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CURRENT PROBLEMS IN RESEARCH

The New American Archeology

Its changing interests are bringing new kinds of understanding and a generalized view of its problems.

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It is well known that the fortunes of archeology have been greatly improved by new technical aids such as radiocarbon dating. A more important but far less celebrated advance is represented, I think, by a shift of interest in recent years toward problems of far greater generality than pertain to any single excavated prehistoric site. Part of this shift of interest to more general problems must be ascribed to the outstanding work of V. Gordon Childe and others in the Old World, but the greater reason perhaps is to be found in the close ties which most American archeologists have maintained with general anthropology and through this, more tenuously, with the wider domain of social studies.

This juxtaposition of anthropology and archeology in North American universities came about for the good historical reason that this continent contained living primitive cultures as well as prehistoric ones. The work of Americanists has with reason been called social-science archeology. Not only do many Americanists have a cultural anthropological background but they find fruitful applications in archeological thought of the studies, for example, of social anthropologists such as Julian Steward and Robert Redfield. A series of papers in a recent volume entitled *Seminars in Archaeology: 1955* (*1*) comprised the following titles: "An archaeological classification of culture contact situations"; "An archaeological approach to the study of cultural stability"; "The American Southwest: A problem in cultural isolation"; and finally, "Functional and evolutionary implications of community patterning." Had a sociologist found himself at these meetings, he would have had no trouble recognizing the problems, even if the factual data seemed a little strange. An anthropologist writes of these four seminars that they demonstrate "a growing together rather than a falling apart of archaeology and the other special disciplines of anthropology" (*2*).

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First Approach

The understanding that is emerging as a result of shifting interests and new problems can be shown by comparing recent archeology with the older variety. Since American archeology is regionally specialized—Andean, Eastern, Middle American, Southwestern, and so on—and because some of these regions were ahead of others in development, I find it easier to use the older archeology of eastern North America as a base line for the kind of contrasts that I propose to make.

Up until World War II the chief concerns of eastern archeology—with some exceptions—seem to have been the description of archeological sites and the description—often simply the definition—of prehistoric cultures. The latter might be presented individually or in terms of culture provinces (*3*). Sometimes particular categories of material culture—for example, all the known prehistoric pottery from the eastern United States—were presented in terms of provinces (*4*). Some fine work was done on the identification and methods of manufacture of prehistoric stone tools (*5*).

A considerable advance was represented in the Midwest by a Linnaean-like taxonomic system (*6*) which appeared just at the time it was beginning to be realized that cultural stratigraphy was present in the Eastern areas. The Midwestern taxonomic system was regarded as a necessary first step. It organized archeological materials into categories based on degrees of likeness of the assemblages being unearthed. Unfortunately, there was a tendency to regard classification as the end of research, and some archeologists who were obtaining long stratigraphic sequences, which in some cases showed gradual culture change, were hard put to classify these in Midwestern terms, although they continued for years to do so. In being able, now, to observe material culture changes in time and space, they already have part of the means for establishing *kinds* of historical connection, whereas the taxonomy they tried so hard to employ could only specify something about degree and could not deal with continuities.

I think it is fair to say that before World War II American archeological studies were in a condition similar to that which Northrop (*7*) has characterized as the natural-history stage of inquiry. The emphasis was on archeological data as things in themselves rather than on the values offered by different ways of looking at them. Moreover, it was considered, in practice, as important to excavate a site meticulously and to record every scrap of evidence which might conceivably bear on any future problem as it was to have a reason for excavating the site in the first place. One result of all this was the development of a specific kind of problem which treated classificatory entities as independent realities; one might inquire into the content of cultures known from preserved material objects, examine their temporal or spatial boundaries, or try to establish

the degree of relationship among them.

A second result was the development of a specific kind of analysis to set up the comparisons required to solve problems of this nature. Types were routinely established as an economical means of describing small objects, pottery, constructions of one sort or another, and burial customs. These types were considered adequate for all comparisons which might later be made but were not designed to solve particular problems. Problems might certainly occur to one after the types had been established. Types of this kind, since they were immediately apprehensible regardless of problem, were in some quarters considered to be real entities, and rightly so.

The third result was the development of a specific kind of history—a history of material culture—which, at best, described the succession of the preserved archeological assemblages in each culture province. At worst, such a history was confined to the area of a modern state and made unnecessarily complex by the assignment of different names in different states to cultural manifestations which, on the basis of the criteria in use, should have been assigned the same name.

The essentially dull and uninteresting character of this "culture history" was a matter of concern to some archeologists. Walter W. Taylor (*8*) called for the construction of fuller cultural contexts—for attention to "the interrelationships which existed *within*" each cultural entity. Others attempted to inject a lifelike note by substituting the word *people* for *culture* whenever possible. Thus, in a semipopular book (*9*), the "Savannah River Culture" became the "Savannah River People," with corresponding shifts in referential pronouns.

Transition

A trend away from local specialization was initiated in the 1940's in monographs by Ford and Willey in 1941 (*10*) and by Griffin in 1946 (*11*). These men made themselves familiar with a vast amount of uncollated and unpublished data which had emerged from the hundreds of excavations undertaken under various federal relief agencies. The prehistory of the eastern United States was found to be most readily susceptible to presentation in terms of a succession of pan-Eastern periods or eras, reflecting the importance of time and continuity in contemporary archeological thought. The picture obtained from these formulations was of a steady development of material culture and of the essential unity of the East: The various prehistoric cultures assigned to each period in this vast region were usually more alike than were the temporally separated entities within any particular subarea. Hence, each of these major periods could also be regarded as a developmental stage.

In 1958, Willey and Phillips (*12*) applied what is essentially the same kind of formulation to the whole of the New World, as a series of pancontinental stages. The theoretical foundations of their work were stated at length, some hundreds of areally based prehistoric cultures were characterized, and many special hypotheses regarding the interrelationships of these were proposed, weighed, or discarded. The result of this method was again to show the cultural interconnectedness of the area treated—in this case the entire Western Hemisphere—and to suggest that the civilizations of Mexico and Peru emerged from the same background as the other American cultures but proceeded through additional stages leading to civilization.

American archeology still leans heavily on the idea of areally based cultures and probably always will. We have even improved the utility of this view by the concept of tradition—a culture area having depth in that it is allowed to shift its boundaries through time. If we now suggest some new ways of thinking about areal traditions, this does not mean that we are ready to dispense with them. They do represent more or less closely one kind of natural or common-sense division among the primary materials we have to work with. Where we have improved on the older archeology is by asking different kinds of questions of the materials, and this is directly bound up with the new interests we have noted.

The New Archeology

The new archeology in America is tending to be more concerned with culture process and less concerned with the descriptive content of prehistoric cultures. There are now two kinds of problems, historical and general, which can be suggested either by distinctions seen in the data themselves or by results of archeological research in other parts of the world, or which can emerge out of other disciplines such as ethnology or philosophy, and then be brought to the data as propositions to be tested.

We may characterize our new interests in the following way. Where formerly we were concerned with the identification of things and of cultures—whether, for example, a particular artifact should be regarded as a knife or as a scraper, or whether a given archeological assemblage should be classed with this culture or that—we have added an interest in the identification of culture processes and situations. Thus, W. R. Wedel's "Environment and Native Subsistence Economics in the Central Great Plains" (*13*) examines culture-environment connections in that area, and since that time other archeologists, stimulated no less by A. L. Kroeber's "Cultural and Natural Areas of Native North America" (*14*) than by the fine Viru Valley Project in Peru (*15*), have turned their attention to the interrelations between natural ecology and human populations and settlement patterns, with respect to cultural level.

Another approach to cultural and historical processes is seen in the wealth of inferences which can be derived from changes in cultural forms seen through time—that is, through stratigraphic and constructed sequences. Whether or not changes were diffused from another region can be inferred from knowledge of whether or not they occurred earlier elsewhere. That changes are of local development can be inferred when their prototypes occur locally at an earlier time. Something about the historical situation can be inferred from rates and magnitudes of changes in cultural forms. A sudden change in a whole series of artifact forms may herald a prehistoric invasion; gradual changes in forms occurring at different times suggests a period of comparative tranquility during which cultural development was not greatly influenced by outside areas. Whereas the older Midwestern taxonomic system could establish degrees of connections among cultural assemblages, we are now finding various methods of inference which will enable us to see the kinds of connections.

Present archeology still reflects an indiscriminate use of the notion of a prehistoric "culture," by which is sometimes meant a few artifacts of some former society and, at other times, a number of societies historically related, but perhaps in different ways and in different degrees. We are increasingly sensitive to the value of making distinctions between cultures as opposed to societies (*16*). Observations which can be made about behavior are for the archeologist

mediated through cultural forms, but his inferences need not always refer back to culture. Sometimes it is better to use the concept of interaction area instead of culture area; not only is thought thus referred directly to the behavior of people instead of to a "culture," but in some cases this idea is better suited to the archeological facts of continuous intra-areal diffusions of cultural forms. In other instances we can make inferences concerning social organization itself (*17*).

Still another basis for our changing interest stems from the idea of pattern or configuration, which has had a considerable vogue in anthropology although it is not new with that science. The archeologist is inclined to see cultural patterns in developmental terms. A pattern represents some kind of regularity or organization. If a pattern can be recognized, the features we use to account for its presence may perhaps be stated in terms of the processes which brought it into being or perhaps in terms of the factors which operate to maintain it.

With the idea of cultural patterns and developmental patterns, modern archeology has reached a point where many possible patterns and hypotheses can be suggested, each of which seems to propose cultural "facts" that are not necessarily mutually exclusive and that do not necessarily contradict each other but which *in the same body of materials* reflect various aspects of a many-sided reality. To take a very simple example of the way in which a given body of archeological materials may mirror different historical facts, suppose that a stratigraphic sequence of flint projectile points is used to suggest the answer to the question of whether these points were javelin tips or arrowheads. If both types are present, it may be that the bow and arrow was replacing the javelin during this range of time. We could perhaps arrive at an answer to this problem by using a type system with criteria based upon the size and weight of the specimens. On the other hand, the question might be whether the flint was being obtained from a distance through trade, and for this we should have to examine the projectile points in the light of another type system based on kinds of flint correlated with different localities—not on sizes and weights as in the other case.

In the foregoing example it is relatively easy to see how a given body of archeological materials represents different historical or cultural facts. In the case of cultural pattern or configuration, however, the "reality" of proposed fact is less apparent because the particular interests of the investigator, and perhaps the historical development of the science, intrude more strongly into the result. Thus, Willey and Phillips' stadial conception of New World prehistory is also concerned with a particular reality; they might have devised other conceptions of equal validity had their interests been other than what they were.

New Understandings

The views held by Julian Steward, a social anthropologist (*18*), show how additional understanding has been reached by a different approach. Steward rejects "unilinear" cultural evolution, maintained at the end of the last century by ethnologists like Tylor and Morgan and now in part by Willey and Phillips (*19*), which says that with certain allowances for diffusion, all human cultures pass historically through similar developmental stages. According to Steward's theory of "multilinear" evolution, all cultures do not pass through similar stages but we can discern a finite number of parallel evolutions in which societies adapted to particular environments and natural resources pass through successive and distinctive levels of "sociocultural" integration. Steward's comparisons deal with societies from various parts of the world. Features of these societies are treated by Steward as types, and certain recurrent associations of important features represent "cross-cultural types."

Conclusions concerning processes involved in particular evolutionary sequences are regarded not as natural laws but as regularities or generalizations of limited range, upon which, one supposes, we may in time build further. Steward says: "Ecological adaptations can be considered as causative in the sense that a degree of inevitability in cultural adjustments is directly observable. Patrilineal bands of Bushmen, Australians, Tasmanians, Fuegeans, and others represent a type in that the ecological adaptation and level of integration are the same in all these cultures. In these and other cases, factors producing similar types such as environment, food resources, means of obtaining food, the social cooperation required, population density, the nature of population aggregates, sociopolitical controls, the functional role of religion, warfare, and other features, will have an understandable relationship to one another."

Steward's work is concerned with processes of culture change manifested in a number of distinct developmental sequences and arrives at generalizations of limited range stated in terms of cultural process, whereas, the Willey-Phillips formulation stresses the interconnectedness of the prehistoric societies of the Western Hemisphere and arrives at a series of cultural levels applying to the area.

Some of Steward's proposed cross-cultural types, such as Formative, Regional Florescent, Empire, and Conquest, are designed to show the processes leading to civilization. They are nearly parallel to the later stages of the Willey-Phillips formulation. Steward's types are now being examined and somewhat modified by archeologists familiar with the various regions (*20*). The developmental similarities of Steward's types may be stated in causal terms, because between the Old World and the New World there is not much chance that the similarities are due to historical connection.

A new approach sometimes brings a wealth of understanding. Archeology seldom affords direct evidence of social institutions, although Childe has suggested some means by which these can be inferred, and recently Sears has been able to propose a correlation between prehistoric burial mounds on the Gulf Coastal Plain with the presence or absence of strong social classes in the societies involved (*21*). Now Steward provides another method for arriving at such inferences, as Eggan has pointed out (*22*). Archeology usually does offer data (for example, the bones of food animals and the size and locations of sites) concerning ecological adaptation. Some social institutions can be satisfactorily inferred from this if, as Steward maintains, they are causally connected with ecological adaptations.

I recently proposed (*23*) a conception of the development and spread of early civilizations which, like the Steward and Willey-Phillips formulations, rests on a hypothesis. The body of available data is here divided differently, and in thus shifting the focus of our interest, new cultural "facts" are created. According to this scheme, there has been, in the areas which developed civilizations as well as in those which did not, an "Archaic" culture type with certain definable developmental features. These developmental features can be used to account for the emergence of civilizations in some areas as well as for the absence of civilization in other areas. Once a civilization has developed, however, some of the processes involved in its

spread are best seen in terms of a contrast between two additional culture types: "nuclear civilization" and, in the areas outside of civilization, "nonnuclear culture."

The most important developmental feature of the Archaic culture type in eastern North America was the achievement of primary forest efficiency. This was a cumulative process manifested in the development of ambush hunting, in seasonal economic cycles (transhumance), and in the discovery of new sources of natural foods. It is supposed that something like this may have occurred wherever Archaic cultures are found in forested lands. An extension of this idea leads to a definition of a "plains efficiency" for the hunters of large migratory game and a "maritime efficiency" in coastal areas. These various "efficiencies" are meant to be the logical counterparts of "primary farming efficiency"—a term originally used by Braidwood (*24*) to describe the economic platform upon which civilization may arise.

Plant raising was known in areas where nuclear civilization did not arise. However, it was *only* in areas of nuclear civilization that food production was the economic basis for society. Perhaps the plants used had greater potentialities; perhaps growing populations or the progressive depletion of other resources, or both factors, brought about a Toynbeean challenge which was successfully met.

In the nuclear civilization culture type, it is the achievement of primary farming efficiency which permits the changes leading to civilization. In the nonnuclear culture area of eastern North America, where primary forest efficiency was well established, it was this very efficiency which tended to direct subsequent economic innovation along lines previously established. Changes only represented further development of hunting-gathering systems.

While a degree of residential stability and comparative freedom from want can be achieved by peoples who live by hunting, fishing, or gathering (witness the American Indians of central California and the northwest Pacific coast), it appears that urbanization and civilization cannot appear without the development of food production on an extensive scale.

The growth potential of different economic patterns is clearly delimited in comparing the nuclear and nonnuclear culture types. The mechanics of the limiting factors can be seen in comparing each of these two with their common antecedents in the Archaic culture type.

What new understanding can be reached by viewing culture developments in the Western Hemisphere in terms of two contrasting types, nuclear civilization and nonnuclear culture? Such a view suggests one way to find connections which became established between the areas of civilization and the areas beyond, and the outward spread of civilizations can be formally examined both in time and in space. It becomes possible to ask certain questions about the spread of civilizations, and although the particular historical events may seem to be of infinite variability, it may be possible to account for these in terms of a finite number of general processes. Within the framework of the contrast between nuclear civilization and nonnuclear culture, it is relatively easy to describe certain intermediate cultural balances as of mixed descent. To do so emphasizes the role of such hybrid cultures as active agents in the spread of civilizations. Finally, it calls attention to the different developmental patterns between the spreading civilizations and the cultures which confront them. An acculturation situation consists of far more than the simple adoption of features of the greater culture by the weaker. Both are affected, and both reinterpret culture transfers in terms of their own views and interests, which we *can* see as patterned in terms of a particular historical development.

Conclusions

It is supposed that behind the infinite variability of cultural facts and behind the infinite and largely unknown detail of historical situations we shall discover the workings of a finite number of general cultural processes. This hypothesis underlies much of recent archeological thought despite the view, often propounded, that because of level, cultural facts are much more complex than those of the physical sciences. This latter assertion does not make our task impossible. Not all cultural facts are of equal importance in determining a given pattern or trend. Certain developmental patterns must surely be overriding in their effects upon other patterns. A major historical pattern may serve to unite or in some cases to subordinate other patterns of more limited range.

Although, as I have tried to show in this article, cultural facts vary with the hypothesis, and although the hypothesis varies with the special interests of the investigator, this does not mean that archeological formulations at the pattern level cannot be tested and that some kind of validation cannot be secured. The pathways of archeology are strewn with the wreckage of former theories which could no longer be supported in the light of new data. Some hypotheses are concerned with different aspects of a reality reflected in a single body of materials. There are also hypotheses which can be shown to be logically inconsistent with each other and among which a choice must be made. As time goes on, tests of compendency will become increasingly specific. Finally, here in the realm of postulated cultural facts there are some from which test cases can be constructed, and in this way the truth of the postulates can be tested. One way to disprove the Willey-Phillips postulate that all the cultures of the New World went through similar developmental stages would be to show that an important area of New World cultures did not go through these stages but did go through others.

I said in the beginning, and have tried to show with reference to the convergence of archeology with anthropology and social studies, that archeology is now turning to questions of greater generality than pertain to any single excavated prehistoric site or culture. I think that our interests will become still wider. The similarities between Steward's views concerning the importance of the food quest in determining the institutions of the simpler societies and Marx' production relationships, which formed the basis for his labor theory of economics, may already have occurred to the reader. V. Gordon Childe apparently found much in Marx' historical formulations to stimulate his own conceptions of prehistory.

Since archeology expects to deal with a range of problems pertaining to former societies and often seeks the aid of other sciences to do this, it tends to make connections among various kinds of studies. Moreover, the appropriateness of archeological data for questions which have arisen in general studies of history or art has long been recognized. Archeological findings from the earth, viewed in terms of time, space, and cultural behavior, offer a vast body of material for inference. And as for philosophy, I think that the usefulness of archeological data will be recognized and that closer connections with that discipline will be established. What does a stratigraphic sequence of changes in cultural forms have to say about the nature of historical causality?

What does the regularity which such changes often show imply concerning historical determinism as opposed to human liberty?

If it is the wise archeologist who now restricts his formulations to the development and persistence of civilizations, cultures, technologies, arts, and lesser matters, it must also be the very dull archeologist who could be unconcerned with the implications of these for some of the perennial problems of Western man.

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CURRENT PROBLEMS IN RESEARCH

Cloud Physics

Not all questions about nucleation, growth, and precipitation of water particles are yet answered.

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Cloud physics is concerned with the condensation and precipitation processes of the atmosphere. In scale, the phenomena studied range from the nucleation of the more ordered phases of water substance and the growth of particles by water-vapor diffusion to the dynamics of the atmospheric processes that lead to the formation of clouds. Although not a new field, cloud physics was given a substantial stimulus in 1946 by the discovery, by Langmuir and Schaefer, of means for the artificial nucleation of ice in supercooled water clouds. In a short article it is not possible to cover all aspects of what has become an active field of research. An effort will be made to point up some of the more recent developments and certain of the intriguing but as yet unanswered questions. The subject of the artificial stimulation of rainfall will be touched on only incidentally, because an adequate treatment of this still-controversial topic would require an article in itself.

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Homogeneous Nucleation

A central problem of cloud physics is the nucleation of a new phase—of water from water vapor or of ice from the liquid or the vapor. The theory of homogeneous nucleation in which the new phase appears without the intervention of any foreign substance has been developed by Volmer and Weber (*1*) and has been expanded upon by others. According to this theory, the appearance of an embryo of, say, water from the vapor is considered to result from the chance aggregation of molecules. If the surface free energy of the embryo is less than the energy released when the molecules aggregate (latent heat), the embryo will persist and become a nucleus; otherwise it will be disrupted into its molecules. The rate of increase of the surface energy is proportional to the radius, while the rate of release of latent energy is proportional to the square of the radius. Hence, there is a critical radius above which the embryo will persist, and this is given by an equation developed by Kelvin (*2*).

$$r_c = \frac{2M\sigma}{\rho RT \ln p/p_\infty}$$

where r_c is the critical radius, M is the molecular weight of the liquid, σ is the specific surface energy of the interface, ρ is the density of the liquid, R is the universal gas constant, p is the pressure of the vapor, and p_∞ is the equilibrium vapor pressure over a plane surface at the absolute temperature T. Thus, homogeneous nucleation is a probabilistic phenomenon and may be said to occur when the probability of the chance aggregation of molecular aggregates large enough to persist becomes arbitrarily large. From Kelvin's equation and the statistics of molecular aggregation, it is possible, in principle, to predict the conditions under which homogeneous nucleation will occur. Unfortunately, inadequate knowledge of certain physical constants, notably the specific surface free energy of molecular aggregates, to which the equation is very sensitive, preclude definitive quantitative answers. Theory plus experiment suggest that the homogeneous nucleation of the liquid from the vapor occurs only at six- to eightfold supersaturations and that the homogeneous nucleation of ice from the liquid takes place at about −40°C. It appears that it is energetically easier for ice to be nucleated from the vapor via