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BY CHARLES SCHUCHERT

The death of Edward Salisbury Dana on June 16, 1935, brought to an end a "dynastic" influence in American science, which had had its inception with the appointment of Benjamin Silliman to the chair of Chemistry and Geology at Yale in 1802, and had been handed down from him to his son, Benjamin Silliman, Jr., to his son-in-law, James Dwight Dana, and thence to the latter's son, Edward. This influence, manifest through teaching, through original investigation, through text-books, through voluminous correspondence, and through editorial stimulus and counsel, constitutes an unusual record in scientific history.

Through his father, Edward Dana was of the sixth generation from the American founder of the family, Richard, who settled in Cambridge, Massachusetts, at least as early as 1640, and from his wife, Anne Bullard. His grandfather, James, born in 1780 at Ashburnham, Massachusetts, settled at Utica, New York, married Harriet Dwight, of Williamsburg, Massachusetts, and died in 1860. James Dwight Dana, eldest of their ten children, was born in 1813. Attracted to Yale by the renown of Silliman, he entered with the class of 1833, and found in New Haven not only a great scientific career, but an alliance with two other distinguished families, marrying Henrietta Frances, daughter of Benjamin Silliman and Harriet Trumbull, in 1844. Both the Trumbull and the Silliman families trace direct descent from John Alden and Priscilla Mullins, and date their coming to America from the arrival of the *Mayflower*.

Edward Salisbury Dana, named for one of his father's Yale colleagues and closest friends, the first professor of Sanskrit in America, saw the light of day on November 16, 1849, in the home on Hillhouse Avenue which his father had built and in which he himself lived for most of his long life. At the time of his birth, his father had already established himself in the world of mineralogy by his publication of the *System* (1837, 1844) and the *Manual* (1848), and in that of zoology by the preparation of his monumental reports on the collections made by the Wilkes Expedition. Although appointed Silliman Professor of Mineralogy and Geology in 1850, James D. Dana did not enter upon his academic duties until 1856, but, by the time the younger Dana was graduated from Yale College, his father was devoting himself almost entirely to the field of geology, of which he was to become one of America's foremost representatives. This narrowing

of the elder Dana's interest was probably responsible, in part, for the son's turn toward mineralogy.

Leaving college in 1870, Dana entered the Sheffield Scientific School to take up graduate studies, giving special attention to mineralogy under George J. Brush (1870–1872). In May, 1872, he went abroad, and, after traveling about during the summer, he settled down in October at Heidelberg for the winter and summer semesters. The following winter he studied mineralogy and chemistry at Vienna under Tschermak and Lang, and in April, 1874, he returned to New Haven to take the M.A. degree.

During the summer of 1875, Dana made an extensive reconnaissance trip with George Bird Grinnell as a member of Captain Ludlow's expedition from Carroll, Montana Territory, to the Yellowstone National Park. What they saw in the way of geology is interestingly told in forty-two pages of the Ludlow volume, and forms one of the two geological reports Dana wrote. The fossils they collected were described by R. P. Whitfield. The formations, identified on the basis of marine fossils, were Upper Cambrian, Lower Carboniferous (Madison), Pennsylvanian, Jurassic (Sundance), and late Cretaceous (Pierre and Fox Hills); the Fort Union, the Miocene, and the alluvial deposits of the upper Missouri River were also described. The two young men ascended Cone Butte of the Judith Mountains and found it to be a "trachytic hill", 3400 feet above the Missouri River. Finally, they examined the Yellowstone geysers and described eight of them.

The other geological paper by Dana (and Grinnell) treats of a Miocene intermontane "lake basin," Lake Baker, more than 5000 feet above the sea and about 50 miles east of Helena, Montana. Its deposits were reported to be 200 feet thick and to be overlain by 50 feet of Pliocene, all fresh-water strata with mammal bones.

After his return from abroad, Dana began his productive period of research (1874–1892). As it was necessary for him to earn a living, and as there was no opening at Yale in mineralogy (and, although, as he remarked, he was most proficient in Greek!), the fates decreed that he should take a tutorship in mathematics, physics, and chemistry, which he held until 1879. In that year, he became assistant professor of natural philosophy, and in 1890, he was made professor of physics, holding that chair until his retirement in 1917. It seems curious that, with his great reputation in mineralogy, his teaching career should have been devoted almost wholly to another science.

The years between 1880 and 1893 were Dana's most strenuous ones, because, in addition to his teaching, he was defining terms in physics, geology, and mineralogy for the Century and Webster dictionaries, turning out many papers on mineralogical research, and writing text-books. The strain finally proved too great for his strength, and in March, 1893, he

became nervously prostrated, a breakdown that necessitated the cessation of all work. From that time on, his health was a matter of concern, as was his father's before him. With his wife, he sought health in Europe from the fall of 1893 until the beginning of 1895, when he resumed his duties, but he found that all of his hoped-for research must be given up. Of the later years (1893–1917), he said that his work consisted of a moderate amount of teaching, a good deal of administration in the college faculty and in the Peabody Museum, and the editorship of the *American Journal of Science*. In January, 1902, he had a second breakdown, and again was compelled to give up college work until September, 1903, when he took up a limited amount of teaching and carried it until his retirement in 1917. His emeritus years were devoted largely to the *Journal*.

As has been stated, Dana's chief work as a teacher was done in physics. Nevertheless, from 1880 onward, he did teach mineralogy to a small class of college seniors in the Peabody Museum lecture room, where he had installed a table for blowpipe analysis. Charles H. Warren, Dean of the Sheffield Scientific School, one of his students in elementary physics and mineralogy, says that he was "a delightful teacher, and gave a human touch to physics which was not then and is not now particularly characteristic of teachers of that subject." His undergraduate teaching led him to produce, in 1881, *A Text-Book of Elementary Mechanics for the Use of Colleges and Schools*, which attracted favorable attention and was used successfully for many years. He also undertook research along the line of physics, such as studies with A. Schrauf "On the thermo-electrical properties of some minerals and their varieties" (1874). Moreover, his wide knowledge of what was being done in the field of physics brought many important contributions to the *Journal*, among them epoch-making papers by Henry, Gibbs, and Michelson; and, in the words of Leigh Page, "during the entire period of Professor Dana's editorship, the accounts of current physical discovery, published under the heading 'Scientific Intelligence,' and the reviews of current literature in Physics, continued as valuable, and, in many respects, unique features of the *Journal*."

According to the late Louis V. Pirsson, another of Dana's colleagues, the first investigation of a rock and its constituents, from the petrographic point of view, was made by Dana in 1872, and published in the *American Journal* under the title "On the Composition of the Laboradorite Rocks of Waterville, New Hampshire." During the next two years, Dana studied microscopic petrography in Europe, and after his return he completed a dissertation on the subject of the trap rocks of the Connecticut Valley (1874). These two papers blazed the way for the development of a new science in America, namely, Petrology.

For an appreciation of Edward Dana's accomplishments in the field of Mineralogy, one may turn to his collaborator in later editions of the *Text-*

book of Mineralogy, the present professor of Mineralogy at Yale, William E. Ford, who says:

"Dana's first mineralogic paper was published in 1872 when the author was only twenty-two years old. It was a description of the crystals of the mineral datolite found at Bergen Hill, New Jersey. Many of his succeeding papers (47 in number) during the years from 1872 through 1890 were concerned with the crystallographic and optical properties of minerals. Noteworthy are those on the crystallographic and optical characters of chondrodite, on the twin crystals of staurolite and pyrrhotite, on the crystallization of danburite (the first complete description of the crystallography of this mineral), on crystals of monazite from North Carolina and of stibnite from Japan, on the crystals of gold and of the native copper from Michigan, on the crystals of brookite from Magnet Cove, Arkansas. Included in the papers of this period are the descriptions of the new minerals beryllonite and durdenite, both papers written in collaboration with H. L. Wells.

"The mineral locality at Branchville, Connecticut, was first discovered in 1876 and two years later Brush and Dana began the publication of a series of papers describing this astounding deposit. Only one other mineral occurrence in the United States, that of the zinc ores at Franklin, New Jersey, can be said to have excelled it in its interest and importance, and indeed few deposits in the world have contained so many new and interesting mineral species. The Branchville papers were five in number. The first four appeared in rapid succession from 1878 to 1880, while the last was published ten years later, in 1890. From Branchville some fourteen different minerals were described by the authors, nine of which were at that time new species. It is interesting to note that with the exception of two or three all these minerals have since been found at one or more other localities. One of the papers was devoted to a detailed description of the spodumene found in the deposit, with its very interesting alteration products. For all these papers Dana furnished the crystallographic and optical data.

"Important as Dana's research was, his greatest contributions to mineralogical science were in the books he published. Because of these and their influence his fame became world-wide. Following in his father's footsteps, his first book was the *Text-book of Mineralogy*, published in 1877. It contained not only descriptions of the minerals but chapters on Crystallography. Optical Properties, Chemical Tests, etc. It at once became the most important text-book of the subject that had been published in English. Twenty years later, after the publication of the sixth edition of the *System*, the *Text-book* was entirely rewritten for its second edition. The section on Crystallography in particular was greatly changed and became the first important modern treatise on this subject. This book has since appeared in two later editions.

"Another of his books is *Minerals and how to Study them*, appearing in 1895. This little book is skillfully written and still is one of the best of the elementary introductions to the subject."

Dana's outstanding contribution to mineralogical science, according to Professor Ford, was his publication in 1892 of the sixth edition of the James D. Dana *System of Mineralogy*, with 1134 pages. On it, his fame securely rests. Of it, Ford says,

"This book, while based upon the previous editions by his great father, with further help from Professor George J. Brush, was entirely rewritten, and because of the

rapid growth of mineralogical research during the preceding twenty years was of necessity much enlarged. It was a very great task for one man to accomplish, practically unaided. He is said to have worked about ten years upon the book and at such pressure as to have seriously injured his health. He, himself, has told that in the reading of the final proof the discovery was made that during the casting of the plates some of the minus signs placed above certain of the crystallographic indices had been lost. This necessitated the added burden of a most careful checking of the entire proof in order to make certain that all such errors had been corrected.

"One of the most important contributions made by this book was in the character of the crystallographic descriptions. Dana had all the crystal constants and interfacial angles recalculated, a great work in itself. Many errors in previous descriptions were in this way discovered and in many instances new and better crystal orientations were discovered and adopted. He set a standard in this part of the work that has had a great influence upon all succeeding crystallographic investigation. The book showed great judgment and discrimination in the selection and arrangement of its material, always a most difficult task in writing a book of this character. His success is evidenced by the constant reference in the literature to 'Dana' in controversial matters. One of the most notable features of the book is its extraordinary accuracy. During the more than forty years since its publication very few errors, even those of a typographical kind, have ever been discovered. It at once became the leading mineralogical treatise in any language and in many ways has remained unchallenged. Without question it has been the one book most universally referred to as an authority by mineralogical investigators during this period. Through it Dana has influenced the science more than any other individual of his generation. In 1899 he published the first appendix to this edition of the *System*. Two other appendices have since appeared, in 1909 and 1915. At the present time the seventh edition is in preparation."

The Dana *System of Mineralogy*, Charles Palache remarks, "is the Bible of every mineralogical institute which I have ever been in." Waldemar T. Schaller adds that, great as was the reputation of James D. Dana, "it did not overshadow that of his son. I have been told by others and found it true myself in 1912, that every European mineralogist has Dana's *System of Mineralogy* on his desk. I well remember how pleased he was when on a visit to Washington we showed him a copy of his book so much used that it was all frayed and worn and literally worked to pieces. He was so gratified that on his return he had a new copy sent us with his compliments. I think I have worn out three copies during the thirty years I have been on the United States Geological Survey."

Earlier in this article, mention was made of the fact that, in addition to teaching and research, Dana was called on for a great deal of administrative work of various kinds. In 1876, the first Peabody Museum building was completed, and, as the large collection of minerals belonging to Yale College needed to be transferred to the new Museum, Dana succeeded his father as curator of mineralogy in 1874, in anticipation of this transfer. This mineral collection had long been acknowledged to be the largest and most important scientifically in America, and around it the Peabody Museum had grown. Accordingly, a good deal of Dana's time went into

the husbanding and expanding of this collection, and into the building up of a meteorite collection, which now has about 325 separate falls. From this curatorship, Dana retired in 1922.

Again following in his father's footsteps, Dana was made a member of the Board of Trustees in 1885, becoming the secretary of the Board in 1895, and, after the death of O. C. Marsh in 1899, taking his place as chairman, an office that he held until 1929. Important administrative duties in Yale College also devolved upon him as early as 1883, and in later years he rose to be a power behind the throne in college affairs, serving for long terms on two of the most important committees, that on the Course of Study and that on Ways and Means.

The field in which Dana labored longest was the administration and editing of the *American Journal of Science*. This journal, founded in 1818 by Benjamin Silliman, "the guardian of American science," was maintained by Silliman alone for the first twenty years of its existence. He was then joined by his son, Benjamin Jr., and in 1846 by his son-in-law, James D. Dana, and these three ran the journal together until the death of the elder Silliman in 1864. The younger Dana was added to the staff in 1875, and Benjamin Silliman Jr. retired in 1885. The Danas, father and son, were then proprietors and editors of the journal until the death of James D. Dana in 1895. From that year on, Edward Dana assumed the full burden of what he felt to be a family responsibility, and he carried it until 1926, when, in consequence of his serious illness, the magazine was turned over to Yale University. With his recovery, he resumed the financial responsibilities and helped with the reviews and the correspondence; the editorship was for a short time in the hands of Alan M. Bateman, then in those of Ernest Howe, and, since the latter's death in 1932, it has been assumed by Richard S. Lull. The *American Journal of Science*, long known as the "Silliman-Dana family child," now, after 117 years of fostering care, passes to the complete custodianship of Yale University, accompanied by contributions toward its maintenance from the Silliman, Dana, and Bristol families, and from Editor Howe.

When the *Journal* celebrated its centenary in 1918, one of its chroniclers pointed out that it had then published a little more than 92,000 pages of scientific matter, including upward of 1500 distinct articles in geology, exclusive of the many hundreds of papers on Mineralogy. What a vast treasure house of geological knowledge is stored up in these 194 volumes, and how well the editors have lived up to the proposed "Plan of Work" stated in the opening volume! Not only is it the oldest continuously published scientific journal in this country, but its pages afford a fair idea of the gradual progress and expansion of the earth sciences.

That such signal accomplishments as these should have received high honor is understandable, but the modesty with which these honors were

worn is far from common. Dana always insisted that, whereas his father was a "creator", he himself was but a "plodder." He is known to have refused honorary degrees, even from his Alma Mater. Apparently, he never put together a complete list of the scientific societies to which he had been elected, and the following one is probably not all-inclusive.

His election as corresponding member of the Vienna Reichsanstalt came in 1874, and this same year he was elected to the Sociedad Mexicana de Historia Natural. At the age of thirty-four, he was placed on the roster of honorary members of the ancient Mineralogical Society of St. Petersburg. Acclaim in his own country came also in that year, with his election to the National Academy of Sciences, of which he was at his death the second oldest member, the oldest one having been elected in 1883. He was a member of the Geological Society of America (1908), the American Academy of Arts and Sciences (Boston), the American Philosophical Society, and the Physical Society of America, a foreign member of the Geological Society of London (corresponding member, 1888), and a member of the Edinburgh Geological Society, the Mineralogical Society of Great Britain, the Philosophical Society (Cambridge), and the Vienna Academy. He was honored at the three hundredth anniversary of the University of Dublin. In 1925, the Mineralogical Society of America elected him Honorary President for life; in 1934, the Mineralogical Club of New York made him an honorary life member, and the American Museum of Natural History gave him the same distinction. The Yale Corporation, meeting on the day of his death, passed a resolution, of which the following are the closing words: "Foremost American mineralogist of his time, he brought to himself and to the University widespread recognition in the world of science."

Turning now from the scientific achievements of Edward Dana to the man himself, he was somewhat shorter than his father, but had the same quickness of movement. His full head of hair, gray to white in the thirty years the writer knew him, framed a rather ruddy face, lit by a pair of wide-open, very blue eyes, which were usually smiling. A generous mouth showed the humor that was one of his marked characteristics. Intellectually alert, interested in the world at large, modest, keen to the last about all advancement in scientific matters, friendly and charming of manner, "Eddie" or "Ned" Dana, as he was affectionately known among college men, was a remarkable and lovable man.

Of himself, he said that one of his strongest characteristics was his love of Nature, inherited both from his parents and from his maternal grandparents. He was a famous walker, finding in this pastime the rest and recreation his uncertain health needed, as did his father before him. In his eighty-fifth year, he climbed Pemetic Mountain on Mount Desert. Continuing the custom of his father, he acted as his own mail carrier, and

every morning, rain or shine, his sturdy gray-clad figure could be seen coming up the avenue with the day's grist for the *Journal*, his only concession to winter weather being the addition of a sweater under his suit coat. His intense love of Nature found fullest expression during the summer months, which he spent at Seal Harbor, Maine. The Mount Desert country had been brought to his notice in the nineties, when he was in search of relief from hot weather, which affected his health. A visit to the island brought enchantment, and, in 1896, he built one of the first summer homes on the cliffs high above Seal Harbor, and thus became witness to its development into the fashionable resort of today. Here, he and his wife found their earthly Paradise, and here they both are buried.

Dana's delight in Nature was at its peak only when it was shared, as was his joy in books, in poetry, and in music. He had a rare gift for companionship. He was, moreover, a lifter of burdens, be they mental or material, and he was never too busy to lend an interested and sympathetic ear to those on whom the shadows fell thick. It was his pride, also, that he had ironed out many a misunderstanding between others, often with the light touch of humor that so successfully dissolves such mists. Because of this deep store of kindliness, a host of friends, cultivated through his long life by frequent contacts, and by active correspondence, find the world he has left a sadder place.

Dana was married on October 2, 1883, to Caroline, daughter of William Brooks Bristol, member of a family long prominent in the legal profession in New Haven; she died in 1916. Surviving him are a brother, Arnold Guyot Dana; a sister, Maria Trumbull Dana; his three children, Mary Bristol (now the wife of Alexander C. Brown, of Cleveland), James Dwight, and William Bristol; seven grandchildren, and one great-grandchild, to all of whom he leaves as a heritage the memory of a long and distinguished career in American science.

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