I should like to begin this paper with the statement of a proposition: that archaeological pollen studies are of two distinct categories. The primary category of studies is that which is traditionally undertaken. Here, the objective of the pollen work is to determine the occurrence of, and the nature of, significant ecological variation through time and to explain this variation by reference to climatic and biological factors. The archaeological record is then correlated with the sequences of change discovered, with the expectation that this will shed light upon cultural phenomena.

Studies of the secondary category are distinct in their objective. Here, the problem is to design a palynological study which will resolve specific archaeological problems. In effect, studies of the primary category seek to recover ecological information of value to archaeology; studies of the secondary category seek to discover archaeological information through the use of the technique of pollen analysis. The traditional pollen chronologies, which inform us of the variations which have occurred in forest composition through time in an area, are of tremendous value to archaeologists. They reconstruct the broad picture of climatic limitations imposed upon cultures once in existence, and they allow the dating of cultural horizons which cover large units of time. But the value which these studies have for archaeology is relatively accidental. The studies were designed to allow reconstruction of the nature of forest coverage and this happens to be information which the archaeologist can utilize.
In the secondary category we find examples of pollen work which do not accord with that traditionally undertaken. There was a study of sediments from the floors of houses, which demonstrated that the cultural function of a house could be recognized from the pollen flora its floor contained. There was a study of the variations in non-arboreal pollen in a chronology which demonstrated changes in weedy flora concomitant with agricultural practices. My own studies in this category have been directed towards the reconstruction of variations in moisture and length of growing season which affect the agricultural potential of maize, regardless of the effects of these climatic factors on the general flora. Such studies were designed to illuminate archaeological problems, and the value they may have to paleoecologists or paleobiogeographers is largely accidental.

Of course, this division into two categories is artificial. Many, perhaps most, pollen studies are not designed to recover specific kinds of information. Rather, they are attempts to recover all the kinds of information that may be recovered. But for the time being I should like to proceed as if it was more common to design the course of analysis for the resolution of specific questions. This is recognized as something of a logical fiction, but it is one which allows us to more clearly define some of the particular characteristics of archaeological pollen work. For the duration of this paper, I shall speak principally of the problems facing the pollen analyst who attempts studies of the secondary category; that is, the pollen analyst who attempts to design his studies more for the recovery of information of archaeological than paleoecological value. By contrasting these problems with those of the analyst who designs his
his studies to recover information of the primary category, I hope to demonstrate some of the very specialized problems of archaeological pollen studies.

The analyst who desires maximal information of archaeological value must recognize that the archaeological site itself is often the best available source of sediments for the recovery of the kind of data he needs. If he wishes to discover that types of crop plants were utilized, he may either look to the pollen content of the ancient fields themselves, or the pollen content of the garbage middens that have been deposited at the locality of human occupation. If he wishes to verify the archaeologist's assumption that a specific sort of room was utilized for storage of plant foods, while another type of room had another function, the sediment samples must come from within the rooms themselves.

However, there are a number of difficulties which arise from the analysis of sediments from cultural contexts. The principal problem is that of pollen preservation. Usually, the quantity of pollen preserved is very much lower in sediments of cultural provenience than in the organic and lacustrine deposits with which palynologists deal more commonly. The sediments have often been deposited very quickly, and are highly inorganic. One or two meters of garbage or midden deposit may accumulate in only a few years, trapping very little of the local pollen rain in any given centimeter of deposition. Thus the analyst who deals with sediments from cultural contexts must expect relatively greater difficulty in extracting significant amounts of pollen from his samples. At one series of sites I was able to obtain enough pollen from only about one-third of the samples which were processed.
The quality of pollen preservation is also usually not very good in sediments from cultural contexts. The sediments are not often deposited under anaerobic conditions, so the effect of the atmosphere and its microorganisms on the pollen may be pronounced. One often finds badly decomposed, corroded, and broken pollen, which makes identification difficult. Exine-exine relationships are commonly completely obscured. Differential destruction of pollen types often is evidenced by the quality of preservation.

Another difficulty arises from the effect of the human population at the site. One must presume, when analyzing sediments from cultural contexts, that there is direct or indirect influence on the pollen spectrum through cultural activity. The whole spectrum, indeed, may sometimes be as artificial as the deposit from which it was recovered. Pollen of weeds which invade disturbed locations may be presumed to be overrepresented in sediments collected from a garbage midden, as may the pollen of plants utilized as foodstuffs. In samples from house floors one may find over-represented pollen types indicating the results of manufacturing processes, medicinal and ceremonial practices, or storage habits. From the interiors of vessels one may recover a pollen spectrum evidently biased by the material, perhaps honey, which the vessel once contained. Such misrepresentations as can be explained by the provenience of the sample can be compensated for and provide useful information. However, one may also recover pollen statistics which may be artifacts or may be indices of a change in the conditions of the local environment. A significant rise in the frequency of a certain pollen type on a certain horizon might be due to either a cultural or a natural set of factors.
Because of the over-representations (and subsequent under-representations of other taxa) in the statistics of the pollen spectra, samples collected from the same time horizon may or may not appear comparable. Certainly, one need not expect that the pollen spectrum from a cultural deposit will appear comparable to one from a natural deposit of the same age. But beyond this, a sample from a garbage midden need not be expected to appear comparable to a sample from a house floor at the same site of the same age. To compensate for these difficulties, the analyst who deals with sediments from cultural contexts must apply himself to the problem of statistical manipulation of the raw pollen data. If two samples are known to be of the same age, and to come from an area which may be assumed to be one ecological unit, then the discrepancies in their pollen spectra must be due to cultural, rather than natural, phenomena. By statistically factoring out the discrepancies, one segregates the "natural" from the "cultural" condition. There is no difference, in principle, in factoring out culturally determined statistics and certain naturally determined statistics. It is not unusual for palynologists to factor out the statistics of aquatic pollen types where these represent a specific natural condition which bears no relationship to the object of their study. Factoring out the "natural" and "cultural" aspects of the pollen statistics from cultural contexts is a similar operation. However, the evaluation of which pollen statistics should be manipulated is based upon different concepts. In the case of non-cultural contexts, the palynologist evaluates the pollen statistics from the viewpoint of ecological and geological knowledge. In the case of pollen records from cultural contexts, the pollen statistics must be evaluated from the viewpoint of archaeological knowledge.
Another set of difficulties may face the archaeological pollen analyst in regard to chronology. Archaeological problems of dating, both relative and absolute, demand quite different types of horizon markers than do the problems of paleoecology and paleoclimatology which are more usually investigated through pollen analysis. In geological stratigraphy, horizon markers are considered fully adequate if they segregate periods of millions of years duration. In non-archaeological pollen studies, or studies of the primary category, horizon markers which segregate periods of thousands of years duration are the rule, though some effort is directed to determination of the proper millennium during which climatic changes occurred. In modern archaeological research, however, even these periods are often too extensive. There is no need to turn to pollen analysis for absolute dates of horizons which can be established by the techniques of radiocarbon dating. The question is not which half-millenium saw the introduction of agriculture in an area; the artifact record and radiocarbon dating will yield the answer to this without pollen work. However, pollen analysis can resolve the question of when agriculture was introduced within a half-millenium time span. By sampling older and younger deposits within this period, such a question may be resolved.

Archaeological problems of microstratigraphy may also be dealt with through pollen work when other techniques fail. It is often important to determine when, within the period of occupation at a site, some particular cultural features were in existence. By sampling the floors of houses, and comparing the resultant pollen spectra against a stratigraphic series collected from a garbage midden, one may discover which houses are earlier than others. By this technique, we have been able to map the growth pattern of the village of sapawe in New Mexico through
time. In a similar fashion, we have demonstrated the contemporaneity of sites and parts of sites over a general region on time horizons of less than a century.

Finally, there are special problems of archaeological pollen studies which derive from the fact that man is a fully terrestrial organism who makes use of terrestrial environments. The ordinary techniques of pollen extraction are, actually, not particularly well suited to sediments which are not functions of aquatic and sub-aquatic deposition. If we are to undertake pollen research at archaeological sites, we must be prepared to extract pollen from terrestrial deposits. In Oceana, archaeological sites are basically composed of sands derived from the breakdown of coral. I have tested such sediments from Melanesia, and know that they contain pollen, but I know of no efficient means of extracting it. The pollen content of alluvial, colluvial and eolian deposits is a more common problem. Application of the extraction techniques used for lacustrine deposits often yields sufficient pollen for analysis, but just as frequently does not. Efficient techniques for the extraction of pollen from terrestrial sediments must be devised before many kinds of sediments can be dealt with in archaeological pollen studies.

But perhaps it is most important to recognize the special problems which derive from the fact that archaeological pollen studies play one very particular role in archaeological research. Pollen analysis provides the best available technique for recovering data about the relationship between culture and environment. Through pollen analysis it is possible to discover the specific character of the ecological patterns within which a culture once operated. Like other organisms, however, man exploits only some of the many possible environmental patterns existing in his surroundings. One must be able to devise palynological
studies that recognize the various distinctions in the general pattern if one is to ultimately comprehend what the actual relationships between culture and environment may have been.

These distinctions must be expressed in human terms, if they are to be of maximal utility in archaeological research. Ordinarily, in making our environmental reconstructions, we say that a certain period was colder and wetter, or warmer and drier, and that a certain kind of forest existed. This is important to know, but it is not a reconstruction that is expressed in the terms that may have influenced human activity. Granted it was once colder and wetter; does this mean that stout shelter was needed? Does this mean that more territory was needed to provide meat for the family of a paleolithic hunter? Does this mean that movement by foot was hindered for certain seasons of the year? We say that an oak forest existed at a certain time, but how many nut trees could be harvested on an acre? Exactly what plant sources could have been exploited for fuel and food in the immediate area or a site? Were the regions of fertile soil widely available or concentrated in certain places? Were farmlands, or hunting camps, located relative to certain concentrations of floristic types?

These are archaeological questions; questions which pollen studies may resolve. But they are not to be resolved by pollen analysis alone. Rather their resolution will entail evaluation of palynological data relative to information only archaeology can provide. If we wish to know what plants in the neighborhood of an archaeological site may have been used as fiber sources, we must need to first know what kind of textile technology the people might have had. Does the
site contain implements which might have been utilized in manufacturing
cordate from linden bast? If it does not, the fact that Tilia may have occurred
in the area could be irrelevant. As far as these people were concerned, linden
may not have been a cordage source even though it occurred in the region.

Put concretely, I have attempted to point out that archaeological pollen
studies which use the technique of pollen analysis as a tool in archaeological
research have special problems that do not arise when the technique of pollen
analysis is used as a tool in paleoecological research. Some of these problems
arise from the fact that the pollen samples may come from sediments of distinctive
character affected by both terrestrial deposition, and calculated or inadvertent
cultural contamination. Other problems arise from the fact that the chronological
precision demanded by archaeology may be of a quite different order than that
demanded by paleoecology or geological stratigraphy. Most important, however,
are the special problems which develop from the recognition that human relation­
ships to environment are not at all like those of other organisms. Man does not
respond to his environment through instinctive patterns of behavior; man responds
relative to his cultural knowledge and training. To use pollen analysis as a method
of investigating the relationship between a culture and its environment requires
some measure of comprehension of both the cultural condition and the natural
condition which the pollen record expresses. This is truly interdisciplinary
research, which may be expected to involve very unusual methodological features.