in the four evening sessions will include well-known technical men in the aircraft industry. New aircraft techniques and a projection of post-war plans will be discussed in thirty-eight papers to be read at sixteen separate meetings. The conference is under the auspices of the Southern California Section of the society. Dr. Clarence A. Dykstra, provost of the University of California at Los Angeles, will address the opening session on Monday evening, June 11.

THE "Oliver Lodge Scholarship," with a basic annual value of £250 and tenable for one year, has been founded to commemorate the twenty-fifth jubilee of the radio section of the British Institution of Electrical Engineers.

IT is reported in *The Times*, London, that the University of Bristol, which already has chairs of mechanical, civil and electrical engineering, will establish a department of aeronautics in the faculty of engineering. This development is made possible by a gift of £60,000 by the Bristol Aeroplane Company for the establishment of the Sir George White Chair of Aeronautical Engineering, named in memory of the founder and first chairman of the company, who was one of the pioneers of British aviation.

DISCUSSION

A NOTE ON DR. NOVIKOFF'S ARTICLE

HAVING myself been for a long time deeply interested in the philosophy of organism and the theory of integrative levels in its application to the sciences, the appearance of Dr. Novikoff's article in SCIENCE for March 2, 1945, during the few weeks when I happen to be in the United States on my way back to Chungking, where I direct the Sino-British Science Cooperation Office, was for me a happy coincidence. It is a great pleasure to see this philosophy gaining ground, nearly twenty years after the pioneer work of J. H. Woodger, which found its expression in his "Biological Principles" (Kegan Paul, London, 1929).

Once we adopt the general picture of the universe as a series of levels of organization and complexity, each level having unique properties of structure and behavior, which, though depending on the properties of the constituent elements, appear only when these are combined into the higher whole, we see that there are qualitatively different laws holding good at each level. The phenomena of a higher level can not be understood without knowledge of the behavior of its constituents at the lower levels. Exactly how much light the lower-level phenomena throw on the higher-level phenomena at each stage, however, will probably long remain a matter involving differences of opinion. Thus Dr. Novikoff seems to take the view (p. 213) that the behavior of the lower animals, whether solitary or in primitive association (societies?) has little relevance to the phenomena of human society, while Gerard, as well as Emerson, on the contrary, have argued that the lower animals have much to teach us about the higher human level. On this point I should be inclined to agree with Dr. Gerard, who is, I am sure, not likely to fall into what I have elsewhere called "the heresy of biologism" ("Time, the Refreshing River," Macmillan, 1944), the fascist doctrine that unending internecine strife is as much the law of human society as it is of the wild forms of animal life. It would be a pity if, in the interests of maintaining the uniqueness of the human sociological level, we were to return to an almost ecclesiastical separation of man from the rest of the living world, without the consolation of an angelic world with which he might ally himself. This would hardly be in accord with the idea of scientific socialism.

Novikoff also takes Gerard to task for speaking of a "mysteriously operating 'organizing trend'" in the universe. Mysterious it may still be to us, as it was to Anaximander or to Lucretius, but it is undoubtedly there. For me it has never been possible to describe it otherwise than as an overall continuous rise in level of organization through cosmic, biological and social evolution. Perhaps Dr. Novikoff fears that a belief in this trend might lead to inaction in the social field. The United Nations, he says, do not rely on any evolutionary fatalism, but rather on armed might, actively applied, to defeat fascism and keep humanity on the road of progress. I have always felt that a helpful reflection here is that, although the general direction of process is known, the speed at which it goes on is not known, and depends directly on the activities of each one of us, thinking willing monads of the highest level. If a thousand years of human suffering more or less depend upon our actions here and now, we need hardly fear succumbing to fatalism when we recognize a universal trend in the world process.

I would like to add once again my appreciation of Dr. Novikoff's stimulating contribution to the discussion of this fundamental subject.

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EXTRAPOLATION FROM THE BIOLOGICAL TO THE SOCIAL

IN his article in SCIENCE,[1] Novikoff cuts a wide

[1] Alex B. Novikoff, SCIENCE, 101: 2618, 209–215, 1945.

critical swath, and we are among the frail straws cut down. His argument starts much on the same premises as ours, and ends by agreeing with many of our conclusions, but he finds our intervening course badly muddled and rather reprehensible. Gerard, especially, is accused of teleological and fatalistic views likely to give comfort to fascists and to sluggards. This is a novel experience to one often called a positivist and a mechanist.

We are grateful to Novikoff for bringing attention to our papers[2] and urge interested readers to refer to these more extended statements (and to Allee[3]), if they would discover what the shooting is about. Novikoff raises several valid queries. Mostly his answers and ours are in agreement; sometimes his criticisms are based on a misunderstanding of our position and occasionally are inconsistent with his own statements; and, finally, one or two real differences exist between us.

Novikoff emphasizes that: the part-whole relationship is reciprocal; atomism on the one hand and holism on the other are but parts of the truth; a new level of organization is attained by some integration of the simpler units but not by their mere summation; different mechanisms of interaction operate at different levels with unique laws, but that common attributes are encountered at the different levels (integration, individuality, evolutionary continuum, ontogeny, inheritance). We have been as emphatic on these points, yet Novikoff writes as if he were refuting us. Gerard,[4] as Novikoff, has emphasized the integral aspect of neural activity. Novikoff writes, "There is both continuity and discontinuity in the evolution of the universe; and consideration of one to the exclusion of the other acts to retard the development of biological and social sciences"; but then stresses the uniqueness of each level and upbraids us for emphasizing some similarities. Yet we have also dwelt upon distinctions, and he has recognized resemblances, both in attributes and causitive forces. But here is a real difference at last, for Novikoff seems, at the psychological-sociological level, to isolate completely everything human from the rest of nature and strenuously objects to our failure to do so.

We have argued that, since societies are living systems, they obey those most general laws which apply to all living systems. This says, for example, that social evolution and biological evolution are both subject to any statements applicable to "evolution," not that the two subclasses are identical. To recognize that growth of an individual, increase of a population, gene duplication and even, probably, learning are all subsumed under the concept of autocatalysis does not imply that the same detailed mechanism is involved in all cases.

The emergence of symbolic communication as a factor in evolution is no more dramatic than is the emergence of the rapid nerve impulse. It hardly justifies Novikoff's statement that "Progress in social development is basically different from progress in organic evolution. . . . Progress in organic evolution occurs without a set plan or direction; social progress rests upon planned activity of men." Has not, in fact, biological evolution exhibited a single direction, towards greater complexity and integration, as have inorganic and social evolution as well? Has a lion stalking his prey no "plan" and is his behavior without influence on organic evolution? Conversely, has social evolution been rationally planned over much of history; is it so even now to any great extent? Has natural selection played no role in shaping the appearance of human cooperation, which furthers man's adaptation in meeting such biological needs as nutrition, defense, reproduction and environmental control? Are we to be dubbed mystics for asking, concerning the human mind which makes man's integrated societies possible, how it came to be evolved—instead of asking only how it evolved?

The human mind, or eye, is understandable in terms of its function, as well as of its mechanism. Man can make sense of its appearance in nature, in each case, by noting what it does or, in evolutionary terms, what its adaptive significance is, how it aids its possessor. This is certainly teleological or "purposive" in a naturalistic sense. But it does not imply a "divine purpose in nature." And it in no way interferes with, but rather helps to raise, the mechanistic question—"How does this thing work, or develop?" The physiologist frequently thinks in terms of what would be useful to the body, of what job a mechanism might do, and so gets cues for his experimental search. Aquatic mammals could use special devices to enable them to remain long submerged; such were sought. The parathyroid hormone raises blood calcium, teleology suggests low blood calcium as an effective stimulus to parathyroid secretion. The basis of physiological regulation—a disturbance in equilibrium engenders a response tending to counteract that disturbance—is purposive in its effects, as is indeed the very concept of regulation. Mechanism and purpose are merely looking at sets of events from the two directions of the time axis. Looking backwards reveals mechanism; looking forwards, utility or purpose. Both are useful and supplement one another. Neither is to be fully understood without a knowledge of its development and evolution. Both imply uniformity (or period-

[2] Especially: R. Redfield (editor), "Biological Symposia" 8, 1942; R. W. Gerard, *Philos. of Science*, 9: 92–120, 1942.

[3] W. C. Allee, SCIENCE, 97: 517–525, 1943.

[4] R. W. Gerard, *Ohio Jour. Sci.*, 41: 160–172, 1941.

icity) and usefulness (or adaptation) in nature. Purpose, as we have used it, does *not* imply a sentient purposer.

Novikoff would reserve purpose to man, as a conscious volition, and so set him apart. Seeing purpose elsewhere, he says, is an anthropomorphism. And so it is, if conceived as conscious volition based upon symbolic learning. Indeed, so is seeing causation, related to man's feeling of volition in himself. Alas, so is everything man thinks, for he can think only as man. But if man's mind is itself a natural phenomenon, this is not too disheartening. For we see the mind evolving as part of the whole epic of evolution, and to be explained causally in terms of the body and its environment, just as life earlier evolved from the inanimate and is still tied to the laws of matter. To recognize that the known universe trends toward greater complexity is not to say that some intelligence has this as a deliberate purpose; and it is nonsense to state that such recognition leads to social inaction. (See Needham's accompanying note.) Our position seems to us far less mystical and more intellectually frank than to offer reason and purpose, as Novikoff does, as epiphenomena somehow uniquely acquired by man independently of any biological causation or evolutionary trend.

Novikoff quotes Emerson's statement that "the evolution of human social and ethical characteristics is governed by the same forces which have been directing organismic evolution through the ages," and then states that these "forces" are social in the human case, biological (mutation, etc.) in the other. But ethical systems help to integrate human society, as genetic systems do organisms, so that both have at least certain similarities of function. Further, both systems vary; favorable variations in either survive in relation to their function; and these variations are often inherited. Both systems thus evolve similarly under similar pressures; and these similarities are not "purely formal and therefore meaningless." Purely formal similarities are often very meaningful; on just such a basis, for example, the effect of myelin internodes in accelerating nerve conduction was predicted by Lillie from the behavior of an iron wire in an interrupted glass tube in nitric acid.

Biological evolution, on a genetic base, is indeed very different from social evolution based on transmitted symbols; but fundamental similarities might still allow some general predictions. The natural selection of whole integrated systems, for example, has led to an evolutionary increase in specialization and integration (cooperation) of the units composing individuals and superindividuals, both at the biological and the social levels. (And including the tapeworm, *contra* Novikoff.) Is it an unsound extrapolation to expect human social systems also to evolve toward greater cooperation? If two systems have both likenesses and differences, it is no argument against the likenesses to point out the differences. Novikoff, agreeing that "society will develop eventually to a high level of cooperation," still evidently thinks that the causes of similar evolutionary trends in societal and biological systems[5] have no basic identity.

True homologies (genetic similarities) are not to be expected between two different levels, as intracellular organelle and multicellular organ, or body organ and social institution. But analogies (functional similarities without genetic identity) may well exist, and are not all merely chance resemblances or euphonious metaphors. Convergent evolution of analogous functions between different organismic levels is well established, and inquiry into their origins and causes, far from being extrascientific, leads, for example, to clearer formulation of evolutionary pressures as of how the environment operates through natural selection.

We have also expressly recognized the dangers in analogical reasoning based on spurious or superficial resemblances in the presence of basic differences. Especially with phenomena in widely separated fields of knowledge, the scholar in one may go astray in the other. Also, rationalization from personal bias has often occurred.[6] Spencer certainly committed gross errors in detail, and it would be surprising if we do not. The less similar two systems, the more difficult is it to detect true resemblances; but, when these are discovered, the more important is the resulting insight likely to be. Nor is it of light importance that the tremendous accretion of physiological, zoological and sociological knowledge since Spencer's time permits more precise comparisons which dramatically substantiate earlier generalizations.

Which brings us, finally, to a genuine philosophical difference. We maintain that at each superposed level of integration new unexpected properties emerge, but that the new properties must be commensurate with the old; must fit in their general framework, not violate it. Novikoff disagrees with, shall we say, enthu-

[5] As we have used the terms, biological and societal, the impression might be given that they are parallel categories. There is a change in level from the so-called solitary individual to the social group, alike in insect and human. In both cases, a specialized society has developed from more primitive groups, of sex, family and other aggregations. The social level is one of the most evolved sublevels of living systems in the same sense as the biological level is of material systems. To restrict the term "social" to human groups, depending on symbolic interchange, and separate it sharply from "biological," which encompasses insect groups, is an arbitrary semantic decision on Novikoff's part.

[6] R. Hofstadter, "Special Darwinism in American Thought, 1860–1915," 191 pp. Philadelphia: University of Pennsylvania Press. 1944.

siasm, when he condemns, as a support for fascism, "the thesis that man's biology decides his social behavior." In his view, the laws and behavior of higher level systems are *by their nature* unpredictable from those of their lower level constituent systems, and presumably the reverse; in our view, they are not of necessity unpredictable. Emergent attributes are difficult to predict, to be sure, because man yet knows little; but every significant scientific experiment is an act of faith or confidence in the ultimate understandability and predictability of nature. And this is not atomism, for it works both ways—the brain could never be fully understood without knowing mind, nor the mind without knowing brain. Where Novikoff would say that man's affairs are sharply separable into the sociological or the biological and that blurring the distinction is dangerous, we say they are part of each and that blurring the similarity is also dangerous. We recall that Darwin's clue for the concept of biological evolution came from sociological considerations and that his concept was, in turn, the stimulus to fruitful sociological thought.

Fortunately for our main theme, whether the particular mechanisms of evolution are alike or different at cellular, organismic or societal levels, comparable qualities repeatedly emerge. It remains true that the fact of evolution applies to all the universe we know—inanimate, living, thinking—and that its overall trend is consistently towards greater differentiation by specialization of units combined with greater integration (interaction or cooperation) of units in the whole.

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THE COLORATION GIVEN BY VITAMIN A AND OTHER POLYENES ON ACID EARTHS

IN one of the recent issues of SCIENCE, A. Lowman[1] reported on the blue coloration which appears if vitamin A, which is dissolved in a non-polar solvent, is brought into contact with the commercial adsorbent, Super Filtrol. His observations were confirmed by H. R. Kreider.[2]

Evidently because of the prevailing difficulties in obtaining foreign literature, neither of the authors mentioned seems to be aware of the fact that this interesting reaction has been observed and interpreted by P. Meunier[3] three years ago. According to Meunier's explanation, some acid earths which possess incomplete electronic octets are able to give rise to an intensely blue color when they are in contact with vitamin A which is dissolved in a non-polar solvent; by donating unshared electrons to such adsorbents, the vitamin molecule undergoes polarization and forms positively charged, strongly resonating structures. A few very debatable points in Meunier's interpretations shall not be discussed here; for example, the alleged restriction of the resonating system to twice four double bonds in the β-carotene molecule.

The Carr-Price reaction and some color tests given by sterols have also been treated by Meunier and his collaborators.[4]

Of course, the coloration on acid earths can not be expected to be specific for vitamin A. In fact, carotenoids were mentioned by Meunier and the reaction was observed by Lowman to be given by carotene.

A similar coloration is also shown by a new polyene, now under investigation, which is widespread in plants, shows intense fluorescence in ultraviolet light and was recently reported in collaboration with A. Polgár.[5] We find that if a highly purified, colorless petroleum ether solution of e.g. 0.01 mg of this compound is placed in contact with filtrols, the solid phase turns azure blue. The formation of this color is irreversible in the sense that an alcohol or acetone eluate, after transfer into petroleum ether, does not show the typical extinction maxima of the starting material (331, *348*, 367 mμ) as represented in a published curve.[5]

A deep coloration on acid earths, *e.g.*, on purified Super Filtrol can also be obtained with a benzene solution of diphenyloctatetraene, $C_6H_5(CH=CH)_4 \cdot C_6H_5$, under suitable conditions.

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ANAEROBIC RESPIRATION VS. FERMENTATION

THE terms fermentation and anaerobic respiration have justifiably been put under the microscope in two recent discussions in SCIENCE.

Seifriz[1] objects to the use of the term fermentation for anaerobic respiration when the reactions involved are substitutes for energy-yielding anaerobic processes necessary for life.

The criticism seems a valid one, for the word fermentation as used historically by Pasteur *et al.* and, as used currently, does not denote the part which oxygen may or may not play in the reactions. In the literature, reference is repeatedly made to "alcoholic fermentation" and "acetic acid fermentation." The

[1] A. Lowman, SCIENCE, 101: 183, 1945.
[2] H. R. Kreider, *ibid.*, 101: 377, 1945.
[3] P. Meunier, *Comptes rendus de l'Acad. Franç.*, 215: 470, 1942.
[4] P. Meunier, R. Dulou and A. Vinet, *Compt. rend.*, 216: 907, 1943; P. Meunier, R. Dulou and A. Vinet, *Bull. soc. chim. biol.*, 25: 371, 1943; P. Meunier and Y. Raoul, *ibid.*, 25: 173, 1943.
[5] L. Zechmeister and A. Polgár, SCIENCE, 100: 317, 1944.
[1] William Seifriz, SCIENCE, 101: 88–89, 1945.