on as a process entirely independent of religion. It transformed religion, however, for it brought forth for the first time a god of brotherly kindness. While men lived as tillers of the soil they discerned only a god of fertility; when the state arose and men caught their first vision of a supreme personality they called their god a king. Then when society developed and the friction and ferment of social struggle had taught men kindness and forbearance, they saw a god of character and of brotherly kindness whom they called "the good shepherd," two thousand years before the Good Shepherd of Christian faith. It was thus from the richly colored palette of human life itself that man drew the colors with which he glorified his picture of his god. That splendid vision arose out of the earliest spiritual revolution. It was caught up and exalted by the Hebrew prophets and through them has brought into our lives a light which still shines from the East.

I have given you some rapid glimpses at a few of the new materials by which we have begun to bridge the gap between the emergence of physical man and the rise of Europe. It is by these researches that we are slowly creating what I have called the New Past. They form a task which must go on for centuries, and as it proceeds now and later, its results will disclose to us and to our posterity an ever clearer vision of the highest process in the universe, as far as we know it today—the unfolding life of man. It is to these purposes that we dedicate this building.

THE NATIONAL ACADEMY OF SCIENCES

AWARD OF GOLD MEDALS TO DR. ANNIE J. CANNON AND PROFESSOR HENRY B. BIGELOW

AT this year's autumn meeting of the National Academy of Sciences, held at Yale University from November 16 to 18, two gold medals were awarded. Introductory remarks by President William Wallace Campbell were as follows:

The National Academy of Sciences is fortunate in possessing financial foundations for the awarding of nine gold medals and one prize, at appropriate intervals of time. Two of the medals are to be presented to their recipients this evening.

The Henry Draper Medal, bearing the honored name of a deceased member of the academy, was established by the widow, Mrs. Henry Draper, in 1883. The committee charged with the duty of administering the Draper Foundation recently recommended to the academy, and the academy decreed, that the Henry Draper Medal be awarded to Dr. Annie J. Cannon, member of the staff of the Harvard College Observatory. The reasons for the selection of Miss Cannon as this year's recipient are as recorded in the committee's report to the academy. In the absence of Professor Henry Norris Russell, chairman of the committee, the report will be presented by his fellow member, Director Harlow Shapley.

The report was as follows:

The Henry Draper Medal is awarded by the academy "for notable investigations in astronomical physics." This provision has wisely been broadly interpreted. Among the twenty investigators to whom it has been given during the last forty-five years, the majority have naturally achieved distinction through their work in the observatory—for example, Pickering and Campbell. Others, like Rowland, Zeeman and the lamented Michelson, made their contributions in the laboratory, and a few, of whom Eddington is the chief, have worked in the theoretical field. Yet one characteristic is common to almost all. There are not more than three of the twenty who have not, at one time or another in their scientific careers, been actively engaged with spectroscopic matters.

To-day the academy, while departing, with excellent reason, from one precedent, confirms another. For the first time the Draper Medal—and indeed any medal of the academy—is awarded to a woman; and the notable investigations in astronomical physics which abundantly justify the decision have been *par excellence* in the field of spectroscopy.

When Pickering—the second Draper Medallist—was appointed director of the Harvard College Observatory fifty years ago, he aroused the criticism of the conservatives of that day by devoting his remarkable energy and enthusiasm, and the resources of the observatory, to investigations in the physical side of astronomy.

Far from the least among these was the systematic observation and classification of stellar spectra. With a telescope affording a wide field of good definition, and having a prism placed before its objective, the spectra of hundreds of stars can be photographed simultaneously on one plate, so that there was no difficulty in securing observational material. But to record the results of investigation adequately for thousands of stars, and yet in a form not too bulky for publication, was no small problem. If stellar spectra presented the vast variety which is exhibited by living organisms the situation would be almost hopeless; but fortunately they are much less diverse. Hundreds of stars show spectra which are practically indistinguishable from one another under any ordinary dispersion, so that a relatively small number of symbols suffices for the description of the vast majority of spectra.

The Harvard observers very wisely decided to make these symbols purely formal, without any theoretical connotation. Mrs. Fleming employed letters of the alphabet, Miss Maury Roman numerals. Miss Cannon—our medallist of to-day—coming to her work a little later revised and refined the former system, and thirty years ago gave it the form which, with trifling changes, is now internationally adopted.

It is generally known as the Draper Classification, for the work on which it was based was supported by the Henry Draper Memorial—a gift to Harvard by the widow of Dr. Henry Draper, a pioneer investigator, who obtained in 1872 the first photograph showing lines in a stellar spectrum. Our academy likewise owes the Draper Fund and Draper Medal to Mrs. Draper's generosity, and it is especially fitting that we should recognize, by the award of the Henry Draper Medal, the long and productive labors of the investigator who has done far more than all others to give the Henry Draper Memorial the distinguished place which it occupies and must permanently continue to occupy in the history of astronomy.

Miss Cannon's introduction to her first "Catalogue of the Spectra of 1,122 Stars" describes the criteria upon which her classification is based so well that it has ever since been the standard authority upon the subject. No clearer statement could be made to-day of the great principle upon which the system is based —that almost all stellar spectra can be arranged in a continuous linear sequence. Though the spectra of stars near opposite ends of the sequence—for example, of Sirius and Arcturus—are so unlike that they seem at first glance to have hardly anything in common, yet a succession of stars can be found whose spectra differ from one another by barely perceptible degrees, and together form a complete transition from one to the other, and this transition is always through the same intermediate stages—there is no alternative path.

The older classification had assigned letters of the alphabet to various more or less obviously different spectra, as they appeared on the photographs. The newer dropped from the list those letters which proved to correspond to poor photographs or unimportant differences, and in some cases rearranged the order to agree with that of the linear sequence whose existence had become unquestionable.

By the survival of the fittest, the letters O, B, A, F, G, K, M were left to represent standard types along the sequence. Intermediate spectra are represented in the Draper Classification by a decimal notation, B_0, B_2, B_3, B_5, B_8 being successive stages in the transition from B to A. The resulting system has proved so convenient that all it has since required is the addition of affixes to take account of certain details which had necessarily to be ignored in the pioneer work. With this admirable system at hand, our medallist faced a task which might have appalled even the stoutest heart—the observation and classification of the spectra of all the stars in the heavens which could be photographed with the instruments of the Harvard Observatory—at that time the most powerful in the world for this purpose. It was no longer a question of thousands of stars, but of hundreds of thousands. The mere mechanical arrangement of the work, the identification of the stars, the recording and indexing of the observations, demanded careful planning and extensive clerical assistance.

This labor of years culminated in the publication of the nine volumes of the Henry Draper Catalogue, which give the positions, magnitudes and spectra of 225,300 stars, covering the whole heavens from pole to pole, and including all the stars brighter than the 8th magnitude and many which are fainter. Every one of these spectra has been examined and classified by our medallist in person. There is probably no other instance in the history of science where so great a mass of important data has been obtained by a single observer on a homogeneous and uniform system.

With the completion of the great catalogue seven years ago, a less devoted observer might have felt justified in resting. But improvement in observational technique had made it possible to photograph the spectra of fainter stars, and so the "Henry Draper Extension" was begun.

This extends the observations down to magnitude 11.5, and sometimes below. The number of stars which might be observed is now so great that it is impracticable to wait until the whole heavens have been covered, and then publish a general catalogue, and the results for various regions of the sky are being published as they are obtained. About one hundred thousand spectra have already been classified, and the work still continues. Long may it prosper!

The value of these great catalogues can hardly be overstated. Knowledge of the spectral type must lie obviously at the very foundation of any investigation of the colors, temperatures, real and apparent diameters and physical constitution of the stars. It has proved to be of almost equal importance to the investigators of their distances, motions and distribution in space.

Even in such an apparently local problem as the determination of the solar parallax by observations of an asteroid, the observer must know the spectra of his reference stars if he is to avoid the peculiarly troublesome errors which come from differences in color of the stars and of the planet. It is, indeed, hard to specify any branch of the study of the stars in which these great catalogues of spectra are not already almost indispensable.

With these consequences of her work—fascinating as they are—our medallist has concerned herself but little. True to the ancient tradition of the observer, who labors cheerfully for the joy of the work, and only rejoices the more that other men of different interest will enter into his labors and base their own upon them, she has used her unique skill and experience in the steady accumulation of a great addition to the permanent capital of astronomical science—a fund which, itself remaining intact, will continue to produce income in the work of astronomers yet unborn, who may well "rise up and call her blessed."

President Campbell then said:

The Agassiz Medal, awarded by the academy in recognition of valuable contributions to the science of oceanography, represents also a most commendable spirit of internationalism. The financial foundation was provided in the year 1911 by the celebrated Scotch oceanographer, Sir John Murray, in honor of his friend, Alexander Agassiz, member of the academy from 1866 until his lamented death in 1910, and president of the academy during the period 1901 to 1907. The committee on the Murray Fund recently recommended, and the academy decreed, that the Agassiz Medal be awarded to Professor Henry Bryant Bigelow, director of the Oceanographic Institution at Woods Hole. The reasons which governed the selection of Dr. Bigelow as this year's recipient of the medal will be stated, in the absence of Professor Lillie, chairman of the committee, by his fellow member, Professor George H. Parker.

Professor Parker said:

Professor Henry Bryant Bigelow, who is to receive this evening the Agassiz Medal, has only recently passed the half-century mark. He was trained in the Harvard laboratories and took his doctor's degree there in 1906, but before he had attained this distinction he had begun work on subjects dealing with the sea.

His first paper, entitled "Birds of the North-east Coast of Labrador," appeared in 1902. In the winter of 1901–02, he accompanied Mr. Alexander Agassiz on a voyage to the Maldive Islands, and in 1904 he published his report on the jelly-fishes of this expedition. In 1904–05, he again accompanied Mr. Agassiz, this time on the expedition to the eastern tropical Pacific; and in 1909 he published his very extensive report on the Medusae of this expedition, and two years later the report on the Siphonophores.

Meanwhile, through the advice of Sir John Murray, he began to take an active interest in the oceanography of the New England waters. In 1908, the U. S. Fisheries schooner *Grampus* was sent under his general management on an expedition to the Gulf Stream, a report of which he published in 1909. This initiated his extensive series of studies of the waters of the Gulf of Maine. These were made possible largely through cooperation with the U. S. Bureau of Fisheries, which repeatedly put at his disposal the use of the *Grampus*. In 1914 he reported on the oceanography of this region, and in the same year he published an account of the plankton of Massachusetts Bay. This was followed by a report on the oceanography and plankton of the waters between Nova Scotia and Chesapeake Bay. In 1917 an additional report was made on the region from Cape Cod to Halifax. Then followed the three extensive contributions of 1926 and 1927 covering the plankton of the Gulf of Maine, its dynamic oceanography and its physical oceanography. Meanwhile, in conjunction with William Welsh, he had issued his important volume on the fishes of this region. The proposal for an ice patrol as a means of greater security for shipping in the North Atlantic had been taken up by the United States Government, and, in association with Lieutenant Smith, Bigelow worked out much of the details of this organization. A report on this subject was published by him in 1929.

As work progressed the conviction grew upon him that an oceanographic institution should be started on the Atlantic coast of the United States, and he reported on this subject to the National Academy of Sciences in 1930. The material of this report was finally issued in the form of a volume entitled "Oceanography, its Scope, Problems and Economic Importance." This volume was published in 1931 and was distributed to the members of the academy. As a result of these activities the Woods Hole Oceanographic Institution was organized and a building to house it was erected near the Marine Biological Laboratory at Woods Hole and opened this past summer. Dr. Bigelow is serving as its first director.

I can not conclude this rather bare description of Bigelow's oceanographic activities without a closing note of warning. Bigelow was reputed to have been far from a diligent scholar. In his student days, one of his old teachers, long since past, took him aside, so I am informed, and told him that he would do well to withdraw from the Harvard laboratories, for he was both negligent and idle. Would that that teacher could be here this evening to face him and to tell us, who are also teachers, how easy it is to misjudge the young who come to sit at our feet. We who know Bigelow are well aware that the real salt of the sea flows in his veins and that he will devote himself to the end of his days to the promotion of oceanography.

Mr. President, your committee took the greatest pleasure in recommending to the National Academy of Sciences for the award of the Agassiz Medal Professor Henry Bryant Bigelow, associate and lifelong

friend of Alexander Agassiz, and an oceanographer of the highest standing.

CENTENARY OF THE BIRTH OF OTHNIEL CHARLES MARSH

AT the dinner of the National Academy of Sciences at the New Haven meeting, Professor Charles Schuchert was called upon by President Campbell and presented the following statement and resolution:

By an odd coincidence, I was at Lockport in the western part of New York on the 29th day of last October, for the purpose of visiting the birthplace, the youthful environment and the ancestral grave of Othniel Charles Marsh. That day one hundred years ago a child was born in that village, of humble parents, Caleb Marsh and Mary Peabody, whose forebears were amongst the first settlers of old Massachusetts. This boy was destined to be for twelve years the president of our distinguished academy.

Graduating at Andover and Yale, and then spending several years at the seats of learning in Heidelberg, Breslau and Berlin, Marsh was appointed in 1866 to the chair of paleontology at Yale, the first professorship in that science in any institution. Beginning with the seventies and until the end of his life in 1899, he brought to light in rapid succession so many astonishing antediluvian animals that the unexpected became the rule with him. He revealed over and over again in complete skeletal restorations the medieval and Tertiary animals of our bad lands of the high plains. One of the strongest of personalities, Marsh in his time "stood without a peer" in his chosen field of endeavor. "To Yale he gave his services, his collections, and his estate."

At the height of Marsh's scientific career came what he regarded as the greatest honor of his life, namely, election to the presidency of this academy, and from 1883 to 1895 he served it, and through him it often became the adviser of the government in matters of a scientific nature. Over the academy he watched with as much of interest and care as over his personal affairs.

In view of these circumstances, I present the following resolution:

Resolved, That in this year which marks the centenary of the birth of Othniel Charles Marsh, and in the environment where he lived and worked so long, the academy recalls with pride the personality and mental gifts of that great paleontologist, whose distinguished service as its president was entirely in keeping with a lifetime of uninterrupted devotion to science.

In response to this resolution, Professor Richard Swann Lull spoke as follows:

Professor Marsh's birth and early training have been mentioned by Professor Schuchert. It is appropriate to express in greater degree something of his services to Yale University, especially to the Peabody Museum of Natural History with which he was so closely identified.

Coming to Yale as professor of paleontology in 1866, Marsh's services covered just a third of a century.

Inspired by a trip to the west in 1868, when he actually found a three-toed horse and is said to have discovered the first dinosaur bone found in the Rocky Mountains, he was filled with a desire to continue his search for fossils in the great west. The first formal expedition went west in 1870, and thereafter until 1873 parties, consisting largely of students or men recently graduated from Yale College and the Sheffield Scientific School, went annually to search for the scientific treasures which the region revealed. Marsh's choice of members for these parties was admirable, for almost invariably they were men who subsequently made their mark in the world, though few if any went into paleontology as a profession. Cooperation with the military authorities was obtained, and cavalry escort against the possibility of Indian attack was the usual thing. After 1873, the Indian menace becoming more acute, the student expeditions were abandoned and thereafter material was gathered by paid collectors, former guides and others, many of whom became famous in the archives of the museum. Later, as United States vertebrate paleontologist, collections were made for the U. S. Geological Survey as well as for himself and assembled here at Yale as the basis of a series of projected monographs, but two of which he lived to complete.

In 1898 Marsh's share of his collections was presented to the president and fellows of Yale, and after his death the United States material was separated out and transferred to the U. S. National Museum. His work as a collector has thus served greatly to enrich two institutions.

Not content with this, Marsh published a continuous stream of papers descriptive of the collections, and the world's knowledge of curious and bygone forms, of species and genera, families and even orders as yet unheard of was thereby vastly increased.

His anatomical knowledge was marvelous, and his paper restorations, though in but one plane of space and therefore open to possible error, became classic. To those of us who are privileged to carry on his work, the storehouse seems inexhaustible, and we are struck with the almost uncanny accuracy with which he seized upon the essentials of a new and but partially complete or developed specimen upon which to base his terse but significant description of a new species. While these descriptions, in the light of fur-