

none too common. We smile, for example, at the folly of the sailor whose fears may be drowned in a pot of beer and who commits his fate to a rusty horseshoe nailed over the entrance to his forecastle. And yet, our 'city fathers' permit epidemics of typhoid fever to prevail with startling frequency and with frightful mortality. Think, too, for a moment of the shocking waste of health and wealth to which the alluring advertisements of quacks and other charlatans bear testimony in the daily and weekly press. Think also of the waste of time and money which comes from the habit of gambling so common in all races from the lowest to the highest. All such vices are deeply rooted in the human family and fortified by our superstitious tendencies to accept without proof anything which promises the marvelous. No mere literary training can help much to overcome this deplorable inheritance. Nothing short of the scientific frame of mind and habits of thought can prevail against such ancestral traits.

There is endless scope, therefore, for additional improvements and advances along the lines your training in science has fitted you to follow. Science bids you look forward, then, with confident optimism. But you should waste no time in idle contemplation of the splendid achievements already attained. The price of progress, like that of liberty, is eternal vigilance. One must be ever active, ever patiently persistent, proving all things and holding fast to that which is good.

R. S. WOODWARD.

*THE RELATION OF SCIENCE TO COMMON LIFE.**

I HAVE been honored by being selected to speak to you on the present occasion.

* Sigma Xi Society address, June 18, 1903, before the chapter of the University of Pennsylvania.

The high ideals of this society demand that I should attempt to leave my restricted field of study for a time, and that I should speak of those broader questions that agitate general scientific thought—that I should drop the rôle of the botanist, and assume that of the scientist and the man.

My theme is 'The Relation of Science to Common Life,' the life of the mass of individuals, of the nation, if you will. A very unacademic subject, you will say, as measured by the older standards. I chose it on that account. In not a few university centers, the time has not long gone when such a subject would have been curtly dismissed with the remark, 'We have nothing to do with common life; we follow our own high educational aims.' Too often the universities have stood aside in cold and unsympathetic isolation—shall I not also say in helpless disfavor—while the busy thinking world outside has carried forward the beacon lights of truth and progress. Listen to Whewell when, as Master of Trinity College (Cambridge), he went up to London fifty years ago to deliver his notable address before the Royal Institution. Speaking on 'The Influence of the History of Science upon Intellectual Education,' he said: "I venture to address you, relying upon an indulgence which I have more than once experienced. Of such indulgence I strongly feel the need, on various accounts, but especially that, being so unfrequently in this metropolis, I do not know what trains of thought are passing in the minds of the greater part of my audience who live in the midst of a stimulation produced by the lively interchange of opinion and discussion on the prominent questions of the day." Uttered soon after the exhibition of 1851, and when the scientific world was entering on new conquests, such an apology may seem unaccountable. Happily, our university presidents of to-

day are more in touch with the throbbing, vibrating life of humanity, even though they may not claim the profundity of thought that lived in the master of 'Trinity.'

If there be one characteristic more than another of our age and day, it is the steady welding and cooperative development proceeding among the leading races of the world. Nowhere is this seen on so phenomenal a scale as in our country, where, with the Anglo-Celt, Jew and Greek, Frank and German, Italian and Norseman together ply the arts of peace. And why such a commingling of human lives? The answer may be given, and so far well, that here liberty is assured to all, that equal rights and equal opportunities come to all. Back of this, however, is the basic fact that in this country scientific progress has been comparatively unhampered by costly patent laws, by hereditary vested rights, by lands being held in the hands of a few. But perhaps above all, and permeating all, though often silently working, there exists a keen and rapid method of inductive reasoning that carries forward the individual and the community on progressive and yet safe lines. It is this method, applied to all branches of science with increasing exactness, as human freedom increasingly asserted itself during the bygone century, which has culminated in the marvelous scientific position occupied by the country to-day.

Our Sigma Xi Society, as a university organization, stands for 'the nobility of science.' What then is its relation to the university on the one hand, and to the common life of mankind on the other? In reply, let me quickly review the growth of universities during the past millennium. With Lacroix we may regard the University of Paris as the first great effort made by Abelard and his successors to dispel the

shades of the dark ages. Here in the four nations met scholars of every language, creed and degree of poverty or wealth. A thirst for learning was their common bond. Later the Universities of Bologna, Padua and Oxford widened and deepened the channel of democratic learning, that spread out and vivified Europe. It is noteworthy that amid all the machinations of emperors, kings, popes and knights the fearless champions of freedom of thought, and so of freedom of the individual, from the tenth to the fourteenth century, issued from the universities, and were often more powerful, and more feared by autocratic rulers, than armed hosts.

But the appearance in succession of Galileo, Francis Bacon, Descartes and Newton, with many lesser lights clustered round, gave rise to that comparatively recent university renaissance which is spreading to widest proportions in our own land and time. We owe it *almost wholly* to the close pursuit of accurate inductive, scientific methods, which have yielded deductions of profoundest value. By slow degrees, through observation and experiment, fact has been cumulated on fact, till these have, in their combined perfection, permitted some great hypothesis to be advanced, or some great law to be deduced, that has grouped all lesser laws in crystal-like symmetry.

But only after the biological inductions and deductions of Lamarck, Spencer, Wallace and Darwin were we in position to apply scientific methods to living things, to man himself. One fundamental keynote of their teachings is that 'Use vindicates and prolongs existence.' The cry is still raised, though from a scattered remnant that is fast being left in the rear of educational progress, that utilitarianism is disastrous to university education and to highest scholarship. This remnant desires

to retain the exclusive spirit and sectarian bigotry that characterized some universities, which had started well but unfortunately were 'captured' for a time by a privileged and unrepresentative few, from the sixteenth to the nineteenth century. John Bright dubbed one of these institutions with cutting but deserved sarcasm as 'the home of dead languages and of undying prejudices.'

Science knows no such distinctions, and refuses to recognize them. She writes deeply on the warp and woof of human and of all organic existence the law that *utility conserves, strengthens and continues life, that disuse weeds out and destroys*. I glory then in the utilitarian, which in the recently gone century has stirred our common human life to titanic action in every field, has revived and advanced true education, has sown broadcast colleges and universities, and has sent forth from these enthusiastic disciples aglow with the spirit of research and of experiment. This young century, then, before its death, will witness mighty scientific achievement, compared with which all that has been unfolded will be only the prelude.

But here let us linger over the terms use, utility, utilitarianism. It is easy to distort and misconstrue their precise scientific significance. When one looks with the botanical eye at those large, bright-blue marginal florets of the corn-flower, and discovers in them neither stamens nor carpels for fruit production, one is apt to exclaim hastily: 'They are useless, they have no claim to existence.' But patience tells us to watch, to observe and to learn how these attract passing insect visitors to the small inconspicuous central florets, which by aid of the attracted visitors set abundant fruits. The marginal florets seem at first gaudy superfluities, but though they have only one use in life, like the

leader of men who had once blacked shoes, they can all claim: 'Didn't I do it well?' Every scientific fact is *useful*, but may not necessarily be *used*. As Darwin patiently dissected cirripeds, studied and described the structure of orchid blooms, observed the slow revolutions of twining plants, counted the number of seeds that different plants might produce, a financial speculator escaped from the unhallowed bedlam of the stock exchange, and looking in on the sage in his quiet country home at the week's end to cool his nerves, might have declared it all a waste of time and labor. We know that Darwin was laying the foundations of those principles that have revolutionized all thought, and that he was paving the way for the economic death of this speculating friend, who biologically is a human parasite.

What relation then has science, and should it have, to our universities on the one hand, and to common life—to the mass of free, earnest thinking people, on the other? In attempting to answer we must constantly keep in view tradition and history—our relation to our ancestors, real or imaginary. We all, like the Chinese, worship these ancestors—at least in their relations—and they worship them most powerfully who are furthest removed from the land that gave them birth. So it is that we fear to break with the past, and inherit incongruous combinations. Says Whewell in the lecture already referred to: "You will not be surprised to be told that our modern education has derived something from the ancient Greek education, because you know that our modern science has derived much from the ancient Greek science. You know that our science—in the ordinary sense of the term—has derived little from the ancient Romans. * * * But if we take the term science in a somewhat 'wide' acceptance, we shall derive from the Roman history

not a negative but a positive exemplification of our proposition. For in that wider sense there is a science of which Rome was the mother, as Greece was of geometry and mathematics. The term science may be extended so widely as to allow us to speak of the science of law—meaning the doctrine of rights and obligations, in its most definite and yet most comprehensive form; in short the science of jurisprudence. * * * And thus two of the great elements of a thorough intellectual culture—mathematics and jurisprudence—are an inheritance which we derive from ages long gone by; from the two great nations of antiquity.”

So far Whewell, who in attempting to elevate Roman law to the dignity of a science forgot that much of it was unscientific to the last degree, and tended to produce, not organic national equilibrium, but to set the patricians against the plebeians, and both against the bondmen, who often showed finer qualities than either. Little wonder is it that Rome fell, unsaved by her laws.

Let us see whether a different viewpoint and source of origin for the science of law and equally for all scientific relations might not be obtained. Huxley thus puts it: “It is a very plain and elementary truth that the life, the fortune and the happiness of every one of us and, more or less, of those who are connected with us, do depend upon our knowing something of the rules of a game infinitely more difficult and complicated than chess. It is a game which has been played for untold ages, every man and woman of us being one of the two players in a game of his or her own. The chess board is the world, the pieces are the phenomena of the universe, the rules of the game are what we call the laws of nature. * * * Education is learning the rules of this mighty game. In other words educa-

tion is the instruction of the intellect in the laws of nature, under which name I include not merely things and their forces, but men and their ways; and the fashioning of the affections and of the will into an earnest and loving desire to move in harmony with those laws. * * * The object of what we commonly call *education*—that education in which man intervenes and which I shall distinguish as artificial education—is to make good defects in nature’s methods, to prepare the child to receive nature’s education. * * * In short all artificial education ought to be an anticipation of natural education. And a liberal education is an artificial education which has not only prepared a man to escape the great evils of disobedience to natural laws, but has trained him to appreciate and to seize upon the rewards which nature scatters with as free a hand as her penalties.” To pursue Huxley’s reasoning to its ultimate limit, advanced teaching of all the laws of nature is the highest function of the university in relation to our common life. In other words to make each man who leaves its portals most highly qualified for useful, intellectual, manly life. But, as I hope to show later, this qualification is to enable him to use wisely—not meanly—the forces around him, so as to build society into an organism.

Therefore, every upright pursuit in life which man enters on should have the highest principles and practice governing it represented and taught in our universities, by the best men in the most perfectly equipped manner. This may be an ideal at present. Granted, it is nevertheless one toward which, I am persuaded, every university must move. In this manner science will confer the dignity that is deserved on the physician’s scalpel, the bricklayer’s trowel, the chemist’s test-tube, the engineer’s lathe, the biologist’s microscope, the

agriculturist's spade or ploughshare. When he saw the spirit of destruction honored and that of construction lightly esteemed, Carlyle rightly growled out as follows in his immortal 'Sartor Resartus': "The Hinterschlag professors knew syntax enough, and of the human soul this much: that it has a faculty called memory, and could be acted on through the muscular integuments by appliance of birch rods. Alas! so it is everywhere, so will it ever be, till an *architect* is hired, and on all hands fitly encouraged; till communities and individuals discover, not without surprise, that fashioning the souls of a generation by knowledge can rank on a level with blowing their bodies to pieces by gunpowder; that with generals and field-m Marshals for killing, there should be world-honored dignitaries, and, were it possible, true God-ordained priests, for teaching. But as yet, though the soldier wears openly and even parades his butchering tool, nowhere, far as I have travelled, did the schoolmaster make show of his instructing tool; nay, were he to walk abroad with birch girt on thigh, as if he therefrom expected honor, would there not, among the idler class, perhaps a certain levity be excited?" Happily the twentieth century gives promise of emancipation alike from the marshal's sword and the dominie's rod. It is for us to struggle toward securing that honored recognition for every branch of knowledge which Carlyle dimly presaged.

It has often been urged that the intrusion of so-called technical science into our universities will break up all cherished university ideals and dissipate the poetic side of life. Both objections are equally erroneous. Even in acquiring the most technical detail of science, the student can still exclaim with Kepler, in all humility and dignity: 'O God, I think thy thoughts after Thee.'

And as to real poetry and romance, science is just beginning to unfold such. You will forgive me, as a botanist, while I tell you of the wonder and pleasure our students expressed about a month ago, when carried past Jersey fields of scarlet clover in full bloom. This plant had converted former sandy wastes into a floral paradise. But more, our workers had learned the reason for its presence in such quantity, and could picture to themselves the originally scant, but now rapidly multiplying, myriads of 'nitromonas' bacteria that were absorbing and fixing loose atmospheric nitrogenous compounds. They knew that these handed on much of this to the *Rhizobium* organism of the soil or of the clover tubercles, and that finally the fixed assimilated nitrates were utilized by the clover for its sustenance. Truly a romance verified.

Let me try to pick up another with you from the gutter, and illuminate it with the rays of latter-day discovery. Philadelphia every year pours into her rivers millions of tons of sewage. As you are aware, this is rich in all the chemical products needed for plant life, but, like every valuable thing, it must be handled carefully. We have hitherto called it waste, and have puzzled our brains how to get rid of it. One of our railroad companies has found it profitable to build a large viaduct over the Delaware to carry our citizens quickly to the New Jersey coast. No one has yet been enterprising enough to build an equally large aqueduct into which our sewage might be pumped, and ultimately distributed over the thirsty but capable sands of New Jersey, which would blossom into life were such given. To apply the statistics now to hand, 4,000 acres of New Jersey land within ten miles of Philadelphia could then be made to produce the fruits and roots that Phila-

delphians consume, while much of the sewage water might again be collected, and returned to us as hygienic water which might well replace that of the unregenerate Schuylkill. The correctness of every detail of this Berlin has already demonstrated in her broad irrigation system.

In the accomplishment of such truly romantic results the schoolman and the layman, the university teacher and the shop worker, have equally had to do. Already it is recognized that to prepare, cut, stain and microscopically examine a paraffin section, or to separate out the constituents of a chemical mixture, are both liberal educations in which the skilled hand, eye, nose and ear all cooperate with their complex and correlated central manifestation that we call *mind*. Measured by such methods knowledge is not the mental quantity and quality supplied by this or that university, but is the earnest effort of man to enlighten and guide himself and his fellow man.

As brethren of the Sigma Xi then it becomes us to agitate constantly for the restoration of the grand ideals set by Paris and Bologna universities of the tenth to the fourteenth century. There learning was imparted to all who loved it, there nationality, or name, or condition formed no bar to the owner—whose gown at times served to cover his rags, and there the scholars of their day—courted by emperor and entertained by the nobles—were the teachers of these famous old centers. Above all we should so school ourselves as to be ready to slough off during each unfolding year—with its new possibilities for progress—the skin of prejudice or preference that may have hardened round us in the preceding period. The biological teaching of Huxley in '55 was very different from that of '75, and this again from that of '90. In university life the caution is constantly

needed. A recent magazine number chronicled the people's vote of three large cities, in favor of municipal ownership of distributive agencies, and somewhat pungently added: 'While the academicians are discussing the theory of municipal ownership the people, in these cities at least, are getting into the habit of voting for it.' Periodic intellectual molting conduces often to sound mental life.

It is a property of most scientific questions that they project themselves into the future. Whether we accept the teachings of Kidd's suggestive couple of volumes or no, his prophetic outlook into the future is inspiring, and despite destructive criticisms his principle of 'projected efficiency' is one that every true scientist tacitly believes in and works up to. We all think of leaving the world better for our descendants—be they fleshly or mental children—and the man who asked in selfish unconcern, 'What has posterity done for me?' deserved no children, and equally deserved that his good deeds should be buried with him. Like that of Paul, our life should be a consecrated unrest. We have not yet attained, neither are we already perfect.

While it will gladly be conceded that few if any countries foster scientific advance more than America, it will as readily be conceded that this has been mainly on the applied side, and that much remains for accomplishment in non-remunerative educational equipment. Here I place in front rank the need for spacious and splendidly furnished museums for all the sciences. Those of us who have walked, time and again, through the mechanical, the chemical, the zoological, the mineralogical and other sections of the South Kensington Museum, or corresponding ones of the continent—not to speak of many local museums of lesser

repute—know that we have nothing to compare with them. Suppose we make observation for a time in the mechanical section, where accurate models may be even seen at work. There the schoolboy lingers inquiringly before them, and he thus forms great conceptions of man's inventive relation to the world forces around him. The factory worker learns how his machines have grown, have been evolved, and how he may possibly perfect them further. For the college and university teacher these collections furnish comparative and concrete illustrations by which a lasting picture is fixed in the mind. Such institutions are costly to erect, to furnish, to man, and to support annually. Their high educational worth must be gauged not by the fruits of years, but of decades and centuries, for the mental stimulus they afford is often hidden away and silent. The question of cost should be a minor consideration in planning such undertakings, amid the corporate and individual wealth that characterizes such centers as our own. Civic pride and loyalty, national pride and loyalty, pride in and loyalty to our highest human development should be sufficient impelling force. Here let me say, with all caution and reserve, but yet with perfect conviction of purpose, that when we read or learn of lavish individual expenditures, for individual gratification alone, it should arouse in every one of us the desire to so mold public opinion that such superfluous ostentations shall cease. If the owner of the wealth thus diverted can be shown that his wealth can most patriotically be expended in building up the country's institutions, then we have successfully done battle for the right. If history has lessons for us, does it not remind us that at one phase of Rome's history the poet could truthfully say,

“For Romans in Rome's quarrel, spared neither
land nor gold,
Nor son nor wife, nor limb nor life, in the brave
days of old,”

and that a later time came when Rome's matrons had few if any robust sons to fight, when the patricians had largely squandered their patrimony in sensual indulgence, when—with decayed institutions—none were ‘so poor as to do her reverence.’

Let me suggest another need or couple of needs, easy of fulfilment, and which it behooves us as members of the Sigma Xi to supply. I refer to a graduate and undergraduate society or branch of this one, for general scientific improvement and information. We as graduates and teachers are, or unfortunately in some respects must be, specialists living and working along narrow grooves. A vigorously and comprehensively planned meeting, held once a month, would refresh and expand us all. Picture to yourselves a meeting such as we might have had during the past few weeks with an intellectual bill of fare such as the following: ‘The Separation and Properties of Radium,’ ‘The Biology of Laziness,’ ‘The Dotter in Naval Practice,’ ‘The Organism of Smallpox,’ ‘The Physical Principles involved in the Formation of Mountains’ and ‘Luminous Bacteria as a New Illuminant.’ To finish these in a night would afford a meal worthy of mental digestion for a month. Such meetings would also promote that *esprit de corps*, that common effort, that contagious enthusiasm, that self-sacrificing spirit, which when combined ensure an institution's progress.

Equally would I urge the need for undergraduate organization, though largely for other reasons. Our developing scientists and aspirants to the honors of Sigma Xi should have fullest opportunity for debate, discussion and presentation of views. A

freshness and savor would be imparted to class work that those of us who are teachers desire; it would early promote the spirit of research, and would quicken each speaker to excellence in literary style and oratorical effort. Too little attention is often given to form, and too much to substance, in scientific presentations.

A few sentences back a note of warning was sounded against the dangers of specialization. I trust that every one directly or indirectly connected with our institutions realizes its dangers. Though Darwin pathetically confessed as to its effects, no one has put it more forcefully than Stuart Mill, who says: "The increasing specialization of all employments; the division of mankind into innumerable small fractions, each engrossed by an extremely minute fragment of the business of society, is not without inconveniences, as well moral as intellectual, which if they could not be remedied, would be a serious abatement from the benefits of advanced civilization. The interests of the whole—the bearings of things on the ends of the social union—are less and less present to the minds of men who have so contracted a sphere of activity. * * * This lowering effect of the extreme division of labor tells most of all on those who are set up as the lights and teachers of the rest. A man's mind is as fatally narrowed, and his feelings towards the great ends of humanity as miserably stunted, by giving all his thoughts to the classification of a few insects, or the resolution of a few equations, as to sharpening the points or putting on the heads of pins. The 'dispersive specialty' of the present race of scientific men, who, unlike their predecessors, have a positive aversion to enlarged views, and seldom either know or care for any of the interests of mankind beyond the narrow limits of their pursuits, is dwelt on by M. Comte as one of

the great and growing evils of the time, and the one which most retards moral and intellectual regeneration. * * * He demands a moral and intellectual authority charged with the duty of guiding men's opinions and enlightening and warning their consciences; a spiritual power whose judgments on all matters of high moment should deserve and receive the same universal respect and deference which is paid to the united judgment of astronomers in matters astronomical." We must acknowledge, to a large degree, the sanity of Mill's position, but if we all cease specializing one day in the seven at least, the spiritual power desiderated will have opportunity to dwell in our midst. The Jewish Sabbath is by no means the worn-out institution that some would have us believe.

Another rock ahead in the channel of progress demands most careful consideration and steady action. Our present-day political and economic systems often foster methods by which science and scientific discovery are degraded or robbed of their true value, while the scientific worker is often defrauded of that reward that should come from sturdy effort of mind and hand. It has truly been said that 'crafty men condemn studies, simple men admire them, wise men use them.' The founding by Besant of what might be called 'the authors' mutual protection society' marked an epoch in the history of English literature. No such organization has yet been evolved to foster and protect scientific discovery. The attempt has been made in some scientific circles to divorce the discoverer from the fruits of his labors, under the specious plea that it is unprofessional to be associated with these in trade relations. Yet were he allowed or enabled to guide their progress, he would often place them before mankind on a more generous footing than when they are left to be ex-

plotted by some crafty unscientific dealer. But to put the whole question on a much higher plane than that of mere financial well-being, I venture to say that since science stands for accuracy, probity, clear statement of fact, unveiling of error of every kind—whether intentional or unintentional—it can have no sympathy with the deceit and chicanery that are so rampant around us, and that threaten at times even to swamp the high ideals of our universities. Toward the close of his valuable work on 'The Rise of the Swiss Republic,' McCracken says: "It has become somewhat of a commonplace assertion that politics in the United States have reached the lowest stage to which they may safely go. There seems to be no longer any necessity to prove this proposition, for the general conviction has gone abroad, amply justified by the whole course of history, that no democracy can hope to withstand the corrupting influences now at work in our midst, unless certain radical reforms are carried to a successful conclusion. Our calm American complacency seems, at length, to have received a shock; our habitual optimism to have given place to a feeling of apprehension, lest the malignant forces now uppermost in our national life may not, after all, prove too strong for us; and a corresponding desire is being manifested to set in motion other benign forces which shall save the state from destruction while there is yet time.

Unfortunately all attempts to probe the fundamental first causes of our corruption are checked at the outset by the difficulty of bringing the popular will to bear upon public questions. Our whole administrative system, and all the methods by which the people are supposed to make known their desires, are perverted and diseased, so that the sovereign body are prevented by mere tricksters from exerting their legit-

imate control over the making of the laws which are to govern them. We are suffering not only from deep-seated economic and social diseases, of which perhaps the most alarming symptom is the concentration of wealth into the hands of a few, but from the rule of the boss, and from the lamentable fact that the people at large are divorced from legislation. As a matter of fact nothing stands between us and the tyranny of municipal, state and federal bosses, as unscrupulous as any feudal lordlings in the thirteenth century, except public opinion, imperfectly expressed by the press."

Later he says: 'As for the introduction of the referendum and the initiative into the United States, there are, in reality, no insurmountable obstacles to bar the way.' And again: "Those who have no faith in the principles which underlie all genuine democracies, in the equality and brotherhood of man, and in his natural rights; who fear the people as an unreasoning beast which must be controlled; and therefore look to reform by means of artificial laws, rather than by those of nature—such men will naturally dread anything which savors of direct government, and will of course find the referendum and the initiative a stumbling block and a bugbear. But the increasing number of those who place their utmost confidence in the common sense of the people as a whole 'will welcome both as the most important contributions to the art of self government, which this century has yet seen.' " I have thus quoted at length on a subject that may not seem to be germane to our meeting, but which on a little reflection we can all see should *most* concern us. Assuredly all who desire their country's good will acknowledge that the writer speaks forth words of scientific truth and soberness.

The exposure of such existing evils,

here and now, brings us face to face with a biological principle to which we must all bow in attempted improvements or advancement, that of changed environmental relations and resulting modification therefrom. It can fairly be claimed that science has bettered and is bettering the environment of the workers, while it is uniting mankind in ever-widening bonds of unity and cooperation. Holyoake has well said: 'Cooperation is commercial peace, competition is commercial war.' The railroads that make possible scientific congresses, the steamships that link the scientists of continents in annual or triennial reunion, the telephones that almost annihilate phonic space, the food canning that makes life agreeable in every clime are a few of the many environmental products of the past century, that link man to man by chains of amity and peace, and that promote his international well-being.

Are the laws of science then, as we ordinarily understand these, to be our sole guide and rule in life? This inquiry causes me to recur to Huxley's picture of life already quoted. Are all the moves on the human chess board to be dictated only by thoughts of self-interest and self-preservation, or even by thoughts on behalf of our friends and offspring, as Huxley, in his later days, attempted to prove. Some of the 'moves' operated repeatedly in the world's past have given us as an environmental human outcome, products that we call 'strong lives,' 'strenuous lives,' 'unscrupulous lives,' 'useful lives,' 'instructive lives.' But the greatest type, and the one that we almost unconsciously worship is 'the beautiful life.'

Every organism from amoeba to man lives by a process that we may call 'organic molecular equilibrium.' When the supplies of life energy and food integration exceed the dissipations and disintegration, growth and

development proceed. When both are balanced maturity has been attained. When the converse to the first holds true; decay sets in. Applying this fundamental principle to our common human life, the highest human scientific aspiration might be expressed in the aphorism 'society an organism.' Such a condition society is far from having attained to. But like all organic bodies, if it is rightly to perform its functions, and to perpetuate its like, such it should become. At present, even in its highest expression, it consists of human molecules that often exhibit abundant energy, that undergo permutations and combinations, that show affinities and repulsions, but that lack some form of energy necessary to link them into an organic whole, to give them social equilibrium and stability. Society has been struggling through millennia to become an organism, has been searching for that energy and that source of energy that will give it life equilibrium. At times and in places the result seemed to have been achieved, only again to be impaired, or lost amid a chaos of discords, by the disrupting agency of one or of a few unscrupulous souls, who have acted like a disorganizing ferment on the organizing mass.

Though unfashionable with many to-day, and not least with the followers of science, the only motive form of human energy that has stood the test, and that is stronger to-day than ever before, is the power, the force of love, of compassion, of sympathy, as communicated by the greatest social lawgiver the world has seen. The early founders of Christianity were charged with it, and for three centuries they shook and finally subdued the Roman empire. We have it in our midst and it lives through all the upheavals consequent on human competition, on commercial war. In our hospitals, in our college settlements, in our

church and public beneficences, in our increased regard for human life, we feel the effects of this energy, though we see it not. The social settlements of Owen and others were truly preliminary nineteenth century scientific experiments to test the strength of the law of love, and the amount of this energy needed to vivify and unify the social organism. Like thousands of scientific experiments before and since they partially failed, but their failures and successes have been recorded, so that succeeding experimenters might carry the inquiry to a successful issue.

The fetish of unbridled commercial competition which has too long lorded over us, is in many ways inimical to our highest interests. It can be a helpful servant if kept in subjection, it becomes a harsh tyrant if worshipped as a god. It can not retain *supremacy* alongside the gospel of peace and love. If so, the latter suffers or becomes effaced, and mankind becomes the loser.

If back of all our failures and achievements, our hopes and our disappointments, some great and desirable human goal is not to be attained, then in spite of the genuine pleasure that comes from discovery of new knowledge, man may well turn from his labors exclaiming, 'Vanity of vanities, all is vanity.' But I thank God that beautiful lives have lived and still live, and that imperfect though I may be, energy—inspiration, if you care so to call it—can be got by drawing supplies of like energy as theirs from the great fountain head that has energized them. The science of life, and the religion of life *may* dwell apart, but who knows whether, when our profound ignorance has been dispelled, it may not appear that both are linked together, and are governed by similar great laws that we are asked by observation and experiment to verify and to accept.

Illimitable fields of research still remain for us to enter; the masses of our fellows are eager to learn what fruits we gather and bring back. We can only afford then to be optimists, and to exclaim with Mackay:

Blessings on Science! When the earth seemed old,
When Faith grew doting, and our reason cold,
'Twas she discovered that the world was young,
And taught a language to its lisping tongue.

J. M. MACFARLANE.

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SCIENTIFIC BOOKS.

Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands and elsewhere collected during the Years 1895, 1896 and 1897. By ARTHUR WILLEY. Part VI. (August, 1902). Cambridge (Eng.) University Press. Pp. 691-830, pls. 75-83.

The sixth instalment of Willey's 'Zoological Results' is devoted entirely to an account of the natural history of the pearly nautilus and is by Dr. Willey himself. The account opens with a personal narrative in which he relates, in addition to the many observations bearing directly on the problem of securing the eggs of the pearly nautilus, numerous incidents and occurrences that he met with while sojourning among the inhabitants of the Eastern Archipelago. This is followed by a detailed account of the pearly nautilus itself.

Many interesting and important observations on the natural history of this animal are here recorded. The natural coloration is such that, though the animal is a conspicuous object when in the hand, it is quickly lost sight of when dropped into the sea, a condition which has led Willey to believe that its coloration is of a protective character. Sexual dimorphism in *Nautilus* has long been known and is easily recognized even in the dead shells. Willey has brought to light the remarkable fact that while in *Nautilus pompilius* the males outnumber the females (150 to 66), in *N. macromphalus* the reverse seems to be true (10 to 16). No important information was obtained as to the way in which the