JAMES DWIGHT DANA.

JAMES DWIGHT DANA, Professor of Geology and Mineralogy in Yale College and for fifty years one of the editors of this Journal, died suddenly at his residence in New Haven, Connecticut, on the fourteenth of April, 1895, at the age of eighty-two years and two months.

He was born in Utica, New York, on the twelfth of February, 1813. His father, James Dana, was of New England birth, having moved to Utica from his parents' home in Massachusetts. He was a successful business man and died in 1860 at the age of eighty. His mother was Harriet Dwight, daughter of Seth Dwight of Williamsburgh, Massachusetts.

The strong inborn taste for science was shown in early years, and he was fond of relating his pleasant experiences at the Bartlett Academy in Utica, when, as a boy of twelve, he studied chemistry with his associates, sharing with them the responsibility of preparing the experiments and delivering to the others the formal lectures. At the same time, frequent excursions after minerals with his companions served to give a special direction to his scientific interests and thus helped to determine the department in which his first work was to be done when maturity had developed his powers. These excursions were led by Mr. Fay Edgerton, the excellent instructor in Natural Science, and extended to distant parts of the State and also to neighboring States; one excursion into Vermont was remembered with much delight.

To the opportunities afforded by the early training in science, that have been alluded to, and to the interest it excited, Professor Dana ascribed much of the success that he afterwards attained. One of his schoolmates, closely associated with him in the Bartlett Academy, was S. Wells Williams, for many years missionary in China and in his later life again a colleague

among the corps of instructors at New Haven. A number of others, who subsequently rose to prominence, were among those who shared the inspiration of Mr. Edgerton's instruction. It is also of interest that Dr. Asa Gray, a close friend from early days, took Mr. Edgerton's place in the school in 1831.

In 1830, attracted by the name and reputation of Professor Silliman, he came to New Haven and entered the class of 1833 of Yale College, then in its Sophomore year. He was a faithful student, but those were days of a rigid course of study, chiefly in the classics, affording little to appeal to a mind with a strong bent for the methods and facts of science. It is not surprising, therefore, that though obtaining a good place on the honor list he did not make a brilliant record for general scholarship. He was, moreover, at a disadvantage because of insufficient training in the ancient languages, felt especially by one entering after the close of the first year of the course. It should be stated, however, that during his undergraduate life, he attained distinction in mathematics, a subject for which he always had decided aptitude. During this time he made much progress in science, especially in his favorite study of Mineralogy. In Botany also he took great interest; during his College life he made a large collection of the plants of the New Haven region, and a printed list of the local flora, carefully checked and annotated by him, is still preserved.

For music he had throughout his life a strong love, and when in College he devoted much attention to it, being on one occasion president of the Beethoven singing society, and for a time the leader of the college choir. He also made some attempts at musical composition. One of these was the music for an ode to the Ship "Peacock" of the Exploring Expedition (see p. 332), written by the Surgeon, Dr. J. C. Palmer; both gentlemen found a source of recreation and pleasure in their joint musical and poetical work during the voyage. It is interesting to note that many years later when upwards of seventy and unable because of ill health to write, he came back to his music and derived much comfort from working at it.

The influence of the elder Silliman, then at the height of his powers and reputation, did much to decide him to devote him-

self permanently to science, as will be seen in the events that followed. It is a point of interest also, as proving how deep his natural love of science was, that from home he obtained no encouragement whatever in turning his studies in this direction; indeed, from the time of graduation he assumed the entire burden of his own support. To his father's practical mind scientific pursuits did not commend themselves, but it should be stated that he lived to take a cordial interest and pride in his son's success.

Mr. Dana left New Haven in August, 1833, somewhat in advance of graduation, to avail himself of the opportunity offered of a cruise in the Mediterranean, as instructor in mathematics to the midshipmen of the United States Navy. In this capacity he visited a number of the seaports of France, Italy, Greece and Turkey, while on the "Delaware" and the "United States." This trip, lasting about fifteen months, brought much pleasure and profit. He was cut off for a time from his favorite minerals, but he occupied his leisure hours on shipboard with working out, by methods of his own, many of the more intricate problems of mathematical crystallography. Some notes of the voyage also mention the fact that he was interested in the study of the geology of the island of Minorca and that he made some collections in Natural History while there. It will be observed that the first paper recorded in the Bibliography, which follows this notice, is an account of the condition of Vesuvius in July, 1834, at the time of his visit; this was published in this Journal in 1835.

In 1836, Mr. Dana returned to New Haven and for two years remained there, occupied for more than a year as assistant in Chemistry to Professor Silliman. It was during this period that he published his first important contribution to Science,—the System of Mineralogy, a volume of 580 pages. This was in May, 1837, hardly four years after his graduation from College and when a young man of twenty-four; notwithstanding his youth, the work is that of a thoroughly mature and well informed scholar. A little earlier (1835) his notes mention the fact that he had constructed a set of crystallographic models in glass, probably the first time this had been attempted.

While at New Haven, another opportunity came to him for travel and observation, this time as Mineralogist and Geologist

to the Exploring Expedition then about to be sent by the government of the United States to the Southern and Pacific oceans under the command of Commodore Charles Wilkes. The invitation, when first received in 1836, was refused, but on the urgent solicitation of Dr. Asa Gray, then expecting to go as Botanist, the decision was reconsidered and finally the position accepted. He was disappointed in failing to have the companionship promised, but subsequent events brought the two men closely together and Dr. Gray remained an intimate personal friend and highly valued scientific associate until his death in 1888.

The expedition, consisting of five ships, sailed in August, 1838, and Mr. Dana was connected with it until June, 1842. The route was briefly as follows. First to Madeira, then to Rio Janeiro, down the coast and through the Straits of Magellan, after passing which, while on board the "Relief" he nearly suffered shipwreck off Noir island, the ship remaining three days and nights in extreme peril; in the same storm one of the smaller accompanying vessels was lost. Then to Chili, Peru and across to the Paumotus, to Tahiti and the Navigator islands; then to New South Wales, where the naturalists remained while Commodore Wilkes went into the Antarctic; then to New Zealand, the Fiji islands, where two of the officers were murdered by the natives; to the Sandwich islands, the Kingsmill Group, the Caroline islands and thence north to the coast of Oregon. Here, near the mouth of the Columbia river, the "Peacock," the ship to which he had been assigned, was wrecked, entailing the loss of all his personal effects as well as many of his collections. He was, then, one of the party that crossed the mountains near Mt. Shasta and made their way down the Sacramento river to San Francisco. In his report of the expedition he states that the geological features indicated the probable presence of gold. This was six years before the discovery of gold in California, and rich mines have since been discovered in the region the party went over. At San Francisco the party were taken aboard the "Vincennes" and the homeward journey was made by way of the Sandwich islands, Singapore, the Cape of Good Hope and St. Helena. The arrival in New York was on June 10, 1842.

The opportunities of this long journey to many of the most interesting points in the world were such as have been offered to few young men of his years and could never come again. The stimulus of the multitude of new facts to observe and of new forms of life to collect and study was extraordinary, and the effect of these four years upon the attainments of his subsequent life was profound. Of the beauties of the life in the sea about the coral islands and of that of the tropics in general he never tired of speaking; his lecture on "Coral Islands" delivered in later years to many generations of college students, contained a vivid description of the scenes he enjoyed so much.*

It is interesting to note here, that a few years before the American expedition was in the Pacific, the British ship "Beagle," having the naturalist Darwin on board, had sailed through much of the same region. The theory explaining the formation of the coral atoll by gradual subsidence, first advanced by Darwin (1842), was also independently worked out to a large extent by the American naturalist.† The latter showed, moreover, that the reef-building corals lived only in water of at least 68 degrees Fahrenheit, which proved that the distribution of corals depended on the temperature of the water.

As already stated, Mr. Dana was first appointed in the field of Geology, and his observations and deductions are given in a large quarto volume of 756 pages with a folio atlas of 21 plates (1849). Later, however, in part because of the return of one of his colleagues to the United States, he assumed charge also of the Crustacea and Zoöphytes. These combined departments gave full scope to his zeal and industry. The results of his work in this department of Zoölogy include a *Report on Zoöphytes*, a quarto volume of 741 pages, with a folio atlas of 61 plates (1846); also a *Report on Crustacea*, in two quarto volumes aggregating 1620 pages (1853) and accompanied by a folio atlas of 96 plates (1854). These three reports will be more particularly spoken of later, but it may be mentioned here that a large part of the drawings of the plates in both works were made by his own hand.

* This subject is presented in somewhat popular form in the work entitled "Corals and Coral Islands," first published in 1872.

† A brief discussion of this theory is given on a later page of this number (p. 426); it was one of the last subjects on which he wrote.

In June, 1842, Mr. Dana returned to the United States and for the next thirteen years devoted his chief energies to the study of the material collected on the expedition and to the preparation of the reports mentioned. His labors, however, were not limited to this field, for during the same period, he prepared and issued three editions of the System of Mineralogy (1844, 1850, 1854) and two editions of the Manual of Mineralogy (1848, 1857), besides writing numerous papers for this and other scientific periodicals.

From 1842 to 1844, he resided in Washington, and later in New Haven. On June 5, 1844, he married Miss Henrietta Frances, third daughter of Professor Benjamin Silliman, whose assistant he had been in 1836–37, and with whom he was from this time closely associated in scientific work.

The labor on the material from the Exploring Expedition was carried forward with the enthusiastic zeal of an earnest student with a new world open before him, and who was but little restrained by the thought that injury to health was possible. How severe and intense the labor of this period was will be evident from the fact that a few years after the last Report was published, Mr. Dana's health broke down, and so completely that though he lived thirty-five years after this and accomplished a wonderful amount of scientific work, life was from this time ever a struggle and, not always with success, against physical disability.

In 1846, Mr. Dana was made an editor of this Journal, associated with Professor Benjamin Silliman, who had founded it twenty-eight years before, and with his son, Professor Benjamin Silliman, Jr. His labors in connection with the Journal continued until the close of his life.

In 1850, Mr. Dana was appointed Professor of Natural History in Yale College, and in 1864 the title was changed to that of Professor of Geology and Mineralogy. His duties as instructor, however, he did not take up until 1855, but, after this date, with some interruptions due to ill health, as more particularly noted later, his active connection with the college continued until 1890. It is perhaps interesting to add that just before his appointment to Yale in 1850, he had been invited to a similar position at Cambridge, Massachusetts, in connection

with Harvard College, but by the prompt action of a generous friend in the Yale Faculty in providing the necessary funds, he was induced to remain in New Haven on the "Silliman Professorship." This gentleman, who is still living, remained throughout the life of Mr. Dana one of his closest friends.

In 1859, as already noted, long continued over-work brought a break-down of a serious character and from which he never fully recovered. The nervous prostration was very complete at first, and even a period of nearly a year abroad, from Oct. 1859 to August 1860, seemed to have little result in the way of restoration. Although later some degree of health gradually came back, he was always subject to the severest limitations until the end of his life. Only those immediately associated with him could appreciate the inexorable character of these limitations and the self-denial that was involved not only in restricting work and mental effort, but also in avoiding intercourse with other men of science and friends in general, in which he always found the greatest pleasure.

Little by little the power for work was restored and by husbanding his strength so much was accomplished that, besides other writing, he was able to bring out in 1862 the first edition of his Manual of Geology, and in 1864 the Text Book of Geology, and four years later his last and most important contribution to Mineralogy, the fifth edition of the System.

This last great labor, extending over four years, was followed by a turn of ill health of an alarming character and from which restoration was again very slow. The years that immediately followed were filled with the same quiet labor, on geological investigations in the field, the writing of original papers and books, the editorial work of this Journal, and his duties as a college instructor. They were remarkably productive years, notwithstanding the difficulties contended against, notably renewed illness in 1874 and 1880, as will be seen by reference to the Bibliography. A large number of important papers were published, chiefly in this Journal: new editions of the Manual of Geology were issued in 1874 and 1880; of the Text Book in 1874 and 1883; while a new geological volume called "The Geological Story briefly told," was issued in 1875 and one on "Corals and Coral Islands" in 1872.

The years from 1887 to 1890 include the time when he most nearly threw off the limitations of ill health. In the summer of 1887, accompanied by his wife and youngest daughter, he revisited the Sandwich Islands, the acquaintance of which he first made in 1840, when on the Exploring Expedition. This was, indeed, the first long journey made except that to Europe in search of health in the years of 1859–60, since the expedition returned in 1842. He was led to make this journey* because of the interest aroused in discussing the phenomena connected with the eruption of the volcano of Kilauea on the island of Hawaii. The journey brought the keenest pleasure, not only that due to revisiting the Sandwich Islands themselves but also that of making the acquaintance of a number of interesting places in the western United States. Although travel had ordinarily been too severe a tax since his health gave out, this journey of ten weeks extending over ten thousand miles, proved of profit, and every incident was entered into with the enthusiasm of a mind which years could not make old. A number of papers upon the Hawaiian volcanoes were the result of this summer's outing, and in the winter of 1889–90, he prepared a volume on Volcanoes, a companion to that on Corals and Coral Islands, a new edition of which was issued at the same time. The prefaces of both works were dated on his seventy-eighth birthday, February 12, 1890.

In the summer of 1889, he attended the meeting of the American Association at Toronto, the first time he had been present at such a meeting since he delivered the presidential address more than thirty years before.

With the autumn of 1890 came a more serious illness than any since 1859, and the indications seemed very alarming. For a number of months absolutely no work was done, and later only a little light labor by means of dictation. It was at this time that the small volume on the New Haven region entitled "The Four Rocks," was given to the public. This disability was again partially thrown off—although he never again resumed active College duty—and the work on the fourth edition of the Manual of Geology, then far advanced, was resumed slowly at first and then with more vigor with returning

* See this Journal, vol. xxxiv, 349, Nov. 1887.

strength. From this time, however, till the end he seldom exceeded a limit of three hours labor each day.

In February, 1893, the printers began their work on the volume mentioned and it was just two years before the last proof had been read and the volume was complete. To himself and still more to those about him it seemed many times as if the completion of this great work would have to be left to others, but with the self-control born of a strong will and long experience, and with the never failing watchful care of his life-long companion—without which his labors could never have been so productive nor have been continued so long—he worked on slowly, doing each day only what he had strength for, and, finally, the labor was accomplished. The completion of this work, which was rewritten and rearranged from beginning to end, involving a critical consideration of the many new facts and theories of the science, will be granted to have been a remarkable performance for a man of eighty-two. He finished it in February, 1895, and a month later he had completed the manuscript of a new edition of his Geological Story and then commenced work on that of the Text Book.

On Saturday, April 13th, he took his usual excursion to the Post Office, and through the day was as bright and vigorous of mind as ever. That evening there was a recurrence of a slight trouble in the action of the heart, of which there had been some manifestations in the few months immediately preceding; the following day he did not rise, although feeling relieved; in the evening the trouble returned and after a very brief period of unconsciousness, he passed quietly away.

The concluding years were marked by an ever increasing serenity, and happiness in his work and in the friends about him. Up to the last day there was no evidence of diminished mental force, though his physical strength was somewhat impaired. It was for him a most happy ending of a life, full of fruitful activity and honor.

The chief scientific results of this long life of continued and, except for its limitations, ever happy labor for science have been already indicated. To estimate properly their value and originality belongs to another place and time and demands the services of specialists in each of the three departments of Mineralogy, Geology and Zoölogy. Some further general words in regard to them seem, however, to be required.

The subject, to which he was earliest attracted, from the time of his first excursions, as a boy, after minerals, and that with which his name is, perhaps, most frequently connected is Mineralogy. The first edition of the System of Mineralogy was issued, as has been stated, in 1837, when he was only twenty-four years old. This large volume shows a close study of the great works of Häuy, Mohs and Naumann and of others who had preceded. It is, however, more than an industrious compilation from earlier authors, particularly as regards the chapters on crystallogeny and mathematical crystallography. The classification adopted is the so-called Natural System, the serious shortcomings of which were later fully appreciated. The nomenclature attempted, devised by him to suit this classification, was on the dual Latin plan "so advantageously pursued in Botany and Zoölogy." The second edition of the System (1844) preserved these features, but in a supplement, a classification based on chemical principles is proposed and this, further developed, is adopted in the third edition (1850) while the Latin nomenclature is abandoned.

In connection with this fundamental change, it seems worth while to quote from the preface of this edition, since what is said here was so characteristic of the author's attitude of mind to scientific truth in general.

> . . . To change is always seeming fickleness. But not to change with the advance of science, is worse; it is persistence in error; and, therefore, notwithstanding the former adoption of what has been called the Natural History system and the pledge to its support given by the author, in supplying it with a Latin nomenclature, the whole system, its classes, orders, genera and Latin names have been rejected. . . .

It was in the fourth edition of the Mineralogy, in 1854, that the chemical classification, essentially as now understood, takes

its full place. In this edition, moreover, the other parts of the work were put in new and better form, containing the result of much thought on crystallogeny and homœomorphism. The fifth edition (1868), which includes only the description of species, is a monumental work—the most complete treatise, indeed, that had ever been attempted. In it the classification was still further developed, the nomenclature simplified and systematized, and in connection with the latter subject an exhaustive review of the entire mineralogical literature from the beginning was made in order to unravel the vexed questions of the history and priority of mineral names. This last feature of the volume was a labor involving great patience and skill. It was in recognition of this work that he received the degree of Doctor of Philosophy from the University of Munich in 1870. In the sixth edition of the System (1892), by his son, he took a lively interest, but was unable to coöperate in the labor actively, in consequence of the condition of his health; even the reading of the final proofs, though attempted, had to be soon given up.

Besides the System, he also issued a small work, called the Manual of Mineralogy, which has passed through four editions (1848, 1857, 1878, 1887). The pages of this Journal also contain, particularly down to 1868, many papers on mineralogical topics; his last paper in this field was published in 1874. The subjects that interested him were, for the most part, those of a general and philosophical nature, such as questions of classification, theories of crystallogeny, and the morphological relations of species. In the points connected with the descriptions of individual species he took less interest, though his observations here were numerous and important.

Mineralogy, however, did not afford scope enough for a mind so active, indeed he often spoke of it as a department of limited ideas and principles. To the broader field of Geology and geological investigation, he had been early turned by his labors for the Exploring Expedition, the results of which have been already mentioned.

The several editions of the Manual of Geology (1862, 1874, 1880, 1895) have been briefly alluded to. To the many geologists familiar with this work, it is unnecessary to remark that, like the System of Mineralogy, it is not simply a compilation

of the facts of the science but a development of the whole subject with a breadth, philosophy and originality of treatment that has seldom been attempted. One of his colleagues remarks:

"The treatment of strata and fossils from a chronological point of view as Historical Geology is a characteristic feature of his Manual. The growth and development of the earth, its continents and seas and the progress in the organic life on its surface, were thus unified into a special department of Geology, the history of the earth and of its inhabitants, which was by other authors dealt with as formational, stratigraphic or paleontologic geology."

Each edition of the Geology was carefully worked over and the last was completely rewritten from beginning to end. It was a great pleasure to him in connection with this work to have the constant and ready coöperation of a number of the able young geologists in the country, without whose aid the volume could not have been so satisfactorily completed. Similar coöperation and pleasant relations he had enjoyed while at work upon his earlier volumes both in Geology and Mineralogy, but this is hardly the place to speak of that in detail. Allusion has also been made to the smaller works, the Text Book (first edition, 1864,) and the Geological Story (1875); of the last the manuscript of a new edition is now in the printers' hands.

In the general department of Geology his contributions again were largely to subjects of a broad and philosophical character: the origin of continents and of the grand features of the earth was discussed in early papers as well as later; the problems of mountain-making and the phenomena of volcanic action, to which he devoted much thought, are some of the other topics treated at length.

But, as a geologist, he was not only a thinker and writer in his study but also an active observer in the field. This remark applies obviously to the four years with the Exploring Expedition but further particularly to the period from 1872 to 1887, when he was carrying on the study of the crystalline rocks of the so-called Taconic system chiefly in western New England; also of the glacial phenomena of southern New England (1870 *et seq.*) The region included in western Connec-

ticut and Massachusetts, and extending westward into New York and north to Vermont, was tramped and driven over many times, until one might almost say that there was hardly an outcrop accessible to any of the roads in this difficult region that had not been visited, its rocks examined and observations recorded on the dip and strike. These results and the conclusions derived from them fill many pages of this Journal. Against the dictum that all crystalline rocks, not volcanic, must be of pre-Paleozoic age, he rebelled strongly as against all similar dogmatic treatment of scientific facts and principles. His strength of feeling on this point was what largely prompted him to spend so much time and strength in this investigation.

He was no less interested in the country immediately about New Haven, especially as regards its glacial phenomena. In 1870, he published a large memoir on the Geology of the New Haven region. The observations, recorded in this paper, were made at a time when work at his table was impossible and the open-air exercise brought profit to health as well as scientific results. Twenty years later, when again incapacitated from writing and close thinking, he issued a small volume entitled "The Four Rocks of the New Haven region" describing some of the chief features of the region in popular form.

Thus far only his labors in Mineralogy and Geology have been spoken of in particular, and probably most of the younger generation of workers in science know him only in these fields. But his most extensive original contributions to science were in the department of Zoölogy, to which he made early contributions although chiefly attracted to it by the chance opening when on the Wilkes Expedition. The large volume devoted to the Zoöphytes, and the two volumes of the Crustacea, each work with an atlas of beautiful plates most of them drawn by himself, are classical works containing the descriptions of hundreds* of new species and with a philosophical development of the classification and the relations of species that is truly

* The number of new species of zoophytes described was over two hundred; in the Report on Crustacea six hundred and eighty species were described, of which upwards of five hundred were new. A large part of the collections in Crustacea were lost by the wreck of the Peacock on the shores of Oregon. It may, perhaps, be worth recalling that many of the type specimens were later de-

profound. It is in this matter of the classification that the most important contribution to Zoölogy was made. This is true in general of both the works, and though the last half century that has elapsed has brought some slight changes to the classification of the Crustacea here developed, that of the Corals stands to-day nearly as it was given in the Expedition Report.

The volume upon the Zoöphytes is what would be called to-day a report on the Anthozoa, including the description of the corals and coral-making animals and of allied forms, of sea-anemones and including also a few hydroids. The value of the work is much increased by the fact that it was the first time that any considerable number of the coral animals had been described and figured from life; the original colored drawings were made by Mr. Dana from the living animals, as described in the quotation below, taken from the preface. The beautiful drawings of the sea-anemones, it should be stated, were made by the artist of the Expedition, Mr. Drayton. The volume thus marked a new era in the subject, since collections had hitherto been limited for the most part to the corals themselves.

. . . . . The field for geological investigation there offered [the Fiji islands], was limited, as we were shut out from the interior of the islands by the character of the natives: at the same time coral reefs spread out an inviting field for observation, hundreds of square miles in extent. The three months, therefore, of our stay in that group were principally devoted to exploring the groves of the ocean, where flowers bloomed no less beautiful than those of the forbidden lands, and rocks of coral growth afforded instruction of deep interest. The specimens were obtained by wading over the reefs at low tide, with one or more buckets at hand to receive the gathered clumps, or where too deep for this, by floating slowly along in a canoe with two or three natives, and through the clear waters, pointing out any desired coral to one of them, who would glide to the bottom, and soon return with his hands loaded, lay down his treasures, and prepare for another descent. When taken

stroyed by fire in Chicago, while the copies of the published work suffered three times most seriously in the same way. The first time was during its publication at Philadelphia and resulted in the loss of many of the original colored drawings, to the permanent injury of the work, since they could not be replaced. The two other fires were at New Haven, the last one (1894) largely destroyed the residue of the plates when being collated by the binder preparatory to their being presented to some friends of the author.

out of its element, the coral often appears as if lifeless: but placing it in a basin of sea-water, the polyps after a while expand, and cover the branches like flowers. Four-fifths of the observations in this department were made at the Feejee Group. . . . . .

The work accomplished on the expedition is the more remarkable, because there was from the first but little sympathy between the prominent naval officers and the active members of the scientific corps. This lack of coöperation resulted in the throwing of many obstacles—sometimes petty and provoking, again very serious—in the way of the young and ardent observer, and it is only fair to him to allude to this subject here, though it was one of which he was by no means fond of speaking. There is a painful contrast between the course of events in these particulars with the Wilkes expedition and the cordial aid given to science in some of the later ones.

Many papers upon zoölogical subjects were published in this and other Journals, especially during the time he was working up the collections of the Exploring Expedition, and these present many of the results and conclusions arrived at. The principle of Cephalization, or the domination of the brain in determining the development of an animal organism, was first brought out in 1852.* In regard to this subject, particularly in its relation to evolution, he says in the Manual of Geology (1895, p. 439):

This subject has much interest in connection with the successional lines in the animal life of the globe which geology has brought to light. But the preceding remarks are not to be understood as intimating anything with regard to the origin of species. There was no such reference in the author's first presentation of the views in 1852. At that time the idea of evolution by natural causes had scarcely an advocate; for Darwin's work did not appear until 1859. Neither are the facts now to be regarded as adding to the causes of derivation. This much, however, may be learned from them:—

1. Whatever the natural causes or methods concerned in evolution, organic conditions have determined lines, limits, and parallel relations, in accordance with the principle of cephalization.

* In the Report on Crustacea; in 1863 the subject was discussed in this Journal.

2. In the evolution of the animal kingdom a "tendency upward" is a necessary consequence of the presence of a cephalic nervous ganglion or brain.

The theory of evolution, or the development of species, was one, as indicated above, that his mind approached slowly. He started, like most others, with the belief in the special creation of species; at the same time, his mind even at this period was opening out to a broader idea of the relation of species to each other. This is hinted at in the closing sentences of the following paragraphs quoted from a chapter on the geographical distribution of Crustacea.*

. . . . . Although we cannot admit that circumstances and physical forces have ever created a species (as like can only beget like and physical force must result simply in physical force) and while we see in all nature the free act of the Divine Being, we may still believe the connexion between the calling into existence of a species and the physical circumstances surrounding it to be as intimate nearly as cause and effect."

In 1857 again, in a paper upon Species, published in this Journal (vol. xxiv), he says, (p. 307, the italics are his):

A species among living beings, then, as well as inorganic, is based on *a specific amount or condition of concentered force defined in the act or law of creation.*

On a later page, he again speaks of a species as "essentially permanent or indestructible."

He always maintained, however, that the true scientific spirit was to keep the mind open to the reception of new truth, even if this was at first opposed to preconceived notions. This principle he had exemplified in regard to a subject of limited bearings by the change of view on mineralogical classification, as is well shown by the quotation from the preface to his Mineralogy given on a preceding page. And now in relation to this, perhaps the broadest generalization in science, he was true to this principle again. For gradually, by steps that it would be interesting to trace, he came to accept very fully the principle of evolution as a fundamental law,

* Report on Crustacea; also this Journal, vol. xx, 358, 1854.

although it should be said that Darwinism in the narrow sense never seemed to him a sufficient explanation of the origin of species. To attempt to explain his views in full would be inappropriate in this place, but by quoting a few sentences from the closing chapter of the last edition of his Manual (1895), the main points in the position finally reached may be shown.

. . . . The principles above stated are all in accord with a theory of evolution and through the added facts of later years, they favor the view of *evolution by natural variation.*

. . . . It is perceived that the law of nature here exemplified is *not* "like produces like," but like *with an increment* or some addition to the variation. Consequently, the law of nature, as regards kingdoms of life, is not permanence but change, evolution. . . . . The survival of the fittest is a fact; and the fact accounts in part for the *geographical distribution* of the races of men now existing and still in progress; but not for the *existence* of the fittest, or for the power that has determined survival. . . . . But the origin of the variation is without explanation. And so it is for the most part throughout the kingdoms of life. Enough is known to encourage study.

And finally, the closing paragraph of the work is as follows:

Whatever the results of further search, we may feel assured, in accord with Wallace, who shares with Darwin in the authorship of the theory of Natural Selection, that, the intervention of a Power above Nature was at the basis of man's development. Believing that nature exists through the will and ever-acting power of the Divine Being, and that all its great truths, its beauties, its harmonies, are manifestations of His wisdom and power, or, in the words nearly of Wallace, that the whole Universe is not merely dependent on, but actually is, the Will of one Supreme Intelligence, Nature, with man as its culminant species, is no longer a mystery.

These are the words of the Christian Philosopher, with a rarely comprehensive grasp, and with whom the faith of his youth only grew stronger as his insight became deeper into Nature's laws.

As an editor of this Journal, Professor Dana was associated first with the two Sillimans (1846 to 1863), later with Benjamin Silliman, Jr. alone (1863 to 1875) and finally with his son Edward Salisbury, from 1875. The elder Silliman died in 1864 and the younger Silliman in 1885. The editorial labors were carried on almost continuously from 1850 to the end of his life. Ill health interrupted this work less than that involving severer and more consecutive thought. The closing pages of the present number contain several notices prepared by him within the past few weeks.

In connection with this labor, he did a vast amount of writing, including, besides original papers, hundreds of abstracts, critical reviews, obituary notices, and notes on many topics. These are far too numerous to find place in the Bibliography here given. He threw into this editorial work much of his best energy and always felt that he was serving science well in this way. No degree of pains was too great to ensure completeness and accuracy, and if an outsider might have thought that he insisted too strongly upon some rule of punctuation or spelling, it would have been from the failure to understand a mind which could be satisfied only with the highest degree of accuracy and excellence attainable. A piece of manuscript written for the Journal, like that of his books, was corrected and amended again and again, and the process of erasure and insertion of new words and paragraphs went on up to the moment of its passing into the printers' hands; the result was often trying to the compositor notwithstanding the clearness of the hand-writing.

As a College Instructor his labors commenced in 1855 and, except as interrupted by ill health, as has been explained, continued until 1890; in 1892 he formally retired and, in 1894, was made *Professor Emeritus*. He gave instruction at first in Mineralogy and Geology, but afterward in Geology alone, with occasional courses of lectures, as on Evolution and Cosmogony. The subject of Geology did not occupy a large place in the curriculum and consequently the number of exercises per week was not large. This, as he appreciated fully, was a great gain to him personally, so far as original writing was concerned, for it not only gave him much of his time for his own work but

during seasons of ill health made the strain as light as possible. It had the accompanying disadvantage, however, that it did not bring him so near to the successive classes of young men as would otherwise have been the case. His personality, however, was so strong, his interest in the subject he was teaching so profound, his patience in explanation so untiring, that few of his many pupils could have failed to carry away a lasting impression of him, if not always of his subject. His relations with the students, always friendly, were made more close by the excursions to the various points of interest about New Haven and its vicinity, which he enjoyed himself quite as much as the boys and in much the same youthful spirit. These excursions were generally largely attended, and by many whose tastes did not lead to science; not a few of them will remember the earnest manner of the genial Professor in his out-door lectures and the quick step with which he led them up and down the hills, faster perhaps, in some cases, then they would have chosen to go.

In the deliberations of the College Faculty, he was always in favor of progress and especially interested in any step leading to the development of science. He was active in the building up of the University collections in Mineralogy and Geology, not only in the early years but also later as a Trustee of the fund given to the University by Mr. George Peabody in 1866 for a Museum of Natural History. The construction of the building erected in 1876, as regards internal arrangements, was largely determined by plans made by him. He also coöperated cordially in the establishment of the Scientific department of Yale University, known as the Sheffield Scientific School, and always took a sincere pleasure in its progress. The profound results of his influence, particularly in encouraging his younger scientific colleagues, can hardly be overestimated.

Of his habits of work, the constant activity of his mind, and of many personal characteristics, aside from those already hinted at, much might be said; but of these points it is more appropriate that others than the writer should speak, as also of the wonderful powers of generalization of one, who was a master of three sciences and at the same time had a profoundly comprehensive view of nature as a whole. Of his unquestioning religious faith, too, this is not the place to speak

Of the honors which fall to the successful worker in science, Professor Dana received a large number, but his mind was too free from pride or ostentation to dwell upon them. It would be most in accordance with his habit to omit any detailed statement here, but this account would then lack completeness.

In 1872 the Geological Society of London conferred on him the Wollaston medal, "in acknowledgement of his services to Mineralogy and Geology." In 1877 he received the Copley gold medal from the Royal Society of London, "for his Biological, Geological and Mineralogical investigations, carried on through half a century, and for the valuable works in which his conclusions and discoveries have been published." In 1892 the Boston Society of Natural History conferred upon him their "Grand Walker prize of $1000 for distinguished services in Natural History."

Professor Dana was elected president of the American Association for the Advancement of Science in 1854 and in August of the following year delivered his retiring address at the Providence meeting. In 1872 on the celebration of the fourth centennial of the University of Munich, he received the degree of Ph.D. and in 1886 at the Harvard celebration the degree of LL.D., was conferred upon him. The latter degree had been earlier given by Amherst College in 1853 and was also received from the University of Edinburgh in 1886. He was one of the original members of the National Academy of Sciences in the United States, and since the time when he was made correspondent of the Academy of Natural Sciences in Philadelphia in 1836, such honors were frequently conferred upon him, until he became thus connected with a large number of the scientific societies in the United States and abroad, including the Royal Society of London, the Institute of France, the Royal Academies of Berlin, Vienna and St. Petersburg and many others.

Professor Dana leaves a widow, four children, and four grandchildren.

The photograph from which the accompanying plate was made was taken about six weeks before his death.

E. S. D.

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