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Devoted to the Science of Religion, the Religion of Science, and the
Extension of the Religious Parliament Idea

Founded by EDWARD C. HEGELER

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Frontispiece to The Open Court.

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PROGRESS THROUGH SCIENCE.

BY ROBERT SHAFER.

“**P**ROGRESSIVE human activity subduing the world”; “a common society, working together for the conquest of nature and the improvement of life”; “the evolution of that collective human force which is growing and compassing the conquest of the world”;—where has one, or where has one not, heard these phrases before? They are the air we breathe, the authentic creed of innumerable men and women now living. The phrases come, in fact, from *The Living Past*, a little book by Mr. F. S. Marvin, but Mr. Marvin did not invent them. He would himself indeed not claim that sort of merit for his work; and it is just because he has succeeded in making himself representative of a very large contemporary group that his writings deserve scrutiny from men who wish to understand the present age.

The movement of thought during the last two centuries has been exceedingly complex, and has landed us at length in such a confusion of ideas, purposes, and standards, as cannot be exaggerated. During these centuries on the one hand the material of knowledge has rapidly grown to such unwieldy bulk that scarcely any one can now grasp it even in outline, and, on the other hand, men have become increasingly busy with their own private affairs, with ever less inclination and less time for contemplation of the work and thought of others. The result is that practically no one today takes or is capable of taking a complete view of his world. Yet, though the complete view has become practically impossible, and though the effort towards it is cried down by those who have a vested interest in partial views, men still find in themselves an

unconquerable need for generalization. Not some men, but all men have a deep necessity for a general belief or creed which will give meaning to their lives and their age—and what do they do? For their practical working purpose they take whatever is at hand, the data furnished by their own limited experience and imperfect development, and erect it into a structure which somehow serves them. The building looks sound in fair weather when no winds blow. Their method is simple, yet they do not truly simplify. They do what they can; they seize upon the dominant idea closest to their practical activities and make it serve all ends.

No one can doubt that in recent years the two ideas dominant in the minds of most men have been Progress through Science and Progress through Political Reconstruction. For the moment the latter is in the foreground, but it has not superseded the first idea. On the contrary, social theorists and political reformers for the most part assume progress through science to be a fact and make it the foundation for their effort. Examination of this "fact," consequently, is of immediate importance. The phrase means, in brief, that exact science has given us almost unimaginable power to control nature for our own purposes, and has thus opened up before us illimitable vistas of real progress towards a perfect human society. We are given to understand, moreover, that science's past achievements are but an earnest of greater things in store.

This popular belief Mr. F. S. Marvin has sought both to expand and to strengthen in *The Living Past*, already mentioned, and in *The Century of Hope*.¹ His method is historical; he calls the former volume "A Sketch of Western Progress," and the latter "A Sketch of Western Progress from 1815 to the Great War." His object is to disclose progress through science as the central "clue" to the whole history of the race. He says of *The Century of Hope* that it "endeavors to exhibit the growth of humanity in the world, taking as a leading—though not exclusive—thought, the development of science and its reactions on other sides of national and international life." He explains somewhat more fully in the Preface to *The Living Past* that this interpretation of history "first came clearly into view with Kant and the philosophers of the eighteenth century. Take Kant's theory of universal history as the growth of a world-community, reconciling the freedom of

¹ Both books are published by the Clarendon Press.

individuals and of individual states with the accomplishment of a common aim for mankind as a whole. Add to this the rising power of science as a collective and binding force which the century since Kant has made supreme. You have then one strong clear clue which, with the necessary qualifications, seems to offer in the field of history something of the guidance and system which Newtonian gravitation gave to celestial mechanics in the seventeenth century. The growth of a common humanity; this is the primary object to keep in view. But it will prove vague and inconclusive, unless we add to it a content in the growth of organized knowledge, applied to social ends."

The recipe for history, then, is a fervent belief in "science organizing industry in the service of an united humanity." Mr. Marvin, it should be said, is an outstanding figure amongst those who advance this view. He endeavors to be frank and straightforward; he is at once more thoughtful and more temperate than are some of his fellow spokesmen² for the army of believers in progress through science; and indeed it is safe to say that in his writings this view appears on the whole at its best. Hence it is just to centre in them a consideration of the doctrine. By some it might be supposed that the war has been itself an adequate criticism of this doctrine; but the war, in this direction as in others, appears very little to have affected opinions held in those different days before the summer of 1914. All available evidence supports such a conclusion. Mr. Marvin spoke for very many besides himself when in 1915 he confidently said that "catastrophes such as we are now witnessing can only delay, but not defeat, the purpose of the ages and the nature of man." Later he was even able to persuade himself, as any one can see in *The Century of Hope*, that the war was actually furthering his notion of "the purpose of the ages."

Belief in progress through science is not, of course, an entirely new thing. It has spread widely and become a dominant article of faith practically within the memory of men now living; yet some centuries ago the compass and gunpowder first notably showed men the power and consequent profit that might accrue from putting natural forces to work for human purposes. And following these

² See Professor Walter Libby's *Introduction to the History of Science* (1917), particularly the last chapter and the Preface; also M. George Sarton's article, "The Teaching of the History of Science", *The Scientific Monthly*, September, (1918).

discoveries at a considerable distance came Bacon, sharing "to the full the enthusiasm and the sense of power which the age of discovery had inspired in western Europe", and adding "to these the two fundamental traits which distinguish the great founders of modern science in the seventeenth century. One is the critical spirit, determined to sweep away the false Aristotelianism and mere authority which obstructed the progress of effective knowledge: the other, the new impulse to turn to nature as the source and material of truth, and on the truth of nature to build a system for the general amelioration of mankind." Bacon was not one of the actual builders of the new structure. "He was distracted by his erudition and his literary gifts"—two qualities which generally arouse the distrust or hostility of the eulogizers of science—"and still more fatally by the interests of wealth and world success," whereas "the actual builders were men of intense and unbroken devotion to the pursuit of truth."

They were, in the first instance, Italians, but the pursuit of truth soon became "an international work, within the area of that smaller progressive world, which Greek intellect, supported by Roman power, had divided from the rest of mankind." The particular kind of truth pursued "in common by many minds in all the leading nations"—"forming a model, as well as a stimulus, to human co-operation"—was what the founders of the Royal Society elegantly called "Physico-Mathematical Experimental Learning." Whether or not the mathematical and astronomical developments in the sixteenth and seventeenth centuries were regarded by those who took part in them as steps towards "the amelioration of mankind," the advances made at least "show the natural co-operation of several independent minds, working consecutively to attain the one simplest and most consistent explanation of a vast number of hitherto uncorrelated facts." Newton, in whom the development culminated, had "the genius which perceives true resemblances between remote and apparently disconnected facts," and his achievement is "the most fruitful instance in history of the unifying tendency of thought, seen more or less in all its aspects, but above all in mathematics, the 'art of giving the same name to different things.'"

Earlier than Newton, however, there had appeared a worthy companion of Bacon in Descartes. "All his science," Mr. Marvin says, "arose from the intensive cultivation of his own spirit, which

was enlarged, as he tells us, by the unfolding of every new truth in surrounding nature." This sentence is perhaps almost worthy to stand beside Mr. Marvin's statements that Archimedes "is the first pure man of science whose works have come down to us," and that Newton invented the law of gravitation, and that Harvey discovered the movements of the earth. Concerning Descartes we have specially to note that he shared Bacon's confidence in the meliorative efficacy of physical science. Mr. Marvin quotes his prophecy: "We shall be able to find an art, by which, knowing the force and action of fire, water, air, stars, the heavens and all other objects, as clearly as we know the various trades of our artisans, we may be able to employ them in the same way for their appropriate uses, and make ourselves the masters and possessors of nature. And this will not be solely for the pleasure of enjoying with ease and by ingenious devices all the good things of the world, but principally for the preservation and improvement of human health, which is both the foundation of all other goods and the means of strengthening and quickening the spirit itself." Descartes, we are told, "was the first clearly to suggest" a reconciliation "between the fullest individual culture and the pursuit of a social end;" and "the three centuries since Descartes have brought more and more fully into prominence the social harmony between science and life." In a specifically scientific direction Descartes' greatest achievement was the "mathematical expression of that fundamental conception in modern science which distinguishes it from the science of the Greeks, the idea of movement and continuous growth." This was an achievement which he shared with Newton and Leibnitz, and "with the invention of the calculus in the seventeenth century we reach the last stage yet known to us in that part of measuring which brings the world into subjection to man."

The nature of this achievement indicates for us the general trend of seventeenth-century science. It was, as the founders of the Royal Society had adumbrated, "a physico-mathematical movement, and as such it ran its course before the more complex sciences of life took definite form. It has grown continuously ever since, and by its connection with industry and the practical arts has become the most powerful and typical branch of science as the agent in subduing the forces of nature to the use of man." Yet there were in the seventeenth century isolated advances in other sciences, such as Harvey's anticipation of the foundation of biology and John

Mayhow's discovery, through experiments with candles and small animals, of the existence and fundamental property of oxygen; and—though we are not told why—these "instances bespeak the intimate similarity of all scientific truth."

The eighteenth century witnessed two grand results of the scientific development of the seventeenth. In England it saw the industrial, and in France the social and political, revolution. The former led to the socialization of science, for science "did not affect the whole of society, until the sweeping changes in the life of the people, which resulted from the union of science and industry, brought men together in masses and made all men think." This union of science and industry "is really another example of that integration of human powers of which science by itself offered so many striking instances." What happened essentially was that, first through the steam-engine and ever since through a miraculously increasing number of other devices, science actually began to be applied to the satisfaction of human needs and desires. Practical fulfilment came to the prophecy of Bacon and Descartes. And thus the English mine-owners and cotton-mill operators of the eighteenth century were in reality the great humanitarians of the period, although the merely superficial results of their labors of love were such that Mr. Marvin admits that "the condition of the mass of the people of England was probably worse than it had been at any previous period, while landlords, manufacturers, and capitalists generally, were making larger profits than ever." This was the temporary result of sweeping changes. The permanent result was the utilization, made possible by capitalists and manufacturers, of the almost unimaginably great stores of power for the control of nature opened up by iron and steam. One aspect of this industrial revolution calls for special notice. Wherever modern industry has developed it has gathered men closely together into towns. This has been essential "for the work in hand in the world." "The assimilation of the vast resources which the new science and mechanical inventions had put in man's command, and the organizations of a society strong, keen, and united enough to grasp and utilize them," has demanded a "quick exchange of ideas, vigorous combination of many minds and many wills. This is the gift of the town."

"The gift," Mr. Marvin sagely observes, "must be studied with discernment and the eye of faith." Proper discernment and faith

show, in the first place, that the highly specialized work necessitated by modern industry is an important step towards human unity; it is, "from one point of view, narrowing, mechanical, monotonous; from another, an impressive lesson in the dependence of every particle in the social organism on every other and on the whole. To the countryman, to the workman in a simple state, the fact, equally true, is more remote; the factory worker is surrounded by his fellows and depends at every step on what others send him. . . . This co-operation, which we take for granted in any running concern or running engine, is really the expression in concrete fact of a vast force of organizing mind, which has itself grown up with the system, making and being made by it together. Nor does it reside exclusively in any one set of minds, though there must be special organizers, such as foremen and directors. Every person taking part in such a system has in some degree his spirit of co-operation heightened." And in the second place Mr. Marvin, with similar discernment and faith, says that "the town even more than the trade encourages this tendency. . . . For the business-relations, which gave rise to the town, become but a small part of all the forms of association by which its members are developed in co-operative activity: and it grows by its own growth. It is Aristotle's city-state, writ large, in letters of steel. The necessities of machine production made the modern town: its organization offers to the citizens a larger and fuller life. Iron for marble, smith's work for sculptor's and mason's—much of the difference between the modern state and its archetype is expressed in that change—both as a fact and as a symbol. Less beauty, less individual work, less freshness of thought mark the modern structure; but its material is more durable, the lines of the building are larger, and the ties and stresses are arranged in the light of a higher mechanical science."

Such, then, were some of the earlier results of the application of science to the amelioration of mankind. They gave, Mr. Marvin proudly says, definite primacy to the leading nations of western Europe; and he adds in quaint forgetfulness of the whole purpose of his writings that England in particular now "indisputably took the lead of the world" because of her early use of her providentially-given "sinews of the new war."

Concurrently with this English development there came into prominence in France a group of thinkers, commonly known as

the Encyclopædists, who united to preach the perfectibility of man. The doctrine was in the air. Everybody had begun to believe in it, yet each one had his own pet theory for attaining the easy perfection of the race, and it is sometimes difficult to discover their common element. Diderot and some of his immediate associates derived the idea as well as the inspiration for the Encyclopædia largely from Bacon. As Mr. Marvin says, not incorrectly, "They refer constantly to Bacon as their apostle and use his language to express their purpose. Like him they set out to found an 'empire of virtue' and to increase human happiness by the growth and spread of science." They went further, however, than Bacon expressly did—though not further than most have thought he should have done on his principles—in denying the validity of all revealed religions, most of them showing a special and venomous hostility to Christianity. Our sole source of knowledge, they said, is the observation of nature, and all possible knowledge is summed up in the descriptive and generalizing exact sciences. They saw that Bacon had already been proved correct in his prophecy that we should learn to command nature by observing or discovering her laws and obeying them; and they looked forward to a progressively increasing command over nature for the satisfaction of human desires as the exact sciences should further develop. Thus these sceptical materialists, flushed with optimism, dreamed that at last humanity was on the true path leading to a perfect state where misery should no longer exist, and where all should dwell in happy concord.

But the precept to obey nature's laws led also to a somewhat different argument. Were not men's miseries due simply to the human institutions of civilization which had resulted from the pursuit of mischievous and perverse ideals and wrong-headed aims? Did not men become vicious just through their failure to obey nature's laws in their highly artificial organization of society? Would they not, therefore, speedily attain perfection if they resolutely struck off their fetters of custom and law, and so achieved freedom to be their naturally good selves, to satisfy their naturally good desires? Such a view puts the responsibility for men's miseries and imperfections entirely upon Society, and accordingly it was asserted that the immediate condition of indefinitely great progress for humanity was revolutionary change in the direction of securing for all men freedom, equality, and unity or concord.

A still different yet allied view of progress came a little later

in the biological speculations of Lamarck. He had been, it is true, anticipated in some respects by Diderot, and in others by other thinkers of the period. But he it was primarily who brought the theories of the time to bear upon the subject-matter of biology. "We find in him," Mr. Marvin says, "frequent mention of an inherent tendency to progressive improvement in living things. Nature was compelled, by a law the Supreme Being had imposed, to proceed by the constant fresh creation of the simplest forms, the monads of life which are the only beings directly created. These then develop by gradual steps towards the highest level of intelligence and organization, partly through their own innate tendency to perfection, partly through the force of external circumstances, the variations in physical conditions on the earth and their relations to other beings." "What is this?" Mr. Marvin asks, "but a short and general statement of beliefs held by a large part of all subsequent thinkers on the subject?"

Mr. Marvin goes on to say that Lamarck in his investigations foreshadowed later geology as well as biology, and so supplied "the first hint of the correlation between earth and life. . . . , Lyell and Darwin, which was ultimately to win universal assent for the doctrine of evolution." And in the middle of the nineteenth century Darwin, "and his fellow workers on the doctrine of evolution, transformed the old simple faith in human perfectibility by two additions. They gave a body of facts, a set of operative causes to fill out the vague and somewhat empty formulæ which satisfied the first enthusiasts. And they supplied the other complementary term which any sound notion of progressive life requires, the idea of the environment upon which the developing organism acts and which reacts upon it. To Condorcet, to the enthusiasts of the Revolution, the future was a vision of 'mankind marching with a firm tread on the road of truth, virtue, and happiness,' a road on which 'we could see no limits to our hopes.' To Darwin, to any one who had studied the facts of life from the new perspective, progress was no less real, it was a palpable and concrete thing, but its reality could and should be measured by the adaptation of the living being to its environment, including in its environment those fellow creatures with whom it lives." Mr. Marvin is aware that biological science has not the exactness of physical science, and he instructively compares the former to a journey by aeroplane: "There is no permanent way. We travel quickly; we feel our way and dart hither and

thither to escape a contrary wind. But the speed, the exhilaration, the prospect are superb, and the solid world recedes beneath our flight." Yet, he says, "however Darwin's theory is finally modified, it remains the dominating influence in all the sciences of life. It transferred the centre of interest from the life of the individual to the growth of the species. . . . Darwin's law, moreover, becomes itself another and potent link in the unification of mankind, for like all science it brings together the co-operating and consenting minds, and also gives us an objective unity among things outside us which were before regarded as separate beings. In the light of a general law of evolving life, all animal and vegetable species appear as branches and twigs and flowers of one great tree springing from a common root."

This I think is true. Darwin, Lyell, and their co-workers and followers seem to prove what many had already said and what everybody was anxious to believe. Not quite everybody, after all, yet to speak thus inclusively is not to ignore the great controversies of the nineteenth century; it is only to recognize what most have long since felt, that the resounding battles against Darwinism, as they were actually conducted, were lost before they were begun. The Darwinians "had the goods." They seemed to guarantee the fact of real progress towards perfection as an inherent natural tendency of all living things. It was enough; it meant a "fuller life on all sides, the fullest life of which the individual is capable," as a fact which we might all count on in the future. Whose future was scarcely asked, in an age of action rather than of sickly thought. It was for a constantly increasing number of men sufficient that the new facts gave substance "to a view in which all good things, the beauty of nature and the joy of living, as well as knowledge itself, are all included in that manifestation of the Highest to which our being tends. The barriers of asceticism, partly mediæval, partly puritan, have been broken down, and our ideal of the Best does not seem to grow only as one side of our nature by some stern law imposed from without, but embraces all congruent things, and will, as the self develops, embrace still more." Doubtless; and, men felt, the instrument of this so charming progress is science itself, which has miraculously begun, is doing more, and will surely end by doing everything.

Very important for this progress is the increasing unity of mankind, without which, indeed, its chief benefits can never be achieved.

Mr. Marvin is certain that much has already been accomplished towards this end. The first steps were taken in the building-up of the ancient empires in the rude religious infancy of the race. "For the task of building up a great society round one centre of government, the scientific intellect is of itself unsuited; it is a probe before it is a link." But the beginnings once safely made, science became in modern times—need it be said?—"link" as well as "probe." This in fact is Mr. Marvin's fundamental claim, which he never wearies of repeating. "The earlier developments of applied science. . . . tended on the whole in a very marked degree to the unification of the world. Steamships, steel rails, and telegraph wires were the chief agents, and later improvements, the turbine engine, the internal-combustion engine worked by oil, wireless telegraphy, are all developments tending in the same direction. The inhabited world thus moves on clearly to a common goal just as the members of the solar system are all one in their concerted movements round the one source of light and heat and motion." Mr. Marvin goes on to say that this alone is a stupendous fact, full of lessons for us. It may both inspire and guide us. In these achievements "man has found himself as the continuous creator. His thought, growing from age to age, has linked itself in the work with his active and inventive powers, and gone on adding strength to strength. It is the application of his knowledge which proves to him both its foundation in reality and his own capacity for using these realities for his own ends. From this comes confidence and a vista of fresh conquests awaiting him in the future. The guidance comes from reflecting on the conditions which have made this progress possible. The thought lying at its basis is a collective thing, not limited by any national boundaries, but spreading freely wherever it finds congenial elements, just as a Frenchman, an Englishman, and a German co-operated to establish the law of the conservation of energy. The fact that such co-operation is often unconscious is the strongest evidence of the inherent likeness in the working of all human minds and of the common process which unfolds itself continually throughout the world. Unconscious and obscure as the first workings of this thought may be, when once announced and applied to the world of facts it proceeds to create an organization of life as complete and unbreakable as the links which bind the thoughts themselves together. This is the patent and most significant result of the triumph of applied science in the last century, as true and striking as the

social nature of the science itself, Society has become, in all those countries where industry has been organized and developed by science, a far more united and stable thing than it was before, or than it is in other regions less advanced in this respect."

This and preceding quotations exhibit Mr. Marvin's reasons for asserting that science is our greatest agent, and a demonstrably efficacious agent, for unifying mankind. Yet he may be quoted further upon so important an assertion: "This growth of science," he says, "is by no means the whole of civilization, but it holds a commanding position in it, and several features in the scientific evolution seem identical with the conquering social spirit itself. Like language, the method of exact science has a double aspect, the external facts which it brings together and arranges, and the human minds of which it correlates and expresses the thought. Now on each side of this double process the unifying action of scientific thought is its most striking feature. On the objective side it carries the generalizing process of language much further and applies it exactly. Where language gives the same name to like things, science, seeing deeper, can give it to the superficially unlike, and express by the same equation the fall of the stone and the revolution of the planet. . . . It is the logical essence of the process, though we are here rather concerned with the social aspect of the fact. Just as the method consists objectively in collecting resemblances from the complex of phenomena and expressing them in the simplest exact general statements or laws, so, on the side of the human minds perceiving the resemblances and formulating the statement, there is a corresponding process of comparison and unification. The differential equation, though Leibnitz suggested its precise form, sums up the consensus of innumerable minds, the earliest savages who noticed the likenesses of things around them, the first measurers who agreed to lay out their fields and decorate their buildings on a common scale, the Greeks who formulated the similarities of figures in the first equations, the Arabs who improved the notation, the thinkers of the seventeenth century whose genius, co-operating, through many minds, carried the idea of a common law into the recesses of space, and expressed it so concisely that it has become the universal and permanent intellectual currency of mankind." Thus "scientific method" is "firmly established as the natural and fundamental link of progressive human society." And, further, both the history and the use of science "proclaim the necessity unity of human effort.

For science arose from the simplest facts of common experience, and grew by the co-operation of the mass of men with human intellect at its highest. And when developed it returns again to widen and strengthen the common intelligence and increase the common good. Above all, more perfectly than any other form of thought, it embodies the union of past and present in a conscious and active force."

Thus we see that exact science exerts its unifying influence in several directions. It unites diverse appearances in the world of phenomena, knitting up lightning and magnetism, falling stones and the revolving earth, plant and animal and man, past and present, into one coherent whole. Likewise through the steamship, the railroad, the aeroplane, the telegraph, the telephone, it makes our world more compact, throwing all men closely together, making them rub elbows, as we say, so that it is no longer possible for us to escape our fellows if we would, but as never before, necessary for us to accommodate ourselves to each other, suppressing our peculiarities or "unsocial" qualities in the process. Further, science unites men's minds; it "is man's true universal language;" and in its theoretic aspect it is both international and co-operative in character in the greatest degree, while in its applications in industry it again brings home to every worker the fundamental importance of co-operation in human effort for the common good, and exhibits to him the complete dependence of each human being upon all others. This last point perhaps deserves further support from Mr. Marvin, who says that "just as the humblest worker in a great observatory may feel some glow in the revelations of the telescope above him, or the fitter on the railway bridge reflect that his work is vital to the lives of thousands and the welfare of a continent, so we may believe that all organized industry is capable of inspiring this feeling and giving the worker this foothold in a universal scheme."