from a handful of aging scientists left over from World War II, to nearly 75 active researchers in three Survey centers (Washington, Denver, and Menlo Park, California). At the height of activities in the 1970s and 80s, more than 100 geologists, paleontologists, technicians, photographers, artists, and other support staff made it the most talented and diversified paleontologic research "institute" in the world.

Systematic biologic expertise covered most of the animal and plant phyla and biostratigraphic syntheses of fossil assemblages in each of the Phanerozoic systems were published. A wide range of paleontologic applications came under investigation, including evolution, paleoecology, environmental analyses, modern reef analogues of ancient reef systems, fresh-water lake assemblages, coal-swamp features of the Carboniferous, etc.

Two developments in the 1990s led to the demise of the P & S Branch: 1) the Federal initiative for "out-sourcing" many scientific research activities, which were looked at by middle managers as money-sump "losers"; and 2) a reorganization of Agencies in the Department of the Interior resulting in the elimination of subunits in the USGS, driven by budget, program and personnel realignments.

Beginnings (1940s–1950s)

In the process of reinventing government after World War II, the USGS was among those Federal Bureaus that reorganized their internal structure and programs to meet the challenge of a nation that was devouring its natural resource base at an exponential rate.

An essentially individual research-project oriented agency before the War, the Paleontology Section was a loose-knit group of scientists with John B. Reeside (Fig. 2) as Chief Paleontologist. Edward O. Ulrich (Fig. 3) was responsible for the "Lower Paleozoic," and George H. Girty (Fig. 4) headed the "Üpper Paleozoic" research. Julia Gardner (Fig. 5), the first woman paleontologist on the Survey, was a Tertiary mollusk specialist, and Roland Brown (Fig. 6) handled paleobotany and shared responsibility for the Mesozoic with Reeside.

FIGURE 1. Preston E. Cloud, Jr.

During the war years, the Survey rallied around with emergency programs to fulfill wartime needs for strategic studies of metals, nonmetals and fuels, and terrain analyses for military purposes, and basic paleontologic studies came to a standstill.

The post-War Survey revamped its research goals in most of the basic earth science disciplines. This specifically involved developing laboratories to work on all aspects of field research. Among a handful of others, the work in paleontology, stratigraphy, and sedimentology was the responsibility of the Paleontology and Stratigraphy Branch which was placed in the hands of Preston E. Cloud, Jr., recently a professor at Harvard University.

In 1948, Cloud began an ambitious plan to build a research organization in the soft-rock geology area, second to none. His approach was an eclectic one. He had inherited a handful of older paleontologists from the pre-War 1930s, whom he called on to lead subunits in his Branch Organization Chart. These units were responsible for logical subdisciplines, largely based on the fossil collections that had been assembled over more than 50 years of USGS work across the nation. Most of these collections were being curated by an individual or a small group of scientists housed in the Museum of Natural History in Washington. Although not legally linked, a common community of interest had drawn both Museum and Survey paleontologists into a loosely-knit, collections-oriented, informal research institute.

The P & S Branch of 1950 had 5 subunits: Lower Paleozoic, Upper Paleozoic, Mesozoic, Tertiary, and Paleobotany/Vertebrate Paleontology. Old-timers in these subunits were unofficial assistant Branch Chiefs who acted collectively as the Branch Chief's staff for program, budget, performance evaluations, etc. At the outset, these men were: LP — Charles Merriam, UP — James Steele Williams, Mes. — J.B. Reeside, Tert. — Druid Wilson, and Paleobot/VP — Roland Brown.

Cloud, with the backing and blessings of Chief Geologist Bill Bradley, began to build research strength in these areas by searching the Survey roles for permanent employee paleontologists who had been on various wartime projects. Thus, within a few years, the Branch inherited, or dragooned: Josiah Bridge, Jean Berdan (Fig. 7), Israel Gregory Sohn (Fig. 8), Helen Duncan, Mackenzie Gordon (Fig. 9), Julia Gardner, Esther and Paul Applin, Ralph Imlay, Bill Cobban, and

FIGURE 2. John B. Reeside, Jr.

FIGURE 3. Edward O. Ulrich

FIGURE 4. George H. Girty

FIGURE 5. Julia Gardner

FIGURE 6. Roland W. Brown

FIGURE 7. Jean M. Berdan

FIGURE 8. Israel Gregory Sohn

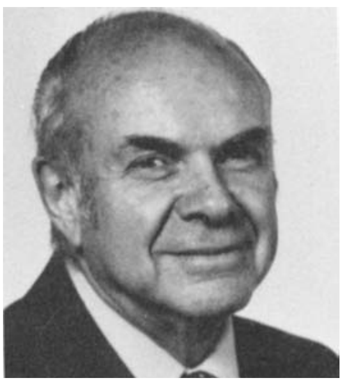


FIGURE 9. MacKenzie Gordon, Jr.

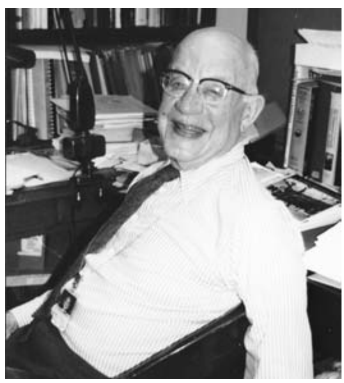


FIGURE 10. Frank C. Whitmore, Jr.

others. This trend continued through the 1950s with the addition of: Jim Schopf, Harry Ladd, Wendell Woodring, Frank Whitmore (Fig. 10), Ruth Todd, Charles Read, Ed Lewis, Chuck Repenning, John Huddle, and others.

Cloud had the idea that any viable research group, within the USGS framework, should have experts in all areas of soft-rock geology that might be the focus for "service" requests from the Survey itself, state surveys, academia, other federal programs, and the general public. He thought that each major group of animals and plants should have an expert systematist and that each geologic system needed at least one biostratigraphic specialist. Some of these areas could be combined in a single paleontologist, of course, but his Table of Organization had slots for each of these specialties.

Consequently, in more than the decade of P and S growth under his aegis, Cloud kept his eye open for young paleontologists who fit into his organizational scheme and who were interested in Federal Service. His wide circle of associates in academia and industry enabled him to hire during that decade: Pete Palmer, Rube Ross, Art Boucot, Tom Dutro, Bill Oliver (Fig. 11), Rich Boardman, Norm Sohl (Fig. 12), Ray Douglass, Serge Mamay (Fig. 13), Ellis Yochelson (Fig. 14), Norm Silberling, Estella Leopold (Fig. 15) and Bob Neuman. This trend continued through the 1960s and 70s when these younger scientists were added: Warren Addicott, Tom Ager, Gus Armstrong, John Barron, Blake Blackwelder, Platt Bradbury, Laurel Bybell, Ray Christopher, R. M. Forester, John Hanley, Anita Harris, John Pojeta (Fig. 16), John Repetski, Joe Hazel, Fred May, Wylie Poag, Bill Sliter, Mike Taylor, Page Valentine, and Lucy Edwards, among others.

Thus, within a quarter-century after Cloud had retired in 1962, his dream of a "National Laboratory" was in place. Two fine office/laboratories, opened in the 1950s, grew into regional centers in Denver and Menlo Park, California; with small outlying special purpose labs (at various times) in Columbus, Ohio, Albuquerque, New Mexico, Flagstaff, Arizona, Laramie, Wyoming, Woods Hole, Massachusetts, in Florida, and at Santa Barbara, California.

People from Washington who initiated the two main centers were: Rube Ross, Bill Cobban, Norm Silberling and Ed Lewis in Denver; and Charlie Merriam, Mac Gordon and Dave Jones in

FIGURE 11. William A. Oliver, Jr.

FIGURE 12. Norman F. Sohl

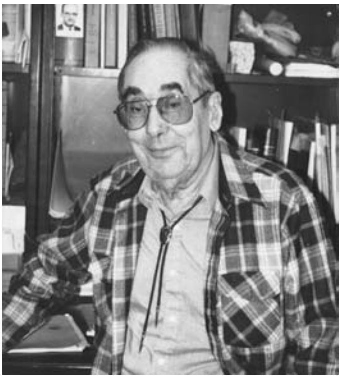


FIGURE 13. Sergius H. Mamay

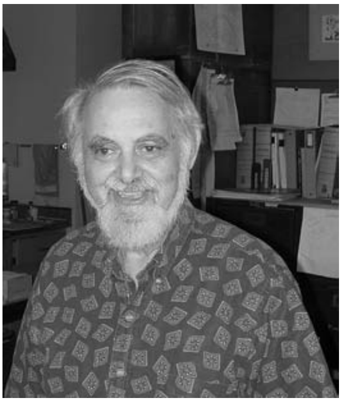


FIGURE 14. Ellis L. Yochelson

FIGURE 15. Estella B. Leopold

FIGURE 16. John Pojeta, Jr.

Menlo Park. Both centers grew by adding new scientists and, at about the time of the USGS Centennial Celebration in 1979, the P & S Branch (institute) was near its zenith. This was also true for other Branches with nationwide impact: isotope geology, volcanology, petrophysics and remote sensing, analytical labs, global seismology, rock mechanics, astrogeology, tectonophysics, and military geology, among others.

In the late 1980s and early 1990s, two trends in the USGS began to erode away this ideal situation: 1) loss of budget and program control at the Branch level, and 2) a Federal Executive move to “outsource” all non-profitable projects and services.

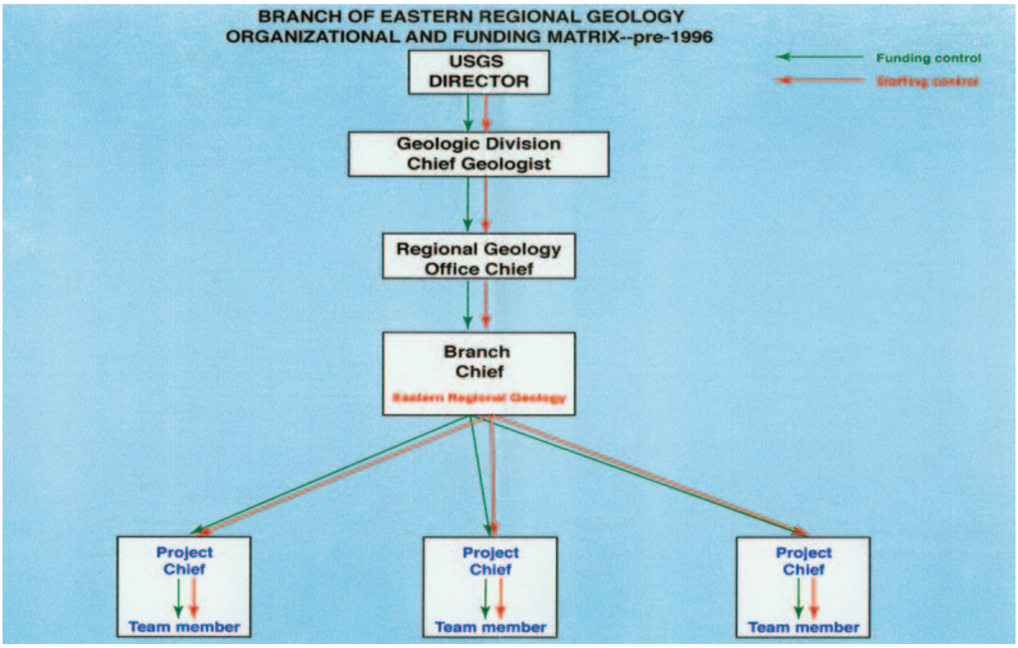
Finally, an ultimate reorganization of the USGS in the late 1990s led to the effectual elimination of the old organization, including the Branches themselves. These three charts (Figs. 17–19), depicting the organizational and funding matrices in: 1) pre-1996 (50 years of stability!) (Fig. 17), 2) 1996–1998 (separation of staffing and funding controls) (Fig. 18), and 3) 2003 (present chaos!) (Fig. 19), graphically illustrate the decline and fall of the Branch structure in the Geological Survey.

Summary and Results

The P & S Branch in the last half of the 20th Century, fulfilled the fondest dreams of its first post-World War II chief, Preston E. Cloud, Jr. During the middle decades of that time, 1960–1990, it was the most influential force in paleontology in the Western Hemisphere (perhaps in the world). Its scientists produced a steady series of: 1) taxonomic monographs in diverse biologic groups; 2) biostratigraphic correlation papers in every Phanerozoic System; 3) and thousands of administrative reports (the Examination and Report) to USGS geologists, and others, who referred fossils to the Branch for study, analysis, and age-dating. Many of the monographs and stratigraphic syntheses provided major breakthroughs that solved, or were parts of the solutions of, climactic geologic enigmas. Most of these works, some now over 50 years old, continue to guide the residual research paleontologic efforts in government, academia, and the few remaining industrial laboratories. Production of scientific results took every imaginable form during this 50-year period and a conservative estimate of published papers and abstracts is over 5000. The administrative reports (E and Rs) number in the hundreds of thousands! Averages mean very little, of course, but over sample decades of the 60s and 70s, each professional paleontologist published two or three research papers and another two abstracts each year and was involved with biostratigraphic service work for four or five separate projects during that year.

For more than 30 years, this large active group of researchers accepted any challenge and more often than not came up with significant results. For example, Josiah Bridge’s work on the fossils of the Mascot-Jefferson City zinc district in Tennessee helped mining companies work out the geologic structure and thus locate more than a million tons of ore. Helen Duncan identified tubular holes in a dolomite core as a Mississippian syringoporoid coral, in Utah, which encouraged the company to continue drilling, and a large sulfide ore deposit was subsequently discovered. Anita Harris’s pioneering research on color changes in conodonts, related to temperature, has provided vital data to companies that are exploring for oil and gas in the Appalachians, the Basin and Range, and in northern Alaska.

In the 1960s, Serge Mamay and Charlie Read published a Professional Paper detailing paleobotanical biozonation of the Carboniferous of the eastern United States. More than 50 years later, this monograph remains the standard for correlation of the nonmarine Carboniferous and has not been supplanted. Roland Brown delineated the Cretaceous-Tertiary boundary with his work in the 50s on the plant-bearing beds in the Denver Basin. Spore-pollen description was done by Bob Tschudy. Recent isotopic dating of the boundary has put an age in years on this event so critical to



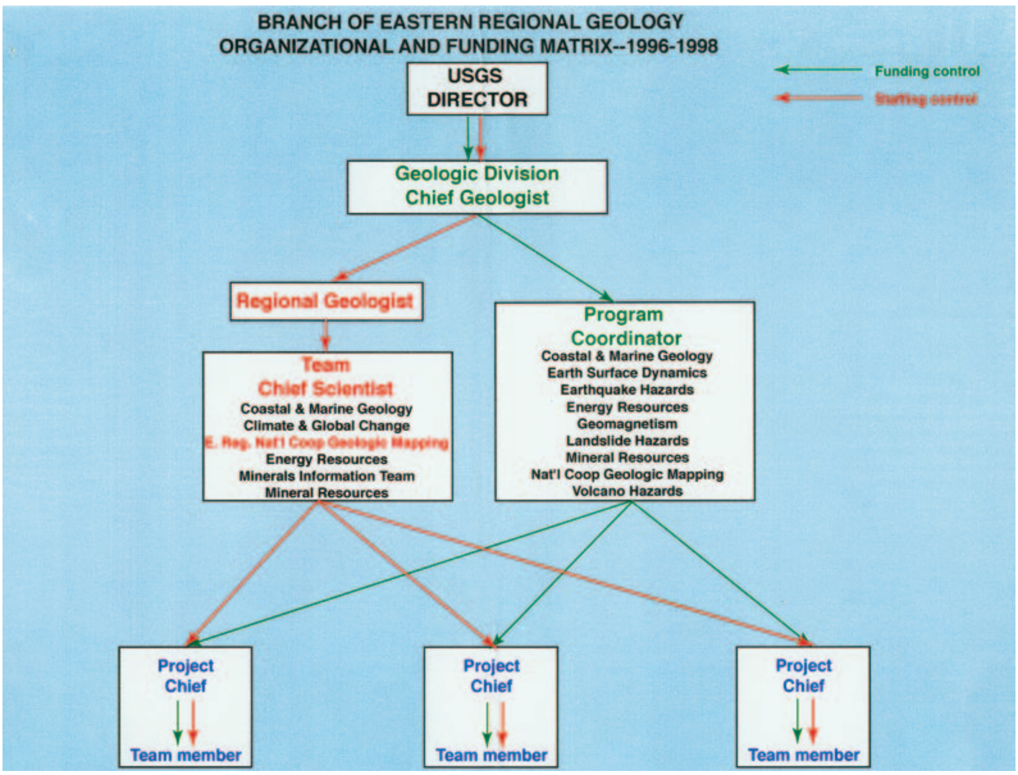


FIGURE 17 (above). pre-1996 (50 years of stability!).
FIGURE 18 (below). 1996–1998 (separation of staffing [red] and funding [green] controls).

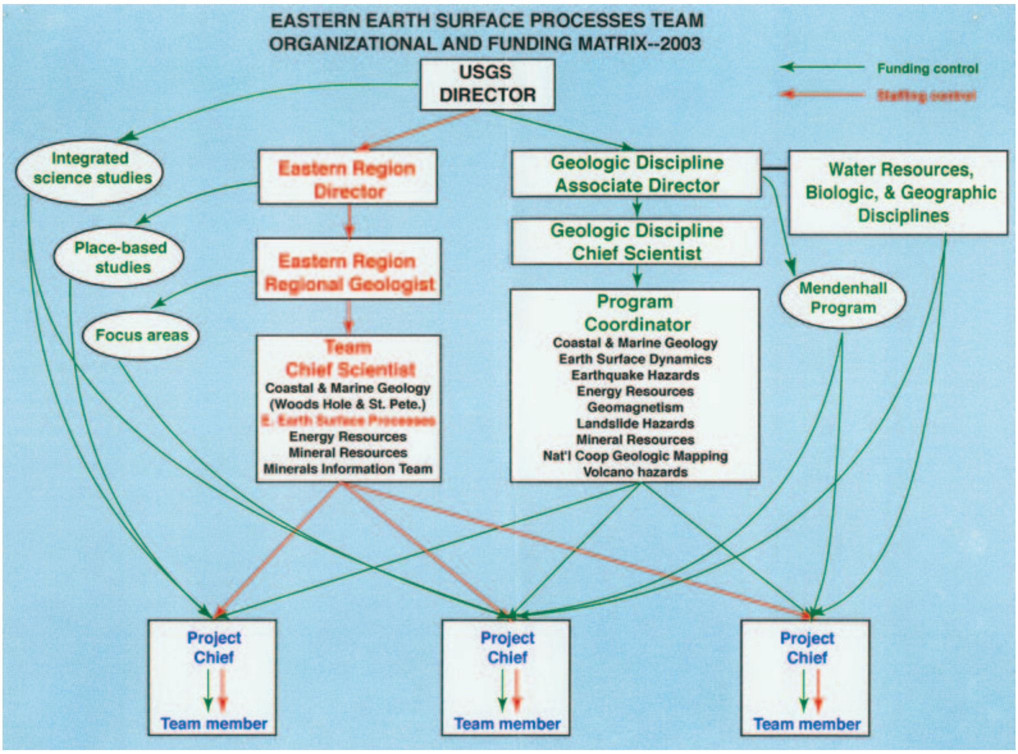


FIGURE 19. 2003 (present chaos!).

extinction theory, but the accuracy of the stratigraphic position of the boundary is unchanged since Brown and Tschudy's work. Mac Gordon's systematic studies of Carboniferous goniatites and regional biostratigraphy produced a detailed synthesis for the Arkansas bauxite field, and his cephelopod zonation has become a standard for North American Carboniferous studies from Arkansas and Oklahoma to the Great Basin and California to northern Alaska. Bill Cobban's intimate knowledge of Cretaceous stratigraphy and detailed ammonite distribution allowed him to establish a biozonation consisting of 30 zones in Montana. These zones, along with Peterson's isotope-based dates on interlayered ash beds, produced a fine-scale age template for late Cretaceous events. This multipurpose Cretaceous calendar is still used extensively for studies of dinosaur extinction and end-Cretaceous geologic events everywhere in North America.

In retrospect, a national laboratory concept could not have survived in the late 20th century U.S. Geological Survey. The vision of Cloud and Bradley, nurtured by the general climate of science in the 1950s, was a grand one. The P & S Branch was a focus of paleontologic research in the United States for more than a quarter-century. Many of its scientists developed international reputations and became leaders in their fields. The stronger researchers, supported and supplemented by a variety of talents in less viable specialties, developed teams to attack everything from the origin of life to the evolution of coral reefs. Evolutionary patterns were clarified for many groups of fossils. And all these data were added to the common pool of paleobiologic knowledge in the latter half of the 20th Century, and became the backbone for dozens of large-scale syntheses including great chunks of the *Treatise on Invertebrate Paleontology*, the development of the detailed Geologic Time Scale, regional geotectonic basinal studies and plate-tectonic controlled paleobiologic historical studies. Certainly, the demise of the P & S Branch, along with other basic geologic research in the U.S. Geological Survey, has been a scientific disaster of epic proportions.

Photo Credits

Figure 1, National Academy of Sciences; Figures 2, 4–6, 8–9, 11–12, U.S. Geological Survey; Figure 3, Smithsonian Institution Archives; Figures 7, 17–19, John Pojeta, Jr.; Figures 10 and 13, Department of Paleobiology, National Museum of Natural History; Figures 14–16, Alan E. Leviton.

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Oceanography and Fieldwork
Geopolitics and Research at The Scripps Institution

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In 1933 W.E. Allen, a phytoplankton specialist at the Scripps Institution of Oceanography in La Jolla, California, published a newspaper article entitled "Caged Animal not Natural." Allen defined himself as a naturalist and throughout the 1920s and 1930s wrote a weekly column on natural history topics distributed through the news corporation Science Service. That particular essay, however, was different: it was a thinly veiled attack on the policies and priorities of Scripps' director Thomas Wayland Vaughan. Allen charged that Vaughan was de-emphasizing fieldwork in favor of laboratory-based research. In Allen's words, Vaughan had shifted Scripps' mission from outdoors to indoors, from sea to land.[1]

Allen's statement applied to oceanography but also related to larger issues. Beginning in the late nineteenth century experimental laboratory-based research became dominant in the biological sciences in the United States. Although natural history and fieldwork were not eliminated, scientists touted new experimental methods in genetics and physiology as the best means for doing productive research. As experimental biology outstripped natural history in financial support, journals, and university positions, natural history institutions became more and more marginal. Such changes seriously threatened naturalists and they frequently struck back, condemning experimentalists and highlighting the importance of fieldwork.[2] At Scripps fieldwork pertained to research at sea and Allen condemned Vaughan's interest in constructing a new experimental research laboratory while use of the institution's ship, the *Scripps*, declined.[3]

The claim that there was a vacillating commitment to fieldwork at Scripps may seem odd. Scripps is situated right at the edge of the Pacific Ocean, which suggests that it would naturally be an ideal location for seagoing research. But as Allen's criticisms indicate, work at sea was not always the top priority at the institution. This paper will explore Scripps' changing commitment to ocean research during that institution's first half century, from 1903 to the mid 1950s. Intermittent sea studies coincided with the availability of resources, namely ships. However, different directors also held distinctive ideas about oceanography and had different priorities. This paper will claim that the changing political economy of oceanography, especially during wartime when the government became a major patron for the science, had significant consequences for research at Scripps.

The Scripps Institution for Biological Research

Although this paper concentrates on the Scripps Institution of Oceanography, that organization cannot be fully understood without knowledge of its predecessor, the Scripps Institution for Biological Research. Established in 1903, that institution was the brainchild of William Emerson Ritter (Fig. 1). A marine biologist who received his Ph.D. from Harvard University, Ritter became professor and head of the Zoology Department at the University of California, Berkeley in 1892.

Over the next several years Ritter and his students conducted research while looking for a suitable, off campus biological laboratory. Ritter and his University of California colleague Charles Kofoid were impressed by the abundance of marine organisms and opportunities for year-round research in the San Diego area. In 1903, with enthusiastic support from local naturalists and financial commitments from business leaders, most notably E.W. Scripps and his sister Ellen Browning Scripps, Ritter agreed to establish a marine biological station in San Diego. Originally located in the boathouse of the Coronado Hotel, it moved the following year to a small facility in nearby La Jolla. In 1907 E. W. Scripps purchased a lot north of the village that became the new, permanent site for the laboratory two years later. With a $50,000 endowment from Ellen Browning Scripps, Ritter had the financial support that enabled him to move ahead with a scientific research program.[4]

FIGURE 1. William Emerson Ritter

The new station differed in important respects from other biological institutions. In contrast to the Marine Biological Laboratory at Woods Hole, Massachusetts or the Naples Zoological Station, Ritter stressed that his scientists would conduct investigations in marine biology rather than "general biology prosecuted on marine organisms."[5] Scientists elsewhere, he claimed, examined evolutionary or physiological problems and used specimens that just happened to be marine organisms. Scripps' scientists were dedicated "to finding out what marine organisms are as such." In addition they maintained that hydrographical research, the study of the temperature, salinity, and oxygen content of seawater, was "as indispensable as any recognized field of biology." Only through analysis of physical and chemical conditions could scientists begin to understand how environment affected the distribution, migration, and physiological processes of marine organisms.[6]

Given those objectives, studies at sea were a crucial feature of the institution's research program. Ritter called for repeated investigations in a localized area, and as early as 1901 he and his students were conducting dredging and trawling operations in southern California. By 1905 he had identified an area between Point Conception on the north and west, and Point Loma on the south and east, as the region he and his colleagues would survey (Fig. 2). After acquiring their own ship, the *Alexander Agassiz*, in 1908, Scripps' scientists launched a more systematic program of collecting plankton samples, hydrographic data, and ocean bottom sediments. In addition to developing improved instruments for gathering data, they instituted precise recording methods. The system that they developed for identifying the location, time and date, and data collected was not new; scientists had employed such techniques for decades. But the emphasis on accuracy and amassing large numbers of observations reflected the institution's commitment to fieldwork.[7]

Over the next ten years the marine biological station grew. In 1910, the institution obtained its

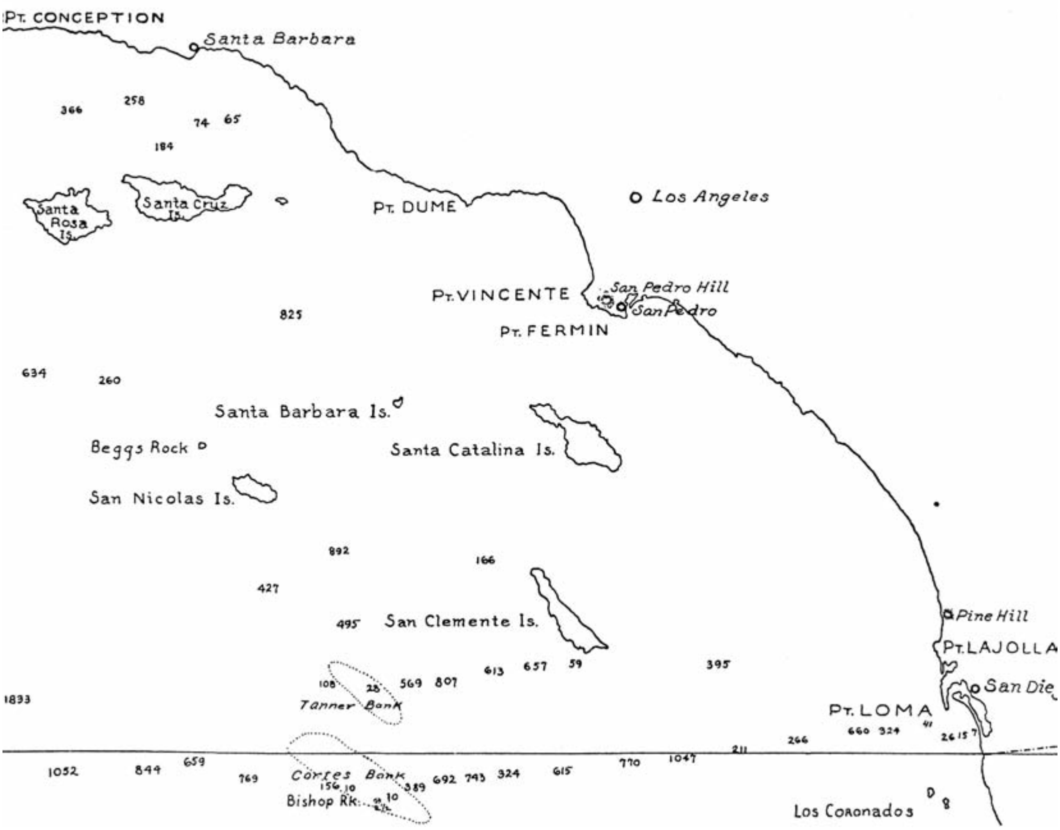

FIGURE 2. Scripps survey map. Area to be surveyed by the Scripps Institution for Biological Research. William E. Ritter, The Marine Biological Station.

first building, the George H. Scripps Memorial Marine Biological Laboratory, which, in addition to housing offices, laboratories, the aquarium, and library also served as the residence for the director and his wife. In 1912, it officially became part of the University of California. More important, it emerged as a productive center for fieldwork and research. In addition to Ritter, early staff members included E.L. Michael, who studied worms, Calvin O. Esterly, a zooplankton specialist, and George F. McEwen, a physical oceanographer. Each pursued their own investigations but they embraced Ritter's larger agenda. That included combining fieldwork and laboratory research. They were also committed to employing quantitative methods, but not for economic or strictly empirical purposes. Instead Ritter emphasized collecting massive amounts of data, and developing precise methods for organizing that data, as the basis for establishing the relationship between organisms and their environment. By organizing their data according to a specific environmental factor, such as temperature, Scripps scientists could calculate the frequency of a species within a particular temperature interval. Comparing that to the frequency of the species under different temperature conditions then enabled them to establish a correlation between environment and organism. Using that approach Michael sought to explain how water temperature, depth, and density influenced the migration of worms. Esterly examined similar factors in his studies of the habits of copepods.[8]

Extensive field data were also necessary for McEwen's research. He had an interest in the phenomenon of upwelling, the process by which the impact of winds on surface waters results in the upward flow of deep, cold waters near a coastline. Through the study of hydrographic and biological data collected by Scripps scientists, including himself, McEwen developed a sophisticated interpretation of upwelling off the California coast.[9]

But not everyone at Scripps was fully committed to work at sea. Francis B. Sumner, who had previously established a reputation for his studies of fish, took up an entirely different line of research when he came to La Jolla. Interested in the problem of the inheritance of acquired characters, Sumner devoted his attention to studying the evolution and distribution of deer mice. His project entailed fieldwork but was unrelated to the activities of a marine biological station and later an oceanographic institution.[10] Nor was McEwen an ardent proponent of fieldwork. Certainly he participated in cruises and collected field data, but in the mid 1910s he noted that data on hydrobiological relations had become too complex, and as a result Scripps discontinued its plankton investigations and limited data collecting to temperature and salinity samples. Rather than gathering more information McEwen wanted to use the data at hand to establish agreements with or deviations from average conditions. In other words he was now primarily interested in applying the principles of mathematical physics to data already accumulated in order to derive formulas.[11]

Ritter also moved away from fieldwork, largely as a result of his close association with E.W. Scripps. A newspaper magnate who had built a winter home in San Diego, Scripps originally had little interest in the scientific work being done at the marine station. As a businessman his priorities were "management, capitalization, and the creation of new enterprises," one of which was the marine station.[12] Gradually, however, he became interested in Ritter's science and began to press the director and his colleagues to "explain what kind of a thing this damned human animal is, anyway." Scripps wanted the scientists he supported to account for human customs, ethics, religion, and especially democracy. He and Ritter frequently engaged in extended discussions on those topics and gradually Ritter, who had studied development and evolution, abandoned field research. He devoted himself to developing a philosophical biology, most fully embodied in his 1919 book *The Unity of the Organism or the Organismal Conception of Life*. Ritter developed a form of non-vitalistic mysticism in which unity, cooperation, and interdependence constituted the basic principles of biology and democracy. The close personal relationship between Scripps and Ritter, patron and client, had a profound impact on the laboratory director, and it is likely that Ritter changed his priorities to address E.W. Scripps' "enormous belief in science as an instrument for human welfare."[13]

The emphasis on science as a means for promoting human welfare had additional consequences for the institution. When the United States entered World War I in 1917, the Scripps Institution took part in two large-scale government projects: kelp harvesting and fisheries. The latter was especially important, and when Ritter became director of operations for the U.S. Bureau of Fisheries for southern California, Scripps scientists began investigating the distribution and habits of tuna. With support from the National Food Administration and the Council of Defense of California, Scripps scientists also conducted biological and hydrographic studies in support of the fishing industry. As a result of those new initiatives in pelagic research, the institution in 1917 sold the *Alexander Agassiz* since it was "too large and expensive to operate for the particular phase of the marine investigations we are now entering upon." Virtually all investigations, including plankton studies, were "now subordinated, in one way and another, to fisheries problems, . . ."[14]

Wartime developments and fisheries research also influenced Ritter's changing ideas on the role of science. In earlier years Ritter had recognized a role for applied science but was intent on making "research primary and loaves and fishes secondary."[15] Now, however, he highlighted fisheries as a means for achieving scientific and social objectives. Through fisheries research the Scripps Institution could play a leading role in studying problems of the North Pacific. For Ritter, influenced by his interactions with E.W. Scripps, fisheries was more than just a scientific or economic issue; it concerned international relations. Rather than freedom of the sea Ritter emphasized the uses of the sea. For Asians as well as Americans the Pacific represented travel, adventure, and economic gain, resources that had profound social and economic consequences for humanity. The Pacific was "an interpeoples" problem that required an "interracial consciousness," he stated. By the late 1910s Ritter was convinced that fisheries research in the North Pacific provided a means to address the problems of civilization, democratization, and improved social and economic relations among nations that he and E.W. Scripps considered so important.[16]

As Ritter outlined an enlarged view of science, he began to advocate changes in the institution's research program. Inshore studies remained important, but now Ritter called for research on diatoms and bacteria in the open ocean. Plankton, long a staple of Scripps hydrobiological research, should now be studied as a source of fish food. And he increasingly touted the importance of oceanography. In 1908 he had told Charles Kofoid that

> while we are greatly interested in oceanographic problems as such, we must not, as I see it, ever let these rise to the place of primary importance. Biology is our main interest and we must in general keep all other interests secondary to that.[17]

Within a decade he was attempting to move the Scripps Institution beyond a narrow adherence to marine biology. Analysis of oceanographic conditions and their impact on spawning had become a top priority. The importance of currents off California and Japan and the relationship between oceanography and meteorology, especially the consequences for agriculture, were a major reason for studying the North Pacific.[18] But Ritter's growing commitment to oceanography did not result in increased fieldwork. Since Scripps no longer had its own ship he called for new vessels to undertake oceanic research, but none were purchased. On occasion the institution rented boats and scientists did some work onboard government ships. Ritter suggested that federal government agencies begin supplying Scripps with information on seawater temperature, pressure, and salinity, but that was not immediately put into practice. Without a ship Scripps scientists now relied primarily on collecting from the pier, which was constructed in 1915–1916. Nevertheless, Ritter, influenced by E.W. Scripps, had taken advantage of the changed political economy of science during WWI to redefine the institution's mission.[19]

Scholars have identified several factors in explaining Scripps' change from a marine station to an oceanographic institution. E.W. Scripps' increased interest in population studies and Science Service, Ritter's impending retirement, and the institution's need for greater financial support all played a role.[20] Yet Ritter's changing ideas about the institution's priorities, specifically his commitment to oceanography, must also be considered. From 1917 to the mid 1920s he frequently expressed his views in publications, presentations, and meetings with E.W. Scripps and John C. Merriam, director of the Carnegie Institution of Washington (CIW). Merriam and Ritter, both faculty members at the University of California, were old friends. They were also members of the National Research Council (NRC) Division of Foreign Relations, a committee originally devoted to problems of the Pacific. Merriam knew that Ritter had addressed that committee on the importance of oceanography, just as he was aware of other proposals to promote oceanography currently circulating in Washington, D.C. As Deborah Day has indicated, Merriam played a crucial role in determining the future of the Scripps Institution. It was not coincidental that the person selected to succeed Ritter, Thomas Wayland Vaughan, had spent several years doing ocean related research at the CIW. Nevertheless, it was Ritter, an advocate of science as a means for promoting human welfare, who had championed the shift from marine biology to oceanography.[21]

Vaughan and Scripps Institution of Oceanography

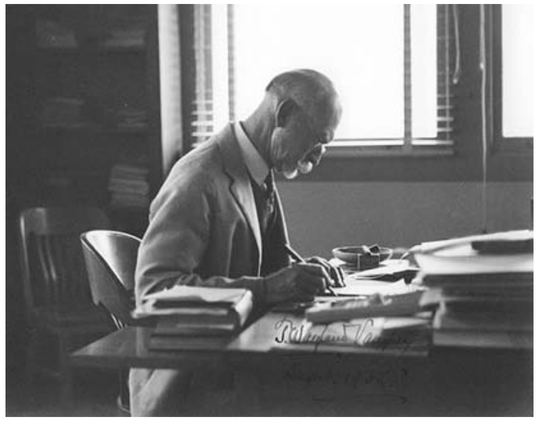

FIGURE 3. Thomas Wayland Vaughan at his desk, ca. 1932.

Selecting Vaughan (Fig. 3), a geologist, to head an oceanographic institution was in some respects peculiar. At the time, however, there were no other oceanographic centers or trained oceanographers in the United States. In addition Vaughan had certain strengths. He had considerable administrative experience at the U.S. Geological Survey and the United States National Museum. He was well known within the scientific community and actively promoted oceanography through the NRC. Following World War I Vaughan and other Washington scientists made a concerted effort to establish a federal agency for oceanography. That venture failed but Vaughan, as chair of NRC committees on seafloor topography, sedimentology, and shoreline processes, encouraged oceanographic research. Even before he moved to La Jolla, Vaughan, relying on his ties to leading scientists and government officials, had arranged for the Navy, the Coast and Geodetic Survey, and the Bureau of Lighthouses to provide the institution with oceanographic data.[22]

Vaughan's scientific interests influenced developments at Scripps. His research focused on coral reef formation, and he approached that problem from an interdisciplinary, ecological perspective. At the CIW's biological laboratory at Dry Tortugas, Florida, he had investigated the physiology of corals and the chemistry of seawater. In order to understand the effects of ocean bottom sediments on reef formation he studied the latest developments in sedimentology.[23] As director Vaughan saw the need to add marine geology and marine chemistry to the institution's traditional emphasis on marine biology and physical oceanography. He added Erik Moberg, a recent Ph.D. in chemical oceanography, to the staff, and arranged for Parker D. Trask, a geologist sponsored by the NRC and the American Petroleum Institute, to use Scripps' facilities for his investigations on the origins of oil. Vaughan's efforts to make Trask a staff member failed, but in 1929 he hired A. Haldane Gee whose work in marine bacteriology included the study of petroleum sources.[24] Vaughan also began the *Bulletin of the Scripps Institution of Oceanography*, an important vehicle for publishing the research done by the institution's scientists.

Although well aware that oceanography was a field science, Vaughan did not always give top priority to research at sea. At the time of his appointment the institution had no ship and was receiving plenty of data from government agencies. Vaughan, in addition, was impressed with the increasing significance of experimental laboratory research. His work on coral reef formation relied heavily on field observations, but experimentation was also important. He exposed corals to varying degrees of temperature, salinity, air, and light. He cemented colonies to terra cotta tiles in an effort to determine the best surfaces for coral larvae attachment. By 1929 Vaughan was convinced that

> As scientific research advances, emphasis changes. This is as true of marine biology as of any other field of investigation. In order to understand the relation of marine organisms to their environment, the shift has been to methods of attack through the medium of experiment and physiology.

In contrast to Michael and Ritter, who stressed the importance of field observations, Vaughan was convinced of the value of laboratory research and made it a priority for his students in geological oceanography.[25]

Vaughan's preference for laboratory research had institutional implications for Scripps. In the late 1920s Vaughan, Henry Bryant Bigelow, and Frank Lillie headed up a National Academy of Sciences committee that convinced the Rockefeller Foundation to provide much needed support for oceanography. Most of the Rockefeller money went toward creating the Woods Hole Oceanographic Institution, but Scripps received $40,000 along with matching gifts from Ellen Browning Scripps and the State of California. Vaughan dedicated the money to building an experimental research laboratory and planned for Ancel B. Keys, a graduate student working on marine physiology, to have a prominent role in designing and running that facility. Vaughan's plans to hire Keys ran into problems, but the new laboratory, named Ritter Hall, was completed in 1931. The next year Vaughan hired Denis Fox, a marine biochemist, and Claude Zobell, a marine microbiologist. Both men were primarily laboratory scientists.[26]

W.E. Allen vigorously objected to Vaughan's initiative. Physiological research, he claimed, was too expensive and "does not fit naturally into our oceanographic program of observations." Allen had worked closely with Esterly and it was not surprising that he considered Vaughan's decision to drop zooplankton studies shortly after Esterly's death as "unfortunate." He was equally put out by what he perceived as a lack of work at sea. Although shipboard work had been on the decline since the sale of the *Alexander Agassiz*, the Scripps family purchased another vessel in 1925, renamed it the *Scripps*, and Allen and Moberg were soon using it for short cruises (Fig. 4). Allen, however, claimed that Vaughan placed obstacles in their way and over the years the number of cruises declined.[27]

FIGURE 4. Roger Revelle collecting onboard the R/V *Scripps*, ca. 1936

Nor was Allen alone. W.C. Crandall, the former captain of the *Alexander Agassiz* and longtime business manager of the biological research institution, seconded Allen's claims. According to Crandall, Vaughan's emphasis on "physiological experimental work" threatened to "defeat the purposes for which the institution was founded, and which the people of California believe it is doing . . . research upon the ocean." J.C. Harper, attorney for Ellen Browning Scripps, declared that the oceanographic laboratory had become "a desk institution."[28]

Although there was merit to those criticisms, they were not unvarnished. In the first place, each of those individuals had an axe to grind. Allen was disturbed that Vaughan's allocation of resources to other fields would adversely affect his research. Crandall, who had hoped to succeed Ritter as Scripps director, was sent packing when Vaughan arrived. In addition, the relationship between Vaughan and the Scripps family was awkward; in their view he did not adequately consult with them about the institution's affairs. Crandall, now Ellen Browning Scripps' business agent, continued to stir up ill will toward the director, perhaps explaining Harper's attitude and the unwillingness of the Scripps family to fully support Vaughan's actions.[29] The criticisms of Vaughan's research program also did not take into account all of his efforts. It was not entirely coincidental that the institution acquired a new ship shortly after Vaughan's appointment. Although use of the *Scripps* may have declined between 1926 and 1930, work at sea was still greater than it had been since 1917, when the institution sold the *Alexander Agassiz*. Vaughan also had other research plans in mind. He had arranged with the CIW for Scripps to obtain the non-magnetic ship *Carnegie* after completing its round the world voyage in 1929. In anticipation of acquiring the vessel, Vaughan began planning a major expedition in the Pacific. But an explosion destroyed the *Carnegie* and with it Vaughan's hopes for an ocean-based research program. Since Moberg, the only Scripps faculty member capable of operating the ship had sailed on the *Carnegie*, albeit prior to the explosion, the *Scripps* went unused in 1929.[30] Vaughan was interested in expanding studies at sea, but by devoting so much money and attention to laboratory research he had created personnel problems and raised questions about the status of fieldwork at Scripps.

Those difficulties became the source of personal and professional frustration for Vaughan. Bitter animosity and rancorous confrontations characterized the relationship between Allen and Vaughan over the next several years.[31] Criticisms of the institution's research program influenced Vaughan to devote greater attention to the institution's work at sea, but with mixed results. Following the loss of the *Carnegie*, Vaughan pressed the Scripps family to purchase another vessel but because of economic hardship they did not do so. However, Robert P. Scripps, E.W.'s son, did pay for modifications to the vessel, including a diesel engine, a mast, and sails. In his annual reports, Vaughan now devoted more attention to work at sea and noted that an increase in the number of people able to handle the *Scripps* allowed for greater use.[32] Vaughan also arranged for Scripps students to go to sea. In 1933 Richard H. Fleming worked onboard the Coast and Geodetic Survey ship *Hannibal*, and Roger Revelle gained similar experience on the *Pioneer*. The following year he spent three months onboard the U.S.S. *Bushnell*, a Navy submarine tender operating between Alaska and Hawaii.[33] Increasingly Vaughan emphasized the importance of what he called the "big problems" of the Pacific. By that he meant studies of circulation as well as temperature, salinity, and oxygen distribution, in short, the data needed to study the ocean as a fluid in dynamic equilibrium. Although dynamical oceanography was cutting edge science in Europe by the early 1930s, it was still not fully understood or studied at Scripps. By emphasizing the need for students to learn dynamical oceanography and gain greater experience at sea, Vaughan was attempting to shift the focus of his research program, although the new emphasis was not all that different from what Ritter had advocated fifteen years before.[34]

Vaughan's overtures were not solely a response to Scripps' internal controversies. Throughout his career he was in close contact with European and American scientists and had worked to keep up with new developments in oceanography. He had known of dynamical oceanography for some time, even if he didn't fully understand it. Vaughan also had a longstanding interest in Pacific science. Since the early 1920s he had participated in the Pacific Science Congresses, and from 1926 to 1936 served as chair of the International Committee on the Oceanography of the Pacific.[35] Still it was only after 1929, the year when the controversy with Allen erupted, that Vaughan truly began to emphasize fieldwork and the importance of studying the oceanographic problems of the Pacific. Even then he was not entirely successful. With the acquisition of the *Scripps*, Vaughan was able to promote oceanographic field observations, but he did not succeed in establishing a coordinated research program or taking Scripps to sea. He did, however, have a hand in selecting a successor who would.[36]

Harald U. Sverdrup

That man was Harald U. Sverdrup (Fig. 5), a Norwegian scientist considered one of the world's leading oceanographers. Trained in a tradition of dynamical meteorology, Sverdrup applied those principles to the study of the oceans. He likewise had extensive experience at sea. In the 1910s and early 1920s he participated in the *Maud* expedition, a study of Arctic waters designed to take three years; it ended up lasting seven. In later years, he participated in a venture to take a submarine to the Arctic and conducted research expeditions in Greenland and Spitzbergen. As the new Scripps director, Sverdrup was committed to fieldwork.[37]

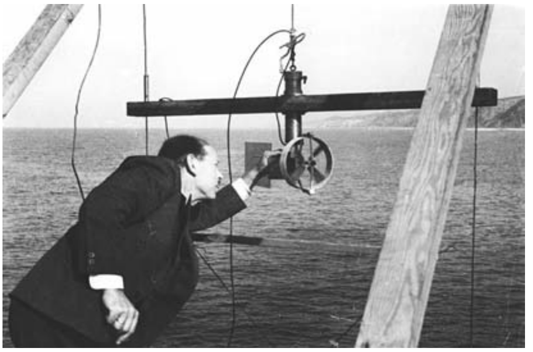

FIGURE 5. Harald U. Sverdrup checking current meter, ca. 1940.

When Sverdrup arrived at Scripps in the summer of 1936 he quickly devised a new curriculum for the graduate program. Developing a research program at sea took considerably longer. Sverdrup came from a background in the geophysical sciences and studied oceanic and atmospheric phenomena in terms of fluids in dynamic equilibrium. As a Norwegian he also knew the importance of fisheries research. But he was completely unprepared for the wide range of activities being pursued at Scripps. As Richard Fleming stated, Sverdrup was "shocked by the fact that we felt oceanography had a much broader content than he had ever imagined." Rather than a coordinated team of scientists pursuing a coherent program of research, he found a diverse, even eclectic group of individuals pursuing a wide range of specialized studies, some unrelated to oceanography. From Sverdrup's perspective the institution seemed to possess no explicit mission. He complained that Scripps was not an oceanographic laboratory but merely an "institution of marine sciences," and its ship nothing more than a "filthy, cramped washtub." Although Sverdrup was hired with a mandate to develop a coordinated, seagoing research program, for the first year he had no clear idea how to do so.[38]

Two developments changed the situation. In November 1936, the *Scripps* blew up, killing one crewmember and permanently injuring another. That was a tragic loss but it gave Sverdrup the opportunity to lobby the Scripps family for a new and better ship. It took about a year but by December 1937 the new *E.W. Scripps* (Fig. 6) was outfitted and ready to go. Capable of carrying over a dozen people and going farther offshore than the *Scripps*, it symbolized the possibility of a research program at sea.[39]

FIGURE 6. RV/*E.W. Scripps*, ca. 1938.

Even more important was a request in January 1937 from the California Division of Fish and Game. Concerned about declines in the annual catch of the California sardine, fisheries scientists approached Sverdrup with a proposal to study currents and their relation to spawning conditions. Work done that spring onboard the Fish and Game ship, the *Bluefin*, had significant consequences for Scripps oceanography. Originally Sverdrup had anticipated that the institution would undertake large regional investigations, but the sardine project convinced him of the importance of intensive, localized area studies.[40] Those would become the model for Scripps' future research. Onboard the *Bluefin* Scripps scientists concentrated on upwelling, a process that required analysis of organisms and biological processes, subjects in which Sverdrup was not an expert. He now saw an opportunity to provide a greater role for Scripps' biologists, and in addition to collaborating with Allen, immersed himself in the study of marine and fisheries biology. Most important, that project enabled him to envision a cooperative research program at sea, one in which the investigations of individual scientists would "mutually reinforce one another."[41]

Drawing on the Fish and Game project Sverdrup now launched a program of fieldwork. With the new *E.W. Scripps* he and colleagues planned a systematic series of investigations, and between 1938 and 1941 Scripps scientists participated in more than thirty expeditions. But the fisheries project was more than a model for research; it also provided much needed financial resources. In the late 1930s the Scripps family was hit hard by the depression and its support for the oceanographic institution declined. Contracts with the U.S. Fish and Wildlife Service for studies of the sardine problem were crucial for sponsoring research at sea. In addition, the Geological Society of America supported a Scripps expedition to the Gulf of California (Fig. 7), largely because Revelle had suggested that the region could be a source of oil.[42] Sverdrup had created a research program based on fieldwork at sea, but in certain important respects his understanding of oceanography had evolved. The fisheries project led him to incorporate biological research. Previously he had defined Revelle and other marine geologists as "independent workers" who were marginal to the main research program. Now, however, they were an important component of the institution's activities. Sverdrup was an outstanding scientist and inspirational director whose commitment to dynamical oceanography had influenced his new colleagues. From a diverse group of specialists he had created a research school committed to fieldwork at sea. Under his leadership Scripps scientists produced a new textbook, *The Oceans*, which became the "bible" for the next two generations of oceanographers. Yet the changing political economy of science had also shaped oceanography at Scripps. Support from outside agencies helped bring certain scientists and their fields of investigation to the forefront. In short, patronage had an important impact in defining what work was done, by whom, and where.[43]

FIGURE 7. Scripps Gulf of California expedition, 1939.

World War II and Scripps Oceanography

World War II profoundly changed the tiny community of oceanographers. Like scientists throughout the country, Scripps oceanographers joined the war effort. Some enlisted in the military, others went to work at a new civilian laboratory in San Diego: the University of California Division of War Research (UCDWR). There they worked closely with physicists, engineers, and Navy personnel. The war also emphasized a new field of investigation: research on underwater sound in support of anti-submarine warfare. In short, Scripps oceanographers were now pursuing new studies with new instruments for a new patron, the Navy, which was interested in developing weapons for operational, mission-oriented objectives. For a time Sverdrup worked at UCDWR, but in March 1942 he ran up against another feature of the new context for science: he was denied security clearance. Sverdrup returned to Scripps, but since the University of California had turned over the *E.W. Scripps* to the government for war work, he was isolated in La Jolla with no ship, few colleagues, and no opportunity to do research at sea.[44] When he received partial security clearance in the summer of 1943, he too went to work on military projects. In addition to training weather officers, Sverdrup and Scripps scientist Walter Munk developed a new system of sea, swell, and surf forecasting in support of amphibious warfare. In conjunction with scientists at UCDWR he developed manuals to aid submariners in locating and evading enemy ships.[45]

The changes that came with WWII continued to influence Scripps oceanography in the post-war period. Although Sverdrup and others claimed that they were returning to the basics of prewar oceanography, the science had changed in terms of patrons, instruments, and fields of research. The institution would expand its prewar studies of the sardine problem, leading to the development of the CALCOFI project, but the Navy became the major patron of oceanography (see Appendix). Scripps' educational program tripled in size, and throughout the 1940s military personnel comprised at least half of each new class. The institution also obtained a new fleet, mostly former naval vessels. Scripps now housed its ships at Point Loma, fifteen miles south of La Jolla, at a new location eventually named the Nimitz Marine Facility. Point Loma also became the site for two additional institutions, both of which soon became part of Scripps: the Marine Physical Laboratory, a facility supported by the Navy Bureau of Ships and the University of California, and the Visibility Laboratory supported by the Air Force.[46] And mission-oriented objectives influenced the trajectory of oceanographic research. According to Scripps oceanographer Revelle (Fig. 8), who remained in the Navy until 1948, "with the exception of some fields of marine biology, the entire program in oceanography is of particular military interest." During the next two decades research in physical, chemical, and geological oceanography, crucial for anti-submarine warfare, dominated over the biological sciences. The use of military vessels and instruments, including sonar, radar, and magnetometers, was equally important for postwar oceanography.[47]

FIGURE 8. Admiral Paul Lee presenting Roger Revelle with Commendation.

With substantial military support Scripps oceanographers gained access to an entire new world of research. Throughout the 1950s Scripps, largely through the efforts of its new director, Revelle, became a leader in worldwide, deep-sea expeditions. In contrast to previous intensive areas studies off the coast of California, Scripps scientists now participated in expeditions to the Marshall Islands in the western Pacific, the Arctic and Antarctic, and in later years the Indian Ocean. Those voyages provided extensive new information on waves, currents, and seawater temperature, pressure, and salinity worldwide. Relying on new techniques in explosive seismology, scientists gained a much greater understanding of the ocean floor and the earth's interior. The Scripps Mid-Pacific (1950) and Capricorn (1952) expeditions yielded important discoveries of underwater mountain chains, trenches, and heat flow through the ocean floor. Such work was crucial for basic ocean science; it also contributed to the plate tectonics revolution of the 1960s.[48]

But it is equally important to emphasize that that work also served military objectives. Fundamental research on seawater temperature and pressure contributed to greater understanding of underwater sound transmission and anti-submarine warfare. Improved techniques in deep-sea dredging, bathymetry, and mapping of the seafloor provided valuable new data on underwater conditions that could affect war fighting in the ocean environment. Seismological projects, work on the earth's gravitational field, and studies of terrestrial magnetism yielded new geophysical data; they also served as means for tracking underwater guided missiles and atomic bomb explosions.[49]

Fieldwork in oceanography also supported America's geopolitical interests in the postwar era. Even before WWII had ended civilian and military leaders were defining a global role for the United States. The wartime allies agreed that the United States, Great Britain, China, and the Soviet Union would each have their own spheres of influence, but America would be the "prime guardian" of a new international order. Concerned about the threats of economic depressions and authoritarian rulers that had given rise to the war, the United States now called for an open economic and political world based on free trade, freedom of the seas, and self-determination. Foreign trade would stimulate the emergence of stable, democratic governments. It also had important strategic value. "America's security needs," stated Thomas G. Paterson, "demanded not only economic expansion in order to satisfy raw material requirements but also a global military watch." America emerged from the war as the world's leading military power, but ongoing security concerns and a "preparedness ideology" combined to promote an activist military policy, even in the midst of demobilization. Dominance of the Atlantic and Pacific oceans was considered "indispensable," and defense of the nation required creating military bases worldwide.[50]

Those commitments had important consequences for ocean science. "Considerable expansion of our knowledge of the oceans is necessary in order to aid in strategic and tactical planning," the first director of the Office of Naval Research stated. Scientific data gathering and the development of predictive models would enable the military to understand and control war fighting environments on the land, on the sea, and in the air. Revelle's comment that "the society which knows the most about its environment and how to turn it to account, is going to be the more likely to win the next war," highlighted the connection among geopolitical priorities, military objectives, and oceanographic research.[51] By the 1950s, fieldwork had become a hallmark of Scripps oceanography, and deep-sea expeditions a rite of passage for Scripps graduate students. But research at sea, the goal of previous generations of Scripps oceanographers, now served more than the purposes of science. It was also vital to America's global Cold War policy.

Conclusion

Research at sea underwent several changes in Scripps' first fifty years. Following an auspicious beginning, research cruises declined after World War I and throughout the 1920s. Sverdrup's emphasis on intensive area studies in the 1930s was followed by the commitment to worldwide expeditions after World War II. At various times marine biology, fisheries investigations, and dynamic physical oceanography dominated research at the institution. This paper claims that, in addition to the priorities of different laboratory directors, the changing political economy of science influenced the commitment to fieldwork at Scripps.

The importance of political economy, especially in the field sciences, is a subject that it often overlooked in the study of natural history institutions. Oceanographic laboratories as well as natural history museums are dependent upon the opportunity to collect and examine specimens in their environmental context. Yet field studies, whether in the oceans or on land, require material and financial support. They also require access to locations where specimens can be found, studied, and collected. It is not only economic support but also political power relationships that make research in the field possible. The great natural history museums of the nineteenth and early twentieth centuries were the product of imperialism, and exhibits frequently embodied attitudes concerning the relationship between the colonizer and the colonized.[52] Imperialism did not play a role in Scripps oceanography in the early years, largely because research at sea rarely extended much beyond the coast of southern California. Yet World War I, World War II, and the advent of the Cold War profoundly changed that science and that institution. As this paper has indicated, the changed political economy of science, as evidenced by twentieth-century wars and America's global interests, played a crucial role in Scripps' development of a new and robust research program at sea. Historically economic support and political power relations have influenced work in the field sciences. It is worthwhile to consider the ways in which more recent developments, including the end of the Cold War, globalization, and bioprospecting are affecting today's institutions of natural history, oceanographic and otherwise.

Acknowledgments

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Notes

1 For archival abbreviations see **Archives** (p. 201). Allen's article appeared in the *San Diego Evening Tribune*, UCPR, CU5, folder 1933: 804; W.E. Allen to Erik G. Moberg, 12 July 1933, ibid.

2 On experimentalists and naturalists: Garland E. Allen, Naturalists and Experimentalists: The Genotype and the Phenotype, *Studies in History of Biology*, 1979, 3:179–209. Also: Keith R. Benson, Problems of Individual Development: Descriptive Embryological Morphology in America at the Turn of the Century, *Journal of the History of Biology*, 1981, 14:115–128; Jane Maienschein, Shifting Assumptions in American Biology: Embryology 1890–1910, *Journal of the History of Biology*, 1981, 14:89–113; Ronald Rainger, The Continuation of the Morphological Tradition: American Paleontology 1880–1910*, Journal of the History of Biology*, 1981: 14:129–158; Frederick B. Churchill, In Search of the New Biology: An Epilogue, *Journal of the History of Biology*, 1981, 14:177–191. On marginalizing museums: Steven Conn, *Museums and American Intellectural Life, 1876–1926* (Chicago: University of Chicago Press, 1998). For a discussion of one naturalist's reaction to the growing predominance of experimental biology see Ronald Rainger, *An Agenda for Antiquity: Henry Fairfield Osborn and Vertebrate Paleontology at the American Museum of Natural History, 1890–1935* (Tuscaloosa: University of Alabama Press, 1991), 105–122.

3 Allen to Moberg, 12 July 1933; W.E. Allen to Scripps Staff, 15 July 1937, WEA, box 2, folder 37.

4 Helen Raitt and Beatrice Moulton, *Scripps Institution of Oceanography: First Fifty Years* (San Diego: Ward Ritchie Press, 1967), 3–44.

5 Raitt and Moulton, *Scripps Institution of Oceanography*, 31.

6 The quotations are from Ellis LeRoy Michael, Dependence of Marine Biology Upon Hydrography and Necessity of Quantitative Biological Research, *University of California Publications in Zoology*, 1916, 15: i–xxiii, on iv, x. Also

William E. Ritter, The Marine Biological Station of San Diego: Its History, Present Conditions, Achievements, and Aims, *University of California Publications in Zoology*, 1912, 9:137–248, on 180–225.

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[9] George F. McEwen, The Distribution of Ocean Temperatures along the West Coast of North America deduced from Ekman's Theory of the Upwelling of Cold Water from the Adjacent Ocean Depths*, Internationale Revue der gesamten Hydrobiologie und Hydrographie*, 1912, 5:243–285. George F. McEwen, Summary and Interpretation of the Hydrographic Observations Made by the Scripps Institution for Biological Research of the University of California 1908–1915, *University of California Publications in Zoology*, 1916, 15: 255–356, on 255–279. On McEwen's work see: Eric L. Mills, Useful in Many Capacities: An Early Career in American Physical Oceanography, *Historical Studies in the Physical Sciences*, 1990, 20:265–311, on 270–280.

[10] Raitt and Moulton, *Scripps Institution of Oceanography*, 86–89; William B. Provine, Francis B. Sumner and the Evolutionary Synthesis, *Studies in History of Biology*, 1979, 3:211–240.

[11] Ellis LeRoy Michael and George F. McEwen, Continuation of Hydrographic, Plankton, and Dredging Records of the Scripps Institution for Biological Research of the University of California (1913–1915), *University of California Publications in Zoology*, 1916, 15:207–254, on 208. Mills, Useful in Many Capacities, 280–287.

[12] Deborah Day, Scripps Benefactions: The Role of the Scripps Family in the Founding of the Scripps Institution of Oceanography, in *Oceanographic History: The Pacific and Beyond*, eds. Keith R. Benson and Philip F. Rehbock (Seattle: University of Washington Press, 2002), 2–6, on 3.

[13] Philip J. Pauly, *Biologists and the Promise of American Life: From Meriwether Lewis to Alfred Kinsey* (Princeton: Princeton University Press, 2001), 208. The quotation is from William E. Ritter, The Relation of E.W. Scripps to Science, *Science*, 1927, 65:291–292, on 291. Also William E. Ritter, A Business Man's Appraisement of Biology, *Science*, 1916, 44: 819–822. William E. Ritter, *The Unity of the Organism or the Organismal Conception of Life*, 2 vols. (Boston: Richard G. Badger, 1919). On Ritter's biological philosophy: Eric L. Mills, *The Scripps Institution: Origin of a Habitat for Ocean Science* (La Jolla: Scripps Institution of Oceanography, 1993), 17–24.

[14] William E. Ritter, Scripps Institution for Biological Research (1917), in *Annual Report of the President of the University of California* (Berkeley: University of California Press, 1917–1918), 151–154, on 153; William E. Ritter, Scripps Institution for Biological Research (1918), in *Annual Report of the President of the University of California* (Berkeley: University of California Press, 1918–1919), 1–8, on 4.

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[16] One of Ritter's first attempts to come to grips with the relationship between pure and applied science is in: William E. Ritter, What the Scripps Institution is Trying To Do, *Bulletin of the Scripps Institution for Biological Research*, 1916, 1:19–24. William E. Ritter, The Problem of the Pacific, *Bulletin of the Scripps Institution for Biological Research*, 1919, 8: 1–8, on 8. Also William E. Ritter, Problems of Population of the North Pacific as Dependent upon the Biology, the Oceanography, and the Meteorology of the Area, *Science*, 1919, 50:119–125.

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[18] Ritter, Problems of Population of the North Pacific. In his annual report for 1919 Ritter included a document that outlined his changing views of the institution's objectives: "A Move in the Interest of the Future of the Institution." William E. Ritter, Scripps Institution for Biological Research (1919), in *Annual Report of the President of the University of California* (Berkeley: University of California Press, 1919–1920), 3–15, on 12–15.

[19] On the call for new ships and reliance on government agencies: Ritter, Scripps Institution for Biological Research (1919), 13–14; and Ritter, Scripps Institution for Biological Research (1920), in *Annual Report of the President of the University of California* (Berkeley: University of California Press, 1920–1921), 161–169, on 165. In 1920 Ritter, for the first time, began his annual report with a section entitled Oceanography and Hydrography. Boat work is noted in Ritter's 1920 report, 163, and Ritter, Scripps Institution for Biological Research (1921), in *Annual Report of the President of the*

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[23] Thomas Wayland Vaughan, Corals and the Formation of Coral Reefs, *Smithsonian Institution Annual Report for 1917*, 1919:189–276; Thomas Wayland Vaughan, Researches on Sedimentation, *Bulletin of the Geological Society of America*, 1920, 31: 401–410.

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[28] Quotations are from: W.C. Crandall, Memo Concerning Boat at Scripps Institution, 13 November 1930, SFP, box 3, folder 43; W.C. Crandall, Memo Regarding Scripps Institution of Oceanography, 1 September 1931, SFP, box 3, folder 34. J.C. Harper to Robert P. Scripps, 22 September 1931, SFP, box 3, folder 43.

[29] On suggestions that there were problems with the family see Raitt and Moulton, *Scripps Institution of Oceanography*, 99–100, 112. Also Deborah Day to Ronald Rainger, 28 July 2003.

[30] Vaughan to W.W. Campbell, 11 May 1928, and 25 May, 1928, SDV, box 1, folder 47. Vaughan to Frank Lillie, 5 September 1929, SDV, box 2, folder 61.

[31] The controversy heated up again in 1933 when Allen published the "Caged Animal" article and criticized Vaughan at a meeting of the American Association for the Advancement of Science. Vaughan to Robert Gordon Sproul, 27 October 1933, UCPR, CU5, folder 1933:804. Vaughan's call for Allen's dismissal led Sproul to appoint a tenure committee to consider the matter. Eventually Allen agreed to cease making public remarks and was reappointed under conditions acceptable to Vaughan. Monroe E. Deutsch to Sproul, 13 October 1933, UCPR, CU5, folder 1933:804; Conference between Vaughan

and Moberg, 19–20 October, 1933, UCPR, CU5, folder 1933:20. On the tenure committee: C.G. Haines to Sproul, 10 April 1934, UCPR, CU5, folder 1934:37.

32 Vaughan to Harper, 15 September 1931; Vaughan to Sproul, 10 May 1932 and 11 May 1932, SDV, box 2, folder 91; Vaughan to J. Stanley Gardiner, 13 May 1932, SFP, box 3, folder 35.

33 Richard H. Fleming, Oceanographic Work of the U.S.S. *Hannibal* in the Central American Pacific*, Association internationale oceanographie physique, Proces verbeaux*, 1937, 2:104; Roger Revelle, Oceanographic Work of the U.S.S. *Bushnell* in the North Pacific*, Association internationale oceanographie physique, Proces verbeaux*, 1937, 2:105. On the *Pioneer*: Vaughan to C.B. Lipman, 18 July 1935, SDV, box 3, folder 110.

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37 Robert Marc Friedman, Contexts for Constructing an Ocean Science: The Career of Harald Ulrik Sverdrup (1888–1957), in *Oceanographic History*, eds. Benson and Rehbock, 17–27. William A. Nierenberg, Harald Ulrik Sverdrup, *National Academy of Sciences Biographical Memoirs*, 1996, 69:339–374.

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Appendix

Financial Support for the Scripps Institution of Oceanography 1903-1955

Financial support for the Scripps Institution changed considerably in the 1940s and 1950s. Prior to those decades the institution relied primarily on funding from private sources. By far the most significant contributors were the members of the Scripps family. From 1903 to 1912 E.W. Scripps and Ellen Browning Scripps provided "almost all the operating funds for the station . . . ." [Day, Scripps Benefactions, 2.] E.W. Scripps donated his yacht, the *Loma*, and during his lifetime contributed over $50,000 to the institution. His sister's contributions were even larger. In 1906 she gave $50,000 to the fledgling biological station and the following year donated $1,000 to purchase the site for the biological laboratory. In 1909 she established a $150,000 endowment for the institution and by 1914 had given an additional $160,000 in donations. During the 1920s and 1930s she annually donated at least $9,000 per year to the institution, and made arrangements for her estate to continue those contributions after her death. Ultimately Ellen Browning Scripps gave over $400,000 to the institution. She likewise provided funding for the construction of the George H. Scripps Laboratory, the roads, and the pier. She also gave the money to construct the laboratory's ship, the *Alexander Agassiz*. In the years 1912 to 1946, the institution's overall expenses totaled $2,683,523, of which the Scripps family provided more than $1,300,000 or 53%. (Day, Scripps Benefactions, 2; Raitt and Moulton, *Scripps Institution*, 37, 40, 48, 53, 67-68; Regents of the University of California, Finance Committee Report, 18 September 1946, UCPR, CU5 folder 1946:414).

Other agencies also assisted the institution. Beginning in 1912, when the biological laboratory became part of the University of California, the State Legislature and the Regents made annual appropriations to the institution. Originally that contribution was $7,500 per year (Raitt and Moulton, *Scripps Institution*, 68), but by the 1920s and 1930s the appropriation averaged around $22,000 per year. During the 1930s Vaughan suggested an annual increase from the University and the Scripps family, and by the early 1940s the State of California's annual contribution had increased to approximately $45,000 per year (Sverdrup to Sproul, 18 December 1939, SDS, box 1, folder 15). In addition the State of California and the Rockefeller Foundation each donated $40,000 for the construction of Ritter Hall. During World War I federal agencies sponsored research on kelp and fish. W.C. Crandall, the institution's first business manager who also had an interest in marine biology, received support from the Department of Agriculture's Bureau of Soils for studying the potential uses of kelp as a fertilizer. The U.S. Bureau of Fisheries called on Scripps to study the distribution of tuna, while the Federal Food Administration sponsored research on plankton as a food supply for commercial fish. George F. McEwen's work on weather forecasting brought in additional funds. By the late 1920s and early 1930s several public utility companies and various agricultural interests were contributing about $6,000 per year to that project, although Sverdrup ended it when he became director (Raitt and Moulton, *Scripps Institution*, 90–91, 106–107).

Although support from the Scripps family continued throughout the 1930s, by 1938 those contributions had begun to decline and increasingly the institution relied on other patrons. In 1937 the institution assumed administrative responsibility for Francis P. Shepard 's $9,000 grant from the Geological Society of America. Revelle and Shepard also received several additional grants from geological organizations and oil companies in support of their investigations on the source of oil. The largest of those was a $2,500 grant from the GSA that supported the 1940 Scripps Expedition to the Gulf of California (W.S.W. Kew, Roger Revelle, and Francis P. Shepard, 12 March 1940, SDR, box 4, folder Grant Applications 1933-41). In addition that research resulted in a long-term grant from the American Petroleum Institute. In 1942 the API awarded Scripps a $6,500 grant; by 1950 it had given the institution over $80,000. (API Research Project 45A, 1942-1945, SSF, box 16, folder 26; Roger Revelle to Chief of Naval Research, 28 December 1950, SDR, box 1). From 1939 to 1941 Sverdrup successfully negotiated contracts with the U.S. Fish and Wildlife Service for studies of the California sardine. In 1939 and again in 1940 Scripps received $2,000 for that work, and during the fiscal year 1941 approximately $2,800. (Memorandum of Cooperation between the U.S. Fish and Wildlife Service and the Scripps Institution of Oceanography, 19 April 1939, SDR, box 5; Sverdrup to O.E. Sette, 16 October 1939, SSF, box 16, folder 21; Memorandum of Cooperation between the U.S. Fish and Wildlife Service and the Scripps Institution of Oceanography, 5 November 1940, SDR, box 5; Report on the Investigations during the Fiscal Year 1941 between the Scripps Institution of Oceanography and the Fish and Wildlife Service, U.S. Department of the Interior, Concerning Cooperation in Investigations of the Marine Fisheries of the Pacific Coast, SSF, box 15, folder 24).

During WWII the Scripps Institution, while still drawing on Ellen Browning Scripps' endowment and the regular appropriation from the State of California, began receiving greater support from federal agencies. From the mid 1930s to 1941 Scripps was able to hire numerous workers with money from the Works Project Administration. When the National Defense Research Committee established the University of California Division of War Research in July 1941, the University turned over the *E.W. Scripps* to the government. The government paid the university $70 per day for the ship, resulting in $127,750 in income over five years. From 1941 to 1943 the Kelco Company paid Scripps $3,400 for research on kelp, and the Fish and Wildlife Service supported C.K. Tseng's agar research (Scripps Research, 1932-1949, SSF, box 16, folder 15; SSF, box 16, folder 32).. In 1937 Sverdrup signed a contract with the Navy Bureau of Construction and Repair for work on anti-fouling agents to protect ship hulls. The original contract was small, only $480 in expenses and salary for one Navy officer, but by 1940 the project included several workers and amounted to $12,000 (Sverdrup to Sproul, 24 October 1940, UCPR CU5 folder 1940: 414A). In 1942 the Army Air Force agreed to pay Scripps $34,000 for work on isothermal charts, meteorology, and oceanography. Sverdrup's security clearance problems prevented him from participating, but several other members of the Scripps staff worked on the project (Don Z. Zimmerman and John B. Ackerman to Regents of the University of California, 4 June 1942; Sverdrup to Sproul, 15 June 1942, both in SSF, box 16, folder 37). By 1943 the contract had increased to $46,700 (SSF box 16, folder 38). A year later when Sverdrup received clearance, the Navy Hydrographic Office negotiated a contract for $39,000 for research on several topics including sea and swell forecasting. (Navy Hydrographic Office to Regents of the University of California, 14 August 1943, Record Group 37, entry 48, box 124, folder HI, NARADC). By 1945 that contract had increased to $100,000 (Sverdrup, Plan for Oceanographic Work at the Scripps Institution of Oceanography under the Hydrographic Office Contract, 1 March 1945 to 30 June 1946, SSF, box 5, folder 55). The Hydrographic Office also sponsored Scripps' work on the bathythermograph, an instrument that measured seawater temperature at depth. Other military agencies that were supporting Scripps in 1944-45 included the Navy Bureau of Ships ($6,000 for research on breakers and surf, and $18,000 for study of the oceanography of the surface layers), and the Amphibious Training Command for teaching courses on sea, swell and surf forecasting ($4,700). (Sverdrup to Robert M. Underbill, 15 February 1945, SDS, box 1, folder 26; Sverdrup to Sproul, 1 July 1946, UCPR CU5 folder 1946:414; Sverdrup to B.E. Dodson, 6 June 1944, SSF, box 16, folder 40).

Following WWII, scientific, educational, and military needs resulted in a tremendous increase in Scripps' financial resources. In 1947 the State of California, concerned about the continuing decline in the annual catch of the California sardine, sponsored a massive research effort that relied on several agencies, including Scripps. In that first year the state provided Scripps with $300,000 for its work on the project. For the fiscal year 1948 that contract was increased to $400,000, and by the mid 1950s the Scripps Marine Life Research Program was receiving over $500,000 annually (Minutes of the Meeting of the Sardine Research Committee, 13 March 1947, SSF, box 13, folder 11; Russell Barthell to Sproul, 14 October 1947, SSF, box 13, folder 15; Report of the Marine Life Research Budget, 1956, CLH, box 24, folder 9).

In addition, considerable research on fish took place through the Institute of Marine Resources, a new organization established by Revelle in 1953. As a university-wide center IMR was separate from Scripps, but it contributed significantly to research and resources in La Jolla. Beginning with the university's appropriation of $22,000 in 1953, the state's contribution reached $175,000 by 1960 (UCIMR, Meeting of 29 March 1961, Office of the Director Records, box 7, folder 393). Projects included studies of fish distribution and fluctuation, development of artificial bait, and synthesis of new food products from fish fat and protein. But Revelle was eager to expand the institute's mission and by the mid 1950s IMR had become a center for ocean engineering. As such it attracted the interest of numerous federal agencies and private organizations. One notable contributor was the American Petroleum Institute, which had previously sponsored Scripps research on sources for oil. That organization continued its support of Scripps by helping to fund a new foraminifera laboratory, but in addition the API launched a new project on recent sedimentary processes that was based in IMR. By 1955 the API contribution totaled $125,000 per year. Other IMR projects included research on marine minerals, notably manganese deposits, water pollution, marine corrosion, and food technology. Atomic Energy Commission support for studies of nuclear waste disposal quickly became a major source of income (A Partial List of Research Projects, January -September 1953, UCIMR, box 6, folder 76; Annual Report, 23 April 1956, UCIMR, box 7, folder 392).

The biological sciences attracted far less funding than the work in fisheries biology, ocean engineering, or geophysics. Most of the support came from foundations and individual contributors. While it is difficult to track funding for individual researchers and graduate students, one of the most important patrons was the Rockefeller Foundation. From 1947 to 1950 it contributed $19,000 for studies in marine biology. In the mid 1950s, when Revelle sought to replace traditional marine biology with research in genetics, physiology, and experimental biology, the Rockefeller Foundation launched that initiative with a $1,000,000 grant to Scripps. (Shor, *Scripps Institution of Oceanography,* 202).

By far the greatest financial support came from the military, especially the Navy. Deborah Day, the Scripps Archivist, has estimated that from 1945 to the mid 1960s Navy sponsorship accounted for 80 to 90% of the Scripps budget (Day, Navy Support for Oceanography at SIO). Most of that money came from the Hydrographic Office, the Bureau of Ships, and the new Office of Naval Research. In 1946–47, in addition to the $100,000 from the Hydrographic Office, Scripps received $132,000 from ONR for general work in oceanography and a project on fog forecasting, and $105,000 for various projects from the Bureau of Ships. By 1948 support from ONR and the Bureau of Ships alone totaled $963,475 (Scripps Contracts, 5 May 1948, UCPR CU5, folder 1948:414). With the onset of the Korean War those amounts increased dramatically. Between 1949 and 1955 Scripps had 13 separate, multi-year contracts with ONR totaling $7,840,164, while Bureau of Ships funding rose to almost $500,000 per year (Scripps Federal Contracts, 8 September 1955, SSF, box 5). Other military agencies also sponsored Scripps' research. The Air Force was responsible for almost all funding of the Visibility Laboratory; in addition Scripps was under contract with the Air Force Cambridge Research Laboratory for $50,000 per year. In 1954 the Air

Force negotiated two additional contracts with Scripps, one for work on air/sea boundary problems, the other on storm surges at sea, for a total of $64,000 (Proposed Budget Expansion for National Defense, 13 December 1950, UCPR CU5 Series 4, box 32:29; Scripps Federal Contracts, 8 September 1955, SSF, box 5). In 1949 Scripps and the Army Corps of Engineers Beach Erosion Board entered into a contract for $45,000; by 1953 it was $120,000 (Scripps Contracts, 12 March 1953, SSF, box 5). During those years Scripps scientists participated in several major expeditions to the Pacific. Those voyages produced important scientific contributions, but in addition they included analyses of the effects of nuclear bomb testing. Beginning in 1952 and continuing into the late 1950s, the Armed Forces Special Weapons Project paid Scripps $500,000 per year for assistance on atomic bomb tests in the Pacific (University of California, Scripps Institution of Oceanography, "Proposal to the Atomic Energy Commission for a Study of Oceanic Disposal of Nuclear Wastes in the Offshore Waters of California," [1955], JI, box 38, folder Proposals Atomic Energy, 1955).

In addition to contracts, the military provided considerable material support to Scripps. Navy ships worked side by side with Scripps vessels in the Pacific, and that agency provided logistical support as well as funding for equipment, scientific instruments, new buildings, and various other items. Complete data on military support are not available since many records remain classified. Although the National Science Foundation became an important patron of Scripps oceanography in the 1950s, military sponsorship far surpassed any other source of support for the institution (Day, Significant NSF-Sponsored Ocean Research at SIO, 1950-2000).

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Success Story: The History and Development of the Museum of Paleontology at the University of California, Berkeley

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The University of California Museum of Paleontology (UCMP) has diverse roles in the university, national and international science and education communities, providing resources for research, teaching and outreach. These programs developed over the last 150 years, and are substantial mainstays of the natural history program at UC Berkeley. UCMP's history is rooted in the formation of the State of California, and its early decisions about resources and education. After an initial attempt to gather information on the mineral and natural historical wealth of California, the Legislature appointed J.D. Whitney as State Geologist and Director of the Geological Survey of California (1860–1874). Some of the Survey's collections formed the foundation of the paleontological, zoological and botanical museums of the University of California, founded in 1868.

Joseph LeConte, the first geologist, natural historian and botanist appointed to the faculty of the university, encouraged paleontology through his lecturing, particularly on evolution and fossils, his students, and his acquisition of fossil collections for the university. His most brilliant student, John C. Merriam became the first professor of paleontology, and though his interactions with Annie Alexander, a wealthy woman with a paleontological avocation willing to support the field at Berkeley, the first Department and later Museum of Paleontology were formed in 1909 and 1921. Although developments were not always smooth, a strong and internationally-recognized paleontology program emerged before World War II, followed by increasing strength and diversity of programs in the years after the war.

Strong educational programs were assembled in the Department of Paleontology, and the Museum continued to gather fossils until it now has the largest fossil collection in any university in the world and second in size only to the Smithsonian in the USA. In the last decade and a half, the paleontology program has emerged at the top in America, in large part because of the research and educational resources of UCMP. In addition, a very powerful Internet-based outreach program for the public, teachers and students attracts millions of visitors and international attention. UCMP, its associated faculty and its students are a highly regarded, unique resource of the University of California that continues to inform studies of conservation biology, biodiversity, evolution, systematics, paleoenvironments, astrobiology, and environmental biology. Paleontology at Berkeley interfaces with a larger number of other disciplines in the life and earth sciences than ever before and it continues to make significant contributions on all fronts of research, teaching and outreach. UCMP and the paleontology program are very big on-going success stories!

Visitors to the University of California at Berkeley often ask questions about the Museum of Paleontology (UCMP): "What is the Museum of Paleontology? Where is it? Why does it exist?

Who uses it? When will it go extinct?" These are not easy questions to answer for a museum that traces its beginning back 150 years ago, to even before the founding of the University that houses it, that has had many hundreds of faculty, staff and students, plus a few benefactors, and that contains more fossils than any other museum in the USA save the Smithsonian Institution. Its history is rich, its services are diverse, the accumulation of so many fossils has involved many different kinds of efforts, and all its people had personalities, goals and wishes that were seldom focused identically. Although paleontology has been an important discipline on the Berkeley campus since its founding in 1868, UCMP was not formally established until 1921. Nevertheless its collections, traditions, associations with departments, and early personalities are interwoven with the earliest history of the State of California and the University of California. UCMP is and always has been a multifaceted and complicated organization! This essay is a summary of this complexity starting in the 1840s through the present, and even with some projections into the future.

UCMP has usually been closely associated with the paleontology faculty and students in the former Departments of Paleontology or Geology and the current Departments of Integrative Biology and Earth and Planetary Sciences (Table 1). Together the museum and departments have been on-going success stories, and their histories are intertwined. The program has had a few difficulties and many major victories along the way, but it has always moved forward and been a center for paleontology, geology and evolutionary biology in the West. The work goes on with the same vigor and rigor today as past UCMP paleontologists used. Indeed, the University of California can be justly proud of the paleontology program, UCMP and their century and a half of work and contributions!

What is the Museum of Paleontology?

UCMP is a research and educational center of the UC Berkeley campus. Its mission is to support research, teaching and outreach in paleontology, sedimentary geology, evolutionary biology, systematics, molecular biology, and, increasingly, conservation and environmental biology. As the possibility that life may be discovered on other planets arises, UCMP is also involved in astrobiology. To do all this, it maintains and keeps track of the second largest collection of fossils in the United States and largest of any university in the world. These collections provide the basis for much of the rest of the work and mission of UCMP. UCMP has seven laboratories, much equipment, pertinent reference papers and books, computer facilities for science, outreach and data base activities, and archives of documents and photographs related to past UCMP activities and people. These are the things that make its mission achievements outstanding.

One thing UCMP is not: A display museum in the usual sense that most people understand one as a place to visit to see fossils. It has, for the most part, only a few displays (Fig. 1); instead it is more akin to a library with cabinets full of fossils that tell separate stories about life in the past, just waiting for scientists to unravel. And unravel these life stories they have done!

UCMP is one of eight museums for which managerial responsibility lies with the Office of the Vice Chancellor for Research. The museum itself is simply organized. A Director, who must be a faculty member in the Academic Senate, heads it (Table 2). The Director reports to the Vice Chancellor for Research. Faculty curators are members of campus departments (they are not employed by UCMP) who maintain research and teaching interests commensurate with the UCMP mission (Table 1). They act primarily in an advisory capacity to the Director and museum, and they work to develop the collections. Over the years, the paleontology program has had a number of highly skilled and competent scientists working on the collections (Table 3). Without them, UCMP could not have become what it is, but their achievements, as important as they have been, were not

TABLE 1. Faculty in paleontology and/or Faculty Curators of UCMP, 1869–2004. Many graduate students and visiting scientists were appointed as instructors or lecturers at various times. Likewise, many had temporary positions in UCMP. Most of these Faculty Curators remained associated with UCMP after their retirement.

Faculty Curators in UCMP or its Antecedents and Their Departments.	*Discipline*	*Dates at UCB and UCMP **
Joseph LeConte, Geology & Natural Sciences	Geology, Natural History & Botany	1869–1901
John C. Merriam, Paleontology	Vertebrate paleontology	1894–1921
Bruce L. Clark, Paleontology	Invertebrate paleontology	*1918–1945
John P. Buwalda, Geology	Vertebrate Paleontology	1921–1926
Chester L. Stock, Geology	Vertebrate Paleontology	1921–1926
Charles L. Camp, Zoology	Vertebrate paleontology	*1922–1930
Paleontology		*1930–1960
William Diller Matthew, Paleontology	Vertebrate paleontology	*1927–1930
Ruben A. Stirton, Paleontology	Vertebrate paleontology	*1949–1966
Ralph Chaney, Paleontology	Paleobotany	*1931–1957
Robert M. Kleinpell, Paleontology	Micropaleontology	*1946–1973
J. Wyatt Durham, Paleontology	Invertebrate paleontology	*1947–1975
Emeritus		*1975–1996
Donald E. Savage, Paleontology	Vertebrate paleontology	*1949–1987
Emeritus		*1987–1999
Ralph Langenheim, Paleontology	Invertebrate paleontology	*1952–1957
Zach Arnold, Paleontology	Micropaleontology	*1957–1978
Wayne L. Fry, Paleontology	Paleobotany	*1957–1988
F. Clark Howell, Anthropology	Human evolution	1970–1991
Emeritus		1991–
Human Evolution		*1996–
Joseph T. Gregory, Paleontology	Vertebrate paleontology	*1960–1975
Emeritus		*1975–
William B. N. Berry, Paleontology	Invertebrate paleontology Environmental geology	*1960–1989
Geology		*1989–
William A. Clemens, Paleontology	Vertebrate paleontology	*1967–1989
Integrative Biology		*1989–2003
Emeritus[1]		*2003–
Timothy D. White, Anthropology,	Human paleontology	1977–1988
Integrative Biology		*1989–
Carole S. Hickman, Paleontology	Invertebrate paleontology & Paleobiology	*1978–1989
Integrative Biology		*1989–
A. Roger Byrne, Geography	Palynology	*1979–
Charlotte Brunner, Paleontology	Micropaleontology	*1979–1987
Kevin Padian, Paleontology	Vertebrate Paleontology	*1980–1989
Integrative Biology		*1989–
Jere H. Lipps, Paleontology	Micropaleontology &and Paleobiology	*1988–1989
Integrative Biology		*1989–
Roy L. Caldwell, Zoology	Animal Behavior	1970–1989
Integrative Biology	Invertebrate evolution	*1989–
James W. Valentine, Integrative Biology	Paleobiology	*1990–1993
Emeritus		*1993–
Anthony Barnosky, Integrative Biology	Vertebrate paleontology	*1990–
Lynn Ingram, Geography	Isotope paleontology	1995–1998
Earth & Planetary Sciences		1998– *1996–
Walter Alvarez, Geology	Extinction theory	1977– *1991–
David Stoddart, Geography	Coral reefs	1986–2001 *1991–2001
Nan Crystal Arens, Integrative Biology	Paleobotany	*1993–2001
David R. Lindberg, Integrative Biology	Invertebrate paleontology	*1994–

[1] Clemens retired from the faculty in 2003, but was recalled to be Interim Director of UCMP in 2003–2004.

FIGURE 1. *Tyrannosaurus rex* exhibited in the spiral stairway outside the Museum of Paleontology on the ground floor of the Valley Life Sciences Building. The *T. rex* is an exact replica of a specimen collected in Montana by the Museum of the Rockies and purchased by UCMP and the Dean of Biological Sciences. The cast was erected by Mark Goodwin and his crew over three months with an opening of the exhibit, the *T. rex* Expo in September, 1995. Photograph by Jack Penkethman, 2001.

recorded in detail because many of them were short-term employees, students or volunteers. Now professional paleontologists (all have Ph.D.s) are employed as Museum Scientists by UCMP. They are in charge of the collections and laboratories, and provide expertise in certain groups of organisms. One of them oversees the entire scientific operation of the museum, while four others are directly responsible for the maintenance of the collections, curation of new materials into them, and certain laboratories under the general supervision of the Director. Graduate students associated with the Faculty Curators use the collections on material that they know well, and undergraduates are also hired to work in the collections where they perform a variety of specimen-based or database tasks. Visiting Scholars and Researchers come to UCMP to work on research projects of their own or in conjunction with Faculty Curators or Museum Scientists. UCMP also employs a preparator, a molecular biologist, an outreach specialist, an administrative assistant, and several other support staff. Overall, the museum involves the activities of about 12 staff, 18 Faculty curators, usually about 20 graduate students and a variable number of undergraduates, plus occasional visiting researchers. UCMP has not always been organized this way, but the current arrangements are complete, efficient and functional.

The chief responsibility of the museum is the development and maintenance of collections of fossils and related materials used in research, teaching and outreach. These collections are quite complex too. They contain representatives of every major lineage of life, from bacteria to vertebrates, from just about every geological time segment from the early Precambrian to the Recent, and from places all over the globe, although most are from western North America. These collections have grown for nearly 150 years and continue to grow now. Not all of the specimens are fossils; indeed UCMP has about ½ million modern invertebrates, thousands of pollen grains from living plants, a collection of cleared modern leaves, the skeletal elements of many living vertebrates, and modern representatives of foraminifera, radiolaria, coccolithophorids, and other microorganisms. These modern specimens form an important collection, for paleontologists need comparative material from living organisms to understand the relationships, ecology and function of extinct forms. Some of these collections are unique, for example the J.G. Cooper collection of non-marine snails made for the Geological Survey of California in the early 1860s, and provide ecologic guidelines for what California was like before its massive development.

The UCMP collections contain millions (billions or tril-

TABLE 2. Directors of the University of California Museum of Paleontology, 1921–2004.

Dates	*UCMP Paleontologist*	*UCB Ph.D.*
1921-1927	Bruce L. Clark, Invertebrate paleontologist	1914
1927-1930	William D. Matthew, Vertebrate paleontologist	
1930-1935	Charles L. Camp, Vertebrate paleontologist	
Fall 1935	Samuel P. Welles, Vertebrate paleontologist	1940
1936-1949	Charles L. Camp, Vertebrate paleontologist	
1949-1966	Ruben A. Stirton, Vertebrate paleontologist	1940
1958-1960	*Robert M. Kleinpell, Micropaleontologist	
1967-1968	*Donald E. Savage, Vertebrate paleontologist	1949
1968-1971	Donald E. Savage, Vertebrate paleontologist	1949
1971-1975	Joseph T. Gregory, Vertebrate paleontologist	1938
1975-1977	*William B. N. Berry, Invertebrate paleontologist	
1977-1988	William B. N. Berry, Invertebrate paleontologist	
1988-1989	William A. Clemens, Jr, Vertebrate paleontologist	1960
1989-1997	Jere H. Lipps, Micropaleontologist	
1996-1997	*David R. Lindberg, Invertebrate paleontologist	
1998-2003	David R. Lindberg, Invertebrate paleontologist	
2003-2004	** William A. Clemens, Jr, Vertebrate paleontologist	1960

* Acting Directors. **Interim Director

TABLE 3. Some of the scientific staff of the fossil collection 1880–2004. UCMP was established with a staff in 1921. Many students and temporary assistants were also employed over the years in UCMP but they cannot be included here. These scientists made substantial contributions to the museum in terms of research, curation, and innovation. This list is incomplete.

JamesJohn Rivers	Curator of the University Museum.	1880s & 1890s
Eustace L. Furlough	Curator and preparator	1917–1926
Ruben A. Stirton	Curator of mammals	1929–1949
Samuel P. Welles	Museum Paleontologist	1930–1978
Joseph Peck	Museum Scientist in invertebrate paleontology	1948–1988
John Hutchison	Senior Museum Paleontologist	1964–1993
J. D. Gouge	Museum Scientist in Recent Microorganisms	1960s–1970s
Gordon Hornaday	Museum Scientist in Micropaleontology	1960s–1970s
Howard Schorn	Museum Paleontologist	1964–1993
Mark Goodwin	Museum Specialist	1978–
Robert Takagi	Museum Scientist in Invertebrate Paleontology	1960s–1990
David Lindberg	Research Paleontologist	1982–
Laurie Bryant	Museum Scientist	1987–1989
Karen Wetmore	Museum Scientist in Micropaleontology	1991–2000
Anthony Fiorillo	Museum Scientist	1992–1995
Susan Jenks	Museum Scientists in Molecular Biologist	1995–1997
Martin F. Wojciechowski	Museum Scientist in Molecular Biologist	1998–2001
Pat Holroyd	Museum Scientist in Vertebrate Paleontology	1995–
Diane Erwin	Museum Scientist in Paleobotany	1995–
Jane Mason	Preparator	1997–
Sharon Mosel-Lynch	Museum Scientist in Molecular Biologist	2001–
David Haasl	Museum Scientist in Invertebrate Paleontology	2002–
Kenneth Finger	Museum Scientist in Micropaleontology	2002–

lions, if each microfossil were counted!) of specimens; many hundreds of thousands are numbered and curated into individual trays in storage cabinets, and many others are still in collection plaster jackets or rocks. They are divided into five parts, each of which is overseen by dedicated Museum Scientists, and several sub-parts: Micropaleontology (mostly the microscopic fossilized and modern remains of tiny single-celled organisms, especially foraminifera, radiolaria, and various groups of single-celled algae), Palynology (fossil and modern pollen and spores), Paleobotany (fossil plants), Invertebrate Paleontology (representing sponges through sea squirts), and Vertebrate Paleontology (all vertebrate animals except humans). Each of these very large collections has subcollections of type specimens (those that have been illustrated or documented in the scientific literature), including primary (holotypes, paratypes) and secondary types. In total, about 40,000 type specimens are cataloged by UCMP and are listed (in part) on-line at www.ucmp.berkeley.edu. A collection of modern organisms containing DNA that has been analyzed in the museum's molecular phylogenetics lab is also developing. Teaching collections of fossils and modern organisms used in courses taught at UC Berkeley, including beginning courses for freshmen all the way to advanced graduate specialty courses, are also maintained by UCMP.

Some very special collections are housed in UCMP. These include collections made by organizations or individuals other than the faculty, staff and students of the museum. The special collections have great significance because they were donated to UCMP. These include, for example, the Geological Survey of California collection of invertebrate fossils made between 1860 and 1863 (Fig. 2), the Whitfield Paleozoic invertebrate collection made in the 1870s and 1880s, the Crawfordsville (Indiana) crinoid collection also made in the 1880s, the T. Wayland Vaughan collection of 627 slides of larger foraminifera donated to UCMP when Vaughan was Director of the Scripps Institution of Oceanography, the Loeblich and Tappan life time collection of over 6000 microfossil samples, the Los Angeles County Museum of Natural History's paleobotany collection, the UCLA Microfossil Type Collection, the UC Riverside Fossil Mammal Collection, the U.S. Geological Survey invertebrate fossil collection, the Lambert modern coral collection, the Thomas and Beatrice Burch Hawaiian sample collection, several very large microfossil and invertebrate collections donated by oil companies, and many more.

FIGURE 2. Fossil ammonite originally described by Gabb (1864b) in the first volume of the Geological Survey of California from fragments as *Criocera percostatus* and reconstructed as an evolute form. In the second GSC paleontology volume, Gabb (1869:138, pl. 24, fig. 19) recognized that he had placed several fragments of a heteromorph ammonite together, based on new material including this specimen donated by C.D. Voy to the University of California, and he reassigned the species to *Ancyloceras percostatus* (Gabb). Later, Anderson (1938) recognized that the Voy specimen represented a new genus and species, *Shastoceras californicum*. Image by Lorraine Cazassa, 2004.

UCMP has a large specimen preparation, micropaleontology preparation, acid preparation, thin-section and histology, general use, DNA extraction, and molecular sequencing laboratories. The full resources of the Berkeley campus are available as well, including stable isotope, electron microscope and chemical analysis laboratories. The molecular sequencing laboratory, known as the Molecular Phylogenetics Laboratory (MPL), is jointly operated with the University and Jepson Herbaria. MPL provides paleontologists with another kind of historical record that can be used to interpret relationships between groups and comparisons to the fossil record of evolutionary events. All of these laboratories are well equipped and are used by UCMP faculty, staff, Visiting Scholars, graduate and undergraduate students, and occasional visitors from elsewhere. Without these laboratories and equipment, much of the study of fossils would not be possible.

Where is the Museum of Paleontology?

This question is not easy to answer, for the museum has moved several times, has occupied more than one building at a time, and some of its best known contributions occupy no space at all but reside only in memory on its computers that provide linkages to the World Wide Web (Scotchmoor and Lipps, 1995). The growth of the collection, faculty and staff over the years and the increasingly sophisticated laboratory requirements have forced paleontology to move five times since 1873 (Table 4). At first courses in natural history were held in Oakland (1869–73), and then moved to South Hall (Fig. 3), constructed in 1873 and which still stands today, where a museum was opened that displayed fossils, among other natural history items. In 1911, the space had become too crowded so the Bacon Arts and Library Building was renovated, renamed Bacon Hall (Fig. 3), and paleontology moved into it (Wagner 1969). Later buildings were the Hearst Mining Building, with collections stored around the balconies, the Earth Sciences Building (now McCone Hall), and finally in 1995, the Valley Life Sciences Building (VLSB) (Fig. 4).

Table 4. Buildings occupied by paleontology at the University of California from 1873–2004. Joseph LeConte and his fossil collections and museum, Department of Paleontology and the University of California Museum of Paleontology from 1873 to 2004 (partially from Gregory 1995). Asterisks (*) indicate facilities used chiefly for storage only.

Name of Building	*Dates of Occupation*	*Campus Location*	*Functions. and Reasons for Moving*
South Hall	1873–1911	Central Campus	Exhibit of fossils, faculty offices.
			Too crowded.
*California Hall	Late 1800s–1911	Central Campus	Storage in basement.
			Moved to Bacon Hall.
Bacon Hall	1911–1930	Central Campus	Exhibits, collections, offices.
			A. Alexander initiated move with President Wheeler because collections were unsafe there.
*Campanile	1914–present	Central Campus	Storage. Four floors are filled with fossils, mostly from Rancho La Brea.
Hearst Mining Building	1931–1961	East Campus	Exhibits, collections, offices.
			Moved to new Earth Sciences Building (now McCone Hall) built for Paleontology, Geology and Geography.
*UC Storage Facility, Richmond	1961–1981	City of Richmond	Bulk storage and large specimens.
			Closer storage available at Clark Kerr Campus and Marchant Building.
Earth Sciences Building (now McCone Hall)	1961–1995	North Campus	Collections, offices, exhibits.
			Paleontology consolidated with Integrative Biology and faculty and UCMP moved to renovated Life Sciences Building, renamed the Valley Life Sciences Building.
*Clark Kerr Campus (Dwight-Derby)	~1982–present	South of main campus.	Large specimen preparation lab and storage for bulk specimens and collections.
*Marchant Building	~1982–present	6701 San Pablo Ave.	Bulk storage area (large specimens, old exhibits, casts, and others).
Valley Life Sciences Building	1995–present	West Campus	Collections, offices, labs. UCMP occupies most of the west wing of the lower floor. Some public exhibits in halls.

The museum for sometime has had such a large collection that it can't be stored in a single place, so UCMP now has five different areas (Table 4) to keep its collection. The main research collection and museum is in VLSB in a facility designed and built for them. The cabinets containing the specimens are mounted on compactors that nearly double the storage space of the room. Seven laboratories and Museum Scientists' offices are distributed near the collections. Faculty curators also have offices and laboratories in VLSB or McCone Hall, but these are departmental not museum spaces. UCMP has another laboratory at Clark Kerr Campus, where specimens that are too large to be handled in VSLB are processed. The Clark Kerr Campus facility also houses storage areas for large collections and specimens, such as whales and dinosaurs, and the Loeblich and Tappan collection of microfossils, all processed material collected by them around the world. The Campanile (or Sather Tower) was completed in 1914 and has five very tall floors (Fig. 5). Four of them belong to the Museum of Paleontology and they're filled chiefly with vertebrates from the Pleistocene Rancho La Brea collected between 1906 and 1913. McCone Hall, the old Earth Science building that was vacated when the museum moved to VLSB, still houses the palynology collection. UCMP has special areas in the Marchant Building at 6701 San Pablo Avenue, Berkeley, a general facility of the university, with whale, dinosaur and other bulky specimens and items stored in them.

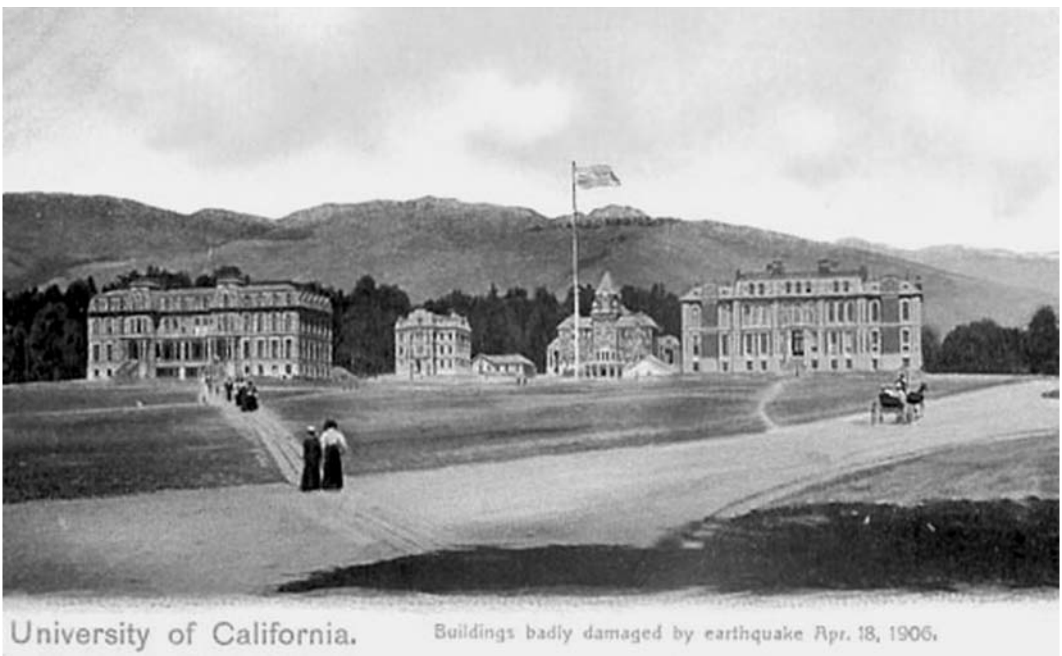

FIGURE 3. The first two buildings housing paleontology at the University of California. In this view looking northeasterly, the Berkeley campus stands as it was from about 1881 through the early 1900's (see Pickerell and Dornin, 1968). In 1873, LeConte moved into South Hall (right) to teach geology, natural history and botany (Fig. 11) and to organize a museum with geological and fossil materials. The newly organized Department of Paleontology (1909) was housed there until 1911, when it and the Geology Department moved to Bacon Hall (center, behind flag pole). Paleontology and Geology stayed in Bacon Hall until 1930 when both moved to the Hearst Mining Building (not shown). North Hall (left), Bacon Hall and the Mechanical Arts Building and annex (left of Bacon Hall) were demolished, but South Hall still stands as the campus's oldest building, just south of the Campanile. It was renovated in 1968–70 and seismically upgraded in 1986–88 (Braunstein, 2003). From a Charles Weidner chromolithograph post card from 1906 with the caption "University of California. Buildings badly damaged by earthquake, April 18, 1906". Post card is numbered 17. Printed in Germany. From the J.H. Lipps collection.

FIGURE 4. The Museum of Paleontology moved into new quarters on the ground floor (lower right) of the Valley Life Sciences Building in 1995. Image by J.H. Lipps, 2004.

WHY DOES UCMP EXIST?

UCMP exists because of the role paleontology played in the early history of the state and university, and its continuing importance to the economy of the state and education of its students. UCMP's history thus tracks the development of the State of California, starting when California was part of Mexico, to the description and interpretation of fossil biotas throughout the state and the west, through the oil boom before and after World War II, to the modern study of paleobiology and its use in evolution and environmental studies.

Paleontology in California before 1900 can be divided into two parts, the period from American explorations and intrusions into Mexican California to the publication of volume 2 of the Geological Survey of California in 1869 and the period starting in the 1890s (Merriam 1921). The history of the University of California Museum of Paleontology is tied to both of these periods, although the UCMP itself was not yet even an entity. The events in the 1840s and 1850s shaped later decisions by the State that got the Museum of Paleontology's collections off to a beginning and made the University the center for paleontology in the west. Paleontology at UC Berkeley after 1900 can likewise be divided into two parts: the era of Annie Alexander as beneficiary and visionary and the post World War II through modern period.

FOUNDATIONS OF PALEONTOLOGY AT THE UNIVERSITY OF CALIFORNIA, BERKELEY

The first scientific interest in fossils in the state was by John C. Fremont during his military operations in Mexican California from 1843–44. He had no geologist, but he collected fossils anyway which were later described by James Hall (Hall 1845; Hall and Fremont 1845). When the United States finally declared war on Mexico in May 1846, Fremont, who had been in California agitating for independence, subdued parts of the state, and later accepted the surrender of Andres

Pico in January 1847, ending the fighting in California, but not the rest of Mexico. Just before California officially became part of the United States under the Treaty of Guadalupe Hidalgo with Mexico (Feb. 2, 1848), gold was discovered at Sutter's Mill on the American River (January 24, 1848). Word spread slowly at first (Ryan 1971), to Sacramento, then San Francisco in May, across the Pacific to Hawaii and up the coast to Oregon, but it was not until President James Knox Polk addressed Congress on December 5, 1848, on the abundance and value of gold in California that a country-wide gold rush began (Bieber 1948). The gold-seekers headed west in huge numbers ("The 49'ers"), creating a need for information about the resources of the new territory. Up to this time, the geology of California had been generally ignored, although Philip Tyson and James Dana had traveled through the region, and they immediately reported on the geology of the deposits and of California (Dana 1849; Tyson 1850).

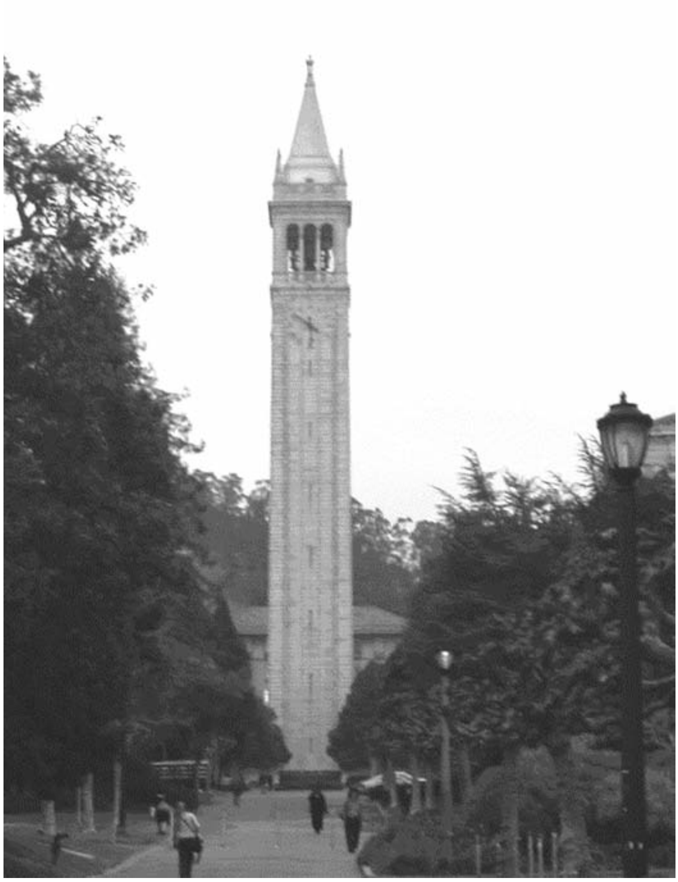

FIGURE 5. The Campanile (Sather Tower) has five floors, four of which are assigned to UCMP for the storage of fossils. Since its construction in 1914, it has served to store the invaluable Rancho La Brea vertebrate collections made by J.C. Merriam between 1906 and 1913. Image by J.H. Lipps, 2004.

When California was admitted to the Union in 1850, the new State Legislature soon decided to survey it for natural resources. J.B. Trask, a physician enamored with geology and a founder of the California Academy of Sciences, was asked in March 1853 by the Senate to provide information on the geology of the state, during which some fossils were found but not described. Later that year, Trask was appointed to make studies of the Sierra Nevada and Coast Ranges (Trask 1854, 1855, 1856). His appointment and money received from the Legislature ($5000 for his 1853 report plus $2000 for his expenses) for further studies have been construed as the First Geological Survey of California, but no official act declared that or appointed Trask as State Geologist (Leviton and Aldrich 1982). Apparently, his title of State Geologist, with which he was listed in the San Francisco City directory, was honorific and not official (Leviton and Aldrich 1982). Later, Trask returned to his medical practice, and stopped listing himself as a geologist. At the same time, W.P. Blake was requested by A.D. Bache of the Coast Survey to write a paper on the geology and geography of the coast from Bodega Bay, north of San Francisco, to San Diego. Blake found fossils, including microfossils, at various points along the coast (Blake 1854, 1855). He continued his geologic and paleontologic work with the Pacific Railroad Surveys (Williamson 1856). In the meantime, Jules Marcou published two geologic maps of the United States that showed California consisting broadly of just several types of rocks and some of these were in incorrect relationships with one another (Marcou 1854, 1855).

All of this activity then prompted the California Legislature to consider an official survey of the natural resources of the entire State, including animals and plants. Joseph LeConte, who later played an important role in the University of California's paleontological development, wrote from South Carolina to encourage the formation of the survey and recommended W.P. Blake to lead it. But the Legislature asked Josiah D. Whitney, a well-known geologist whose book on the *Metallic Wealth of the United States* (Whitney 1854) was surely influential in the appointment of a geologist to survey a state well known to have such riches. Thus, in 1860, just 10 years after statehood, California had its first official State Geologist and the first Geological Survey of California. Because of the confusion surrounding Trask's earlier work, the Geological Survey of California has been called the Second Geological Survey or the Whitney Survey, but in fact it was the first and only Geological Survey of California, and remains so today even though the California Division of Mines and Geology was given the pseudonym of the California Geological Survey by the Director of the Department of Conservation in 2002.

Whitney was a great scientific geologist who understood that good science had to underlie applied geology, the chief reason that the Legislature appointed Whitney and formed the Survey to begin with (Nash 1963; Oakeshott 1971). By December 1860, Whitney had acquired his field staff (Fig. 6) consisting of William H. Brewer (party chief), James T. Gardiner (mining engineer), Richard Cotter (packer) and Clarence King (geologist), and began work. This work included observations on the geology, geography and natural history of the state (Farquhar 1940), as well as the collection of fossils all over the state and even beyond and the study of fossils contributed by individuals (Trask, Mills, Voy) and those held by the California Academy of Sciences. Others were asked to collect and contribute with pay to the Survey as well, including J.G. Cooper, a natural history collector and expert on marine and terrestrial mollusks (Coan 1981). A variety of other living organisms was also collected and later studied (Nash 1963). W.M. Gabb and F.B. Meek were employed by Whitney to study the fossils (Fig. 7).

FIGURE 6. The Geological Survey of California field party of 1864 consisting of William H. Brewer (party chief), James T. Gardiner (mining engineer), Richard Cotter (packer) and Clarence King (geologist). California Division of Mines and Geology photograph.

The first volume published by the Survey dealt with Paleozoic and Mesozoic paleontology of California (Gabb 1864a, 1864b; Meek 1864a, 1864b). This beautifully-produced book with gold embossing of an ammonite (taken from Pl. 13, fig. 17 of *Ammonites chicoensis* Trask) on the front cover and the seal of the Survey on the back (Fig. 8) was a disappointment to the State

FIGURE 7. The Geological Survey of California, December 1863. Left to right: C. Averill, W.M. Gabb, W. Ashburner, J.D. Whitney, C.F. Hoffmann, C. King, and W.H. Brewer. California Division of Mines and Geology photograph.

Legislature (Nash 1963; Oakeshott 1971), as was the second volume on the Tertiary paleontology of California (Gabb 1869). Indeed, the Legislature did not understand Whitney's focus on such mundane matters and his seeming neglect of the economic aspects of the work (Nash 1963). Like all state geological surveys from the first one in North Carolina in 1823 to the 51 current surveys (including Puerto Rico), the California Legislature expected that its survey would focus on applied matters (Hendrickson 1961; Nash 1963). It thus cut funding to the Survey. Whitney did not help matters, however, with his direct and blunt style of speaking and writing. In a rather famous geological quote, Whitney said *"It is not the business of a geological surveying corps to act . . . as a prospecting party."* He told the Legislature *"We have escaped perils by flood and field, have evaded the friendly embrace of the grizzly, and now find ourselves in the jaws of the Legislature"* (Whitney 1862, 1863a, 1863b, 1863c). His budget continued to be cut and by 1867, no more money was available. The conflict with the Legislature made it impossible for Whitney to complete the Survey's publications as planned, and much of its results appeared later in publications not associated with the Survey or California. By 1874, the Geological Survey of California was over, and it was directed to deposit the fossils and other materials it had collected in the State University at Berkeley by virtue of the Organic Act of 1873, which Whitney agreed to do (Whitney 1873).

The fossils collected by the Geological Survey of California thus formed the basis of the collection that was to become UCMP's. However, not all of them were deposited with the University. Whitney took some with him upon his appointment as Professor of Geology at Harvard and placed them in the Museum of Comparative Zoology, and Gabb took most of his type specimens to the Academy of Natural Sciences of Philadelphia (Stewart 1928, 1930). The University of California ended up with 107 types (Fig. 2) of which about 30 are gastropods and 48 are bivalves (Merriam 1895; Stewart 1928, 1930) together with a few hundred specimens of miscellaneous invertebrate

FIGURE 8. The ammonite and the seal of the Geological Survey of California embossed on the front and back covers respectively of the first official volume (Palaeontology) published by the GSC in 1864. Images by Susie Lipps, 2004, from the original binding of the 1864 book.

fossils. In addition, the types of J.G. Cooper's modern mollusks were deposited in the university's collection with duplicates going to the California Academy of Sciences (Coan 1981). Thus the collection of Museum of Paleontology had a significant but hectic beginning!

Starting Paleontology at the University of California.

The University of California, formed from the College of California and its lands in Oakland and on the hill slopes 4 miles to the north, was chartered on March 23, 1868. Soon thereafter, the Regents started to appoint faculty members, and with that, began the first of several contentious issues that characterized paleontology at Berkeley throughout much of its history. J.G. Cooper, who had collected all over California including the lands to be occupied by the new university for the Geological Survey of California, wanted the faculty position in natural history. To this end, he solicited signatures, including those of Joseph Henry and Spencer Baird of the Smithsonian Institution, on a petition to the Regents requesting his appointment (Coan 1981). However the petition arrived too late, the Regents having already appointed Joseph LeConte to the position and an embittered Cooper wrote to Baird that LeConte had been elected because of the strength of the southern influence among the Regents. He added that the university was "being made into a perfect asylum for ex-rebel professors" (Coan 1981), with obvious reference to LeConte and his brother. Whether or not Cooper would have been an effective professor, LeConte surely was a very positive influence on paleontology.

Joseph LeConte (Fig. 9) arrived at the University of California in 1869 as the first geologist, natural historian and botanist appointed to the University. In 1857 he held the Chair of Chemistry and Geology at South Carolina College in Columbia, SC (Armes 1903). During the Civil War, Columbia was burned by General T. Sherman; and life became difficult. Joseph lost all his possessions (property and slaves), but he optimistically believed that he could still succeed. When the College reopened in 1866, Joseph and his older brother John, a physicist, began teaching once again. However, the two of them became wary of the attitude of the South Carolina State

Legislature toward the College, and when they heard about the newly forming University of California, they both applied for faculty positions. They were hired in 1868, John in November, the first of the faculty and initially acting President of the University, and Joseph in December (Armes 1903). Joseph arrived after John in September, 1869, to begin his duties. The LeContes went on to establish outstanding records as teachers and to have a large impact on the new University and science in general. John and Joseph taught initially in buildings at the former College of California in Oakland. When the university's first buildings on its hillside site were completed in 1873, the Le Contes took up lectures in South Hall (Fig. 3). For some time, they and the students commuted by horse-car to the new campus from Oakland until housing could be built in the newly developing town of Berkeley. In 1874, Joseph LeConte finally moved to Berkeley.

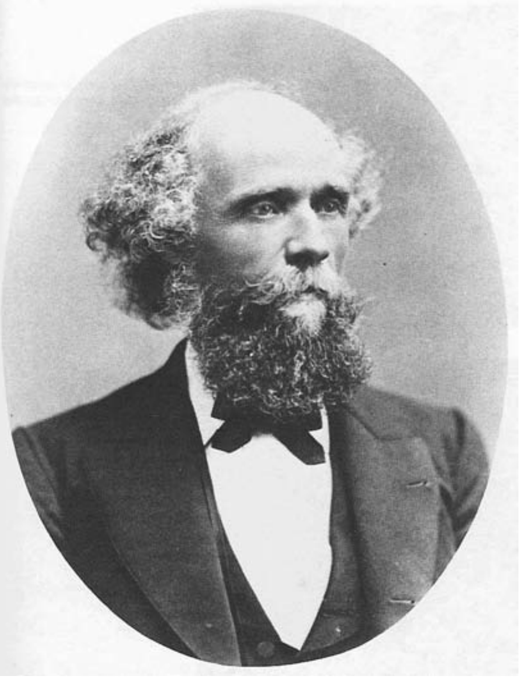

FIGURE 9. Joseph LeConte, about 1875. Courtesy of the Bancroft Library.

The LeContes were highly respected and received many honors, including the naming of buildings, streets, awards, and natural formations for them. John LeConte went on to be President of the University from 1876–1881. John, not Joseph, is remembered on the modern Berkeley campus by John Lawrence LeConte Hall, dedicated in 1923 and located in the central campus area. It is appropriately occupied by the Physics Department. The LeContes are also remembered in other ways—the north side of the Berkeley campus by LeConte Avenue, LeConte Science Magnet School in Berkeley, near UCLA where a street in Westwood was named after Joseph by Herbert Foster, a Berkeley graduate who admired him, in Westwood again where Joseph LeConte Junior High School is located, Mt. LeConte in the Sierra Nevada near Lone Pine, California, LeConte Cascade on the Tuolumne River, the Joseph LeConte Memorial Lodge (Sierra Club) in Yosemite, Mt. LeConte and LeConte Lodge in the Great Smoky Mountains near Gatlinburg, Tennessee, a LeConte Club in the Mountain National Bank of Gatlinburg, by LeConte Hall at the University of Georgia and LeConte College at the University of South Carolina, named for both brothers, and by the annual LeConte Award now given by the Department of Integrative Biology at Berkeley to an outstanding undergraduate student. Joseph's son Joseph Nesbit LeConte, also a Berkeley professor and Sierra Club member, has a number of features named for him. Joseph LeConte died on an outing with his daughter in his beloved Yosemite in 1901 and is buried in Mountain View Cemetery in Oakland (Fig. 10).

Joseph LeConte significantly influenced the development of paleontology at the University of California in three ways: he lectured and wrote not only on geology but on evolution and life of the past (Fig. 11), he acquired still more collections of fossils for the University, and he influenced students. Indeed, the success of the paleontology program at Berkeley can be traced directly to him. LeConte was very concerned about paleontology and evolution, and he reconciled them with religion, at least in his own mind (Armes 1903; LeConte 1888b). He never did research on evolution but he became the foremost American proponent of evolution (Stephens 1982) in the late 1800s. ".

. . I was an evolutionist, thorough and enthusiastic. Enthusiastic, not only because it is true, and all truth is the image of God in the human reason, but also because of all the laws of nature it is by far the most religious, that is, the most in accord with religious philosophic thought. It is, indeed, glad tidings of great joy which shall be to all peoples." (Armes 1903). He uses "enthusiastic", most likely, in its older meaning of "inspired by God". Indeed, the *Oakland Tribune* called LeConte "The Prince of evolutionists" in 1897. Although he was not a particularly religious person, he founded or helped four new churches in Berkeley. Clearly, he believed that religion was important in the lives of ordinary people, yet he emphasized that the evidence for evolution demonstrated its truth. His textbooks on geology (LeConte 1878, 1888a) combined physical and historical geology with about half of each devoted to the history of Earth and life on it. Over half of the 903 illustrations in the 1878 book are of fossils, which like all illustrations in the book, he selected and supervised their renderings (Armes 1903). Some of them are reproduced from the Palaeontology volumes of the Geological Survey of California. He even had a chapter about the antiquity of humans. His smaller and briefer book (LeConte 1888a), designed for high school students, also included much paleontology. His interest in paleontology is evident in his lecture material as well, which he used almost entirely to write his textbook (LeConte 1878). As he said, *"My textbook,* Elements of Geology*, was simply the embodiment of my daily class lectures, but far less discursive and illustrative and therefore far less interesting than the viva voce lectures"* (Armes 1903).

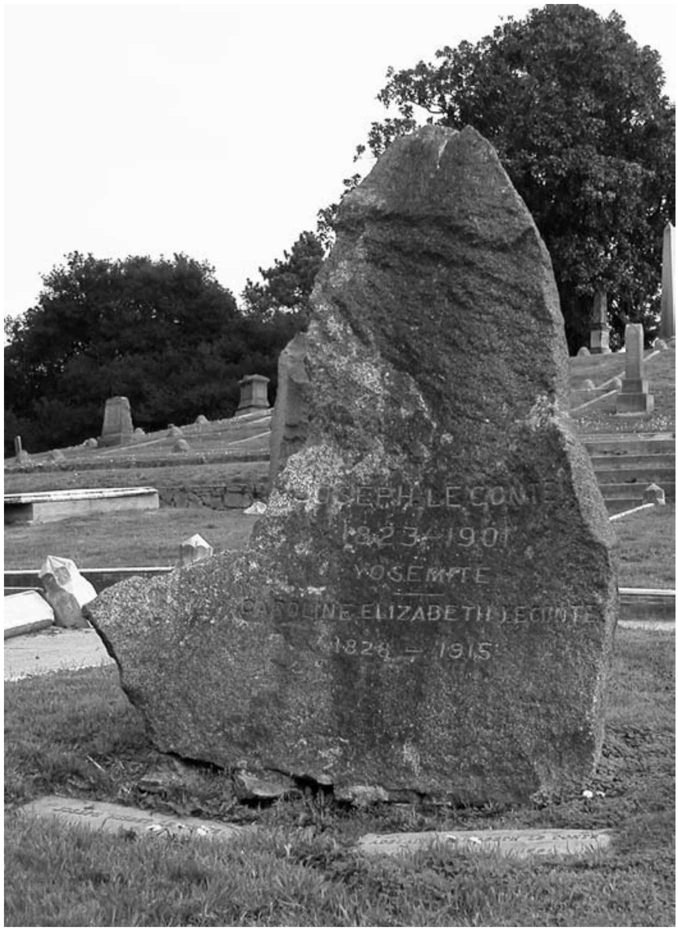

FIGURE 10. Grave of Joseph LeConte and his wife in Mountain View Cemetery, Oakland, California. The headstone is a piece of granite carried from LeConte's beloved Yosemite Valley on his death there in 1901. Image by J.H. Lipps, 2004.

LeConte continued to acquire yet more outstanding fossil collections for the University. He purchased a Paleozoic invertebrate collection from Robert P. Whitfield of the American Museum of Natural History, an outstanding crinoid collection made at Crawfordsville, Indiana, from Prof. A.D. Bassett of Wabash College (Lane 1963), and others. The Crawfordsville crinoid collection contained 121 "packages and pieces" including several slabs with up to 16 crinoids on them for $1000, a significant amount of money for 1883 (Van Sant and Lane 1964). Lane points out that

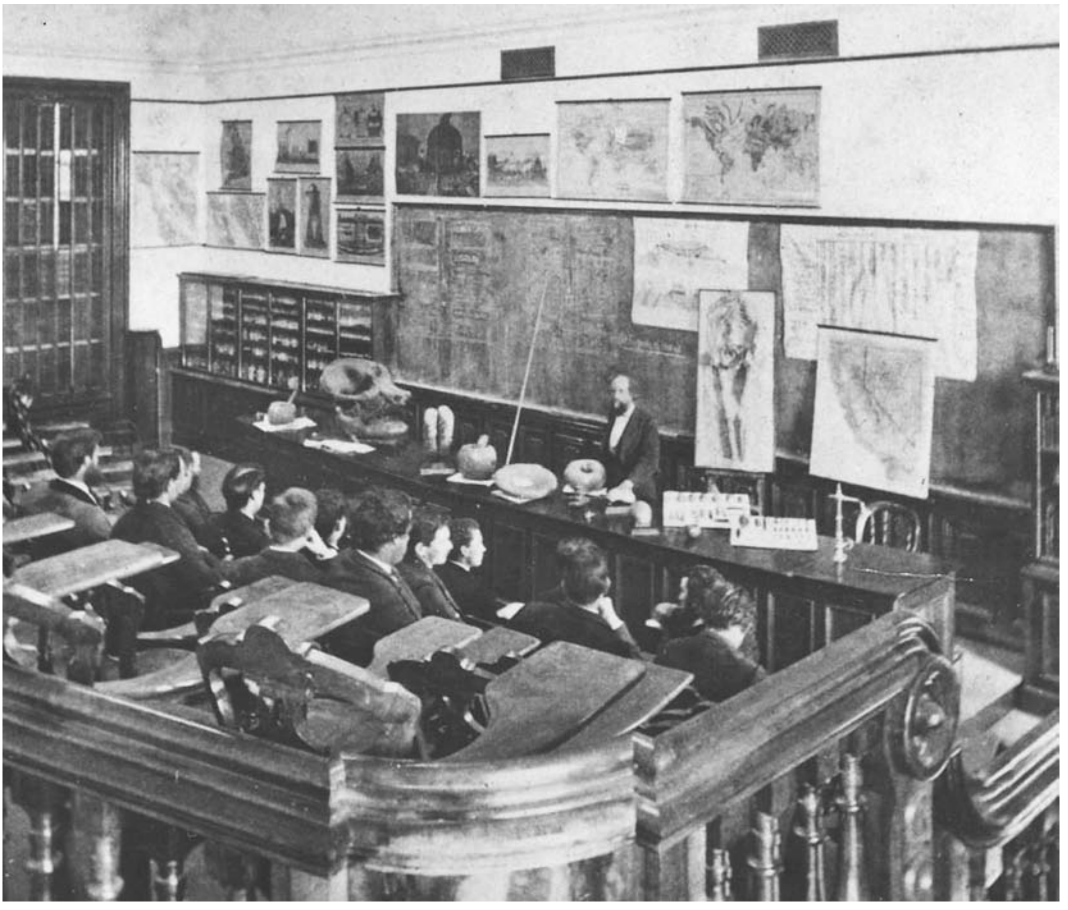

FIGURE 11. Joseph LeConte lecturing in South Hall during the 1880s. From the Bancroft Library, used with permission.

Bassett's salary at Wabash College was only $1500 a year, so that his fossil business must have made him quite wealthy for a college professor (Van Sant and Lane 1964). LeConte also encouraged people to donate collections to the university. The San Francisco financier F.L.A. Pioche left his natural history collection of minerals, fossils and mollusks, to the university when he died in 1872 (Dalin and Fracchia 1974). The C.D. Voy collection, purchased by D.O. Mills of San Francisco and given to the University along with his own mollusk collection, was particularly important. The Voy collection of fossil plants formed the basis of Lesquereux's report presented to Whitney as a contribution to the Geological Survey of California. These fossil plants (Fig. 12) from the auriferous gravels were not the original ones collected by the Survey, for those had been destroyed in a fire (Lesquereux 1878), but were collected by C.D. Voy from the same area that the Geological Survey of California had collected. Whitney arranged to have them published by Harvard's Museum of Comparative Zoology as a contribution to the Survey. LeConte displayed many of the fossils he accumulated in the Museum of Natural History in South Hall and as demonstrations in his courses (Fig. 11).

A Paleontology Program Develops

During LeConte's tenure at Berkeley, his best known student was John C. Merriam (Fig. 13), who, inspired by LeConte's textbook on geology, came to Berkeley for an undergraduate degree, and then went on to study with the famed paleontologist Karl A. von Zittel in Munich for his Ph.D. Merriam returned to Berkeley as professor of paleontology in 1894 in the geology department. Soon he was teaching a complete array of undergraduate and graduate paleontology courses (Table 5), including several on vertebrate history. Helping him were a number of students and graduates, some of whom achieved high standing in paleontology themselves, such as Loye Holmes Miller, an avian paleontologist who helped to found the Zoology Department at UCLA, and Chester Stock, who became an assistant professor at Berkeley (Table 1), and then moved to the California Institute of Technology where he started a highly regarded paleontology program in the new geology department there. Many of the famous early California paleontologists were trained at Berkeley under Merriam.

Merriam's teaching was highly regarded, and it attracted many students to his lectures, including Miss Annie Alexander (Figs. 14–15), a wealthy newcomer to the Bay Area. Alexander, born and raised in Hawaii and recently moved to Oakland, attended one of Merriam's courses in 1900 and was thrilled by it. This began a lifelong enthusiasm for paleontology and its support at the University of California. Alexander, a remarkable woman, was vital to the development of paleontology, vertebrate biology and botany at Berkeley; her life and contributions are well told by Stein (2001). Soon after taking Merriam's course, Alexander organized expeditions to collect fossils from many places and ages. This work continued until 1906 when she organized an expedition to Alaska to collect examples of living animals, bears in particular. This trip was stimulated by C. Hart Merriam (no relation to John C.) who was particularly interested in bears. She

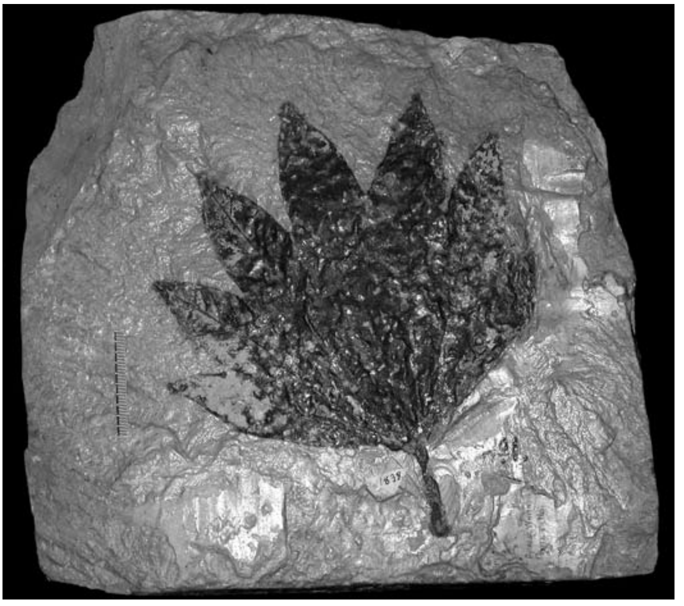

FIGURE 12. Fossil leaf collected by C.D. Voy from the Sierra Nevada auriferous gravels that had been collected originally by the Geological Survey of California. The GSC collection of fossil plants burned in a fire, so Whitney asked Lesquereux to study the Voy collection from the same site donated to the University of California by D.O. Mills. Lesquereux (1878) named this *Aralia whitneyi* (now *Macginitiea*) for the former State Geologist. Image by Lorraine Cazassa, 2004.

TABLE 5. The first courses in paleontology, taught by J.C. Merriam at Berkeley in the early 1900s. They formed the framework for the paleontology program into the 1980s. Some (*) are still taught.

Paleontology 1.	General Paleontology.
Paleontology 102.	Invertebrate Paleontology*
Paleontology 103.	Invertebrate Faunas of the Pacific Coast
Paleontology 104.	Vertebrate Paleontology*
Paleontology 105.	History of Vertebrate Life in North America
Paleontology 206.	Seminar in Paleontology*
Paleontology 207.	Individual Research*

FIGURE 13. John C. Merriam, ca. 1920. Courtesy of the UCMP archives.

FIGURE 14. Annie Alexander posing with her brother's shotgun in the mountains northeast of Bly, Oregon, mid-June, 1901, on a three month collecting trip to Fossil Lake. Alexander supplemented the collecting party's food supply with fresh game (see also Stein 2001, illustration of Alexander aiming shotgun from a sitting position). Courtesy of the UCMP archives.

still continued her deep interest in paleontology and supported J.C. Merriam's research and many more fossil collecting trips until 1920. Her contributions to UC paleontology were many: financial support to faculty and the University, collecting expeditions across the west, donation of specimens, encouragement to UC paleontologists, support of students, persuasion applied on behalf of paleontology on several Presidents of the University, and endowment of the UC Museum of Paleontology. These contributions continued for nearly 50 years, and paleontology still benefits from her largesse (Stein 2001). Without Alexander, paleontology would not have thrived at Berkeley. With her, paleontology became a renowned discipline on the campus built on the foundations laid and the collections developed by LeConte, Merriam and her.

Merriam was also an exceptional researcher, fossil collector and prolific author of many papers on vertebrate paleontology and a few on invertebrates of western North America. Much of this was made possible through the financial support of Annie Alexander. His work on the vertebrates of the Pleistocene Rancho La Brea in Los Angeles, including a note on the occurrence of human bones (Merriam 1914), was outstanding. He and L.H. Miller, then in Los Angeles, together with others excavated the tar-soaked sands and asphalt from 1905–1907 and in 1912–13 with funds from the University Regents. Later in 1913, the Los Angeles County Supervisors were given exclusive excavation rights to the tar pits, thus ending Merriam's collecting (Heric 1969) but not his studies of the material. His remarkable and huge collection was sent to Berkeley, studied by Merriam and his students including Stock, and stored in the Campanile on campus where it remains today. Merriam continued his studies on other faunas as well. He was an important expert on the paleontology and geology of the John Day fossil beds in Oregon, where he had run Berkeley expeditions for about

20 years starting in 1899 (Miller 1950). Merriam studied the fossils, describing them in detail, and the stratigraphy, naming several formations in the area (Merriam and Sinclair 1907). During this work, Merriam proposed that the fossil beds be made a state park and preserved for posterity. In 1974, the John Day fossil beds were declared a U.S. National Park Service National Monument. This became an important role for Berkeley paleontologists later on as additional important fossil sites were studied and deemed worthy of preservation as parks and monuments.

FIGURE 15. Annie Alexander watching the excavation of fossils on the Saurian Expedition, 1905, Humboldt County, Nevada, led by John C. Merriam. Courtesy of the UCMP archives.

Merriam was very highly regarded on the Berkeley campus and was invited to deliver the second Berkeley Faculty Research Lecture in 1914, quite a distinguished honor, on the "Paleontology and Historical Geology, Extinct Faunas of the Mojave Desert: Their Significance in a Study of the Origin and Evolution of Life in America" (Merriam 1915a). He wrote a number of general interpretive papers, even on human evolution (Merriam 1919), and many excellent monographic works, often coauthored with his students and others. By 1915, Merriam was able to provide a useful sketch of the history of life on the Pacific Coast, mostly based on research that used the collections at Berkeley (Merriam 1915b).

Annie Alexander also became a great supporter of vertebrate biology, and Merriam fostered her efforts in this endeavor. She met Joseph Grinnell for the first time in the hall at the Throop Polytechnic Institute, later transformed into the California Institute of Technology, in Pasadena while organizing another collecting trip to Alaska in 1907, and, after a brief conversation, left. But Grinnell remembered that she had been acknowledged in J.C. Merriam's paleontological publications as a collector and financier of his research. Grinnell believed that she was a serious supporter of science, and so he wrote her an impressive letter about collecting in the wilderness that attracted Alexander's attention and interest (Stein 2001). Thus began a long, cordial and highly productive relationship with Grinnell that led to the formation of the Museum of Vertebrate Zoology (MVZ) at Berkeley in 1908 and his appointment as its first Director. The establishment of the MVZ required significant negotiation with President Benjamin Wheeler and the Regents, for Alexander wanted complete control of the museum and its research agenda (Stein 2001). This proposal and her plans were supported by J.C. Merriam with a strong statement that such a museum would greatly aid instruction and research at the University, as well as provide comparative material for research in paleontology, geology and anthropology. Her proposal was rejected by the Regents, because giving her control of a University facility would be a violation of the Organic Act of 1868. The matter was settled diplomatically by Wheeler, and Alexander accepted his compromise that would allow her to continue to direct the affairs of the new museum along with Grinnell.

Paleontology also continued to develop, with Alexander's support in all ways, although it had more problems, however, because it was part of geology and its collections were part of that department. Paleontology also included a much wider area of study than vertebrate biology, because it required understanding the geology and ages of fossil sites, and of course it included the discovery and description of a wide range of invertebrates and microfossils. Paleontology thus had an inextricable relationship with geology, as it still does. The relationship between the geologists and paleontologists in South Hall became difficult. Alexander did not like this strain between the geologists and her paleontologist, and with money and appeal to President Wheeler, a Department of Paleontology was created in 1909 with Merriam as its Chairman (Stein 2001). The fossil collections became part of this department. A year later, she pushed for new quarters, the ones in South Hall having become too crowded (Wagner 1969). In 1911, the Paleontology Department and its collections along with the Geology Department moved into Bacon Hall (Fig. 3), the renovated Bacon Arts and Library Building built in 1881 (Wagner 1969).

The fossil collection continued to grow, chiefly through the work of Alexander, Merriam, and students and staff. By 1915, the Paleontology Department had a collection totaling over 150,000 invertebrate, 15,000 vertebrate and 3000 plant fossils, of which several hundred were type specimens (Evermann 1915). It was the most significant fossil collection on the west coast for it contained far more fossils than any other museum west of the Mississippi, including such places as Los Angeles's Museum of History, Science and Art, which had the notable collection of Rancho La Brea material, and San Francisco's California Academy of Sciences (Evermann 1915), which had had extensive collections of fossils collected by Trask, Cooper and others that were destroyed in the Great Earthquake and Fire of 1906. South Hall at Berkeley had come through the same earthquake relatively safely (Fig. 3) as did the fossil collection therein. This collection was referred to informally as a museum of paleontology, but UCMP itself did not yet exist.

The University of California Museum of Paleontology

Until the appointment of Bruce Clark, an invertebrate paleontologist, to the faculty in 1918, the Paleontology Department consisted of only Merriam. Merriam had taught, with the help of students and graduates as instructors (Fig. 16), a broad set of courses (Table 5). The beginning paleontology course was attended by 250 students at a time. The future of paleontology looked glorious and Annie Alexander was pleased. She had great hopes and had invested much money in Merriam's paleontologic research and her own collecting expeditions. However, Merriam had additional goals, as his interests moved towards administration and the scientific community beyond Berkeley. In 1920, he became Dean of the Faculty and then he left Berkeley at the end of the year to accept the presidency of the Carnegie Institute from 1921 to 1938 in Washington, D.C. He continued to be associated with Berkeley and stayed involved with paleontology there, with the blessing of the campus administration who thought of him as a positive figure to have associated with the university. Much of his Berkeley-based work was published in Carnegie publications. Annie Alexander was greatly disappointed by this change of emphasis in Merriam, his move and the lack of acknowledgment of the University. A sometimes bitter relationship, which had been simmering for several years, developed between them (well described by Stein 2001, chapter 17).

The departure of Merriam did not end his input to the Paleontology Department, much to Alexander's frustration. She was unable to counter this interference, so she brought pressure on the University to establish a Museum of Paleontology separate from the Department. She proposed that

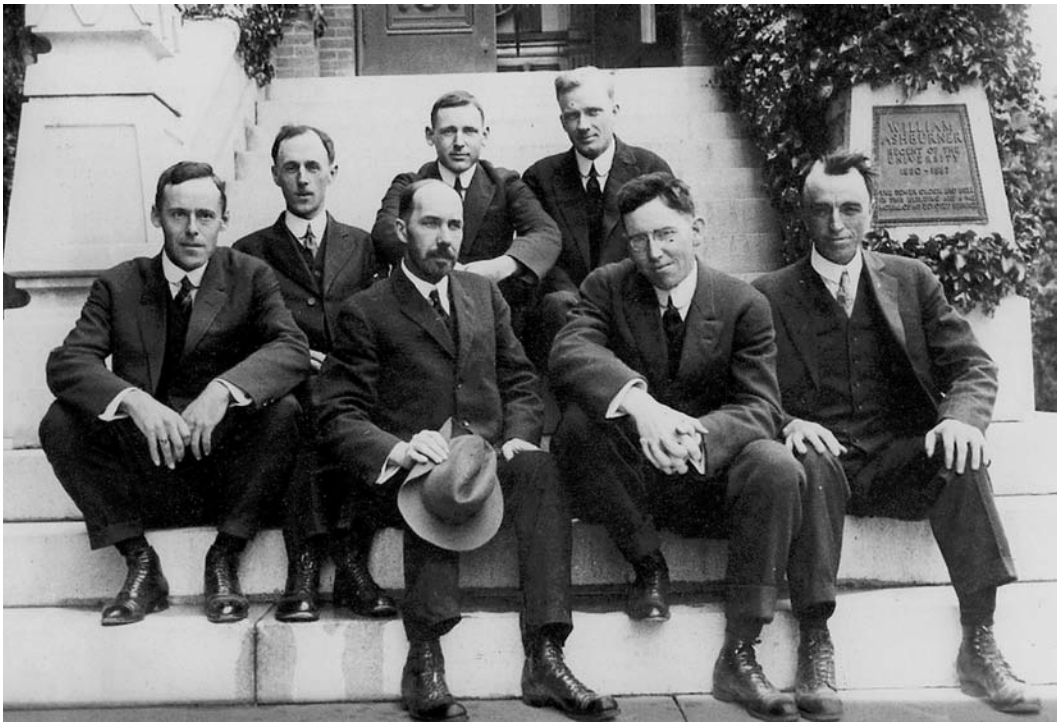

FIGURE 16. Faculty and instructors of the Department of Paleontology. Top row, left to right: E.L. Packard, W.S.W. Kew, J.O. Nomland. Bottom row, left to right: John P. Buwalda, John C. Merriam, Chester Stock, and Bruce L. Clark. Circa 1915. If the date on this photograph is correct, then only Merriam was a professor at that time, although Buwalda, Stock and Clark were appointed professors in geology a few years later. Courtesy of the UCMP archives.

she would increase her funding to the museum through her own resources, if the university would do likewise (Stein 2001). However, Merriam was to have nothing to do with the new museum. The University accepted her proposal and established the Museum of Paleontology in 1921 with Professor Bruce Clark as its director. In the meantime, Merriam lobbied from Washington first that no one be appointed in his former position as chairman of the Department of Paleontology, and then for the appointment of Ralph Chaney as chairman, leading to so much indecision and discord that paleontology once again became part of the Department of Geology. The fossil collections passed to the new Museum of Paleontology but were housed with the departments. Clark remained a professor in geology, which had also added two vertebrate paleontologists in 1921 to its faculty: Chester Stock and John Buwalda, both students and collaborators of Merriam's (Buwalda and Merriam 1916; Merriam and Stock 1921, 1925; Merriam et al. 1925). In the museum, Clark was joined a year later by Charles Camp, a student of Grinnell who held a position in the Department of Zoology. Merriam, now aided by Stock, was still involved in the affairs of the department and UCMP so much so that Clark decided in 1926 to resign the directorship of UCMP. After much delay, the University appointed Ralph Chaney, a paleobotanist from Iowa, as Director of UCMP, but Alexander objected sternly to this because she believed this was more interference from Merriam, and she withdrew all support for the museum (Stein 2001). The administration then changed its course and recanted its offer to Chaney. Buwalda and Stock left Berkeley in 1926 for positions in the newly forming Geology Department at Cal Tech.

Shortly thereafter, in 1927, the university appointed William Diller Matthew (Fig. 17) as director of the Museum of Paleontology and chairman of the reestablished Department of Paleontology (Gregory 1996b; Stein 2001). He had been at the American Museum of Natural History for 33 years and had an outstanding record of high quality research and publication in vertebrate paleontology. With his appointment and the departure of Merriam's collaborators, tranquility fell on the museum and department. Alexander's hopes were once again renewed and she began anew her annual donations of support to the museum. This feeling of accomplishment and hope lasted only three years before Matthew passed away from kidney failure in 1930. This began yet another round of dispute in paleontology. Alexander met with President Gordon Sproul and they agreed that Charles Camp should be appointed director of UCMP, if she would continue her support of its activities, but Sproul decided that Ralph Chaney, Merriam's own choice, would become chairman of the Department of Paleontology. Alexander was dismayed and began a series of negotiations with Sproul and the Regents. Nevertheless, Chaney was appointed, and soon difficulties between the museum and the department ensued. Much of this revolved around how Alexander's gifts to the museum would be used; Merriam and Chaney, she believed, wanted to be involved in the museum's affairs, and to this she objected. She again met with Sproul to explain her desires of complete separation of the museum from the Department of Paleontology, physically and financially, with separate staffs for each. Camp would be totally in charge of the museum and the others would have no say in its operation at all. She told Sproul that if he implemented these things, then her level of support would remain; if not she would withdraw it. The university agreed to her demands, and the two units and their leaders were separated completely (Stein 2001).

FIGURE 17. William Diller Matthew, bust sculpted by his daughter, Margaret Matthew Colbert. At least two copies were cast in the laboratories of the American Museum of Natural History by Otto Falkenbach (Anonymous 1946). One copy was donated to the Osborn Library of the American Museum and the other to the Matthew Memorial Library of the University of California, Berkeley. This image is of the Berkeley copy, now housed in the offices of the Museum of Paleontology in the Valley Life Sciences Building. Image by Lorraine Cazassa and Sarah Rieboldt.

Alexander then decided to approach Sproul about new and safer facilities for UCMP. The museum was moved to Hearst Memorial Mining Building in 1931 where it remained for 30 years. During this time, the administration of the museum and department were sometimes joined under one person appointed as Director and Chairman and at other times they were separately administered (Tables 2, 6). While tensions existed between various factions of the department and museum, as is common in small organizations anyway, the two units, one supporting research and the other carrying out academic functions, ran fairly smoothly. In 1934, Annie Alexander thus endowed UCMP with the significant funds she had promised in 1921. She continued her research support as well over the years and in 1948 made a final contribution to the UCMP endowment. In 1948, she also established two graduate student scholarships, one in paleontology and one in vertebrate zoology. These are still administered by UCMP and MVZ. At the time of her death in 1950, she had donated substantial and nearly equal sums to the UCMP and MVZ as endowments and much over the past half century to support the research and students in each museum. Both museums today benefit from her generosity and foresight.

Table 6. Chairs of the Department of Paleontology.

Term	*Chairman*
1910–1920	John C. Merriam
1927–1930	William D. Matthew*
1931–1939	Ralph Chaney
1940–1946	Charles L. Camp*
1947–1948	J. Wyatt Durham**
1949–1955	Ruben A. Stirton*
1956–1959	J. Wyatt Durham**
1960–1965	Joseph T. Gregory
1966–1975	Donald E. Savage
1976–1987	Willam B. N. Berry*
1988–1989	Willam A. Clemens*
1991–1994	Jere H. Lipps* (Chair of Integrative Biology)

* Simultaneously director of UCMP. ** acting chairman

Annie Alexander's support for field work in paleontology continued after 1930 significantly. Now she was supporting the work of Charles Camp and Sam Welles, who often teamed up together on big projects. These included excavations of ichthyosaurs near the ghost town of Berlin, Nevada, the discovery in Arizona of *Dilophosaurus*, the spitting dinosaur incorrectly but famously portrayed in the movie *Jurassic Park* (Crichton 1990; DeSalle and Lindley 1997), work in New Mexico (Fig. 18), and many other projects, most of which involved students too. Welles was famous for his field prowess — he could find fossils where no one else ever could (Camp 1969).

From February 19 to October 29, 1939, and May 25 to September 29, 1940, the San Francisco Bay area hosted the Golden Gate International Exposition on Treasure Island to celebrate the openings of the San Francisco-Oakland Bay Bridge (1936) and the Golden Gate Bridge (1937), the economic strength of the Bay Area, the unity of the Pacific, and the hope that the Bay Area would be a gateway to the Pacific Rim. The Exposition was crowned by elaborate buildings and sculptures of all sorts by many artists. UCMP participated with its own exhibit, featuring the sculptures of William Gordon Huff (Fig. 19). On the opening day of the Exposition, well over 100,000 people visited. As a result of the popularity of the Exposition, it was extended for another summer season in 1940. UCMP still has the Huff sculptures in its collection of non-fossil materials.

World War II and the Development of Modern Paleontology

World War II impacted the paleontology program significantly, as it did so many others at Berkeley and elsewhere. The staff and faculty were busy with war efforts, some having enlisted in the service. The collections were of some concern, since the west coast of the United States was designated a combat zone. Vanderhoof reported ". . . attention has already been given to the preservation of types from destruction. Some thought has even been given to the preservation of paleontologists, but they, of course, can be replaced." (Vanderhoof 1942). Charles Camp at age 50 served part time in the Coast Guard, Sam Welles was in Electrical Engineering in the Engineering Science War Training Program (Stirton 1944), and Vanderhoof joined the Manhattan Project. World War II made the practice of paleontology difficult at Berkeley, as everywhere.

After the war, the paleontology program regained its vitality. Three new faculty appointments in micropaleontology, invertebrate paleontology, and vertebrate paleontology created a strong center in all paleontology. R.M. Kleinpell, D. Savage and J.W. Durham joined Camp and Chaney, and in the museum, Ruben Stirton and Sam Welles, forming a powerful group that covered all of paleontology. Annie Alexander's interests began to move toward plants, largely under the influence of her partner Louise Kellogg. The two of them spent many months collecting plants and donating them to the University Herbarium. This and other diversions caused Alexander to become less involved in the ordinary operations of the Museum of Paleontology. She still maintained an interest in and support for UCMP, however, but now paleontology was mostly on its own. In 1950, Annie Alexander passed away.

FIGURE 18. Sam Welles, Museum Paleontologist, supervising an excavation with his field party in New Mexico, about 1937. From the Welles Archive, UCMP.

Charles Camp, who had established himself as a foremost reptilian paleontologist by virtue of his collecting and publishing activities, trained a continuing line of vertebrate paleontologists (Gregory 1996a). His interests were wide and included history of the west and of paleontology, as well as book collecting. He wrote outstanding descriptive and interpretive monographs and papers on various fossil reptiles. He and Sam Welles collected late Triassic ichthyosaurs (*Shonisaurus populari)* from near Berlin, Nevada (Fig. 20), an area of 1153 acres that was set aside by the State of Nevada as Berlin-Ichthyosaur State Park. Camp and Welles excavated 40 of the animals (Camp 1980), recognized the uniqueness of the occurrence and petitioned Nevada to preserve the site. *Shonisaurus populari*, the largest ichthyosaur known, has been adopted as the Nevada State Fossil (Rowland 1999).

Ralph Chaney remained a faculty member in the department and a Faculty Curator in UCMP. He worked on the fossil floras of the west and taught paleobotany for many years from 1931 to 1957, producing students and publications. One of his major accomplishments was the documentation of the history of Redwoods in North America. As part of this work, he went to China and returned with seeds and seedlings of the imperfectly known Dawn Redwood, thought to have been extinct but discovered by Chinese workers to be living in parts of China. Two of Chaney's specimens still grow outside McCone Hall.

Ruben Stirton, who had been a curator in UCMP since 1930, was appointed to the faculty in 1949, as Professor, Chair of the Department of Paleontology, and Director of UCMP (Gregory 1997b). He continued a vigorous program of mammalian paleontology, teaching and involvement with campus activities. He wrote a textbook of general paleontology (Stirton 1959), organized a major field expedition to Australia to document the early history of marsupials there, published extensively on many groups of mammals, developed the UCMP collections, and tutored many vertebrate paleontologists who have gone on to make major contributions to the field.

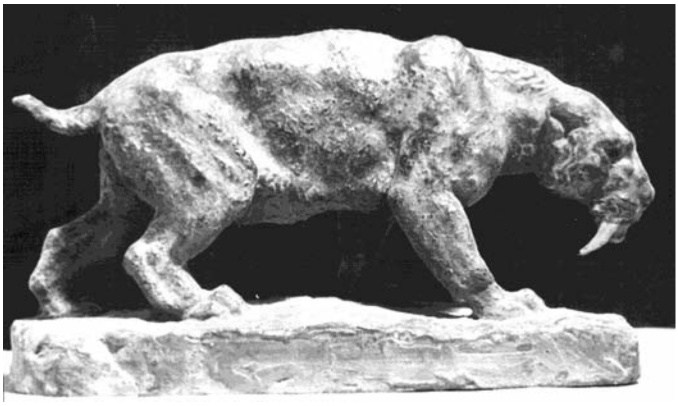

FIGURE 19. A sculpture of the Sabre-Tooth Cat *Smilodon californicus* done by William Gordon Huff for the Golden Gate International Exposition, 1939–1940. The Exposition included pavilions and exhibits by most countries around the Pacific and others from Europe and South America. UCMP had its own exhibit which included a number of Huff's sculptures. From the UCMP archives.

FIGURE 20. Charles Camp's cabin at his ichthyosaur dig near the ghost town of Berlin, Nevada. Camp constructed his cabin from lumber borrowed from some of the buildings in Berlin and at Union, another ghost town also nearby. Camp and Welles and their assistants and students used this cabin from 1955 to the 1960's for living, laboratory work, storage, and packing fossils. Photograph by J.H. Lipps, 1994.

Robert M. Kleinpell, who in 1938 had established a Miocene biostratigraphy of California (Kleinpell 1938) based on his Ph.D. dissertation at Stanford University, was appointed to the faculty and UCMP in 1946. His work on foraminiferal biostratigraphy provided one of the fundamental exploration tools for the thriving oil industry. Until his retirement in 1974, he produced a long line of students in micropaleontology as well as a number of influential and important works on fossil foraminifera and biostratigraphy of California. He and his students developed a very large collection of foraminiferal samples and slides that formed an outstanding resource in foraminiferal work. Kleinpell was regarded as the foremost Californian micropaleontologist by the oil industry and academics alike, and a student of the history of the field itself (Kleinpell 1971, 1972).

J. Wyatt Durham was named to the faculty and museum in invertebrate paleontology in 1947. He, too, had many students, and he published widely on many groups of invertebrates and their history. He dealt with their biostratigraphy, paleoecology and evolution, and held strong opinions on continental drift, and later, plate tectonics. His collecting activities took him far away to collect both modern and fossil animals. He was especially attracted to and collected from the amber deposits of Chiapas, Mexico.

Donald Savage continued on as a faculty member after finishing his Ph.D. in the Department of Paleontology under Stirton in 1949 (Gregory 1997a). His work featured the description and stratigraphy of vertebrate faunas throughout the west. Savage collaborated with geologists to document the radiometric ages of the vertebrate ages used across western North America. He too had a number of outstanding students. He was well known as a craftsman in making displays of fossils.

Savage also worked hard to have the Sabre-tooth Cat, *Smilodon californicus*, from Rancho La Brea, declared the California State Fossil in January 1974 (Fig. 19).

Sam Welles, who received his Ph.D. in paleontology in 1940 at Berkeley, decided that he did not want to be a faculty member but would rather dedicate himself to the collection and description of vertebrate fossils (Gregory 1997c). Welles specialized on reptiles and worked closely with Camp in the field although he treasured his own numerous and major contributions. He described the plesiosaur *Hadrotherosaurus alexandrae* and dinosaur *Dilophosaurus*, among many other accomplishments. Welles believed that the chief goal of a paleontologist was to collect fossils in the field before natural processes destroyed them, and he was very good at that task.

Biology and Paleontology

For more than 100 years, paleontology in the US had been steeped in the tradition of description and stratigraphy out of necessity, with some exceptions dealing with the history and development of the biota. This of course continued at Berkeley, but as the next decades unfolded, a more biological emphasis developed. In 1955, the Department had six paleontologists on its staff covering all subdisciplines of paleontology (Fig. 21). Two years later, the department hired Zach Arnold, a protozoologist working on foraminifera. This first step into paleobiology was continued with further hires (Table 3) in functional morphology of vertebrates and invertebrates, paleoceanography, paleoecology, evolutionary paleontology, and paleobiology. These faculty hires replaced previous faculty who retired, passed away or moved to other places, thus maintaining a level of seven paleontologists in the department. During this period from 1960 to 1989, UCMP and the Department moved once again into the new Earth Sciences Building together with Geology and Geography (1961).

Under the leadership of Director William Berry (1975–1988), outreach was established as an important activity of UCMP, the collections began a long period of computerization, the collections were provided adequate housing, the Friends of Fossils organization of interested people was established, the Young People's Lecture Series was started, an enormously successful UCMP Open

FIGURE 21. Faculty of the Paleontology Department, UC Berkeley, about 1955. Clockwise from top left: Ralph W. Chaney, Ruben A. Stirton, Robert M. Kleinpell, Charles L. Camp, J. Wyatt Durham, Sam Welles, Ralph L. Langenheim, and Donald E. Savage. Welles was never a professor in the department, but served as an instructor for a time and as a Museum Paleontologist. From the UCMP archives.

House took place each year, the Blackhawk Fossil Quarry in Danville was acquired assuring its preservation, an agreement was reached for a major UCMP Hall in the proposed Museums at Blackhawk in Danville, and an annual conference of all paleontologists in the University of California (all campuses) was initiated and later changed to include paleontologists from any college or university in California (Gregory 1998). Importantly, Berry was involved in campus discussions on the reorganization of biological sciences at Berkeley, and he negotiated for new Museum of Paleontology facilities in the proposed renovation of the Life Sciences Building. Berry became the first Director who was also Chair of the Department in over two decades since Stirton last occupied both positions in 1955. The joining of both administrative positions brought paleontology together as a whole, with research and academic goals intertwined. This work was continued and expanded by later Directors.

The reorganization of biological sciences changed a good deal for paleontology. The Department of Paleontology was disestablished and included with other biology departments in the reorganization. A new Department of Integrative Biology was formed in 1989 by the merging of faculties of paleontology, zoology, botany and other biology disciplines into a single large department. The paleontology department had seven faculty members at that time, six of whom joined the new biology department and one who joined the Geology Department but remained a Faculty Curator in UCMP. Although they joined new departments, the faculty and students remained in the Earth Sciences Building (now McCone Hall) while awaiting the renovation of the Life Sciences Building. In 1995, the faculty in the merged Department of Integrative Biology moved into the renamed Valley Life Sciences Building, along with UCMP, MVZ, the University and Jepson Herbaria, and the Biosciences and Natural Resources Library. The move of UCMP took most of a year with just the moving vans and crews working eight hour days for nearly 6 weeks, shuttling the short distance between McCone Hall and VLSB. In this same period, the University of California budget was decreased about 20%, which resulted in early retirements, layoffs and financial cuts in most programs. The early 1990s were years of turmoil as the departments and museums adjusted to these rapid changes within the university and their own settings. Faculty and students found themselves in new relationships to their colleagues, the collections were closed and moved over several years, and budget restrictions affected everyone. UCMP, although suffering loss of some staff and budget, received no cuts deeper than those imposed on other units of the university, thus preserving its integrity and strengths. It lost one Faculty Curator and several museum staff who chose early retirement.

In spite of the turbulent times during the early 1990s, UCMP took on a new role as an independent research organization not directly associated with a department, as it had been for several decades. Now it provides services of various sorts to a wide diversity of users as described above. It maintains close affiliations with the Department of Integrative Biology as many of its Faculty Curators and most of its graduate students come from that department. However, it operates separately from any other unit, although it is a member of the Berkeley Natural History Museums (BNHM). In 1994, the Museum of Paleontology, the Museum of Vertebrate Zoology, the University and Jepson Herbaria , the Essig Museum of Entomology, and the University Botanical Garden joined together with the help of the Vice Chancellor of Research to form the BNHM. The BNHM is a powerful consortium sponsoring lectures, workshops and research projects, and facilitating student interactions. The campus administration recognizes the importance of the museums as unique research, teaching and outreach organizations that few universities anywhere have.

UCMP also provided fossil displays at several venues: the Petrified Forest National Park, the University of California at Davis, the California Academy of Sciences, the Doe Library on campus, and the Big Fresno County Fair, where attendance was over ½ million visitors at UCMP's exhibits. The President of the University acknowledged the role of the museum and University in Central Valley affairs with a special message to the citizens made through the museum's exhibit. UCMP aided in the establishment of the Stewart Valley Fossil Site under the auspices of the Bureau of Land Management. As the University began an association with the Museums at Blackhawk in Danville, California, UCMP began a fossil exhibition, following the negotiations of three directors over nearly a decade. A well-designed hall for paleontology ("Explorations of Ancient Life") was developed and displays mounted, with its grand opening in 1991. The paleontology exhibit hall was very popular with schools and the public, with attendance of over 50,000 each year. Although the paleontology exhibits were scheduled for a three-year run, the hall remained open to the public for over six years. The Museums at Blackhawk ran an extensive outreach program, with lectures and workshops done in association with UCMP. A particularly successful outreach effort was a community dig at the Blackhawk Fossil Quarry near the museums run by UCMP and the Museums at Blackhawk (Fig. 22). Families came on the weekends in the summer to dig for fossils, which were then curated into the UCMP collections. The visitors did not mind as their work was valued by the museums. Later, the Blackhawk Quarry was part of the "Trail through Time", a collaborative effort of UCMP and the Mt. Diablo State Park and its volunteers. Trails were marked that led through the rocks exposed on the flank of Mt. Diablo, from late Miocene to Jurassic in age, some 150 million years of geologic time. Each year, a Trek through Time along the Trail hosted many hikers. Negotiations are now underway with the Mt. Diablo State Park to transfer the Blackhawk Fossil Quarry to its ownership and care.

FIGURE 22. A community dig at the Blackhawk Fossil Quarry, 1993, consisting of families. The community digs continued for several years with several hundred children and their parents taking part. The digs were supervised by Museums at Blackhawk and UCMP personnel. Photo by J.H. Lipps, 1993.

UCMP also promoted international activities. It sponsored several major scientific meetings during the 1990s: American Malacological Union 1991, Forams 1994, and the North American Paleontology Convention 2001. New collaborations with the Paleontological Institute of the Russian Academy of Sciences started in 1993 with an exchange of scientists and students. As part of this, Berkeley students were supported by the Graduate Division for work related to their research. The museum has its own publication, *Paleobios*, where scientific reports may be published. It is widely distributed to countries all over the world.

As the budgets were restored in the following years, UCMP recovered its full complement in paleontology staff and facilities. Indeed, the paleontology program, centered on UCMP, was judged number one in America by *U.S. News and World Report*, an honor that the campus administration is proud of. The paleontology faculty, staff and past students continued to demonstrate their involvement in the affairs of international societies of paleontology (Table 7). Many Berkeley paleontologists have been honored by the Paleontological Society Medal, membership in the National Academy of Sciences, and other awards (Table 7). In all ways, UCMP has been a success story.

TABLES 7A–E. UCMP affiliates who were Presidents and Awardees of Paleontological Societies and the National Academy of Sciences.

A. Paleontological SocietyPresidents and Medalists

UCMP Paleontologist	*UCB Ph.D. in Paleontology*	*PS President*
John C. Merriam, Professor & Director		1917
William D. Matthews, Professor & Director		1922
Ralph W. Chaney, Professor & Director		1939
Chester Stock, past student	1917	1945
J. Wyatt Durham, Professor	1941	1966
James W. Valentine, Professor		1974*
Warren O. Addicott, past student	1956	1980
Jere H. Lipps, Professor & Director		1997
UCMP Paleontologist	*UCB Ph.D. in Paleontology*	*PS Medal (Instituted 1963)*
Ralph W. Chaney, Professor & Director		1970
J. Wyatt Durham, Professor	1941	1988
Daniel I. Axelrod, past student	1938	1990
Malcolm C. McKenna, past student	1958	1992
James W. Valentine, Professor		1996
Jack A. Wolfe, past student	1960	2000

B. Presidents of the Society of Vertebrate Paleontology

UCMP Paleontologist	*UCB PhD in Paleontology*	*SVP President*
Charles L. Camp, Professor & Director		1945
Chester Stock, past professor and student	1917	1947
R. A. Stirton, Professor & Director	1940	1950-51
Joseph T. Gregory, Professor & Director	1938	1957-58
Samuel P. Welles, Museum Scientist & Director	1940	1961-62
Paul O. McGrew, past student	1935	1967-68
Donald E. Savage, Professor & Director	1949	1971-72
Theodore Downs, past student	1951	1972-73
Wann Langston, Jr., past student	1952	1974-75
Malcolm C. McKenna, past student	1958	1975-76
S, David Webb, past student	1964	1978-79
Richard H. Tedford, past student	1960	1979-80
Michael O. Woodburne, past student	1966	1988-89
William A. Clemens, Professor & Director	1960	1992-94.

C. Cushman Foundation for Foraminiferal Research President

UCMP Paleontologist	*CFFR President*
Jere H. Lipps, Professor & Director	1976-77* & 2001-02

*Served before appointment to the Berkeley faculty.

D. Members of the National Academy of Sciences

Paleontologist	*Year Elected*
Joseph Le Conte	1875
John C. Merriam	1918
Ralph W. Chaney	1945
F. Clarke Howell	1972
James W. Valentine	1984
Walter Alvarez	1991
Timothy White	2000

E. Palaeontological Association Lapworth Award

James W. Valentine, 2004

Who uses UCMP?

UCMP today is used by a wide variety of people both within and without the University of California at Berkeley. Campus users are the most frequent visitors to the collections and laboratories but the general public experience UCMP constantly through its award-winning web site. In addition, visiting scientists and school groups also come to the museum to examine fossils or hear lectures. Several thousand people actually come to the museum or use its collections in courses or demonstrations each year, excluding the many thousands that attend open houses, lectures and special exhibits. More than 3 million people use the museum's on-line services each month.

Undergraduates

A huge number of Berkeley undergraduate students use the teaching collections and exhibits of the museum in their course work. The courses range from Biology 1 through graduate level courses. For example, Biology 1 laboratory sections use fossil brachiopods in exercises in cladistics, others use the *Tyrannosaurus rex* exhibit (Fig. 1) to learn about function and locomotion in animals. In Integrative Biology 158 and Environmental Sciences and Policy Management 107, "Biology and geomorphology of tropical islands", taught at Berkeley's Gump Research Station on Moorea, French Polynesia, a collection of various mollusks, corals and foraminifera from the reef and lagoon at Moorea are studied by juniors and seniors to learn to identify them before the students try to do it in the field. All paleontology courses use the teaching collections as well (vertebrate paleontology, invertebrate paleontology, marine micropaleontology, and paleobotany). Similar teaching collections have been provided to other campuses of the University for the use of their students as well. Undergraduates also occasionally do research for senior thesis in the museum collections.

Researchers

UCMP Faculty Curators and Museum Scientists, and graduate and undergraduate students associated with faculty all use the collections and laboratories for research. In particular, graduate students associated with Faculty Curators use the collections and facilities of the museum in their academic work, and their dissertations and theses materials are deposited into the collections and copies of their works are placed in the museum's library. Part of the job of faculty, Museum Scientists and students is collections development and conservation, and they have accumulated and curated by far the majority of the collections as part of their research activities. They have worked on all continents in rocks of all ages, with the result that all of this activity for more than a century has resulted in thousands of scientific publications that have documented the history of life in California, the United States, and much of the rest of the world.

In addition, other faculty, both at Berkeley and other UC campuses, and visiting scientists and graduate students from around the world use UCMP and contribute materials to it. Some faculty at other campuses of the University of California or of the California State University system collect fossils, and curate them into the UCMP system for permanent deposition, even though they retain the collections at their own campus for their and their students use. Specimen loans are made to scientists at other institutions as well. UCMP also has a teaching function, in which a good deal of effort is expended on the development and maintenance of teaching collections used in departments at Berkeley and some other campuses. The collections are open to anyone with a need to study fossils.

The Public

UCMP has a very strong public and kindergarten though college outreach program. Parts of this program started years ago, as the staff realized that UCMP had a unique appeal to the general public, but a concerted effort started in the early 1990s to reach very large numbers of people, teachers and students. Now UCMP has a diverse outreach program, including teacher workshops, lecture series, curriculum development, K-12 tours of the museum, an annual open house, and an award-winning website. These activities service thousands of people with general interests and teachers and students in K-16 grades, as well as Berkeley students. The UCMP website (*www.ucmp.berkeley.edu*) contains more than 10,000 pages of information about paleontology, geology, evolution, biodiversity, and history of science as well as K-12 teaching materials. It is now accessed about 3 million times a month from over 700,000 different domain names. This web outreach started in 1993 when graduate students noticed that a new internet format was being introduced, the World Wide Web. Immediately, the museum organized its own site, which was one of the first 50 or so on the Internet. Since then, an outreach staff was hired and grants were received to develop an extensive on-line outreach program. This has been designed and developed not only by the staff but also the efforts of many graduate students. It is still one of the top sites on the WWW for which UCMP has won many awards. UCMP opened two new websites this year. *The Paleontology Portal* (www.paleoportal.org), in collaboration with the Paleontological Society, the Society of Vertebrate Paleontology, and the U.S. Geological Survey, and funded by the National Science Foundation, will provide access to information about geologic time periods, paleoenvironments, and ancient life in particular geographic regions. The second site *Understanding Evolution* (*http://evolution.berkeley.edu*), funded by the National Science Foundation and the Howard Hughes Medical Institute, assists teachers, their students, and the general public to better understand the processes, patterns, and importance of evolution. In *Explorations Through Time* (*http://www.ucmp.berkeley.edu/education/explotime.html*), funded through NSF-funded Instructional Materials Development, combines the scientific expertise of UCMP with teacher professional development to make a series of interactive, inquiry-based digital modules used in classrooms. These activities are assisted by an advisory board of teachers that help develop, pilot and evaluate programs designed for the K-12 classroom.

UCMP also has a long history of providing professional development opportunities and classroom resources for teachers in the natural sciences. These include annual short courses for teachers and workshops in local school districts as well as at annual meetings of the California Science Teachers Association, the Geological Society of America, the American Geophysical Union, and the Society of Vertebrate Paleontologists, for a combined audience of more than 600 teachers annually. UCMP's short courses, lectures and field trip for teachers and the general public provide the latest information on a wide variety of topics — evolution, history of California, geology of the west, and history and environment of San Francisco Bay, as examples. Usually these programs take place on a weekend with lectures on Saturday and field programs on Sunday. These have included topics ranging from evolution through the history of San Francisco Bay to field trips on the Bay and the geology of a vineyard in the Napa Valley. On occasion the museum has sponsored, sometimes in conjunction with other University units, field expeditions that are open to interested people. For example, expeditions to Montana and Alaska dinosaur beds, the oldest animals on the White Sea, Russia, and fossils from Israel have been very successful.

For decades, the museum has held open house one weekend each year. In the past, they were special days designated by UCMP, when the collections, preparation and particularly outstanding fossils were demonstrated to the public. Since 1995, these UCMP open houses have taken place as part of Cal Day, the general campus open house. Thousands of people tour the campus, and many of them come by UCMP to see the latest in fossil discoveries and research.

Exhibits are a small part of UCMP's activities, largely for lack of space and the academic environments where it has been housed. Nevertheless, a few exhibits have always been part of UCMP. Currently, the museum displays a few outstanding fossils in the foyer of the VLSB, including a *Tyrannosaurus rex* (Fig. 1). The *T. rex* is a cast, an exact replica in foam and plastic, of a very complete specimen collected in Montana by a Museum of the Rockies team, which included UCMP people. The cast, standing in the circular stairwell of VLSB, is seen by hundreds of school children and thousands of other people each year.

When will UCMP go extinct?

Because the museum maintains large collections, has a significant endowment, and supports so many diverse and important activities for so many people, it is a permanent part of the University of California at Berkeley, as it has been for many decades. As paleontology in general expands into environmental analyses, conservation biology, astrobiology, biometrics, biodiversity, and other emerging new fields where it can make a contribution, it will continue to fulfill an important role in the university and general public. Its preeminence in the field should continue unabated! UCMP should survive for many more decades.

Acknowledgments

In spite of a wealth of help and information on various aspects of UCMP and its history provided by many people, I have decided for this article to restrict myself to published accounts and archived images. Much remains to be documented by discussions with past and present faculty, staff and students, study of oral histories, manuscripts, letters, and administrative documents, but that would result in a rather long book! Nevertheless, I am indebted to many people for assistance of various sorts in gathering the information I used here. In particular, I am indebted to Professor Joseph Gregory for his series of UCMP History articles in the UCMP News and discussions with me. Among the Faculty Curators, past and present, I thank William Berry, William A. Clemens, the late J. Wyatt Durham, David Lindberg, and the late Donald Savage, and, from among the Museum Scientists and Paleontologists, the late Sam Welles, Diane Erwin, Kenneth Finger, Mark Goodwin, David Haasl, Pat Holroyd, and Howard Hutchison for interesting discussions and pointers about the history of UCMP and help locating various materials, fossil and otherwise, that clarified much of what has been written. Cheri Branson, Judy Scotchmoor, David Smith, Robin Walker, Colleen Whitney, Lorraine Cazassa and Sarah Rieboldt provided assistance in finding or acquiring images, books and letters, while former UCMP student Edward Mitchell (Ph.D. 1967) told me much about his oral history of Charles Camp, now housed in Berkeley's Bancroft Library, and other sources of historical information. I was also privileged to talk with Vanderhoof at the Santa Barbara Museum of Natural History in 1960, Ruben Stirton when I was an undergraduate visitor to UCMP in 1962, and Robert M. Kleinpell in 1968. Those memories kindled other leads and made this paper all the more interesting for me to write. Susie Lipps helped me in many ways including the location of Joseph LeConte's grave and information about his relatives. I thank all of these people and A.E. Leviton and M.L. Aldrich of the California Academy of Sciences for organizing the symposium that resulted in this volume and for their incredible patience.

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In Search of Relevance: The Museum of the Twenty-first Century

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Natural History Museums are among the most beloved of our cultural institutions. They help preserve our heritage, explain our traditions and inspire our dreams and hopes for the future. But the future of museums, under threat from a number of outside forces, is in doubt.

Relevance is a broad term when it comes to cultural institutions. Museums, like all cultural institutions, are both products and creators of their cultures. A museum today is more than a repository for artifacts — it must hold meaning and resonate with the issues that matter to ordinary people. By far the most difficult task a museum has is to define its place and its role in the complex changing nature of contemporary culture.

Even though museums are a relatively recent cultural development, they have served to capture and communicate the intrinsic wonders of the natural world. Natural history museums have, over time, procured an edited collection of objects from the natural world and made them available to the community.

As our species progressively becomes physically and emotionally removed from the day-to-day contact with what we refer to as nature, this role has taken on added importance. The natural world is under increasing threat from humans and it is incumbent on institutions to make a stronger commitment to the future.

Future shock

In order to talk about the museum of the twenty first century, one must consider possible developments in the coming decades. Predictions of the future are risky, but some relatively safe assumptions gathered from a number of diverse sources help to illustrate some mega-trends:

> By 2025, when today's kindergartners have kindergartners of their own, the U.S Population is expected to grow 25% to 350 Million, an increase of 70 million people.

Overcrowding, loss of natural spaces and resources, and intense competition for decreasing wealth will contribute to global debates about planning and management of human cultures.

This population growth will combine with increasing diversity to create an ever-growing list of market segments. By 2025, by far the biggest segment of the population will be over 65. The number of seniors will double, to 70 million, and they will define themselves not by their age but by their activities, values and interests. Echo-boomers, the children of the post war generation, will be almost as large a segment of the population. Seniors and young adults will dominate the marketplace and the cultural landscape for the next several decades even as they continue to age.

Our future as a species will depend in large part on the future of scientific knowledge and our ability to assimilate that knowledge into the cultural gestalt.

The biological and cultural diversity of the planet is being lost faster than it is being described. According to Stanford professor Paul Ehrlich, the inquiry into biodiversity must extend also to population and ecological diversity. This seems a real possibility with science becoming more interdisciplinary. Cross-over fields of study are becoming the norm rather than the exception. There are several emerging examples of inter-disciplinary sciences that merge formerly separate fields of study in physics, chemistry, biology, anthropology, psychology, sociology and medicine. A few examples are: Astrobiology, evolutionary biology, molecular biology, conservation biology, developmental psychology, information theory, artificial intelligence and various branches of neuroscience. It may not be an exaggeration to say that the natural sciences are in the midst of a major transition.

Not unlike the revolution that occurred in the physical sciences at the beginning of the twentieth century, that lead physics to a completely new vision of the world of fundamental matter, this new biological view of what life is and how it works may similarly transform our perception of the living world.

At the same time, inquiries into complex systems on the macro scale are revising the scientific view of ecological relationships within the natural world. What we have is an emerging picture of a dynamic interrelated web composed of living and non-living systems, and this view is producing a sea change in perceptions about the human relationship with the natural world. The true implications of science will be to transform how we see ourselves.

Globalization of transportation and communication technologies will shape entirely new cultures

Human cultures are no longer limited by geography. A global transportation infrastructure is facilitating inter-cultural migrations at an unprecedented rate.

Inter-cultural exchange is a daily occurrence in most large cities, but it's not uncommon in smaller towns and remote village. The media are full of images that illustrate the global blending of cultures.

Meanwhile, communications technologies are advancing at an unprecedented rate. According to Moore's Law, the speed of computers doubles every eighteen months. Through rapidly advancing technologies — satellite communications and the Internet — a globally connected human population is becoming a reality via In the coming decades, successive technologies will create seamless real-time streaming information from anywhere to anywhere.

Today there are hundreds of media channels that cater to every interest. As personalized information proliferates we may increasingly find the population simultaneously divided into small specialized segments and unified into large connected communities.

Here's the question—as the population grows, as our local cultures become more diverse, and our global cultures more alike, can the personalization of museums be far behind?

Before examining that let's look at another issue — public science literacy.

Dumb and Dumber

People today are relatively less knowledgeable about the sciences than they were a generation ago.

In survey after survey, the level of science knowledge and general awareness of scientific information is in decline. At a time when many of our everyday decisions require a working knowledge of the physical and biological sciences, people harbor gross misconceptions, and what's worse; those misconceptions are often reinforced in the popular media, where most people get their information. And the future looks bleak — scientific literacy among school children, especially in California has plummeted.

In 1991 the American Association of Museums published a report entitled *Excellence and Equity,* in which they present an expanded definition of museums' educational role. This report, and I quote:

"…speaks to a new definition of museums as institutions of public service and education, a term that includes exploration, study, observation, critical thinking, contemplation, and dialogue."

A dozen years after that study, we have to ask ourselves why so much of the U.S. population is scientifically illiterate when people have access to more science and natural history museums, aquariums and planetariums than ever before? Does this lack of literacy imply complacency about the issues confronting the natural world and the future of human societies?

It seems there is a dichotomy here. On the one hand there exists a backlash against science, mostly from religious fundamentalists, while on the other, there is a kind of blind faith that science and technology will be able to solve all our problems in some imagined future.

Museums, to truly be relevant have a responsibility to counteract these misconceptions and to provide a forum for dialogue on the major issues of our day — dialogue that allows for a diversity of viewpoints.

Edu-Tainment and other Daydreams: Why they do (and don't) come

At a time when the dissemination of scientific information is most needed, museums are in danger of becoming irrelevant.

The public today is underserved by the kinds of exhibits typically found in museums. While people do go to museums, for a variety of reasons, there is evidence that museum experiences are not fulfilling their potential. People who study market trends are beginning to see some major shifts in public values — a large segment of the population is becoming less materialistic and more mindful of life's other qualities. Education, the environment, peaceful resolution of global conflicts, and social justice are all issues that are high on the list of people's concerns. Consumers are demonstrating a marked interest in paying for unique experiences.

On the surface this should be good news for museums — so why are so many science museums suffering? Maybe it's because they aren't competing with a product the public wants.

The competition for people's leisure time is more intense than ever and that trend will continue.

Competition is impacting almost every leisure industry. Attendance is down at theme parks, movie theaters and museums. Sales are off for many retailers. Even major sports franchises are seeing a decline in ticket sales and television revenues. Whether people have more or less leisure time today is irrelevant — the market for leisure activities is saturated and the financial stakes are high for those in the various industries competing for our time, attention and dollars.

Museums are behind the curve in providing and marketing attractive experiences for potential audiences.

Some years back journalists coined the term "edutainment" to describe attractions that wrapped educational content in an entertaining presentation. It was applied to museums and also to big brand retailers who leveraged their intellectual property to sell products. There was a frenzy of investment in flagship stores and museum exhibits that attempted to grab visitor attention by capitalizing on popular culture. Various museums have mounted exhibits on topics ranging from Jackie O's gowns to the history of motorcycles. The Field Museum currently has a traveling exhibit on Chocolate. Aquariums have exhibits that resemble zoos and planetariums have resorted to Star Wars-like shows to attract dwindling audiences.

It sometimes seems that museums are self-conscious about the topics and implications of science. Advocacy is a dirty word in the museum world. But by not serving as advocates on issues of importance, museums inadvertently perpetuate the ignorance they are trying to erase. Science museums have not been very successful in promoting the sense of wonder and discovery about our world that propels scientists and science itself. They have not excelled in the medium of story telling. They have not connected science with the human stories that resonate with ordinary people. The interaction of culture and nature can be told from almost every conceivable perspective. The discoveries at the edge of science, the incredible origins and evolution of life, the global spread of human cultures and potential collapse of natural ecosystems — these are all high drama! This is relevant content, but with few exceptions, museums haven't addressed these stories with the kind of creative energy and compelling presentation the public wants. They've been content instead to present the world in boring textbook monologue or as dumbed-down entertainment.

What are the alternatives to death by irrelevance?

The Evolution of Content

We are living in an age where content is king and intellectual property is the kingdom.

Natural history museums are wealthy — their assets are their intellectual property — the collections, archives and knowledge they contain. Intellectual property is like the equity in your house; it can be leveraged to improve your circumstances.

Today there are museums about nearly every topic from UFO's to Elvis to trailer park memorabilia. Museum spaces have been allocated to the work of fashion designers, car makers, agribusiness corporations, glass makers, sporting goods companies, radio and television. There are museums in airports, office buildings and national parks.

The trend in museums, not surprisingly, echoes commercial trends — catering to and nurturing niche markets. The fragmenting of the marketplace into ever more specific niches with information available to every interest will probably continue as long as it is profitable. Today's technologies have enabled a consumer-driver marketplace where personalization and customization are becoming the norm. This has spawned a new generation of self-expression among consumers who now expect and demand personalized information, products and experiences. The resulting demand for content is enormous.

Unfortunately, many museums are not prepared to deliver on those kinds of demands and expectations. They are not organized the way their commercial competition is. They don't have the tools for rapid response, and frankly don't attract the kind of non-scientific talent to create compelling material. Non-research museums don't actually own assets and must rely on others for raw content. There is a shake-out coming and it remains to be seen where the leaders will emerge.

Here's a prediction: Exhibits, as we know them today
will be obsolete in ten to twenty years.

In a few decades, even a museum being built today will have changed to the point of being largely unrecognizable. The building will be there but the content will be very different from anything we find today. This may be a disturbing thought to many scientists as their imagination conjures up science theme parks and multi-media motion-simulation immersion theaters — the Disneyfication of science. But the kind of change coming in content will be in both style and substance.

Museum content will reflect the integration of the sciences as holistic comprehensive stories designed not for the transfer of knowledge but as a tool for understanding. New research into learning processes and learning styles are already having an impact on how some forward looking institutions develop programs.

In the coming years new communications tools will change the way information is conveyed and received. Data networks will reshape the way the smart museum will detect and respond to visitors' interests, assisting them to assemble information in self-directed story making. The visitor experience will be dialogical rather than didactic. The use of symbolism and suggestion will reinforce objects, facts and data. Rather than attempting to communicate or "push" messages the new museum will facilitate inquiry and exploration, allowing the visitor to "pull" meaning out of the objects and information. This will put more control over the experience in the hands and minds of museum visitors.

Museums will strive to identify and connect with universal human values: compassion, responsibility and community. Content emphasizing respect for living things and concern for healthy natural systems will overlay the more traditional information offering. Activities will facilitate social interaction and provide a forum for meaningful exchange of ideas. Program materials will engage visitors emotionally as well as physically and intellectually.

Museum content will be available through multiple channels, both physical and virtual.

As the Internet and its successors create new and highly sophisticated virtual domains, museum buildings will assume reduced importance in the exchange of ideas. The same will hold true for schools, banks, libraries and other location-based public services. Many of these facilities will survive, simply because the emotional connection to Place seems ingrained in our consciousness, but the ease of access to content will make them less relevant from a functional point of view. We'll want to know they are there but we won't depend on them.

People will be able to browse content on demand. They will have the ability to cast wide or delve deep. They will have information filtered and delivered based on their own preferences, an outgrowth of something called collaborative filtering that exists today and is employed by a number of on-line providers of product and information services. Think of your web browser homepage on hyper-drive and totally mobile.

But just as E-tailing has not replaced retailing, digital museum content will not replace the desire for contact with the primary assets of museums — the objects available in the grand spaces that house them. People will want to visit their familiar icons and will at the same time expect to find the new and current, the unique and unusual surprises, the Next Big Wow. The public's appetite for great experiences will grow along with its expectations.

By now anyone involved with producing museum programs is seeing big dollar signs floating in front of them — the financial implications of the evolution of content are huge.

Where will the money come from?

Museums are already flirting with sources of funding outside of the traditional realms of private individuals, foundations and government grants. Corporate sponsorships of halls and exhibits are becoming commonplace. Could this trend lead to corporate influence over content? If we suppose that museums become increasingly reliant on corporate funding and if other funds continue to become scarce, will the only alternative be to essentially sell off the rights to intellectual property to support programs?

While this seems far-fetched right now, look at what is happening today in big media. Consolidation is the name of the game. The FCC is entertaining a proposal to allow for more control of the mass media by fewer entities. Will the intellectual property of scientific institutions become another commodity vulnerable to acquisition? What's the alternative? How can museums protect their assets?

The Museum of the Twenty-first Century: A Collaborative Network

Museums as singular institutions could band together in collaborative partnerships to produce and distribute content.

In order to serve the public, maintain their integrity and attract visitors, museums might form networked communities of information/ experience providers, sharing everything from specimens, space and even staff expertise. More importantly they could share the cost of producing and distributing content. They could form content production companies to leverage resources and produce product. They could consolidate power to resist the incursion by others who would seek control of their assets.

Outwardly, to the visitor, there would still be the California Academy of Sciences, the American Museum of Natural History, the Field Museum, the Smithsonian, along with all the smaller regional museums, some with research facilities, some without. The collaborations will occur in the utilization of assets on both the research and public sides as museums eventually get their assets data-based and develop sharing protocols that allow for common use of data, images and even specimens. As specimens become catalogued and digitally stored, the need to conserve them in their physical form may become less critical, enhancing their availability as objects of display. The digitized images and data will become an important part of the array of content available to the public. Museum collaborations will develop new content products and will partner with existing media companies in need of that content. All of this will require new organizational structures that can facilitate broader production and distribution of content while protecting intellectual property rights.

Those institutions that recognize these trends and plan accordingly will position themselves as the leaders for the future.

New enterprise-based organizations will provide needed support for the current endowment structure of exhibit funding. The museums of today that recognize this eventuality and begin to formulate organizational and programmatic plans incorporating an enterprise mind-set, and search out and maximize opportunities that support it, will be the ones who will emerge as leaders in the twenty-first century. Endowments, grants and donations will continue to play a major role in funding museum programs. The additional revenues available through the leveraging and sharing of core assets and intellectual property will help to support quality, marketable products. To effectively compete in the crowded marketplace, museums will need to re-think the nature of their organizations, re-frame their missions and align their resources.

Developments that influence and mold all of our cultural institutions will continue to unfold

— developments that cannot possibly be foreseen today. One of the attributes of success for any institution will be its ability to adapt to changing circumstances — to anticipate major trends and have in place the organizational and creative tools to respond.

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Opening a New Natural History Museum in Twenty-first Century America: A Case Study in Historic Perspective

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The great natural history museums of America were built in the latter half of the nineteenth century around two basic purposes: to house collections of specimens for use in scientific research, and to enlighten the general public about the natural world and humans' place in it. No major non-university natural history collection has ever succeeded in America without a major public education role. As natural history museums enter the twenty-first century, they face essentially the same challenges they always have — providing service to and deriving support from this very broad spectrum of users, from society at large to the general public to students at various levels to professional scientists. Although much has changed in society, science, and the culture of museums over the past 100 years, the institutional and intellectual structure, mission, and justification for natural history museums in America have changed surprisingly little. The challenges and opportunities confronting these museums today are, in a way, unprecedented, but in another have always been inherent in their nature.

The Paleontological Research Institution spun off from Cornell University in the 1930s and survived through much of the century as a tiny independent enclave serving mostly scientists. Over the past decade, however, it has reinvented itself and in late 2003 opened a major new public exhibit facility, the Museum of the Earth, based on many of the same premises — and facing many of the same challenges — as the great natural history museums of a century ago. While this new museum will serve mainly visitors from the northeastern region of the country, it is also intended to allow its parent institution to assume a larger national role in both public education and scientific research in the future.

If you were designing a natural history museum from scratch, what would you do? Where would you start? Would you focus on exhibits, education, collections, research? What would the right balance among these be? These questions have not been answered very often over the past century, as very few new major natural history museums have been established during this time. The "golden age" of starting natural history museums in America was the second half of the nineteenth century, a fact that might suggest caution to anyone considering doing so in the early twenty-first century. Yet this is precisely the situation in which the Paleontological Research Institution (PRI) found itself in the early 1990s. After six decades of building a major fossil collection and publishing well-respected scientific journals, it sought to expand its mission to include greater service to a wider public. PRI approached this task philosophically and historically by asking what a natural history museum is and what it is for. This exercise led the Institution to the conclusion that, far from being a dusty anachronism, the modern natural history museum is a vibrant, relevant, coherent intellectual enterprise consisting of an inextricably interconnected and mutually reinforcing nexus of collections, research, and public outreach. These functions are inseparable, and one cannot exist without the other two. Although much has changed in science, education, and society over the past century, the natural history museum (whether international, national, or regional) remains as essential a part of the modern cultural landscape as it was when their great period of establishment began in the nineteenth century. This paper tells the story of the historical exploration that PRI undertook and the lessons that it learned as it examined its own mission and built the Museum of the Earth.

What is a Natural History Museum?

Use of the word "museum" for a place "devoted to the procurement, care, study, and display of objects of lasting interest or value" (*Webster's New Collegiate Dictionary* 1974) is a relatively modern convention.[1] The word "museum" comes from the Greek *mouseion*, meaning a "place or seat of the Muses," that is, a place of inspiration, creativity, and knowledge.[2] The Latin word *museum* (or *musaeum*) referred more generally to a place for learned occupation. The great library and university at Alexandria, Egypt built by Ptolemy Soter (372–283 BCE) is generally cited as the first "museum" in this sense. The word does not appear to have "had any independent meaning of its own" during the Middle Ages (Findlen 1989:61; see also Alexander 1979). As the Renaissance began, "museum" began to refer not just to a collection but of knowledge but to a collection of objects that represented knowledge. This shift from a very broad concept toward one focused on objects occurred gradually during the sixteenth and seventeenth centuries, and was linked to two important elements of Renaissance humanism — encyclopedism and the connection between knowledge and real objects (Findlen 1989, 1994). By around the middle of the seventeenth century, "museum" had come to refer most frequently not just to a collection, but also to a physical place in which were stored objects from nature or human culture and works of art, historical artifacts, or natural curiosities (Findlen 1989). Initially, these storage places were pieces of furniture and eventually whole rooms in the homes of wealthy individuals, who called them "cabinets of curiosities", *Wunderkammern, Kunstkammern*, or (increasingly) "museums" (Impey and MacGregor, 1985; Yanni, 1999). Those of Ferrante Imperato in Naples (1599) and Ole (or Olaus) Worm in Copenhagen (1655) are among the most well-known and frequently illustrated (see Schepelern, 1989). These very early museums were important not only because they assembled collections of objects arranged in a particular way, but also because they "established specific places for studying nature" (Yanni 1999:23).

By the end of the seventeenth century, museums were changing from strictly private and exclusive domains to public institutions. The first museum to explicitly announce its public and institutional status was the Ashmolean Museum at Oxford, which opened in 1683, based on the collections of John Tradescant and his son (Alexander 1979; Findlen 1989; Yanni 1999). The British Museum, the first true "national" museum, opened in 1753, in Montagu House (the home of the Earl of Halifax), to hold the collections of Sir Hans Sloane (Alexander 1979; Yanni 1999:24).[3] Thus, by the eighteenth century, the word "museum" had come to combine two meanings, describ-

[1] The American Association of Museums has defined a museum as "an organized and permanent non-profit institution, essentially educational or aesthetic in purpose, with professional staff, which owns and utilizes tangible objects, cares for them, and exhibits them to the public on some regular schedule" (AAM, 1973, quoted in Alexander, 1979, p. 5).

[2] The Muses were the nine goddesses of poetry, music, and the liberal arts. "They are called Muses," wrote Jaucourt in the entry under "Musée" in his *Encyclopédie* (1765), "from a Greek word which signifies 'to explain the mysteries', μὺειν, because they have taught men very curious and important things which are from there brought to the attention of the vulgar" (quoted in Findlen 1989:60).

ing a place where collections of objects were housed, cared for, and made available for study and public exhibit and a center of storage, scholarship, and public education.

The term "natural history" has an equally long and complex etymology. In the eighteenth and nineteenth centuries it meant essentially the study of all objects and phenomena in nature. The first edition of the *Encyclopedia Britannica* (1771) defined "natural history" as "that science which not only gives compleat descriptions of natural productions in general, but also teaches the method of arranging them". In 1802, John Playfair (famous as the popularizer of the "father of geology" James Hutton) described natural history as "the branch of knowledge which collects and classifies facts [in] the three kingdoms, the mineral, vegetable, and animal." This usage, however, is somewhat puzzling: if it is simply description and classification, why call it "history"?

The answer lies in the term's distant past. The earliest use may have been by Pliny the Elder (Caius Plinius Secundus, 23–79 CE) in his 37 volume work *Historia Naturalis*. There, Pliny said, his purpose was "to give a general description of everything that is known to exist throughout the earth". Pliny's use of "history" for this field of inquiry, however, may come from the even earlier work of Aristotle (384–322 BCE), whose *Historia Animalia* included descriptions of much of what was then known about animals, including their form, habits, and reproduction. Aristotle may have used the word "history" for at least two reasons: first, he saw all life as connected to a "great chain of being", a system of connections that implied temporal continuity. Second, although no evolutionist in the modern sense (Mayr 1982), Aristotle was much impressed by a sense of motion in all animals — an unfolding during embryology, a realization of potentialities (Nordenskiöld 1928); in a word — history. Organisms, thus, were seen to come from something earlier, not from nothing; they have histories. This theme (and even the title) is repeated fifteen hundred years later in the works of early "natural philosophers" such as Conrad Gesner (*Historia Animalium*, 1551) and John Ray (*History of plants,*1686; *History of fish,*1686; *History of insects,*1710), reaching its acme in Georges Buffon's 44 volume masterwork *Histoire Naturelle* (1749–1804).

It is not coincidental that Ray, Buffon, and others of similar interests set the stage for Lamarck and Darwin in the early nineteenth century (Bowler 2003). Evolutionary biology (and the closely related disciplines of paleontology and historical geology) rely at their heart on the notion that things in the natural world have *histories* — that they have not been created from nothing in completely their modern form, and that these histories leave records in the shapes of natural objects. The ancient classical authors and their Enlightenment descendants thus recognized the need for history even if they did not grasp the mechanisms by which it is played out.

Even while "natural history" was at the forefront of what would eventually be biological science, it also began to be connected to a more popular pursuit of description of nature. Beginning with Gilbert White's enormously popular and influential *Natural History of Selborne* (1789) (see e.g., Daniel 1985), a tradition of practice, as well as a literary genre, developed of avocational description of local nature by non-professionals (Barber 1980; Merrill 1997). This natural history "did not emphasize objectivity, but rather reveled in the pleasures and the romance of nature" (Rainger 2001:12). It is this tradition, as well as the shifts of biology and other sciences toward experimentation and away from pure description (e.g., Reingold 1964; Bruce 1987; Mayr 1982), that are responsible for the more pejorative usage of the term "natural history" that has become common in the late twentieth century. Modern dictionaries define it as "the study of natural objects esp. in the field from an amateur or popular point of view" (*Webster's* 1974) or "the study of these sciences [botany, zoology, etc.], esp. of a non-technical nature" (*Random House Dictionary* 1975).

[3] Peter the Great of Russia (1672–1725) had a great interest in collecting curiosities and opened a state-supported, nominally "public" museum in 1715 in St. Petersburg, although this may have been more of a royal cabinet (see Impey and MacGregor 1985; Asma 2001).

Coming out of this usage, the use of the term "natural history" has more recently expanded to applications of the (somewhat analytical) description of almost anything (e.g., Ackerman 1990; Fisher 1995; McMillan, 2002), further diluting its scientific credentials.

Yet, despite the "old fashioned" and obsolete reputation that natural history acquired in many quarters over the past century, the approach of the natural historian has been and remains essential to biology. Natural history is much more than "mere description"; it is the area of human endeavor that takes as its goal the understanding not just of how natural phenomena work, but where they came from (e.g., Bates 1950). The central method of natural history is comparison, and the "comparative method" lies at the heart of all historical science (e.g., Harvey and Pagel 1991). In order to pursue comparison, adequate data are of course required, and those data originate in description, are organized by classifications, and are vouchered by museum collections. Natural history has, furthermore, always been concerned with the diversity of life, the exploration of which, as discussed in more detail below, is now of paramount importance to biology as a major biodiversity crisis is upon us (see, e.g., Wilcove and Eisner 2000).

More generally, natural history fulfills the need to see nature as a unified whole. When Charles Darwin was on the voyage of HMS 'Beagle', he was once ashore in South America and introduced to a local military commander as a "naturalist". When the soldier asked what a naturalist was, the translator, who had some knowledge of the kinds of things that Darwin had been doing on the voyage, said that a naturalist is "a man that knows every thing" (Capt. Robert Fitzroy's journal, quoted in Darwin, 1962:82). The definition embarrassed Darwin, but was strikingly accurate. Naturalists — scientists who study natural history — must think about, if not "know", just about everything, from genetics to geology, because in seeking historical causes for things all parts of the Earth are connected (e.g., Allmon 1993; Wilson 1994, 1998).

A Historical Perspective

How did the essentially European notion of the natural history museum become realized in this country? What were the central elements of American natural history museums? These were crucial questions as PRI struggled to envision what a new public museum should look like. We examined the individual histories of eight of the largest American natural history museums established during the nineteenth century.[4] We wanted to know how these institutions in their early years balanced the separate missions of collections, research, and public education, and what, if anything, we could learn from this history that might guide us as we designed our new museum.

The Academy of Natural Sciences: The Academy of Natural Sciences of Philadelphia was founded in 1812 in order to achieve intellectual independence from the city's botanically-oriented Linnaean Society. It was also distinct from the American Philosophical Society, which encouraged the arts as well as science, and from the museum of Charles Willson Peale (1741–1827), which, despite Peale's aspirations to make it the national museum of the United States, was viewed as aimed primarily at mass education and entertainment (Alexander 1979; Sellers 1980; Semonin 2000). The original purpose of the Academy was thus not explicitly public, and its early member-

[4] This paper focuses on the early history of natural history museums in America. The history of such museums in Europe is somewhat different. Almost all European museums were wholly or mostly state-sponsored. American natural history museums, furthermore, were, from the very beginning particularly and explicitly focused on public education as one of the several major reasons for their existence (see, e.g., Burt 1977; Alexander 1988, 1997; Orosz 1990; Kohlstedt 1995; Conn 1998), to a greater degree than their European counterparts. The decision to focus only on museums founded in the nineteenth century was an arbitrary one. Several major natural history museums were founded in the early twentieth century in the U.S. (e.g., Natural History Museum of Los Angeles County).

ship was very small. This changed, however, when a series of public lectures was established. In 1815, the treasurer reported that these lectures had caused the Academy to rise "into public notice, has attracted the attention of strangers and has established for [the Academy] a character and reputation far exceeding our most sanguine expectations" (Gerstner 1976). In 1828, the Academy opened its first public exhibit hall for "two half days in every week for citizens" as long as they held a ticket signed by a member of the Academy. The opening of the Academy's public exhibit space has been said to mark "the beginning of museum-based natural history in this country" (Conn 1998:38).

The decision to open a formal public exhibit space was a logical outgrowth of the Academy's earlier experience with public lectures, but was also probably a result of the influence of William Maclure (1763–1840), a successful businessman, avocational geologist, and philanthropist interested in public education (Stroud 1992:31). Maclure not only encouraged the Academy to expand its role in public education but also donated funds, as well as thousands of volumes to the Academy's library. The shift was probably a crucial one:

> The relatively early trend toward public involvement in the Academy through its museum may have been a factor in the survival of the Academy through the first half of the nineteenth century, when other societies rose and then disappeared with some frequency . . . . The tendency after 1850 to emphasize the museum at the Academy suggests that the [public] museum may have been looked upon as the road to long-term survival and security. (Gerstner 1976:63.)

The Smithsonian Institution: When Englishman James Smithson died in 1829, he left a bequest "to the United States of America to found at Washington, under the name of the Smithsonian Institution, an Establishment for the increase and diffusion of knowledge among men." Yet it was not until 1846 that Congress finally approved establishing such an Institution. Much of the delay was due to controversy over what type of entity it would be: a library, a national university, a research institute, or a national museum (Kopper 1982; Rivinus and Youssef 1992). Under its first Secretary, Joseph Henry (1797–1878), arguably the leading American scientist of the day, the Smithsonian emerged as essentially a research institute, emphasizing pure research rather than public education and collections, and Henry resisted efforts to make it anything like a national museum. This did not change until Henry's death in 1878, when Spencer Fullerton Baird (1823–1888) became Secretary. Baird was a collector of the first order and established the United States National Museum in 1879 within the Smithsonian as both a repository of collections and a public museum. The Smithsonian as we know it today is essentially the construct of Baird (even though the USNM was officially abolished in the 1970s):

> Today's assemblage of museums and galleries, devoted to memorializing our national achievements and resources and constituting the Smithsonian Institution, is essentially the bequest of Spencer Baird to the millions who visit them annually. Obviously, each of the secretaries who have succeeded him have added elements extending the scope of the Institution far beyond even Baird's dreams. However, the American people are the direct heirs of Spencer Fullerton Baird in their cultural and educational enjoyment of this great national museum complex. This would not have been true had the development of the Smithsonian followed Joseph Henry's interpretation of James Smithson's intent. (Rivinus and Youssef 1992:190.)

Baird employed a young ichthyologist, George Brown Goode, (1851–1896) as his assistant in charge of arranging exhibits for the Philadelphia Centennial Exposition of 1876. Goode went on to become the leading American museum professional of his time (Goode 1888, 1895; Alexander 1979; Kohlstedt 1991; Conn 1998). He held that a natural history museum, especially a "national" museum, should exist to accomplish several functions: to preserve material on which scientific knowledge could be based, to carry on basic research, to be "a nursery of living thoughts", and to educate the visitor by illustrating "every kind of material object and every manifestation of human thought and activity" (Goode 1888).

The California Academy of Sciences: The California Academy of Sciences was founded in 1853 (as the California Academy of Natural Sciences) by seven prominent citizens of San Francisco for the purposes of "a thorough survey of every portion of the State and the collection of a cabinet of her rare and rich productions". The founders clearly thought that there was (or would be) significant public interest in such a venture. "Natural history", read one of the new organization's earliest documents, ". . . has within the last half century attracted the attention of the scientific world; and our own countrymen have shared largely in the general enthusiasm, which is year to year becoming more general and absorbing" (Leviton and Aldrich 1997:12–13). The early years of the Academy were very lean financially and focused mainly on scientific research by its members. At the October 16, 1854 meeting, however, it was resolved "that the Curators examine and report at their earliest convenience whether there are in the Cabinet any surplus specimens which can be spared as donations to a Cabinet for the Public School at North Beach in this city" (Miller 1953:25). The Academy did not open its first public museum until 1874, in a rented church building. In 1873, San Francisco real estate magnate James Lick (1796–1876) donated a piece of valuable downtown property to the Academy and his estate ultimately provided substantial funds as well (Leviton and Aldrich 1997). In 1891, a large building was erected on the Lick property on Market Street; the structure was described as one of the finest public museum buildings in America at the time (Miller 1942). This building and virtually all of the Academy's collections and library were destroyed in the 1906 earthquake and fire; "nothing was saved except what could be loaded into one spring wagon and carted to safety ahead of the fire" (Miller 1942:371). The Academy's present museum complex in San Francisco's Golden Gate Park opened in 1916, with major additions in 1923, 1934, and in the 1950s, 60s, and 70s (with a major renovation currently underway).

The Museum of Comparative Zoology: The Museum of Comparative Zoology (MCZ) was founded at Harvard College by Louis Agassiz (1807–1873) in 1859. Agassiz raised funds for his museum by appealing to Brahmin sensibilities of the relationship between religion, science, morals, and education, and by pitching with masterful skill his peculiar view of this relationship (Lurie 1960). He convinced Boston industrialists such as Francis Calley Gray and Abbott Lawrence, as well as state legislators and College administrators, that the public good could be served by an institution that would not only collect and research, but also present to the general public, the works of the Creator. Even with Agassiz's loss of prestige in the aftermath of the publication of the *Origin of Species*, he remained able to generate support from these sources. The influence of Agassiz and his museum went far beyond its status as a "university museum" (Winsor 1991). He set standards of simultaneous scientific use and public presentation of the collections, and these standards were influential on his many accomplished students, including A.S. Bickmore (founder of the American Museum), S.F. Baird and G.B. Goode (founders of the U.S. National Museum), H.A. Ward (founder of Ward's Natural Science Establishment in Rochester, NY), D.S. Jordan (president of Stanford University), and C.F. Hartt (founder of geology at Cornell University).[5] The extraordinary degree of independence enjoyed by the MCZ for most of its history was further secured when Agassiz's son Alexander (1835–1910), who had made his fortune in copper mining in South America, returned and bestowed upon it a large endowment (Winsor 1991).

The Peabody Museum of Natural History: In October, 1866, banker George Peabody (1795–1869) gave $150,000 "for the foundation and maintenance of a Museum of Natural History, especially in the departments of Zoology, Geology, and Mineralogy, in connection with Yale College" (Schuchert and LeVene 1940:84). The Peabody Museum of Natural History was founded at the urging of and essentially for Peabody's nephew, paleontologist Othniel Charles Marsh (1831–1899). Construction of the Museum was completed in 1876, but of its 34,000 square feet only one modestly-sized room was devoted to exhibits. Only in 1924, when the original Museum had been torn down and a completely new structure completed, was adequate space made available for public exhibition (Schuchert and LeVene 1940). Marsh was largely responsible for the stature of the collections that were ultimately to comprise most of these public exhibits (even if he forbade skeletons to be mounted in life positions). Peabody's bequests paid for Marsh's famous expeditions to the American West and the resulting discovery of skeletons of *Brontosaurus, Stegosaurus, Diplodocus* and *Triceratops*, among others; Peabody also provided for Marsh's salary, and Marsh received no salary from Yale until 1896 (Rainger 1991; see also Wallace 1999; Jaffe 2000).

The American Museum of Natural History: Albert Smith Bickmore (1839-1914) was an ambitious man with few resources or social connections (Preston 1986). After attending Dartmouth and Harvard, he moved to New York City in 1867, where he began to make contact with wealthy patrons who might further his vision of a great and democratic museum for that city. Bickmore envisioned a museum with not only important research collections, but also learning opportunities for the general public. Through his persistence and persuasion, the idea gained the ears of the city's rich and powerful, including Theodore Roosevelt, Sr., Benjamin A. Field, Isaac N. Phelps, Robert Colgate, William E. Dodge, and later and most importantly J.P. Morgan (1837–1913) and Morris K. Jesup (1830–1908). Thus was founded in 1869 the American Museum of Natural History. The cornerstone of the new museum was laid by President U.S. Grant on June 2, 1874. Joseph H. Choate, a prominent lawyer and politician, was influential in obtaining the support of the New York political boss William M. Tweed and Superintendent of Parks Andrew H. Green. From its beginning, the Museum was organized as a public institution that received maintenance and operating expenses from the city's Department of Parks and Recreation (an arrangement still in effect), but private philanthropists on its Board of Trustees were responsible for the acquisition of collections and the management of the institution (Rainger 1991:55). President Rutherford B. Hayes dedicated the Museum in 1877.

The early years of the Museum were financially difficult ones, but this changed in 1881, when Jesup became President (in the same year, Bickmore stepped down as Superintendent). Almost single-handedly, he saved it from its uncertain financial future, and presided over (and in large part paid for) a period of extraordinary growth. Under Jesup's leadership, the Museum established its first endowment to support research and moved firmly in the direction of both education and science, in addition to public exhibition (Alexander, 1979). This captain of industry surprised many when he stressed that the Museum must be dedicated "to something that cannot be measured in the scales of the merchant" (Rexer and Klein 1995:26). Jesup's attitude to the Museum was strongly influenced by his moral and religious fervor. He "infused the institution with his mandate for popular instruction at a critical moment when the appeal of Bickmore's scientific research was waning among upper-class patrons" (Kemp 1990:273). For example, Jesup promoted a project to provide lectures on nature and science to the state's school teachers. The lectures proved so popular that in 1887 an addition had to be made to the building to accommodate the classes. "The program pro-

[5] Agassiz was famous for giving an incoming student a single natural object and telling them that their entrance examination consisted of their adequately describing it. Bickmore's was a sea urchin (Preston 1986:14). Agassiz was also famous for the dictum "study nature, not books" (which he may or may not have said; see McCullough 1991). This philosophy — that natural objects had only to be carefully and patiently observed and described to reveal their secrets — was a widespread one among nineteenth and early twentieth century museum naturalists (see further discussion below).

vided the museum with much-needed exposure and resulted in additional funds from the state superintendent of education and the legislature" (Rainger 1991:58). Jesup's estate eventually left the Museum bequests totaling $6 million.

J.P. Morgan served as Museum treasurer during the 1880's and made large and numerous personal donations of funds as well as a famous gem collection. Morgan was the uncle by marriage of Henry Fairfield Osborn (1857–1935), who joined the staff of the Museum in 1890 and was its President from 1908 to 1933 (succeeding Jesup). With funds provided by Morgan and others, Osborn was able to expand the Museum, and particularly vertebrate paleontology, still further, raising private funds for, among many other projects, the Central Asiatic Expeditions of the 1920's (more than $1 million) and the great mammal life groups in the 1930's ($10–35,000 each at the depths of the Great Depression; see Bodry-Sanders 1991) (Hellman 1968; Preston 1986; Rainger 1991).

The Field Museum of Natural History: The Field Museum of Natural History was founded to house the materials from the Columbian Exposition, which had been held in Chicago in 1893. That same year, Marshall Field (1834-1906) wrote a check for $1 million to begin what was at first known as the Field Columbian Museum (Boyer, 1993). The articles of incorporation of 1893 defined the museum's purpose as "the accumulation and dissemination of knowledge and the preservation and exhibition of objects illustrating art, archaeology, science, and history" (Alexander 1979:56).

In 1906, Field's will provided $4 million for construction of the grand building on the shore of Lake Michigan and $4 million more for endowment. Construction began in 1915 and was completed in 1921. In the meantime, the Museum's staff amassed large collections and built impressive public exhibits in its "temporary" home in Jackson Park. In 1895, for example, Field brought Carl Akeley to Chicago to create the first of his famous habitat groups of Recent birds and mammals (Bodry-Sanders 1991). In 1898–99, the Museum launched an expedition to Wyoming for dinosaurs, fully funded by Field (Porter 1990:10). From 1909 to 1962, Marshall Field's nephew Stanley served as the Museum's President, and was central to its success during this period. He oversaw day-to-day operations of the Museum and also personally funded its operations during lean years, such as during the Great Depression. Stanley Field was also responsible for securing for the Museum subsidies from the Chicago Park District (Boyer 1993).

The Carnegie Museum of Natural History: The Carnegie Museum of Natural History was founded in Pittsburgh in 1896, completely with funds provided by Andrew Carnegie (1835-1919). The original museum building alone cost more than $10 million. Fascinated by the accounts of recent dinosaur discoveries, Carnegie immediately made the Museum's top priority the acquisition of a dinosaur "as big as a barn" (Rainger 1991:97); the discovery of *Diplodocus carnegiei* in 1899 more than fulfilled that objective (Rea 2001). In 1909, Carnegie field parties found the site of present-day Dinosaur National Park in Utah, and the Carnegie quickly amassed one of the world's outstanding collections of dinosaurs which, with Carnegie's additional personal donations of over $250,000, continued to grow until his death (Porter 1990:10). From the beginning, Carnegie saw his Museum as a contribution to public education, albeit with somewhat conflicting emotions and mixed motivations. The Museum was a monument to his rejection of orthodox social Darwinism and to his contention that the masses could be improved by education, while at the same time a testament to organic progress. "Despite the dinosaur fossils with which Carnegie illustrated [progressive] evolutionary development, his museum was dedicated to uplifting the weak. It owed little to Spencerian philosophy and much to the philanthropic tradition of George Peabody. Carnegie himself insisted that the museum entablature of great men include Franklin, the patron-saint of self-improvement" (Kemp 1990:271). In any case, dinosaurs and other exhibits served an essentially public purpose that supported as a byproduct behind-the-scenes scholarly research: "At the Carnegie and other museums, vertebrate paleontology served a social objective: to educate and entertain the public. That was the bedrock on which a program of fieldwork and research in vertebrate paleontology was sustained" (Rainger 1991:22).

The Lessons of History

This brief survey of the history of some major museums of natural history in America reveals that some things have changed over the past 150 years, while others have remained the same.

Differences Between Past and Present

Today's great natural history museum were creations of the nineteenth century, a time very different from our own. Even as it gave birth to much of modern western culture, the Victorian age was intellectually very different from the early twenty-first century (see, e.g., Gay 1984–1998; Lightman 1997; Conn 1998; Wilson 2003). It was a time when observation (as opposed to experimentation) was at the cutting edge of science, and objects, rather than theories, were at the core of learning; "facts" were at the core of education and it was widely accepted that nature could simply "speak" to you if you were willing to listen. It was also a time of colonialism and empire, which made collections of cultural and natural objects from abroad both easy to obtain and potent symbols of political power. It was a time of widespread racism, which affected the study and public presentation of topics such as human culture and evolution. It was also a time of environmental exploitation, when conservation was still a novel concept.

Observation, objects and knowledge: The Victorian period was dominated by an "object-based epistemology"; that is, the "belief that objects, at least as much as texts, were sources of knowledge and meaning" (Conn 1998:4). This translated beyond intellectuals and academics to the more general passion for collecting and popular natural history that was so much a part of Victorian culture (e.g., Barber 1980; Merrill 1997; Conn 1998). But this soon changed, with profound implications for the future role of museums in American culture. "By the first quarter of the 20th century, objects could no longer hold the meaning with which they had been invested. In an intellectual world now dominated by theoretical and experimental knowledge, produced at dynamic and expanding universities, objects, and the museums which housed them, remained static. When the curtain fell on an epistemology based in objects, museums left the center stage of American intellectual life" (Conn 1998:31), their place being taken largely by universities.

The late nineteenth and early twentieth centuries were also a time committed to Baconian inductivism, in which "facts" of nature were widely believed to be able to "speak for themselves". With their collections of objects, museums were particularly well-suited for such an approach. This Victorian belief that "the meanings held within objects would yield themselves up to anyone who studied and observed objects carefully enough" (Conn 1998:4). George Brown Goode wrote that "The museum cultivates the powers of observation, and the casual visitor even makes discoveries for himself and under the guidance of the labels forms his own impressions" (*ibid*, p. 22). Henry Fairfield Osborn said that "The peculiar teaching quality of a museum is that it teaches in the way nature teaches, by speaking to the mind direct and not through the medium of another mind" (Osborn 1912).

Most of these ideas are anachronistic at best today. We live in a time of uncertainty, contingency, and constant and rapid change. Modern science is dominated by extreme specialization, experimentation, and reductionism. Despite the explosion of information, education is decreasingly about memorization of facts and increasingly about critical thinking "inquiry-based learning" (NRC 1996). Furthermore, the nature of knowledge itself no longer appears as clear as it once did. Objects no longer have unambiguous meanings, and "truth" is a much more elusive thing than it once was. Even though the most extreme of post-modern attacks on science appear to have been beaten back (e.g., Koertge 1998; Sokal and Bricmont 1998), almost all scientists accept that scientific knowledge is created in a social context and can be shaped by non-scientific influences.

Colonialism: The imperialism and colonialism of the Victorian period fostered — with regard to the natural and cultural objects of colonial lands — an ethic of, at best, paternalism and at worst justified taking the spoils of war. From the Elgin Marbles to Theodore Roosevelt's big game safaris to the manufacture of Northwest Coast Amerindian art exclusively for the museum trade, the collecting of natural and cultural materials during the nineteenth and early twentieth centuries added enormously to the holdings of European and American natural history museums, but frequently did so in what we now judge to be ethically questionable or even scandalous ways (e.g., Cole 1985; Sheets-Pyenson 1988; Thomas 1991; Barringer and Flynn 1998). Even if it was ethically possible (and it mostly is not), it is in many cases logistically not possible to make such collections today. Many human and non-human communities are simply gone. Others are convulsed in war or other strife that make them impossible to examine. The politics of repatriation are, furthermore, an ever-present issue for modern museum collectors and curators (e.g., Griffin 1996; Harth 1999), something about which explorers such as Roy Chapman Andrews generally did not have to worry. The end of empire has also affected how objects from foreign lands are displayed. In the post-colonial world, the expectations of museum visitors are very different (Simpson, 1996; Macdonald, 1998).

Racism: The nineteenth and early twentieth centuries were also a time of explicit racism, scientific and otherwise, which was easily and deliberately transferred to museums for public consumption (e.g., West 1996; Shipman 2002; Regal 2002). Museum exhibits routinely displayed non-white races as evolutionarily "lower" than Caucasians and non-European cultures as inferior to those of white Europeans (e.g., Macdonald 1998; Rainger 2001).

Social Engineering: Even while they were dedicated to teaching about nature, early natural history museums were also strongly motivated by a paternalistic and elitist desire to "civilize" the lower social classes. Charles Willson Peale wrote that his natural history museum would be an instrument for teaching order, harmony, and progress, inspiring citizens through "charming models for every social duty, in order to render man . . . more content in the station where he is placed" (quoted in Levin 2002:56). In the late nineteenth and early twentieth centuries, many of the leaders of both the New York Zoological Society and the American Museum of Natural History (the two organizations had many benefactors in common) believed that one of highest purposes of Museum and Society was to "teach immigrants and the native poor how to behave in public places and how important the conservation of nature was" (Regal 2002:112).

Complexity: Finally, the modern world is immeasurably more complex than the Victorian world. Museum administrators today worry about a host of issues, from information management to human resources to earned income streams, of which nineteenth century museum "superintendents" could never have dreamed (Brown et al. 1997; Schwarzer 2002). Modern large museums are truly huge organizations with enormous budgets and infrastructure. Even mid-size and small museums today are organizationally and bureaucratically much more complex than — and therefore significantly different from — their nineteenth-century counterparts.

Similarities Between Past and Present

For all of these differences, however, history tells us that there are strong and important similarities between the structure, mission, and role of the natural history museum today and in the past.

Funding and Mission: Almost all of the great museums depended early in their history on the generosity of one or a few wealthy patrons. American museums have been called more "democratic" (e.g., Levin 2002), in part because they have relied on a mix of government funding and private philanthropy, rather than almost wholly on the state as was (until very recently) the case in Europe. But in almost all cases it was a few rich and powerful men who funded the early years of America's great natural history museums, and this meant that the motives of these individuals played a disproportionate role compared to those of the public at large or the scientists who staffed the new institutions. These motives ranged from national, regional, or local pride and boosterism to belief in the importance of public education to evangelical zeal for one or another social or intellectual ideal. In other words, almost all natural history museums have had to appeal to the sometimes narrow interests of donors, while they also appealed to the broader (or different but equally narrow) interests of the general public and/or scientists. Although museums of all sorts are today heavily dependent on government support of one sort or another, it remains true that the agendas of the rich and powerful can play an important role in the mission and activities of museum programs and exhibits.

Balance: Almost all of these institutions began with a fundamental mission to collect and study — regionally, nationally, or internationally — objects of natural history. Some were also dedicated from the outset to broad public education. Others initially held their mission to be the service of a small select constituency of scholars and serious aficionados, but these eventually broadened their scope to serve a much wider public. The role and level of active scientific research also varied throughout the history of each institution. In all cases, however, the collections remained at the core of the institutional mission. All continued to care for, increase, and study or provide for the study of their collections even while they expanded their mission into public exhibition and education and scholarly research. Museums have thus always struggled to balance the demands and opportunities of their core missions of collections care, research, and public education.

Learning about nature: The founders of America's great natural history museums wanted to understand the natural world — for scientific, economic, aesthetic, or educational reasons. And they wanted to share that understanding with the wider public. Museums still do this through their most distinctive attribute, their collections — and they do so in a way that no other institution of society can. Whereas the ultimate motivation for this understanding may once have been to reveal the thoughts of the creator, now a, perhaps the, most powerful motivation is to ensure that as much of the natural world as possible is saved from the ravages of human environmental modification. Collections have always been central to this quest and they remain so today. As discussed below, the biodiversity crisis is new, but in a way it is an extension of the investigation and presentation of the diversity of life to which natural history museums have always been committed.

Authority: We no longer believe that objects can be presented in museums without context, that they "speak for themselves". Despite their pronouncements to the contrary, museums have always exhibited their objects with some point of view. Museums have come under criticism not just for the particular point of view that they presented (often mostly male, Western, paternalistic, imperialistic, ethnocentric, and anthropomorphic), but also for not acknowledging that they were in fact presenting a point of view not inherent in the objects. Authority has, therefore, come to be something of a dirty word in the museum business. Museums, in their critics' view, should "present all sides" of issues, and acknowledge relativistically that all views are equally valid (e.g., Becker et al. 1992). Yet there is a strong contemporary counter-view. Many directors and curators in art museums have stated baldly that museums *should* be elitist in what they show the public. James Cuno, Director of Harvard's Fogg Museum of Art, for example, has stated that "museums are by their very nature elitist . . . Museums exist as sacred precincts, places apart, and we need to articulate that purpose well. I firmly believe in the civilizing role of the museum. We have preserved, pulled aside from the tumult of the world, these precious things, and have made them accessible" (quoted in Tassel 2002). The Director of the Metropolitan Museum of Art, Philippe de Montebello, agrees that art museums are elitist: "That is exactly what we are. That is what art is, and that is what every visitor to the Met is — by crossing the threshold they are joining the elite" (quoted in Tassel 2002; see also de Montebello 2004). The museum, writes Michael Kimmelman, the chief art critic for the *New York Times*, "exists to provide an experience unlike any other in life . . . it exists to give people something they can't get elsewhere. Of course art is elitist. The glory of the art museum is that anyone who walks through the door becomes an elitist too" (Kimmelman 2002). The same could easily be said about the natural history museum.

Unique Challenges and Opportunities of the Present

These similarities between the beginnings of natural history museums and conditions today offer something of a roadmap to what a natural history museum can and should be in twenty-first century America. But the differences enumerated above have also put natural history museums in a position to offer new benefits of enormous social value that were undreamed of 150 years ago.

Authenticity: In a world of increasing virtuality, the "real thing" is more important and valuable than ever. This applies to art as well as natural history. Philippe de Montebello says that "In an increasingly prosaic and materialistic world . . . especially with the growth of the new electronic media, it is the mystery, the wonder, the presence of the real that is our singular distinction and that we should proudly, joyfully proclaim" (quoted in Kimmelman 2002). "In our highly simulated post-modern culture," writes Glenn Lowry, Director of the Museum of Modern Art in New York, "museums play what the philosopher Andreas Huyssens would call a compensatory role by providing authentic experiences" (Lowry 1999). Even as — or perhaps especially because — museums of all kinds are aggressively pursuing digital imaging of their collections (e.g., Müller 2002), the continued existence of and accessibility to the original is a vital touchstone and reality check, a reminder of the "power of the original object — even the fragment of an object — to stir, stun, and exalt" (Tassel 2002:54). After all, "digital technology can perfectly replicate only what is already digital" (Anonymous 2001).

Interdisciplinarity/Wholeness: The natural history museum, writes Alexander (1979:57-58), "occupies a unique place in the cultural world" because the naturalists who inhabit them "are often generalists who examine plants and animals as wholes or entities living in the complex environments of the natural world. These scientists can help solve modern-day problems . . . problems of the highest social and economic importance to all humankind." Modern science is still dominated by specialization and reductionism, but there are, increasingly, calls for the unification of knowledge (e.g., Wilson 1998). By their very nature, natural history museums can contribute to this movement.

Conservation and Biodiversity: Although accumulations of dead animals may strike the modern visitor as antithetical to conservation, natural history museums have become major forces in conservation biology, particularly around the problem usually called the "biodiversity crisis". The scope of the crisis has been widely discussed (e.g., Cracraft and Grifo 1999; Wilson 1992, 2002). If even the moderately dire predictions are true, the Earth's biosphere is facing devastation on a geological scale and the situation is a reason for the gravest concern and the most urgent of actions. Museums have a major role to play in understanding, and perhaps in mitigating this crisis (e.g., Mehrhoff 1997; Novacek 2001; Wheeler 2004) by pursuing the basic systematic biology they had been doing all along and for which they are uniquely well-qualified. To the basic descriptive strengths of systematic expertise and collections, many museums have added new administrative, educational, and fundraising structures, new exhibits, and new analytical lab capabilities. It remains to be seen whether museum visitors are grasping what is being presented to them about all of this activity and urgency.

PRI and its Museum of the Earth: A Case Study

At its founding in 1865, Cornell University was strongly dedicated to the natural sciences. This was due in part to its land-grant mission, but also to the intention of the founder, Ezra Cornell, that "any person can find instruction in any study". Louis Agassiz was a visiting professor for several years and played an important role in the beginnings of both geology and zoology at Cornell.

Col. Ezekiel Jewett (1791–1897) had fought in the Mexican-American war. He became an accomplished amateur paleontologist and eventually curator of the New York State cabinet of natural history. He was described in his time as "unsurpassed in America as a field paleontologist" and was an important early influence on a young O.C. Marsh (Schuchert and LeVene 1940:17–18). Jewett eventually offered his large fossil collection to Marsh at Yale for $7,000, but Marsh was unable to raise the funds. Jewett then raised the price to $10,000 and it was purchased at this price by Ezra Cornell (*ibid*, p. 89). The Jewett collection was described as "especially rich in New York fossils, containing many of the original specimens described in the state reports, and not a few unique specimens" (Merrill, 1903:117). By the turn of the century, to this collection had been added a number of significant collections: "rich faunas of the Cretaceous and Tertiary formations along the eastern and southern parts of the Union; a large number of characteristic English and European fossils; a fine series of English Mesozoic fossils; of Tertiary fossils from Santo Domingo; of preglacial fossils from Sweden; and numerous smaller collections from various typical localities in our own country; the Ward series of casts [see Kohlstedt 1980]; the unique collection from Brazil made by Prof. Hartt and party on the Morgan expedition [see Brice 1994], containing the original specimens and a great number of duplicates" (Merrill 1903:17). All of this joined significant collections of zoological, entomological, and anthropological specimens in the Cornell University Museum (Fig. 1), housed in McGraw Hall (Brice 1989).

In 1932, Gilbert Dennison Harris (1865–1952), who had taught paleontology and geology at Cornell since 1895, was preparing to retire. The University's museum had been largely disassembled by this time, and Harris lacked confidence in the University's willingness to care for his collections as well as his scientific printing enterprise in perpetuity.[6] He demanded that the University build a new building that would house his legacy. But Harris had not ingratiated himself with the University administration, and they demurred. So he built a small building next to his house just behind the Cornell campus, applied for and received a State charter for an independent educational institution, and founded the Paleontological Research Institution as a place where people like him and his students could study their fossils (Brice 1989, 1996).

Over the next half century, the PRI collections grew enormously and the *Bulletins* became the oldest paleontological periodical published in the nation. After Harris' death, his protege and student Katherine V.W. Palmer (1895–1982) assumed the helm of the Institution. Although she appar-

[6] Harris had started his own journals, *Bulletins of American Paleontology* (in 1895) and *Palaeontographica Americana* (in 1916).

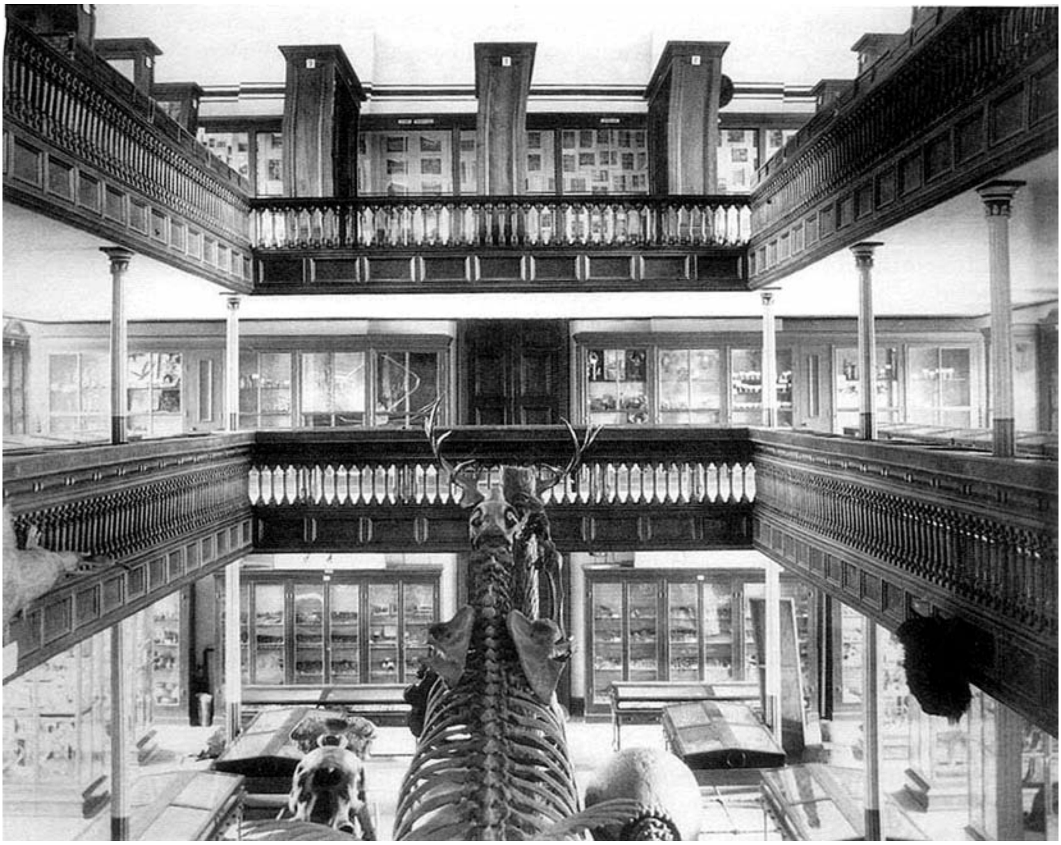

FIGURE 1. Zoological, entomological, paleontological, and anthropological specimens in the Cornell University Museum, housed in McGraw Hall around 1890. Courtesy Cornell University Archives.

ently never received more than a token salary as Director, Palmer went on to become one of the leading paleontologists of Cenozoic mollusks in the world (Caster 1983). She retired in 1978 at age 83; a modest (in both size and tone) history of PRI was her final publication (Palmer 1982).

Yet there was no public side to this institution. Although hundreds of paleontologists around the world knew of PRI, almost no one in Ithaca, New York did. The journal was widely respected within the discipline, however, and the collections were among the 10 largest in the U.S., but there were no educational programs and no significant public exhibits. In 1991, the Institution's Board of Trustees took the dramatic step of voting to change course. They did not know exactly what they wanted, but they knew they wanted to take PRI out to a broader constituency — to share it with a wider world.

It quickly became clear that the way to do this most effectively was with a new permanent exhibit facility — a "museum" in the public sense of that word — which would showcase the collections and, it was hoped, attract a broader base of financial support, public and private, to the Institution as a whole. It was also immediately clear, however, that such a project was a major opportunity in several respects. There was no other major natural history museum for at least 150 miles, a region inhabited by more than 3 million people. The Finger Lakes region of central New York State is an area of unparalleled paleontological and geological richness and beauty (Kurtz 1883; von Engeln 1961; Linsley 1994; Doeffinger 1997; Allmon and Ross 1998). Finally, a truly interdisciplinary museum could be designed from the ground up to reflect the true nature of paleontology today — solidly integrated into the other Earth and life sciences — an integral part of what is now called "Earth systems science" (e.g., Stanley 1998; Kump et al. 1999). Coincidentally, Cornell was in the process of adding an undergraduate major in "Science of Earth Systems" and of changing its Department of Geological Sciences to a more interdisciplinary Department of Earth and Atmospheric Sciences. And so was born the idea for the Museum of the Earth — a public exhibit facility that would bring the wealth of PRI's collections to an under served audience in an area of magnificent local geology — a national-class museum about the entire world that would take as its primary examples the geology of the northeastern U.S., particularly New York State.

A working group of staff and Board members, assisted at various times by outside consultants, eventually developed a core of central tenets or "major messages" for the Museum:

1) the Earth is a set of interconnected systems (atmosphere, hydrosphere, lithosphere, biosphere);
2) paleontology/Earth science is not something done only by professional scientists; it is accessible to everyone, and you (the visitor) can do it yourself;
3) humans have a major impact on the Earth;
4) the Earth has a history.

In addition, we developed a set of philosophical "rules" that would guide our development of public programs and exhibits in the Museum:

1) specimens are paramount and should be used to illustrate every idea when at all possible;
2) exhibits should have multiple points of intellectual access; not everything should be accessible to everyone, but each and every visitor, regardless of age or background, should be able to take away something of value from almost every exhibit;
3) exhibits should strive to achieve a middle path between the classical specimen-rich approach of the best traditional natural history museum with the hands-on dynamism of the best interactive science center;
4) exhibits should emphasize how we know, as well as what we know.

Money was of course a crucial issue, as PRI had almost no significant previous history of fundraising. The project appeared to have little hope of success until a Board member coordinated two matching $1 million gifts, one from the State of New York, and the other from the Park Foundation of Ithaca. Both of these lead gifts were focused on the potential of a new natural history museum in Ithaca to attract tourists and therefore contribute to local economic development. Although neither of these gifts were focused on the content of the proposed exhibits, they came about because a credible case could be made that high quality exhibits could be produced because of the size and national caliber of the PRI specimen collections.

When PRI set out to find an architect who could realize our vision, we had at least two primary ideas in mind: we wanted a building that, within the very tight constraints of our budget, would be a noted regional landmark, and we wanted a building that "made sense" as a geology museum; that is, we wanted the building to be part of the visitor experience and not just a box to hold the exhibits. We eventually chose Weiss/Manfredi of New York, previously best known for designing the Women's War Memorial at Arlington National Cemetery (Weiss and Manfredi, 2000). They designed a visually striking building that was part of the site itself — a "museum of the Earth coming out of the Earth" (Fig. 2).

Exhibit design began with staff visioning and eventually came to involve several groups of outside consultants, designers, and fabricators. The 10,000 or so square feet of permanent exhibits include a chronological tour through the history of the Earth and its life, with a strong emphasis on the northeastern U.S., and featuring more than 650 specimens from the collections. The exhibits

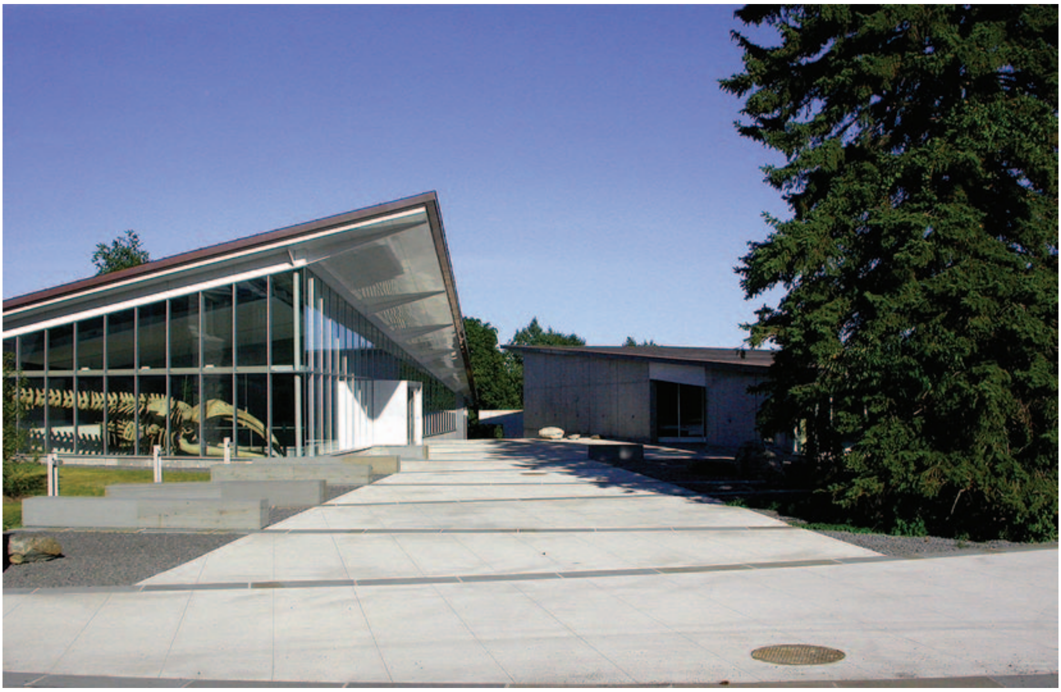

FIGURE 2. The Paleontological Research Institution's recently completed "Museum of the Earth" building. Photo by Phoebe Cohen.

focus on three "worlds" or moments in time particularly well-represented by the rocks of the northeastern U.S.: the Devonian of New York; the Triassic-Jurassic Newark Series of the Connecticut, Hudson, and Newark Basins; and the Pleistocene of New York. Object theaters take visitors through the intervening time intervals with mixtures of actual specimens and audio-visual presentations. There is a working preparation lab visible to the public, as well as three interactive "discovery labs" (one in each "world"), in which visitors can sit and manipulate and explore real specimens with the assistance of a docent.

Because Cornell never had a tradition of vertebrate paleontology, PRI's collections were almost completely invertebrate. Initially, staff and Board maintained that compelling public exhibits could be concocted featuring only invertebrate specimens. Formal and informal discussions with the public, however, quickly convinced us that we needed "charismatic megavertebrates" to anchor the exhibit experiences, which could then include numerous invertebrates and other specimens (Fig. 3). We therefore acquired the skeleton of a modern North Atlantic right whale (*Eubalaena glacialis*), which died in 1999 off New Jersey tangled in fishing gear (Allmon 2004) (Fig. 4), and a complete skeleton of an American mastodon (*Mammut americanum*) excavated by PRI in New York's Hudson River Valley in 2000 (Fig. 5) (which was the subject of an hour-long documentary by the Discovery Channel, *Mastodon in Your Back Yard: An Ultimate Guide*) (Allmon et al. 2004). Through a series of fortuitous events, we also acquired a new 500-foot mural, *Rock of Ages Sands of Time*, by Ithaca area artist Barbara Page, which illustrates the history of the Phanerozoic Eon (Page and Allmon 2001) (Fig. 4).

Both staff and Board were also committed to connecting the past, present, and future via exploration of the modern biodiversity crisis, which has become a topic of active discussion among paleontologists in recent years (e.g., Ward 1994; MacPhee 1999). The final exhibit in the

FIGURE 3. One of several exhibits in the Museum of the Earth. Photo by Paul Warchol.

Pleistocene world suggests to visitors that the current biodiversity crisis may well have begun 10,000 years ago, when mastodons and other large mammals disappeared, perhaps as a result of human over-hunting.

The Museum of the Earth (Fig. 3) opened to the public on September 27, 2003 (*http://www.museumoftheearth.org*).

CONCLUSIONS

Natural history museums are under increasing pressures today to "redefine themselves", to "adapt to changing markets", or to move in new directions, such as "edutainment" (e.g., Mintz 1994). One might argue that to do otherwise — to stay put — would be anachronistic and suicidal in a rapidly changing world. It may be useful at such times of rapid change, however, to look back at what you really are, and to reaffirm what you are not. Natural history museums are not vaults or places of dead storage; they are not research institutes, or societies of scholars or science centers or universities, colleges, or public schools. They are not theme parks or theater multiplexes. There are already many other organizations that fill these roles. Natural history museums are unique cultural institutions that serve scientists, students, teachers, and the general public by making natural history objects and knowledge based on them available to as wide an audience as possible. The history of the nation's major natural history museums shows that this unique status has a long tradi-

FIGURE 4. Rock of Ages mural with North Atlantic right whate in background. Photo by Paul Warchol.

tion and that few if any institutions have been able to stray far from it and continue to be relevant.

This is not a recipe for stagnation, but an affirmation of the unique value and services that only natural history museums can provide to society. Few if any museums have survived or even been established without being public institutions and benefitting from the financial support of either government or individuals that is drawn by such a role. At the same time, however, few have persisted purely for purposes of public education or entertainment. Successful natural history museums in America have historically walked a fine line between maintenance of their collections for the benefit of scholarship and scientific research and presentation of a portion of those collections and that research and scholarship to the paying public. Natural history museums by their very nature have always been, are and must be both "inner" and "outer" museums (*sensu* Humphrey, 1991); there cannot be a choice between one and the other. History suggests that movement too far in one direction destroys this delicate balance and the institution does not continue. Those that focus too much on research and collections risk losing public and private financial support; those that focus too much on the public risk losing scientific credibility and connection to authenticity. Natural history museums continue to be unique and to play a unique and successful role in society when they do what they do best: provide venues and opportunities for people of all backgrounds to interact with and learn from the actual objects of the natural world.

Although the natural history museum was invented two centuries ago in a very different time and social setting, its value persists today. Natural history museums are windows into the natural

FIGURE 5. A complete skeleton of an American mastodon (*Mammut americanum*) excavated by PRI in New York's Hudson River Valley in 2000. Photo by Phoebe Cohen.

world — interpreters, libraries, venues for inspiration, knowledge and insight — and they are distinctive from all other human institutions in these respects. They have changed somewhat — or rather society changed around them — but this distinctiveness persists.

PRI's history is "quirky and improbable" (Rhodes, 1996), but in some respects we found comfort and confidence in our journey from knowing that, although we were trying to be innovative, fresh, and new, we were not really striking out into new territory. Rather, we are joining a noble and long-standing fraternity whose value to society has never been greater.

PRI had a collection of national importance. This was the basis for everything. It gave us credibility, it provided a basis for exhibits and education. It separated us from other science museums in our region. More broadly, it was the "back end" of a major natural history museum. By building the Museum of the Earth, we were simply adding the "front end"— completing an entity — the modern natural history museum — that is unique among human enterprises.

According to the website of the American Association of Museums, there are around 16,000 museums in America. Does this nation, or the northeast region, or New York State need one more? We believe that it does. For people who already know something about the Earth and want to learn more. For people who have never thought about the Earth and its history and need to learn more. For everyone who wants to think about our place in the world — and that should be all of us.

I once had a friend who was thinking about writing a book about the environment, but she said there was no point because there were already so many books out there on the subject. I asked her whether there were still people out there who did not know or believe what she wanted to say about the environment. She said, "Of course." I said, "Then there's room for at least one more book."

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Botanical Gardens and the 21st Century

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Botanical Gardens resemble other forms of natural history museums, but also differ sharply from them. But all institutions are unique individually. For example, the California Academy of Sciences has a natural history museum, a planetarium, and an aquarium under the same room — an unusual combination. At any event, natural history museums of all kinds share many of the same problems and challenges today, and they clearly can find inspiration from one another.

Botanical gardens were first organized in European universities in the early 1500s to provide instruction to medical students about the plants that they could use to cure their patients. In Pisa, Padua, and other early universities, they were regarded as essential; and they soon spread around Europe. Gradually these herbal gardens expanded into more comprehensive exhibitions of living plants, many of them found in the course of the exploration of Asia, Africa, South America, and Australia from the 15th century onward. In contrast to botanical gardens, natural history museums were formed as cabinets of curiosities, often also from distant lands, and were from the beginning designed for the edification of the general public. Aquariums and zoos arose more recently in their modern guise. The oldest ones we have were organized in the 19th century, and most were founded late in that century or even in the 20th century, first in Europe and then in the United States. Historically, zoos are outgrowths of carnivals, general exhibitions of animals, often traveling from place to place. Such exhibitions have been popular for many centuries.

As a result of their different origins, the different kinds of natural history museums have had different histories and different kinds of institutional connections and sponsorships. For example, I do not know of any example of a university organizing or sponsoring a zoo to exhibit living animals to the general public. A few, like the Scripps Institution of Oceanography in La Jolla, California, have organized display aquaria, but that is a fairly unusual occurrence. On the other hand, as I have already stressed, botanical gardens have basically originated within universities, and many are still associated with universities, as are a number of natural history museums, whether solely for research purposes or including exhibitions for the public.

To speak in more detail about the Missouri Botanical Garden, we are an institution of about the same size, age, number of volunteers, membership and budget as the California Academy of Sciences, but we deal primarily with plants. Our Garden was organized in the 1850s, like the Academy, starting with an outdoor exhibition of plants and later developing a research program. Our founder, an English immigrant named Henry Shaw, opened the Garden to the public in 1859, and he ran it himself for the next 30 years. Although courted by Washington University in St. Louis, Mr. Shaw determined that his Garden would be independent. He linked the two institutions, however, by endowing a School of Botany at the University and mandating in his will that its head would also be the Director of the Garden. The first Professor of Botany at Washington University, William Trelease, thus was chosen as director of the Garden on Mr. Shaw's death in 1889. This relationship has been the basis for a strong graduate program involving the Garden and the

University from 1885 onward, expanded in the 20th century to include St. Louis University and the University of Missouri-St. Louis in similar models. We have pursued our goals, becoming a world-class botanical garden through the years, and the university has pursued theirs, with the whole certainly being greater than the sum of the parts.

The common feature of all botanical gardens is that they display diverse collections of living plants. Like zoos, they are not, intrinsically, research institutions. By the 19th century, however, some of the larger ones, such as the Royal Botanic Gardens, Kew, The New York Botanical Garden, and the Missouri Botanical Garden, began to organize extensive research departments comparable to those that were being built up at the larger natural history museums. It must, however, be mentioned that only about 10% of the botanical gardens in the United States list research as their primary activity, and a majority have no research activities at all: so the trend is my no means universal. Unlike zoos, which do not have research departments focusing on large collections of prepared specimens of animals but rather focus entirely on their living collections, some botanical gardens have significantly taken the same track as their counterparts in natural history museums. Over the years, however, zoos have become increasingly preoccupied with conservation issues and studies of populations of living animals, and botanical gardens have in part acquired a similar focus in recent decades, so that the missions of the two historically very different kinds of institutions have converged greatly.

Botanical gardens collectively have very extensive collections of living plants, even if they are often not populations adequate from a genetic basis to insure the survival of the species involved (Fig. 1). Thus, more than 90,000 species of plants are currently in cultivation, the great majority of them in botanical gardens, of a world total of perhaps 300,000 species — a very large sample indeed. Botanical gardens are strong participants, under the leadership of the Center for Plant Conservation and of Botanic Gardens Conservation International, in the realization of the goals of the World Plant Conservation Strategy, adopted by the Convention on Biological Diversity in 2002. Through such participation and their individual actions, they are striving to insure the survival of as large as possible a sample of the world's plants through this century and beyond. In addition, all botanical gardens, through their display and educational functions, are informing and strengthening the role of the public in pursuing the conservation of plants throughout the world.

Because plants are much easier to maintain in captivity, as it were, than vertebrate animals, their conservation in principle presents simpler issues, and is

FIGURE 1. Ron Liesener identifies specimens recently collected in Latin America. The Missouri Botanical Garden adds about 150,000 specimens to its herbarium each year.

intrinsically less extensive. All sexually-reproducing organisms present similar problems of inbreeding depression and the like, but even for larger populations, as mandated for the United States National Collection of threatened and endangered plants, chartered by the Center for Plant Conservation, plants are much easier to maintain than vertebrates. This offers great promise for the future of many species of plants, and it should in principle be possible to conserve the great majority of them even in these environmentally troubled times.

What is of key importance for conservation of any kinds of organisms is an adequate number of people who can recognize them in the field and understand their biology. Although it is commonly asserted that there are fewer systematists today than there were in earlier times, the facts do no bear this out. There are actually many more, but not many who deal with and can recognize organisms in the field. Further, with the extensive environmental degradation that is going on throughout the world, we feel a need for many more systematists to recognize and classify organisms and lay the basis for saving them from extinction. We also now understand that there are many more kinds of organisms in the world than would commonly have been believed a half century ago, and we know that the current numbers of systematists will not be able to deal with them in any reasonable period of time. Finally, we expect a great deal more from our use of these organisms in building a sustainable world for the future, another severe stress on the system and one that demands greater numbers of trained professionals if we are going to be able to realize the potential benefits. The diversity of organisms is the basis for understanding their molecular relationships, but we must first understand the diversity in order to be able to deal with it adequately. The abandonment of instruction in systematic biology by many university departments has led to a concentration of specialists in museums, botanical gardens, and similar institutions, and to increasing doubts about where the next generation of trained professionals is going to be found.

In addition to all of these problems, the pace has increased in modern times to the point at which it is difficult for trained systematists or other professionals to find time among the daily grind of other tasks, and the necessity of constantly writing grant proposals to find funds to support their laboratories, to carry out the science for which they were originally trained. Carl Linnaeus or George Bentham led tranquil lives that they could devote to the calm study of a much smaller number of specimens in producing their magisterial works. Spared the tribulations of Spam, the demand for instant answers to any e-mail message, constantly ringing telephones, service on committees, and all the other demands of a modern professional career, they could simply get a lot more done than most of us feel possible to accomplish today.

It will be important in building a sound future for our disciplines, so that they can be of maximum service to humanity, that we find ways to train additional professionals. It is understandable that university biology departments over the past 50 years have concentrated so heavily in molecular and cellular biology, because the discoveries made in these fields are of such extraordinary scientific and economic importance. Notwithstanding those opportunities, however, it is ultimately true that gene function and the evolution of families of genes, the comparative study of genomes, and similar approaches will be of great importance for the future of biology. This relationship is being recognized as increasingly important, but we have not yet found the appropriate ways to nurture those who have the knowledge of organisms that will make such approaches feasible and of the highest quality. Perhaps better partnerships between natural history museums, botanical gardens, zoos, and aquaria hold the key to future progress, but it has proved difficult in practice to construct such partnerships well and maintain them. I believe that it is definitely worth the extra effort to do so. Perhaps the National Science Foundation, the National Institutes of Health, and similar bodies could develop and sponsor programs that would facilitate such partnerships. It would certainly seem to be worthwhile to do so.

Of all of the challenges facing us, however, extinction is undoubtedly the most important. Although as I have already pointed out, it is easier to maintain plants in cultivation than other kinds of organisms, this by no means makes their preservation automatic. For the estimated 10 million or more species of eukaryotic organisms, of which we have given names so far to only about 1.6 million species, the extinction of perhaps two-thirds is likely by the end of the 21st Century unless we can find ways to achieve a level population, sustainable consumption, and better technology. We are certainly degrading the productive capacity of the Earth now more rapidly than it is being replenished, and encountering great difficulties in improving the situation. Increasing wealth in countries like China can only accelerate the challenge to our future sustainability, and to the future or a large proportion of the organisms with which we share our planet now.

What should we do about this? Biologists in general are divided over whether we should be concentrating on producing an encyclopedia or all life on Earth or finding ways to sample that diversity while it still exists. Certainly with the development of electronic methods of recording information about organisms and making it available, it is feasible to do much more than we would have thought possible only a short time ago. The Smithsonian Institution sponsored "Encyclopedia of Life" program, which promises to create web pages on all known species, is certainly one exciting approach to the problem. Bar-coding using molecular methods like the sequencing of a section of Cytochrome C (COI) seems to be working well for animals, although no suitable analogue has been found yet for plants or fungi. The Global Biodiversity Information Facility (GBIF), set up by a consortium of OECD countries and headquartered in Copenhagen, is providing a growing and useful index to databases of all kinds about organisms, and institutions like the World Conservation Union (IUCN), World Conservation Monitoring Centre (WCMC), and NatureServe are creating databases of different kinds about species for conservation and other purposes. The relatively small sums of money allocated to such purposes, however, indicate that they are still not being taken seriously on a global scale, which is frightening in view of the immensity of the problem and the disastrous consequences that ignoring it will have for humanity in terms of unrealized objectives and global instability over the decades to come.

Another approach would be attempting to bring our knowledge of a few index groups that are relatively well known and others of obvious economic or ecological importance, such as plants, vertebrates, butterflies, mosquitoes, and ticks up to as complete a state as possible and to sample the rest in ways that would give us some idea of the dimensions and variability of the groups involved. For nematodes, mites, fungi, and certainly bacteria, it seems important to devise and implement sampling methods while the respective biota are more or less intact. Funding has rarely been available for such approaches, however, and I recommend that they be considered much more seriously in the future. The truth is that we cannot even speak intelligently at present about the distribution and abundance of, for example, nematodes all over the world — how many are there, are there more in the tropics than there are in temperate regions, are there more in the soil under the Reserva Ducke Reserve near Manaus in Amazonian Brazil than there are in the soil of Golden Gate Park? Such a question seems very basic, and yet we are not even trying collectively to find the answer — a neglect that is likely to be looked up as a major mistake in the future, when the opportunities will be far smaller than they are now. For most groups of organisms, such as bryophytes, fungi, nematodes, and many groups of insects, we do not even know whether there are more species in the tropics than in temperate regions, even though it is almost an act of faith that there should be more in the tropics.

Turning now to the particular problems and opportunities of botanical gardens, one major problem is that we still do not have any dependable method of finding what is in cultivation in around the world: there is no organized database. If I want to find cultivated (and thus easily accessible) individuals of a family of plants that is endemic to Southeast Asia, the only way that I can do it now is to guess where they might be and send an e-mail message or letter, or telephone, and sometimes I am fortunate enough to find what I am seeking. As a result of this lack of coordination and efficient recording and exchange of information, the several thousand botanical gardens all over the world tend to duplicate the same kinds of collections. They certainly lack the ability to add to their collections efficiently plant species that are not cultivated elsewhere. Scientists and other who would like to have access to their material do not know where to find it! Considering the collective budgets of several thousand botanical gardens and their aims, this seems an unacceptable situation. Therefore, the efforts by Botanic Gardens Conservation International to prepare a computerized list of the names of plants in cultivation are most welcome, and I hope that they will form the basis for an even more systematic and comprehensive approach in the future.

Another problem facing botanical gardens is that even when they have research departments, there is often little or no connection between their efforts and the living collections of plants in the same gardens. As in natural history museums, the exhibits certainly need to be broader than the research programs in order to demonstrate the world of plants and the many relationships in it, and between plants and people, but research should be made more explicit in the exhibits. In addition, the collections of living plants, even though they may not be on public view, should be used more often in ways to assist the research. A few botanical gardens, and the Royal Botanic Gardens in Edinburgh present a particularly good example of this, have built up large, synoptical collections that are of direct relevance to their research programs, but this is a relatively rare situation. Internal linkages within the gardens between research, education, and horticulture, often less than ideal, can be of great benefit to the institutions if fostered properly. For example, involving research scientists in developing the educational material is very helpful, and involving education and display professionals in research expeditions can be equally so.

Increasing amounts of effort in botanical gardens, as with zoos, are being devoted to maintaining living samples of threatened and endangered species that can provide material for re-introduction into nature when the conditions become suitable. These populations may become increasingly important because of the growing importance of invasive alien species in destroying natural habitats, a trend that is already of immense importance and can only grow, and with the burgeoning effects of global warming on natural habitats. Regarding the latter, it is obvious that if present trends are not curtailed, the natural habitats of many species of organisms will simply disappear in nature over the course of the present century. Reserves and parks may not be adequate to maintain them in the face of these trends, and thus botanical gardens, zoos, and aquaria may become to an even greater extent modern Noah's Arks, saving species for the future and developing strategies about the best ways to preserve individual species (Fig. 2).

In a general sense, botanical gardens are important for the same reason that all kinds of natural history museums are important. It is the scientific possibilities combined with the teaching and the educational and exhibit possibilities, which include things like pleasure, recreation, joy, or the simple thrill of being there that immerses people in the experience of that particular group of organisms that really makes them worthwhile and very special. We need to emphasize that to a much greater extent in the future than we have in the past. We must remember that when we are talking about conservation, and we all need to be talking about conservation in some way, that conservation is a matter of several elements, and that no one class of institution fulfills all of these. First, there is information; there are databases about the organisms involved, their characteristics and their ranges. Second, there is dealing with and being able to recognize those organisms and their populations in nature, and that would be a role, in the case of botanical gardens, of the gardens and their trained individuals. Third, there should be links to conservation organizations, such as The

FIGURE 2. The Climatron, completed in 1960, displays tropical plants. It was the first use of a geodesic dome as a greenhouse.

Nature Conservancy, or the World Wildlife Fund, or the Sierra Club, to spread the message. Fourth, there is need for linkages to educational institutions, to the media, and to outreach organizations, which continually inform people about the need for conserving biodiversity. No one institution can bridge all of those areas, which is a strong argument for networking among different kinds of institutions for the purpose of building a sustainable world.

I shall conclude with a few general points that apply both to botanical gardens and to similar natural history institutions. The first point is that we need to consider how effective we are in informing the people who come to our institutions either as visitors or to attend classes. William "Bill" Conway, the legendary directory of what is now the Wildlife Conservation Society, once put it this way: he said, "I somehow think that teaching school children in the Bronx that African elephants have big ears whereas Asian ones have small ears is not going to do the job of convincing them that there's a whole world out there that they need to care about and try to conserve." In order to encourage the development of the kind of a world in which we would like our children and grandchildren to live, we need to be a lot more explicit about those particular items and about the ways in which a sustainable world will help to maintain the quality of life for the people in that world (Fig. 3).

Secondly, we need to improve the quality of our messages, and we need to know how those messages are being received. So often the signs and informational material presented in museums are simply collections of annotations or notes about individual exhibits. Collectively, then, they may give no real sense of the central message of the institution being visited. I urge natural history museums, zoos, aquaria, and botanical gardens to get together, think about the common themes that they are trying to present, and devising ways to impart these themes effectively. For example, if at the San Francisco Zoo, the San Francisco Botanical Garden (Strybing Arboretum), the California Academy of Sciences, and the other public natural history museums, nature centers and parks of the Bay Area would develop together a series of common themes, it would be possible to present these themes concisely and well at all of the institutions and thus to affect the public much

FIGURE 3. Seiwa-En, the Japanese Garden, was completed in 1977. It symbolizes friendship between the United States and Japan.

more profoundly than is the case at present. If that seems a worthwhile challenge, it would be easily implemented.

Natural history institutions are in general vastly out of date in our selection of exhibition techniques. Few of us do a truly outstanding job of presenting any message to the public. When it has been re-established in Golden Gate Park, the California Academy of Sciences has a wonderful opportunity to do well in this area. The Eden Project, which is a set of greenhouses and related exhibit facilities in Cornwall, England, is an exciting example of what can be accomplished with imagination and a flexible view of what is possible. It is called a "project," and not a "botanical garden," because it is seen as continually improving and developing, and so far it has kept the promise implicit in its name. We should all be doing the same!

Three more points I should like to make. First, I think that all of our institutions need to think much more carefully about sustainability in architecture, in engineering, in the use of materials, in the use of energy and in the use of recycling. We need to present outstanding examples in these areas because the world needs to move in this direction and we are prominent public institutions visited by large numbers of people on a regular basis. We should present excellent examples of green architecture, and call them to the attention of our visitors. By doing so, we can contribute in yet another way to the formation of a sustainable world.

Next, we should consistently emphasize internationalism around the world. The United States often has suffered badly from a lack of global vision, and we will clearly suffer the consequences increasingly in the future. With 4.5% of the world's people, we use 25% of the world's resources to support our standard of living and cause equivalent amounts of pollution and environmental damage; yet we depend on all the nations of the world for our own sustainability, and must find a common path with them in the future. The 70 million people that are projected to be living in the

FIGURE 4. The Monsanto Center, a good example of green architecture, houses part of the Garden's research program and provides space for its graduate students and library.

State of California by the middle of the century, consuming at 30 or 40 times the rate of individuals living in the jungles of the Amazon or in Indonesia will exact an enormous tax on the world, equal to the effects of an additional 2–3 billion people living in the tropics. Our consumption rates and lack of development of appropriate technologies pose truly formidable threats for our future, and that of everyone else as well. Consequently, long-term partnerships with institutions around the world, but particularly in developing countries, are of great importance. Even more important will be informing our own visitors about the dimensions of the problem and their individual responsibilities and opportunities in this area.

As Bill Conway has often stressed, it is critical for our institutions to think harder about moving our visitors beyond awareness of these problems to action. Extinction and our non-sustainable use of the natural world are important ideas, but what can we do about them individually? People should be encouraged to live more sustainable lives, to think about energy conservation, recycling, sustainable architecture, being interested in expressing their informed views as members of the body politic, or taking local action for conservation and sustainability and of doing all the kinds of things for which a democracy empowers us.

In summary, the power and scope of botanical gardens and other natural history museums are huge and underexploited. We can and must take many constructive steps forward if we are to contribute to the fullest extent to the realization of sustainability based on knowledge in our communities, and for all people in the 21st century.

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Reinventing a Natural History Museum for the 21st Century

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Given this critical time in the history of our species, natural history museums have a responsibility to become wholly relevant to people's lives, providing profound insights into natural systems, and presenting alternatives as to how humans can better live in the world. The Utah Museum of Natural History (UMNH) at the University of Utah, Salt Lake City, is in the process of "reinventing" itself, with the above challenges foremost in mind. This process includes a major capital campaign aimed at building a new facility on a 16-acre site adjacent to the campus. Considerable attention has already been given to philosophical aspects such as vision and mission, informed by discussions with interested communities outside the museum. The new mission of the UMNH is to "illuminate the natural world and the place of humans within it." As envisioned, this perspective will be presented using two fundamental, complementary themes — ecology and evolution—with the ultimate objective of facilitating new perspectives on nature and culture. All museum activities are currently being re-evaluated so as to reflect this philosophy. Rather than subdividing exhibits along traditional disciplinary lines, exhibitions in the new facility will be integrated, interpreting, for example, the workings of entire prehistoric and recent habitats in a web of life approach. The museum expects to serve as a place of convocation and meaning for the community, and more thoroughly to integrate traditional "front-of-house" and "back-of-house" activities. Even the building — conceived as a green, ecologically "intelligent" facility — will be interwoven into the message, becoming perhaps the most featured exhibit. Throughout, emphasis will be on the intermountain region, with visitors strongly encouraged to use the Museum as a starting point to help them connect with the marvelous natural history of the region.

The Utah Museum of Natural History (UMNH), a member of the University of Utah system, was established in 1963 to create a central location to house various natural history collections held in disparate locations on the campus. The UMNH opened to the public in 1969, following conversion of a 1930s, Depression-era, library building (Fig. 1). Today, the museum serves as the state museum of natural history. It houses more than one million objects divided into three major collections — anthropology, biology, and earth sciences — representing all of the natural sciences, with a strong emphasis on Utah and the surrounding intermountain region. Currently, the UMNH has 35 full time and 15–30 part time staff, in addition to more than than 300 volunteers. In addition to the active research conducted by four curators and several affiliated "research curators," the exhibits and education departments are both involved in dynamic programming that reaches throughout the state. Total space within the museum building is 87,000 ft^2, of which 24,000 ft^2 is devoted to col-

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FIGURE 1. The current Utah Museum of Natural History facility on the campus of the University of Utah. Photo by Jill Schwartz.

lections and 28,000 ft^2 to exhibits. In recent years, it has become increasingly evident that the present facility is wholly inadequate to support the growing collections and diverse activities of the museum. Specimen collections are now filled to capacity, staff and volunteers are overcrowded, the organization of space does not meet current needs, and visitor parking is limited to only 12 stalls!

The UMNH is now engaged in a major capital campaign aimed at a new and larger facility. The proposed building will be 169,000 ft^2, approximately doubling available area. Also planned is an underground parking facility with 200 stalls. The new building will be located on a spectacular 16-acre site adjacent to the campus, situated at the interface of Salt Lake City and the Wasatch-Cache National Forest on the Wasatch Front mountain range. Nearby will be several other cultural attractions, including an arboretum, zoo, and park. At the time of writing (October, 2003), it is estimated that the new facility will be completed in less than five years, at a total cost of approximately $60,000,000. Three consulting firms have been hired to aid in the initial planning and programming phase — a project facilitator (Hanbury Evans Wright + Vlattas, Norfolk, VA), an architectural planner (E. Verner Johnson and Associates, Boston, MA), and an exhibit planner (Ralph Appelbaum Associates, New York, NY). Master plans for architectural programming and exhibits are scheduled for completion by summer of 2004. The next phase, design selection followed by the actual design, will be completed by early 2006. Finally, we expect construction of the building and exhibits to be finished by fall of 2008, at which time we will open to the public.

The museum has used this time of radical physical change to reflect upon its vision and mission and literally "reinvent" itself, reassessing basic goals and philosophies. Along the way, we have sought answers to several fundamental questions. What is the role of a natural history museum in the 21st century? In particular, how can we become more relevant to our community, both residents and visitors? What are the major issues that most need to be communicated to the general public? How can we best foster understanding of these issues? The remainder of this paper focuses on this process of inquiry and presents some of the answers that have surfaced. It is important to note that many, perhaps most, of these answers presented here are not unique to the UMNH. Other institutions of natural history around the country (e.g., California Academy of Sciences, Monterey Bay Aquarium), and indeed around the world, have begun to address similar issues in parallel fashion. This is no coincidence. Clearly the time has come for natural history museums to dramatically increase their relevance, given the many critical issues facing humanity, most of which are inextricably linked to natural history.

Natural History in Changing Times

Traditional Natural History Museums

Traditional natural history museums can be characterized on the basis of a number of features. First, exhibit, education, and research programs tend to be organized around distinct scientific disciplines — for example, biology, geology, and anthropology. This could be called the "ology" approach. Second, exhibits tend to be object-focused. That is, the objects themselves form the basis of the message. So, for example, a dinosaur fossil, stone tool, or insect collection would include such pertinent specimen information as name, age, location, and perhaps, in the case of living animals, a brief synopsis of lifestyle. Third, traditional museums tend to have abrupt distinctions between public and private areas — that is, between "front-of-the-house" and "back-of-the-house." Finally, relevance to community often has not been made explicit. Natural history museums have been places where people come largely to see natural and cultural objects. The primary message has concentrated on the past and present, with minimal regard to the future.

Increasingly, museums of all types are realizing that a fundamental change in philosophy and approach is necessary, in part due to growing competition amongst institutions for leisure time, but more importantly due to the state of global environments (see below). Consequently, there is a growing shift toward greater relevance, with ongoing efforts to increase the value of the museum experience. In the words of museologist Stephen Weil (2002),

> Museums are quintessentially places that have the potency to change what people may know or think or feel, to affect what attitudes they may adopt or display, to influence what values they form.

But how do we go about making natural history museums more relevant, active members of their respective communities? Relevance should be a measure of how well an institution is able to meet the most pressing needs of its community. So what are those needs?

Global Crisis and Science Literacy

Life on planet Earth is in crisis. Paleontologists recognize five previous mass extinctions, and it is now clear that we are in midst of the sixth such extinction. During the past century, the rate of species extinction has skyrocketed, reaching levels 100 to 1000 times greater than those prior to the arrival of human civilization. To date, biologists have formally named and described less than two million species, with an overwhelming emphasis on large-bodied forms. Estimates of the total number of living species range from 10 million to over 100 million, with 30 million being a common approximation. Between 10 and 40 percent of this vast, little understood diversity is now imperiled. The current range of biological diversity, a product of millions years of evolution, is being extinguished in mere decades. At present rates of extinction, over half of the species currently in existence will be extinguished by the close of the 21st century. In the words of E.O. Wilson (2002),

> It takes a long time—millions of years—to create species as fully developed as the ones around us. . . We are destroying species a hundred times faster than they could be created, even if we left the environment alone. We are doing the equivalent of drawing hard on our bank account; and you can't draw down on your bank account at a hundred times the rate you're putting new money in without going broke very fast.

The unique aspect of this particular mass extinction is that it is being precipitated by a single species, *Homo sapiens*. The United Nations World Resources Institute recently completed a project entitled "Pilot Analysis of Global Ecosystems (PAGE)." Involving 170 scientists representing a broad array of disciplines, this study concluded overwhelmingly that this ecological crisis is being driven by human activities. With regard to habitats, almost 60% of coral reefs are threatened; more than half of the world's wetlands have been destroyed; 80% of grasslands are imperiled as a result of soil degradation; and 20% of drylands are in danger of becoming desert. The causes of this dramatic, widespread environmental degradation are many, including deforestation, global warming, overpopulation, spread of toxic pollutants, and overexploitation of animal species. As noted in the quotation above, we are spending our environmental capital at an unprecedented rate. Without a radical and virtually immediate shift in global priorities, we are destined for ecological bankruptcy.

To compound matters, recent polls indicate that most people do not even realize that we are in the grip of a sustainability crisis, one that threatens the majority of species on this planet, including our own. On the contrary, we continue to hold onto the erroneous, outdated notion that endless economic growth is not only possible, but the preferred course of action. This remarkable level of ignorance can be attributed to a variety of factors. In the United States, as in Europe, most people live in cities and, therefore, are far removed from the natural systems that sustain us. And, apart from, or perhaps better stated, despite where they live, most people have enough difficulty dealing with the present — earning a living, raising children, meeting monthly payments on homes, cars, and the like, and in many instances simply meeting the needs of their daily diet requirements — that the future, perforce, is left to take care of itself. As a consequence, and because ecological change is a long-term phenomenon, typically on the order of decades, our society is not geared to fathom, let alone respond, to such long-term changes. Perhaps most importantly, however, there has been a failure of education, not only in these United States but in nearly every country worldwide. More specifically, in the United States, numerous recent studies underline the general lack of basic knowledge relating to the sciences. For example, in a recent Gallup poll on evolution (Alters and Nelson, 2002), 45% of Americans chose the response, "God created human beings pretty much in their present form at one time within the last 10,000 years." Only 35% those polled believed that "the theory of evolution is supported by evidence." The science literacy problem extends to those with university degrees as well, including science majors, inasmuch as most post-graduate education is concentrated on specialized training aimed at specific careers rather than the development of better community citizens (Orr 1994). Even for individuals with a basic knowledge of the current sustainability crisis, there is a tendency to believe that science will simply be able to solve any and all ecological problems that we encounter. As noted by environmentalist David Suzuki (1997), "the deep-seated beliefs and values of modern culture are both creating these problems and blinding us to their consequences."

Shifting Paradigms

Specialization within the ranks of science has a lengthy history. Science has traditionally viewed nature through a mechanistic, clockwork perspective that has fragmented and compartmentalized the natural world into increasingly smaller topics of study. This perspective can be traced back to sixteenth century thinkers like Galileo and Descartes, who effectively founded the scientific method. The reductionist mindset has dominated science for four centuries, producing remarkable insights into the structure and function of the universe, from the cosmic scale down to the subatomic. It has also had obvious technological applications in areas such as communication, travel, and medicine. Within the academic realm, entirely new disciplines have continually emerged as scientists focused their efforts on successively smaller units of nature. Thus, within biology, fields of inquiry include ecology, systematics, developmental biology, physiology, cytology, genetics and molecular biology. Yet the separate disciplines recognized throughout science are largely artificial constructs—categories that relate more to how the natural world has been compartmentalized and scientific research has been practiced than to how the universe itself is structured. Moreover, in addition to its many successes, this practice of fragmenting nature has severely limited our ability to comprehend the inherent interconnectedness of nature.

The underlying assumption for these four centuries has been that if only we could dissect nature to its smallest components, all would become clear. In the twentieth century, however, many problems across numerous disciplines appeared intractable because of their sheer complexity. How can we predict the pathway of a subatomic particle, shifts in weather patterns, or ecological dynamics given all the contributing factors in each case? Increasingly, it was realized that an understanding of the components alone is insufficient. Rather, the key is often determining how those various components interact with one another.

Over the past three decades, a large-scale paradigm shift has been underway, creeping through the ivory towers of science. In contrast to its aged predecessor, this radical new view is all about connections (e.g., Capra 1996). Today, numerous disciplines are feeling the effects of this change, becoming increasingly integrative and holistic. We are actually seeing a reverse trend, with the unification of once separate fields into new disciplines, with names like geobiology and biocomplexity. Much effort is now devoted toward unveiling the complex, web-like connectedness that links all living and non-living systems. Chaos and complexity theory are both intellectual offspring spawned from this integrative outlook. Emphasis is now being directed toward such topics as dynamic systems, feedback loops, and networks.

This enlarged perspective, encompassing the entire forest, offers unique and deep insights never conceived of while concentrating solely on the trees. It turns out, however, that although this view may be new to modern science, it has an ancient pedigree dating back centuries, and probably millennia. Indigenous peoples around the world have a lengthy tradition of viewing nature through connections, of seeing themselves as fully embedded within life's web. Science and western cultures, long distracted by a mindset devoted to fragmenting the natural world, are now returning to this ancient wisdom. Given the current crisis of sustainability, such a perspective is needed more now than at any other time in the history of our species.

Natural History Institutions in the 21st Century

So how do we go about making institutions of natural history more relevant, increasing their potential to change attitudes and perhaps even worldviews? Given the issues presented above, one of the most pressing needs common to virtually all communities in this country is higher levels of science literacy, particularly as it relates to issues of local, regional, and global sustainability. These issues are applicable to any community, because they can be addressed from a variety of levels. Of course, despite the grave nature of the current situation, the message need not (and should not) be one of gloom and doom. Rather it should always be founded on hope, tempered with pathways toward solutions. Confronted with the current state of the planet, visitors should receive a variety of options describing how they as individuals can be part of solutions. In addition to science literacy, another critical need is to increase peoples' level of engagement with nature, fostering what E.O. Wilson has termed "biophilia," or a love of nature (Wilson 1984). As noted by several commentators, people are unlikely to save something they do not love.

Importantly, institutions of natural history (museums, science centers, aquaria, zoos, and botanical gardens) are in perhaps the best position to fulfill these needs. Far more than public schools and universities, they have the potential to immediately take a holistic, connections-based approach to natural history, thereby enabling people to understand human interactions with the natural world. In doing so, such institutions can promote both the dissemination of knowledge and a sense of engagement with nature. Through their programs, they even have the potential to influence school curricula in positive directions. In sum, natural history institutions have the opportunity to lead the way in filling this education gap.

A key first step is to consider adoption of a more synthetic view of nature, one that moves away from traditional "ologies" and integrates scientific disciplines, in accordance with the scientific paradigm shift described above. For natural history museums, emphasis then shifts from an object focus to connections and relationships among objects. In other words, whether the objects are butterflies, potsherds, or dinosaur bones, the message is about context — in particular, ecological and evolutionary context. In contrast to traditional views, there might be a blurring of distinction between public and private areas within the museum. Importantly, greater focus would be placed on the future. Specifically, objects from the past and present time would be used to inform visitors about future likelihoods, often surrounding important and problematic issues. Ultimately, then, this new museum would have direct relevance to the lives of its visitors. Below we detail how the UMNH is in the process of adopting exactly this approach.

Utah's New Museum of Natural History

Natural History and the Intermountain West

Rather than adding band-aids to an aging physical and conceptual framework, the Utah Museum of Natural History has the rare opportunity of envisioning an entirely new museum with a philosophy that directly reflects changing times and the needs of local communities. The UMNH has the great advantage of being intimate with nature. The majority of Utah's population, including Salt Lake City and surrounding communities, is situated in a restricted region along the Wasatch Front mountain range. Within 15 minutes, one can drive from the core of downtown Salt Lake City into one of several mountain canyons. Within 30 minutes, one can experience habitats relating to the entire water cycle, a situation that is perhaps unique for a major urban center in this country. Moreover, Salt Lake City is literally surrounded by diverse and wondrous examples of natural history, occurring as it does at the confluence of three major ecological regions: the Great Basin, the Colorado Plateau, and the Wasatch/Uinta Mountains. Within five hours drive is Yellowstone Park (to the north) and the Grand Canyon (to the south), and closer still, within the state boundaries, are ten national parks including such world famous locales as Canyonlands, Arches, Zion and Bryce Canyon. Therefore, unlike the great majority of urban areas within the United States, residents and visitors in Salt Lake City need not limit their experience of nature to a natural history museum. Rather the museum has the potential to serve as a portal, enabling visitors to encounter the surrounding landscape in new and exciting ways. The question then becomes, how do we go about making these experiences a reality?

A New Mission

Realizing that all museum activities should cascade from the institution's mission, the staff of the UMNH reexamined this fundamental statement to develop a more integrative perspective. After much discussion with staff, volunteers, board members, and other constituencies, the core mission was reconceived as follows: "*The UMNH illuminates the natural world and the place of humans within it*." Within that philosophical foundation, we then defined several subsidiary goals:

- Foster an understanding of science as a journey of discovery and wonder.
- Promote the preservation of biological and cultural diversity.
- Preserve collections in trust for future generations.
- Encourage new perspectives on and inspire passion for the natural world.
- Celebrate Utah's native peoples and cultures.
- Showcase Utah's unique and extraordinary environments.
- Create knowledge through innovative research.
- Demonstrate the myriad links connecting the past, present, and future.
- Transcend scientific disciplines to reveal the networks inherent in nature.
- Serve as a center for science literacy, acting as a bridge between the scientific community and the public.
- Empower people to make thoughtful decisions about the future.

In short, this mission recognizes the need for the Museum to become directly relevant to the community, to encourage people to engage with nature in new ways, and to make informed choices about issues relating to natural history. In addition, the revised mission fully embraces the ongoing paradigm shift in science described above, seeking to break down traditional disciplinary boundaries and present the natural world from a connections-based, web of life perspective.

The Story of Life

Science is perhaps best communicated through stories, since they are an effective means of presenting information in an engaging manner. So, given the institution's revitalized mission, what is the primary story that will best serve our needs? Ultimately, it was decided that two related themes — ecology and evolution — best communicated our message in a unified manner. At its essence, ecology is the web of life, the totality of all the intricate, interwoven relationships that connect all organisms and their environments. Key ecological concepts include feedback loops, energy flow, chemical recycling, and sustainability. Evolution, in contrast, is change through time, the history of life's web, including a range of short- and long-term processes that, together with ecology, have generated the wondrous world around us. Important evolutionary concepts include mutation, natural selection, adaptation, and symbiosis.

Although traditionally separated for educational purposes, these two themes are truly inseparable from Nature's perspective. Ecology without evolution is largely a description of the relationships within a given ecosystem. Lacking any reference to time and origins, these relationships appear two-dimensional. Conversely, evolution without ecology is often restricted to Darwinian natural selection, an examination of long-term processes and effects. Without the infusion of an ecological outlook, evolution is virtually irrelevant to the daily lives of humans. Unified into a single, powerful perspective, these complementary themes provide a refreshing window through which to view all of nature. Importantly, these two themes do not exclude other areas within the natural sciences. Rather they are fully inclusive, encompassing all aspects of natural history. The key departure here is one of perspective, broadening the focus to search for links instead of dissecting the world into its component parts. I emphasize here that the UMNH is not alone in walking this new path; other institutions have also embraced this revised philosophy.

Envision walking into an exhibit hall with three large dinosaur skeletons of Late Jurassic age (about 150 million years ago). One is a menacing predator, *Allosaurus*, the others a long-necked herbivore, *Apatosaurus*, and another plant-eater with plates and spikes, *Stegosaurus*. At first glance, the scene looks just like many others recreated in museums around the world. Looking closer, however, you see that there are also fossil remains and reconstructions of various other Late Jurassic animals from western North America — turtles, crocodiles, mammals, even insects — as well as a range of plants, from low-lying ferns to giant conifers. Rather than simply naming the organisms, the interpretative information concentrates on the role that each played in this ancient habitat, from the plant producers to the various animal consumers. Building upon concepts presented elsewhere in the exhibits, visitors learn of the cyclical flow of energy that characterized this Mesozoic ecosystem. Also addressed is the possible coevolutionary relationship between conifers and dinosaurs, with the trees and the long-necked herbivores achieving enormous sizes at approximately the same time earlier in the Mesozoic, perhaps at least partially in response to this plant-herbivore interaction.

In sum, the long-term plan of the UMNH is to dispense with the traditional halls of paleontology, botany, zoology, and anthropology. In their place will be a series of exhibitions with more integrative themes that will offer a truly connected perspective on the natural world. In particular, the dual and complementary concepts of ecology and evolution will enable us to tell the biggest story of all — that of who we are, how we got here, and our intimate links with nature.

Short-Term Effects

Big ideas are one thing, implementation another. Certainly, wholesale change of an institutional philosophy is a nontrivial task. It became clear to the museum staff early on that we could not maintain the traditional style of communication in the face of this new mission. As a result, the UMNH has been going through a (sometimes awkward) growing process as we attempt to redefine ourselves, with much higher levels of integration between and among divisions. For example, over the past two years, curators have spent considerably more time interacting with education, exhibits, and communications staff than in years previous. We have also focused tremendous energy on consensus building, with committees and teams often composed of individuals with varying talents across departments. The primary goals of this strategy are greater efficiency, higher levels of creativity, and greater communication through the establishment of within-museum networks. This process has also involved regular consultations with interested constituents on campus, in the regional Salt Lake area, and around the state. In particular, we are proud of the relationship developed with regional native cultures through both an active Indian Advisory Committee and ongoing consultation with Utah's native nations. The UMNH anthropological collections span the human history of the region, and they have particular importance for the living native peoples of Utah. Thus these collections must be managed and programmatically interpreted within the context of that relationship.

This philosophy has lead to productive partnerships, expressed most fully in an exhibit entitled *Utah's First Nations*, which ran during the 2002 Winter Olympics.

Importantly, while keeping one eye on building a new institution, we realized that the fundamental shift in our programs must occur in and beyond our present, more limited facility. Thus we have built several in-house exhibits of a more integrative nature, in part to try a variety of approaches and test gauge audience response. One of these highlights the geology, flora, fauna, and human history of a major laccolith feature in southern Utah known as the Henry Mountains. The exhibit interweaves these topics, demonstrating how each is intimately related to the others. Integrative outreach programs have grown five-fold in as many years, with new programs such as *Field Crates*, *Museum on the Move*, and *Scientist in the Classroom* reaching the most remote communities in the state. In another example, the UMNH has partnered with faculty in the Department of Geology and Geophysics to initiate a major educational program sponsored by a substantial grant from the National Science Foundation (GK-12 program). Project WEST (Water, Environment, Science and Teaching), as it is called, will team eleven graduate students from the University of Utah with public school teachers over a period of four years. The resulting classroom and fieldtrip activities aim to communicate key environmental issues to students throughout targeted regions of Utah, using water as a theme.

Public Collections

In the traditional museum setting, visitors confront boundaries that separate public programming from research and collections areas. Although collections and research form the conceptual basis for most natural history museums, their associated activities are largely hidden from public view, making it extremely difficult for these institutions to incorporate collection resources into their educational programming. Museums have sought to circumvent these problems through such efforts as building fossil preparation laboratories in public spaces, placing more objects on display, or by providing "virtual" electronic access to collections. Nonetheless, the traditional boundaries between programming and collections have remained firmly in place. For the vast majority of museum visitors, direct access to collections is entirely precluded or, at best, restricted to infrequent special events.

To overcome these issues, we envision an innovative program that will facilitate new ways of integrating collections resources into public programming. One means of achieving this goal is to develop specific inclusive themes, select representative specimens from within each collection, and then provide visitors access through a directed tour. The variety of themes is essentially endless and would be developed jointly by collections and education staff. Perhaps the most obvious candidates are places: for example, the Wasatch Mountains or Arches National Park. Classes of students, and perhaps public tours, would be guided through the various collections areas, witnessing firsthand some of the museum's holdings relating to that particular place. The docent might first highlight the rocks and related geological activities that formed ancient soils. Next she/he could introduce some of the native plants from the botany collection. Then it might be to the entomology and vertebrate collections to address pollinating insects and birds, culminating with the archaeological remains in order to address human occupation of the area. Once again, emphasis would be placed on the connections between collections (e.g., source rocks for making stone tools, bird-insect-plant interactions) rather than simply the objects themselves. To enhance the experience further, some of the specimens chosen from each collection would be touch specimens. In each collection area, permanent storage units would be set aside to showcase materials selected for a particular theme. Themes would change regularly to provide a fresh perspective or to enhance other museum programming such as temporary exhibits.

A Building with a Message

In keeping with the vision of integrating all aspects of science and illustrating connections among disciplines, we envision that the new museum building will be "green" and "ecologically intelligent." That is, following recent architectural successes elsewhere, we are considering a building that serves as a model of sustainable design. Possible features include: 1) state-of-the-art, sustainably harvested building materials; 2) alternative energy sources such as geothermal cooling systems; and 3) waste recycling employing communities of microorganisms. These green design components and others — for example, seismic protection — will allow visitors to gain an understanding and appreciation of the building's ecology. In this way, the building itself will be featured as a primary exhibit and educational tool, suggesting alternative choices that minimize environmental impact.

The location of the building will also be a key element in its message. The planned site, nestled into the Wasatch Front mountain range (Fig. 2), commands a spectacular view of Salt Lake City and its surrounding valley, including the Great Salt Lake and the Great Basin Desert. It also occurs at the boundary of the city and the National Forest, a literal and symbolic interface that will be featured in the new Museum. Appropriate use of windows will not only offer spectacular views, but also provide opportunities to connect the museum's primary story directly with the surrounding area.

A Museum Without Walls

The 16-acre site on which the new museum will be situated offers additional opportunities for exciting, hands-on interpretation. With the guidance of docents, visitors will be invited to experi-

FIGURE 2. The site of the planned museum facility, situated at the nature/urban interface between the Wasatch Mountain Range and Salt Lake City. Photo by Derek Smith.

ence the habitat surrounding the building. Key features include the rocks (tectonic history of the Wasatch Front) and various lifeforms — bacteria, fungi, plants and animals adapted to the arid desert habitat. Taking advantage of the remarkable vistas, telescopes could be used as aids to help contemplate such topics as climate change, urban sprawl, and water use (through the Great Salt Lake). A nature path up the mountainside will take more intrepid visitors through a series of montane communities. They might be able to choose between a docent lead tour or a leisurely walk on their own, with interpretative signage adding to the experience. In this way, the UMNH will blur the boundary between inner and outer worlds, encouraging visitors to see the latter with new eyes (Fig. 3).

FIGURE 3. Concept rendering of proposed landscape gallery in new museum facility by Ralph Applebaum Associates, Inc. Features include visible collections, a functioning, hands-on "Rock Lab" accessible to visitors, and a viewshed interpreting the surrounding terrain.

Given the great size of the Utah, many citizens will never come to the Museum's physical location. Therefore, in order to fulfill our mandate as the state's natural history museum, the UMNH must engage in active outreach. Fortunately, we already have several successful programs firmly in place, such as *Museum on the Move* and *Scientist in the Classroom*. These efforts have been augmented by traveling exhibits that are loaned to schools and nature centers throughout the state. In addition, the UMNH plans to greatly increase its website presence, reaching audiences in Utah, the intermountain west, and beyond. Among other offerings, the website is expected to include virtual exhibits, curriculum materials developed as part of education programs, and photographs of objects in the collections.

A Place for Convocation and Creativity

In keeping with the goal of greater relevance, the UMNH plans to become a center of convocation for the local community, a place where key issues relating to natural history are presented and opened for further exploration. We hope that the new museum building will serve as a location for meetings of organizations such as natural history societies and other interest groups, facilitating discourse on topics related to the Museum's mission. Public lecture series and open discussions could address such difficult topics as water and land use, among others. These series could also be linked to temporary exhibits presenting key elements on all sides of the debate.

The University of Utah, an RU-1 institution, offers many fine opportunities for productive linkages. As part of the University of Utah community, the UMNH is working toward stronger ties with various academic departments. These include a number of departments directly related to natural history, including Biology, Geology and Geophysics, and Anthropology. A planned rotating exhibit space in the new museum will feature ongoing campus research of direct relevance to natural history. In addition, a variety of nontraditional university connections are being explored. For example, students in the Department of Architecture have played with various design concepts for the new museum as part of their curriculum. Moreover, although we have just begun to make contacts with Fine Arts faculty from such departments such as Music, Theater, and Modern Dance, these conversations have already fostered creative ideas about incorporating performance space into the new museum as a novel means of interpreting natural history. In the long run, a key goal of the UMNH is to strengthen its role as a window between the university campus and the outside world.

Conclusion

Natural history museums and related institutions are ideally positioned to help forge a path toward greater science literacy and engagement with nature. The UMNH has taken up this challenge with a new, integrative philosophy and plans for a vibrant new home on the margin of the University of Utah campus. The museum is fortunate in being situated in an area of magnificent and easily accessible natural diversity, and we plan to use this remarkable proximity to help achieve our goals. While recognizing the importance of a new building, we also understand that any true connection with nature will not occur in enclosed spaces, even a magnificent new museum. Only through direct, hands-on interactions with landscapes are people likely to forge strong, long-lasting links with the natural world. In accordance with this view, we view the museum largely as an interpreter, helping people understand the language of nature and thereby enable them to experience natural environments with revitalized senses. We hope that this description of an ongoing adventure in re-envisioning a natural history museum will aid similar institutions as they contemplate their respective futures.

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Planning for Research in the 21st Century at a Large Natural History Museum

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I have been serving as the Director of Research at the California Academy of Sciences for the past three and a half years, which puts me in a position to have had firsthand experience with the planning process that I will be describing for the future of the research enterprise at the Academy. In this presentation, I will first discuss why are we planning and why in the time frame that we have chosen. I will then outline the steps we have taken in our planning process and the sequence of events that have transpired over the past few years. Lastly, I will talk about where are we now in the planning process and conclude with a consideration of some of the remaining challenges that we face at the Academy?

Why Planning and Why Now?

Our planning process actually began nearly eight years ago in response to a number of stimuli, both internal and external, to our institution. The external stimuli included the approach of a new millennium, traditionally a time when institutions and cultures take a serious look at themselves — review their past, take stock of their present status, and look toward their future — and it is an auspicious time to do that. Our current Executive Director, Patrick Kociolek, who was then Director of Research at the Academy, recognized that profound changes were occurring in the systematics community, in systematic biology; and he wanted to see how well the Academy's research program was aligned with current trends in this field, to try to anticipate what additional changes might lie ahead in systematic biology, and to ascertain how well prepared we were to meet any new demands brought on by these changes.

Changes underway at that time affected just about all aspects of our research effort (see Jablonski and Ghiselin, 2004). These included challenges to and changes in the theoretical bases of systematic biology, even including our traditional systems of botanical and zoological nomenclature and their appropriateness for classifications based on phylogeny (see, for example, Härlin 2004). Previous analytical methods were under new scrutiny and challenged by new approaches (e.g., parsimony versus maximum likelihood and Bayesian methods for evaluating data, constructing phylogenetic hypotheses, and evaluating cladograms). Our tools were changing, perhaps more rapidly and dramatically than any other aspects of our science. Certainly the rise and widespread use of molecular tools were already underway in systematics; but the development of new tools for imaging, data analysis, data gathering, databasing, GIS, electronic publication, and use of the Worldwide Web were opening up a new set of powerful capabilities for increasing our output and broadening the scope of dissemination of new information that our research generates. We needed to know if we were in position to take advantage of these new tools.

Perhaps most importantly, we sensed that changes were occurring within the World community with respect to the perceived relevance of systematics and what it has to offer for discovery and description of biodiversity, for conservation, and for resource planning and management. There were, and are, signs that suggest that we may be entering a golden age for systematics, one in which there is a growing appreciation for what systematics is capable of delivering to society at large, as well as to the scientific community, if we make use of the tools and techniques that we have available to us now.

Our planning process also gained impetus from several internal stimuli. Most obviously, we were faced with an aging building complex that had inadequate, outmoded, and, at least in some areas, literally crumbling infrastructure. At a minimum, a basic facilities upgrade was urgently required. But more subtle stimuli were also operative. In 2003, we would celebrate our 150th anniversary as an institution. Such an event is another good occasion for an institution like ours to celebrate both its past and its present and reassess its directions with respect to the future. In addition, it was not an insignificant fact that, at that that time, we had our first non-rotating Director of Research at the Academy. Traditionally, that administrative position had rotated on a more or less regular basis; and Dr. Kociolek was our first "permanent, non-rotating" Director of Research. Whether he actually stayed in that position longer than his predecessors or not (which he did not), he was free, by mandate, to adopt a mindset that his predecessors did not have. He could look to the long term success of the research enterprise and begin processes that he could expect to guide and develop over a longer term. I think that this was a major factor resulting in the start of a most fruitful review and evaluation process.

It was already clear to everyone on staff, and especially to Dr. Kociolek, that we needed extensive changes to and upgrades of our physical facilities, our organizational structure, and our resources in support of research. At that time, we could not anticipate all the changes that were ahead of us, and both the pathway taken and our the goals have changed since this review and planning process began.

Steps in Our Planning Process

The planning process really began in June 1996, when the Academy initiated a "situation analysis" of its research enterprise. This was a combined internal and external review of our programmatic assets, our strengths, our weaknesses, our limitations, and the opportunities of which we might take advantage. At that time, we were not yet contemplating any major renovations of the physical plant; and minor renovations were all that we could expect to have approved for the facility in Golden Gate Park. The focus was mainly on programs, collections, human resources, and on what we could accomplish without radical changes to the physical plant. The main thrust of our assessment was on program.

In July 1997, a little over a year after the process had begun, and once the results of the situation analysis had been digested and distributed in a report, Dr. Kociolek convened a Research Division retreat to discuss and evaluate the findings of that report and, subsequently, to clarify our institutional programmatic aspirations. What could we hope to achieve? What was beyond our means? In what areas were we underachieving? What were we lucky that we had been able to do? We also wanted to formulate some specific goals and strategic initiatives for the research enterprise at the Academy to fulfill our aspirations. It was a wonderful session. We sat down and told each other to "dream the dream." What did we want to do, what did we want to be, and how can we achieve these dreams? Again, we were still constrained by a sense that we were not going to be able to alter radically our physical plant. With such a constraint, we kept encountering limits to what we felt we could do; so this kept our focus mainly on program and what we might be possible within the existing facility.

In 1999, Dr. Kociolek became the Executive Director. With the change of administration came a new vision for the whole institution (see Kociolek, in this volume) and certainly for the Research Division. We preceived it as a great advantage for the Research Division, and for the whole institution, to have a practicing scientist as Director. The vision that Dr. Kociolek articulated, and with which staff agreed, was that of a fully integrated natural history museum, one in which research is at its core and permeates everything the institution does. In light of this vision, staff were then charged with re-examining just about every aspect of our programs, our organizational structure, our facility, our infrastructure, and the various collaborations that we had developed, both internally and externally. It was an incredibly expanding experience to start thinking about what we were doing on that broad a scale. It became clear immediately that this vision could not be implemented fully in the current or even modestly expanded facilities, and that wholesale changes in the physical plant were required. In turn, such a physical change could eliminate former programmatic limits and permit the growth of broader capabilities than previously conceived (see Kociolek, this volume).

Freed from former physical limitations, at least in theory, the planning process shifted to an evaluation of our program, present and future at three different level. First was our intellectual program – what do we want to do? For the Research division, the answers to this question had already been generated through the steps taken during the previous two years. We had a plan, an intellectual program, that we had worked out together. The next step for us was to integrate that plan with the plans and programs that were being developed in education, exhibits, and other public programs at the Academy. That was the main modification that we had to make to our intellectual program for Research.

The second level of evaluation was of our organizational program. What organizational structure would best facilitate the intellectual program for Research and, then, the integrated program for all the elements within the Academy. At that time, for example, Education was part of the Research Division; and the programs for these two major elements were too diverse to be administered together. Subsequently, our Education department was moved to its own Division of Education with its own director, and the office of Provost was established to coordinate the programmatic interaction and integration of these two major units. Within the Research Division, we looked at how we were structured to determine if the present organization of departments, or some other arrangement, would better enable us to implement our intellectual program.

The third and final level of evaluation addressed our physical program. What facilities do we need to carry out our intellectual program? Our present facility includes 13 buildings, more or less conveniently linked to each other, each built at a different time and presenting different infrastructural challenges and limitations. Freed, at least intellectually, from the constraints of the existing complex, we've focussed most of our time over the past three years looking at our physical program. Our evaluation included a careful new review of the current facilities, and their strengths and weaknesses. We'd just gone through this process with the situation analysis; but the new option of a major renovation of facilities provided expanded possibilities and required another look at what changes might be beneficial. What are our special needs? What are the major growth areas among our collections? What adjacencies are necessary or at least preferable? How would we rearrange departments, laboratories, and offices given the freedom to do so? What kinds of internal and external collaboration do we really want to foster, and what, if any, are the physical needs of these collaborations?

As part of this process, and in my capacity as division director, I made benchmarking visits to about a dozen other institutions around the country that had recently built new facilities or renovated old ones. I saw the good, I saw the not so good, and I think we gained greatly from the experience of the other institutions. I found that curators, in general, are outspoken about their facilities; and whether facilities work well or not, you hear about it. Staff at every one of the institutions visited had stories to tell about things that went wrong (e.g., air ducts that passed through the middle of collections spaces). Obtaining such feedback was essential for evaluating our own planning, a good check to see if our ideas were in line with best practices and developments elsewhere. Let me cite four examples from among the many facilities visited.

Dr. Tom Daniel, of our Botany Department, and I visited the New York Botanical Garden's new wing (Fig. 1) that was designed exclusively for collections, but which was not yet fully occupied. Although there are a couple of visitor office spaces in that wing, at that time (2000) the location of staff office spaces in relation to the collection building had not been determined. Fron a collection standpoint, this is a fantastic facility, with fully a compactorized library and collections in a combination of new and old cabinetry (Fig. 2), all modified for the same moveable carriage system.

The Missouri Botanical Garden's Monsanto Center (Fig. 3) is another a wonderful facility with a superb spatial relationship between the collections and the research work area. We also visited the Research Institute at the Getty Center in Los Angeles (Fig. 4), mainly to view their 12-foot high compactors (Fig. 5). Because of the high cost per square foot for new construction, we were interested to see what the upper height limit might be for storing collections. Our conclusion was that 12 feet was probably too high for compactors for natural history collections. I also visited the new museum on the University of Oklahoma campus — the Oklahoma Museum of Natural History (Fig. 6). It is an institution endowed with abundant space, built on a 40-acre site with room to expand, so planners did not need to consider compactorization. Among several interesting features of this facility were perhaps the best facilities and protocols I had seen for quarantine and fumiga-

FIGURE 1. Exterior view of the new wing for botanical collections at the New York Botanical Garden, New York City. Photo by author.

FIGURE 2. View of a collection area in the new wing for botanical collections at the New York Botanical Garden, New York City, showing compact storage system and layout space. Photo by author.

tion of materials entering the museum. Figure 7 shows the museum's registrar standing next to an inflatable carbon dioxide chamber that is used to fumigate large objects or large quantities of incoming materials. The freezers along the back wall in the picture also are used to treat certain incoming materials.

CURRENT STATUS OF OUR PLANNING AND PROJECT

In response to our initial situation analysis in 1996, and largely as an outcome of our 1997 retreat, we generated a current status report. Among our findings were the following: (1) we currently have eight research departments in locations widely distributed throughout our building; (2) our facility is a complex of buildings that were added, one by one, over the last 70 year period; (3) our collections total more than 18 million specimens and are worldwide in scope; (4) each of our collections has particular geographic and taxonomic strengths, and most are ranked in the top ten nationally or internationally; (5) all of our collections are out of expansion space, or nearly so; (6) our collections are active and growing at an average rate of about 2% per year, though faster in the Entomology, Invertebrate Zoology, and Herpetology sections; (7) at present, collection growth rate is probably higher than at any other time in at least the last 50 years, this as a result of activities associated with grants through the BSI, PBI, and Tree of Life programs at NSF — all programs that foster intensive collection acquisition, if not curation; and (8) with regard to electronic databasing

FIGURE 3. Exterior view of the Monsanto Center, Missouri Botanical Garden, St. Louis. Photo by author.

of collections, our record is varied; whereas small to relatively modest percentages of the largest collections have been databased with specimen-level databases (e.g., Entomology, Invertebrate Zoology), others are fully databased (e.g., Herpetology). Our Anthropology collection, which is our smallest collection, not only has all of its specimens databased but most are already digitally imaged. At the other extreme is Entomology, our largest collection, with perhaps eight million specimens still requiring retroactive databasing, although we're doing a very good job keeping up with incoming material and have databased nearly one million new specimens in the last two years.

We also determined that our physical plant severely limits many aspects of our current program and will not support what we envision for ourselves in the future. In particular, we have very poor adjacencies. We also have inadequate laboratory facilities for the tools that are available or should be available to us now. With regard to the research personnel, we have a modest staff considering the size of our collection: 21 curators and another 10–20 research scientists (including post-docs, resident research associates, Emeritus Curators, and other researchers). In all, we have about 130 paid staff in the Research Division, totaling about 80 FTE's. At the moment, our graduate student population is steady at about 25; they are supervised by Academy curators or researchers. Finally, we have hundreds of volunteers, who contribute greatly and are essential to the work of our departments.

Another finding of the status report was that research staff are distributed too widely throughout the institution to facilitate frequent interaction and easy collaboration. Figure 8, a map of our current facility with the locations of our curators' offices plotted in different colors for different

FIGURE 4. Exterior view of the Research Instititue at the Getty Center, Los Angeles. Photo by author.

floors, shows that our scientists are distributed broadly, mainly around the periphery of the complex. We view this distribution as a negative.

We have an excellent institutional record of obtaining facility and collection support grants; and, in the last five years, we have had many more research grants awarded than in the past. Also, our record of modest research productivity and relatively low representation in so-called "high impact" journals has improved dramatically.

We currently have several successful collaborative programs in place for training students and young scientists in systematic biology, with virtually all of these having been established within the last five years. Figure 9. shows the expansion of our training program, for several "student" categories ("measures"), over the past 10 years, but most dramatically over the last five years. We now have formal joint programs with San Francisco State University (our most active program), and also with the University of California at Santa Cruz and Stanford University. We also share students with Sonoma State University and the University of California at Davis. This has resulted in a rapidly increasing involvement of our staff in the training of students at the graduate and undergraduate levels, especially over the past five years. Also, we've been very fortunate to have received substantial foundation support, specifically for the training of students from developing countries. We also have a program called the Summer Systematics Institute, which now has been running for eight summers, that brings undergraduates from all over the country to San Francisco to work directly with Academy scientists on real research projects. This program has enjoyed consistent and enthusiastic support from the NSF.

FIGURE 5. View inside 12-foot high compact storage system at the Research Instititue of the Getty Center, Los Angeles. Photo by author.

FIGURE 6. Exterior view of the Oklahoma Museum of Natural History, University of Oklahoma, Norman. Photo by author.

ASPIRATIONS AND GOALS

Based on our planning to date and following our extensive self-evaluation, we have articulated a set of aspirations that are shared throughout the Research Division. They include (1) excellence in whatever we do; (2) leadership in systematic biology and in the training of graduate students in systematics; (3) integration of the research with the other aspects of a natural history museum; and (4) collaboration, both within our institution and with scientists and institutions outside of our own walls. NSF is creating program after program that support these aspirations. The natural sciences today require greater levels of collaboration than we have been used to traditionally.

Those are our aspirations. What are our goals? We want to achieve high levels of productivity and quality in original scientific research. We want to foster multidisciplinary research, especially within our own walls. Such collaborations represent a return to our roots. The collections we have now really sprang from the recovery after the earthquake and fire in San Francisco with the return of the schooner *Academy* from the 1905–06 expedition to the Galápagos Islands. We had numerous Academy multidisciplinary expeditions to Baja California, to China, and elsewhere around the globe early in our history, and we're returning to this approach because it is still a good way to work. We want to play a major role in the training of the future generations of systematic biologists. We want to further develop the depth and breadth of our Academy collections. We make good use of them, and it's something we ought to do because we do it well. We want to make the Academy collections and the data that are associated with them more accessible and useful to the

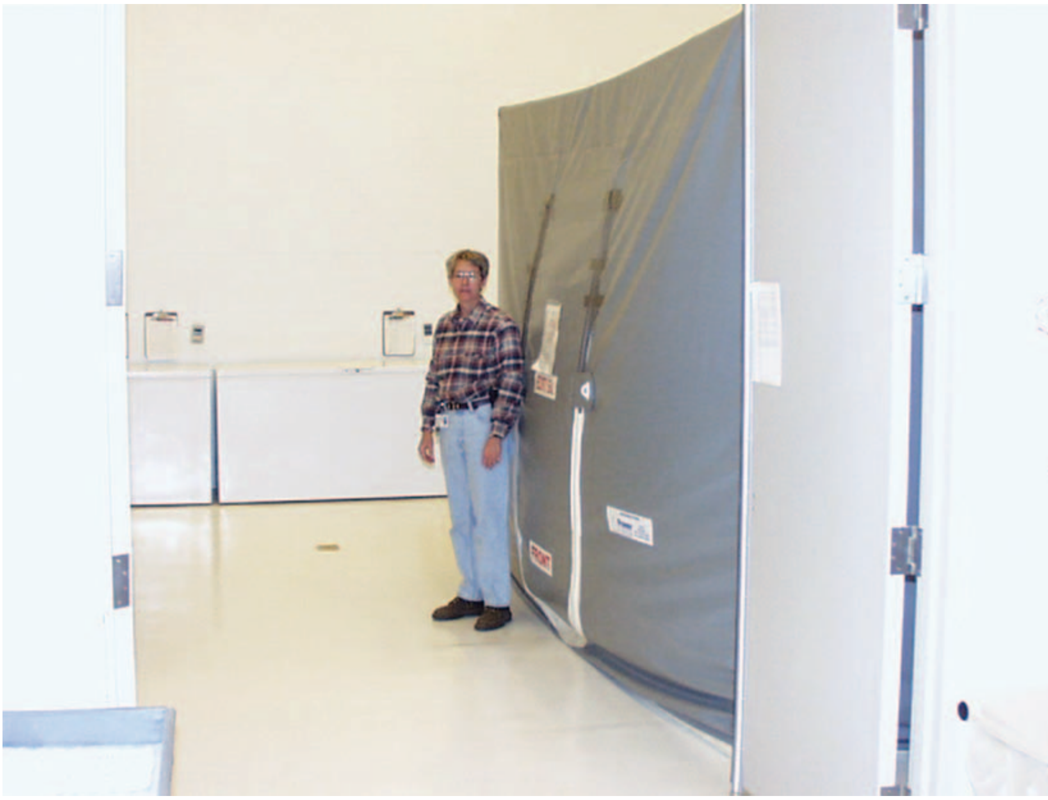

FIGURE 7. View of the quarantine and fumigation area at the Oklahoma Museum of Natural History, Norman, with the museum's registrar standing beside an inflatable CO_2 fumigation chamber and "fumigation" freezers in background. Photo by author.

broadest as possible audiences. We also want to increase public and peer awareness of the Academy research enterprise as broadly as possible.

We plan to accomplish these goals through a series of strategic initiatives that include, among other, the following: Focus staff energies and resources on building leadership in research, which might include restructuring departmental units within the Research Division. We have eight research departments; and three of them are single curator departments, so some merging of departments may be productive. We have needed to review our curatorial appointments, promotions and review procedures, and salaries, and have recently made significant improvements in all of these areas, most significantly in salaries, so that we are much more competitive than we were just five years ago. We want to create a wide range of opportunities to elevate the intellectual environment of the Academy, particularly by attracting visiting scholars, offering postdoctoral fellowships, adding to our graduate student population, and offering undergraduate fellowships and internships, all areas in which we are making good progress already. We will require that our new facility contributes to this development even further. We wanted to create a center for biodiversity research and information, and this we have already done. Its charge is to foster multidisciplinary research and the preparation of broader and higher impact publications, based on syntheses of the work of individuals working collaboratively. Also, this office and center will be responsible for and facilitate development of information systems that cross disciplinary lines and are created in a way that makes them more useful throughout the institution and also externally.

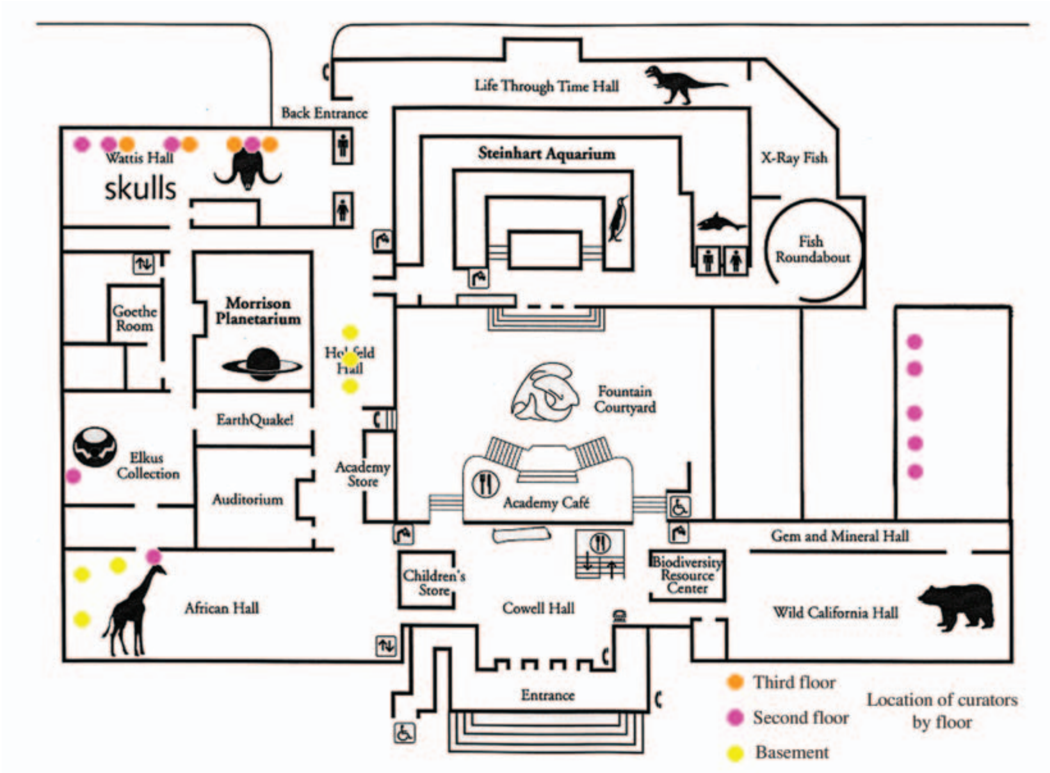

FIGURE 8. Floor plan of the present California Academy of Sciences, with the distribution of curator offices by floor (indicated by color circles [see legend]).

Goal: Training of the Next Generation of Systematists

measures	1991-92	1996-97	2001-02
# Postdoctoral Fellows	3	4	4
# Graduate Students Committees	18	14	26
# Graduate Students Supervised	0	2	24
# Undergraduate Interns	0	9	8
# Foreign visiting students/ young professionals	?	?	15

FIGURE 9. Goal: Training of the next generation of systematic biologists at the California Academy of Sciences, 1991 through 2002

Through our different cross-disciplinary discussions, we identified several geographical areas in which several of us plan to continue working collaboratively. Chief among these are Madagascar, China, Myanmar, the Galapagos Islands, and Papua New Guinea, areas that already represent both institutional research and collections strength. We want to continue to build on these strengths, and we want to recruit staff for this purpose. At the same time, because we, as an institution, must manage our collections for the benefit of the larger scientific community, we cannot ignore our responsibilities to that community. For instance, we feel an obligation to provide a safe haven for orphan collections through selective acquisitions and to provide working space for those who need to access those collections for. Thus, we recognize the urgent need to obtain additional space for research and collections.

Early on, we recognized and established a series of 15 or so assumptions that not only have guided us in our planning process, but that have survived the test of time and still remain in affect. For example, we assumed (1) that the research staff, departments, and collections would remain in Golden Gate Park with the education and exhibits programs; (2) that we would build the space required to accommodate fully our staff and programs; (3) that we would have ready access to our collections; and (4) that adequate space would be available not only to accommodate our existing collections but also allow for at least 20 to 30 years of growth.

Where Are We Now? — Challenges Ahead

At present, we are still in constant dialog with our architects, who continue to refine their designs for the new facilities in keeping with our programmatic requirements for space allocation and attributes, adjacencies, and fiscal concerns. Current plans call for a nearly complete dismantling of the present physical complex and then building of the new facility on our present site in Golden Gate Park. The demolition and rebuilding process is expected to take nearly four years to complete. This plan will require that we move our entire operation, including all collections, to an interim facility for that period.

For most of us, the sheer magnitude of the effort that will be required for the moves, first to temporary quarters and then back again a few years later, represents a daunting challenge. Not only do we plan on maintaining as complete a research program as possible during the period in temporary quarters, but we also will use this period to test many of our assumptions about appropriate adjacencies and spatial needs and attributes, how we will work in the future, and the effectiveness of our strategies for reaching our long-term programmatic goals. It should be an exciting and challenging time!

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The California Academy of Sciences 150 Years Young with a Vision for the Future

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Innovations Past and Present

The California Academy of Sciences has had a long and rich history (see Aldrich and Leviton 2000; Leviton and Aldrich 1997; McCosker 1999 for excellent examples). Established in 1853, it was the first scientific institution of its kind west of the Mississippi River, predating similar museum-based organizations in New York, Pittsburgh, and Chicago. Many "firsts" mark the institution's history. The Academy established the first public museum in San Francisco in 1874. The institution employed the first paid woman curator in the country in 1883, Mary Katharine Layne Curran (the future "Kate Brandegee"), and she was quickly followed by a second, Rosa Smith (the future Rosa Smith Eigenmann), in 1884. The Academy served as the first home to the Sierra Club, which had its offices in the first decade or so of its existence at the California Academy of Sciences. The Academy is also a unique suite of a natural history museum, aquarium (Steinhart Aquarium), and planetarium (Morrison Planetarium) all in one place, coupled with research and education.

In addition to its many "firsts," the Academy has had in its research, education, and exhibition programs many innovations, from dioramas that are some of the most beautiful ever produced, to the aquarium, which was one of the earliest in operation (and as of this symposium the oldest continuously operating aquarium in the country), to the planetarium. The latter, when finished in 1953, was only the seventh in the entire country. It was also the only one ever fabricated entirely inhouse, this because, following the Second World War, the Academy was unable to obtain a commercially produced star projector for its newly constructed planetarium. So, it produced its own in its instrument shop. The design and approach served as the basis for the first star projector for the Goto Co., a Japanese manufacturer still in business. The roundabout tank in the Aquarium was the first of its kind built in North America. The Academy, starting in the mid-1950s, also produced what appears to be the one of the earliest television shows on nature, *Science in Action*. The live show was broadcast from the Academy. For most of its existence, the Academy has taken pride in seeking new venues to communicate our interest in the natural sciences to the public, and this has continued down to the present day. Today, nearly 2 million people per month visit us by the Internet.

The Academy sponsors a vigorous education program, armed with docents giving numerous tours of the museum. It offers nearly 200 classes a year, all held at the Academy, except for its field trips, which serve to introduce people directly to nature through a wide range of outdoor educational opportunities. And every year, half of all of San Francisco school children pass through our facility; they come from every school, public and private, in the city. Actually, 40 percent of the California's schools from Santa Cruz to the Oregon border, a distance of more than 400 miles, send at least one class to the California Academy of Sciences every year. Annually, over 400,000 people are served by our education programs.

Academy scientists, numbering nearly three-dozen, are this year studying in 33 different parts of the globe. Our scientists published over 90 peer-reviewed papers and books last year. As would be apropos, the cover image of a recent issue of *Science* magazine is titled "The Tree of Life" (*Science* 300[5626]:cover, 13 June 2003). The identification, description, evolutionary relationships of the organisms that comprise the earth's natural endowment, and their distributions over space and time form the core of our scientific studies. With those activities, approximately 18 million specimens have been amassed in Golden Gate Park, accumulated mostly since 1906. It was in that year that almost all of our collections, painstakingly acquired during the first 53 years of our Academy's existence, were destroyed by the fire that followed the great San Francisco earthquake of April 18, 1906.

Multidisciplinary research has been a big part of our history. That approach has included a series of expeditions to Galápagos, and, more recently, major, multi-year, multidisciplinary commitments that involve work in China, Madagascar, and Myanmar (Burma), each engaging the attention of most every scientific department at the Academy. The tradition of multidisciplinary expeditions was begun many years ago, during the latter part of the 19th century starting with expeditions to Baja California; we will assuredly continue that tradition into the future.

Scientific research and education, comprising our dual mission "To explore and explain the natural world" strongly express the work of the Academy. That exploration and explanation are becoming more critical as the natural endowment of the earth is ever more threatened. However, the Academy is not new to the area of conservation. Conservation has been a part of the Academy for a long time, whether it was supporting the proposal in the early 1860s to set aside Yosemite Valley and its bordering highlands as a park dedicated to the people in perpetuity, to the establishment of Big Basin State Park, to the protection of Mt. Shasta and its environs in the late 19th century from overzealous logging interests, to a wide variety of other conservation issues in a state that, in particular, has been a leader in conservation issues locally, nationally and internationally.

The institution has had and continues to have significant impact worldwide. And in San Francisco, in a city that celebrates its cultural diversity and its cultural institutions, the Academy is by far its largest cultural institution.

Challenges Facing the California Academy of Sciences and Natural History Museums In General

Despite the wonderful, rich history of the Academy, and the impacts it makes locally, nationally and internationally, our institution, and institutions of natural history in general, face major challenges. The challenges are *intellectual, strategic*, and *physical*.

Intellectual challenges for natural history museums are those within the museum and others, quite similarly, from outside the building. Internal challenges include the vestiges of perceptions related to museums not being on the forefront of science, relegated to a storage/caretaker status for collections whose relevance is less and less clear. In this situation, the collections are seen not as assets but as resource sinks, both for money and space. These dated perspectives linger in the worlds of trustees, some administrators, and public programs staff. Outside the museum, natural history museums are viewed by some as stagnant, never changing facilities. It was as if, with their exhibitions based on building blocks of marble and brass, the museum and science itself sought eternal, never changing truths, and that these collections of facts were then embodied in a presentation system that was difficult to change. The relevance of natural history museums has not been well understood or perceived, even by many of those most closely associated it, including staffs, trustees, and visitors.

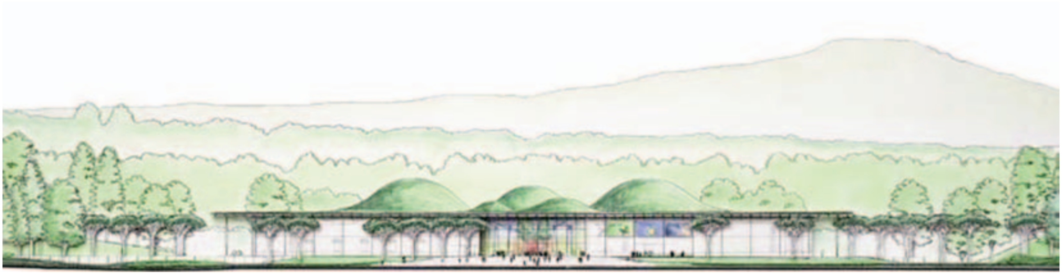

FIGURE 1. An artist's sketch of the new Academy building as seen from the the front. Image provided by Renzo Piano Building Workshop.

Yet, in a poll done by the Academy with Harris Interactive, the need to understand biodiversity is clear, and the relevance of *Science* to people's lives, including basic decisions people make every day, is well understood. Natural history museums, with their dynamic research programs, concentrated taxonomic expertise (to help address the taxonomic impediment in the biodiversity crisis), and playing the role of an equalizer in society, providing access to objects and ideas that the general public might not find elsewhere, are well positioned to address societal imperatives in research and education.

Strategically, for natural history museums to meet the demands of the future, they need to become more integrated in terms of their own research programs, fostering interdisciplinary studies, and across programmatic units, i.e., research, education, and exhibitions. And, instead of imparting institution-based "facts", museums also need to be sensitive to the interests and needs of their visitors, intellectually in terms of content, its changing nature, and amenities demanded by the marketplace. The changing nature of information is a given in the world of science. It is a world not of developing dogma, the old museum model, but of challenging dogma, of creating new data and generating new ideas and hypotheses. Science is a dynamic enterprise, not a static one, and the challenge, then, is to be able to share and express the dynamic nature of science, not keep it locked away from public view in musty storage cabinets, insulated laboratories, and technical literature. (See also Allmon, this volume, and Sampson and George, this volume.)

Many natural history museums face the additional challenge imposed upon them by their own buildings. These buildings, though large, strong, and often impressive in appearance (see Kohlstedt, this volume), are actually impediments to meeting the intellectual and strategic challenges museums face. The nature of their designs rebel against flexibility and change, and due to the way many of these institutions have grown, with additions in collections, scientific tools and disciplines, education programs and new exhibitions, the physical facilities are many times a hodge-podge of additions without the context of a long-range plan for the physical plant. In addition, they may be deteriorating due to their age (many institutions have been in their buildings 80+ years), and too rigid to support the level of change needed today and for the future. At the Academy, the ages of our 12 buildings show: serious seismic issues, systems and code deficiencies, e.g., lack of an integrated fire and safety system, ADA inaccessible, and leaking roofs. Programmatically, at a time when we are striving for integration within the institution, our intellectual capital has been pushed away, to the point where the two most distant points in our facilities, a distance of no less than a fifth of a mile, end up in scientists' offices.

MEETING THE CHALLENGES AND LOOKING TO THE FUTURE

The project to renew and rebuild the California Academy of Sciences was initially viewed as

FIGURE 2. Illustration shows the interaction between the Architect for the building and Exhibition.

one to address the physical needs of our buildings. But early on we found ourselves taking a hard look at how we could best play our role in society, given our mission "to explore and explain the natural world." Research plans have been developed that relate to creating a better understanding of the world around us and the ways our data could be used by a broad cross section of traditional as well as potential new users. The nature of needs in science in the schools also have been extensively discussed, especially given the poor showing of California's schoolchildren in national math and science tests. Meetings and focus group conversations with a wide range of constituencies centered on their needs and expectations about a natural history museum in the 21st century. These conversations led to insights about the marketplace, mindful of the competition for people's time as well as money, people's expectations, and people's aspirations for the institution.

The desire of our scientists to work more in interdisciplinary research, as well as to bring information together in a more cohesive fashion thus enabling them and their colleagues better to make informed decisions not only within their own specialties but in addressing concerns about conservation problems around the world, have also driven our planning. In terms of educational programming, we are trying to do nothing short of making a more scientifically literate citizenry. This is a lofty goal, but an absolute imperative. People are making important decisions related to themselves and California, a state where the economy has been fueled by science and technology. In this state, schoolchildren have consistently scored very low relative to the rest of the nation. So, for California, "Where is the next generation of scientists going to come from?" is a fundamental question. We think we can help answer that question. We believe that a museum, both on the public education side and for formal education, can be a great equalizer in our society, providing access to objects and ideas for the future.

We have been looking at three "programs' to help us address these societal needs. One is our

FIGURE 3. CAS Creative Design Team: CL = Client (=Academy Executive Director); CD = Creative Design Director; Δ = Design Group: OD = Octal Design, CAS = Academy Exhibit Design, RPRW = Architect; ▭ = Content group: E I = CAS Interest Content Spec; ○ = CAS groups to provide detail contents.

programmatic response, which we call an "intellectual program", that deals with addressing questions like "How will our science work?", "What are the education programs that we will offer?", "What are the exhibits that we will have at the Academy, and how will we assess their impact?" The second "program" is an organizational agenda, how the Academy will achieve the intellectual program. This is a very difficult set of analyses and considerations, because it deals not only with organizational structure, but also with the people and skills necessary for the 21st century, and the way people must work together to get things done.

Given an intellectual program and way of working, we then asked "does the current complex of buildings in Golden Gate Park allow us to support those programs?" In other words, can the current form support the future functions? That is how we thought about this project; "What do we need to do?", "How will we get it done?", and "What kind of facility will allow us to accomplish our goals?" We needed a building to support the wide array of programs at the Academy, to meet the aspirations we have in research, education, and exhibitions, and as an institution dedicated to societal aspirations.

A Building in Support of Science

In order to understand not only our programmatic needs, but also how the building might look and operate, we developed a wish list for our building. First, we knew we would have to create inspiring spaces to be synergistic with exhibits, and also support all of our other programs. We were actually very active clients to say that this is the program that this building has to support in these areas. We knew that we wanted the building to express a relationship with Golden Gate Park. And we wanted it to be a creative blend of old and new, whereby we recognize the contributions and values of the past but build for the future. Also, the building needed to be adaptable, durable, flexible, safe, and assuredly accessible. And, in all this, we wanted this building to express our ethic and values about nature (Fig. 1).

The contour of the roof is in some ways an expression of our values as an institution. The roof has seven undulations; one of those undulations is where the planetarium will be, another expresses where a major new exhibition on rainforests will be. Another of the undulations will be associated with the Steinhart Aquarium, allowing you to look into the Academy. One of the undulations will be associated with an elevator (and stairs), because you will be able to go up and be on the Academy's roof. The roof will be a living roof. It will be a sod roof of almost three acres. Twenty-four different California native species will comprise that roof. It is part of the sustainable approach to architecture that this building will encompass. The roof has been designed to take on about 2 million gallons of rainwater each year, water that will not go to the storm drains of San Francisco. The rainwater will either evaporate or we will capture the excess and use it in a "gray water" system in the building. Our visitors will be able to go up and have views of the park, but also this building will tell its story; it will be an exhibition in and of itself about sustainable design. Energy efficiency and conservation, water conservation, natural light and air for our staff have been taken into consideration. Thus, this strategy will help us create a "green building." But if one is going to build a green building, what "shade" of green should it be? The U.S. Green Building Council certifies green buildings, and their certifications are silver, gold or platinum. The Academy's building, by design, will be a platinum-rated building — one of only a handful in the entire country and, once built, it will be by far the largest, most visited platinum-rated building in the world. Thus, the building should not only support a well thoughtout program, both intellectual and organizational, but also express the ethics and values of the organization. In this case, a wonderful juxtaposition of natural form and life with the high technology necessary to harvest and use natural resources in the most efficient and effective ways.

Process and Sacred Cows

When making change on the scale that we are doing at the Academy, we find there are a lot of sacred cows in the institution, items large and small, that people want to preserve, ranging from buildings, to exhibits, to programs. A relatively little discussed area relates to the processes of an institution. These can be viewed as sacred cows, too. Usually people do not think about processes in this regard, but in some ways they are more important than physical elements.

There are many constituencies who might perceive, and want to preserve sacred cows of any type. These may be people outside the museum, visitors, donors, politicians and consultants; but they live within the institution too — well-meaning, thoughtful individuals among the staff, among the trustees, among our volunteers, and others. One area addressed by the Academy on this rather sensitive issue is with regard to the development of exhibits, and the relationship of the architecture and exhibits as sacred cows. When this project was started, some people told us that we had to do the architecture first. The argument was, "The museum serves everybody. It's not just an exhibition space. You need to get the building right and then the exhibits can follow." Others told us, "The museum is about the public, and you have got to get the exhibitions first. That's what's paying the bills, so let the exhibit folks take off and then build the building around the exhibits." This led to the question of who should have primary responsibility for the design of the exhibits. Some advocated that the in-house staff should have primary responsibility. The argument was that the internal staff had knowledge about the museum, they share the passion and the mission of the organization, and, therefore, they can express the institution's ethic and mission in the design.

Others advised that we use external folks. "This is a once-in-a-lifetime opportunity, requiring the best and the brightest" and "You'll want to pay for high levels of creativity that you can't otherwise afford 365 days a year as a not-for-profit organization." In the end, the approach the Academy took reflected neither of the two points of view, either with respect to the debate over architecture versus exhibitions or the debate over who should design the exhibitions. Our approach was to strive for synergy. Architecture and exhibits are to be integrated (Fig. 2), in the same way as our institution is striving to be a more integrated institution. So, we had to figure out a way to marry content and design, bringing different expertise to the table, just as you would in a research project. To do this, we decided to create a team for our creative process. This team came to include four outside design firms, our own exhibits department, the architects, as well as content specialists from within and outside the institution. And, rather than assigning the outside firms to some specific tasks, such as one firm gets the aquarium, another the planetarium, a third the natural history museum, we wanted a single team working together (though these four firms were simultaneously competing for work on other projects) with the architects at the table. We had to, and wanted to, by design, manage the planning as a single, integrated process and the group as a single team (Fig. 3). What we had to do was introduce all of those diverse people, each with different skill sets, to each other and to the Academy. We had to figure out a way to get them to collaborate, to set their intradisciplinary jargon aside, to develop a sense of shared values about what we were trying to do as an organization, and to impart to the unified team the imperative and importance of this project. There were many management issues along the way.

In addressing the design of the building, and the way in which we approached the design of the exhibitions, and the integration of the two processes, we have striven for innovation and leadership as an organization. The building is not only innovative in the way it is designed and the resources that it uses, but operationally as well — the Academy will be a green organization. In terms of leadership, the way that we are thinking about what a natural history museum is, and the processes that we use to achieve our goals, we think will be exceptionally important for many of the other projects that are coming online both here and elsewhere. The large number of projects being considered by sister institutions will be able to benefit from our experiences. We are rebuilding this 150-year-old institution on our strengths and assets. There are intellectual and physical assets, specimens, scientists, and projects. In some ways we are rediscovering our past, like expeditions, like the power of real things; this innovative spirit that has been part of the California Academy of Sciences for 150 years. And we are continuing to challenge ways of thinking about what a natural history museum is and the role it can play in communities not only in the United States but even worldwide. All of that is done ultimately to develop a set of programs, a way of working, and ultimately a facility that will serve society and the Academy well into the 21st century.

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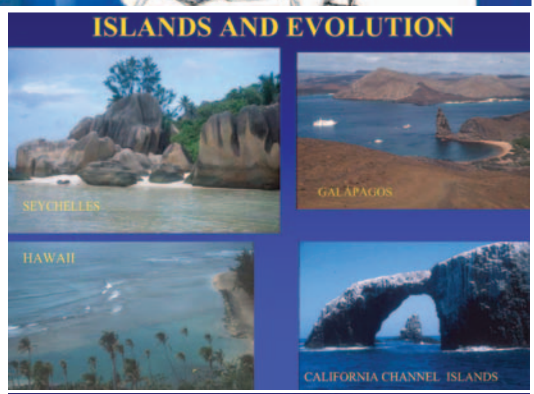
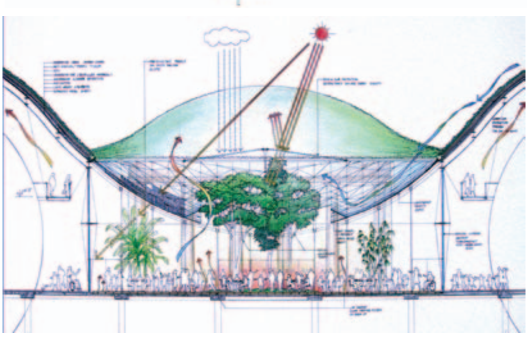
Living Rainforest
Costa Rica
Madagascar
Borneo
Entry Vestibule
Amazon
Flooded Forest


ISLANDS AND EVOLUTION
SEYCHELLES
GALAPAGOS
HAWAII
CALIFORNIA CHANNEL ISLANDS




GALÁPAGOS THEMES
Endemism
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Epilogue

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This volume celebrates a proud legacy of natural history museums, including earth science institutions and botanical gardens, particularly in the United States. It is a tradition that dates back to our founding as an independent nation. Moreover, the science and the collections of these institutions are what have traditionally defined their character and their individual and collective impact.

The first eight papers in this volume bring to light the historical traditions that have molded our exploration of the natural world, beginning in the late 18th Century and continuing through much of the 20th Century. The times and the challenges that each institution has faced differ markedly, but the flowering of these natural history institutions is underscored. It is evident that unrelenting visionaries such as Charles Willson Peale, Spencer Fullerton Baird, and William Temple Hornaday are largely responsible for the noble traditions we have inherited and often take for granted. It is also made clear that our natural history institutions have taken on the personalities of the individuals who have led them and worked at them. Each one has its own changing character, and each has flourished or suffered from good or bad leadership, as well as times of good and bad fortunes.

On the other hand, it was Giovanni Pinna (2000) who called our attention to an alarming trend that has become rampant among natural history institutions. He observed that in recent years natural history museums have become more and more homogeneous. Each one has installed its very own obligatory dinosaur, it has a mineral hall, and it has some form of dioramas. The latter may be classical or, in more contemporary treatments, open. Pinna contends that this homogenization is largely a result of the programmatic separation of the research and public program enterprises in the realm of natural history museums. This trend has been compounded by trends in the academic enterprise that spill over into the museum arena.

One of the most profound intellectual changes that began in the 1960s was the marginalization of systematic biology. With the advent of "more important" molecular biology and biochemistry, organismal biology began to languish in terms of its stature and funding. This had profound impacts at universities, where systematists and other organismal biologists as members of their faculties, were not replaced on retirement. As a result, natural history museums became the last bastion of systematic biology. This trend essentially bottomed-out in the mid- to late 1980s. Two events have prompted the resurgence of systematic biology. The first is an intellectual one, the so-called "Hennigian Revolution," which included the acceptance of a new paradigm for the more rigorous testing of phylogenetic relationships and the deriving of a classification system of organisms

Some visions of the future for the California Academy of Sciences(left): From coral reef habitat (top) to central themes such as Island Evolution (right center) and Galapagos Islands (right bottom) to tropical rainforest (left center) and sustainable architecture (left bottom).

directly from these results. This major advance rekindled the acceptance of modern systematics as a vital science. The second is the realization that we grossly underestimated the diversity of life on Earth, and this realization is coupled with a human-induced extinction of species that rivals the great extinction events of the geological record. These factors combine to produce a biodiversity crisis that necessitates systematic biology as the primary vehicle for understanding the diversity and distribution of life on the planet. We cannot protect and conserve that which we do not know!

Other factors have profoundly influenced museums in recent years. For instance, one dynamic that has shaped the direction of museum exhibits is the concept of the "traveling blockbuster" exhibit. This is an idea that began with fine arts museums in the 1970s and produced exhibits such as "King Tut". It also morphed into a reliance on the traveling exhibition as a way of bringing freshness to museums to compliment permanent halls and to sustain visitation. Another trend in museums has been the establishment of science and technology centers. Based on the traditions of long established institutions like the Children's Museum of Boston and the Museum of Science and Industry in Chicago, and the success and innovation of San Francisco's Exploratorium, a proliferation of science and technology centers has occurred around the globe. These institutions focus on combining interactive exhibits and visitor experiences to meet predetermined educational outcomes.

Presently, natural history institutions are re-examining the roles they must play the meet the challenges we face in the 21st Century. Thus, the major natural history museums in the United States, and many other similar research institutions both here and abroad, are in the midst of dynamic change. In some ways, they are returning to their roots, rather than trying to be "everything to everyone." In focusing on their individual, and oftimes unique strengths, whether national, regional, local, or academic, all are looking for innovative ways to help turn the tide against the trend of decreasing science literacy at a time when scientific knowledge is ever more important to a contemporary citizenry. That citizenry is simultaneously becoming more diverse culturally. The challenges are great, but so, too, are the opportunities. We see this in the final six papers in this symposium that explore case histories of how different institutions are coping with changing societal needs within the context of their core missions. Whereas each institution is looking at these challenges in a different manner, there are remarkable similarities in the ultimate direction they are choosing. Yet, Giovanni Pinna would be pleased with the paths they are taking. Each is exploring ways of building on its strengths and traditions, and this will, undoubtedly, lead to institutions each with its own distinctive suite of characters rather than homogeneity that seemed to be taking over. Bill Conway's tale of "elephant ears" (see Raven, this volume) may have run its course. Out of necessity, these institutions will also serve our society well in an epoch of dealing with fundamental challenges to the survival of species in a rapidly diminishing natural world. Each is responding positively to further our understanding of both biodiversity and the need to conserve that biodiversity and other natural resources, as Dr. Raven has so aptly argued in his presentation in this volume.

Literature Cited

Pinna, Giovanni. 2000. A philospophy for natural history museums. Pages 333–337 *in* M.T. Ghiselin and A.E Leviton, eds., *Cultures and Institutions of Natural History*. Memoir of the California Academy of Sciences 25.

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(Compiled by Michele L. Aldrich and Alan E. Leviton)

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