say, in a sermon that I heard him preach in Boston when this Association met there 20 years ago, that you can get no idea of eternity, by adding century to century or by piling æon upon æon; but that, if you will remember how little you knew when you sat at your mother's knee to learn the alphabet, and how with every acquisition of knowledge which has marked the intervening years you have come to feel, not how much more you know but how much more there is to be known, all can get some idea of how long eternity can be, because all can understand that there never can be time enough to enable any one to learn all that there is to know. There is so much to be known, that even the great advances of the last generation do not make us feel that everything is discovered, but they appeal to new aspirations and awaken renewed energy in order to make fresh discoveries in a region that teems with so much that is worthy of knowledge. I congratulate you upon your success, and I bid you welcome to Columbia.

ADDRESS OF THE PRESIDENT.

Professor Woodward said: Under the favorable auspices of this institution of learning, with its commodious quarters and its scientific atmosphere so generously placed at our disposal, we meet to-day to begin the forty-ninth session of the American Association for the Advancement of Science.

The life of this Association has been contemporaneous with an epoch of triumphant scientific progress; and in this last year of the century one is tempted to look back into the history of the achievements of our predecessors, in order to render them due homage, and in order to learn from their experience the wisdom essential for future guidance. One is prone especially to recall the noble lives and the indefatigable industry of the founders and early workers of this Association, who are no longer with us, but whose careers are sources of admiration and inspiration to the present generation of scientific men in America. There were Rogers and Henry and Bache, and Agassiz and Peirce and Dana, and Torrey and Hall and Lea, and Barnard and Gould and Gray, and Marsh and Dawson and Newton, and Brinton and Cope; and many others not less worthy, whose life work was intimately related to the work of this Association. The mere mention of a few of these honored names may suffice, however, on this occasion, to remind us of our indebtedness to them, and to assure us of the steady progress which has attended the Association in its growth from a single section of a half century ago to the nine different sections and twice as many affiliated societies of to-day. The fertility of the study of our planet in stimulating thought and in leading thought to action is at once apparent when we recall that out of the small beginnings of a few naturalists who styled themselves the American Geological Society have sprung the varied activities of this Association and the kindred societies which meet with us this week. Verily we may say, in the noble words inscribed over the entrance to Schermerhorn Hall on our right, "Speak to the earth and it shall teach thee."

But science knows no nationality, and the forward movement in which our Association is engaged is only a part of a world wide advance which is undoubtedly the most noteworthy characteristic of the civilization of the present half century. And wherein, we may fittingly ask ourselves, and still more fittingly may the general public ask us, does this advance consist? What, in common parlance, are the contributions which the science of our day has brought to the betterment of man's estate? In a summary way, disregarding material

benefits, which everybody recognizes, these contributions may be specified under three heads in the order of their historical succession.

First, there is the far-reaching generalization known as the law of conservation of energy, whose establishment dates from about 1850. This law holds in what for the present we find it convenient to call the material world. It enables us to describe what goes on in that world in the simplest terms and in the most comprehensive fashion. It relates unknown to known phenomena; and it enables us to predict with practical certainty not only the feasibility and efficiency of the vast aggregate of mechanical appliances on which the continuity of daily life now depends, but also the range and limitations of the physical processes of the entire visible universe. This doctrine supplies at once the principal criteria of, and the principal methods of investigation in, physical science. It is the most precise and the most comprehensive of theories devised by man.

Secondly, there is the doctrine of evolution, which dates substantially from the publication of Darwin's work on the Origin of Species in 1859. This, like the doctrine of energy in the material world, enables us to describe in the simplest terms and in the most comprehensive fashion the succession of events in what for the present we find it convenient to call the organic world. It enables us to trace the lines of development along which life has proceeded from age to age in geologic time, and to predict with some degree of probability the course and order of development in the future. It enables us to see how in the endless interactions of the organic and inorganic worlds, the former is adapted to the latter and the latter is moulded by the former; so that the history of terrestrial life, with its teeming forms of animal and vegetable organisms, becomes, in the light of this doctrine, at once readable and verifiable. But the law of evolution is not limited in its application to the lower forms of life alone. It extends to man as well, and proclaims him a part of, and not apart from, the world of phenomena we seek by scientific methods to explain. Thus, with the advent of this doctrine, the anthropocentric theory of the universe, so long held by man, vanishes; but by way of compensation, if any were needed, the new view of his rôle confronts him with the transcendent problem in which the instrument of investigation is, in a far higher degree than hitherto, the object of research.

Thirdly, and perhaps most important of all, there is the educational renaissance which seems to be a direct result of the increase and diffusion of science in our times. Learning is no longer restricted to a narrow range of subjects. Studies are no longer strictly divisible into those which are liberal or humanistic, and into those which, *per contra*, must be illiberal or demoniacal; and the value of knowledge is no longer measured by linguistic standards alone. In short, we have come to understand the essential unity of knowledge and the universality of its sources; and that progress is attained not so much by journeying along the easy highway of *à priori* reasoning as by following up the rough trails of observation and experiment. So rapidly and completely has this renaissance come about that many of the present generation are quite unable to understand how educational affairs could have been at all different in the preceding generation. That liberal provision should be made for the teaching of science in every school, and especially in every college and university, now goes without saying; and munificent endowments for the maintenance of scientific instruction and investigation are everywhere the order of the day. But it was not very long ago—quite within a stretch of the

recollection of many here present—when science was an unknown quantity in our common schools and a sort of imaginary quantity in our colleges. The average school boy's idea of science, as Huxley says in one of his earlier essays, was that it meant 'skill in boxing.' One professorship in a college was commonly comprehensive enough to include all the sciences, and frequently too comprehensive for the peace of college faculties; for, strange as it now appears to us, some of the growing sciences were looked upon as threatening the stability of the social fabric, and all were regarded as dangerously aggressive. Laboratories were either wholly wanting or little used; and although most students gained the idea that all that is worth knowing was ascertained long ago and is to be found in books, libraries seemed to be maintained for the sole benefit of librarians and bookbinders. These were the good old times when the college professor heard recitations by day and read polite literature by night.

It is matter of history that the educational progress of the past three decades has not been accomplished without an intellectual struggle, the noise of which is still heard, occasionally, in the wail of those who fear that the treasures as well as the rubbish of the golden age of antiquity may be engulfed by the iconoclasm of the present age of steel. But whatever may have been our prepossessions, as we look back on this struggle, with our senses of proportion and humor not overstrained by the pressing nearness of events, there appears little cause for regret. The emancipation of education from the dominance of classical tradition is seen to be merely an incident in the general advance. Whatsoever is worthy and noble in the ancient learning has acquired new and increasing interest in the light of the growing science of anthropology; and whatsoever is unworthy and ignoble may well wither in the light of modern criticism.

But surprising and gratifying as have been the achievements of science in our day, their most important indication to us is that there is indefinite room for improvement and advancement. While we have witnessed the establishment of the two widest generalizations of science, the doctrine of energy and the doctrine of evolution, we have also witnessed the accumulation of an appalling aggregate of unrelated facts. The proper interpretation of these must lead to simplification and unification, and thence on to additional generalizations. An almost inevitable result of the rapid developments of the past three decades especially is that much that goes by the name of science is quite unscientific. The elementary teaching and the popular exposition of science have fallen, unluckily, into the keeping largely of those who cannot rise above the level of a purely literary view of phenomena. Many of the bare facts of science are so far stranger than fiction that the general public has become somewhat overcredulous, and untrained minds fall an easy prey to the tricks of the magazine romancer or to the schemes of the perpetual motion promoter. Along with the growth of real science there has gone on also a growth of pseudo-science. It is so much easier to accept sensational than to interpret sound scientific literature, so much easier to acquire the form than it is to possess the substance of thought, that the deluded enthusiast and the designing charlatan are not infrequently mistaken by the expectant public for true men of science. There is, therefore, plenty of work before us; and while our principal business is the direct advancement of science, an important, though less agreeable duty, betimes, is the elimination of error and the exposure of fraud.

As we contemplate the future activities

of our Association, one of the interesting and inspiring signs of the times is seen in the increasing number of international conferences for the promotion of art, commerce, education, science, and, above all, peace and good will to men. At the joint meetings held last year by the British and French Associations for the Advancement of Science, steps were taken to form an international organization, which has since been perfected under the name of the International Association for the Advancement of Science, Art and Education. The first meeting of this body will be held during the present summer at the Paris Exposition. May we not entertain the confident hope that, under the influence of such an association, science, which has done so much to enlighten the minds and ameliorate the conditions of men during the nineteenth century, will play a still more beneficent rôle during the twentieth century?

And now, with a cordial invitation to our hosts, the Trustees, the President, and other representatives of this institution of learning, and with a like cordial invitation to the general public as well, to attend the sessions of the various sections of the Association, I declare this meeting formally open for the transaction of its regular business.

---

*ON THE TEACHING OF ASTRONOMY IN THE UNITED STATES.**

HAVING to teach Astronomy at the University of Michigan, it has been necessary for me to make inquiries regarding the instruction in this subject given at other universities. I have tried to learn also the character of the work done at the different observatories, from the point of view of the development of students and the encouragement of the spirit of scientific research. Thus I propose to discuss briefly the position taken by our colleges, and observatories also, in the teaching of Astronomy.

Not so very long ago in this country of ours, which is rather new after all, many of the young men educated at the colleges were intended for the ministry. They were trained in Latin, Greek, Hebrew, and a little Natural Philosophy, as it was called, this latter subject including all the known sciences, and being taught by one man. There was almost no laboratory work. At present, whether for good or ill, the rule of the clergymen over our colleges is pretty well broken. The old style college president, usually a clergyman of scholarly tastes and sympathies, who teaches the seniors Moral Philosophy, is becoming rare. His place is being taken by the sharp business man, who in his scholarship corresponds very much to a librarian, having a wide knowledge, but not necessarily an accurate one on any subject.

Of late years the elective system has been introduced, and has been extended very far, so that a degree may represent almost anything, in many cases a good deal of technical and professional work being included. If a large number of students are to go to colleges it is necessary, probably, that the technical studies should be allowed to remain, as many would not have the means to give themselves a liberal education.

Of course, it is hard to discuss in a fair and intelligent way the intrinsic merit of Astronomy or any other study. I believe myself that students who can manage it ought to obtain something of a classical training. But in the case of any given student who elects Latin, for instance, is the subject really chosen for the culture which it gives? I must say that in most cases that I know about I can't tell. Sometimes I think that in college all studies

* Address of the Vice-President and Chairman of Section A—Mathematics and Astronomy—at the New New York Meeting of the American Association for the Advancement of Science.