of new industries giving employment to great numbers of men, perhaps more men than have been simultaneously displaced by new labor-saving devices in the older industries. However, the time may come when governments will endeavor to regulate, not the discovery of knowledge in the domain of the sciences, nor the speed of discovery, but the applications of new or old knowledge, in the form of mechanical inventions or new methods, to the work of the world, in order that labor would have time to adjust itself to conditions which governments may think are changing too rapidly. Quite likely the governments of the nations will attempt, by international agreements, to prevent the killing of enemy peoples by microbes, by poisonous gases, by giant bombs dropped out of the blue sky. Some of the agreements or treaties on the subject might prove to be "mere scraps of paper." Even so, we could wisely recall that the present-day use of automobiles by kidnappers and other inhumans does not even suggest to any of us that no more automobiles be made. Realizing that all such problems of attempted control by government would have to deal with human beings and human nature, one is impelled to hope that the guidance of the economists and the social scientists would be found ready and equal to the extremely difficult occasion, in case of call.

I have confidence that all thoughtful persons, including the young men and the young women who, spiritually at least, are the most tragic sufferers from the ill economic winds which have been blowing throughout the world, will join us in saying that the Golden Age of mankind is in the future and not in the past.

PRESENTATION OF THE MARY CLARK THOMPSON MEDAL[1]

By Dr. DAVID WHITE

SENIOR GEOLOGIST OF THE U. S. GEOLOGICAL SURVEY

FULFILLING the unanimous recommendation of the committee, you are to-night bestowing the accolade of tribute to distinguished service in geology and paleontology on a member of the academy whose first collegiate experience was that of professor and whose first scholastic investiture was that of master of arts, in honor, at Yale University.

In common with many boys in Cincinnati, Schuchert began at an early age (12) to collect the abundant Ordovician invertebrate fossils which public improvements had made accessible in many new quarries and exposures; but his matriculation in paleontology as a profession was delayed until he was 17, when he became a paid assistant to E. O. Ulrich, then curator of geology at the Cincinnati Society of Natural History, and now also a Mary Clark Thompson medalist of the academy. Four years afterward he was called, together with his collections, to assist James Hall at Albany, who was preparing an "Introduction to the Study of the Genera of Paleozoic Brachiopoda." Next he worked at the Peabody Museum with Beecher, who was studying the ontogeny of the same great class, in which Schuchert had long been deeply interested.

In 1893 Schuchert went to the Geological Survey and the National Museum in Washington as assistant and understudy to Walcott on the invertebrates of the older Paleozoic. There he took part in Walcott's great monograph on the Cambrian Brachiopoda, besides sharing in the excitement of working out the Cambrian Medusae.

Where could a student have found more satisfying courses in Paleozoic paleontology than under Ulrich, Hall and Clark, Beecher and Walcott?

While in Washington Schuchert completed his "Catalogue of Brachiopod Genera and Species"[1] and inaugurated the present admirable plan of cataloguing, arranging and exhibiting the invertebrate fossils, of which he was curator, in the National Museum. This work is a model followed by many other institutions.

To Schuchert the ancient world is a ceaselessly shifting landscape, alive with constantly changing and evolving animals and plants. Accordingly, the appeal of paleogeography to his vivid paleontological realism was as natural as it was fortunate. Paleogeography treats of the succession of geographies of geologic times. It gives orientation to geological history and sets a background to the history of life. It is a most fascinating and stimulating task, which, nevertheless, few geologists have the courage to undertake and still fewer to print their products—which is probably well.

Starting with shore lines definitely determined at a number of points—with feet on the ground, so to speak—the paleogeographer proceeds to trace his coasts, mountain regions and principal basins and streams through points less well located, and on to points less probable, and, finally, through points

[1] At the dinner of the Academy in Cleveland.

[1] U. S. Geol. Surv., Bull. 87, 1897.

based on conjecture or mere guesses weighted by his best judgment. He must take into account the causes of present geography, the relations, composition and migrational distribution of the extinct land and sea faunas and floras and the indicated land connections; the characters and sources of the sediments; the climates, continental warping in conjunction with progressive invasions and recessions of the sea; tectonic trends and transgressive folding. It calls for the systematic examination and orientation of all the existing information of all sorts and geological insight, together with a restrained imagination, in its evaluation.

Since 1905 Dr. Schuchert has published over 50 different paleogeographic maps, and he now has on his desk about 125 maps on which he is platting new matter or is correcting, revising and confirming previous work as new data come to his hand. This is a monumental work, more than has ever been done in this field by any other man, and—what is better—it is highest in scope, reliability and detail.

Largely from Schuchert's indefatigable paleogeographic researches have emerged the learning, the perspective and the analytical philosophy which characterize both his short papers, which cover a wide range of subjects, and his text-book writings. In scholarly form they impregnate his work as associate editor of the *American Journal of Science,* and as reviewer and commentator.

Meanwhile Schuchert's most important contribution to paleontology, a memoir by Schuchert and Cooper, revising the genera of the brachiopod sub-orders Orthoidea and Pentameroidea, was published in 1932. The classification there presented is followed by most paleontologists at home and abroad.

In conclusion, the committee ventures to add its wishes that Dr. Schuchert may live many years to continue his valuable labors and to enjoy in contentment the triumphs of his students and followers who have caught the fire of his zeal and his realistic conceptions of the panoramic life of the ancient past and its relations and reactions to an incredibly complicated geological history.

RESPONSE BY PROFESSOR CHARLES SCHUCHERT

SOME months since, when I was informed that I was to be awarded the Mary Clark Thompson Medal, the greatest honor, next to election to this academy, that can come to an American geologist, I was not only most agreeably surprised, but as well immensely pleased. And now this pleasure is still further increased by the remarks of the chairman of the committee of award, and especially, if I may say so, by his evaluation of my results in paleogeography.

When the good news of this award came to me, two remarks made by my parents long ago flashed through my mind. One Sunday evening, when I came home from an afternoon's hunt for fossils on the hills of Cincinnati, my shoes covered with the sacred soil in which the fossils had been entombed, my dear mother's greeting to me was: "You bring more dirt into the house than your rocks are worth." And on several other occasions my father remarked: "Charlie, if you would only pay as much attention to furniture making as you do to the collecting of fossils, you would become a rich man!" However, it was from such days of communing with nature and her fossilized creations that I was learning her ways of genesis, and if my parents are looking down on me to-night, perhaps they will agree that those golden Sundays were not wasted, after all.

I got my first fossil when I was seven or eight years old. As I stood watching a gang of men digging a trench near my home, one of the Irish laborers threw a bit of rock up to me with "Here, Johnny, here's something for you." For some years this curiously shaped piece of rock remained a what-is-it, since no one about me could tell me what it represented. My father had read a little in Von Humboldt's *Ansichten der Natur,* and he thought it might be a *Versteinerung,* a petrifaction, but what kind of a living thing it once was, he had not the slightest notion. A year later, father brought me another fossil given him by a friend who lived near a limestone quarry, but this, too, long remained just another what-is-it.

In those youthful days, I very much wanted to own a goat—not a billy with long horns such as I had made unfortunate acquaintance with, but one of the gentler sex. The young nanny-goats that I coveted had, I noticed, very small horns with blunt ends, which reminded me of the fossil the immortal Irishman had tossed up to me. Also, their split hoofs looked like the second fossil in my collection. So, since any well-ordered cabinet must have labels, I wrote out two: one read, "The petrifaction of a nanny-goat's horn," and the other, "The petrifaction of a nanny-goat's hoof." Thus, you see, even if my mother could not buy a live nanny-goat for me, as an embryo paleontologist I set to work to get together a petrified one! In the sequel, however, I found that one of my fossils was a coral and the other a bivalve shell.

Such were my beginnings in paleontology, in the days when most geologists had not yet taken kindly to the theory of organic evolution, when many believed with Bishop Ussher that the earth had been created in a week, 4,004 years before Christ, and that the long geologic record could be made to agree with

the seven days of Genesis. Since then I have labored professionally with geologists for nearly fifty years, have seen the geologic column—the geologist's yardstick—lengthen sixfold, have read of tens of thousands of new species of fossil plants and animals added to our knowledge and have witnessed the pushing backward in time of the origin of the earth from six thousand years to something like two billion. Truly, time and organic creations are without end!

When I became an active collector of fossils, I knew of no public geological museums, and now our country has a great number, and of these a half dozen or so are rated among the best in the world. Then, but few states had geological surveys, and the Federal Government none that was permanent. Today, nearly all the states have such, and the government as well, and they are of immense service to the people in economic and theoretic ways. Then, there was no general geological society, and now there are several, two of them having a combined membership of upward of 3,000, of whom two thirds are in search of profitable rocks—those containing oil, coal and ores—and the remainder are teachers of geology and research workers. And the oldest of these geological societies now has an endowment of four million dollars, given to it by one of its fellows.

We are now living in the transition period into the age of science, and if humanity continues to apply what science provides, the day will come when no one will need to work more than the decreed thirty hours a week. No one, that is, except the research workers!

In retrospect, I am indeed grateful to that unknown Irishman who threw me my first fossil, since it was the first step in the path that led to this evening's event. Mr. President, I thank the academy, the committee of award and you for the great honor conferred upon me by the award of the Mary Clark Thompson Medal.

VARIATION AND EVOLUTION AMONG THE STARS[1]

By Dr. HARLOW SHAPLEY

HARVARD COLLEGE OBSERVATORY

(1) Variation and evolution are defined. In cosmic problems, the short life of the observer, or even of his civilization, compared with the time of major changes, makes it necessary to infer evolutionary tendencies rather than observe them. Variety in types of objects is an indication of past developments. Theories of stellar evolution are based on studies of variation and varieties.

(2) The clearest direct evidence that stars change and that the universe evolves is in the simple fact that sun and stars shine; for we now know that outgoing radiation is outgoing mass and that a hot radiating body in cold space decreases steadily in material content because of its inevitable radiation. Because it shines, it must change steadily also in temperature, in density, in mass, in all its physical properties. A globular star cluster, for instance, loses through its radiation into empty space a million million tons of matter every second—a loss that not only spells evolution for its thousands of stars, but alters the gravitational structure of the cluster itself.

(3) The varieties of galaxies and the variations in their positions and velocities are direct evidence of the evolution of the whole universe, and are the bases of the expanding universe interpretation. The probability is high that the red shift in the spectra of galaxies indicates an expansion, and the rate is about one hundred miles a second for every million light years of distance.

(4) The variations that most concern astronomers are the changes in the light of stars. The changes are of three sorts: (a) Periodic variations that perhaps do not directly indicate evolution because of the recurrence indefinitely of the same conditions; (b) irregular variations that have little rhyme or reason; (c) progressive alterations.

(5) The most observed star in the sky during the past several months has been the fourth magnitude (naked eye) eclipsing double star, Zeta Aurigae. A recent study at Harvard, based on about three thousand photographs, gives a history of this thousand-day variable for the past forty years. An eclipse of the sun lasts, at the most, seven minutes; but the total eclipse of Zeta Aurigae persists for thirty days. The double is remarkable in that the masses and luminosities of the two companions are equal, but the volume of the red giant component is thirty thousand times that of its hot, blue associate.

(6) The first results obtained with two large new reflecting telescopes are presented at this time; both instruments have been set in operation during the past year. With the 61-inch Wyeth telescope at the Oak Ridge Station of the Harvard Observatory, Dr. W. A. Calder has measured photo-electrically the variations of an important eclipsing binary, u Herculis, and from his work it is found that the orbit is

[1] Abstract of a popular illustrated lecture for the citizens of Cleveland, November 19.