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THE MESSAGE OF THE BIOLOGIST[1]

IT is eminently fitting that we biologists, like virile swarm spores, should periodically come together in a holiday spirit of mutual exchange, and after giving and receiving our messages, go back to our life work, reinvigorated and reoriented, to prepare for another brief period of social conjugation.

The messages we send to one another will have little carrying power, and little influence on the receiver, if they are not specific in content, limited in scope, and securely wrapped up in the precise technical terms of our own familiar code.

On the other hand, the biologist would be wholly lacking in social instincts if he failed to recognize that he also has a more comprehensive message for the layman, who is largely dependent on the biologist for his working knowledge of the great domain of nature-life, and by whom the biologist is provided with the necessary means of existence.

This larger message must have a different vehicle. It must first be summarized, digested and metabolized into the vernacular, before it can circulate through the body of social life, reach its terminals, and there accomplish its strengthening and rectifying purpose.

We may well ask ourselves whether we have such a message to give, and if so, what it is, and who, or what, is our authority. And by "we," I now mean all of us, not merely the biologist, but the astronomer, geologist, chemist, physicist and psychologist, for we are what we are to-day because of the underlying community of our methods and purposes, and because, in our concept of evolution, we acknowledge the same mental sovereignty.

This concept, of which we are the trustees,

[1] Address of the vice-president and chairman of Section F, Zoology, American Association for the Advancement of Science, St. Louis, January 31, 1919.

initiated in man a veritable intellectual mutation, which is now rapidly expressing itself in new phases of social action, and in the emergence, like the parts of a growing embryo, of new types of social architecture. It is our duty to interpret this concept, and to see to it that its real significance is understood, and rightly used in social growth.

The social metamorphosis which historians call the renaissance was largely due to organic improvements in the system of educational circulation and the transmission of mental possessions from man to man. Learning was democratized by translating the bible and the classics into the vernacular, and by this betterment in transmission across time and space, the profits of a dead past were made to flow more freely into a living future, making those profits in some measure the mental heritage of the common people, and their enduring germinal possessions for self-constructive purposes.

In this accelerated social growth, the base line for the orientation of human conduct, and for the measurement of right and wrong, good and evil, was the bible, the classics, and the divine right of civic and religious leadership. The power and stability of these external directive agencies was universally acknowledged, the source of their authority unquestioned, and like radiant beams, their trophic influence was formally expressed in the prevailing architectonics of social procedure.

We are now witnessing, incident to a new birth of social vision, a new social convulsion, much more significant than that of the middle ages, in which science, and especially biological science, unconsciously played, and is still playing, a very important part. For when we recognized a new source of authority in lawful nature-action and in evolution, the old base line for the measurements of human conduct vanished, and many of the old bonds of social allegiance were destroyed; and now we are asked: What shall be the new compulsion to constructive social action, and on what authority can we stay the march of anarchy?

And you, as biologists and American men of science, can not shirk the grave responsibilities of social leadership now thrust upon you, for it requires little gift of prophecy to forsee that America is destined quickly to become the world's chief center of biological learning, as she is to-day the center of the broadest sympathy with human life and nature.

Perhaps it may clarify our vision if we first ask, not what biology is, but what science, as a whole, does, and what she tries to do. It will little help us to enumerate all the sciences, or be told there is "pure" science and applied science; science experimental, and descriptive. Behind and beyond all these varied aspects of science there must be common motives, and common purposes in the scientists, if we are rightly to include them as intelligent beings in the same class.

Let us therefore precipitate and remove these adjective purities and impurities, and you will then agree with me, I believe, that there still remain in science several overlapping functions and purposes. First to explore and to chronicle. To that end, she aims to discover what things are contained in nature, where they are, what they do, what the order is, step by step, of their coming in, their growing up, their going out. And then to memorize, to conserve her mental possessions, to register, in convenient and enduring symbols the result of her explorations, for future usage. Second, to compare and explain. To that end, she aims to discover why things are as they are, in what respects they differ, in what they agree, how one thing influences another, constructively, or destructively, and to distinguish the right ways of doing things from wrong ways. Her third function is to do things rightly. In that respect, she is artistic, architectural. To that end, by conforming her ways of doing things to nature's ways, she aims to create, and to conserve, and to use her records and her knowledge of right and wrong profitably.

Thus three qualifying motives pervade science: the acquisitive, the ethical and the moral. She seeks knowledge through experience, wisdom through understanding, and profit through obedience. One purpose is self-constructive, or egotistic, the other, self-

giving, or altruistic. Both are cooperative functions; in action, continuous; in rightness, cumulative; in effect, creative.

The renaissance of to-day has its chief creative impulse in the consciousness of evolution. This revelation of modern science, which we all acknowledge as our guiding star, has come to mean world-growth, or the progressive organization and architectural upbuilding of nature. Nature is now the source of our authority, and creative nature-action, as expressed in nature-growth, is the standard of all our values. Science is therefore compelled to express all her measurements in positive and negative constructive terms, which ultimately must be oriented in reference to this gradient base line of nature-progress, called evolution.

In this nature-growth, we fail to discover any gain or loss, either in basic constructive matter, or in energy. But gain there must be, if evolution is a reality. That gain is, in reality, a moral and ethical gain, or a gain in that creative action and constructive rightness which we call organization and directive discipline. There are no better positive and negative terms to express those gains, both relatively and absolutely, than the familiar terms, right and wrong, good and evil.

On this point, therefore, there need be no equivocation in our message. The profit in evolution is in better constructive action. By the conservation of these profits, nature augments her capital in constructive rightness.

But how is this profit made and conserved? That is the really vital question. Until it is answered there can be no underlying intellectual stability in human life, individually, or socially; no basic unity of purpose in human conduct. Here our vision is not so clear. Many of us believe that on this point we have no comprehensive message to give.

The most familiar attempts to explain how evolution takes place are restricted to special aspects of evolution, and are often epitomized in personal names, such as Darwinism, Lamarkism, Weismannism, Mendelism. Among us there are naturalists, morphologists, physiologists, and psychologists; breeders, experimentalists, and bio-chemists. And surrounding us on all sides are the physicists, chemists, geologists, and astronomers, with whom we must reckon, for their domains and their subject matter overlap ours in countless ways.

But unfortunately between all these workers there is little common understanding and much petty criticism.

Are we building out of aimless contributions to science a new Babel's tower of disjointed, slippery words, with nothing to hold them to constructive lines, and preserve the unity of purpose in our social architecture?

Perhaps the most comprehensive terms, although they have little meaning outside the organic world, are "natural selection," the "struggle for existence," and the "survival of the fittest." But granting their validity within the organic world, they have no definite moral significance. They convey no implication as to how man, or anything else, must act in order to exist, to say nothing of surviving. What is the fittest? Why is it fit? Why does it survive? If right combinations happen primarily by chance, why, or how, do they come to happen regularly? How can "right accidents" become cumulative, or lawful, or determinate, unless there is a saving, or more enduring, directive element in that something we call rightness?

When the layman makes his holiday call on his biological menagerie and points his umbrella at us, hoping to receive through that safety-first device a brush discharge of information, we fail to "come across" with illuminating answers to these very pertinent questions. But to conceal our low potential, and preserve our self-respect, we all resort to certain unintelligible sounds, or warning signals, according to the particular pen in which we have been bred and exercised, and which are guaranteed to scare away, or charm into inaction, the most intrepid questioner. One mumbles something about "environment" and "ecology," and crawls back into the bushes. Another wheezes something about "enzymes" and "vitality"' and goes on with his experimenting. Another climbs to the top of his

cage and yells "eugenics," while his mate in the corner faintly lisps "euthenics." Some particularly active youngsters jump into a revolving wheel, and every time it makes a complete revolution shout "chromosomes, chromosomes, chromosomes." A few old-moss-backs, a rare variety, mournfully harp on "morphology." And one majestic megatherium comprising all in one, coughs up an "energy complex," followed by a prolonged roar, in several volumes, in which one can distinguish the words "action, reaction, and interaction." The clergymen, senators, and Bolsheviki, with their retinues of lady friends, exclaim "How wonderful, and so true." Life indeed is complex, energetic, and full of actions, reactions, and interactions! And all of them deeply impressed, go back to their deadly work, and act, and believe, if at all, just as they did before.

After they are gone, all the animals agree that no one has any right to bother real, simon-pure scientists with such fool questions. Let them go to—well, Where? To Germany? To Nietsche, Bernhardi, and Treitsche? To the militant philosophy of dominion, to a half-witted selfishness, in politics, commerce, and kultur, frankly upbuilt on the doctrine of the survival of the fittest, the fittest universally acknowledged, by themselves, to be the Germans and their system?

Or to the spiritualists, anthropomorphists, and sentimentalists, who see nothing clearly in the mirror of nature but a distorted image of themselves?

Or to Huxley and his "I don't know" followers, who can discover no ethics or morality in nature-action; neither warning nor invitation, nor directive discipline, but merely a drab, unoriented neutrality of "unmorality," leaving man nothing but himself with which to orient himself; leaving him to create his own system of ethics and morality out of his own inner consciousness?

The biologist has found no evidence for the broad assumptions of these philosophers. In nature, he sees no one-sided dominion of the strong over the weak, or the weak over the strong; no special privileges; and no freedom from obligations. Neither does he see any warrant for puling sentimentality, nor any expectation of an unaggressive neutrality in nature-action.

Nature, so far as we have been able to discover, is an enduring, self-constructive system, gaining and preserving her gains, in a definite way, according to her own system of ethics and morality. In so far as nature-growth is manifest in evolution, we can not deny that at least to that extent her ethics are constructive and her morals saving.

Man's constructive and saving principles can not be otherwise, without severing all his bonds with nature-action in a futile attempt, like that suggested by Huxley, to set up an anarchistic "imperium in imperio," or a Bolshevistic "microcosm within the macrocosm."

I can not believe we have reached that parting of the ways, for man's highest activities are all too clearly but extensions of nature's ways and means of creating and preserving her products, in which man uses whatever intelligence he may have, and the cultural implements he has constructed, as special instruments to attain his ends.

The specific gravity of the western variety of biologists will not let him float in a vacuum of cosmic mysteries with the Hindoo; and he does not care to wallow in a quagmire of metaphysics with the Greek. He gladly plants his substantial mental feet on the first firm substratum he can reach. And even though that substratum be nothing more than the molecular quicksands of physics and chemistry, it safely leads him to the rising shores of hard realities.

But now that we biologists, as evolutionists, feel reasonably safe in our storm-proof shelters of established facts, the spirit of adventure again leads us forth to wider excursions, and we ask ourselves whether it is possible to reduce all the constructive processes of nature to a simple formula, which can be expressed in familiar terms of universal human significance? This is a venture doomed apparently beforehand to defeat, for it takes us back again to the most ancient beaches of human controversy, strewn with the wreckage of all man's early and late

attempts to launch a religion, or a philosophy, that will stand the test of experience.

And all these mournful wrecks are jealously guarded by marooned mariners of hope, and their beach-combing followers, who show no mercy to intruders. But modern science, which has wisely built on firmer, though drier ground, must ultimately extend the foundations of all of her out-housings down to the low water mark of this old shore, and while the attempt is fraught with danger, it will ever be an inspiring task for those engaged in the process of social reconstruction that now lies before us. I know of no other engineers whose occupation should better fit them for leadership in this task than the biologists, occupying, as they do, a central strategic position in relation to chemistry and physics, geology and astronomy, sociology and the humanities.

When to this end, we examine, as best we may, the attributes of these basic, chemical elements of nature's substance, we find in them, as in human social atoms, a potential constructive and creative power which becomes clearly manifest in the familiar processes of chemical action. In that process we are compelled to assume, if we are willing to assume anything, that some influence, or effect, we know not what, or how, is exercised by one element on another, the result of which may be the formation of a new unit, or compounded individuality, with a new style of architecture of its own. Coincident with this construction, the former attributes of the constituent parts vanish, and in the new unit a different attribute appears which was not there before.

We may profitably translate this constructive process into the vernacular, without, I trust, seriously offending the properties of the purest scientist, even though the words may savor of morality.

We may say, for example, that when the right chemical elements are in the right relations to one another, or if they are moved into them, or placed there or if these elements themselves find the right relations by chance, or otherwise, cooperative action between them then takes place automatically, or under a compulsion neither can resist, and something new is created. In this cooperative action, each element evidently does something, or gives something to the other, and receives something from the other. It is in fact apparently a clear case of creative action through mutual subjection and mutual service—not necessarily service for each other, because for all we know these elements may be the original anarchists and would much prefer neither to give anything to anybody, nor receive anything from anybody—but for the molecule so created.

In this creative process, the essential factors are, unity, mutual service, mutual discipline, and some sort of constructive rightness. When these conditions are fulfilled, something new is created, and these anarchistic elements then become, perforce, altruistic agents, or accessories, to some ulterior creative act, in which they may or may not be interested. In spite of themselves, by their mere existence, they are compelled to act for something beyond self, and in doing so they cease to be anarchists and become more or less orderly servants in a staid molecular society.

Mr. Molecule, therefore, is created by the mutual services and directive discipline of his constituent atoms, or elements, and by his home surroundings, all acting cooperatively to give him birth. In his creation, he becomes endowed with a sovereign quality of his own, subject to the sovereignty of his outer world. He endures as long as those cooperative services are rightly performed, and the discipline rightly maintained, and no longer. His existence, therefore, is contingent on the performance of these services, and on the existence of some degree of rightness within himself, and outside himself; and that molecule which does survive has preserved within its makeup some measure of that rightness. In that measure of cooperation and rightness lies the fitness of his constituents, and the selective agency in the evolution of the molecule.

But the molecule thus peremptorily set up in business for itself, and without being consulted in any way as to his own wishes in the matter, has his own work in the world to do,

subject to his own specific attributes and external compulsions. This new anarchist, by force of circumstances, may be compelled to help in the construction of proteids to be used by some future plant or animal life, even if his anarchistic soul does rebel at the performance of such useless altruistic labor, and at such unwarrantable interference with his freedom of action.

If we now make a momentary excursion toward the other extreme of nature-action, into the domain of the astronomer, we apparently find the same constructive, selective, and saving agencies at work that are manifest in the upbuilding of the molecule, only the system and its component parts are larger, the time and space factors greater, and the unknowable movers have different names.

Here the cooperative agencies are the sovereign cosmos, and the sovereign individualities it contains. These solar systems, with their constituents suns, planets, and satellites, and their subordinate elements, are grouped in partially visible architectural entities, suggesting the wholly invisible molecular entities of physics and chemistry.

The gains in this cosmic action-system are formulated in sidereal architecture, and the continuity of its constructive services is manifest in the stability of its organization. The morphology of the heavens, like that of molecules and living organisms, is not only an index of past and present physiologic action, but an assuring prophecy of future action. Without this forward and backward aspect, along a gradient line of progressive nature-action, science itself could not exist, for there would be no base line for the profitable orientation of intelligent thought or action.

In each of these larger sidereal units, and systems of units, is embodied the summed up profits of past cooperative actions. In this self-construction lies the egoistic phase of these individualities. The ulterior altruistic services to which they are accessories are in some measure apparent in the terrestrial conditions under which, without our consent or approval, we now exist. So let us get back to earth again, where these agencies have made life and constructive thought a possibility, and have rigidly defined its impossibilities, whether we like these invitations, restrictions, and compulsion of nature's discipline, or not.

In the terrestrial world, the most convincing and familiar example of creative unity through cooperative action, is the living organism. But plant and animal life stand on, and in, the altruistic achievements of the physical world. They are pensioners of the past, using both the oldest and newest instruments of nature in their self-construction. The individual plant, or animal, is the product of its cooperating elements, cells and organs, and its environment, and is itself a cooperative agent in that environment. It is subject to its own sovereign attributes, as well as to those of its constituents and its habitat. The individual gain is everywhere contingent on the general. The plant can not long endure without the animal, the male without the female, and neither without their retinues of other servants. They exist, as they do, because of these mutual services, within and without, past and present. Their profit is in service betterments: their working capital, past betterments conserved.

In this phase of nature-action, the cooperative system is formless, elastic, and democratic. Plants and animals are the actor-units, widely separated it may be, in time and space, but everywhere intermingled regardless of high or low degree. And the system now assumes the familiar give and take of predatory life and reproduction, where consumer and consumed, parent and offspring, egoism and altruism, perform reciprocal functions in the universal metabolism of nature-life.

Consider, for example, the nut, the mouse and the cat.

If the mouse destroyed all the nuts, it would destroy itself. Its interests are best served when nuts are encouraged. If it had intelligence, it would cherish and preserve them. If it had the necessary cultural implements, it might profitably spend its spare time and energy in producing more and

better nuts. Not even a "nut" could reasonably object to that. On the other hand, the cat is an efficient educator. It teaches the mouse to confine its attention to its own affairs, and both teacher and pupil are the better for that.

And when the mouse is about to die, and is brought to earth, it does not wholly go to waste. A percentage of him goes to make another nut, and a percentage helps to make another cat, which without the one and the other could not exist. And finally nature levies a tax upon the cat, and in due season the cat pays his taxes.

By virtue of this rigorous nature discipline, which prescribes when, and how, and where, the nut, the mouse, and the cat may act, and what they must, and must not do, each in its own way makes a living, as many others like them have done in similar ways before, a sufficient testimonial to the constructive and saving virtue of the system.

But this is only one part of this system of give and take. The plant, the mouse, or the cat, as an individual, not only gets, or receives enough income from all sources to pay his personal running expenses, but on the whole, each in his own way, makes a profit. Part goes into alterations, repairs and additions, or into what we call growth. But there is always a definite limit to individual holdings, or to the growth of every individual system, which is peculiar to itself. When that limit of cohesion is reached, or approached, the surplus overflows into other individualities and becomes their possession.

Much of this surplus of the profiteer, which for him is unusable, is scattered right and left with astounding prodigality, and this unwilling altruism on his part becomes one of the chief sources of income to life at large. But an adequate percentage becomes a special entailed endowment to a new individual, similar to the first, thus setting up a substitute, or a direct lineal descendant in the business of life, giving him a fixed capital in germinal materials, quick assets in germinal food-stuffs, with containers and protective envelopes, all rightly constructed and arranged, and the whole package so located in time and space by the administrators of these estates as to insure for it, in the long run, a new life of adventure among the hazards and inviting opportunities of the outer world.

Thus in this larger spongeoplasmic fabric of nature-life, visible only to the more comprehensive instruments of the mind, kingdoms and classes, races and species, young and old, the physical and organic entities of the living and the dead, are unconscious partners in a common system of cooperative action. In this social metabolism across the larger reaches of time and space, each unit, in the reciprocal egoism and altruism of life and death, plays its respective anabolic and catabolic functions, and thereby gives the system, as a whole, its self-sustaining, vital power.

Through the shifting patterns of this growing fabric, we most clearly see the converging threads of genetic lineage, the long, gradient lines of alternating youthful egoism and parental altruism, on the one hand vanishing in the primordial life that has its issue in the terrestrial loom, and on the other, radiating into the abyss of future possibilities. Everywhere shot through and across these more rigid hereditary lines are those which mark the sinuous course of predatory action, and other actions less discriminating. Thus the whole system is woven into that variegated plexus of success and failure, tragedy and comedy, joys and sorrows, good and evil, which makes up the cooperation functions of life and give it creative unity.

And then man, a new nature-anarchist, the most modern pattern in this moving-picture fabric, makes his appearance on the screen, and surrounded by his satellites of cultural instruments, and with both positive and negative poles of his very material self flaming with the auroras of intelligence, attempts to set this system which gave him birth to rights.

He is little conscious of the source of his own endowments, or that his ethics and morality, as manifest in his sporadic outbursts of social philanthropy and benevolence, are not his own institutions, but the compulsory application of world-old constructive principles to his own peculiar affairs. Nor is

he fully conscious that his boasted material inventions and discoveries, his canoes and battleships, his ovens, highways and machinery, his microscopes, telephones, and telescopes, his commerce, literature-science, and art, are but improvements, or enlargements, outside himself, of his own internal organs and functions, and that he must use these cultural instruments if he would use them constructively, in precisely the same ways his vital organs are used in his bodily growth and preservation.

In their functioning, these cultural instruments extend, deeper into time and farther across space, the power of his sense organs to discriminate between good and evil, and increase the range and velocity of the load his muscles, blood vessels, nerves, and other bodily organs can move, or carry. In other words they serve to increase the rate and diversity of the mutually profitable exchange, mental and physical, between the human molecules of social life, and between man and nature. They alone give man's social life its cooperative unity and power, just as the cooperative action of molecules, cells, and organs give unity and power to his body. Their saving and constructive action is contingent on the growth and right usage of intelligence, as the construction and preservation of his body is contingent on the evolution of right reflex actions and instincts.

And now, in this twentieth century of the historian's calendar—when the human blastoderm, for the first time in cosmic evolution, has practically enclosed the terrestrial egg, filling in all the habitable surface of this cosmic yolk-sphere, establishing its capillary network of highways, and its nerve plexus of communication, joining its racial blood-islands and national placodes into one organism —humanity has ceased to be a germinal potentiality, or a mere vision of the prophets. It has become a present and very obvious reality, and the academic flickerings of the philosophic auroras are now sufficiently luminous to be visible, as practical questions, to the politician. Indeed there is still hope that some rays may eventually pass the threshold of senatorial sensibility.

But the man of normal social instincts and average intelligence, in spite of himself, is now compelled to recognize this unity in human life and nature, and the dependence of that unity on the fulfillment of mutual rights, of mutual services, and mutual obligations. In this more humble state of mind, he does not now ask "What will I do?" but "What must we do?" to preserve social life and social structures. What is our protection against the will to destroy? With destructive agencies everywhere now at hand for those who have the will to use them, What shall be the compulsion to constructive action?

The answers to these questions can not be found in precedents, for there are no precedents in the whole history of evolution for man's present social conditions. The solution must be found in the intelligent application of the elementary principles of ethics and morality, principles which have their roots in the biological and physical sciences.

We must not accept Huxley's despairing assertions that "cosmic nature is no school of virtue, but the headquarters of the enemy of ethical nature," and that "the cosmic process has no sort of relation to moral ends." To do so we should have wholly to ignore the manifest creative power in cosmic action. We may surmise, from internal evidence, the irritation that provoked Huxley's brilliant but unconvincing dialectics, and it may be said that his point of view then, and the chief target of his attack, is not ours now.

And surely it is not for us "to fight the cosmic process" even under a fighting Huxley; nor on the other hand need we accept the stoical philosophy of protective mimicry and regard "living according to nature as the whole duty of man"; nor need we be horrified at the thought of ethics as "applied natural history."

Rather is it our duty to understand nature-action and to cooperate with it; to distinguish between the minor tactics of evolution and the grand strategy of evolution, and with our own peculiar instruments be willing and happy agents in its consummation. Man has

but his animal organs, his cultural implements, and his intelligence, or his knowledge of right and wrong constructive ways to work with. The more those instruments are augmented, the better he can direct nature's constructive agencies to his own egoistic ends, and in so doing, man himself then unwittingly becomes a new and better altruistic agent in evolution.

We scientists, conscious of our purpose as constructive social agents, have three broad fields of activity open to us, as already indicated in defining the various functions and purposes of science. First, investigation, or the discovery of nature's ways and means of creative action. This is the ethical side of our work. Second, the constructive usage of these ways and means, or their application to the growing demands of social life, and their usage in the regulation of human conduct. This is the moral side. And, third, the conservation of our ethical and moral gains through education. The first two we may now ignore, for their significance is duly appreciated and their future is promising. But the educational side of our work is in a very serious condition, and it may even now be too late to avoid disaster. It little matters how much we may develop either our technique, or the spear-head of our research, if the so-called common people still have the ghost-hunter's paleolithic mental attitude toward natural phenomena, and their leaders a similar attitude toward social problems.

No social life can endure that is not under some common compulsion to united action. With the growth of the spirit of freedom and democracy, and the absence of any commonly recognized dictatorship in church or state, that compulsion can come only through a common understanding of the elemental necessities of social life, and through that sense of personal benefit and personal ownership in social institutions which alone can create the will to cherish and protect them.

The compulsion of elemental intelligence, acting in social unison, can alone provide the enduring directive and cohesive power essential to social cooperation. Man's will to create can be steadfast in purpose only when his intelligence becomes stabilized in its trophic attitudes, and rightly oriented to elemental realities. Man, stumbling in ignorance, must be bandaged with restrictions and propped up with crutches of force. A nation, pricked by the poisoned shafts of a lying propaganda, will dissolve in anarchy, though the armies and navies of the world have failed to break it.

In our education, we continually over-emphasized social rights and individual freedom of action, and ignore the obligations essential to partnership in any social or constructive compact. It is not without significance that ordinary people, like you and me, can discover no specific mandate in the Constitution of the United States. It broadly defines what the state does, or will do, in certain contingencies, and what its citizens may, or may not do, but says nothing about what the citizen must do in return for what the state does for him. The absence in citizenship of a formal and specific contract, defining a common purpose and recognizing mutual liabilities and mutual benefits in its attainment, is in marked contrast with modern business procedure, as well as with almost every other form of intelligent cooperation. It is, therefore, not surprising that an international covenant for the specific purpose of reducing the danger of international wars to a minimum, in which an attempt is made to define national rights and obligations in that undertaking, has a strange and unfamiliar sound.

The absence of this covenant principle is noticeable in almost every phase of modern education. Science, even, does not formally recognize a covenant with nature, although nature virtually says to man "Know me, and serve me, and I will serve you." Much of our biological teaching is like a shop window display of nature's competitive goods, with a varied assortment of human notions thrown in, but with no guarantee as to their significance, or quality, or usefulness. The pedagogical barker, seldom having convictions of his own, proudly displays the impartiality of his "purely scientific" attitude, and leaves the callow purchaser to decide for himself

which trinket he will select for his mental adornment.

Perhaps all of us can get together again on common ground by putting our concepts of nature-action into simpler, more comprehensive formulas, universal in application, and somewhat as follows. In so far as we have a right to assume that purposeful action is involved in any constructive functioning whatever, or in anything that has been accomplished, we may assume that the purpose, or grand strategy in nature-action, is evolution, or self-construction, or growth. To that end, serviceable agents must first exist, or be constructed, in which is resident a basic right to receive service, and a basic obligation to give service. As all constructive action is contingent on the fulfilment of these mutual rights and obligations, the categorical imperative to existence is mutual service.

As corollaries to this categorical imperative, the following compulsions are laid upon these constructive agents. In all sustained constructive action there must be: (1) A mutual directive discipline, or mutual adaptation; that is, a mutual subjection, and yielding to one another's influence. (2) An individual freedom of opportunity for self-constructive, or egoistic action, within rigidly circumscribed limitations. (3) Mutual service or cooperative action, in which, soner or later, the profits of egoism must be surrendered, through altruism, to some ulterior creative act. (4) Conservation of these profits as an accumulating capital in constructive rightness, and its endowment to other individualities for usage in further constructive action.

In that phase of cosmic evolution which we call social growth, science and religion are the outstanding cooperative agents. They better serve their ulterior purposes the better their mutual services, and the better their mutual adaptation of thought and act to creative ends.

Science and religion always have asked, and doubtless always will ask, the same fundamental questions. What creates, what preserves, and what destroys the products of nature, and how may man profit thereby? The answers, whatever they may be, must ultimately be expressed by them in essentially equivalent terms, their verification sought in constructive action.

The large element of unpredictable returns resident in all phases of nature-action demands trial; creative turns justify the experiment.

These unsuspected potentialities are revealed in the triumphs of nature's creative art and thus confirm her independence of established laws and precedents. Therein is the source of man's undying hope and faith, his abiding impulse to endeavor.

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ON NIPHER'S "GRAVITATIONAL" EXPERIMENT AND THE ANOMALIES OF THE MOON'S MOTION[1]

From his assumption that matter is entirely electrical, Fessenden concluded[2] that the atoms in the interior of solid bodies are charged electrically, contrary to a common conception that a static charge resides wholly on the surface. Fessenden's assumption has now been completely confirmed by Professor Francis E. Nipher's experiment with an electrified Cavendish apparatus,[3] which shows that when thin electrified shells of metal are substituted for the large leaden spheres, no effect is produced on the inner small suspended spheres, protected by a metal case, when the electricity is applied. This, of course, simply corroborates Faraday's "ice-pail" experiment. But when the large leaden spheres are restored to place and electrified, the electricity gradually soaks in, and after about half an hour this interior charge of the atoms has accumulated sufficiently to produce an electrical repulsion of the small spheres, greater than their original gravitational at-

[1] This paper was read at the twenty-second meeting of the American Astronomical Society at Harvard College Observatory, August, 1918.

[2] *Electr. Soc.*, Newark, 1890; *Electr. World*, August 8–22, 1891.

[3] "Gravitational Repulsion," *Transactions of the Academy of Science of St. Louis*, Vol. XXIII., p. 177, 1917.