

our faculties are increased by the administrations of science.

Scientific truth has likewise this trait of its own; it is absolutely open to the world; it is as free as air, as visible as light. There is no such thing about it as an inner secret, a mysterious gnosis, shared by the favored few, the select illuminati, concealed from the vulgar horde, or masked to them under ambiguous terms. Wherever you find mystery, concealment, occultism, you may be sure that the spirit of science does not dwell and, what is more, that it would be an unwelcome intruder. Such pretensions belong to pseudo-science, to science falsely so called, shutting itself out of the light because it is afraid of the light.

Again, that spirit of science which we cultivate and represent is at once modest in its own claims and liberal to the claims of others. The first lesson which every sound student learns is to follow his facts and not to lead them. New facts teach him new conclusions. His opinions of to-day must be modified by the learning of the morrow. He is at all times ready and willing to abandon a position when further investigation shows that it is probably incorrectly taken. He is in this the reverse of the opinionated man, the hobby rider and the dogmatist. The despair of a scientific assemblage is the member with a pet theory, with a fixed idea, which he is bound to obtrude and defend in the face of facts. Yet even toward him we are called upon to exercise our toleration and our charity; for the history of learning has repeatedly shown that from just such wayward enthusiasts solid knowledge has derived some of its richest contributions. So supreme, after all, is energy, that error itself, pursued with fervid devotion, yields a more bountiful harvest than truth languidly cultivated.

But, perhaps, the picture I have thus drawn of the spirit of scientific inquiry excites in the minds of some a certain

antipathy, or, at least, a sense of dissatisfaction and incompleteness. To such this description may sound narrow and materialistic; the results of scientific study thus rehearsed may appear vague, indefinite, incompetent to satisfy the loftier yearnings of the soul of man for something utterly true, immutably real.

Vain, indeed, were the life work of our Association; bereft, indeed, were we of just claim on your consideration, did we appear before you with such a thankless and futile confession of the ultimate aim of our labor. But it is far, very far, otherwise.

All this prying into the objective, external aspect of things; this minute, painstaking study of phenomena; this reiterated revision and rejection of results, are with the single aim of discovering those absolute laws of motion and life and mind which are ubiquitous and eternal; which bear unimpeachable witness to the unity and the simplicity of the plan of the universe, and which reveal with sun-clear distinctness that unchangeable order which presides over all natural processes.

This is the mission of science—noble, inspiring, consolatory; lifting the mind above the gross contacts of life; presenting aims which are at once practical, humanitarian and spiritually elevating.

DANIEL G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

*AMERICA'S RELATION TO THE ADVANCE
OF SCIENCE.**

"In art and science there is no such thing as nationalism: these, like all things great and good belong, to the entire world, and are promoted only by free interchange of ideas among contemporaries, with constant reference to the heritage of the past." So wrote

* From *What has been done in America for Science*—an Address delivered before the Philosophical Society of Washington, November 24, 1894, by G. BROWN GOODE, retiring President.

Goethe in his *Sprüche in Prosa*. In the present address I have spoken, not of "American Science," but of what has been done in America for science. I have summarized the work accomplished in the study of the physical conditions and biological statistics of two great continents. I have shown that our countrymen have made important contributions to exact knowledge in every one of its departments from astronomy to anthropology, and that, contrary to general belief, these have been chiefly in pure science rather than in the application of science. Most of our American advances in economic science, with the exception of those in the field of electricity, have consisted in multifarious adaptation and bold application of principles and methods first made known in Europe. Except in ingenious mechanical inventions, Americans have done little in connection with applied science that is strikingly new or great.

It is not, however, by determinate contributions to the aggregate of human knowledge that America has aided most largely the advance of science. It has been in a manner vastly more subtle and far-reaching, through the action of an intellectual leaven which has imbued the thought of all mankind.

America has always afforded to scientific workers a most sympathetic and appreciative audience—even at periods in her history when she has been producing the least at home. When Auguste Comte was young he intended, it is said, to seek a career on this side of the sea, but was dissuaded by a friend, who assured him that if Lagrange himself were to come to the United States he could only earn his livelihood by turning land surveyor. This was absurdly false, for in that very year Laplace's *Mécanique Céleste* was being translated, for the first and only time into English, by Nathaniel Bowditch, whose service to science, which was more important through his commen-

taries than his translation, was fully appreciated even during his own lifetime, and who has ever since been esteemed one of the most distinguished of our countrymen.

European science has always been more warmly appreciated by our people than contemporary European literature, and men like Lyell, Huxley, Wallace and Tyndall, when they have come among us, have received the most enthusiastic welcome, and their books have been consumed in much larger editions than at home, and not without becoming royalties to their authors.

Many others have come to us, not in prosperity but through necessity, and were none the less heartily welcomed—Gallatin, Hassler, Priestly, Cooper, Bernard, Duponceau, Cupont de Nemours, Nicolle, Rau and others.

Humboldt wrote in 1807 :

"During five years passed in the Spanish colonies of America a few French emigrants we found at Nueva Valencia, in Guatemala, were the only ones we saw. Beyond the Atlantic the United States of America afford the only asylum to misfortune. A government, strong because it is free, confiding because it is just, has nothing to fear from giving refuge to the proscribed."*

Priestly, who had been forced to withdraw from the Royal Society, called America 'The Land of the future,' and Richard Price, in the midst of the Revolution, one of the most popular men in England, in declining the invitation of Congress to remove to this country wrote : "The United States is now the hope and likely soon to become the refuge of mankind."

There is even more to be said concerning the influence of our people upon the thought and practice of the Old World.

The liberal policy of our State and National governments toward many branches of scientific work is well understood abroad, and has had an influence, especially in en-

**Personal Narrative*, Vol. ii., Chapter I.

couraging the publication of dignified and well illustrated reports upon the results of scientific exploration and research.

An illustration of the popular appreciation of knowledge in this country is to be found in the growth of libraries, and in the increasing volume of the stream of books, new and old, which pass constantly to the westward across the Atlantic.

Augustine Birrell, M. P., in an address at Dumfermline, Scotland, has presented some most astounding statistics in regard to books and libraries. He said that in the public libraries of Europe there are twenty-one million printed volumes; in those of Australia, one million more, while those of America contain fifty millions—more than twice as many as in all the rest of the world.*

The mere possession of books does not in itself count for much, but the eagerness to acquire the means of research, not books only, but all other instruments and appliances for intellectual progress, is very significant. It should be remarked also that this tendency, so far as the public at large is concerned, has not become very evident until within the last third of the present century.

There is a relationship still more fundamental between America and the advance of science, to which only a passing allusion is proper here.

I refer to the reflex action of democratic institutions upon those of the Old World—to the influence of human freedom, practically demonstrated upon American soil, upon the freedom of the people in our parent lands.

It was one thing for men like Priestley to fly hither for personal liberty. It was quite

* *Pall Mall Gazette*, September, 1891. The estimate is perhaps somewhat extreme, though the official return of public libraries in the United States (excluding the other American republics and the colonies) show nearly 32,000,000 books in public libraries of over one thousand volumes.

another for Coleridge and Southey to plan for the founding of a pantisocracy on the banks of the Susquehanna, and then to remain at home with Wordsworth and promote human freedom by their writings, or for Price to denounce the oppression of the American colonies as an outrage against liberty, and thus to secure from the people of London, who presented him with the freedom of their city, an assurance of sympathy among their English kinsmen, which encouraged the colonists to declare their independence. If, at the time of the Great Exodus, the men who organized the Royal Society of London had carried out their purpose of removing in a body to Connecticut, there to found an academy of sciences, the higher learning would have been retarded, not advanced.

It is almost impossible for us to understand the manner in which even now freedom of thought and action is burdened in the Old World by the weight of feudal traditions and by the existence of class distinctions and privileges. Americans surely do not understand, but that quick-witted race of Orientals, the Japanese, have done so from the very time when they applied themselves seriously to the task of making their own what is best in the civilization of the circum-Atlantic peoples. To England they went for ideas about a navy and for lighthouses, to Germany for a system of government, for military instruction and for medicine, and to France for a code of laws. In matters of education, however, they have chosen from the very start to be guided by Americans;* their keen perception teaching them that, whatever may be its defects in detail, the American educational plan is that which in some form or other is certain

* Their postal system, their telegraphic code and their meteorological service are also purely American in origin, as well as such foreign agricultural methods as they may have adopted.

to be adopted by every free people, and to work mighty changes in traditional, social and governmental systems. Not less significant, perhaps, in the same connection is the present attitude of Pope Leo XIII. and his counsellors in regard to educational movements in the United States.

The condition of affairs in Germany up to quite a recent day, as shown in Virchow's address to the Congress of German Naturalists in 1872, seems almost incredible.

Describing the organization of that society, fifty years before, he said :

"Not perhaps at the dead of night, but still beneath the veil of secrecy, a handful of savants assembled for the first time at Leipsic, at the invitation of Oken. In fact, in 1822, no considerable body of men could come together in Germany in answer to a public invitation, without the permission of the civil authority. They could not discuss among themselves scientific questions, no matter how unconnected with the political and national questions of the day. Add to this the other fact that, if I am not mistaken, it was only in 1861, at the Congress of Naturalists at Spire, that the names of the Austrian members could be made public, and then we can appreciate the tremendous change that has been brought about in the Vaterland."

In England personal liberty, though not consciously retarded by law, is severely trammelled by the nature of existing social organizations. Distinction in science and letters is, even to-day, practically, subordinated to social distinction. As an illustration one need only notice the position of the President of the Royal Society upon any list in which the names of influential Britons are arrayed in order of social precedence. It is next to impossible for a man of moderate means, however learned, to become president of one of the great English scientific societies, and the honor most highly esteemed by the masses in England, as well as throughout Europe, that of a decoration, is rarely given, except to men who are prosperous in some material way.

"I know in London," writes Leland, "a very great man of science, *nemini secundus*, who has never been knighted, although the tradesman who makes for him

his implements and instruments has received the title and the *accolade*." *

The changes which the last four centuries have wrought are by no means to be all attributed to the influence of the inhabitants of the New World, but in a large degree, no doubt, to the social and political modifications which the discovery of America rendered possible in the Old World.

It is, after all, very difficult to realize the exact relation of this discovery to the intellectual history of mankind, and it may be impossible, unless we were endowed with the gift of omniscience.

A few months ago, standing within the great red fortress of the Alhambra, looking down on the plain of Granada, still green with the orchards and vineyards planted by the former Moorish rulers of Spain, I understood, as I had never done before, that the final expulsion of the Orientals from Europe was almost simultaneous with the discovery of America. Six months before he sailed westward, Columbus stood with Ferdinand and Isabella upon that very tower, and saw the last cavalcade of exiled Moors disappear over the mountains toward Africa. For many centuries the military strength of our European ancestors had been chiefly devoted to repelling the invasions of these restless men of the East. Feudal government held universal domain, and all the learning of Europe was hoarded up within monastic walls.

"The discovery of the New World not only offered new productions to the curiosity of man. It also extended the then existing work of knowledge respecting physical geography, the varieties of the human species, and the migrations of nations. It is impossible to read the narratives of the early Spanish travelers, especially that of Acosta, without perceiving the influence which the aspect of a great continent, the study of extraordinary appearance of nature, and intercourse with men of different races must have exercised on the progress of knowledge in Europe. The germ of a great number of physical truths is found in the works of the sixteenth century ; and

* Memoirs, 1893, p. 127.

that germ would have fructified had it not been crushed by ignorance and superstition."

So wrote Humboldt at the end of the last century. He must have felt, although he did not say so then, that ignorance and superstition were also to be dissipated in the new and expanded intellectual atmosphere. The passage already quoted from his writings shows this clearly.

The establishment of the supremacy of Western civilization, and the finding of a New World were, after all, less important than the discovery which the men of both hemispheres made on this side of the sea—that they might become free and their own masters. It was the opening of a new period in human history. Men were awakening from the slumber of ages. Europe began to emerge from abject intellectual slavery. In political life the traditions of the age of despots were broken, and the development of free institutions begun. In religion a reformation was inaugurated, wider in scope than the movement led by Luther, which is commonly associated with that name. In art, soulless and awkward formalities were replaced by enthusiastic culture of the ideals of classical days, which in time grew broader, more spontaneous and more inspired. In the field of letters, scholastic traditions were cast aside, and each nation in Europe developed a new language and a new literature. In science, similar scholastic and traditional usages were discarded. The students who compiled uncritically and generalized upon the worthless results of their own antiquarian researches, gave place to the restless, skeptical, critical inquirers of modern times.

We have just ended our celebration of the discovery of America, the end of the Dark Ages, the birth of individual freedom and of proper government. We celebrated at the same time the beginning of a new epoch. The Mediæval Renaissance was limited to Europe; ours will embrace all the

nations of the earth. It may be that this should be considered the outgrowth and fulfillment of that which marked the end of the Middle Ages, but whether we are at the beginning of a new movement, or at the culmination of an old one, the last forty years have undoubtedly witnessed greater changes in the spirit of men's thoughts than the four centuries which had gone before.

The earlier Renaissance gave to man the right and liberty to think and act as he, in his own judgment, saw fit. The Renaissance of to-day is leading men to think; not only with personal freedom, but accurately and rightly. Far be it from me to say that I believe that mankind in general are very much nearer to accurate and just standards of judgment than they were four hundred years ago, but the spirit of to-day favors untrammelled and searching investigation of every question in which man is concerned, a critical comparison of the results of such investigation, and a frank intolerance of all illogical or unsound theory and application.

This is the spirit of science—the spirit of unprejudiced search for truth—and this, emphatically, is the spirit of thinking men of to-day in America, in every department of activity.

Who can say what is to be the part of America in the future intellectual life of the world? It cannot be less important than in the past, and in all likelihood the influence of America will be more comprehensive and deep-seated as the years go by. Is it not possible that it may hereafter become the chief of the conservative forces in civilization rather than, as in the past, be exerted mainly in the direction of change and reform?

Brain of the New World, what a task is thine,
To formulate the Modern—out of the peerless grandeur of the Modern,
Out of thyself. * * *

Thou mental moral orb, thou new, indeed new, spir-
itual world,
The Present holds thee not—for such vast growth as
thine,
For such unparalleled flight as thine, such brood as
thine,
The Future only holds thee and can hold thee.*

G. BROWN GOODE.

U. S. NATIONAL MUSEUM.

LEGAL UNITS OF ELECTRIC MEASURE.

It will, doubtless, be interesting to all physicists, as well as to many in other departments of science, to know of the legalization by Act of Congress, within the last six months, of units of electrical measure. It is not necessary in these columns to go into an exposition of the necessity for such action on the part of the Government, nor to refer to the enormous amount of capital invested in the manufacture of instruments, devices and machinery, the sole object of which is the conversion of some form of energy into electricity and the reconversion of electricity into some form of energy. The measurement of the enormous quantities of electricity that have within the last decade been produced and thus converted has, up to a recent date, in all cases depended upon the conventional acceptance of units of measure which have for many years been in use among scientific men, and which originated in the necessity for such units of measure in scientific investigations. It is always worth while to note, however, that the great simplicity and perfection of electrical measurement is due to the fact that the science of electricity preceded the art of its utilization. In this respect electrical engineering has a very decided advantage over all other branches of engineering, for in all others the art preceded the science, and the science, therefore, was obliged to build itself upon the crude and mostly unphilosophical principles that developed in the art.

*Whitman, *Leaves of Grass*.

The fundamental units of electrical measure, namely, the ohm, the ampere and the volt, have been in use among scientific men, to the exclusion of all others, for more than a decade, related as they are to the fundamental units—length, mass and time, which are admirably adapted for use as the basis of all electrical metrology. It has, however, long been recognized that much inconvenience was caused in electrical discussion by the lack of a few additional units, the use of which would greatly facilitate mathematical calculations and numerical statements. The literature of the subject has abounded, during the past ten years, with suggestions as to these additional and desirable units of measure, and various writers have, from time to time, adopted such as seemed to be necessary for their own use, even giving them such values and such names as were best in their judgment. It was evident, therefore, that to prevent confusion in electrical nomenclature it was desirable to have an international agreement as to these units, their value, their number and their names; the demands for this have grown very extensive in the last few years, the result having now been reached in the passage, by Congress, of a law which seems to define and settle these questions as far as the United States Government is concerned.

All readers of this journal are, doubtless, familiar with the fact that as early as 1881 an electrical convention, or congress, was held in Paris for the purpose of trying to agree upon definitions of the fundamental units of electrical measure and their material representations, in cases where material representations were possible. After much discussion, and not without very considerable opposition, there was proposed at that time a material representation of the ohm which was known to be somewhat in error. The real ohm must always be that defined by the Committee of the British Association