sition of terrigenous rocks and minerals in deposits nearer continental shores. There is thus a striking difference between the average chemical and mineralogical composition of Terrigenous and Pelagic Deposits.

It would be extremely interesting to have a detailed examination of one of those deep holes where a typical Red Clay is present, and even to bore some depth into such a deposit if possible, for in these positions it is probable that not more than a few feet of deposit have accumulated since the close of the Tertiary period. One such area lies to the south-west of Australia, and its examination might possibly form part of the program of the approaching antarctic explorations.

Life on the Ocean-floor.

It has already been stated that plant-life is limited to the shallow waters, but fishes and members of all the invertebrate groups are distributed over the floor of the ocean at all depths. The majority of these deep-sea animals live by eating the mud, clay, or ooze, or by catching the minute particles of organic matter which fall from the surface. It is probably not far from the truth to say that three-fourths of the deposits now covering the floor of the ocean have passed through the alimentary canals of marine animals. These mud-eating species, many of which are of gigantic size when compared with their allies living in the shallow coastal waters, become in turn the prey of numerous rapacious animals armed with peculiar prehensile and tactile organs. Some fishes are blind, while others have very large eyes. Phosphorescent light plays a most important *rôle* in the deep sea, and is correlated with the prevailing red and brown colors of deep-sea organisms. Phosphorescent organs appear sometimes to act as a bull's-eye lantern to enable particles of food to be picked up, and at other times as a lure or a warning. All these peculiar adaptations indicate that the struggle for life may not be much less severe in the deep sea than in the shallower waters of the ocean.

Many deep-sea animals present archaic characters; still the deep sea cannot be said to contain more remnants of faunas which flourished in remote geological periods than the shallow and fresh waters of the continents. Indeed, king-crabs, Lingulas, Trigonias, Port Jackson sharks, *Ceratodus*, *Lepidosiren* and *Protopterus* probably represent older faunas than anything to be found in the deep sea.

Sir Wyville Thompson was of the opinion that, from the Silurian period to the present day, there had been as now a continuous deep ocean with a bottom temperature oscillating about the freezing-point of fresh water, and that there had always been an abyssal fauna. I incline to the view that in Paleozoic times the ocean-basins were not so deep as they are now; that the ocean then had throughout a nearly uniform high temperature, and that life was either absent or represented only by bacteria and other low forms in great depths, as is now the case in the Black Sea, where life is practically absent beyond 100 fathoms, and where the deeper waters are saturated with sulphuretted hydrogen. This is not, however, the place to enter on speculations concerning the origin of the deep-sea fauna, nor to dwell on what has been called 'bipolarity' in the distribution of marine organisms.

JOHN MURRAY.

(*To be Continued.*)

THE EARLY PRESIDENTS OF THE AMERICAN ASSOCIATION.

IV.

LOVERING.*

Lovering† was born in Charlestown, Massachusetts, now a portion of Boston, in

* A portrait of Joseph Lovering is printed as frontispiece.

† See sketch in *Popular Science Monthly*, with an engraved portrait on wood, Vol. XXXV., p. 690, September, 1889. Also see article in *Scientific American*, February 27, 1892, with a half-tone portrait.

1813, and inherited a fondness for mathematics from his father who was a surveyor by profession. He was fitted for college by the Rev. James Walker, and entered Harvard in the Sophomore year in the class of 1833, a class that included several members who were afterwards called to fill chairs in their *alma mater*, and one—Jeffries Wyman—who became a president of our Association. Lovering stood fourth in his class and he delivered the salutatory oration at the commencement exercises.

For a year after leaving Harvard he taught in Charlestown, but an inclination towards theology led him to enter the Harvard Divinity School, also at the same time devoting some attention to mathematical studies. It was probably that fact that led to his appointment as tutor in mathematics and physics in 1836 to fill the place made vacant by the illness of Professor John Farrar, and thus his long connection with Harvard began which only terminated in his death, fifty-six years later.

In 1838 Professor Farrar retired from active duty and Lovering was made his successor in the Hollis chair of mathematics and natural philosophy, which he then held for exactly fifty years, when he in his turn retired and was made *emeritus*. He was the first member of the Harvard faculty to fill a professorship for half a century, and his length of academic service was only exceeded by that of Henry Flynt, who was a tutor in Harvard, early in its history. Lovering was also director of the Jefferson Physical Laboratory, holding that office during 1884–88, and he was a regent of Harvard during 1853–54 and again during 1857–70.

In the development of the Harvard astronomical observatory he took a prominent part. He was associated with Professor William C. Bond in 1840, when with but few instruments and indifferent facilities, the beginning of the work in astronomy was made in the Davis House in Cambridge. It is from this small beginning that the present splendid observatory has grown. When Alexander von Humboldt induced the Royal Society of London to undertake the procuring of simultaneous observations on terrestrial magnetism in Great Britain and the colonies, the coöperation of the United States was sought, and one of the three stations in America was located in Cambridge where the taking of the observations was under the direction of Bond and Lovering. Several undergraduates of Harvard aided in the work, and among them was Benjamin A. Gould, who served the American Association as president in 1868.

The exacting duties of his work at Harvard and his own active interest in our Association left him but little time for scientific investigations. Still from 1867 till 1876 he had charge of the computations for determining transatlantic longitudes from telegraphic observations on cable lines, and under the direction of the U. S. Coast Survey, of which his colleague Benjamin Peirce was then superintendent, and the results of his work were given in volumes II. and IX. of the memoirs of the American Academy of Arts and Sciences. It was also to this source that he contributed in 1873 his great memoir on the aurora borealis. His shorter papers were more than one hundred in number and many of them appeared in our Proceedings. They testify to his unceasing activity as well as to his unusual ability. Mention should be made also of the fact that he was associated with Benjamin Peirce in the publication of the Cambridge Miscellany of Mathematics and Physics, to which he contributed articles on The Internal Equilibrium of Bodies; The Application of Mathematical Analysis to Physical Research; The Divisability of Matter, and similar subjects which attracted wide attention throughout this country and the scientific world.

It would be pleasant to review at length his work in connection with the American Association, but the memory of fifteen successful meetings and an equal number of volumes of Proceedings edited by him are all that need be mentioned. His interest in the American Academy of Arts and Sciences was also noteworthy. He was its secretary during 1869–73; its vice-president during 1874–80, and its president during 1881–88.

And so it was with the American Association, the magnificent pioneer work by Lovering made possible the wonderful successes by Putnam, during whose administration our Association reached its high tide of membership and attendance. We shall do well to place the name of Lovering high among those of the fathers of the Association.

The successful meeting in Portland was followed by the even more successful meeting at Hartford, Connecticut, which, according to the permanent secretary, "was one that will make a special era in the history of the Association."* In attendance it was one of the three largest meetings held, subsequent to their resumption in 1866. The presiding officer of the meeting was John Lawrence Le Conte, of Philadelphia.

LE CONTE.

This distinguished entomologist† was born in New York City in 1825. He was of Huguenot ancestry, as is suggested by his name. The first of the family to come to this country was Guillaume Le Conte, who settled in New Rochelle early in the eighteenth century. Among his descendants were Lewis and John Eatton Le Conte, both of whom achieved some prominence for their interest in science. The latter, Major John Eatton Le Conte, entered the U. S. Topographical Engineers and was distinguished as a botanist and as an entomologist. His son is the subject of this sketch.

After finishing his collegiate education at Mount St. Mary's College, in Emmettsburg, Maryland, Le Conte entered the College of Physicians and Surgeons in New York City and was graduated there in 1846. Possessed of independent means, he never took up the actual practice of medicine, but yielded to a fondness for natural history, inherited from his father, he devoted himself to travel, visiting many portions of the United States during the years between 1841 and 1851.

Says Scudder:

> The subject of the faunal relations of animals was a favorite one with Le Conte. He returned to it again and again; he was the first to district much of the vast and then almost unexplored regions west of our prairie country.*

While still a student of medicine he published his first scientific paper, which contained descriptions of more than twenty species of Caribidæ from the eastern United States. His preference for entomology continued throughout his life, and how industrious he was in that direction and what an influence he exerted on that branch of science, is shown by the statement that more than sixty monographic essays, some of them expanding to the form of a volume, and all of them after the first five years of work, direct and valuable contributions to the taxonomy of the order (Coleoptera) appeared from his pen.†

The sketch by Scudder, from which so

* Proceedings, American Association for the Advancement of Science, Vol. XXIII., p. 150.

† Biographical Memoirs of the National Academy of Sciences, Vol. XI., p. 216. John Lawrence Le Conte, by Samuel H. Scudder. This article, accompanied by a photo-gelatine portrait, appeared in the *Transactions of the American Entomological Society* for August, 1884. The *Popular Science Monthly*, Vol. V., p. 620, September, 1874, contains a sketch with engraved portrait on wood.

* Biographical Memoirs, p. 272.

† Samuel H. Scudder, in Biographical Memoirs, p. 274.

much of this material has been taken, contains the following appreciation of Le Conte's work:

That Le Conte was the greatest entomologist this country has yet produced is unquestionable. *Facile princips* will be the universal judgment both now and by posterity.*

Mention must be made of the fact that when the civil war broke out he entered the Union army as surgeon of volunteers and was afterward advanced to the office of medical inspector, with the rank of lieutenant colonel, which he retained until the end of the war. In this duty his fine organizing power and good sense showed themselves to excellent advantage. From 1878 till his death in 1883, he again served the government as chief clerk of the U. S. Mint in Philadelphia.

One of our past presidents, Lesley, who was his life-long friend, said of him:

Let the world reverence his memory as a discoverer, as a philosopher, as a genius.

HILGARD.

For the meeting held in Detroit in 1875 Julius Erasmus Hilgard, of the U. S. Coast Survey, was chosen to preside, and thus for a third time in our history an officer of the U. S. Coast Survey was honored by an election to the highest office within the gift of our Association. Hilgard† was the eldest son of a distinguished Bavarian jurist and writer and came with his father to this country in 1835. Although at that time only ten years of age, he had completed the third grade of the gymnasium in his native town of Zweibrucken, and his subsequent education was for the most part obtained from his father or self-acquired.

In 1843 he went to Philadelphia with a view to the study of engineering and practical employment. He was soon actively at work on one of the new railway lines then coming into existence. While so engaged he became acquainted with Alexander D. Bache, and in 1845 when Bache became superintendent of the Coast Survey, he offered young Hilgard a subordinate appointment in this service, which was promptly accepted with the statement that he preferred to "do high work at low pay than low work at high pay."*

In the short time of fifteen years he rose from the lowest place in the survey to that of first assistant, which was second only to the office of superintendent. During the greater part of the civil war and until the death of Bache in 1867, the actual duties of the superintendent devolved on him. Peirce, who succeeded Bache said of this service:

The distinguished ability with which this difficult service was discharged was manifest to all. He (Hilgard) has extended to me the benefit of this experience liberally and loyally. While I willingly acknowledge myself under deep and lasting obligations to him for the aid thus rendered me, I can also testify that in all respects he has been equally true to my predecessor, the greatness of whose reputation has not been diminished in his keeping.

Hilgard continued as assistant in charge of the office during the superintendency of Peirce, and his successor, Patterson, but in 1881 his services received their just reward by his appointment as superintendent of the Coast Survey, which place he then held for four years. On the advent of a new administration, after a faithful service of forty years, he was obliged to resign. It is not pertinent to this address to discuss the reasons that led to his resignation, but

There can be no two opinions upon the character and value of his life-work in connection with the Coast Survey. He brought into

*Samuel H. Scudder, in Biographical Memoirs, p. 280.

† Biographical Memoirs of the National Academy Vol. III., p. 327. Julius E. Hilgard, by Eugene W. Hilgard. See also sketch with engraved portrait on wood in *Popular Science Monthly*, Vol. VII., p. 617, September, 1875, and Appleton's Annual Cyclopædia for 1891, p. 628, with portrait.

*Biographical Memoirs, p. 330.

that branch of the public service a rare combination of culture, zeal, knowledge of the world, and executive ability; and no man living will claim to have done more than he did for the character and efficiency of the survey.*

The arduous and confining duties of his office in the Coast Survey naturally limited his scientific work to the sphere embraced by his practical work, but he was also recognized "as an active student in other branches of science, especially dynamics and molecular physics."† Of such work, the most important, however, was that connected with the magnetic survey of the United States, which was carried on at the expense of the Bache fund, the direction of which was entrusted to Hilgard by the National Academy of Sciences.

His lectures on The Tides and Tidal Action in Harbors, delivered before the American Institute in New York, was regarded as remarkable for its lucid and terse exposition of principles without the aid of mathematical symbols. Later he delivered a course of twenty lectures before the students of the Johns Hopkins University on the subject of Extended Territorial Surveying, which was received with much appreciation.

His life-work, however, was in connection with the Coast Survey, and his relation to it will always be accepted as his greatest contribution to American science. From 1886 till his death, in 1891, he lived quietly in retirement, vainly endeavoring to regain the health and strength which he had sacrificed in the patriotic performance of his duty to the country of his adoption.

ROGERS.

It was indeed a happy suggestion that led our Association in 1881 to recognize the life-long interest of William Barton Rogers in its welfare by electing him as the first of our honorary fellows. Rogers was the last presiding officer of the Association of American Geologists and Naturalists, and it was he who inducted to office William C Redfield, at the first meeting of the American Association in 1848. It is for this reason that his name stands first in the list of our presidents. This name also appears as the twenty-fifth on the list, for in 1875 he was honored by an election to the presidency and he presided over the meeting held in Buffalo in 1876.

It is not an easy matter to find a suitable designation for so versatile and accomplished a scientist as Rogers, for he was master of more subjects than one, and belonged to a period in the history of science, when teachers were students and authorities in several branches of learning. He was one of the four sons of Patrick K. Rogers, who, for a decade, was professor of natural philosophy and mathematics at William and Mary College, Virginia. William Barton* was born in Philadelphia in 1804, and followed his parents to Williamsburg, in 1819. His early education was received from his father, and for a time he was a student of William and Mary. Later he became an assistant to his father, who wrote:

My second son, who is now in his twentieth

* SCIENCE, May 15, 1891.

† *Popular Science Monthly*, Vol. VII., p. 618.

* There are many sketches of W. B. Rogers, among which are a notice of William Barton Rogers, founder of the Massachusetts Institute of Technology, by Josiah P. Cooke, in *Proceedings of the American Academy of Arts and Sciences*, Vol. XVIII., p. 426; Memoirs of William Barton Rogers, 1804–1882, presented before the National Academy, by Francis A. Walker; The Brothers Rogers read before the American Philosophical Society, by Dr. William S. W. Ruschenberger; and a memorial pamphlet issued by the Massachusetts Institute of Technology with a photo-gelatine portrait. There is also a sketch in the *Popular Science Monthly*, Vol. IX., p. 606, September, 1876, with an engraved portrait on wood, where monthly there has been published a life and letters of William Barton Rogers edited by his wife, Emma Savage Rogers, in two volumes, Boston, 1896, that contains several portraits both of himself and of his brothers.

year, and has a very extraordinary passion for physico-mathematical sciences.*

In the autumn of 1825, with his younger brother, Henry, he went to Baltimore, and there, for a time, pursued various vocations including that of scientific advisor to Isaac Tyson, the chemical manufacturer, but chiefly that of teacher in a school established by the two young men in Windsor. The pursuit of science was the aim of his ambition, and he was fortunate in securing an appointment, early in 1827, to deliver a course of lectures before the Maryland Institute. These were so successful that he gave a second course a year later. Concerning these Henry wrote to his father:

William is still able to command large and ever increasing classes. * * * I cannot refrain from expressing my surprise at William's great success, aided as he is by little more than the blackboard and chalk.†

Walker said of these lectures that he then:

First displayed upon an adequate field, that power of clear exposition felicitous illustration which he possessed in a degree, perhaps, never excelled.‡

In August, 1828, came the death of the elder Rogers, and two months later William was chosen his father's successor in the chair of natural philosophy and chemistry in William and Mary College, "and thence forward became, in a large measure, the head of the family."§ For some years he continued in the active possession of that chair, also during part of the time temporarily filling the chair of mathematics. His professorial duties were naturally paramount, but it must be noted that at that time he published a paper on Dew, and with his brother Henry one on the Voltaic Battery, both of which were subjects directly connected with his professorship.

* Life and Letters, p. 26.
† Idem, p. 47.
‡ Biographical Memoirs, p. 3.
§ Life and Letters, p. 54.

Of subjects less directly associated with his college duties, to which he devoted much attention, were topics connected with geology. He wrote a series of articles on the Green Lands and Marls of Eastern Virginia, describing their value as fertilizers, and says Cooke:

Next we find the young professor going before the legislature of Virginia, and, while modestly presenting his own discoveries, making them the occasion for urging upon that body the importance of a systematic geological survey for developing the resources of the State.

The year 1835 saw the culmination of his ambition in that respect, for in March he was appointed director of the Geological Survey of Virginia.

As was anticipated, says Cooke:

The survey led to a large accumulation of material, and to numerous discoveries of great local importance. As this was one of the earliest geological surveys undertaken in the United States, its directors had, in great measure, to devise the methods and lay out the plans of investigation which have since become general. * * * [Also] there are four or five general results of Professor Roger's geological work at this period, which have exerted a permanent influence in geological science.*

These general results included the study of the solvent action of water in various minerals and rocks; the demonstration that coal beds stand in close genetic relation to the amount of disturbance to which the inclosing strata have been submitted; the announcement and discussion of the wave theory of mountain chains; and the law of distribution of faults. In working out these subjects and in the presentation of papers discussing them he was associated largely with his brother Henry, who was at that time State Geologist of Pennsylvania. It has been well said that "together they unfolded the historical geology of the great Appalachian chain."

* Notice of William Barton Rogers, p. 429.

Popular interest in the survey gradually dwindled, and in the legislature decided opposition manifested itself, until in 1841, its political enemies succeeded in preventing the passing of an appropriation and so the survey came to an end.

It was also in the year 1835 that Rogers was chosen to the chair of natural philosophy and geology in the University of Virginia. Of his career, then President William L. Brown, of the Agricultural and Mechanical College of Alabama is quoted as saying:

I have seen his lecture hall so crowded with young men, eager to hear his eloquent presentation of the subject by the professor, whom they so greatly admired, that not even standing room could be found in the hall. All the aisles would be filled, and even the windows crowded from the outside with eager listeners. His manner of presenting the commonest subject in science—clothing his thoughts, as he always did, with a marvelous fluency and clearness of expression and beauty of diction unsurpassed—caused the warmest admiration, and often aroused the excitable nature of Southern spirit to the exhibition of enthusiastic demonstrations of approbation.

He resigned his chair in 1853 in order to devote more of his time to original investigation, but the students never forgot him, and at the celebration of the semi-centennial of the University of Virginia in 1875, he received a perfect ovation. In the language of a contemporary Virginia newspaper:

The old students beheld him the same William B. Rogers who thirty-five years before had held them spellbound in his class of natural philosophy; and as the great orator warmed up, then men forgot their age; they were again young; and showed their enthusiasm as wildly as when in days of yore enraptured by his eloquence, they made the lecture room of the university ring with their applause.*

Ever since boyhood it had been his cherished hope to work some day side by side with his brother Henry. Such an opportunity now presented itself. The younger man had settled in Boston some years previous, and released from the duties of his collegiate work, William B. Rogers, gladly sought the congenial atmosphere of the northern city where it was possible to devote himself to original work. He associated himself with the American Academy of Arts and Sciences and the Boston Society of Natural History, taking an active part in the proceedings of both of these learned societies, in the latter of which he was in close communication with Agassiz, Wyman, and Jackson. At first during this period his papers dealt with matters of geology and paleontology but later he took up work in physics. No discussion of these publications is here possible, but that they were of high character is conceded. Concerning a paper discussing the phenomena of smoke rings and rotating rings in liquids which was published in 1858, Cooke said: "In this paper Professor Rogers anticipated some of the later results of Helmholtz and Sir William Thompson."*

The crowning and greatest work of Professor Rogers' life was the founding of the Massachusetts Institute of Technology. That achievement was so important in its results, so far-reaching in its prospects, and so complete in its details, that it overshadows all else.

In 1859 [says Walker], Professor Rogers, gathering around him a number of the first citizens of Boston, begun the public discussion of a scheme for technical education, to be associated on one side, with research and original investigation upon the largest scale, and on the other, with agencies for the popular diffusion of useful knowledge. So entirely unfamiliar to the public mind of the day was the idea of technological instruction, beyond the simplest requirements of civil engineering, that the Legislature of Massachusetts could not be brought to see the full merits of Professor Rogers' most comprehensive and as all now view it thor-

* Life and Letters, Vol. II., p. 325.

* Cooke's Notice of Rogers, p. 433.

oughly practical plan, but enough was done by the Legislature during the few years following to secure the chartering, in 1862 and the inauguration in 1865 of the Massachusetts Institute of Technology of which Professor Rogers became the first president, devoting to it all the energy and enthusiasm of his impulsive nature and all the varied wealth of his accomplishments and acquirements. For the rest of his life this was chosen work.*

Rogers lived to transfer to a worthy successor the completed edifice—well established and equipped—an enduring monument to the nobility of character and the consecration of talents. Honored and loved by his associates and students, he came to be recognized as "'founder and father perpetual, by a patent indefeasible.'" †

Of all the delightful memories of the Boston meeting in 1880 the meeting with Rogers is my pleasantest recollection. He was the central figure, losing no opportunity to make that meeting the greatest one in the history of our association. Never shall I forget when he rose

Tall in stature, with a figure of the type known to us through the pictures of Henry Clay; with a face destitute of all assumption or arrogance, was singularly commanding; with a voice whose compass and quality were capable of producing at once the largest and the finest effects of speech. ‡

and bade the Association welcome. He said:

I thank my friends for the patience with which they have listened to one who does not like to call himself an old man, but who feels something of the spirit of the war-worn soldier, who likes at times to shoulder his crutch and fight his battles over again. §

Two years later, at the same place, he rose to address the graduating class of the Institute.

His voice was at first weak and faltering but, as was his wont, he gathered inspiration from his theme, and for the moment his voice rang out in its full volume and in those well-remembered, most thrilling tones; then, of a sudden, there was silence in the midst of speech; that stately figure suddenly drooped; the fire died out of that eye, ever so quick to kindle at noble thoughts, and, before one of his attentive listeners had time to suspect the cause, he fell to the platform—instantly dead. All his life he had borne himself most faithfully and heroically, and he died as so good a knight would surely have wished, in harness, at his post; and in the very part and act of public duty.*

At the Buffalo meeting, in 1876, Simon Newcomb, 'one of the most celebrated astronomers of our time,' was chosen to preside over the Nashville meeting. Newcomb still lives and is our senior past president. He marks the dividing line between our earlier and later presidents. †

Marcus Benjamin.
U. S. National Museum.

* Biographical Memoirs, p. 11.
† Cooke's Notice of Rogers, p. 427.
‡ Biographical Memoirs, by Walker, p. 5.
§ Proceedings, American Association for the Advancement of Science, Vol. XXIX., 1880, p. 739.

* Biographical Memoirs, by Walker, p. 13.
† Nature, Vol. LX., p. 1, May 4, 1899.

THE SENSE OF HEARING IN ANTS.

For many years it has been the generally accepted opinion of naturalists that ants do not possess a sense of hearing, at least within the range of sounds perceptible to the human ear. This opinion has been based upon the failure of the experiments along this line to show any effect whatever of the loudest and shrillest noises upon the ants with which they have been tried. Foremost among the scientists who have investigated this subject may be mentioned Lubbock, Huber and Forel, whose results have all been negative.

I am not prepared to explain why the results heretofore obtained have been so decidedly negative, while those described in this article are so decidedly affirmative, unless it may be that these particular species have never been experimented upon