Levels and systems

All science proceeds by a selective ordering of data by means of conceptual schemes. Although the formulation and application of conceptual schemes are recognized to entail, at some stage of inquiry, more or less arbitrary choices on the part of the theorist or investigator, we all acknowledge, or at least feel, that the nature of the "real world" exerts strong constraints on the development of schemes in science. Some schemes, used fruitfully over long periods of time, come to seem so natural that we find it difficult to imagine their being superseded. One type of scheme is deeply ingrained by our training as social scientists, to wit, the organization of data by levels. Kroeber is only voicing the consensus of a majority of scientists when he writes:

The subjects or materials of science ... fall into four main classes or levels: the inorganic, organic, psychic, and sociocultural. ... There is no intention to assert that the levels are absolutely separate, or separable by unassailable definitions. They are substantially distinct in the experience of the totality of science, and that is enough.¹

MacIver gives substantially the same classification, but instead of using the relatively colorless term "levels," he chooses to segregate the several "nexus of causation" into "great dynamic realms."²

It is significant that scientists, insofar as they do accept the doctrine of levels, tend to work within a level, not with it. The scheme of levels does not itself produce hypotheses; it can scarcely even be said to be heuristic. Its major contribution to the history of ideas has been to confer legitimacy upon the newer scientific approaches to the empirical world that, when they were emerging, had good use for any kind of ideological support.

Quite another type of conceptual scheme, the notion of system, is employed by the scientist in his day-to-day work. Conceptions of interdependent variation, of cause and effect, or even of mere patterning of sequence, derive from the idea that nature (using the term broadly for whatever can be studied naturalistically) manifests itself in collections of elements with more than nominal properties of unity.

No doubt there are many kinds of systems, reflecting the kinds of elements comprising them and the modes of relationship conceived to hold among these elements. The point about this


The ecosystem

Acknowledged dangers of premature synthesis and superficial generalization notwithstanding, ecologists have been forced by the complexity of relationships manifested in their data to devise quite embracing conceptual schemes. The concept of ecosystem, a case in point, has become increasingly prominent in ecological study since the introduction of the term a quarter-century ago by the botanist, A. G. Tansley. "The ecosystem," according to Alice and collaborators, "may be defined as the interacting physical and biotic system." Odum characterizes the ecosystem as a "natural unit . . . in which the exchange of materials between the living and nonliving parts follows circular paths." The first quotation comes from an enlightening synthesis of information now available on the evolution of ecosystems; the second prefaced an exposition of principles concerning the operation of "biogeochemical cycles" in ecosystems. Social scientists whose acquaintance with general theory is limited to eponymous names like Park, Tansley, Odum, and Clements might do well to inform themselves concerning current developments in ecological theory by consulting such sources as these. Even more readily accessible is the statement of Dice:

Ecologists use the term ecosystem to refer to a community together with its habitat. An ecosystem, then, is an aggregation of associated species of plants and animals, together with the physical features of their habitat. Ecosystems . . . can be of any size or ecologic rank. . . . At the extreme, the whole earth and all its plant and animal inhabitants together constitute a world ecosystem.6

Later in his text (ch. xv) the same author undertakes a classification of "human ecosystems." This classification presents in elementary fashion much material familiar to social scientists; but it also conveys an unaccustomed emphasis on the "dynamism" or "reshuffling" of the human phases in its human phases if they clearly have a "pioneer" ecologist, S. C. Lee R. Dice, Social Ecology: A Critical Analysis (New York: Columbia University Press, 1938).

I would humbly add, and lend my own account in its details as those of the human phase world must include the "significant" or dominant species of the human stage together as members of the whole system..."}

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7Robert E. Park, Human Communities: The City and Human Ecology (Glencoe, Ill.: The Free Press, 1952).


verse relationships" of human societies "to their associated species of plants and animals, their physical habitats, and other human societies."

Popularization of the ecosystem concept is threatened by the felicitous exposition by the economist K. E. Boulding of "society as an ecosystem." The word "threatened" is well advised, for Boulding uses "ecosystem" only as an analogy, illustrating how human society is "something like" an ecosystem. His ecosystem analogy is, to be sure, quite an improvement over the old organismic analogy. But ecosystem is much too valuable a conceptual scheme to be sacrificed on the altar of metaphor. Human ecology has already inspired a generation of critics too easily irritated by figures of speech.

If the foregoing remarks suggest that general ecologists have come up with cogent principles concerning the role of human society in the ecosystem, then the discussion has been misleading. Actually, the writing of Dice is an exception as they clearly have not heeded the plea of the whole task of investigating the ecosystem and its human phases in particular. As a discipline, they have not heeded the plea of the pioneer ecologist, S. A. Forbes, for a "humanized ecology":

I would humanize ecology . . . first by taking the actions and reactions of civilized man as fully into account in its definitions, divisions, and coordinations as those of any other kind of organism. The ecological system of the existing twentieth-century world must include the twentieth-century man as its dominant species—dominant, that is, in the sense of dynamic ecology as the most influential, the controlling member of his associate group.

Symptomatically, even when discussing the "ecology of man," the biologist's tendency is to deplore and to exhort, not to analyze and explain. The shibboleths include such phrasings as "disruption," "tampering," "interference," "damage," and "blunder," applied to the transformation of ecosystems wrought by human activities. Such authorities as Elton, Darling, and Sears state very well some of the dilemmas and problems of human life in the ecosystem. They evidently need the help of social scientists in order to make intelligible those human behaviors that seem from an Olympian vantage point to be merely irrational and shortsighted. Insofar as they recommend reforms—and surely some of their suggestions should be heeded—they need to be instructed, if indeed social science now or ultimately can instruct them, in "The Unanticipated Consequences of Purposive Social Action." If social science falls down on its job, a statement like the following will remain empty rhetoric: "Humanity now has, as never before, the means of knowing the consequences of its actions and the dreadful responsibility for those consequences."

Illustration

Now, it is all very well to assert the possibility of conceptual schemes, like ecosystem, ascribing system properties to associations of physical, biological, and social elements. But can such a scheme lead to anything more than a disorderly collection of arbitrarily concatenated data? I think the proof of the ecosystem concept could be exemplified by a number of studies, ranging from particularistic to global scope, in which some such scheme, if implicit, is nevertheless essential to the analysis. Instead of reviewing a sample of these


2Ibid., pp. 525–53.


studies, however, I would like to sketch a problematic situation that has yet to be analyzed adequately in ecosystem terms. This example, since it is deliberately "open-ended," will, I hope, convey the challenge of the concept.

The framework for the discussion is the set of categories suggested elsewhere under the heading, "the ecological complex." These categories—population, organization, environment, and technology (P, O, E, T)—provide a somewhat arbitrarily simplified way of identifying clusters of relationships in a preliminary description of ecosystem processes. The description is, by design, so biased as to indicate how the human elements in the ecosystem appear as foci of these processes. Such an anthropo-centric description, though perfectly appropriate for a human ecology, has no intrinsic scientific priority over any other useful strategy for initiating study of an ecosystem.

The example is the problem of air pollution, more particularly that of "smog," as experienced during the last two decades in the community of Los Angeles. Southern California has no monopoly on this problem, as other communities are learning to their chagrin. But the somewhat special situation there seems to present a configuration in which the role of each of the four aspects of the ecological complex, including its relation to the others, is salient. I have made no technical investigation of the Los Angeles situation and have at hand only a haphazard collection of materials dealing with it, most of them designed for popular rather than scientific consumption. (The personal experience of living through a summer of Los Angeles smog is of value here only in that it permits sincere testimony to the effect that the problem is real.) The merit of the illustration, however, is that it is manifestly related to those postulated by the ecosystem concept are superficially evident even when their nature is poorly understood and inadequately described. I am quite prepared to be corrected on the facts of the case, many of which have yet to come to light. I shall be greatly surprised, however, if anyone is able to produce an account of the smog problem in terms of a conceptual scheme materially less elaborate than the ecological complex.

During World War II residents of Los Angeles began to experience episodes of a bluish-gray haze in the atmosphere that reduced visibility and produced irritation of the eyes and respiratory tract (E→P). It was also found to damage growing plants (E→E), including some of considerable economic importance, and to crack rubber, accelerating the rate of deterioration of automobile tires, for example (E→T). In response to the episodes of smog, various civic movements were launched, abatement officers were designated in the city and county health departments, and a model control ordinance was promulgated (E→O). All these measures were without noticeable effect on the smog. At the time, little was known about the sources of pollution, although various industrial operations were suspected. By 1947, a comprehensive authority, the Los Angeles County Air Pollution Control District, was established by action of the California State Assembly and authorized to conduct research and to exercise broad powers of regulation. Various known and newly developed abatement devices were installed in industrial plants at the instance of the APCD, at a cost of millions of dollars (O→T).

Meanwhile, research by chemists and engineers was developing and confirming the "factory in the sky" theory of smog formation. Combustion and certain other processes release unburned hydrocarbons and oxides of nitrogen into the atmosphere (T→E). As these reach a sufficiently high concentration and are subjected to strong sunlight, chemical reactions occur that liberate large amounts of ozone and form smog. In particular, it was discovered that automobile exhaust contains the essential ingredients in nearly ideal proportions and that this exhaust is one of the major sources of the contaminants implicated in smog formation. It became all the more important as a source when industrial control measures and the prohibition of household open incinerators (O→T) reduced these sources (T→E). Also implicated in the problem was the meteorological situation of the Los Angeles Basin. Ringed by mountains and enjoying only a very low average wind velocity, the basin frequently is blanketed by a layer of warm air moving in from the Pacific. This temperature inversion prevents the polluted air from rising very far above ground level; the still air hovering over
the area is then subject to the aforementioned smog-inducing action of Southern California's famous sunshine (E→E).

The problem, severe enough at onset, was hardly alleviated by the rapid growth of population in the Los Angeles area, spreading out as it did over a wide territory (P→E), and thereby heightening its dependence on the already ubiquitous automobile as the primary means of local movement (T→O). Where could one find a more poignant instance of the principle of circular causation, so central to ecological theory, than that of the Los Angelesos speeding down their freeways in a rush to escape the smog produced by emissions from the very vehicles conveying them?

A number of diverse organizational responses (E→O) to the smog problem have occurred. In 1953 a "nonprofit, privately supported, scientific research organization, dedicated to the solution of the smog problem," the Air Pollution Foundation, was set up under the sponsorship of some 200 business enterprises, many of them in industries subject to actual or prospective regulatory measures. The complex interplay of interests and pressures among such private organizations and the several levels and branches of government that were involved (O→O) has not, to my knowledge, been the subject of an adequate investigation by a student of the political process. Two noteworthy outcomes of this process merit attention in particular. The first is the development of large-scale programs of public health research and action (O→P, E) concerned with air pollution effects (E→P). Comparatively little is known in this field of epidemiology (or as some research workers would say nowadays, medical ecology), but major programs have been set up within the last five years in the U.S. Public Health Service (whose interest, of course, is not confined to Los Angeles), as well as in such agencies as the California State Department of Public Health. Here is a striking instance of interrelations between medical ecology and the ecology of medicine illustrating not merely "organizational growth," as studied in conventional sociology, but also an organizational response to environmental-demographic changes. Second, there has been a channeling of both public and private research efforts into the search for a "workable device," such as an automatic fuel cutoff, a catalytic muffler, or an afterburner, which will eliminate or reduce the noxious properties of automobile exhaust. California now has on its statute books a law requiring manufacturers to equip automobiles with such a device if and when its workability is demonstrated (O→T).

Some engineers are confident that workable devices will soon be forthcoming. The Air Pollution Foundation has gone so far as to declare that the day is "near when Los Angeles' smog will be only a memory." Should the problem be thus happily resolved, with reduction of pollution to tolerable levels, the resolution will surely have to be interpreted as the net result of an intricate interaction of factors in the ecological complex (P, O, T→E). But if the condition is only partially alleviated, how much more growth of population and increase in automobile use will have to occur before even more drastic technological and organizational changes will be required: redevelopment of mass transit, introduction of private electric automobiles, rationing of travel, limitation of population expansion, or whatever they may be? What will be the outcome of experience with increasing air pollution in other communities, whose problems differ in various ways from that of Los Angeles? And the question of questions—Is the convulsion of the ecosystem occasioned by smog merely a small-scale prototype of what we must expect in a world seemingly destined to become ever more dependent upon nuclear energy and subject to its hazards of ionizing radiation?

Conclusion

I must assume that the reader will be kind enough to pass lightly over the defects of the foregoing exposition. In particular, he must credit the author with being aware of the many complications concealed by the use of arrows linking the broad and heterogeneous categories of the ecological complex. The arrows are meant only to suggest the existence of problems for research concerning the mechanisms of cause, influence, or response at work in the situation so sketchily portrayed. Even the barest account of that situation, however, can leave no doubt that social change and environmental modification occurred in the closest interdependence—so close, in fact, that the two "levels" of change were systematically interrelated. Change on either level can be comprehended only by application of a conceptual scheme at least as encompassing as that of ecosystem.

The reader's imagination, again, must substitute for documentation of the point that smog, though a spectacular case and full of human interest, is no isolated example of how problems of human collective existence require an ecosystem frame-
work for adequate conceptualization. I do not intend to argue, of course, that sociologists must somehow shoulder the entire burden of research suggested by such a conceptualization. Science, after all, is one of our finest examples of the advantages of a division of labor. But labor can be effectively divided only if there is articulation of the several sub-tasks; in scientific work, such articulation is achieved by employment of a common conceptual framework.

Sociologists may or may not—I am not especially optimistic on this score—take up the challenge to investigate the social life of man as a phase of the ecosystem, with all the revisions in their thought patterns that this kind of formulation will demand. If they shirk this responsibility, however, other disciplines are not unprepared to take the leadership. Anthropology of late has demonstrated its hospitality to ecological concepts. Geography, for its part, cannot forget that it laid claim to human ecology as early as did sociology.

Of even greater ultimate significance may be the impending reorientation of much of what we now call social science to such concepts as welfare, level of living, and public health. Programs to achieve such "national goals" (to use the former President's language), like the studies on which such programs are based, are finding and will find two things: first, each of these concepts is capable of almost indefinite expansion to comprehend virtually any problem of human collective life; and, second, measures or indicators of status or progress in respect to them must be multi-faceted and relational. Public health, to take that example, is surely some sort of function of all elements in the ecological complex; it is observable in any sufficiently comprehensive sense only in terms of interrelations of variables located at all levels of the ecosystem. Extrapolation of current trends over even a short projection period is sufficient to suggest the future preoccupation of the sciences touching on man with much more macroscopic problems than they now dare to set for themselves. It is perhaps symptomatic that spokesmen for the nation's health programs now declare that the "science of health is a branch of the wider science of human ecology," and that expositions of the problem of economic development have come to emphasize the necessary shift "From Political Economy to Political Ecology." Even the literati proclaim that the "fundamental human problem is ecological." (Cf. the similar remark of Kenneth Burke: "Among the sciences, there is one little fellow named Ecology, and in time we shall pay him more attention.") If one holds with Durkheim that the basic categories of science, as well as the interpretive schemes of everyday life, arise from the nature and exigencies of human collective existence, it cannot be long before we are forced to conjure with some version of the ecosystem concept. The question is whether sociology will lead or lag behind in this intellectual movement.


