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THE FUTURE OF AMERICAN SCIENCE.

THE progress of science in any age is determined largely by the circumstances of its environment. The soil in which it is rooted, the atmosphere from which it draws the materials of its life, and the stimulus of light and heat which it receives, all have a strong determining influence upon its growth. Nowhere, probably, has this influence of the surroundings been more potent than in our own land. The intense activity of our people, the high intellectual, commercial, and social pressure under which they live, their enthusiastic interest in scientific knowledge and the generous liberality with which they foster it, — all these agencies have had a powerful influence in creating the position which American science assumes to-day. We may not, indeed, boast of a scientific record as full and complete as that of other countries; but we may and should take an honest pride in the achievements in pure science which we have already actually accomplished. The names of Agassiz and of Peirce, of Bache, Henry, and Draper, of Hare and Silliman, of Bond, Watson, and Chauvenet, of Rittenhouse and Saxton, of Rogers, Hitchcock, and Cleaveland, are worthy to be enrolled high up in the temple of scientific fame. The work done by these men in the direction of original research will ever stand the test of time, and will always keep their memories green.

The leading feature of American science, however, and that which most distinctively characterizes it, is its utilitarianism. True, there are in our country able investigators working in scientific fields which do not offer the promise of material reward; but notwith-

standing this, it remains still true that those sciences whose principles are capable of useful application are the most zealously cultivated among us, and attract the largest number of students. Nor is this to be at all regretted. Research is none the less genuine, investigation none the less worthy, because the truth it discovers is utilizable for the benefit of mankind. Granting, even, that the discovery of truth for its own sake is a nobler pursuit, because a less purely selfish one; does it become any the less noble when it is ascertained that the truth thus discovered is capable of important applications which increase tenfold the happiness of human life? It may readily be conceded that the man who discovers nothing himself, but only applies to useful purposes the principles which others have discovered, stands upon a lower plane than the investigator. But when the investigator becomes himself the utilizer; when the same mind that made the discovery contrives also the machine by which it is applied to useful purposes, — the combined achievement must be ranked as superior to either of its separate results.

The inventive genius of this country is pre-eminent. We reap the benefits of it on every side. Our houses are more comfortable, our railways more safe, our fabrics cheaper, and our education more thorough, because of useful inventions. Becoming restive at the slow progress of discovery, the inventor has himself assumed the rôle of investigator; and the results of his researches appear in the records of the patent-office. In the olden times the investigator was content to make his discoveries, and to publish them, consecrating to science the knowledge thus obtained. His more modern representative carefully treasures what he has discovered, until he has exhausted its practical applications. In consequence, the

discoveries upon which many of the most important scientific inventions of the day rest, will be searched for in vain in scientific literature. The telegraph, the telephone, and the electric light are inventions which illustrate the fact now stated, in an eminent degree.

Another direction in which applied science has been developed in this country is found in the work done by the various government organizations. Is the weather-probability an important factor in the citizens' welfare? Immediately the signal service of the army is developed into a complete meteorological organization to collect data, and deduce forecasts. Is navigation to be made more safe, and internal boundaries more accurate? The coast and geodetic survey is created to carry on the most refined investigations upon standards of measure, and the various methods of applying them. Is the fishery question an important one to our commercial interests? A fish commission is organized, and under its direction the most elaborate investigations in vertebrate and invertebrate zoölogy are undertaken. Are the mineral lands of the government to be reported on? Geological surveys are commissioned to explore the public domain, and are clothed with ample power to make their work elaborate and exhaustive, and to embody their results in extended reports, not alone on the economic side, but including all the collateral branches of science. Is a knowledge of the properties of iron and steel of essential value in constructive engineering? Forthwith a special commission appears, charged with authority to execute the most refined chemical analyses and the most delicate physical tests upon these metals. Is there danger to agricultural interests from the depredation of insects? An entomological commission is appointed by Congress, with instructions to exhaust the resources of science for the protection of the crops. Moreover, besides the work done in this way, special investigations are always in progress under the direction of the departments; more especially those of war, of the navy, of the treasury, and of the interior; the services of the

engineer-corps, in river and harbor improvements, for example, it is not easy to over-estimate. In the end, it is true, these investigations have a practical object; but to attain this, in many cases, theoretical results are reached which are of the highest value to pure science.

It is no wonder, then, that, in the midst of such kindly appreciation by the intelligent and educated masses of our people, — an appreciation manifested alike by personal munificence and by governmental appropriation, — all the sciences, but especially those which reward appreciation by practical benefits, should have attained their present satisfactory development. Who can say to how large an extent the eminent position of practical astronomy in America is due to the unrivalled telescopes of Alvan Clark? The wonderful microscopic photographs of Woodward have been made possible only by the perfection to which Tolles has brought his object-glasses. The bolometer of Langley has given us new conceptions of sunlight; and the exquisite gratings of Rowland promise to do still greater things for us, in the same direction. In the experimental sciences especially, their unexampled advance is a continual testimony to the abundant return which practice has made for the benefits it has received from theory.

While the scientific cynic may condemn the utilitarianism of our age, the more liberal man rejoices in it, since science is thereby the more advanced. He is thankful that the people view these scientific questions with the broadest liberalism; that they are not disposed to confine scientific inquiry to those investigations alone whose results are practical, but pour out their substance freely in aid of scientific work in all directions, theoretical as well as practical, pure as well as applied. This generous disposition toward scientific research, so characteristic of this country, has called forth unreserved commendation in Europe. The munificence of the gifts which have been made to science, both public and private, the liberality with which research has been endowed in America, have been the astonishment of

men of science in other countries. Such is the environment in which American science has been developed; such the favoring soil, atmosphere, and warmth with which it has thus far accomplished its growth.

Under such conditions, it is not difficult to foresee a brilliant future for American science. Scientific evolution, like the evolution of a species, requires complete conformity to the conditions of existence. The science of to-day is in thorough accord with the spirit of the American people. They are proud of every achievement it makes, and are satisfied with the returns it is giving them for their investments. To continue this *entente cordiale*, should be the object of every scientific worker. He may the more readily concede some practical return for the facilities for investigation which the people have furnished; since the march of discovery is not in the least hindered, but rather promoted, by the practical application of the new truth it develops. His attitude toward invention should be appreciative and cordial. He should cast aside all prejudice against the man of patents and practical devices, and should stand ready to welcome the investigator in whatever garb he appears.

But more than this. Science must be true to itself as well as in accord with its surroundings. It must maintain ever the highest tone and the most impartial accuracy. It must covet the scrutiny of every eye, and must be generous ever in the acknowledgment of its shortcomings. Higher than all, it must be devoted to the truth. It must cheerfully undertake the severest labor to secure it, and must deem no sacrifice too great in order to preserve it. It must have an unlimited capacity for work, and an unlimited enthusiasm in it, while at the same time a proper reserve in affirming the results of it. While striving itself for the highest attainable accuracy, it must be catholic and liberal toward others. It must not magnify differences, nor impute motives. It must be ready to adjust, with the utmost patience, conclusions which are apparently discordant. It must treat all questions with fairness and candor. When it ventures

nearest the boundaries of knowledge, it should assert itself cautiously. In its relations with other departments of knowledge, it must preserve toward them a due consideration. It must venture upon prediction with circumspection. It must take care, on the one hand, not to set too narrow limits to the possibilities of discovery; on the other, it must be quick to discern the directions of advance, and to utilize the smallest suggestion to promote discovery. It must be fruitful in working hypotheses, but it must test these with unsparing rigor before it offers them as a part of established truth.

Moreover, in order that it may advance beyond the boundaries of present knowledge, it must keep fully and constantly informed of the position of the ever-varying line which marks the limits of the known. It must have and use all the publications in which are recorded the work done by others in all the various fields of research. It must not waste its energies in doing again what has already been well done. Beginning its work where others have left off, it must carry out into the misty region of hypothesis the most complete methods known for the solution of the problems it has attacked. Not contented alone with receiving the work of others, it must furnish its methods and results for publication, thus contributing its part to the interchange and discussion of opinions by which discoveries finally become an integral part of truth. It must recognize the importance of making the scientific literature of the day the repository of scientific progress; so that every advance, whether of theoretic or applied science, may find a record in its pages.

The year 1883 opens auspiciously. The scientific sky is clear, and the outlook promising. If true to itself and to its surroundings, American science has nothing to fear from the future. With the increase of a generous people, and the spread of intelligent scientific thought, it has every thing to hope. Under these favorable circumstances, SCIENCE enters upon its career. May it early recognize the conditions of this certain progress, and ever be on the alert to help it forward.