SCIENCE

VOL. LXV MAY 13, 1927 No. 1689

CONTENTS

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal.

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 8, 1879.

CHARLES DOOLITTLE WALCOTT

PALEONTOLOGIST—1850–1927

CHARLES DOOLITTLE WALCOTT, of Shropshire and New England ancestry, was born on March 31, 1850, at New York Mills, New York, and died of apoplexy at Washington, D. C., on February 9, 1927. Standing about six feet two inches in height, slight, but of athletic build, he had a commanding presence that attested a magnificent physique. Confident, quick of decision, with a matter-of-fact face, Walcott suggested the administrator rather than the savant, and yet he "achieved in scientific circles an exalted position attained by few."

Walcott's first paper, on a new species of trilobite, appeared in 1875, and his last one, on the Cambrian, two months after his death. His strictly paleontological and geological bibliography appears to have over 170 titles, and of these about 110 have to do with the Cambrian. The list of his complete writings will rise into the hundreds.

Walcott's education was that of the local public schools, and then of the academy at Utica, an institution in which other leading geologists received their first lessons in science. As a paleontologist and geologist, however, he was virtually self-educated, first by direct contact with nature, and then from books and colleagues. In 1868 he left the academy and during the following two years was a clerk in shops. In 1871, at Indianapolis, he met the state geologist, Professor E. T. Cox, who restimulated him to take up the study of paleontology, which had been dear to him ever since his fourteenth year, when he found his first fossil. The actual meaning of fossils, however, came to him through meeting in 1864 Colonel E. Jewett, one of New York's earliest paleontologists, who advised him and helped him to obtain books.

Following Cox's advice, Walcott took up residence in 1871 on a farm near the picturesque and highly fossiliferous region of Trenton Falls, which is about 15 miles to the northeast of his birthplace, and between times he collected the fossils turned up by the plow and quarried for others. In the course of two years he had amassed a large collection of Trenton specimens that was wonderfully rich in trilobites. This collection he sold in September, 1873, to Louis Agassiz, and now he came directly under the magnetic influence of that great man. Among the trilobites, there was a specimen of *Isotelus platycephalus* that showed, even if imperfectly, some of the ventral

limbs—a discovery made for the first time, but one that only an Agassiz could properly evaluate. Agassiz therefore urged Walcott to search particularly for trilobites preserving the ventral anatomy, and the very next year the latter found his paradise. Quarrying in it, he had at the close of 1876 no fewer than "3,500 entire trilobites; 2,200 were in condition to warrant sections being made of them." This second collection also went to Agassiz.

Walcott's career as a paleontologist now lay straight before him, and with Agassiz' endorsement he became in 1876 assistant to the greatest American paleontologist of the time, James Hall. That summer Hall sent him to Waldron, Indiana, to open a quarry for Silurian fossils, and by the end of the season he had shipped to Albany two tons of fossils and rock, much to the delight of Hall, who never could get enough fossils! Then in 1878, Walcott found, near Saratoga, New York, "primordial fossils" in place; he tells us late in life that he had seen some of these in a drift block near his home when he was only seventeen, and had ever after been on the hunt for the strata from which the slab had come. He naturally wanted to describe these things—one of the dreams of his youth—but Hall was reluctant, and further, seeing the restless ambition of the young man, and his marked capacity for accomplishment, recommended him to Clarence King, the director of the United States Geological Survey. Finally, however, Hall yielded to Walcott's desire to describe the few species found near Saratoga, and published his results in 1879. This was Walcott's first paper on the Cambrian faunas, of which he was to become the great revealer.

In this same year King appointed Walcott assistant geologist, and shortly afterward the whole of the Cambrian of the country was open to his investigation. First came the wide expanse of the Far West, with its wonderful clear atmosphere and its stratigraphy everywhere unobscured. Soon Walcott was overrunning Utah and Nevada, and finally the generalizing Powell took him in 1882 into the depths of the Grand Canyon of the Colorado. Here it turned out that there were not only "primordial fossils," but, even more surprising, 12,000 feet of still older rocks; unfortunately, however, these latter had but few fossils. This older series was for some years included by all in the Paleozoic, but before long was seen to be of another world, the Algonkian era of Powell.

The stratigraphic problems of the Cambrian and the "primordial faunas" of his native state, however, kept beckoning Walcott, especially the extremely difficult "Taconic question," a problem that had vexed all geologists attempting its solution, had thrown its originator, Emmons, forever into the limbo of the improbable, and had been watched over by the eagle eyes of James Hall, James D. Dana, T. Sterry Hunt and Jules Marcou. Walcott apparently never asked, "Can I solve this riddle?" but, Siegfried-like, boldly entered the arena, and, while it can not be said that he completely unravelled the stratigraphic sequence and not at all the structural conditions, he did lay down the ground plan, and, especially by revealing the many local faunas that he found from place to place, made it possible for Arthur Keith to show that most of the structural difficulties of the Taconics are due to the highly imbricated or overthrusted nature of the area extending from the Highlands of New York into Vermont and far beyond to Gaspé.

In 1888, Walcott was placed in charge of all invertebrate fossils in the Geological Survey, and there followed a flood of important papers on the Cambrian of eastern North America. During the summer of 1890, he was in Albany and called on Hall, who, as usual, had a tale of woe to tell about the probable lack of state appropriations for the Survey, which would in all likelihood make it impossible for him to provide a salary for the writer, who was at that time his private assistant. Walcott told me of what Hall had said, and assured me that in case of trouble he would make provision for me on the United States Geological Survey. Again as usual, however, nothing awful happened at Albany, and I did not get to be Walcott's assistant until the spring of 1893.

Walcott succeeded Major Powell as director of the Survey in 1894, holding that office until 1907. He thus inherited the Survey the year after the great cut in its annual appropriations from Congress, when they were reduced one half. Here was a great task ahead, and he worked at it so heroically that in a few years he had regained the lost ground, maintaining, at the same time, the high ideals of the Powell Survey. With this increased burden of administrative work, the detail of his beloved Cambrian problems had to be assigned to assistants, although each summer found Walcott in the field collecting new stratigraphic and faunal data. In the meantime, he not only built up and made larger than ever before the appropriations and publications of the Survey, but also developed the Reclamation Service, initiated the Forest Service and the National Advisory Committee on Aeronautics, and helped along in Congress the appropriations for the United States National Museum.

Even this is not all, for in 1901 Walcott was one of a small committee that went to Andrew Carnegie and appealed to him to make possible the wish of the Father of our Country to have at Washington a national university. The outcome of this appeal was

the founding of that great institute of research, the Carnegie Institution of Washington, of which Walcott was the first secretary (1902–1905).

It has been the history of the Smithsonian Institution that the office of secretary alternates between workers in the physical and the natural sciences. Secretary Langley, as astronomer and physicist, had followed Secretary Baird, a zoologist, and as the former was but little familiar with the ways of Congress, Walcott helped him greatly with his appropriations for the various bureaus under the fostering care of the Smithsonian. Upon the death of Langley, this helpfulness on the part of Walcott naturally brought him favorably into the minds of the regents, and as the appointee was expected to be a naturalist, Walcott was chosen in 1907 to be secretary and executive head of the Smithsonian. This appointment is considered the greatest honor that can come to an American man of science.

The executive duties of the secretary of the Smithsonian Institution need not take up all of his time, and so we find Walcott again working with his vast riches of Cambrian facts and fossils. Moreover, he could now widen out still more the field of his researches, and almost every summer since 1907 he and his family have devoted themselves to unearthing the wonderful Cambrian succession in the Rocky Mountains of Canada. Here the Cambrian is extraordinarily complete, with a thickness of more than 12,000 feet, and an unparalleled abundance of fossils. Walcott also had the Carnegie Institution send an expedition to China, headed by Bailey Willis, to collect fossils, and later on sent J. P. Iddings to make additional Cambrian collections. He likewise persuaded local collectors in many lands to send him Cambrian material and borrowed that of the Geological Survey of India. Truly, Walcott assembled in the Smithsonian more Cambrian fossils than there are in the museums of all the rest of the world!

One of the most striking of Walcott's faunal discoveries came at the end of the field season of 1909. As his party was coming down Mount Wapta, Mrs. Walcott's horse slipped and in so doing turned up a slab that at once attracted her husband's attention. Here was great treasure—wholly strange crustaceans of Middle Cambrian time—but where on the mountain had it come from? Snow was falling and the search for the original layer had to be left to another season. Next year Walcott was back again on the southwest slope of Wapta and eventually the layer from which the slab of the previous year had come was discovered—a bed of black shale, later known as the Burgess shale, 3,000 feet above Field, British Columbia, and 8,000 feet above the sea. A stone quarry in this shale, opened and operated during the summers of 1910 to 1913, and again in 1917, yielded what is probably the strangest and most interesting of all invertebrate assemblages: algæ, many sponges with spicules, an array of annelids showing internal anatomy, brachiopods, and, most numerous of all, phyllocarids and trilobites with appendages and internal structures. Walcott has described 70 genera and 130 species of the Burgess forms, but a vast mine of knowledge still lies buried in these most difficult of fossils.

Of Walcott's striking papers, other than those already mentioned, a few more must be singled out. Among his early contributions to attract wide attention was his vice-presidential address before the American Association for the Advancement of Science in 1893, entitled "Geologic Time, as indicated by the Sedimentary Rocks of North America." Here he opens with the significant remark: "Of all subjects of speculative geology few are more attractive or more uncertain in positive results than geologic time." After a careful analysis of the known facts, he concludes that "geologic time is of great but not of indefinite duration. I believe that it can be measured by tens of millions, but not by single millions or hundreds of millions of years." This was, of course, before radium disintegration was known.

Among Walcott's many papers on trilobites, the most striking one goes back to 1881—"The Trilobite; New and Old Evidence relating to its Organization"—and has to do mainly with his original discovery of the anatomy and the legs of trilobites. Nothing that Walcott did afterward brought him more fame, and coming so young in his life, it aroused expectations of other big results, which followed quickly, one after another. Of his later contributions, the best one dealing with the morphology, growth stages, and phylogeny of trilobites, has the title "*Olenellus* and other Genera of the Mesonacidæ," 1910. It treats of 36 species in 10 genera of these most specialized of all Cambrian trilobites.

Of faunal studies, the most comprehensive one is "The Fauna of the Lower Cambrian or *Olenellus* Zone," 1890, which remains the classic of the subject; it treats of 138 species, but a revision of what Walcott has at Washington will bring the total to several hundred. His most monumental work is, of course, the two-volume "Cambrian Brachiopoda," 1912, which brings together the world's known forms, totalling 535 species in 59 genera, of which 360 occur in North America. This is another classic, the foundation upon which all classification of the Brachiopoda must rest.

At the memorial meeting in Washington on February 10, Walcott's colleagues and associates said: "During the forty or more years of his life in Wash-

ington, he displayed to a degree that excited our greatest admiration a capacity for the dual duties of research and administration." As one of the world's leading paleontologists and revealer of Primordial Faunas, he outshone by far even the illustrious Barrande of Bohemia, and in this country he was one of the outstanding men of all science, evidenced by his presidency of the National Academy of Sciences from 1917 to 1923. Five medals (Bigsby and Wollaston of England, Gaudry of France, Thompson and Hayden of this country), and honorary degrees from Cambridge, St. Andrews, Christiania, Paris, Hamilton, Chicago, Hopkins, Pennsylvania, Yale, Harvard, and Pittsburgh further testify to the high place he held at the seats of learning in America and Europe.

CHARLES SCHUCHERT

NEW LIGHTS ON EVOLUTION[1]

I

THE past two decades or more seem to have been marked by too great a confidence in the experimental method as a universal solvent of biological problems. It would be as unreasonable to expect the physicist alone to be able to unriddle the mysteries of inanimate nature, without any aid from the fundamental science of chemistry, as to assume that the much more complex problems of living matter can be resolved by the investigation of functions and activities alone. Living beings are so much more a product of their past history than of present environment that the historical and comparative study of animate matter will always be of fundamental importance. For the moment many biologists have lost their sense of proportion and have over-emphasized the experimental side with a consequent sterility and loss of interest in the science. Biology from its very nature will apparently always be more a historical and comparative science than an experimental one. For its normal development the experimental and structural study of organisms should obviously go hand in hand.

One of the most interesting tendencies of the present time is the vivid revival of the interest in biology. We are accustomed to regard the epoch, which began with the appearance of the "Origin of Species," as marked at the outset with misunderstanding and lack of interest. It is worth while accordingly to remark that the first edition of fifteen hundred copies of Charles Darwin's immortal volume, published as you will remember in 1859, was exhausted at the time of issue and that within less than a year three other editions, comprising thousands of copies, were called for. I may remind you that the full title of Darwin's great book is the "Origin of Species by Natural Selection." The severest criticisms of the work as a matter of fact have been based on its author's supposed opinion that natural selection alone is able to account for the origin of species. In one of his chapters, however, Darwin states that it is the internal factor of variability which is of the greatest importance in connection with the origin of the species. The only reason that he did not deal at greater length with the subject of variability in living organisms was the complete ignorance, then and since on the part of biologists, as to the cause of variability. In another of his chapters Darwin makes the illuminating and indeed, in the light of very recent events, prophetic statement, that the greatest degree of variability is found in the larger groups of plants and animals. Within the limits deliberately set by himself, Darwin produced a book which will always rank as the greatest classic of the biological sciences.

We may now turn to the question of the present position of the problem of the origin of species, and in this connection we can not do better than refer to some of the recent utterances of the Nestor of American evolutionary biologists, Professor Henry Fairfield Osborn, director of the American Museum of Natural History. In a series of essays devoted to the theme of the teaching of evolution (Charles Scribner's Sons, New York, 1926), he remarks on page 29: "In my opinion natural selection is the only cause of evolution which has thus far been discovered, and demonstrated."

In his recent Oxford address on evolution, delivered on the occasion of the meeting last summer of the British Association for the Advancement of Science, in that venerable university, Osborn points out that as the result of the manifold activities of naturalists in more recent years we are now in the position to state the conditions under which new species make their appearance although not their cause. The most important element from the naturalist's standpoint is apparently isolation such as is found in islands of the sea or in the case of fresh water forms in rivers once connected but now separated by geological change. Such species are in general distinguished by the fact that they do not intergrade with their more nearly related species. His general conclusion is that: "We know the *modes* by which subspecies and species originate; in fact, there is little more on this point to be known. But this very knowledge renders the problem of *causes* infinitely more difficult than it appeared to Darwin."

The question of the origin of species is in fact much too large a one to be attacked successfully by any one line of biological investigation. Of late

[1] Public lecture delivered under the auspices of the Royal Canadian Institute and the University of Toronto.