

## ON SCIENCE AS A GUIDE TO UNDERSTANDING THE ORDER AMIDST THE DIVERSITY OF LIFE

by Paul A. Weiss

This paper is the reprinting under a new title of the "Foreword" of Paul A. Weiss's *Life, Order, and Understanding: A Theme in Three Variations*, published in 1970 as volume 8 supplement of *The Graduate Journal* of the University of Texas (Austin, Texas, \$5.00 [hardcover], \$2.50 [paperback], 157 pages). We reprint this paper here for two reasons. The first is that its beautiful, scientifically grounded imagery of living systems in relation to wave dynamics provides a significant supplement to this issue of *Zygon* on human values in the context of thermodynamics. The second is that it is hoped this foreword will serve better than would a book review to introduce *Zygon* readers to the philosophical and scientific wisdom contained in *Life, Order, and Understanding*.—EDITOR.

A wave may depict fluctuations of our physical environment or of an economic cycle or of the moods and motives of the minds of men, swinging upward and downward on and on, about a median band of stationary equilibrium. When left alone, waves will subside, as in the calming of the sea after the storm, the damping of an oscillating string, the cooling off of tempers after quarreling, the trend to compromise in bargaining. This is the natural course of natural events in *inorganic* nature and of conciliatory human behavior. Thermodynamics teaches us that without reinforcement the swing loses motive force inexorably, as energy to entertain it is dissipated as tribute to the growing pool of entropy. But there are instances in which that downdrift is temporarily reversed. They are a prime distinction of *living* systems. An organism can borrow dissipation-bound energy in one place or period to spend it at another place or time to feed movement or other energy-requiring work. A living being thus not only can keep a wave in motion but, properly timed, can make it swell. Yet, to profit from this game with nature, man must know its rules and play it right. For instance, stored energy, when added to the upstrokes only of a rhythmic motion, makes the momentum of the whole swing grow. Man's productive and creative faculties, but also his powers of destruction, hinge on the ways in which he exploits this principle; for as it enables even frail men to toll a heavy bell, it also makes it possible for political villains to foment

Paul A. Weiss is member and professor emeritus, Rockefeller University, New York.

vicious mob action by the reiterative reinforcement of an insidious rumor. In fact, even erstwhile beneficial excursions can become ruinous when driven to exceed a given tolerable range; for then the following is bound to happen.

Any patterned living system—be it a cell, an organism, a community, or a society—is held together as a viable integrated entity by inner ties that are elastic; the system yields to moderate distortion, and the greater the distortion, the greater also is the counterforce that contains it within bounds. Elastic strain, however, can be sustained only up to the stress limit. If stretched beyond, the bonds will snap: the system loses its cohesion, crumbles, flies apart. Disjointed, the separated pieces then carry on, like moons, as isolated entities in mutual opposition, no longer even tenuously connected. Gone are the connecting threads that kept the parts united as a system. Just think of whirling an object on a rubber string round and round at increasing speed until centrifugal force breaks the string and the object flies off. This is the way in which antagonisms give rise to schisms: by promoting centrifugal disruption. Our world is full of examples. Issues are artificially polarized, the spotlight being turned on the extremes, and then the tug-of-war between them goes on for good. The playful spirit of win-or-lose of the sports field, with friendly handshakes at the end, is violently perverted into a do-or-die precept for either-or survival. What have been merely extreme ends of a continuous spectrum of positions along a graded scale of values become implacably hostile camps contesting for monopolistic status: antagonisms that have started from sheer accentuation of extreme points of view deteriorate into factual conflict and combat, and people change from occupants of opposite ideological stations into actual aggressive opponents.

This tendency for antipolar extremes to rise through emphasis and prominence to eventual total separation is, as I shall outline in one of the following essays, deeply ingrained in the nature of biological existence. Biological nature condones the resolution of conflict by victory rather than by conciliation. Outfighting, outbreeding, or outsmarting a competitor are approved methods of evolutionary progress; true, there are also instances in nature of cooperation and harmonization of interests, as for instance in symbiosis, but those are essentially accommodative arrangements among noncompetitive groups. Being the animal he is, man has inherited a flair for polarizing issues. Instinctively, he even fans their conflict-breeding potential by laying stress on divergence and disparity; doing so, he amplifies the centrifugal separative forces which threaten to disrupt the crucial cohesiveness without which no living system, including the human race, can survive. In

## ZYGON

short, *biological* man cannot be trusted to act in the best interest of humanity.

But then, man is much more than an animal. Through his power of reasoning, he can, if not abolish his deep-set instincts, at least repress and supersede them by intelligent action, whenever he recognizes his primitive instinctive habits to run counter to the higher ideals of a civilized society. Rational foresight lets him spot danger signals of strain approaching stress limit, and insight, gained from experience, enables him to take countermeasures in time to forestall imminent disaster by brakelike damping, decelerating and draining the motive force of extreme swings. In principle, such deliberate regulatory intervention by man corresponds, of course, to the automatic "negative feedback" devices to which any self-preserving system, living or non-living, owes its capacity for maintaining, or oscillating about, a state of relative stability of pattern. Yet, human corrective counteractions differ from those of automatons in their lack of built-in self-restraints: a human counterthrust started as a control act often ends up losing its own self-control.

That is to say, man, although he clearly recognizes the direction in which to counter an excessive move, is not equally adept at choosing the right amplitude for the checking force. A faulty sense of perspective often makes him underrate or overrate it. Misjudgment and timidity lead him to undercorrect, while overreaction to real or envisaged outrage prompts him to overcompensate. There are those who close their eyes to controversy by self-delusion, by simply disputing that the professed extremes actually exist; and there are those others who, in their violent aversion to an excessive swing in one direction, reverse the wave into one no less extreme, even though of opposite sign.

### REGULATION OF DIVERSITY IN CIVILIZATION

Now, let me try to explain what that metaphoric—and somewhat cryptic—preamble on wave dynamics has to do with this collection of essays. I used the simile of undulatory patterns to symbolize man's groping for a civilized existence; more specifically, to emphasize two basic, though commonplace, observations: (1) that *biological* man tends to create antagonisms by emphasizing the extreme ends of a continuous spectrum of notions composed of truths, as well as fallacies and prejudices; (2) that *civilized* man, although he has the rational endowment to counteract that fatal trend to excessive polarization, seems not to have as yet learned to make the most of his rational fac-

ulties by adopting the broad perspective which would let moderation defuse the explosive charge of fanatical antagonisms.

Perhaps more than perspective is needed. What seems to have been lacking above all has been a judicious mixture of idealism and realism, that is, of theory and practice. In theory, one can set for each truthful proposition an opposite, which obviously, by definition, is untrue. Nature offers us models of such absolute bipolarity in positive and negative electricity and the antipoles of magnetism. But the real world of human affairs, in which we live, which we observe, and in which we then look for principles that would merit the accolade of "pure truth," has yet to bring forth a single example of such ideal unadulterated truth. Consequently, we must not expect to meet in that real human world the antithetical phenomenon of "unmitigated untruth," either. The idealistic-realistic precept of civilized society, therefore, should be to sort from both extremes the positive "truthful" fractions which they contain and rally them into a cohesive system, the unity of which would avert irreparable schisms. Thus, what the popular precept of "accentuating the positive" espouses, might lead, in a more sophisticated version, to the depolarization of exaggerated antipolarities, and thereby to the conciliation of putatively irreconcilable antagonisms; in short, to greater harmony through the moderating influence of the broader views gained from a balanced perspective.

To help ascend to such broad perspective should become a prime task of all systems of education and public enlightenment. Inspected soberly, any two phenomena or ideas one might wish to compare critically present both common, or "generic," and distinctive, or "specific," features. As the generic ones, in their repetitiveness, become dull, the specific ones, more conspicuous for being more unique, attract attention and monopolize our interest, thus putting in eclipse the stable, steady bulk of common features that unite them. Minor disparities outshine major identity. The picture of the world one is apt to get from such a confinement of the field of vision will of necessity be a grossly lopsided one. As viewpoints have a way of consolidating into standpoints, lopsided views become the bases for lopsided decisions and actions. Moreover, the habit of singling out for prime attention and categorical confrontation the opposite ends of a continuous scale of values is just a special case of a more general fallacy, namely, that of concentrating on the differences among a set of subjects while ignoring the much larger substance they have in common, of which the differentials are but abstracted attributes.

This is a state of affairs in which education should assume a major corrective and preventive function, hopefully to be joined by the

media of public communication. Their task would be to break the obsessive habit of focusing compulsively on single isolated issues, separated from their context—a major source of partisan self-confinement—and develop in its stead the habit of letting the mind sweep back and forth over the whole continuum of phenomena, which constitute the context. This evidently would imply a major change of attitude, a reorientation of viewpoint and focus of thoughts from centrifugal decomposition of something that has unity to centripetal convergence.

Such a changeover from primitive accent on opposites to civilized practice of moderation looks like a gigantic job; and so it is. It reminds one of the task put to a painter in asking him to paint a new picture over an old one on brittle canvas, but still to let some of the original colors shine through. No doubt it would be quite utopian, and indeed violate our bid for ideological realism, to nurture the illusion that the educational process could accomplish that overpainting with a few bold and broad brush strokes. Educational philosophy is neither unified nor influential enough to tackle such a major assignment. However, on a less ambitious scale, step by step, the objective can be pursued with some promise of success. For, what is the substance of education if not the cumulative distillate from innumerable small lessons of experience? Therefore, if one learns to distill off and keep remembering from all the little acts and observations their common essence, rather than engraving in one's mind the more conspicuous, but trifling, distractions, such habit of concentrating on essentials ought to go far in giving man a sounder rationale for his thinking and actions. The road is long and the task arduous, but if this common objective to become civilized is borne in mind as guidepost for every single step, however small, the countless component steps should add up to a resultant force of reason strong enough to overcome the inertial counterpull of prejudices based on man's more primitive *biological* instincts.

#### A CULTURAL GIFT FROM SCIENCE

These three essays are modest efforts in that direction. They are intended as sample exercises to test whether science, with its rigorous methodology, combined with logic, might not perhaps be more incisive and convincing in illustrating the middle-of-the-road way to harmony than have been the compromises of legal conciliation, economic settlement, or political accommodation. Science has had a good record of success in resolving tenacious sham controversies by proving opposing tenets to be not mutually exclusive but, rather, validly coexisting alternatives. Scientific history abounds with scientific verdicts in which,

on unassailably "objective" evidence, cases of supposedly irreconcilable contradictoriness were adjudicated by showing the conclusions of both contenders to have been valid. The complementarity principle of Bohr, affirming the right of coexistence of both a corpuscular and a wave concept of light; the duplicity theory of von Kries, establishing that both of two theories concerning the function of the retinal elements in color vision, formerly thought to be in conflict, were correct; the perennial fight between the embryological credos of preformation versus epigenesis—whether the whole array of organs of an adult organism is preformed as such in the egg in miniature or whether all development is *de novo* creation—ending in the realization that there is some truth to both concepts; all these are classical illustrations of the incisive resolving power of the mature and disciplined scientific spirit, with its distaste for dissonance. On these grounds, science can truly convey an important educational lesson on how to resolve, or at least depolarize, antagonisms.

But then, science is carried on and taught by scientists, and scientists are people with all the attributes of ordinary human beings, although perhaps in slightly different proportions. As such, and while they are preoccupied with their individual pursuits in library or workshop, they need not be expected to be any more broad-minded and conciliation-bound than men in other walks of life. Indeed, violent dissent among scientists, ending in dead-end polemics, is not uncommon. However, as soon as the scientist gets out of his specialist groove and becomes mindful of his obligations to science as a whole, his sectarian acquiescence in unresolved conflict is overridden by an earnest universalist urge to strive for consonance.

These essays have been written—and should be read—in this spirit of depolarization, of harmonizing conflicting doctrines. As the problems to be dealt with reach far beyond the scope of scientific subject matter into the area of general human concern, the treatment and conclusions of this scientific sample exercise might well lend themselves to some broader cultural extrapolations. The common theme, of which the three parts are variations, is broad enough; it is *the recognition and scientific validation of the rôle of order that pervades the universe* and culminates in human understanding.

The essays were written for different occasions, for different audiences, with different slants. They have, however, an underlying conceptual fabric in common, which to the reader will reveal itself as overlap and repetition of certain fundamental theses. Repetition in different contexts does not connote redundancy. As in the surveying of land the coordinates of a point in space are determined by triangulation,

so a conceptual point of view can be established more securely by an approach from three convergent directions than by a single-tracked attempt to "make a point."

In the first essay, " $1 + 1 \neq 2$ ," I am trying to mediate—or, at least, moderate—the age-old confrontation of the philosophical doctrines of "holism" versus "reductionism," each vested by its adherent sect with the master key to the explanation and understanding of nature. In the second, "The Living System: Determinism Stratified," I am dealing, by way of example, with a specific scientific issue, namely, the problem of "genetic determinism," as it is understood and, more often, misunderstood. I use it to illustrate how such misunderstandings and overstatements, including some ingenious conjectures about the origin of life, can bring a sound body of scientific data dangerously close to the point at which solid knowledge turns soft and becomes warped into misshapen concepts of life and mind and of man's opportunities for self-development. Finally, in the third essay, "Life as Seen through the Window of Life Science," the broader meaning of "determinacy" is subject to a critical reexamination, which leads to the replacement of the rigid micromechanistic ("atomistic") thinking of old by a hierarchical concept of natural "systems," in which order in the gross goes hand in hand with freedom in the small; the evidence gathered there depolarizes and, hopefully, defuses the pernicious categorical antithesis of order *versus* freedom, which has been the source of so much human strife. May strife be superseded by striving.

In sum, the leading motif unifying the three parts of this volume is the scientific rationale and validation of civilized man's obligation to strive for a realistic and balanced perspective, in which he recognizes ideological extremes for what they are: artificially disconnected opposite ends of continuous scales of intergrading values, just fortified in their positions of antagonistic isolation by verbal symbolism and the instinctual vestiges in man of his biological past. The example of the reconciliation of the rule of order in nature with the legitimacy of freedom and diversity serves merely as a model in point. It, so to speak, sets the tune. If education would pick up the tune and amplify it, and if it were to find the proper resonance in men's minds, it would transmit to man a cultural gift from science.

As but a line tells left from right  
 And shades of gray link black to white  
 And stillness waxes into noise  
 And effervescence wanes to poise,  
 So most extremes can be connected  
 And man's contrariness corrected.