THE NATURE OF ARCHAEOLOGICAL EXPLANATION

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ABSTRACT

We argue that the development and use of law-like statements by archaeologists to explain characteristics of the archaeological record has been and should continue to be one of the most important goals of archaeological research. Using a model for explanation developed by the philosophers of science, Carl Hempel and Paul Oppenheim, we indicate the role of such statements in archaeological classification. However, in archaeology such statements are found to be implicit, untested, and extremely general in referent.

We further argue that the testing of potential laws requires a shift from an inductive procedure, or from one in which undirected data collection forms the first and the "abstraction" of laws from data forms the last research step, to a deductive procedure in which the explicit formulation of potential laws and their empirical consequences precedes and directs the collection of data.

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ALL ARCHAEOLOGISTS employ laws in their research. Those of us who are interested in processual analysis have made the formulation and testing of laws our goal. Other archaeologists, those more interested in explicating prehistory or in reconstructing past lifeways, employ laws whenever inferences about the past are used in interpreting data excavated in the present. One measure of the attainment of a science is the degree to which laws are *explicitly* formulated, *explicitly* tested, and *explicitly* used.

We argue that the acquisition and employment of laws necessitates two distinct but related scientific methods. These have been described and defined by the philosophers of science belonging to the logical positivist school (Hempel and Oppenheim 1948; Nagel 1961; Hempel 1966). Our positivist view contrasts with the empiricist view held implicitly by many archaeologists. In one of the rare discussions of the logic of archaeological inquiry, Raymond H. Thompson explicitly formulated this position. He asserts, for example, that "deductive methods of formal logic are not appropriate to the interpretation of empirical data of a discipline like archaeology" (1958:1). We argue that deduction and deductive methods are not only appropriate to but also necessary conditions for valid archaeological explanations.

We will first describe a model for the use of knowledge in scientific explanation which has been proposed by Carl Hempel and Paul Oppenheim (1948:135-175), and will show that it characterizes certain kinds of archaeological explanations. We then describe a method for acquiring laws and contrast it with the empiricist method proposed by B. K. Swartz (1967).

Explicit definitions of the terms to be used in the following discussion are given below:

LAW: A statement of relationship between two or more variables which is true for all times and places.

HYPOTHESIS: A testable statement of relation between two or more variables which is plausible but not confirmed.

EXPLANATION: The subsumption of the relation between two or more phenomena under a general law; the demonstration that the relation was predictable given the law.

CONFIRMATION: (1) A law is confirmed when the researcher demonstrates that a relationship between variables postulated in a hypothesis is true. This definition refers to the outcome of a given piece of research. Clearly, the more independent cases of confirmation of a law, the more confidence one may have in its validity. (2) An explanatory proposition is confirmed when the researcher demonstrates that the relation of phenomena is predicted by a law.

THE HEMPEL-OPPENHEIM MODEL

We argue that the Hempel-Oppenheim model for scientific explanation is, at worst, an important heuristic device which provides insight into the structure of archaeological knowledge. At best it points the way archaeologists must travel if they are to contribute to the corpus of laws of human behavior. The form of this model, that is also known as the Deductive-Nomological (D-N) model (Hempel 1966:51), is given in Fig. 1.

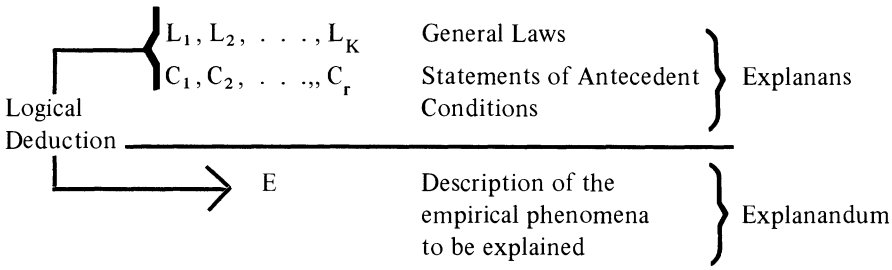

Fig. 1. The Hempel-Oppenheim model for scientific explanation. Adapted from Hempel and Oppenheim, 1948:138.

In this model, explanation is divided into two sections: the explanans and the explanandum; and each section is a division of a deductive argument. The explanans contains the premises or the statements from which the conclusion, or explanandum, can be deduced. In fact, one logical condition of adequacy for an explanation is that "the explanandum must be a logical consequence of the explanans" (Hempel and Oppenheim 1948:137). Unless this requirement is fulfilled the logical connection between the premises and the conclusion is not sufficient and the conclusion does not follow.

The conclusion or explanandum is defined as "the sentence describing the phenomenon (not that phenomenon itself)..." (Hempel and Oppenheim 1948:137). Anything that can be observed and described is a potential explanandum phenomenon. The forms of stars, glaciers, cells, or artifacts are one kind of example. The distributions of galaxies, land forms, trees, or sites are another kind. Descriptions of diachronic processes or events such as the evolution of the solar system, the drifting of the continents, the adaptation of *Homo sapiens,* or the French Revolution are also potential conclusions.

It is important to recognize that an explanandum sentence does not describe the whole or entirety of an object, pattern, or event. All events, for example, are unique in the sense that they do not share all characteristics with other events, but events are similar in the sense that some characteristics are held in common (Hempel and Oppenheim 1948:142). It is the *recurrent* characteristics of phenomena which are described and explained, not the unique. Thus, the conclusion—and, for that matter, the premises—of an explanatory argument refer to specified characteristics of phenomena rather than to the phenomena themselves.

The explanans is defined as "the class of those sentences which are adduced to account for the phenomenon...[It is divisible] into two subclasses: one of these contains certain sentences C_1, C_2,...C_r which state specific antecedent conditions; the other is a set of sentences $L_1, L_2, \ldots L_k$ which represent general laws" (Hempel and Oppenheim 1948:137). These laws have several characteristics. First, they must be true. This means not only that they are plausible or believed to be true, but also that they have been tested. Second, they must be universal in form. That is, they assert that "In *all* cases when conditions of kind F are realized, conditions of kind G are realized as well" (Hempel 1966:55). These are termed deterministic or causal laws because they "assert general and unexceptional connections between specified characteristics of events..." (Hempel 1966:55). In this, these laws differ from laws which state that "In the long run, an explicitly stated percentage of all cases satisfying a given set of conditions are accompanied by an event of a

certain specified kind" (Hempel and Oppenheim 1948:139). These latter are termed statistical laws and the logic employed when they are used in explanation is quite different from that of this model.

Third, these deterministic laws are generally conditional in form; that is, they relate two or more phenomena in a statement which says that *if* one occurs, *then* the other occurs (or will occur) as well. Thus, the variable occurring in the "if" half of the statement is a sufficient condition for the variable in the "then" half. This "if. . .then" form is characteristic of most scientific laws and, as we shall see, necessary for the derivation of explananda. Finally, a law used in this type of explanation cannot be an "accidental generalization" (Hempel 1966:54-58). Accidental generalizations are true, universal, and conditional in form, yet we would not want to call them laws. An example would be, "All houses in this site are semi-subterranean." This is not the kind of statement we would cite to explain why a given house in this site was semi-subterranean. Rather, we would refer to certain socio-cultural laws.

Laws refer to phenomena abstractly and universally, but explanations refer to phenomena concretely and particularly. According to this model, one moves from generals to particulars by means of statements of antecedent conditions, C; these state that in a particular instance the phenomena referred to in the "if" half of the law (or laws) occurred. Because its occurrence is sufficient to produce the occurrence of the phenomena referred to in the "then" half of the law, it must follow that a particular instance of the latter phenomena also occurred (occurs or will occur). The latter phenomena are, in fact, the phenomena which we are explaining.

In short, according to this model, we explain a particular phenomenon by citing another particular phenomenon. The latter is an explanation for the former; and the former occurred because the latter occurred. Our citation of this relationship between cause and effect is not arbitrary; rather, we cite this because we recognize that the relationship between the particular phenomena is an example or special case of the relationship between all such phenomena. The characteristics of and the relationship between the phenomena are defined by laws. The laws are, in effect, the explanation for the particular explanation we have made. Without a law we would be unable to choose *the* causal phenomenon out of all possible phenomena. With it, we are able to select the cause and deduce the effect.

CLASSIFICATION AS EXPLANATION

So much for the model. Does it accurately describe explanations made by archaeologists? We submit that classifications of archaeological data often share many features with this model. In the first place, such classifications have dual referents; that is, they refer not only to certain empirically observable formal and contextual properties of the phenomena classified, but also to the functions of such phenomena. To classify a feature as a "pit house," for example, is to refer both to the fact that it was a large, enclosed space partially sunken into the ground, *and* to the uses to which this space was put. A "hearth" is not simply a pit with burned walls or with charcoal in its fill, but it once contained fuel which produced heat and light energy, and various by-products. Similarly, a "chopper" is both a cobble with an edge unifacially or bifacially flaked, and an instrument for chopping things.

The functional referent of a classification refers not only to the kind of use that a particular artifact or feature had in the past, but also to the behavior of constructing and using it. Thus, to say that a "house" "houses" people is to imply that people constructed and used the house in order to obtain "housing." A "hearth" both "hearthed" (that is, did whatever a hearth should do) and was used for "hearthing" (that is, for whatever a hearth would be used). A "chopper" not only "chopped," but also was used for "chopping."

The second characteristic that such classifications share with the Hempel-Oppenheim model for explanation is that the phenomena are related in a causal or deterministic sense. That classifications refer to *form* on the one hand and to *function and behavior* on the other is not arbitrary. They imply that one set of phenomena (past behavior) was sufficient to produce the second set (the characteristics of the artifact or feature). They further imply that if the latter did not occur, then the former also did not occur. Thus, a hearth, a chopper, or a house did not simply spring from the earth but occurred because it was made and used.

Thirdly, such classifications appear to be certain. When one reads through a site report, he finds that the majority of features are unequivocally assigned to one functional class or another. Archaeologists apparently feel confident in their ability to distinguish "metates," "floor polishers," "beads," and "projectile points," for example. The unequivocal nature of particular explanations derives, in the Hempel-Oppenheim model, from the use of formal reasoning or deductive logic. In fact, such logic is the *only* form of reasoning that can produce a necessary or certain conclusion. It is reasonable, therefore, to expect that the certainty of classificatory explanations also derives from the use of deductive reasoning. To determine this a final parallel must be shown—that of the subsumption of particular explanations under universal laws.

There are sound reasons for believing that such universal laws exist in archaeological theory. First, in order to relate one particular phenomenon to another, it is necessary to have certain ideas about the relation of such phenomena *in general*. This is particularly true when such relating is done by many people in many parts of the world and in many particular cases. Thus there would seem to be agreement among Old and New World archaeologists that a feature with certain characteristics would have these characteristics because they were once "hearths." We can see no way of explaining this regularity except by assuming that they hold general ideas in common which they consistently apply in particular cases.

Secondly, such general ideas are necessary when the rationales for the relation of phenomena are not self-evident. We all know that archaeologists can directly observe the formal and contextual properties of their data, while we cannot directly observe the functions of these data. Yet we are quite willing to assign particular objects to particular uses. This is not done arbitrarily, but with the belief that *such* objects had *such* uses. Without such beliefs there can be no rationale for selecting certain characteristics out of the potentially infinite number that an object possesses, and for stating that these occur because of the "function" of the object. But there must be a *reason* for this belief. We suggest that archaeologists state that such relation exists in a *particular* case because we believe that it exists in *all* such cases. These beliefs, thus, have the form of universal conditional statements. They state, in essence, that if a particular activity has occurred, then a certain set of characteristics will be found in the archaeological record. For example, when we classify an object as an "axe," we do so because we believe that all objects used as axes share certain characteristics which this object has as well.

In short, we suggest that many classifications are explanatory and conform to the Hempel-Oppenheim model. Prior to the classification of particular archaeological data, certain beliefs or laws exist in the form of general classificatory concepts. These relate the function of data to certain formal and contextual properties. We observe a *particular* object or feature and note that it has a certain set of characteristics. We explain these characteristics by classifying it; that is, by stating that it had a certain function in the past. The classification is certain or logically necessary because the reasoning is deductive; that is, it proceeds from a general premise through a particular premise to a particular conclusion.

We feel sure that many other kinds of archaeological reasoning could be shown to conform to the Hempel-Oppenheim model. Classifications of "cultures," or other, more general taxa, for example, require certain assumptions or laws about the nature of "cultures" in general, and about their empirical manifestations. Interpretations of generic relations between specific cultures or of cultural processes within a given cultural sequence are also derived from laws about such phenomena in general.

THE FORM AND VALIDITY OF ARCHAEOLOGICAL THEORY

Several implications follow from the applicability of the Hempel-Oppenheim model. In the first place, deductive logic is not only appropriate to archaeological interpretation, but also actually employed by archaeologists. Thus, Thompson's position is misleading at best. Assuming that some archaeologists reason less well than others, we argue that objective criteria exist for the evaluation of the logical validity of explanatory arguments and the elimination of false arguments.

In the second place, there is a set of ideas or beliefs which function as laws. They relate various behavioral and cultural phenomena to various characteristics of the archaeological record. These assumptions, which jointly might be said to constitute archaeological theory, have the further

characteristic of referring to extremely general phenomena. To say that something is a house, a hearth, or a projectile point is saying something about it, but it is also leaving many things unsaid. Was the hearth used for cooking, heating, lighting, or smudging? The term "hearth" does not tell us. Thus, present archaeological theory contributes less to our understanding of specific human phenomena than many of us would like.

This archaeological theory is also usually implicit rather than explicit. We have noted that classifications rarely give the empirical properties of data and the past behavior which explain them. They are simply implied by the classificatory term. When they *are* discussed, it most commonly occurs when the proper classification of a particular feature is uncertain. Thus, is a feature a "hearth" or a "heating pit"? Is a biface a "projectile point" or a "knife"? The characteristics of each *kind* of feature or artifact may be presented and an explicit judgment made based upon the characteristics of the specific artifact or feature.

Allusions to laws which subsume particular explanations are even more infrequent. In other disciplines, such laws are commonly found in textbooks (Kuhn 1964:10). But it would be quite difficult to find an archaeological textbook which describes the relationships of human behavior and archaeological data. Laws also do not occur explicitly in explanations because the use of such laws is hidden by the implicit nature of explanations.

Finally, these laws do not occur as conclusions to works which establish their validity. It would be difficult—if not impossible—to find in the archaeological literature any argument, demonstration, or proof of the empirical truth of any of these laws. This is a most important characteristic, for it implies that archaeological theory consists of statements which have not been subjected to the same evaluative procedures as have the theories of many other scientific disciplines.

Thus far we have discussed a technique for *using* laws in archaeological research, the largely implicit use of laws to date, and the need for a research design which makes explicit a technique for validating hypotheses giving them the status of laws so that their explicit use is possible. We will now discuss a traditional design for validating hypotheses, present our alternative which we found more suitable, and compare the two approaches. To repeat, the discussion to this point has focused on the use of laws. What we will now discuss is how we obtain these laws in the first place.

A TRADITIONAL RESEARCH DESIGN

The research design which archaeologists have claimed to have used corresponds in essentials to what philosophers of science have termed the empiricist or narrow inductivist approach. Carl Hempel describes this design as follows: ". . .(1) observation and recording of all facts, (2) analysis and classification of these facts, (3) inductive derivations of generalizations from them and (4) further testing of the generalizations" (1966:11).

A recent statement of this approach in archaeological terms was made by B. K. Swartz (1967). According to Swartz, the following would constitute an ideal model for research:

1. Preparation—"Preparation is the acquainting of oneself with the nature of the archaeological problem or basic objective to be resolved. . . .There are two aspects of preparation: (1) survey of work already done, and (2) preparation for the technical problems of field work" (pp. 487-488).
2. Acquisition—"Acquisition is the mechanical process of deriving data from the field for later study and analysis" (p. 488).
3. Analysis—"Analysis is the procedure whereby archaeological data are placed in a framework of time and space. . ." (p. 489).
4. Interpretation—"The goal of interpretation is to discover how an assemblage of artifacts was manufactured and used at a certain place at a specific time. . ." (p. 489).
5. Integration—"There are two aspects of integration: reconstruction and synthesis. The objective of the first is to reconstruct, as completely as possible from inferential data, how a group of people lived in a certain place and at a certain time. . . .Synthesis is the procedure by which larger culture-content units of a taxonomic nature are formulated and described" (p. 493).

6. Comparison—". . .Comparison is not a step developing out of integration, but it is an alternative approach to interpretative data" (p. 494).
7. Abstraction—"The ultimate goal of integration and comparison is the abstraction of general laws or principles, from persisting uniformities and regularities" (p. 494).

The goal of archaeological research according to Swartz is abstraction (1967:494). Swartz maintains, as we have, that archaeologists should seek laws. However, we believe that while empiricists claim that the discovery of laws is their goal, the method which they employ is in direct conflict with this goal. There are two reasons why this is the case.

First, the empiricist approach assumes that all archaeologists collect all the data relevant to any explanatory proposition which might propose itself later in the research. In fact, no archaeologist does this. No archaeologist could do it. In the absence of some specific problem, archaeologists collect those data which they have been taught to perceive. But, there is no guarantee that these data will be sufficient for solving more than a limited number of problems which might occur to the researcher after he has collected his data.

This same objection is extended to the level of analysis and classification by Hempel when he states that ". . .if a particular way of analyzing and classifying empirical findings is to lead to an explanation of the phenomena concerned, then it must be based on hypotheses about how those phenomena are connected: without such hypotheses, analysis and classification are blind" (1966:13). If explanation is to be the product of our research, it must also be the organizing principle. Relevant data, analysis, and classification must be defined before research is actually begun.

Second, the empiricist approach assumes that facts will speak for themselves and that explanations or laws are summaries of facts. If one collects sufficient data, analyzes, classifies, and otherwise juggles it sufficiently, explanations or laws are supposed to begin to propose themselves.

Most philosophers of science would instead argue that trial formulations derive from the creative capacity of the scientist. Abduction—reasoning in which the scientist perceives patterns—is the term which Aristotle applied to the use of this capacity (see Hanson 1965). If discovery is a function not of the time spent in looking at data, but of a conscious attempt on the part of a researcher to perceive patterns, then this fact should be reflected in any model of an ideal research process. By the same argument generalizations, laws, or explanations cannot be regarded as simple statistical or non-statistical summaries of data.

THE EXPLANATORY RESEARCH DESIGN

These criticisms of the empiricist research design are overcome by what we call the explanatory research design. In discussing this research design, we will be considering the case where the researcher wishes to evaluate the validity of a proposed law.

Research would proceed as follows:

1. Acquisition of a hypothesis—research begins at the point when, in the course of his research, the archaeologist acquires a hypothesis to be tested. This would include the antecedent conditions which are offered as the particular explanation for a phenomenon as well as the law or laws which make this explanation predictable. The hypothesis might be an original abduction or might be taken from the literature of any social science.
2. Formulation of test implications—given a hypothesis, the next step is to deduce test implications: statements of relationship between variables which predict these relationships within the data to be collected which should exist if the hypothesis is a valid one. The data to be collected are specified and tests to be used in evaluating postulated relationships are formulated.
3. Formulation of a research strategy—the primary task undertaken at this point in the research is the design of a statistically random or other rigorous sampling plan for collecting the appropriate data. Technical problems of data collection should also be solved.
4. Acquisition of data.
5. Analysis of data—analysis is the process whereby data derived from the field are put into the form in which they will be used in testing.

6. Testing of hypotheses–here the specified tests of the degree of association between variables are carried out.
7. Evaluation of the research–this step involves evaluating the explanatory proposition from which test implications were deduced by referring to the tests. If the relationship between variables, which should have been discovered if the explanation were a valid one, is discovered, then the explanatory proposition is confirmed and an explanation is obtained. If the predictions do not hold, then the explanation must be rejected in terms of the current research.

The employment of this research design would overcome the weakness of the empiricist model. First, data, analysis, and classification relevant to the explanation under consideration are defined at the outset of the research. (Data not vital to the research which is disturbed in the process of acquiring data should, of course, be recorded and preserved. The archaeologist should, however, feel obligated to analyze only those data which are relevant to his research.)

Second, the research design does not assume that facts will speak for themselves. It assumes that valid explanations result from research designed to test the validity of explanations. If explanation is our goal, research must be based upon a model which sets out to test the validity of explanations. If laws are our goal, then research must be based upon a model which sets out to test the validity of hypotheses. Neither laws nor explanations can be an afterthought. They must be the purpose of research and must be allowed to define the appropriateness of research design.

CONCLUSIONS

Two further points should be made. One relates to the present nature of archaeological theory, and the second to the relevance of any archaeological theory. If scientific knowledge can be defined as a set of tested statements describing reality, prescientific knowledge might be defined as a set of statements which are plausible and accepted, but which have not been tested. In this sense current archaeological theory is prescientific. It has not been tested.

Current explanations in archaeology must be considered prescientific in the same sense. One of the conditions of adequacy for the Hempel-Oppenheim model is the empirical truth of the statements employed. Because that condition has not been met, archaeological explanations cannot be considered true in the same sense as explanations using proven laws. To the degree that it is possible that archaeological theory will be proved to be false by testing, explanations using this theory are also potentially false. Since it is impossible to evaluate this possibility without performing the necessary tests, it is also impossible to evaluate the truth or falsity of archaeological explanations. Thus it is impossible to evaluate the validity of classifications or of any other current archaeological explanations.

We believe that this characteristic of archaeological theory is recognized by many archaeologists. We are often reluctant, for example, to assign past function to our data. When we do, we may prefer to use the word "possible," for example "possible water container," or more often, we assign such a general function that we feel the odds for being found incorrect are small. We are more likely to be correct if we classify a feature as a hearth than if we classify it as a cooking pit, for example.

But we all want our discipline to contribute to the knowledge of laws of human behavior. One of the easiest ways that this is can be done is to demonstrate the empirical validity of the regularities we think exist. We have described a research design by means of which this can be accomplished. It entails (1) the explicit definition of the form and relation of specific variables, (2) the argument that specific instances of these variables are predicted by specified laws, and (3) the confirmation (or disconfirmation) that the variables occur (or do not occur) in the predicted form and relation in observed cases.

Another problem deserving of primary attention is the kind of explanations we should set out to test. In the past, archaeologists have felt bound by the explanations which their data "suggested." The explanatory approach removes this restriction, but it forces the anthropologist to justify the explanations which he chooses to test as being valuable uses of research time. In the long run, this obligation can be met only by taking as explanations to be tested problems which are relevant not only to archaeologists but to social science as a whole. Archaeologists claim to

have a set of data which is of unique value in studying processes of long-term change and development. Yet, we have rarely used our data to do this. Given the freedom to choose explanations for testing, we have incurred the obligation to strive to be relevant. We suspect that unless archaeologists find ways to make their research increasingly relevant to the modern world, the modern world will find itself increasingly capable of getting along without archaeologists.

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