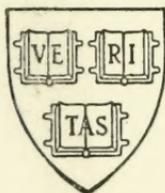


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ADDRESSES

DELIVERED ON THE OCCASION OF THE
DEDICATION OF THE NEW MUSEUM
BUILDING, 29 DECEMBER 1925



NEW HAVEN
THE PEABODY MUSEUM OF NATURAL HISTORY
YALE UNIVERSITY

1926

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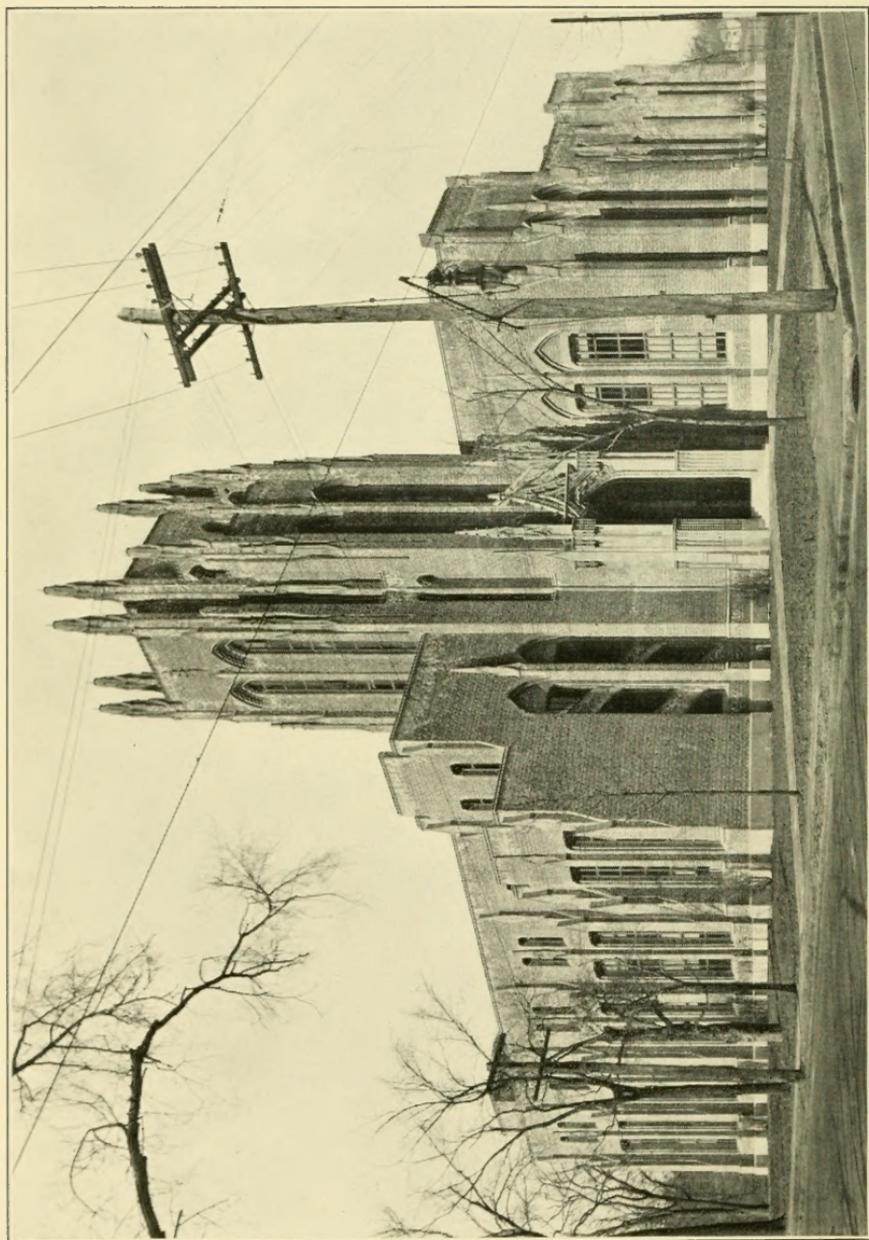
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PEABODY MUSEUM OF NATURAL HISTORY, YALE UNIVERSITY

THE PEABODY MUSEUM OF NATURAL HISTORY

BULLETIN I—NUMBER 1

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DELIVERED ON THE OCCASION OF THE
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THE PEABODY MUSEUM OF NATURAL HISTORY

YALE UNIVERSITY

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CONTENTS

- Presentation of the Building to the University
EDWARD SALISBURY DANA
- Acceptance
JAMES ROWLAND ANGELL
- The Rise of Natural History Museums in the United States
CHARLES SCHUCHERT
- The Origin of Species, 1859-1925 HENRY FAIRFIELD OSBORN

PRESENTATION OF THE BUILDING

BY EDWARD SALISBURY DANA

CHAIRMAN OF THE BOARD OF TRUSTEES, PEABODY MUSEUM

Mr. President, Fellow Trustees, Ladies, and Gentlemen:

IT is the privilege of the Chairman of the Board of Trustees to turn over to you, Mr. President, this Museum Building and all it contains for the future service of the University. We thank you, Sir, for the constant support and encouragement which you have given us in planning for and developing this new home for the scientific collections of Yale in Geology and Natural History.

When you, ladies and gentlemen, pass through the rooms of this building, you cannot fail to appreciate, at least in part, the labors of the Director, Professor R. S. Lull, and each of the Curators in planning the arrangement of the cases and of the specimens they contain. We thank them all cordially.

Our thanks are due also to the active members of the staff for the untiring zeal and energy with which they have devoted themselves—first, to the transfer of the specimens from the numerous places in which they have been in retirement for more than seven years; and, also, to their installation in this new building. What has been accomplished in little more than a year may well excite the admiration of those who have favored us with their presence to-day. To the architect, Mr. Klauder, we extend our thanks for the care with which he met all the often difficult requirements of the situation.

It is with much confidence that we look forward to the future, estimate the certain growth of the collections, and consider the service which they will render to Science, to the University, and to the City in which the Peabody Museum has had its home for more than half a century.

ACCEPTANCE OF THE BUILDING

BY JAMES ROWLAND ANGELL

PRESIDENT OF YALE UNIVERSITY

ON behalf of Yale University, I accept with pride and gratitude this building so skillfully designed to serve its great purposes. Here, for generations to come, serious students will assemble for the intensive study of those profound and revealing chapters in nature's history which are here written. Hither will come citizens young and old to gain broader and deeper conceptions of the history of life, of the earth and its structure and its place in the cosmos. Most important perhaps of all, here will go constantly forward the search for new truth, whose discovery is the abundant reward of those who seek by unflagging study to unlock the hidden secrets of nature. This building may well be called a temple of learning, for such it is to all who use it.

To the Director and the members of the Museum staff who have so patiently endured their years of wandering in the wilderness and who have so splendidly installed the collections in their new home, to the architects and builders, and to all who have contributed by thought or deed to make this day possible, we voice our grateful appreciation.

But it is in no spirit of complacent content that we view the completion of this edifice. Ours is the spirit of eager resolution for the future, in the realization that the Peabody Museum is a dynamic center from which must flow continual service to science and so to humanity. We are opening a new chapter in the history of the University and of the sciences which are here represented. The opportunities which now lie before us intrigue the imagination and inspire our resolution to press forward to ever larger and more significant accomplishment. Only so shall we be quite worthy of that great

philanthropic figure, George Peabody, whose generous vision fifty-nine years ago made possible this structure, and of his nephew, Othniel Charles Marsh, whose illustrious achievements, together with those of many other distinguished scientists, have given this Museum its great collections and its prestige in the world of science. We hope and believe that all who appreciate the unlimited possibilities of this institution will, by their support, enable us to realize its fullest usefulness.

THE RISE OF NATURAL HISTORY MUSEUMS IN THE UNITED STATES

BY CHARLES SCHUCHERT

SECRETARY OF THE BOARD OF TRUSTEES AND
CURATOR OF INVERTEBRATE PALEONTOLOGY, PEABODY MUSEUM

TO the speaker, after long years of prayerful waiting, this day is an especially happy one, when we are dedicating to the people, to all who are willing to learn, and even to those who come solely for intellectual amusement, this rearisen temple first founded in 1866 by George Peabody to house the Yale collections in paleontology, mineralogy, and zoology. George Peabody was a farmer's son of Danvers, Massachusetts, who through mercantile pursuits came to be an international banker, and was the first American Cræsus to give away millions of dollars to better the homes of the poor in London, and to educate the people of the United States. May his spirit, and that of his great nephew, Othniel Charles Marsh, for whom he gave this foundation, be with us this day!

“Some think that a museum is an institution for the benefit of the few; really it is the people's true university, whose scope is infinitely broader than that of the most learned institutions. In a museum, he who cannot even read, may learn something, the student can find the material on which his studies are based, and the professor may carry on his work of research.” These are the words of one of America's best museum directors, Frederic A. Lucas, who, like myself, got his first lessons from that great master of natural history museums, G. Brown Goode. Doctor Goode was at the head of the United States National Museum from 1881 to 1897, and from him came much of our philosophy about museums, their history, and what they should stand for in our national life. A museum, he

believed, should be "one of the chief agencies of the higher civilization—a house full of ideas, arranged with the strictest attention to system." An efficient educational museum "should be a collection of instructive labels, each illustrated by a well-selected specimen," since, by such exhibitions, the museum "cultivates the powers of observation."

A museum cannot, however, stop with these aspirations, but should soar high into the domain of research. With Doctor Goode we again agree that "No museum can do good and be respected which does not each year give additional proof of its claims to be considered a center of learning." It should have "tens of thousands of specimens, interesting only to the specialist, hidden away perpetually from public view, but necessary for proper scientific research" and special education. And pray why? Because they are "the foundations of the intellectual superstructure which gives to the institution its proper standing."

Such is our modern conception of a museum, but the idea has been of slow growth through the centuries. Doctor Goode tells us that the word *museum* arose during the golden age of the Greeks, meaning at first the home of the nine muses who presided over the arts and sciences. The museums of the Greeks "were in the groves of Parnassus and Helicon, and later they were temples in various parts of Hellas." Four centuries before Christ, Aristotle "must have had a great museum of natural history." Soon, however, the meaning of the word changed, and at the palace of Alexandria it was applied to that portion which was "set apart for the study of the sciences, and which contained the famous Alexandrian Library. The museum of Alexandria was a great university, the abiding place of men of science and letters, who were divided into many companies or colleges."

Then came the awful and wilful destruction of the Alexandrian Museum, the political and intellectual downfall of Greece and Rome, the plundering and overrunning of the advanced peoples by the northern barbarians, and everywhere the rising

of religious fervors in Christianity and Mohammedanism. With these impelling motives, the idea of museums and universities dropped out of use from the fourth to the sixteenth century, and over Europe fell the pall of the Dark Ages. With the Renaissance during the fourteenth to sixteenth centuries, it began to be fashionable again to make collections of art, letters, and "curiosities."

The discovery of the Americas led to their exploration for natural wealth, and objects of natural history, mainly plants and animals, were also gathered and sent home, chiefly to England, for study. Hans Sloane, of London, accumulated such materials, and in 1749 he bequeathed large collections of them to the English nation, a stimulus that led Parliament in 1753 to pass an act establishing the British Museum in London. The oldest existing public museum of natural history, however, is the Ashmolean of Oxford, dating from 1667, out of whose collections the antiquarian Edward Lhuyd illustrated "a thousand fossils." The explorations in the New World, then, had much to do with the originating of natural history museums in England, and thence the idea spread to America.

Doctor Goode tells us further that in the early days of the American republic our principal cities "had each a public museum, founded and supported [however] by private enterprise." The oldest of these, described as a "curious collection of American birds and insects," was at Norwalk, Connecticut, where it had been founded by a man named Arnold prior to the Revolution. Among the museums of to-day the oldest of these private enterprises is the Charleston Museum, which was started in 1773 by the local Library Society. In 1815 it received some support from both the state and the city, but such help was not regularly given until 1850. In 1824 the local *Courier* said editorially: "A public museum is as necessary an appendage to a city as a public newspaper or a public library." Even as far back as 1826 this museum was open evenings, when it was "brilliantly illuminated."

In the early days of America, it was the rule that museums

were of societal origin, and of these there is another in flourishing condition. This is the East India Marine Hall started in 1799 at Salem, Massachusetts, and combined in 1867 with the Essex Institute, begun in 1834, to form the Peabody Academy of Science, to which our patron also presented \$140,000 for a building and its upkeep.

The first botanical garden in this country was established by John Bartram in 1728 at Kingsessing, near Philadelphia, but it was the many-sided Franklin who made the City of Brotherly Love itself the first scientific center in America. Franklin established himself as editor and proprietor of the *Pennsylvania Gazette* in 1729, in 1731 he started the first circulating library, and the following year began the publication of *Poor Richard's Almanac*. The year 1743 is more momentous to us on this occasion, however, for then Franklin organized the College of Pennsylvania and the American Philosophical Society, although the latter was not in a flourishing condition until 1769. Another self-made Philadelphian was David Rittenhouse, who constructed his own astronomic equipment in 1770 and was the first American to own an observatory and to be a professor of astronomy. The first fine arts museum, which is still quite active, also found its original home in Philadelphia in 1805 under the name of the Pennsylvania Academy of Fine Arts. Not strange, then, that in this same intellectual mecca arose the greatest of the older public, though privately owned, natural history museums, the "Philadelphia Museum," established in 1785 by the American portrait painter, Charles Willson Peale, and continuing its useful career for nearly fifty years. For a time Peale's museum was housed in the building of the American Philosophical Society, and in 1800 it was full of popular attractions:

"There were a mammoth's tooth from the Ohio, and a woman's shoe from Canton; nests of the kind used to make soup of, and a Chinese fan six feet long; bits of asbestos, belts of wampum, stuffed birds and feathers from the Friendly Islands, scalps, tomahawks, and long lines of portraits of great

men of the Revolutionary War. To visit the museum, to wander through the rooms, play upon the organ, examine the rude electrical machine, and have a profile drawn by the physiognomitian, were pleasures from which no stranger to the city ever refrained."

One of the first divisions of natural history to come into prominence was mineralogy, which once included fossils (then regarded as stones shaped under the influence of the celestial bodies), and out of which was to develop the whole complex of geological sciences. Pope Sixtus V had such a collection in the Vatican, and it was described and excellently figured by Mercati in 1574. The real establishment of mineralogy as a science, however, was the work of Abraham Gottlob Werner, professor in the School of Mines at Freiberg, Saxony, who did for mineralogy what Linnæus had done for botany and zoology. His teaching was marked by such enthusiasm and dramatic certainty that to him flocked, from 1775 to 1817, students from all parts of Europe and a few even from America. In London, the first to teach mineralogy was Professor Schmeisser, a pupil of Werner, and from him David Hosack, a New Yorker, got the knowledge of minerals that led him to bring back home with him in 1794 the first large collection of minerals ever seen in this country. It was shown in New York for many years, and in 1817 Hosack presented it to Princeton, since which time there has been a museum at this seat of learning. At Harvard, Doctor Benjamin Waterhouse had "about half a peck of minerals" as far back as 1784, but its Mineral Cabinet was actually begun in 1793 with the several gifts made by Doctor Lettson, amounting to something like 700 specimens. By 1820, the Cabinet was housed in a room 45 by 36 feet, and twenty years later had about 36,000 specimens of minerals, rocks, and fossils.

The first American fossil was described by no less a personage than the "Great Democrat," Thomas Jefferson, who, in addition to being president of the United States, found time to head the American Philosophical Society of Philadelphia,

and as well to become our first government paleontologist, keeping in the White House in the Quaker City upward of three hundred fossil bones, mostly mastodon, gathered by General William Clarke at Big Bone Lick, Kentucky.

The largest of the early public and research museums of natural history that still continue is that of the Academy of Natural Sciences in Philadelphia, begun in 1812 by a society of citizens, when the city had about 54,000 inhabitants. As we have seen, Peale's "Philadelphia Museum" was its forerunner and in 1812 was not only greater but more popular, since here could be seen the "calf with five legs" and the "child without ears." The Academy at first grew slowly, but when Peale's Museum went out of existence in 1835, the former not only had the leading public museum in America, but was even more renowned as a research institute, since it had then the best library on natural history in the country. This position of preëminence it retained until the eighteen-eighties, when the Smithsonian Institution with its United States National Museum took the ascendancy.

In 1817, thirty-one gentlemen in New York City organized themselves into a Lyceum of Natural History, and for nearly fifty years this institution, we are told by its historian, Professor Fairchild, "filled a place in this city as prominent and as useful for its time as the collections in the American Museum of Natural History do for New York of the present day." On the night of May 21, 1866, however, the collections (but not the library) were destroyed by fire, and though the Society is still in existence under another name, and still publishing, it never again had a museum. Its place was taken in 1869, and more especially after 1874, by what has since become one of the largest, if not the largest, natural history museum, the American Museum of Natural History, now so wonderfully prosperous under the presidency of Henry Fairfield Osborn.

A museum of natural history founded primarily for research had its origin at Harvard University in 1848 with the appointment of Louis Agassiz as professor of zoology and geology. At

first, the collections belonged to Agassiz, but they were eventually purchased by the University. In 1859 was erected the first wing of the Museum of Comparative Zoology, which Agassiz intended "should rival those of the Old World," but which was still, in 1867, in the words of his son Alexander, "nothing but a huge storehouse for collections." The elder Agassiz's intentions have since been fulfilled, however, largely through the efforts of this same son, who told us in 1902 that the Harvard Museum then had cost in buildings, collections, and library more than \$1,250,000, with invested funds of about \$900,000. Its zoological collections are vast, and those of botany, ethnology, and mineralogy very large, making it the richest in materials and facility for study in these subjects of any American institution of learning. Although it is primarily a research museum, it has had since 1902 about two acres of floor space devoted to exhibition collections and open daily to the public.

The idea of a national museum sustained out of public funds came later in our history, and even then had its origin in the private bequest made for that purpose by an Englishman, James Smithson. His gift of more than a half million dollars and of a small collection of minerals to establish an institution "for the increase and diffusion of knowledge among men" was accepted by Congress in 1846. Even so, the actual establishment of the National Museum did not occur until 1875, and the funds for its running first came into the Congressional appropriations of 1878. The building was opened to the public in 1881, and now a still newer building, completed in 1911, is one of the largest of its kind in the world, with a floor space of 468,000 square feet, or nearly eleven acres. In the new Peabody Museum at Yale we have less than two acres of floor space.

With this brief sketch of the rise of museums in America, concomitant with the growth of the sciences, it next becomes of interest to see what part Yale had in this history. Here again, as at Cambridge, and at Philadelphia, the story centers around one man. With the Class of 1796, there was graduated

from Yale College a youth of twenty-three, Benjamin Silliman, known to his classmates as "Sober Ben," a native of Fairfield in this state, destined for the profession of law. He had, indeed, passed the Connecticut Bar, when President Dwight, with an insight into "vocational" psychology that would do credit to the most advanced foundations of to-day, laid his hand upon the young man and appointed him professor of chemistry and natural history. To prepare for these unexpected duties, Silliman gathered up what ores and minerals he could find in the college, and packing them in a "candle box," hied himself to Philadelphia to study chemistry and anatomy under Wistar, the natural sciences under Woodhouse, and to have his minerals named by Adam Seybert, then recently returned from the fount of wisdom at Freiberg.

The Yale Cabinet of Minerals, originating thus in the traditional "candle box" brought back by Silliman in 1803, was greatly enlarged through the purchase, four years later, of the collection owned by a bookseller, B. D. Perkins. The next notable addition to it fell literally from the skies—the meteorite seen to descend near Weston, Connecticut, on December 14, 1807. Silliman at once followed up the report of this "fall" and brought back for his Cabinet several of the stones, about which he published in the following year a full account, in collaboration with Professor Kingsley. This was the first scientific description of the mineral nature of one of these "chips of other worlds" and of the phenomena attending upon its fall, and therefore attracted much attention, so much, in fact, that Jefferson is reputed to have said: "It is easier to believe that two Yankee professors will lie than to admit that stones can fall from Heaven." The collection of meteorites at Yale now numbers about 300 falls, and is one of the few larger collections in the country.

In this same year, Silliman, seeing the collection of minerals brought together by Colonel George Gibbs, then the largest and most valuable lot of European minerals ever brought to America, determined to get it also for Yale. He succeeded in

having it deposited in New Haven, where its 12,000 specimens were fully arranged on the second floor at the north end of Old South Middle, now Connecticut Hall. Here several students' rooms were transformed into a museum 40 by 18 feet, and here, beginning with 1813, Silliman taught mineralogy and geology. The museum idea was now an established fact, for Curator E. S. Dana said in 1878: "For upward of fifty years the 'Mineral Cabinet' has been one of the chief attractions connected with the town, which every friend of the college from abroad felt bound to visit." It became, indeed, the nucleus around which the art and natural history museums were to grow.

Silliman's influence, however, reached far beyond the bounds of mineralogy. He had a warm and impressive personality, making him a good leader and a great teacher, and in consequence his students caught his enthusiasm and made much use of the Mineral Cabinet. As a popular lecturer he was known from Boston to St. Louis. His inspiring delivery has been described in lively fashion by one of his students, Abraham Sager, as follows:

"Perfectly at home among the wreck and ruins of the world, in either hand balancing a flood of waters and a lake of fire before his respectable and attentive auditors, he stands like some kind but mighty spirit sent to instill into the minds of the rising generation the sublime but awful mysteries of the past creation, himself filled to bursting nigh with the majesty and grandeur of the subject."

As an organizer, Silliman was also preëminent, being active in the formation of the first American Geological Society, the Yale Medical School, and the School of the Fine Arts growing out of the Trumbull Gallery opened at Yale in 1832, and in the establishment and long maintenance single-handed of that venerable periodical, the *American Journal of Science*, which "did a service to science, the value of which is beyond estimate."

Silliman's ablest student was James Dwight Dana, later his son-in-law, who, after a voyage around the world with the

Wilkes Expedition, was in 1850 appointed professor of natural history at Yale, retaining the chair until 1890, although the title was changed in 1864 to professor of geology and mineralogy. He is said to have been "the foremost geologist in America and one of the foremost of the world." His contribution to the Yale Museum was the building of a teaching collection in historical geology, large additions to the mineralogical collections, and later a long term of devoted service as chairman of the Peabody Museum Trustees. His work in the latter two lines was carried on notably by his son, Edward S. Dana, who was curator of mineralogy from 1874 to 1922, and has been since 1899 chairman of the Museum Trustees.

With the collections at Yale already of considerable size, there entered the College with the Class of 1860 another youth, who was to complete the work of Silliman by bringing the Yale collections a home, adding to them enormously, and making the institution renowned for its scientific treasures abroad as well as at home. Othniel Charles Marsh was the son of an industrious farmer who had moved from his ancestral home in Danvers, Massachusetts, to the western part of New York, at a time when the Erie Canal was in process of construction. The fossils thrown out by the workmen in this undertaking attracted the attention of both father and son, and under the guidance of Colonel Jewett, a local collector, the boy became so interested in them that he lost his taste for farming. He was bent on getting an education, and with this in view, a maternal aunt enlisted in his behalf the good will of her brother, Mr. George Peabody, the great international banker, then living in London. This gentleman's liberality sent the boy to Andover, and finally to Yale. During his courses at both places he continued his strong interest in mineralogy, and this devotion to scientific matters aroused the interest of his uncle, who visited him at New Haven when he was an undergraduate. After graduation he remained two years longer at Yale as a Scholar of the House, studying mineralogy, geology, and chemistry, and taking the master's degree in 1862. He was offered a pro-

fessorship by his Alma Mater in 1863, but refused it, choosing rather to make his first European trip, visiting museums and studying at Heidelberg, at Berlin, where he began the researches in paleontology that were to mean so much to Yale, and at Breslau. He was already, therefore, well advanced in his subject when he finally accepted the chair of paleontology in 1866.

Coincident with his appointment came the generous donation from George Peabody of \$150,000 to establish at Yale a museum of natural history, to be devoted especially to geology, mineralogy, and zoology. Of this gift, not more than \$100,000 was to be used in the erection of a building, which for good reason was delayed until 1874 and completed in 1876. In the meantime, the building fund had increased, making possible a building that cost, with its equipment, about \$175,000, and leaving intact the original building fund of \$20,000, and \$30,000 for the care and increase of the collections. Now there was 30,000 square feet of floor space available, the first floor devoted to mineralogy and lecture rooms, the second to paleontology, and the third to zoology.

The chair of paleontology to which Marsh was appointed in 1866 was the first to be created in any institution, and it was almost wholly one of research. Marsh had collected fossils long before his graduation from Yale, and after taking his doctorate at Heidelberg, his interest centered upon the wonderful array of extinct vertebrates that the United States Geological and Geographical Survey of the Territories was finding in the "bad lands" of Nebraska. He began collecting for himself in the West in 1868, and from this time on to about 1892 the annual fall flood of boxes shipped to the University grew greater and greater. He brought forth in rapid succession in the *American Journal of Science* "so many astonishing things that the unexpected became the rule." At least 400 new species in 185 new genera were described in abbreviated form, and at the age of sixty-one years he was struggling on, thinking that somehow he could yet describe the great mass of still unknown

animals assembled in the Museum and make all of them fully known in large monographs. Seven years later, in 1899, the Great Reaper took him, with his work still undone, but everything that he had not already given to Yale was found in his will to be bequeathed to the University. As his epitaph says: "To Yale he gave his services, his collections, and his estate." His great collections were his chief thought, and for their further description he left \$30,000 to the University. To Marsh, then, Yale owes most that she has of greatness in paleontology.

Professor Charles E. Beecher took up the work after Marsh's death, and did what Marsh could not bring himself to do, namely, show the public in mounted form some of the strange animals of antiquity. It was Beecher who first set up the bones of a dinosaur on its own legs, and the *Trachodon* skeleton at the north end of the Great Hall was the first one of a series that has now become familiar to all who have visited the museums of this country. Beecher, moreover, was an invertebrate paleontologist, and strengthened that end of the Museum. Long before his death in 1904, the exhibition collections had outgrown the building.

Turning now from the life of the past to that of the present, Yale made another fortunate choice for the Museum in the appointment in 1864 to her professorship of zoology of Addison E. Verrill, a student and assistant of the great Agassiz, who had caught the enthusiasm of his master for the building of zoological collections. When he came to Yale, zoology was unrepresented in the collections then at hand, but his dredgings off the New England coast during the summer months, and especially after 1871, when he was placed in charge of the steamers of the United States Fish Commission, soon started the zoological collections to growing with the speed of the paleontological ones. Most of this material eventually had to go to Washington, but Verrill had the privilege of retaining at Yale a complete series of the marine collections off our coasts. Among the university collections of living animals, Yale

stands second only to Harvard, and her collections have many of the type specimens described by Verrill. In all of this work, Verrill was ably seconded by Professor Sidney I. Smith.

In the gift of George Peabody, no provision was made for a Department of Anthropology, but Professor Marsh began to make such collections as early as 1870, intending that they be essentially of the North American aborigines. All of his collectors were instructed to secure material relating to the North American Indian, and Marsh himself did the same while gathering fossil vertebrates in the wilds of the great West. At the same time he purchased many an archeological collection, reaching out to the Central American primitive peoples as well. By 1877 this department was recognized by the Yale Corporation, and in 1902 it was put in charge of Curator MacCurdy, who still holds the same position.

The early years of the twentieth century passed somewhat uneventfully for the Museum. New material came in gradually, and the staff worked away at the collections, disheartened often when it seemed that our constant pleas for more space were unheeded. Of what use to have a 70 foot dinosaur, if his cry for room to move his cramped limbs fell on deaf ears, even when set to verse in the *Alumni Weekly*? We had long been promised that when we should build, it would not be on the old site, but on the Pierson-Sage Square, and tentative plans had been made looking toward such a new building. When the move was actually made, however, it was due to pressure from a totally unexpected quarter.

On the memorable Christmas Eve of 1916, the Treasurer of the University came to the speaker full of the great news of the Harkness gift of a magnificent new quadrangle of buildings, and asking our help to make it possible by the removal of the Peabody Museum from its stand of over forty years at the corner of Elm and High streets. His words are still ringing in my ears, and I hear him say: "If you can bring this about, the present Peabody Museum building fund of \$250,000 will be increased to \$750,000, bearing interest at the usual univer-

sity rate, along with more land than the Peabody Trustees now have on the Pierson-Sage Square." It was truly to be a grand Christmas present for the Museum, but, he added, "To get this gift the Museum building must be erased and the property ready for the Memorial Quadrangle by July next!" I said: "Do you mean that we are to begin moving at once, go for two years into storage, and then move again into a new building?" He nodded assent. I then asked him if he had not heard that "three moves are as good as a fire." We laughed a "good-night," but the consequence of that meeting was that the seemingly impossible conditions were fulfilled, and the wreckers began the demolition of the old Peabody Museum on the date appointed.

The expectation had been that we would have to wait but two years for a new building, and our material was accordingly stored in fifteen different places, with only a portion of it accessible for use in the Osborn Laboratories, which offered a home to the staff that was thankfully accepted, and is remembered with gratitude. Then President Wilson put us into the Great War, and before the memorable year of 1917 was at an end, the purchasing power of our funds had decreased to fifty cents on the dollar! Instead of two years, seven long years of gloom and confinement were our portion, and before the end of this period the speaker had become emeritus and shifted the burden to younger shoulders.

It is, indeed, a far cry from the Silliman "candle box" of minerals to the surroundings in which we find ourselves to-day. For our progress through the years we have to thank not only those whose names have been mentioned, but a host of others, who have added to our treasures by gifts, both large and small, or have by their labors made our collections better known. Nor are we forgetful of the fostering care of Mother Yale, who deals as best she can with the demands of her brood of clamoring children. May we make full use of the wonderful opportunities that open before us, since our "chariot is now hitched to a star"! In the words of Harvey Maitland Watts,

read by President Dixon on the occasion of the centennial of
the Academy of Natural Sciences at Philadelphia :

Great God of nature, let these halls
The hidden things of earth make plain ;
Let knowledge trumpet forth her calls,
And wisdom speak, but not in vain.

Help us to read with humble mind
Thy larger scriptures day by day—
True bread of life! O be thou kind,
If, erring, we should go astray.

For deep resounding unto deep,
Declares the wonders of thy plan ;
Life struggling from its crystal sleep
Finds glorious goal at last in man.

The mysteries of the eternal laws
Are but the shadows of thy might.
God, ruling all in final cause,
Enshrine the world in love and light!

THE ORIGIN OF SPECIES, 1859-1925*

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CUVIERIAN

Cuvier n'est-il pas le plus grand poète de notre siècle? Lord Byron a bien reproduit par des mots quelques agitations morales; mais notre immortel naturaliste a reconstruit des mondes avec des os blanchis, a rebâti, comme Cadmus, des cités avec des dents, a repeuplé mille forêts de tous les mystères de la zoologie avec quelques fragments de houille, a retrouvé des populations de géants dans le pied d'un mammoth. Ces figures se dressent, grandissent et meublent des régions en harmonie avec leur statures colossales.

HONORÉ DE BALZAC: *La Peau de Chagrin*.

DARWINIAN

Variation, when we observe it carefully, appears to be aimless. The transmission of acquired characters is unproven, and must certainly be incredibly slow in most cases, if it does occur. We may justifiably adopt the working hypothesis that evolution has been due solely to fortuitous variation and the action of selection on its results. But we must remember that this is still only a working hypothesis.

J. B. S. HALDANE: *What Does Darwinism Amount to?*
The Saturday Review, Jan. 3, 10, 1925.

BATESONIAN

The many converging lines of evidence point so clearly to the central fact of the origin of the forms of life by an evolutionary process that we are compelled to accept this deduction, but as to almost all the essential features, whether of cause or mode, by which specific diversity has come to be what we perceive it to be, we have to confess an ignorance nearly total.

WILLIAM BATESON: *Problems of Genetics*.

* The third of a series of addresses on the problem of the origin of species, the first having been "The Origin of Species as Revealed by Vertebrate Palæontology" and the second "The Origin of Species, II," as presented to the National Academy of Sciences.

THE opening of this superb Museum, named after its original benefactor, George Peabody, inspired by the monumental labors of Othniel Charles Marsh between 1851 and 1899, filled with Marsh's unique collections, and dedicated to the furtherance of research in vertebrate paleontology, marks an epoch in the development of Vertebrate Paleontology in America.

Led by Thomas Jefferson, at once naturalist and president of the United States, the pioneers of this historic branch of biology worked their way into the then far West of the Ohio River. Beyond, across the Missouri and the Mississippi, stretched the wonderland of the plains and mountains, awaiting the founders of our science, Joseph Leidy (1823-1891), Edward Drinker Cope (1840-1897), and Othniel Charles Marsh (1831-1899). These three paleontologists entered the broad geologic horizons exposed to the eye by millenniums of aridity, far surpassing in richness and content any of the fossil horizons which in the previous century had made Europe the home of the science of paleontology, or the Siwaliks of southern Asia as explored by the great Falconer, and only recently challenged in richness by the vast arid stretches of Mongolia, the latest scene of American energy and enterprise in exploration.

Under the uniform environmental stimulus of our virgin Rocky Mountain region nothing could be more divergent than the methods and the life work of these truly great scientists: Leidy of the German spirit, broad, deep, unassailable in point of fact, the last naturalist to cover life from the protozoa to man; Cope of the Celtic spirit, eager, impetuous, hasty both in observation and in generalization, a genius in classification, natural philosopher of the school of Lamarck, voluminous writer and pamphleteer; Marsh of the English spirit, a limited writer, deliberate and calculating like Leidy, energetic in discovery and detection of the most significant point in a fossil, glowing with enthusiasm for paleontology, lavish like Cope in personal expenditure, soon surpassing both his rivals in worldwide fame. Aided by Oscar Harger, Marsh was the first to

discover and connect up important missing links in the birds, in the horses, and in many other chains of vertebrate life so eagerly sought by Darwin and his great proponent Huxley. While able and fruitful in establishing great lines of descent and new groupings in classification Marsh concerned himself little about philosophy or about the causes and factors of evolution which so constantly occupied the mind of Cope. Endowed with Marsh's talent for seeing and doing the most important thing first, the Peabody Museum which we now rededicate became the mecca for the evolutionists of Europe and Yale University the most famous center of vertebrate paleontology in the world.

Vertebrate paleontology, from 1847, the date of Leidy's first paper on "The Fossil Horse of America," to 1897-1898, the date of Cope's "Syllabus of Lectures on the Vertebrata," through the very diversity of the genius of these three men firmly established the truth of the Lamarck-Darwin theory of evolution. Thus between 1859, the date of "The Origin of Species," and 1897, the date of Cope's last work, *evolution was firmly grounded as a Law of living Nature, and took its place permanently beside the Law of Gravitation of Newton!*

In view of the widespread reluctance in America to accept Evolution as a Law and the tendency to continue to treat it only as a theory, let us cite Baldwin's definition of "law":

LAW [Lat. *lex*, Ger. *Gesetz*, Fr. *loi*, Ital. *legge*]: Any formulation of sequences which from demonstration, experimental proof, successful application, or for any other reason, is accepted as having the highest degree of probability. . . . Law is commonly compared with HYPOTHESIS and THEORY just in this, that these latter terms carry less than the highest probability, and are still in waiting for the demonstration, crucial testing, or final observation which, by conferring what amounts to certainty, raises them to the dignity of law.

Not only the Law but many of the subsidiary Principles of Evolution, which from the time of Aristotle (389-322 B.C.)

had been conceived and developed in human anatomy, in zoology, and in comparative anatomy, became firmly established through repeated verification in past and present time. These subsidiary principles, five in number, prove to be universal not only in individual development and experience and in racial evolution and progress but in the social and spiritual life of man. Baldwin thus defines the word "principle" in its bearing on science in general:

PRINCIPLE [Lat. *principium*, commencement, beginning; trans. of Gr. ἀρχή, beginning, authority; Ger. *Princip*; Fr. *principe*; Ital. *principio*.] Scientifically, it is the law through which a diversity of facts, otherwise unrelated and unexplained, are classified and interpreted: opposed to datum, brute fact, or "mere" fact. . . . Greek philosophy began with the search after the principle in the literal sense: that original reality (a) from which other things are derived, and (b) out of which they consist. In the sense (a) it was implicitly or explicitly dynamic, a force, a causal power; in the sense (b) it was static, an element of subsistence. The first meaning led up to Aristotle's form εἶδος as a principle; the second to his matter ἕλη.

Briefly, these subsidiary principles discovered and formulated in zoology as confirmed and amplified in paleontology are five in number: First, the principle of individual adaptation or reaction to changes of motion or function which invariably precede changes of form, as first observed by Aristotle and finally confirmed by the experimental observations of Arbuthnot Lane and Felix Regnault; second, the principle of development through use, of degeneration through disuse, of balance through unchanged or static function, understood and expressed by Goethe in the year 1784 when as a brilliant novice in human and comparative anatomy he was on the very threshold of evolution:

Thus by the animal's form is its manner of living determined;
Likewise the manner of life affecteth every creature,
Moulding its form.

Third, the principle of acceleration or the hurrying forward of characters in development and in evolution, and of retardation or the slowing down of characters, according to juvenile or adult needs in the struggle for existence; fourth, the principle of individual and racial struggle for existence and individual and racial survival of the fittest; fifth, the Lamarck-Darwin principle of *ébranchement*, of divergence, the adaptive radiation of Osborn, permeates the diversity of the plant and animal world.

These five great principles, all alike discovered in zoology, were confirmed and ratified in paleontology as the principles of progression and of retrogression, manifested first only in the individual and finally in the race. They are the coefficients both of development and of evolution or phylogeny, as set forth in what Osborn has termed the principle of tetraplasy and the theory of tetrakinesis.

COEFFICIENT. (*a*) Coöperating; acting in union to the same end. (*n*) That which unites in action with something else to produce a given effect; that which unites its action with the action of another.

But these coefficients are not all the process, for in the nineteenth century the paleontologist found new fields to conquer wholly beyond the vision of the zoologist; down through the ages he alone became the *camarade intime* of evolution, of the secular forward and backward marching hosts of separate characters, and the new problem presented itself as to how these separate characters arise and conduct themselves. Whereas to the zoologist every minute mechanical part of every animal is still and dead, to the paleontologist every minute part is alive and moving, slowly unfolding in the original sense of the Latin *evolvere* (*evolutio*), just as to the vision of the embryologist individual development is an *unfolding* of the potency of the germ.

Thus the paleontologist discovers two entirely new princi-

ples, a sixth and a seventh, namely: Sixth, the principle of continuity, of continuous and unbroken advance or recession of each character from invisibility into visibility, and, seventh, closely connected therewith, the principle of rectigradation, of the rise continuously of each new organ out of heredity, passing through stages of increasing mechanical perfection, then perhaps gradually subsiding again into the germ plasm until it finally disappears.

These seven* principles which govern the origin of species in mechanical adaptation also concern genetics, for only through paleontology can we clarify our genetical vision of heredity and distinguish the ripples of "saltation" or "mutation" from the waves of "evolution," the local currents and vortices of "variation" from the rise and fall of the tide of great characters. The minute fossilized tissues of the ivory tusks of the mastodon and the stupendous "thunder-saurian" *Brontosaurus* displayed in this Museum are alike mirrors and "phenotypes" of the evolving germ plasm out of which they once developed. The stages in the evolution of the horse, camel, mastodon, and elephant, in the largest and in the minutest detail, are mirrors of the evolution of the germ plasm. If your intellectual tastes incline you to observe the energy of mechanisms within the range of mechanical vision, seek them with Morgan in *Drosophila*, the fruit fly; if your intellectual predispositions incline you to gaze into paleocrystic mirrors of energy and form, observe the details of ascent from *Eohippus* to *Equus*, of the rise of the Pleistocene mastodon of our forests from the *Palæomastodon* of Oligocene Africa, or the rise of Marsh's giant *Triceratops* from the egg-laying *Protoceratops* of the Desert of Gobi. Whether geneticist or paleontologist, you are observing the initial and the terminal phases of the continuous *creative evolution and adaptation of the germ plasm*, for pale-

* This is a concise restatement of Principles I-IX elaborated in "The Origin of Species as Revealed by Vertebrate Palæontology," the author's first address on this subject.

ontology forces upon us this new creational definition and conception, namely, of the *continuous creation and unfolding of life fitted to a continuously changing world*.

Is it not remarkable that neither through philosophy nor through speculation but through paleontologic research the original Latin word "evolution" becomes inadequate and the old Sanskrit word $\sqrt{\text{kar}}$ reasserts itself?

CREATE [Lat. *creatus*, make, create, akin to Gr. *κρᾶίνω*, complete, Skt. $\sqrt{\text{kar}}$, make]. 1. *trans.* To bring into being; cause to exist. 2. *intrans.* To originate; engage in originative action.

Bergson's term "creative evolution" comes nearer expressing the actual truth of the bio-mechanical aspects of evolution observed throughout a half century but contains teleologic or vitalistic implications which we do not accept. This new definition is made not to please the still surviving "special creationists" but to express the two new principles of evolution discovered in paleontology, namely, the principle of continuity and the principle of rectigradation—the one a denial of mutation in bio-mechanical evolution, the other a denial of fortuity in adaptation.

Before further clarifying these seven zoo-paleontological principles let us glance at the historic explanations of evolution, as old as philosophic Greek thought; they are all summed up in the great names of Buffon, of Lamarck, and of Darwin, who were the first to formulate these historic explanations. Lamarck and Darwin found themselves in an intellectual world very hostile to evolutionism; they were alike too eager to explain; they could not put forth the infant evolution theory without an explanation which would be accepted as in some degree adequate to offset the contemporary creationism; they both were very reliant on what we now know to be only partial explanations.

The essence of the rival Lamarckian and Darwinian theories can be distilled into modern economic phraseology: let us

imagine the germ plasm as our life-capital. In Lamarck's words,

tout ce qui a été acquis, tracé ou changé dans l'organisation des individus, pendant le cours de leur vie, est conservé par la génération et transmis aux nouveaux individus qui proviennent de ceux qui ont éprouvé ces changements [italics our own].

Lamarckism, in economic terms, treats the germ plasm as our life-capital constantly enriched through the inheritance of acquired adaptations.

As expressed by Darwin,

any minute variation in structure, habits, or instincts, adapting that individual better to the new conditions, would tell upon its vigour and health. . . . Those of the offspring who inherited the variation would have a better chance of surviving [italics our own].

The germinal capital of Darwin varies in each individual, and only the variation which best suits the environment is added to the capital of the survivor.

As popularly worded here, these theories, usually regarded as contradictory, are really complementary; they coöperate, they do not conflict, they are not the whole explanation but only a fraction of the explanation of animal and human progress in evolution. Yet overconfident post-Darwin seekers after explanations and causes came in great waves of opinion and founded schools of followers. Darwin and Wallace strongly condemned Lamarck and presented Natural Selection so forcefully that it held full sway from 1859 to 1870; then Lamarckism was revived in the minds of Spencer, Cope, and even of Darwin himself, until in 1880 Weismann gave Lamarckism in its original form a *coup de grâce* and revived Darwinism in its purest original form. In 1890 Darwinism found a new champion in DeVries and Natural Selection appeared under a new name as the "mutation theory"; from 1890 to 1924 this muta-

tion theory enjoyed the following of a great school of mutationists and, in turn, the new support of Genetics, until Bateson, founder of the genetic school, declared that we knew neither the cause nor the mode of the origin of species, and crushed the hopes of mutationists as well as of geneticists to give an acceptable answer to the age-old problem of the origin of species.

DISCOVERIES OF PALEONTOLOGY

Meanwhile some few paleontologists were speculating but others were quietly devoting themselves to gathering harvest after harvest of facts about the modes and causes of the origin of species, and made a series of discoveries.

First, all the principles of *Phylogeny*, or the actual lines of animal descent, which had been sought in vain by zoology and comparative anatomy, were discovered by intensive research into the details of change in one family of mammals after another. Thus in Europe Déperet and Stehlin were ferreting out "ascending and descending mutations" in the sense of Waagen, and in America we were microscoping the four-million-year ancestry of the horses, the rhinoceroses, the titanotheres, and the proboscideans, which had been broadly sketched in the telescopic restorations of Leidy, Cope, and Marsh. There was revealed a minuteness of realistic detail which is soon to be amplified by the still-sought Tertiary ancestry of man, of which we know the branches and the twigs but not the main trunk.

Second, as a unique result of paleontological research we perceive evolution as a secular phenomenon, a process of the ages which, measured either by geology or by the radium content of the rocks, is infinitely longer than either Lamarck or Darwin conceived; as a cause of *secular* evolution Lamarckism in large part holds true, just as Darwinism as a cause of secular evolution universally holds true, although, as we shall show, paleontology denies absolutely the origin of species according to the original conceptions and literal interpretations of either

Lamarck or Darwin. In claiming that all that is acquired is transmitted Lamarck was overconfident, as Darwin was overconfident in claiming that every variation, however slight, favors the chance of survival.

Third, the grand result of paleontological research was to transfer from the field of imagination, reason, and speculation to the field of direct observation the whole question of the modes and methods of evolution and the whole problem of the manner in which new specific adaptations originate and of the details by which new bio-mechanical species are constantly created. I refer to such classic bio-mechanical adaptation as the elongated neck of the giraffe. In this and many other illustrations it appears that "species" and "adaptations" are practically synonymous terms, as may be clearly seen in the following brief history of these two terms.

The origin of Species and the origin of Adaptation have practically the same significance, for every species is an *ensemble* of countless adaptations in various stages of rise and decline. What Aristotle in 300 B.C. called an Adaptation, Linnæus in 1758 called a Species. When Aristotle in his *History of Animals* and in his *Physics* debated the natural causes of adaptations he had in mind the same structures and functions as those which Linnæus used in defining his species. For example, the celebrated passage in Aristotle's *Physics*:

What, then, hinders but that the parts in Nature may also thus arise? For instance, that the teeth should arise from necessity, the front teeth sharp and adapted to divide the food, the grinders broad and adapted to breaking the food into pieces. . . . It is argued that where all things happened as if they were made for some purpose, being aptly united by chance, these were preserved, but such as were not aptly made, these were lost and still perish, according to what Empedocles says concerning the bull species with human heads. . . . Nature produces those things which, being continually moved by a certain principle contained in themselves, arrive at a certain end.

For example, again, Linnæus (1758) defines the anthropoid ape known as the orang:

SIMIA: *Dentes Primores IV, approximati.*

Laniarii folitarii, longiores hinc remoti.

Molares obtusi.

Cauda nulla: Simiæ veterum.

In our natural tendency to follow the line of least resistance, namely, to seek explanations and causes before facts, may we not guard the advice of Pliny as quoted by Fourtau:

Pline l'a dit, et on ne saurait trop le répéter; il convient d'abord de bien experimer ce qui est, avant de remonter aux causes: *Quæ-rere tu causas, mihi abunde est si expressi quod efficitur.* Je m'estimerais très heureux, si, dans ce travail, j'ai réalisé le sage précepte du naturaliste romain.

THEORIES OF CAUSATION

To resume the matter of explanation and interpretation, from the very dawn of human ambition to observe and interpret nature there have been only two broad philosophical solutions of the problem of adaptation and of the origin of species: the supernatural and the natural. Aristotle adopted the natural and fully debated the essential idea of both Darwinism and Lamarckism; to the latter Brooks (1899) has called our attention:

Herbert Spencer tells us that the segmentation of the backbone is *the inherited effect of fractures, caused by bending*, but Aristotle has shown ("Parts of Animals," I. i.) that Empedocles and the ancient writers err in teaching that *the bendings to which the backbone has been subjected are the cause of its joints*, since the thing to be accounted for is not the presence of joints, but the fitness of the joints for the needs of their possessor [*italics our own*].

Since 1859 there have been a host of overworked explanations and hypotheses; the word "variation" of Darwin has been a will-o'-the-wisp leading biologists into many morasses, with its many modern mutant terms, "variation," "selection," "mutation."

Paleontology enables us to winnow out the wheat from the chaff in all these partial explanations of the origin of species, for it demonstrates that hosts of variations such as those set forth by Bateson in the year 1894 in his "Materials for the Study of Variation" are wholly insignificant in the evolution process.

Paleontology also throws its critical light on the relative value of the three historic explanations as to the causes of adaptation, namely, those of Buffon, of Lamarck, and of Darwin, which alike turn on the question of inheritance or transmission of individual adaptation.

First, inasmuch as marvels of origin are due to individual adaptation, which may by inheritance furnish the key to evolution, the idea running through the minds of Aristotle, Lamarck, Spencer, and Cope is shown by paleontology to be illusory, for individual adaptation now proves to be a *secular* rather than immediate cause of the origin of species as Lamarck suggests. Even if we were to demonstrate the immediate, prompt, and entire inheritance imagined by Lamarck, the majority of new bio-mechanical adaptations would still remain wholly unaccounted for.

Second, there is the historic idea of Buffon as to the inheritance of the direct action of new environment; it is true that new species, as observed by systematists, suddenly or gradually originate in this way, as shown by Crampton in *Partula*, because in the laboratories of Nature the new environment endures. A host of field naturalists have long since proved Buffon's principle to be nearly universal among birds and mammals. Another host of experimentalists in America, England, and Germany are demonstrating the immediate origin of new species in *Le Monde Ambient* of chemical and physical

experiment. So far as we see at present, such origin of the species of systematists is chiefly in bio-chemical adaptations in which the germ may be affected permanently by a molecular or atomic saltation. On the contrary, from the secular point of view of paleontology, the germ plasm or *keimplasma* of Weismann is at once the most stable and the most plastic element in life; it offers stubborn resistance to both Lamarckian and Buffonian influences, such as we observe day by day in nature and in the laboratory.

But paleontology proves that in the long run of geologic time both Buffon and Lamarck were right in their main conceptions: organs starved by unfriendly environment finally disappear; organs which do not pay their way and are starved by disuse slowly drop out of the germ plasm; vitally essential organs are absolutely stable. Why not therefore concede the truth of the great conceptions of Buffon and Lamarck, even if immediate inheritance by the germ is disproved in the great majority of cases? Why not concede the still greater conception of Darwin, misled as he was as to time by the marvelously rapid evolution of the germ plasm witnessed in artificial selection? Whereas neo-Darwinians have been as impatient as neo-Lamarckians in looking for instantaneous results in the first or the few following generations, paleontology proves that the deferred secular action of Natural Selection is as firmly established as the deferred secular action of both Buffon and Lamarck factors. Both in progressive and retrogressive organs paleontology proves that every organ needs the sustaining and standardizing power of Selection as it acts to-day in swarms of a trillion mosquitos, in herds of a million bison, in flocks of a thousand ducks.

But if we grant that Buffonian, Lamarckian, and Darwinian factors were all true even in this secular sense, if we grant that the living and the lifeless environment, the adaptation, habit, and survival-of-the-fittest variations combine continuously to produce new adaptations and species, do we then account for all the structures we paleontologists observe in the modes of

origin of species in ascending and descending phyla of all the animals we have been able to study?

We answer, "Certainly not."

Buffonism, Lamarckism, and Darwinism combined account for only a small fraction of what we observe. The unaccounted residue of creative evolution is by far the larger—is, in fact, infinitely the larger—part. Here is the critical point in modern biology where we pass from the rational, i.e., all that is within the range of observation, experience, and reason, to the super-rational, namely, to the ultimate unknown causes of what Lucretius called "the firm and undeviating order," quoting his master Aristotle as set forth in his refutation of Democritean fortuity in nature:

Order and a firm and certain constitution or being are far more obvious in celestial natures than in us, but an uncertain, inconstant, and fortuitous condition is rather the property of the mortal race.

This discovery of the firm and undeviating order with which paleontology replaces all the chance explanations of adaptation from Empedocles to Darwin is the supreme service which paleontologic research renders to biology.

Are we right in concluding with Balzac in his brilliant *éloge* to Cuvier that paleontology comes very close to philosophy, the science of the causes and origins of things? Was the author of *La Peau de Chagrin* right in his prophetic vision of the then infant science, the *paléontologie* named by Cuvier?

Il réveille le néant sans prononcer des paroles artificiellement magiques; il fouille une parcelle de gypse, y aperçoit une empreinte, et vous crie: "Voyez!" Soudain les marbres s'animalisent, la mort se vivifie, le monde se déroule! Après d'innombrables dynasties de créatures gigantesques, après des races de poissons et des clans de mollusques, arrive enfin le genre humain, produit dégénéré d'un type grandiose, brisé peut-être par le Créateur.

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