SCIENCE

VOL. 89 FRIDAY, APRIL 28, 1939 No. 2313

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.

EDWARD ORTON, GEOLOGIST*

By Professor A. C. SWINNERTON

ANTIOCH COLLEGE

INTRODUCTION

SCIENTISTS whose names survive are associated mostly with innovations. Newton and gravitation, Darwin and evolution, Agassiz and glaciation, are inseparable. Recognition is seldom granted the humbler role of the interpreter. Now and again, however, there arises an interpreter whose knowledge is so broad, whose judgment is so sound, whose touch with common folk is so full of understanding and whose integrity is so far beyond reproach that recognition is given spontaneously.

Edward Orton was an interpreter. As one studies his life one finds that Orton's contributions to education, to the state and to science lay largely in the wisdom gained from the discoveries of others, in the perception of values and in the interpretation of them to his fellow men. His contributions in geology can be understood and appraised only by an examination of the man himself; hence this review of his career in science must include a survey of his early years.

I. EARLY YEARS

Edward Orton was born on March 9, 1829, when the presidency of the swashbuckling Andrew Jackson was but five days old. When he went to Hamilton College in 1845, conflict with Mexico was stirring emotions. All through his early years many conflicting views raged over political, economic and regional issues. The emotional tensions of people must have been similar in quality to those of our present day, the primary causes similar, though differing immensely in their applications. Candor in speech, honesty and objectivity in

* Part of an address delivered at the dedication of a monument and park—a memorial to Edward Orton—presented to the State of Ohio by Hugh Taylor Birch, of Yellow Springs, Ohio, October 26, 1938.

judgment, tolerance in human relations and ethical discrimination were not the characteristic of that day any more than they are of our times.

Orton was the son of a minister, and it seemed natural and desirable for him to shape his career toward the ministry. With this end in view, after being graduated from Hamilton College in 1848, he entered Lane Seminary in Cincinnati. However, he remained at Lane less than a year, and a period of preparatory school teaching followed, during which he instructed mostly in the natural sciences. He spent a part of a year in the early fifties in the graduate study of chemistry and botany at Lawrence Scientific School under Eben Horsford and Asa Gray. But he still felt the urge to enter the ministry, for he next turned to Andover Theological Seminary. Here with his friend, John Bascom, he broke with orthodox creeds. But apparently he hoped that his views were not too extreme to be reconciled with institutional religion because in 1855 he was ordained in the Presbyterian ministry as pastor of the church at Downsville, N. Y. However, he held that pastorate only one year; his ideas were too liberal for the church of that day. Soon the New York State Normal School at Albany called him to the chair of natural science.

But Orton did not forsake his religious affiliations. He undertook the leadership of a Sunday School class in one of the Albany churches. It was still a few years before the great controversy between science and religion aroused by Charles Darwin's "Origin of Species," but the seeds of conflict were already present. There is nothing to indicate that Orton deliberately attempted to be provocative; in fact, his nature, whatever his views, would lead him to a more conciliatory attitude. Nevertheless, his religious teaching was sufficiently unorthodox to develop an undercurrent of criticism. His position in the State Normal School should have been free from sectarian influence, but such was the temper of the times that trouble brewed and Orton resigned.

The record is not clear where the fault lay. It is difficult to tell how much pressure for Orton's removal was brought to bear on the school officials, how much he was upheld or to what extent he was made to feel the desirability of withdrawal. But he was sensitive to the situation and would not allow himself and his personal views to become a public issue. His friends began a campaign through the press to embarrass the management of the school and to bring about his reinstatement, but Orton settled the matter by a long public letter[1] in which he assumed responsibility for the situation and absolved the school administration.

Following the trying episode at Albany he became principal of the academy at Chester, N. Y., where he remained six years. Here he formed an intimate friendship with Austin Craig, who was pastor of an independent church at Blooming Grove, near Chester. We know little of the association of the two men; however, in 1865, Craig, who was then acting president of Antioch College, in Yellow Springs, Ohio, invited Orton to become principal of the preparatory department of that college. One may read much between the lines: the influence of Horace Mann at Antioch, the tradition of liberalism in thought and religion, the broader scope of the curriculum which included the natural sciences as well as the classical subjects, the new spirit in education expressed in coeducation and in a variety of other ways. All this must have made Antioch seem like "green pastures." At thirty-six, with much troubled experience behind him, he was just at the threshold of his career.

[1] *New York Tribune*, June 13, 1859.

II. Green Pastures

The history of Edward Orton's eight years at Antioch is available only in outline form. From the college catalogues of those years we learn that he was principal of the preparatory department and, beginning in 1866, also Artemus Carter professor of geology, botany and zoology.

Professor S. C. Derby has given us a brief impression of Orton's relationship to the administration at Antioch:

> It is . . . years since my acquaintance with Dr. Orton began—at Antioch College where he was then the most influential . . . member of its faculty. As an inmate of the President's household, . . . I had unusual opportunity to know how much that officer trusted to the practical wisdom of the alert and untiring professor of Natural History, who was also the head of the Preparatory Department. . . . Then as always Dr. Orton toiled terribly; much of the discipline of an unusually heterogeneous body of students rested upon him; his instruction was not confined to his chair . . . but regularly included Latin, with History or English or a normal class in Higher Arithmetic. . . . His pupils there, as everywhere, were inspired with a good measure of his enthusiasm and carried forward by the forcefulness of his teaching.[2]

At the age of 43 Orton was invited to become president of Antioch. The position of the young college was not well established. Its financial condition was never strong, and its reputation for liberalism did not help fill the coffers. Orton deliberated, for he was not an avid career-seeker, but he accepted.

There is little record of his brief period of presidency, for the next step in his career came quickly. Two decades later he wrote to President Long, of Antioch:

> I look back upon the years which I spent there as among the most enthusiastic and fruitful of a lifetime spent in

[2] "In Memoriam Edward Orton," p. 55, Columbus, 1899.

teaching. There was a certain zest and charm in the work there that I have never found elsewhere. I hope that my successors find equal interest and inspiration.[3]

During Orton's stay at Antioch the second geological survey of the state was authorized by the Ohio Legislature, and Professor J. S. Newberry, of Columbia University, was made state geologist. That Orton's scientific interests and abilities were known outside of Yellow Springs was indicated when he was appointed one of the two assistant geologists. He was assigned southwestern Ohio for his district; and in the first few volumes of the second survey there appeared from his pen more than a dozen county reports. The enthusiasm with which he was regarded by the survey staff is related by one of the young aids—Grove Karl Gilbert:

> I had no opportunity to meet Dr. Orton until late in the season, when I had the good fortune to be bidden to attend a conference of the chiefs at Columbus. While on the journey from Cleveland Newberry prepared me for the meeting by sketching the quality and character of his colleague—a man without guile, direct in his conversation, and absolutely transparent as to motive. The simplicity of manner which would impress me at the start was not of manner merely but was a fundamental trait coordinate with and not contradicted by the wisdom which made him a man of affairs. . . .
>
> In later years, as we met from time to time, as I listened to his voice in public address or read the papers that emanated from his pen, I was able to add here and there a detail which Newberry's sketch had failed to delineate, but no line of it was ever erased, and Orton has remained, for me, one of the safest and most open-minded of investigators and the simplest, kindliest, and most lovable of men.[4]

In 1872, after many years of discussion and controversy, the land grant college of Ohio was at the point of selecting its faculty and of opening its doors. A department of geology and mineralogy was to be included, and Orton was invited to become its professor. The Ohio State University catalogue of 1890–91 in its section on history contains this statement: "Professor Orton declined the professorship of Geology, but in April (1873) succeeding the presidency of the institution was offered to him, which he accepted in May."[5] It is clear that Orton did not give up his commitment of service to Antioch lightly.

Of the history of the Ohio Agricultural and Mechanical College others must speak who have more intimate acquaintance and knowledge than I. To an outsider who has only the published records to read, there appear to have been two major problems facing the new enterprise, both of which required tactful but effective leadership. One was external—the jealousy with which the other educational institutions of the state regarded the new college; and the second—internal dissension among the friends of the institution regarding education policy.

Ohio was one of the last states to organize its land-grant college. In the institutions organized earlier in other states various policies had been followed; some interpreted the Federal Act as intending only vocational education. Neighboring Ohio colleges were struggling with finance and striving to maintain educational standards; it was natural that they should regard with concern the establishment of a low-cost institution, which, if the views of some of its supporters were followed, would change and probably lower traditional standards. To a considerable extent the selection of Orton as president spread confidence. His inaugural address, in which he espoused ardently the cause of breadth of academic training as opposed to purely vocational instruction, left no doubt of the policy he would pursue. His practice followed his preaching. In 1875 there were nine departments offering work chiefly in science and languages. Orton asked the board of trustees for the addition of instruction in history, economics, government and ethics ". . . that the symmetry of the education which we offer may very soon be completed."[6]

In 1878 came the confirmation of the policy which Orton was following. The name of the Ohio Mechanical and Agricultural College became the Ohio State University. As if this made certain the policies for which he had worked, Orton proffered his resignation from the presidency. It was tabled. Subsequent insistence on being relieved finally brought the acceptance of his resignation in 1881.

We must remember that during this period of the presidency Orton was involved in both the work of the State Geological Survey and the teaching of geology. The Newberry survey had become quiescent, for the condition of state finances precluded appropriations for more large volumes, and little systematic field work was in progress. Professor Newberry made fewer trips from New York, and to Orton was left the editorial work and other duties of the state geologist.

Orton was also carrying the responsibility for the geology department alone; he appears to have had no formal assistance until 1895, when J. A. Bownocker was listed as assistant in geology. His daughter writes:

> My father was a very hard worker and took his class work seriously, at all times. We must remember that he had none of the labor-saving devices such as the typewriter, the dictating machine, etc., on which teachers nowadays have come to depend. The manual work of writing out his lectures in longhand—and he was very

[3] "Letter to Daniel A. Long," January 11, 1895.
[4] "In Memoriam Edward Orton," pp. 21–22.
[5] Catalogue, Ohio State University, 1890–1891, p. 35, Columbus, 1891.
[6] Ohio Agricultural and Mechanical College, 4th Annual Report, p. 11, 1875.

careful to keep them . . . revised—plus his professional correspondence, kept him "burning the midnight oil" far too many nights.[7]

So effective was his teaching that his students and friends have perpetuated his memory in the building of Orton Hall on the university campus.

Such were the years of expanding responsibility and accomplishment. "Green Pastures" indeed, for Orton's abilities had found fertile soil and had made substantial growth. But his real career in geology was just beginning.

III. The Mature Geologist

When Edward Orton withdrew from the presidency of the university, he was 53 years of age. One can not help feeling that he was looking forward to the freedom from administrative responsibility. In addition to geology he had many private and community interests. He was a member of the First Congregational Church of Columbus and a close friend of the pastor, Washington Gladden, with whose religious view he was in close accord. He was concerned with municipal affairs and with many public institutions. Although these activities lie beyond the scope of this discussion, they emphasize his great breadth of human interest.

But in 1882 his chief geologic interests must have been his teaching and the continuation of the work of the State Geological Survey of which he was made director. Curiously enough, the geological work which was to constitute one of his major contributions to science was not yet apparent to any one.

In the work of the Geological Survey there were two major problems. The early survey which had been made of the coal measures, while satisfactory from the point of view of industry, was not adequate scientifically. It had been done independent of areas in adjacent states and was out of harmony; to use the geologic term, it could not be correlated. Orton undertook the re-study of the Carboniferous rocks and

> the outcome was that masterly presentation of the whole Carboniferous series of Ohio, in which the relations and variations of every prominent bed as it occurs within the state and adjacent portions of other states are presented in such fashion as to make the discussion distinctively one of the best . . . contributed to Appalachian geology. In this the awkward task of correcting the errors of those who had made the original observations is performed with a delicacy rarely equaled. . . .[8]

The second problem which apparently weighed on Orton's conscience was the promise made by the Geological Survey to publish information on the areal geology of the state, the stratigraphy, the paleontology, economic geology, and in addition agriculture, botany, zoology and even archeology. When Orton became director, only half of these items had been covered. Instead of reconstituting the survey and announcing new objectives when he was made director, Orton continued the second survey, and undertook to fulfil its promises.

It is noteworthy that from his interest in archeology and his inspirational contact with William C. Mills and E. O. Randall, there came the founding of the Ohio Historical and Archeological Society and eventually the Museum building on the Ohio State University campus.[9] Likewise, from his investigation of clays sprang the interest in ceramics which, through the efforts of his son, Edward, Jr., developed into a significant research and instructional department of the university.

An appraisal of Orton's work is particularly difficult to make, not because it was insignificant, but because he was an interpreter rather than an innovator. His work was done with little pomp and ceremony, and much was done by lecture, by letter and in personal interview. His published works were voluminous, but not in comparison with some of his contemporary geologists. In those days little restraint was exercised either in the length or number of published articles. His official reports frequently contain comment on commercial policies and practices, both public and private, of which he either approved or disapproved. One does not look for such "editorial" comment in scientific reports to-day, and yet it may well be asked if that frankness was not one of the most helpful of his public services in the protection of individuals as well as of public resources from wasteful losses.

The range of subjects covered in his writings is extensive. Aside from the county reports, and reports on coal and clay, already mentioned, he wrote extensively on oil and gas and on iron ores, building stones, salines, gypsum, lime, glacial gravels, hydrology and briefly on paleontology. In addition there are several papers of a general nature, such as "The Wastage of Our Coal Fields," and the presidential addresses before the Geological Society and the American Association for the Advancement of Science.

But the measure of the geologist is more than a summary of his publications. In order to understand his position in the world of geology let us review briefly the state of the science at the time Orton became state geologist. The great western explorations of the Powell, Hayden and King surveys had been made, and the results of these had been so significant in pointing the way to the development of the West that the organization of the United States Geological Survey was a natural consequence. Not only was there a great reaching out for the materials of an increasing industrialism

[7] Personal letter from Mrs. F. C. Caldwell, September 19, 1938.

[8] J. J. Stevenson, *Jour. Geol.*, 8: 210–211, 1900.

[9] Personal letter from Dr. Samuel Orton, September 28, 1938.

aided by geological explorations; there was also stimulated a tremendous growth in geological ideas. Large fields of knowledge which we accept to-day as part of the structure of geology were only then becoming known. Physiography was just emerging, inspired by the Western surveys and later interpreted by William Morris Davis in terms of peneplains and rejuvenated and dissected surfaces. Vertebrate paleontology was describing the great collection of Mesozoic and Tertiary bones from the Western foothills and sedimentary basins. The structural complexities of Appalachian mountain-building had yet to be disclosed by the detailed field work of Hayes, Willis and Keith. The use of rock thin-sections still in its infancy was already producing results of great scientific values. The interior liquidity of the earth was largely unquestioned, for the seismograph in embryo had indicated nothing of its power to probe the depths of the earth, and radioactivity was unknown.

This era of geologic discovery produced many great geologists and made many geologists great. We are interested in Edward Orton's place in that geological world of more than half a century ago. Obviously his place was not with those who were making scientific history by their discoveries in the mountains and in the Western plains. His position was assured by two great contributions: one which he planned as a necessary part of research, and one which came to him unexpectedly. The first was the detailed study and correlation of the Carboniferous strata of Ohio. This has already been mentioned in connection with Orton's work with the state survey. The significance of it need not be repeated; let me say only that it has served well as the foundation work for the geology of Eastern Ohio and adjacent regions.

The other enduring contribution related to oil and gas geology. It is a bit startling to be reminded, in these days of Gulf Coast and California gushers, that in 1886 Ohio had the largest oil and gas wells in the world. And all this development took place with startling rapidity. There was relatively little activity in these resources when Orton took over the state survey in 1882. By 1886 the Findlay field was the greatest producing field in the world; and so large was the relative production that the omnipotent Standard Oil Company was depressing the price, saying the market was glutted. Orton's official position gave him access to the drilling records and he was quick to learn the principles which underlie the occurrence of oil and gas. The anticlinal theory then recently propounded by White was found to fit the structural situation in Ohio, and Orton defended it stoutly. But that was not all. He studied the fragments the drill brought up and deduced the coincidence of the reservoir rocks with those parts of the Trenton limestone which had been changed to dolomite. He realized that these two factors, structure and rock character, together delimited the areas of production rather sharply.[10] He measured gas pressures conscientiously, contributing basically to our knowledge of "rock pressure."[11] He read voluminously, and in his writings he surveyed the whole field of both foreign and American literature critically. Reading his works over fifty years after they were written, one can not help being impressed with how little of significance has happened since—much change in detail, of course, but extremely little of basic principle. This impression is not just a vague sentimentalism. A text-book,[12] published late in 1937 in the field of hydraulics and carrying a chapter on oil field fluids, has a bibliography of 94 references for that chapter. Only 21 of those references were published prior to 1910; six of the works were written by Edward Orton and a seventh in collaboration with him! Only one other man in the whole list was referred to as many as four times. The test of time has certainly found his work of substantial quality.

During the height of his geologic activity, when he was returning to Columbus from a public lecture at Antioch, he was taken with a serious illness, which resulted in the paralysis of one side of his body. Despite this tremendous handicap he labored on with his teaching and research work unabated. Some of his most significant field work was accomplished following his illness. A letter which he wrote to a friend is characteristic of him:

> To any friends who inquire for me, I can describe myself in Scripture phrase as "faint yet pursuing"; overtaken by a severe physical disablement in the last public service that I undertook for the College, I have grown old, somewhat before my time. But "I bate not a jot of heart or hope." Life is still worth living, and the port well worth the cruise.[13]

His abilities were recognized by his contemporaries. In 1887, when it was planned to organize the American Geological Society, as an offshoot of the American Association for the Advancement of Science, Orton was made a member of the organizing committee.[14] This committee drafted a proposal for a constitution, which in 1888 was adopted with minor changes. This organization—the Geological Society of America—the leading society of its kind on this continent—celebrates this year its fiftieth anniversary. Edward Orton can be counted as one of its founders. Among the geolo-

[10] *U. S. Geol. Survey Ann. Report*, 8: pt. 2, 475–662, 1889.

[11] *Am. Jour. Sci.*, 3rd ser., 39: 225–229, 1890.

[12] C. F. Tolman, "Groundwater," Chapter XIV, New York, 1937.

[13] Letter to Daniel A. Long, January 11, 1895.

[14] H. LeR. Fairchild, "The Geological Society of America," p. 72 *et seq.*, New York, 1932.

gists famed for their remarkable discoveries in an age of great geological discovery, Orton was elected the ninth president of the Geological Society. No higher recognition was possible from geologists. But two years later, in 1899, the great body of American scientists—the American Association for the Advancement of Science—made him their president. During this year of office came his death.

So we come to the close of the career of that quiet man who loved nature, who loved his fellow men and who served both well. That statement might be said to summarize his philosophy of life. He had as part of it a philosophy of his science. Some elements of this have already been referred to—for example, his willingness to comment forcibly on the methods of commercial exploitation of geological resources, and he was outspoken regarding the "self-deception" attending oil and gas booms. In this way Orton interpreted his relation to his public trust.

In matters of pure science he also had convictions. He stressed the essential unity of geology and protested the lack of breadth of understanding which was beginning to appear in specialization.

> . . . the methods of investigation and research employed in the several sections of geological science are so diverse that it is quite possible for those who work in one to fail in due appreciation of . . . all the rest.
>
> But the putting asunder of things which belong together is always to be deplored. It will be an evil day for geology when, by a confusion of tongues, the utterances of its various builders become unintelligible to one another.
>
> . . . Geology still demands of its students a wide range of knowledge and interest. Its most substantial progress will be due in the future as it has been in the past, not to the level and clinometer alone, not alone to the sagacious interpretations of the relics of life, not alone to microscopic section or to chemical analysis, but to all combined. . . .[15]

In fact, he felt the essential unity of all science:

> Every road in science leads to the end of the world. You can write the history of the vegetable kingdom from the beginning of time, in telling the story of the hyssop that grows on the wall.[16]

Ordinarily tolerant, he had no patience with pretense or with hypothesis founded on fancy rather than fact; for example, this forthright statement:

> These conclusions (he is discussing the vegetable origin of coal) are questioned by no one who has a right to an opinion. Occasionally it is true, some belated denizen of the seventeenth century still attacks the problem of the origin of coal in the *a priori* way and evolves a theory of its formation from his own consciousness. Such theories do not require refutation. Like the seed sown in stony places, they speedily wither because they have no root. Inventions and not discoveries, they are quite likely . . . to go to their own place and be buried with their inventors.
>
> The formation of coal from vegetable growth I do not take to be an unsolved or unfinished problem.[17]

His mind was open toward the future, and on this note I wish to conclude the discussion of Edward Orton. Science is unending, nor is it complete apart from its spiritual relation to man. The interpretation of this concept is unsurpassed in his statement:

> All these things we *know*. Must not such knowledge "grow from more to more?" Can we not be sure that the little problems . . . which now rise before us as unfinished will sooner or later find their solution?
>
> But when they are solved, will all be known? Nay, verily. Out of these old Carboniferous swamps, new questions, larger, deeper than any we now see, will perpetually arise, to stimulate by their discovery and to reward by their solution, that *love of knowledge for its own sake* which makes us men."[18]

OBITUARY

JACOB GOODALE LIPMAN

IN the passing of Jacob Goodale Lipman, who died at New Brunswick, New Jersey, on April 19, 1939, the agricultural world and particularly the field of soil science has sustained a loss that will be felt not only in the United States but throughout the entire world of scientific endeavor for the improvement of agriculture through the development of basic principles and practices. Dr. Lipman was born at Friedrichstadt, Russia, on November 18, 1874, but was reared on a farm in southern New Jersey. He received his early training at the Baron de Hirsch Agricultural School and his B.Sc. degree from Rutgers College in 1898. After serving as assistant chemist at the New Jersey Experiment Station for two years he took up graduate work at Cornell, where he received his Ph.D. in 1903. In recognition of his distinguished service to agriculture he was awarded the honorary degree of D.Sc. by Rutgers in 1923 and by the Catholic University of Santiago, Chile, in 1930. After serving his alma mater in various capacities he was appointed director of the New Jersey Agricultural Experiment Station in 1911 and dean of agriculture in 1915, both of which positions he continued to occupy until the time of his death.

As dean and director, Dr. Lipman has always been active in the affairs of the Association of Land-Grant

[15] American Association for the Advancement of Science Proceedings, 34: 173, 1885 (1886).

[16] *Idem*, 180.

[17] *Idem*, 180–181.

[18] *Idem*, 197.