bureaus for those studies requisite for security. There has been too a fortunate tendency to increase the amount of work done in government laboratories which can be classified as of a fundamental character —that is to say, searching for truth for its own sake rather than for practical procedures immediately applicable to daily life. Essentially research depends upon a large amount of reserve time which can be used by men of great curiosity and industry without the supervision of others except in the broadest way. The ordinary administration of government, the ordinary handling of budgets, do not lend themselves well to research. It requires its own technique. In it there will always be an apparent waste of time and false leads. Most leads in the great unknown are apt to end blindly. The discovery of new facts which once discovered become the eternal property of man, is full of hazards and uncertainties. In some ways the research worker has as difficult a task as that of a blind man trying to thread a needle. Many attempts must be made before success is assured. Because of this it is most important for the modern democracy to set up its relationships to science from the standpoint of the budget in such a way that funds will not be tagged for specific purposes. Funds should be made available for the securing of the best brains possible and for the facilities that they require, in order to pursue the unknown. While this function is carried on by many independent institutions and as a part of great industrial concerns, nevertheless it seems to me that, since science and government are so closely related, government itself must make liberal grants for investigation and research. In the new world's civilization which is now a world-wide structure, interlocked economically and with all kinds of interrelations and intercommunications, a new conception of world citizenship is developed. Truth discovered by the citizen of any country can readily become the property of all. A democracy which is not seeking for new truth and new facts can no longer consider itself safe in this world of harsh reality where facts determine the issue. These facts applied either to industry or to national defense determine not only progress but even safety.

The U. S. Geological Survey is an example of the service which science can render to government. The geologist with his trained mind has made a study of that part of this great continent which is in our possession. Through years of endeavor and the work of thousands of trained men, we possess a fund of information regarding our mineral, water and soil resources which guides much of our national policy in various fields. It is obvious that without the help of the expert we should have floundered in our conquest of the natural resources of the country. Upon the imaginative mind of the geologist and his capacity to visualize the treasures stored below the surface of the earth depends much of our future national welfare. In the Geological Survey we have had much that was practical but also much that was fundamental.

It is a privilege for me to congratulate the men here who represent in person the great services rendered to our country through this particular activity. In them we see the scientist in the service of government. If we can develop in other fields the same type of devoted and earnest and intelligent service that characterizes this survey, we can look with assurance upon the future of our people. But this assurance can only be secured by an understanding on the part of the citizens of our democracy of the true place of science. Majority votes may determine political activities, but they can in no way influence the laws of nature or those of science. A wise democracy will harmonize its program with them. The scholar and the research worker must have the freest initiative to pursue truth, no matter where it may lead, if we are to avoid the perils of ignorance.

RAY LYMAN WILBUR

DEPARTMENT OF THE INTERIOR

THOMAS JEFFERSON, THE PIONEER OF AMERICAN PALEONTOLOGY[1]

IN 1789 the Reverend Nicholas Collin, an accomplished botanist and acquaintance of Linnaeus, remarked before the American Philosophical Society at Philadelphia:

> The vast Mahmot is perhaps yet stalking through the western wilderness; but if he is no more, let us carefully gather his remains, and even try to find a whole skeleton of this giant, to whom the elephant was but a calf.

Collin was one of the prophets of American paleontology, with whom we may rank other historiographers—such as, Samuel Maverick (1636); John Bannister (1686); the French officer, Longeuil (1739), who took the teeth of a mastodon from the mouth of the Ohio River to the great French naturalist, Buffon; also the pious Cotton Mather, who in 1705 described the mastodon remains found at Albany as those of a human giant, and Dr. William Hunter, of Harvard College, who remarked to his medical students in 1767 regarding the mastodon:

[1] Address delivered in Washington on March 21, 1929, on the occasion of the fiftieth anniversary meeting of the foundation of the U. S. Geological Survey.

If this animal was indeed a carnivore, which I believe can not be doubted, though we may as philosophers regret it, as men we cannot but thank Heaven that his whole generation is probably extinct.

But the pioneer of American paleontology was Thomas Jefferson, third president of the United States, a real genius, eager for exploration and exact knowledge, jealous of the prestige of his country even in the prehistoric past. For did he not in his first public paper of scientific import in 1781 refute the assertion of Georges Louis Leclerc, Comte de Buffon, that the living animals of America were smaller than those of the Old World and that on the whole America had produced fewer species? He proved his point by sending a giant American moose to Paris. The signal gun of American paleontology was that which he fired in 1797, when in describing the so-called "Great Claw" or *Megalonyx* as found in the floor of a cavern in Virginia, Jefferson concluded that the creature was a lion three times as large as the royal beast of to-day and wondered what had become of the monster:

A difficult question now presents itself. What is become of the Great Claw? . . . In the present interior of our continent there is surely space enough . . . for mammoths and megalonyxs who may exist there. Our entire ignorance of the immense country to the West and Northwest, and of its contents, does not authorize us to say what it does not contain. . . . In fine, the bones exist; therefore the animal has existed. The movements of nature are in a never-ending circle. The animal species which has once been put into a train of motion, is still probably moving in that train. For if one link in nature's chain might be lost, another and another might be lost, till this whole system of things should vanish by piecemeal.

Jefferson had been imbued with the evolutionary spirit of Buffon. He was no longer fitting *Megalonyx* and *Mastodon* into the story of the Mesopotamian flood. He was as keen to introduce the scientific spirit of France which arose under the monarchy as he was to exploit the political theories which found expression in the Revolution. His paleontology did not rest with *Megalonyx* but continued to be his favorite avocation, the subject of correspondence and eager interest in the successive discoveries of mastodon remains along the Hudson (1801, 1806), and in the arrival of 300 specimens of fossil bones brought to Washington from the Big Bone Lick of Kentucky by General William Clark upon his return from his famous Louisiana exploring trip with George Meriweather Lewis (1804–06). The Lewis and Clark expedition and that of Pike to his lofty Peak in 1806 were favorite projects of Jefferson and owed their congressional support—of $2,500 in the case of Lewis and Clark—to the president's persistent backing. As Theodore Roosevelt, in the year 1910, relaxed after his prolonged combats with the Tammany tiger by reading Osborn's "Age of Mammals," so Jefferson after his constitutional struggles with Aaron Burr found his "supreme delight" in the "tranquil pursuits of science."

Following this great pioneer, the science of vertebrate paleontology, so named in France by its father Cuvier, slumbered for several decades in America, feebly nourished by the work of state geological surveys, under such men as Lardner Vanuxem in New Jersey; Amos Eaton in New York; David Dale Owen and Richard Owen in Tennessee, Wisconsin, Indiana and Illinois; Ebenezer Emmons in North Carolina, and Caleb Atwater west of the Alleghenies. The science was brightened in 1826 by Mitchill's discovery of the first fossil horse; in 1834 by the discussion aroused by Harlan's Zeuglodon, whether it was a giant reptile—Basilosaurus meaning the emperor saurian—or a mammal, and in 1846 by Dr. John Warren's purchase of the superb mastodon of Newburg, which now bears his name.[2]

But by far the most signal event of the year 1846 was Prout's description of bones brought him by a fur trader from Nebraska, as *Palaeotherium giganteum*, a titanothere now known as *Menodus giganteus* in the present Survey Monograph, Number 55. This opened the new era, anticipated in the brilliant mind of Thomas Jefferson when he said, "Our entire ignorance of the immense country to the West and Northwest and of its contents, does not authorize us to say what it does not contain"; for in the whole period of American history previous to 1846 only fifty-nine kinds or species of fossil fishes, crocodiles, various reptiles and mammals had been described, as contrasted to the subsequent long period of American supremacy in vertebrate paleontology, which yielded through the genius of Leidy, Marsh and Cope a total of 2,180 new species and genera, and caused North America to be regarded as the very heart of the vertebrate terrestrial life of the world.

Thus the scepter passed from France, and North America became the chief seat of the world's learning in the science of ancient life.

The leaders of the four original geological surveys of the western territories, from the very first, appreciated the importance of vertebrate paleontology, although Major Powell concentrated his energies more particularly on studying the life of the western Indians. Joseph Leidy, who between 1847 and 1869 prepared his great monograph, "The Extinct Mammalian Fauna of Dakota and Nebraska," culminated

[2] Dr. Warren described this animal in 1852 and became an authority.

his life work in expounding for the Hayden Survey the Middle Eocene of Southern Wyoming: the Bridger region. Both Wheeler and Hayden chose Cope, who was thus led to the Basal Eocene of Southern Colorado and New Mexico and the Lower Eocene of the Big Horn and Wind River region of Central Wyoming, and compiled his bulky "Memoir," known as "Cope's Bible," and said to have been the despair of the Government Printing Office because of Cope's constant and voluminous corrections.

Marsh, chosen by Clarence King for the 40th Parallel Survey, alone survived the consolidation of the four original surveys and went with King into the U. S. Geological Survey, the half century of which we are celebrating to-day. Here he projected six colossal monographs on the extinct birds, giant reptiles and mammals, each to be illustrated by lithographic plates of surpassing size and beauty. He lived to complete only two of the volumes, namely: the "Odontornithes" and the "Dinocerata," leaving to members of the third and fourth schools of vertebrate paleontologists—Hatcher, Lull, Gilmore and Osborn—the completion of this mighty undertaking, which still lacks the final great Sauropoda volume. Meanwhile Scott and Hatcher mastered the paleontology of Patagonia.

Now a fourth school is arising, younger men full of talent, who are not only extending the findings and work of Leidy, Marsh and Cope, but are carrying American field methods, energy and enterprise into Mexico, Central and South America, Cuba, the Antilles, North and South Africa, Java, the Pliocene of the island of Samos, Maragha, Persia, the ancient Siwaliks of India, the Tertiary of China and the Mongolian heart of Central Asia. Little did our pioneer Thomas Jefferson imagine that vertebrate paleontologists of America would some day penetrate even the classic grounds and classic specimens of western Europe and revise from an evolutionary standpoint the specimens and work of Blumenbach, of Cuvier, of Falconer, of Gaudry, of Owen and of Huxley: founders and leaders of the great European schools.

Of personal memory is the profound learning and dignity of Joseph Leidy, the eager brilliance of Edward Drinker Cope and the fundamental and expansive labors of Charles Othniel Marsh. Of these very diverse personalities it may be said that each possessed the scientific qualities which the others lacked; they were complementary characters. The intense rivalry between Cope and Marsh spurred them to greater efforts in exploration and to more lavish expenditure, not only of government but of personal funds, which while it impoverished them, certainly enriched their science and resulted in the vast collections now housed in the U. S. National Museum, the Peabody Museum of Yale University and the American Museum of Natural History, which conserve for all future research types of the 1811 species, genera and orders of vertebrates which these two remarkable men described.

It was the great personal charm of Clarence King, first leader of the U. S. Geological Survey, when his 40th Parallel Survey was housed in the upper floor of the American Museum of Natural History, which first fascinated me with the work of a geological survey: the beauty of his maps, the imposing character of his reports. This fascination doubtless influenced my own final entrance into the service of the survey in 1900. Hayden, brought up amidst the historic influence of the old scientific societies of Philadelphia and familiar with such men as Joseph Leidy and the great paleobotanist, Leo Lesquereux, lent to his surveys a breadth of scientific culture which has never been surpassed. Nor in these personal reminiscences could I fail to recall my genial and inspiring experiences with Major John Wesley Powell, the successor of Clarence King, with whom I took up the publication by Dr. W. D. Matthew in 1915 of the plates for the second volume of Cope's Bible, entitled "Hitherto Unpublished Plates of Tertiary Mammalia and Permian Vertebrata."

But most of all I value the peerless leader, Charles D. Walcott, who not only entered the survey for a long and distinguished period of administration, but contributed several memoirs on early Cambrian faunas which rank among the great classics in invertebrate paleontology. In the spring of 1900 he invited me to succeed Professor Marsh as vertebrate paleontologist of the survey. I accepted this great honor and entered upon the task with confident enthusiasm that in the course of the next three years the text and illustrations of the projected Titanothere monograph would be completed. But these early anticipations were soon frustrated by the discovery that a new and very intensive geological examination of the Eocene and Oligocene Tertiaries was essential, that all the species and types of Leidy, Marsh and Cope had to be reexamined with microscopic accuracy and that a new paleontologic philosophy founded on the Titanothere researches and the fifteen-million-year period during which they flourished was necessary. And so twenty years elapsed before the promised manuscript reached the editorial department of the survey, and no less than nine years elapsed before the last word and final correction was added to the page proof. Meanwhile has occurred the discovery that the homeland of the Titanotheres was not in America, but in Central Asia, and at the last dramatic instant the final stage in the evolution of these giants was condensed into the blank pages at the end of the Titanothere volume: pages 943–945.

It would be impossible in this all too brief review to fairly distribute credit and rightly award the laurel crowns to the long line of explorers, geologists and paleontologists who have wandered from the banks of the Ohio and Hudson to the great deserts of America, of Africa and of Asia, from the pioneer period of Jefferson to the present flourishing period of the U. S. Geological Survey under its fourth director, George Otis Smith, and the Geological and Paleontological Societies of America.

Let it be said that throughout its entire history, our survey rightly crowded and pressed as it has been with the demands for economical surveys, researches and publications, has held aloft the torch of pure science and generously sustained the closely interweaving sister sciences of paleontology and geology.

HENRY FAIRFIELD OSBORN
AMERICAN MUSEUM OF NATURAL HISTORY

THE POTENTIALITIES OF ENTOMOLOGY[1]

WHAT came to your minds as the most important potentialities of entomology when you first read this title, I do not know. If I belonged to the new school of educational psychologists, I would find this out by giving you questionnaires to fill out. But I have such an aversion for this parasitic method of absorbing information that I prefer to commit the crime of guessing rather than steal your time. I will guess that the economic potentialities were among the first to present themselves.

The economic potentialities of entomology have certainly impressed the public. Give us a few more insect outbreaks and importations and we will be as respectable in the eyes of the public as a steel corporation. The man of the street who used to question the advisability of letting men interested in bugs enjoy the same freedom as normal individuals is becoming rare. In fact if one of the public were to ask an entomologist for an excuse for his existence to-day he would soon find himself so embarrassed by the economic arguments that he would feel it necessary to apologize for intruding upon the earth during the age of insects and would have to end his interview by thanking the entomologist for permitting him to continue his existence. From present tendencies the day may come when entomologists will be more in the class of diplomats than scientists. They may be ministers biopotentiary who will arrange for the coexistence of man and insects and will take the necessary steps to see that the movement of man and his articles of commerce from one geographic region to another will not be attended by any serious biological embarrassment.

Some time ago I was called upon to give an account of myself to determine whether I was entitled to certain advantages that I had asked for. After making a case for my project and its scientific significance as best I could, I mention a by-product of the work which involved no real scientific ability at all, but which incidentally saved seventy thousand dollars worth of goods and a million dollars worth of business for a corporation that really didn't need either. This one reference to economic importance trumped all the rest of the case. Even though the judges themselves were scholars, they reacted more quickly to the language of our economic age than to the logic of science.

I realize very well the value of the economic card, and I know that it is usually the trump, but I am not going to play it this time. I take it for granted that we are all aware of the economic potentialities of entomology, but I wonder if we give enough thought to certain other potentialities? Do we consider the potentialities for scholarship and culture?

I have a friend who is a business man of ability, and it happens that entomology has considerable economic importance in his field. In discussing research in entomology he once made the statement to me that he could not conceive of any one doing research work in entomology who did not have, directly or indirectly, as his ultimate aim some economic application of his work. This is not an unusual attitude, not only toward entomology but toward any branch of science. There seems to be a general feeling on the part of the public that a scientist must justify his time in the laboratory on the basis of the economic importance of the results that are to come from the work he is doing.

The public has come to have the attitude of the professional beggar—it expects something from everything that a scientific man does. But the public isn't entirely responsible for this view-point. We have schooled it in this attitude. We apologize for work that is undertaken from the standpoint of original scholarship by saying that no one knows what economic importance the results may have at some future time. Why not justify such work on the grounds that the results sought after are significant in the realm of knowledge, rather than try to make an economic case out of it by some stretch of imagination? I am of course ruling out all work that is designedly economic. Society is rightly entitled to economic benefits from such work, and I may add,

[1] The annual public address by invitation of the Entomological Society of America, delivered on December 28, at New York.