It is to be noted that although the theory of apogenesis is called a theory of evolution it does not deal at all with evolution as that word was used by Darwin. It has nothing to say on the origin of species. On this question it is no more than a doctrine of special creation at one remove. It has no light to throw on classification. If we are to abandon belief in community of descent the whole architecture of the "Systema Naturæ" becomes meaningless.

Professor Przibram claims that "all the facts would be explained more easily" upon his hypothesis, but there is one point on which he speaks with a hesitant voice, and it seems to me a very significant exception. "We can not decide," he says, "whether the differing though related species that inhabit islands or isolated territories are descended from a common source or result from the accidental separation of species which formerly occupied the region together."

Let me recall to you the opening words of the "Origin of Species": "When on board *H. M. S. Beagle* as naturalist, I was much struck with certain facts in the distribution of the organic beings inhabiting South America, and in the geological relations of the present to the past inhabitants of that continent." So Przibram ends where Darwin began. The geographical and geological distribution of organisms, which for the one are merely the negligible residue of unexplained facts, were for the other the very heart and core of the problem he set himself to consider.

It is worth remembering that among Darwin's other qualifications as an interpreter of nature he was an experienced taxonomist, and before he wrote the "Origin of Species" he had produced one of the finest systematic works ever written in his "Monograph of the Cirripedia." Those of us who were present at the memorable Darwin-Wallace celebration of the Linnean Society in 1908 remember how the veteran Alfred Russel Wallace discussed "the curious series of correspondences both in mind and in environment" which led Darwin and himself, alone among their contemporaries, "to reach identically the same theory," and how he gave the first place to the fact that both he and Darwin began by collecting beetles and thus acquired "that intense interest in the mere variety of living things" which led them to speculate upon the why and the how of "this overwhelming and, at first sight, purposeless wealth of specific forms among the very humblest forms of life." It might be worth while to inquire whether a training that proved useful to Darwin and to Wallace would not be of some value to students of zoology even at the present day.

My predecessor in this chair told you that "the present position of zoology is unsatisfactory," and he found the chief hope for the future in the application of the experimental method. He may be right. I am not so sure. The experimental method has answered many questions and it will answer many more, but there are some questions, and these well worth the asking, to which experiment will never find an answer. No one will maintain that taxonomy by itself will answer them, but it will often suggest where the answer is to be sought for, and it will provide a standpoint from which both questions and answers will be seen in a true perspective.

Finally, I would recall a remark once made in my hearing by a wise old naturalist, the late Dr. David Sharp. Some one had been remarking on the decline of systematic zoology and predicting the extinction of systematic zoologists. Dr. Sharp replied, in effect:

> I have seen many passing fashions in zoology, many departments of research becoming popular and then falling into neglect; the one branch that will never fail to attract is the systematic one. The esthetic satisfaction to be derived from contemplating the mere variety of animal forms and from tracing the order that runs through all its diversity appeals to a very deep instinct in human nature. There will always be systematic zoologists.

THE USEFULNESS OF PSYCHOLOGY[1]

By J. McKEEN CATTELL

IT is a pleasure to receive this beautiful gold medal of the Society of Arts and Sciences from Mr. Russell, the president of the society, who in its conduct and in other directons has endeavored to bring together the fine arts and the natural sciences. In some of its aspects science is a fine art and both are children of the creative imagination, born with hard labor. As Keats wrote:

> Beauty is truth, truth beauty;—that is all
> Ye know on earth, and all ye need to know.

It is a satisfaction to be introduced by Professor Thorndike, my friend and colleague for more years than he might like me to tell. To him we owe in large measure the present application of psychology to education, the most useful achievement of our science.

It is an honor without parallel to be associated with the earlier recipients of this medal in science, Mr. Edison, Professor Michelson and Dr. Millikan,

[1] Address at a dinner of the Society of Arts and Sciences, the Hotel Biltmore, New York, on the occasion of the award of the medals of the society, April 17, 1930.

three of those to whom America and the world owe the most, and now with Professor Lewis, preeminent in what is perhaps the most fundamental of the sciences.

At the dinner of this society a year ago when its medals were presented to Professor Michelson and Dr. Millikan, Professor Michelson said that he had done his work "for the fun of it" without regard to its usefulness, though he seemed pleased that his superexact measurements of the velocity of light might be applied to topographical surveying. Dr. Millikan, however, chose as his subject "The Economic Value of Michelson." It is on the economic value of psychology, its usefulness to our modern civilization, that I shall speak for the twenty minutes allotted to me. Before an audience of distinction—I assume that the IQ's range from 150 to 200—I wish to urge the need of united efforts to advance psychology and its applications in the interest of all the professions and of our national life.

When an International Congress of Psychology met for the first time in the United States last year, it marked the fiftieth anniversary of our science, for the first laboratory was established by Wilhelm Wundt, professor of philosophy at Leipzig, in 1879. The first professorship of psychology, held by me, was established at the University of Pennsylvania in 1888. When the American Psychological Association was organized in 1892 there were 31 members, not more than half of whom would now be regarded as psychologists. At the recent congress there were in attendance 826 American psychologists each of whom was supposed to have advanced psychology by research. Our science is young; it is growing fast, as youth should. But we have as yet no institutes for psychological research or schools of applied psychology.

The engineers of the country celebrated last week fifty years of progress in mechanical engineering. It is a remarkable record and one to which America has contributed more than its share. The first schools of engineering were established only one hundred years ago; the industrial revolution may be dated from the use of the steam engine of Watts in the coal mines of Cornwall one hundred and fifty years ago; the physical sciences, on which engineering is based, are scarcely older than Galileo, say three hundred years. Physics is six times as old as a science of psychology; it required two hundred years to construct a scientific foundation on which a profession of engineering could be erected.

There was celebrated last week the eightieth birthday of Dr. William H. Welch, of the Johns Hopkins University, who in his lifetime has witnessed and largely contributed to the establishment of a science of medicine. We can scarcely place its foundation earlier than Pasteur, though medical schools go back to the University of Salerno, a thousand years ago. Medicine had to await the development of the biological sciences before an empiric art could become an applied science. As biology is less advanced than physics, so medicine, despite its long history, is on a less secure scientific basis than engineering.

Medicine, law and theology, together with philosophy, were the faculties of the university until engineering emerged a hundred years ago. Teaching is one of the earliest of the arts, but schools of education are only about as old as the present century. Law, the work of the churches, and education are on a less satisfactory foundation than medicine and engineering because there has not been an adequate science of human behavior on which they could be based. It is no less necessary that these professions should stand on a science of psychology than that medicine should stand on biological science, engineering on physical science.

Law and theology, dependent on tradition, precedent, words and an obsolete psychology of property rights and souls, of rewards and punishments, of motives, virtue and sin, are at present in the position of medicine before it had a foundation of science. The story is told of an argument between a judge and a bishop as to whether the courts or the church had the greater power. The judge finally said that the court could condemn a man to death, to which the bishop replied that the church held the keys of heaven and of hell. "That may be," said the judge, "but when I say that a man shall be hanged, he is hanged." But we do not know whether heaven should be promised, and if so to whom, whether men should be hanged, and if so which.

Teaching has done more to adapt itself to modern conditions and to make use of what scientific psychology we have. But human conduct has been altered and controlled by invention and engineering to a far greater extent than by the churches, the schools or the courts of law.

Business and industry are now becoming professions with their own schools, from the commercial high school to the graduate school of Harvard University. These professions, like law, the churches and the schools, are principally concerned with the behavior of individuals and for their development require a science of psychology. The boys who go from college into business far outnumber those who enter any of the older professions or perhaps all of them together. Yet they must develop their own social organizations and athletic competitions as a

preparation, because we have no adequate psychology of conduct that can be used as a basis, in the way that the biological and physical sciences are used for medicine and engineering. Men of business and affairs are psychologists, but in the sense that farmers are biologists, not as physicians are biologists or engineers are physicists.

It may also be that the study and practice of medicine and engineering will be greatly advanced when we realize the extent to which they should be based on understanding and controlling behavior. A painting in the library of the Engineering Society's building in this city bears the inscription: "Engineering—the art of organizing and directing men and of controlling the forces and materials of nature for the benefit of the human race." According to this definition, chosen by engineers, the relations between engineering and psychology are close. The selection, training and directing of men are problems of applied psychology; it is also for psychology to determine what does in fact benefit the human race. In using the forces and materials of material nature engineering has become an exact science; in its relation with human nature engineering works by the rule of thumb and will continue to do so until it can use an exact science of psychology.

The objects of applied psychology, namely, the control of the behavior of individuals, have been advanced by invention and industry to an extent incomparably greater than has been accomplished by psychology, or by the sciences and professions directly concerned with human nature. The applications of science, by quadrupling the wealth that each can produce and by doubling the average length of life, have completely altered our civilization and the way that each of us reacts to it. The economy of labor and of life which science and invention have caused has abolished slavery and serfdom. It has made productive labor by children needless and has made possible their universal education. The wealth of society is now sufficient to support adequately every child, to give it the education that opens the gateway to the career for which it is fit, to provide equality of opportunity and a true social democracy. Applied science, based in large measure on scientific research whose utility was not at the time obvious, has been the cause of the political and social institutions that we have and of the lives that we lead.

The applications of science have done more to control our behavior than efforts made with this object directly in view, such as those of the churches, the schools, the courts and the state. It may be argued plausibly that the ten commandments would have been broken no oftener, that the precepts of the Sermon on the Mount would have been followed no less rarely, if the churches had never existed. It may be that it is as futile to herd children in pens to teach them their R's as it would be to use similar methods to teach them to walk and to talk. It is quite possible that there would be no more crime in the world if courts and prisons had never been invented.

These partial failures to alter human nature by direct appeals to consciousness are quoted to emphasize the thesis that applied psychology is concerned with the total relation of the individual to the environment. We can try to alter the individual; but we can accomplish more by altering the physical world in which he lives, perhaps most of all by altering the relation of an individual to his surroundings. As modern medicine has made more progress in the diagnosis of disease than in its cure, so psychology can determine the intelligence of a child or a congressman more readily than it can increase it. In like manner as medicine and public hygiene can do more for the health of people by providing surroundings that are sanitary than by curing diseases that have been contracted, so psychology can do more by placing individuals in surroundings where they will act in the way that is wanted than by attempting to change individuals, so that under the same conditions they will act in a more desirable way.

The placing of individuals in the situations in which they act in the way most desirable for them and most useful for society is surely an undertaking the value of which can scarcely be overstated. If every one, from the feeble-minded child to the man of genius, were permitted to do the work that he can do best and were trained to do it in the best way, happiness would be increased on a scale for which we have as yet no units of measurement, the annual production of wealth would perhaps be doubled.

But even this story is not the most extravagant that can be told. The selection of existing individuals for the work for which they are best fit is a small matter in comparison with selecting the individuals themselves. Eugenics is at present only an amateur science—Professor Conklin has called it an "infant industry"—but in the distance it looms up in proportions as immense as they are vague. Darwin tells us that when *The Beagle* was visited by South American savages, they showed no curiosity or concern about the ship, but were greatly interested in a rowboat which came within range of their experience. So it is with eugenics—to us as *The Beagle* to the savages—which must be passed with the guess that here the psychological and biological sciences will ultimately find their greatest work.

The control of thoughts, emotions and behavior

has been undertaken by the churches, the schools, the laws and the rest in order to accomplish definite results that are regarded as desirable, but they have largely failed because it is difficult to change human nature. What we can do is determined when we are born; what we actually do depends on circumstance. Individuals at birth have definite constitutions and will react to their surroundings in accordance with them. But we can place them in situations where they will behave as nearly as their constitutions permit in the way that we want. By changing the surroundings we control behavior most effectively. This is what our industrial civilization has done, but it has advanced without special reference to the kind of mental life and behavior that will follow. What we need is a science that will coordinate all efforts to control conduct with the effects of all changes in the environment. This is the primary business of psychology; it requires the cooperation of all the sciences and of all the professions.

As I understand it this medal of the Society of Arts and Sciences has been conferred on a science rather than on an individual. It is a recognition of what psychology has accomplished within a period of fifty years, a mark of confidence in what psychology will do in the future.

OBITUARY

FLORIAN CAJORI

ON August 14, 1930, there died at Berkeley, California, Florian Cajori, the most prolific and best-known writer on the history of mathematics that this country has produced. He was not, however, a native of America, having been born at St. Aignan, near Thusis (Graubünden), Switzerland, on February 28, 1859, and having come to the United States at the age of sixteen. Entering the University of Wisconsin, he received the degree of B.S. in 1883, spending the year 1884–1885 in graduate work at the Johns Hopkins. He then went to Tulane University (1885) as assistant professor of mathematics, becoming professor of applied mathematics two years later (1887). In 1889 he went to Colorado College as professor of physics, subsequently taking the chair of mathematics (1898–1918) and becoming dean of the department of engineering (1903–1918). During all these years he paid particular attention to the history of the subjects of his major interest, and in recognition of his work in this field he was called to the University of California in 1918 as professor of the history of mathematics, a unique title either in this country or abroad. This position enabled him to devote his time largely to research and writing, and the result amply justified the action of the university in creating the position, and his own decision in accepting it.

Forty years elapsed from the date of the publication of his "Teaching and History of Mathematics in the United States" (1890) to the time when death compelled him to lay aside the work which he had hoped to complete—an edition of Newton's "Principia." During these years his contributions to the history of mathematics, physics, geodesy and astronomy were numerous and of increasing value. Besides writing a large number of articles and making a brief excursion into the text-book field, he wrote the following historical works: "History of Mathematics" (1894, with a revised edition in 1919), "History of Elementary Mathematics" (1896, with a revised edition in 1917), "History of Physics" (1899), "History of the Logarithmic Slide Rule" (1909), "William Oughtred" (1916), "History of the Concepts of Limits and Fluxions in Great Britain from Newton to Woodhouse" (1919), "The Early Mathematical Sciences in North and South America" (1928), "The Chequered Career of Ferdinand Rudolph Hassler, First Superintendent of the United States Coast Survey" (1929) and the work by which he will chiefly be remembered—"The History of Mathematical Notations" (2 volumes, 1928, 1929).

It is interesting to see how he developed in the two-score years of his literary activity. His work of 1890, published when he was thirty-one years of age, showed a considerable range of study of source material and a commendable plan of exposition, but it also showed a lack of thoroughness and of finish. His next three books (1894, 1896, 1899) gave less evidence of the study of sources and showed a somewhat excessive dependence upon other writers, notably Gow and Cantor in the case of mathematics. It was not until he was invited to contribute to the fourth volume of Cantor's monumental treatise, the "Vorlesungen über Geschichte der Mathematik" (Leipzig, 1908), that he showed himself in his true light, that is, as an investigator of the history of mathematics whose work was based upon source material. From this time until his death his books displayed this new spirit. His history of the slide rule, though written twenty years ago, still stands as one of our best authorities. This led him to his first important biographical work, the life and labors of William Oughtred, the leading popularizer of mathematics in England in the first half of the seventeenth century. His other venture in the same field, the work on Hassler, may have been prompted by the fact that this leader in establishing