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ADDISON EMERY VERRILL AND HIS CONTRIBUTIONS TO ZOOLOGY.

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Systematic Zoology loses one of its American pioneers in the death of Addison Emery Verrill, Professor of Zoology, emeritus, at Yale University, which occurred on December 10, 1926, during a visit to Santa Barbara, Calif. At the time of his death Professor Verrill was within two months of having completed his eighty-eighth year. He was associate editor of this Journal from 1869 to 1920, and contributed to it a large number of his briefer taxonomic papers. To Verrill, zoological progress is permanently indebted for having made known to science probably a larger number of new species of marine invertebrates than any other American worker. The exact number of such hitherto undescribed forms which he discovered was not known even to Verrill himself, but he often stated that it was well above a thousand. He never found time to summarize many of his earlier investigations, although he never forgot any of them. His constant urge was to move on into new fields when the outstanding products of the old were exhausted, postponing for a later time the less promising objects.

The type specimens of most of Verrill's species are among the zoological collections of the Peabody Museum of Natural History at Yale University. With only meager assistance, much time was consumed in the routine of sorting and labeling of the vast amount of material which came to the Museum through his connection with the United States Fish Commission. The single assistant connected with Verrill's department for many years, Dr. Katherine J. Bush, proved to be so able an investigator that she was assigned by him to independent research and became a recognized authority on certain groups of mollusks and annelids.

In 1864, when Louis Agassiz, at Harvard, and Joseph Leidy, at Philadelphia, and a few others had developed the study of animal life to such an extent that zoology had begun to be recognized in America as one of the sciences, Yale College called upon Agassiz for a young man who would bring the new science to New Haven. Fortunately Agassiz then had as assistant in the Museum of Comparative Zoology the man who served as professor of zoology at Yale for forty-three years, until he was retired in 1907.

When appointed at Yale, Verrill was 25 years of age, having been born at Greenwood, Me., February 9, 1839. Before his thirteenth year he had learned to recognize the varieties of rocks and minerals to be found in his native town and had assembled a collection of considerable size. The following year he moved with his parents to Norway, Me., and turned his attention to the study and collection of wild flowers. He soon had an herbarium of several hundred species, each of which he could recognize and name almost instantly throughout the rest of his life. At seventeen he made a collection of the local shells, insects, amphibia, reptiles, bird and mammals, making the identification, when possible, with the aid of such few books as were available and noting especially the kinds which were different from any described in his books. In this way, and almost wholly without other assistance, he laid a broad foundation for the taxonomic studies which were to constitute his life work.

In order that he might enter Harvard College and study under the eminent Louis Agassiz, young Verrill attended the local academy, known as the Norway Liberal Institute, and in May, 1859, arrived in Cambridge. He often spoke of his amazement in finding that Agassiz did not give regular courses to his students, but allowed each beginner to select a special problem for investigation. The topic chosen, however, could not be laid aside until it had been mastered in every detail. In his Junior year, 1860, he was appointed by Agassiz as assistant in the Museum of Comparative Zoology, and after receiving his degree of B.S. in 1862 continued two years longer in this position.

The versatility of his boyhood studies in natural history now began to bear fruit, for in the years 1862 and 1863 he published no less than twenty-two papers, of which two were on minerals, one on plants, three on corals and their allies, seven on birds, four on mammals, three on amphibians and the

others on general natural history. Most of these were brief taxonomic papers or lists of local species, but one of them, on the revision of the Polypi of the eastern coast of the United States, showed a remarkable comprehension of the principles of taxonomy and formulated the classification used at the present time.

On his arrival at Yale, Professor Verrill immediately set about the development of a zoological museum out of the old "Natural History Cabinet" in one of the small buildings of the University, but cramped quarters gave little opportunity for exhibits. The building of the Peabody Museum of Natural History offered space for more extensive exhibits and he, with Professor Sidney I. Smith and several assistants, prepared and arranged a zoological collection for public exhibition which for many years compared favorably with that of any college museum in the country. Professor Verrill remained in charge of the zoological collections until 1910, by which time they had increased until they contained more extensive series of marine invertebrates than were to be found in any American museum with the exception of the United States National Museum and the Museum of Comparative Zoology at Harvard.

The building which held these collections was removed in 1916 and the zoological material was later installed in the new Peabody Museum of Natural History, where it is now available for reference and further comparative studies.

It may be of interest to recall that Verrill lived through practically the entire history of zoology in America; from the coming of Louis Agassiz in 1847, to the experimental period of the present century. But while the vogue of the science changed from taxonomy to comparative anatomy, and then to adaptations and the evidences of evolution, later to biometry, regeneration, cell lineage and embryology and, at the beginning of the century, to experimental fields and genetics, Verrill maintained to the end of his life the importance of taxonomy as a necessary preliminary to this more specialized biological work.

The successive stages through which modern zoological discipline evolved, such as section-cutting, egg-shaking, transplantation and artificial breeding, had no appeal for him. Not that he failed to follow with some interest the work of the experimental zoologists, although he often charged them with attempting to interpret nature from artificial rather than

natural conditions. Partly for this reason and partly because of his retiring habits he was little known to the younger generation of zoologists, and the extent and importance of his work has not yet been fully appreciated.

During the summer of 1861, while still a student at Harvard, Verrill and three companions made zoological and paleontological collections along the coast of Labrador and at Anticosti Island, regions which up to that time had been but little explored zoologically. The results of his studies on the natural history of Anticosti were admirably recorded by him in a series of papers published mainly in the Proceedings of the Boston Society of Natural History.

For ten years after coming to Yale, Verrill acted as a curator of the Boston Society of Natural History, and during the years 1868 to 1870 he served as professor of comparative anatomy and entomology at the University of Wisconsin, going to Madison each Spring to deliver a course of lectures, in much the same way that our exchange professors visit other universities at the present day. He spent several summers as a geological expert in the employ of various iron and coal mining companies, and is said to have had remarkable success in the location of productive properties. His interest in geology continued as an avocation throughout his life and in 1902 he published a rather extensive report on the physiography of the Bermuda Islands[1] and another on their geological formations.[2] He also taught physical and historical geology to large classes of students in the Sheffield Scientific School from 1870 to 1894. This was done, however, in a somewhat perfunctory manner, and there is little doubt that it was a mistaken policy on the part of the Scientific School authorities to allow so able an investigator in his special field to carry so much routine work in an alien branch of science, even if his classes in zoology were small.

In his zoological activities Verrill gradually concentrated his efforts on marine invertebrates, with particular emphasis on the polyps and echinoderms, or radiates, as they were then called. Collections of corals and other coelenterates from many parts of the world were sent him for study and determination, and on these groups he did some of his most intensive work in later years.

[1] An abridged bibliography may be found at the end of this article, to which references are introduced in the text.

He published more than fifty papers and monographs dealing wholly or in part with corals and other coelenterates and as many on the echinoderms. Outstanding papers on the former group include: Revisions of the species found on the east coast of the United States;[3] synopsis of the polyps and corals of the North Pacific exploring expedition;[4] numerous papers on the Radiata sent to the Museum of Yale College from various parts of the world, and particularly from Brazil and the west coast of America, during successive years;[5] additions to the Anthozoa and Hydrozoa of the Bermudas;[6] Variations and nomenclature of Bermudian, West Indian and Brazilian reef corals;[7] Comparisons of coral faunae;[8] Corals of the genus Acropora;[9] Alcyonaria and actinaria, including Alcyonaria and Actinaria of the Canadian Arctic Expedition.[10] These, together with his extensive monograph on the Alcyonaria of the Blake expedition,[11] place on a secure basis the taxonomy and systematic relationships of the groups concerned.

Verrill's work on the echinoderms is of no less far-reaching importance, and most of his conclusions as to the classification of the serpent stars and starfishes are likewise generally accepted by morphologists. Of particular merit are his later revisions of the taxonomy of the genera and species of starfishes;[12] his discussion of the evolution and geographical distribution of starfishes,[13] West Indian ophiuroidea and asteroidea;[14] and especially his monograph on the shallow water starfishes of the North Pacific, in two volumes, with more than a hundred plates.[15] Verrill also gave much attention to the mollusks, and with the coöperation of his assistant, Dr. Katherine J. Bush, published a number of extensive papers describing numerous new species in this group.[16] Of particular importance were his studies on the cephalopods,[17] especially the giant squids, some of which were more than forty feet in length, and of which he not only had the opportunity of studying a number of specimens, but also, with the assistance of J. H. Emerton, constructed a life-size model, copies of which are to be seen in most of the larger museums of the world. The Pacific coast octopus was similarly modeled.

Perhaps the work which has brought Professor Verrill the widest recognition is the Report on the Invertebrate Animals of Vineyard Sound and Adjacent Waters, published in the Report of the Commissioner of Fish and Fisheries, for 1872

(452 pp., 38 pls.). This stands as a monumental work in that it was the first extensive ecological study of the marine invertebrates of the inlets, tide pools, mudflats, estuaries and other physical features of the southern New England coast. It includes the natural history of the sponges, hydroids, echinoderms, worms, crustacea, mollusks and other invertebrates found in each of these habitats, in so far as they could be learned at the time. In these studies he was ably assisted by his brother-in-law, Professor Sidney I. Smith, whose death after thirty-one years of service as professor of Comparative Anatomy at Yale University was recently recorded in this Journal. For more than thirty years this Vineyard Sound Report was the standard book of reference for all students of the seashore life of the region, and even to-day it is still much used. It is a remarkable fact that for no other region of the American coast has a similar report been published. For the Vineyard Sound region the ecological work started by Verrill and Smith has now been carried to a much higher degree of perfection with the coöperation of a score or more of specialists. It is but natural that the results obtained by this modern practice are vastly more detailed than could be hoped for by the pioneer methods of earlier days.

The field in which Verrill achieved his greatest distinction was opened by the United States Fish Commission. Under the direction of Spencer F. Baird there was inaugurated what was considered in those days a thorough oceanographic study of the coastal waters of the eastern United States, with the object of determining the environmental relationships of the Atlantic fisheries. In 1871, Verrill was placed in charge of the zoological investigations and from that time until 1887 received at frequent intervals the invertebrates obtained from continuous dredging operations. Large numbers of animals representing not only previously unknown species and genera but even new orders thus came into his hands.

Instead of distributing the different groups to other zoologists, Verrill elected to handle them all. From time to time as particularly interesting animals came to hand, he published brief diagnostic descriptions of them and thus became the authority for a great number of new forms. Many of these were first described in this Journal, with more detailed descriptions and figures in the annual reports of the Commissioner of Fish and Fisheries for 1872 (38 pls.), 1873, 1879, 1880 (4

pls.), 1882 (5 pls.), and 1883 (44 pls.) From 1883 to 1886 he had the able assistance of Dr. James E. Benedict, who sorted and provisionally classified the great bulk of the collections, thus making relatively easy the recognition of species new to science.

After the death of Professor Baird in 1887 these dredging operations were discontinued and Verrill began a summary of the results. Taking up the collections group by group he planned a series of monographs to cover each of the groups of marine invertebrates of New England and adjacent waters. The nemerteans[18] and the planarians[19] were thus completed, while the annelids and other groups remained as unfinished manuscripts at the time of his death.

Having described the more remarkable species of invertebrates found on the New England coast, Verrill turned to other fields which might prove more productive. He naturally selected the Bermuda islands, whence he had received so many of the corals which he had studied.

In 1898 and 1901, and again in 1916, he spent some months at the Bermudas. In 1898 he was accompanied by three of his students, and in 1901 by his son as artist and photographer.

A large number of marine invertebrates were collected and studied, sufficient material being secured to require several years for its investigation.

The breadth of his research on the Bermuda islands is indicated by the title page of the first of the two fully illustrated volumes which he later published, the title being "The Bermuda Islands; an account of the scenery, climate, productions, physiography, natural history and geology, with sketches of their discovery and early history, and the changes in their fauna and flora due to man." This volume covers 548 pages, with 38 plates and 250 text-figures.[20] The second volume, on the geology and marine zoology of the islands, is of about the same extent. The separate papers which comprise these volumes were first published in the Connecticut Academy of Arts and Sciences and subsequently issued as a private enterprise of the author.

The sponges, the corals and other coelenterates, the land snails and slugs, the insects, myriopods and arachnids, the crustacea and pycnogonida, the echinoderms, the tunicates and molluscoidea, and other groups were studied in detail and many

species not previously known to the islands were recorded and many others described as new to science.

Among his last publications are three monographs on the crustacea, the macrura,[21] anomura and brachyura,[22] while he left in the hands of the editor of the Geological and Natural History Survey of Connecticut a manuscript of about 700 pages, with 100 plates, on the higher crustacea of southern New England.

For several years prior to 1890 his work on the marine invertebrates was interrupted while he worked on Webster's International Dictionary. To Verrill stands the credit for the excellence of all the zoological definitions and their accompanying illustrations in this monumental publication. He also coöperated in the supplement to the dictionary, published in 1900.

Verrill's publications extend over a period of about sixty-five years and include more than 350 titles on zoological and geological subjects. That he was able to accomplish so much and in such a wide range of subjects is due not only to his inherited mental ability but also, and in large measure, to his most unusual physique. A man to whom illness or even fatigue was almost unknown previous to his eighty-seventh year, he was capable of a prodigious amount of labor, both mental and physical. He was able to keep at the most arduous tasks for many hours a day; in fact it was known to those most closely associated with him that he sometimes worked right through from one day to the next, with at most a brief nap in the early evening. Habits of labor that would speedily have wrecked the life of an ordinary man appeared to contribute to his well-being. But he never used artificial stimulants.

Sleep to him during periods of his most active labors seemed to be in large measure a casual indulgence, taken, quite frequently, while fully dressed and reclining in his desk chair or on a couch conveniently placed in his study. An after-dinner nap from perhaps eight o'clock until nine, then, absorbed in study, writing or drawing, and quite oblivious of time, he would sometimes work until near daybreak; then a little sleep on the couch before breakfast and off to his laboratory. The noon-day meal was often forgotten, while his reluctance to leave his work frequently resulted in his being from two to four hours late to dinner. Not rarely also the lecture hour passed by unnoticed.

A man of large stature, with his massive head covered with abundant locks of wavy hair, and with piercing blue eyes, he made a striking figure in any company. Genial and kindly when he could be persuaded to indulge in social affairs, his self-contained disposition and retiring nature allowed him to make but few intimate friendships.

So marvelous was his memory concerning scientific matters (and yet so poor regarding his personal appointments) that he was able to recall the name and distinguishing characteristics of nearly every one of the thousand and more species of animals which he had described as new to science. He was a skillful artist, and had such powers of visualization that with a stubby bit of pencil he could make a satisfactory drawing of almost any species that he had ever seen. And finally, his ability to quote references to the literature of the groups on which he worked was truly astonishing. Such an encyclopedic mind not only guarded him against the duplication of generic and specific names already applied, but enabled him to disentangle confusions in synonymy which were baffling to others.

Even when most of his former contemporaries were either dead or living in retired leisure, Verrill's eagerness for discovering new forms of animal life continued unabated. At the age of 85, still sturdy and vigorous, and with eyesight that required no glasses for the keen vision of nearby objects, he entered upon the exploration of the marine fauna of the island of Kauai, in the Hawaiian Island group, with all the enthusiasm he had felt in his college days at Anticosti island. During his two years on Kauai he collected nearly a thousand lots of marine invertebrates, writing diagnostic descriptions of many of the species recognized as new to science and making notes on the colors and habits of others. One paper on these investigations was prepared for publication.

After bringing this collection back to New Haven, Verrill suddenly realized that his strength would be insufficient for its complete study. Although in his eighty-eighth year, up to that moment he had been sanguine of much further work, but in a few weeks he was dead.

Verrill was one of the early members of the National Academy of Sciences. He was for some years president of the Connecticut Academy of Arts and Sciences, a fellow of the A. A. A. S., a corresponding member of the Societé biologique de France, and a member of many American learned

societies. He was given the honorary degree of M.A. at Yale in 1867. In 1899 he was lecturer at the Lowell Institute in Boston.

He married, in 1865, Flora Louisa Smith, a sister of Professor Sidney I. Smith, of Yale. Mrs. Verrill died in 1915. Four of their six children are living.

With the exception of the protozoa, the taxonomy of every one of the invertebrate phyla shows the effects of Verrill's labors. In some, the general scheme of classification was modified, in others new genera and species were added. In all, he exhibited what seems to have been a natural intuition as to the significance of morphological characters which amounted almost to genius. It is natural that in the thousand and more species which he described as supposedly new to science, a few are now known to have been previously described from other parts of the world and a few others are now classed as mere varieties, but the marvel is that he could have accomplished such an enormous task with so few errors of judgment and with still fewer errors of observation.

There seems little doubt that future generations will accord him recognition as one of America's greatest systematic zoologists and one of the most productive of our zoological pioneers.

The portrait which accompanies this notice is from "A Century of Science of America," published in 1918 by the Yale University Press, to which acknowledgments are here made.

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