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ZEBREE 1975
Morse/Mersereau 1976

Phyllis A Morse

A PRELIMINARY REPORT OF

T H E Z E B R E E P R O J E C T

New Approaches in Contract Archeology in Arkansas

1975

Assembled and Edited

by

Dan F. Morse

and

Phyllis A. Morse

Arkansas Archeological Survey

Research Report No. 8

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INTRODUCTION

Dan F. and Phyllis A. Morse

This publication concerns the final excavation of the Zebree site in northeast Arkansas which will be totally destroyed by the U. S. Army Corps of Engineers in the spring of 1976. The site is located within the Big Lake National Wildlife Refuge in northern Mississippi County and is on the National Register of Historic Places (Fig. 1).

The site covers just over 3 acres of jungle-like secondary growth (Fig. 2). About 1 acre was destroyed when a ditch and levee were built to the west around 1920. After 1936 the levee was enlarged and tales exist today of the destruction of considerable prehistoric Indian remains. Big Lake was once thought to have been caused by the New Madrid earthquake, but our summer research shows it to be much older. The left hand chute of Little River flows out of Missouri through Big Lake and joins the St. Francis River several miles to the south. The Sebrees homesteaded the site in the late nineteenth century as commercial fishers and hunters. The Zebree site continued to be cultivated into the 1940's when the land was allowed to return to a natural state. Since the attempts at drainage control began, silting has changed the complexion of local vegetation. Because of the protection of the general area by the Fish and Wildlife Service, we have a better idea of what the original environment was like than in the cleared agricultural areas of northeast Arkansas.

In December of 1974, we were notified that the possible destruction of the Zebree site was imminent. We began developing possible budgets and a general excavation strategy then. We had very short notice concerning the final decisions on mitigation.

The decision to provide mitigation funds instead of moving the proposed ditch was made by the Corps in a meeting in the Memphis District office on May 27, 1975. In five weeks time we had to hire 36 individuals, order thousands of dollars in equipment, obtain official permits, secure a lab and living quarters, and make final decisions concerning excavation strategies. Excavation began on July 8, 1975, when notification of the final signing of the necessary Memorandum of Agreement was received. We were given the task of excavating a wooded 5-acre Mississippian center which involved three additional components. We were restricted to a finite excavation period of late summer and to an absolute maximum of $102,000 because of the U. S. Army Corps of Engineers' interpretation of the 1% limitation contained in P. L. 93-291 (Sections 4 and 7). None of us feel that we have

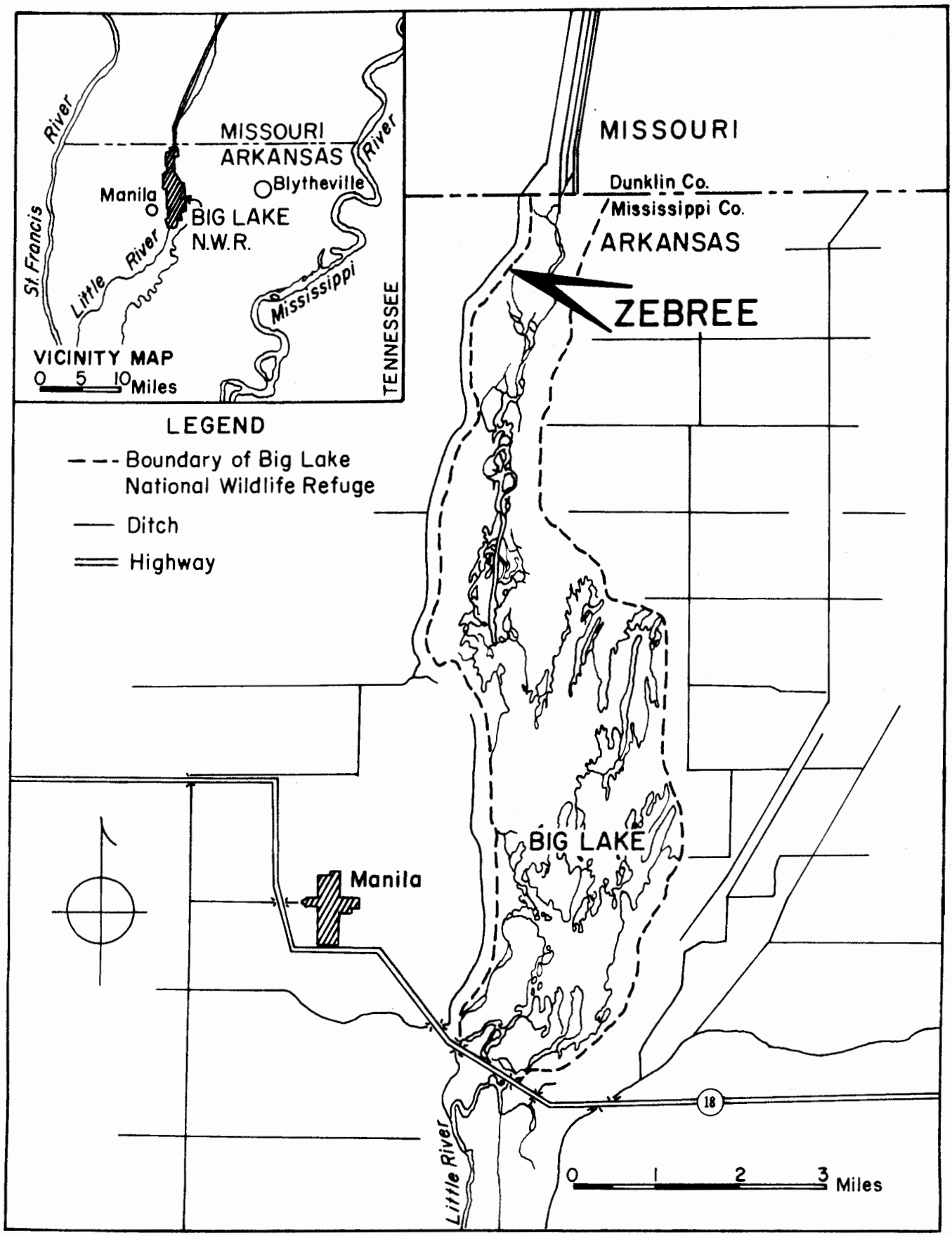

Figure 1. Vicinity map of Big Lake National Wildlife Refuge and location of the Zebree site. Modified from a map by the U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service.

Figure 2. The Zebree site (3MS20) after extensive clearing and immediately prior to excavations, July 1976. View from bridge due south to Area B.

adequately mitigated the adverse effects of the ditch and levee system which will destroy this and other prehistoric and historic sites along the west edge of Big Lake.

You will read in the reports of the principal participants about their part in our approach, both from the standpoint of recovery and analyses. You will not read about the mosquitoes, the poison ivy, chain saws which would not always start, water screening hoses breaking, generators clogging up, "pot hunters" who dug up to and immediately after the excavation, floods which destroyed most of our backhoe trenches, the cliff-hanging delay of the Memorandum of Agreement, a flu epidemic, and the other normal environmental phenomena expected by archeological expeditions. Also not emphasized are stylistic vagaries in ceramics and points, refuse pit dimensions, the number of bones found in a burial, the only whole pot, and other archeological facts and trivia which you can read about at leisure after the final analyses are available in approximately two years. We wish to explain our approaches and to discuss expected results. The emphasis is on recovery techniques because this is all we have actually accomplished so far.

Papers by Morse, Anderson, Newsom, Roth, Harris, Raab, and Smith were presented at the 32nd Annual Southeastern Archeological Conference in Gainesville, Florida, on November 8, 1975 and are presented here with slight modification. Much of the credit for actual editing and proofreading should go to Phyllis A. Morse. The manuscript typing was done by Ruby Chittenden. Brenda Keech, Louis Gregoire, Mark Raab, John Cotton, and Arleen Olson are responsible for the illustrations.

We wish to thank the members of our field and laboratory crews at this time. They are: Richard Brengard, Dixie Bright, Abbie Bush, Julie Chambliss, Jerry Clayton, Jane Cotton, John Cotton, Joseph Darr, Tony Davis, Barry Elrod, Jane Evans, Jerry Gray, Alice Greene, Debbie House, Douglas Hurdelbrink, Richard Hurt, Bob Matthews, D. D. Million, John Priday, Richard Rockwell, Cindy Schrader, Jay Sperber, Nan Stiles, Karin Tucker, Terry Tucker, Iris Weaver, and Ollie Wood. Most of these were college students in both graduate and undergraduate programs. Nine were anthropology majors, the others had interests as varied as wildlife management, physics, and pharmacy. Particular credit must go to Gayland Wilson, the owner and driver of our backhoe. His heavy equipment was the equivalent of another 8-man crew.

The staff of the excavation consisted of Dr. Dan F. Morse, project director; L. Mark Raab, field supervisor; David Anderson and Jeffrey Newsom, field assistants; Phyllis Morse, processing

lab supervisor; Suzanne Harris, ethnobotany lab supervisor; Eric Roth, zooarcheology lab supervisor; and Michael Million, ceramics lab supervisor.

A number of outside experts were employed to give specialized input into the collection and interpretation of data. Dr. Jim Price, University of Missouri, did a metal detector survey of the site which located specifically the single dump area adjacent to the Old Sebree House, which existed here during the late 19th and early 20th century. Dr. Jim King, Illinois State Museum, collected lake cores which appear, at this early date, to confirm the existence of a lake at least 1000 years ago and which contain abundant and well preserved pollen. Two cores were collected to test for the possibility of paleomagnetic dating. Dr. Dan Wolfman, Arkansas Archeological Survey, collected these two cores and two burned site samples as a part of his investigations to test the feasibility of archeomagnetism as a reliable relative dating technique. Lynne Bowers, Shelby State College, collected increment cores and chain saw sections of bald cypress to examine further with dendrochronology the New Madrid episode of 1811-12, evident at the site in the form of earthquake cracks; to provide additional data for the reconstructed environment based on the original land survey maps of 1830-50; and, to correlate with and date the recent flooding of the area apparently caused by bad drainage system planning. This latter has resulted in a significantly higher water table today at the site and flooding not identifiable in any of the prehistoric or even historic deposits at the site. Dr. Alan Solomon, Department of Geoscience, University of Arizona, is examining pollen samples from the site. Human skeletal material from Zebree was curated by Jay Sperber during the excavation and is currently being studied as a class project under the direction of Sandra Scholtz, University of Arkansas. Ms. Scholtz also provided valuable guidance in setting up the computer graphic analysis. Albert C. Goodyear and John House of the Institute of Archeology and Anthropology, University of South Carolina, provided valuable advice and comments regarding the sampling procedures. Dr. B. Miles Gilbert, University of Missouri, lent us a faunal type collection for the summer.

Various suppliers of equipment are due particular thanks in coping with deadlines, delays in billing, and assorted bureaucratic red tape. Barton Lumber Company of Jonesboro located and delivered large orders of supplies with a minimum of delay. Manila Pro Hardware and the Manila Lumber Company supplied later equipment needs which arose. Douglas Drugs of Jonesboro located various unusual items for us. Lone Star, Inc. of Jonesboro supplied fuel for our backhoe. City Water and Light of Jonesboro, contributed

considerable help which allowed us to construct a bridge. County Line Liquor provided us with beer flats to use as artifact bins. The Arkansas State Land Commissioner, Sam Jones, furnished us with original land survey records to help reconstruct the environment in the early 1800's.

John Doebel and the staff of the Big Lake National Wildlife Refuge were very interested in the Zebree project and most cooperative in giving us various federal permits, letting us use a house on the refuge for a laboratory, and lending us boats and items of equipment when needed. Colonel A. H. Lehman, District Engineer, and Don Martin, Contractor's Representative for the Memphis District of the U. S. Army Corps of Engineers, were most cooperative in expediting the signing and circulation of the Memorandum of Agreement.

Thanks for special favors go to Alan Weaver, Paul and Mary Gay Shipley, Dick Stamp, Jim DeSpain, Pat Bell, Bobby Moore, Ray Benefield, Melvin Cude, and the members of CLASS. Tom Watts, an amateur archeologist from Pine Bluff, spent a week helping us on the dig.

A final note of thanks goes to Dr. Charles R. McGimsey III, Director of the Arkansas Archeological Survey and Hester Davis, State Archeologist. They took care of the long and difficult process of negotiating the contract with the Corps of Engineers and obtaining permission to excavate from a series of state and federal agencies.

BACKGROUND OF THE INVESTIGATION

Dan F. Morse

Abstract

The Zebree site is slated to be destroyed in early 1976. Tests in 1968 and an excavation in 1969 revealed four occupations. In 1975, an emergency final salvage program was carried out. A field lab was staffed with an ethnobotanist, a zooarcheologist, a ceramic expert, and a general processing supervisor. In the field were a supervisor and two graduate assistants. Two years have been budgeted for final analyses and publication of results. All personnel had an opportunity for contributing to the excavation research design. A CLASS meeting was held at the site and two reviewers visited the site. This also contributed significantly to the overall excavation/analysis design.

The Arkansas Archeological Survey was created by the State Legislature in 1967 and one of the first sites to be studied was Zebree (3MS20). The original material collected was debris thrown out of a pothole. The artifacts were basically unfamiliar ones and indicated a very early phase of Mississippi. There were rumors that the Corps was going to ditch this and two other related sites and we conducted a month-long Survey-supported preliminary testing program to gauge research potential (Morse 1968). At no time did we ever conduct a survey of the whole proposed ditching project. The other two sites were found to be badly disturbed by previous ditching and late 19th to early 20th century construction and appeared to be of minimal research value. Later a fourth site was discovered and recommended for salvage but was destroyed in early 1975.

At Zebree, where two test pits were excavated in 1968, not only was a new phase confirmed, but one section of the site was discovered to be stratified and definitely separated Woodland and Mississippi deposits thought previously to grade temporally and evolutionally one into the other. This evolutionary notion was

based on mixed deposits near Hayti, Missouri (Marshall 1965). The Cahokia microlith industry at this time was found to be represented at Zebree, the first non-Cahokia site to be recognized as involved in the manufacture of Cahokia-type microliths (Morse 1971, 1974). In addition, the stone used outcropped near Cahokia and was the same used most often at Cahokia for microlith manufacture.

The 1968 Zebree test pits were used as a basis for exposing two large units in 1969 (Morse 1969; 1975b). We spent nine weeks with a small crew at the site working under a National Park Service cooperative agreement. Although some flotation was attempted, sifting soil through 1/4" mesh screen was the standard recovery technique. Our major goals were to confirm the 1968 tests, to collect sufficiently large assemblages of artifacts in good cultural context to provide an adequate and representative sample of all occupations, to relate the two areas of the site to each other, to expose house patterns and at least hints at community plans for each occupation and to obtain sufficient samples to investigate more fully the nature of the Zebree Microlith industry. Some refer to our efforts as "intuitive archeology," others call it representative or nonrandom sampling. Whatever one wants to call it, our problems at that time dictated excavation of large contiguous areas primarily to collect feature and natural strata samples.

We collected much larger and more varied samples than anticipated and it took four years to do the laboratory processing and analyses. The indications from the 1975 excavations were that the two 1968 test pits and subsequent enlargements were in the two richest portions of the site. The excavations in 1969 revealed the possibility of an early Mississippi stockade ditch, exposed a middle Mississippi house complex and provided us with our first substantial Woodland ceramic collection. Almost 50,000 sherds and numerous other artifacts and debris were recovered and together constitute our largest and most complete northeast Arkansas sample for the Mississippi and Woodland periods. Hypotheses to explain recovered data began to accumulate. We formulated and theoretically tested a hypothesis of manufacturing salt from a lake plant. Ceramic debris has resulted in research leading to an understanding of basic Mississippi ceramic technology for the first time (Million 1975).

On the basis of Zebree fauna identifications reflecting a lake exploitation, Roger Saucier developed an alternate hypothesis to the 1811-12 earthquake to account for the origin of Big Lake, which postulates a lake at AD 900-1100 (Saucier 1970). John Guilday and Paul Parmalee (1971) identified prairie chicken and the 13-lined

ground squirrel in the bone debris, which indicated both a prairie exploitation and a complex multiple ecological exploitation. This is similar to the data revealed by the fauna lists in Williams' (1954) account of the Cairo Lowland Crossno Site and now identified as typical for Mississippi in the Central Mississippi Valley by Bruce Smith (1974). We have hypothesized that the newly formed lake attracted early Mississippi peoples (the Big Lake phase) to this area. Cahokia Fairmount-like features such as house plan, vessel forms and decoration, burial pattern, and choice of lithics were recognized and used as a basis for hypothesizing a basic relationship to Cahokia. The obvious stratigraphic break between two distinct traditions previously thought to develop evolutionally caused a re-examination of Willey's migration hypotheses (1953) with an emphasis here on process (Morse 1975a). Sahlins' hypotheses (1961) of cultural change based on African groups were also examined, both for the Woodland data and possible relationships to a migration of Mississippi. Whether these hypotheses are correct or not at the moment is not important. What is important is 1) our research is being guided so that we are asking specific behavioral and biophysical questions before we sample, and 2) our approach is regional and systemic.

In early 1973, the Zebree manuscript on the 1969 work was finished. In the meantime, two years of preliminary work on the later Nodena phase research design were also finished (Morse 1973a) and two Nodena phase sites were tested in as many years with combined University of Arkansas and Arkansas State University field schools (Morse 1973b, P. Morse 1974). We tested ways of processing artifacts as soon as they were excavated. We also tested the use of a specialist in the field (such as a zooarcheologist) who normally was presented a bag of broken bones to inventory for the appendix of a report. Techniques of water screening were tested and experiments run on the use of different screen mesh sizes (Fig. 3). Jeff Flenniken, a chert knapper with the Survey, experimented with 1/4" mesh screen recovery capabilities and discovered that only 15% of preform debitage and 0% of arrowhead manufacturing debitage are recovered using 1/4" screens (Flenniken 1975). We discovered that 1/16" mesh screen could conceivably cause a completely different exploitative strategy model. People whose debris goes through 1/4" and 1/2" screens do not seem to fish nearly as much as people whose debris is sifted through 1/16" mesh screens! One basic difficulty was that water screening through 1/16" screening took a lot of time. We also experimented, as have others, with swinging screens and now, as a result, have discarded our old shaker screens.

Up to the last moment of negotiations there was a slight chance the Corps ditch could bypass the site. When it became evident that Zebree <u>was</u> going to be destroyed, orders for equipment

Figure 3. Water-screening operations, 3MS20. The frame was designed so that screens with differing mesh-size could be readily substituted.

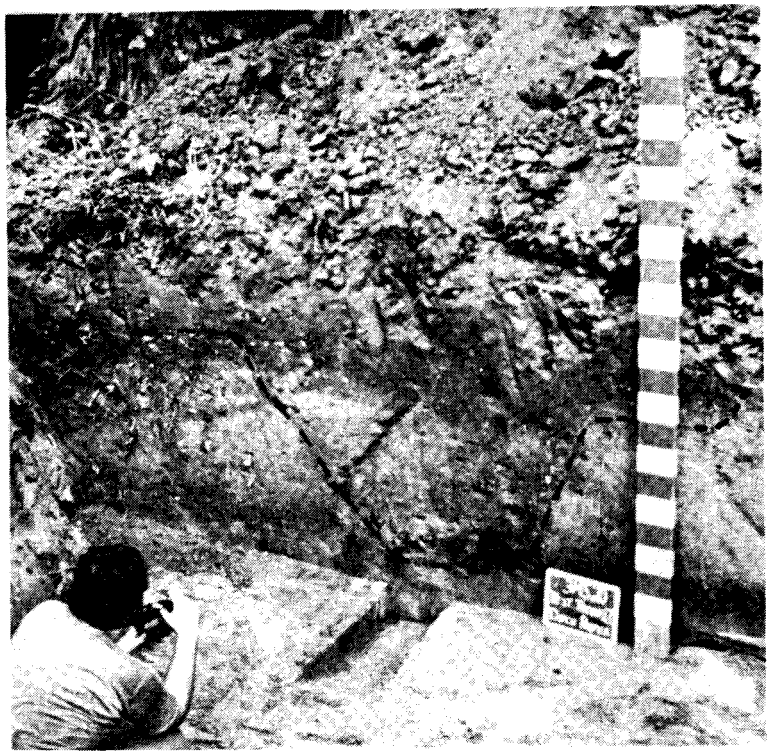

Figure 4. Profile of probable stockade ditch encountered in backhoe trench at north end of site, near the recent drainage ditch that intersected both the stockade line and the site.

included sufficient screening to allow complete field flexibility. Both portable swinging screens on playset swing frames and small portable hand screens to fit within a water screening rack were planned so 1/16", 1/8", 1/4", and 1/2" mesh screening could be utilized depending upon what the needs of each specialist might be. The ceramicist did not want to look at any sherd which could pass through a 1/2" screen. The zooarcheologist wanted 1/8" screens, the 1/4" screens were used for the statistical weight figures for random squares. Lithics seemed to be best served by 1/16" and 1/8" screens. The ethnobotanist wanted unscreened floated samples.

After the 1969 excavation, we indicated we would need at least two years to salvage Zebree adequately. In early 1975, we developed a quarter-million dollar budget which we felt was adequate given the notification that only one year remained before the site would be destroyed. After the Corps notified us considerably later in the year that we could only have a maximum of $102,000, and it appeared we had no choice but to accept, we revised our budget accordingly. The field period was shortened by more than one third and personnel, including supervisors, decreased. The lithics lab and a site survey were abandoned. The anticipated analyses were also narrowed. Overhead would have consumed almost exactly half of this figure, so the Survey contributed my salary and the salary for a graduate assistant and the associated overhead, as well as other material benefits not previously anticipated. While not exactly a shoe string operation, it was considerably less than we felt necessary for adequate mitigation.

Based on the 1969 experiences with processing and analyses, we set up a two-year post-excavation period. The first year involves mostly organizing and copying notes, maps and photographs for a duplicate file and the final processing of artifacts, soil and pollen samples, and other inventory-oriented tasks. Some analyses have been and will continue to be accomplished during this first year, but the majority of analyses are expected to be done during the second year, and will be used in at least two MA theses and a variety of other planned papers. All of these efforts are expected to be published as soon as possible after the termination of the two-year period.

These plans were dictated by our understanding of our responsibility to do good archeology. Representatives of the Corps have in the past told us bluntly that the only report they wanted was a letter notifying them we had left the site. In addition, they indicated we should consider spending all of the money on excavation and wash the artifacts later when we had nothing else to do. This attitude, which we understand is no longer extant, reflects a

failure on the part of archeologists to publicize the necessity of good scientific work on nonrenewable resources being destroyed by Government projects.

We wanted to maximize our personnel resources. This meant we should have as many as possible of the people who would be involved in analysis also involved in excavation. This would allow them some control over the recovery of samples they were to use as the basis for interpretation. There was continual interaction and feedback, and shifts in excavation strategies could take place in response to the needs of those specialists. So, a field lab near the site was established. The collections upon being excavated were cleaned by water screening at the site, dried in the hot sun, and were transported to the processing lab where Phyllis Morse took charge. Flotation and pollen samples as well as all cataloged charcoal were turned over to Suzanne Harris, who directed the ethnobotanical lab. All bone was sorted out, cataloged, and then immediately handed over to Eric Roth who directed the zooarcheology lab.

The ceramics were screened through 1/2" mesh screen with the small elements bagged and cataloged as a unit with the assumption that these were basically fragments of the larger elements. They were not discarded, so this assumption can be tested. The large ceramic elements were sorted into sherds and other ceramic objects such as wasp nests, miscellaneous burned clay chunks, pottery making debris, beads, and others. Michael Million supervised the ceramics lab. He sorted and recorded the sherds on a three-page form, indicating both weight and count, and cataloged each of his categories separately. This information, which he finished for all of the random squares by the end of the excavation, has been used already for computer manipulation. Million also was involved in replication experimentation and other aspects of ceramic technology. Given experts such as these, we would have the capabilities of processing materials sufficiently quickly to be able to direct ongoing excavation on the basis of computer printout (although funds were not sufficient to do this at Zebree).

Lithic materials were sorted into fairly broad categories based on the 1969 analyses and will have to be worked on more fully later since the lithics lab was a victim of restructuring our budget.

Each specialist had one or two assistants depending on relative needs and were able to work in air-conditioned comfort. There was regular rotation between lab and field depending on need and individual wants. The crew members, although operating on a single pay scale, ranged from graduate students in anthropology to majors

in anthropology, law enforcement, pharmacy, botany, zoology, wildlife management, physics, art, and sociology. The heterogeneity of the crew was deliberate, to encourage interaction and feedback at all levels.

In the field, the supervisor, Mark Raab, and the two assistants, Jeff Newsom and David Anderson, allowed at least three kinds of excavation to go on at once. The backhoe was a very important addition to the field crew. We lost the capability to rent a bulldozer to strip large areas of the site when the budget was restructured. We did, however, have the opportunity of opening "block" excavations, and not only could transects for palisade ditches be dug, but loose dirt piles were moved away from pits when they became cumbersome or hazardous.

We wished to structure the excavation so that they would complement rather than duplicate the previous testing. This had to include the better recovery techniques we are now using. The techniques had to maximize the site's potential since it was to be destroyed. In addition, during our rap sessions before and during excavation, we had to compromise between the "theoretical ideal" and our capabilities, with an emphasis on the latter. We viewed our efforts as much a test of methodology as the recovery of data to test a series of site specific hypotheses developed between late 1969 and mid-1975.

There is an informal organization in the Central Mississippi Valley called the Central Lowland Archeological Seminar and Symposium, otherwise knows as CLASS. Its "members" are attempting to pool knowledge and research designs on a natural area which politically is administered by seven states. A meeting of CLASS was held at the Zebree site during the excavation. This enabled many of the primary investigators in the central Mississippi area to see the site, understand its deposits and stratigraphy, and its biophysical location. Most important, if not crucial to our efforts, suggestions concerning interpretation and procedure were received. We were also very fortunate this summer to have two scholars deeply involved in southeastern U. S. archeology, Dr. Bruce Smith of the University of Georgia and Dr. Christopher Peebles of the University of Michigan, visit the site for the purpose of reviewing our efforts. Their visits during the excavation resulted in valuable input.

In 1920-21, the levee and ditch west of the site were constructed. Local stories of burials and considerable debris were basically confirmed in 1969 and 1975 by a discovery of a stockade ditch(Fig. 4) which is interrupted by the modern ditch, and by preliminary computer density patterns. In 1938 the levee was reinforced by the

Corps and at this time all traces of the site west of the ditch appear to have been removed. The final destruction of the site is set for early 1976.

DEVELOPMENTAL-STATISTICAL HYPOTHESES OF MISSISSIPPIAN SOCIETY

L. Mark Raab

Abstract

Scientific information generated by contract archeology should have the widest possible application. Developmental-statistical hypotheses of Mississippian society are presented based on the assumption that there is a causal "path" (temporal ordering) of four major variables representing a model of Mississippian society. The variables are subsistence energy, social differentiation, labor specialization, and population magnitude. Each of the four variables can be operationalized using data from the Zebree site or any other site.

A number of criteria influenced the formulation of this Zebree project research design. The type of prehistoric behavioral system, or "culture" that Zebree represents and previous knowledge of the site were two obvious criteria. This paper, however, will not concern itself with the cultural provenience of the site or its history of investigation since these topics are treated in another paper included in this volume. Nor is this paper concerned with any specific methodological approaches which resulted from the research design, covered in a paper by David Anderson. Instead, this paper will focus on criteria which influenced the creation of the research design.

Considerations of Research Design

The Need for Group Research Designs

In part, the Zebree research design presented here grew out of a previous symposium, "New Theoretical Approaches to Middle Mississippian Archeology," chaired by me at the 1975 Southern Anthropological Society Meeting in Clearwater Beach, Florida. At that symposium there was considerable interest expressed in the possibility of developing and testing group research designs which took a regional approach to Mississippian archeology. That

meeting revealed a pervasive feeling that the scientific goals of contemporary archeology could be most effectively pursued by a community of scholars working to solve common research problems. When I became involved in the Zebree project, it seemed to me an opportunity to develop a large-scale research design for Mississippian studies. This consideration was decisive in formulating the scope and abstraction of the causal model which follows. A carefully designed model should permit a range of regional and topical studies to be subsumed under a general problem orientation. In this sense, the model is intended to serve not only the Zebree project, but subsequent investigations as well. This fact has two important implications:

(1) The research design should reflect a theoretical problem with topical and/or regional significance, i.e., the research problem should include, but not be confined to the Zebree site.

(2) No single site is likely to provide all of the data necessary to do a thorough test of the theories set out in the research design. We should attempt to implement the research design as completely as possible within any given site context while recognizing that limitations of time, money, and the archeological record itself will often result in an incomplete data base. The usefulness of a research design does not depend, therefore, on how successfully its propositions can be tested at a single site, but on how well it fares when confronted with data from a large number of sites.

The Study of Behavioral Change

A second consideration which entered into the Zebree research design relates to archeological epistemology, or the nature and goals of archeological knowledge. Approaches in the past have failed sufficiently to explicit a single, all-important quality of the archeological record: behavioral change. If there is anything that the archeologist has access to in the archeological record, it is time-depth and behavioral change. These data provide archeology with potential to make a profound contribution to the development of social science. In this connection, I believe Plog (1974:11) has a strong case when he asserts:

> Archeologists must begin to discuss our goals and to better focus our aggregate activities. We should seek to explain phenomena other social sciences have difficulty explaining, but in which social science is

interested. I and the archeologists I cited have argued that the study of long-term change is probably the most appropriate goal for archeologists to pursue.

Accordingly, the Zebree research design is an attempt to define systems of variables which can be causally related in sequences of behavioral change.

The Value of Explicit Research Design

A third consideration, explicit research design, refers to a formal statement which sets out theoretical arguments, specific hypotheses to be tested, test implications, and modes of data analysis.

Contract research will be increasingly subject to various kinds of review procedures. It does not seem unreasonable for funding agencies to want better quality control in contract research. Contract archeologists will be asked increasingly to give an explicit statement of their research goals and justify these to an audience of peers; in effect, to develop explicit research designs. From a purely administrative point of view, therefore, it seem imperative that we included explicit research designs in contract research.

Aside from the administrative aspects of contract archeology, a number of fairly recent reports (Binford 1964; Hill 1966, 1973; Vivian 1970; Plog 1974) suggest that the most efficient means of obtaining scientific knowledge in archeology is within the context of explicit research design. In large measure, the value of research design resides in getting our assumptions, theories, methods, and analyses into the open where they may be publicly evaluated by a community of researchers.

Science in Contract Archeology

It is possible and desirable to do scientific archeology in the context of contract archeology. A great deal, probably most, of the archeology to be done in America in the years ahead will be done under contract. If we conclude that we are not capable of dealing with this kind of archeology in a way which is scientifically meaningful, we will be admitting that we are willing to destroy much of the archeological record with little or no scientific return. There is a growing body of successful scientific work performed under contract (cf. Schiffer and House 1975, Goodyear 1975, Raab 1974, Morse 1975b).

The contract archeologist has a responsibility to assess the significance of archeological remains and recommend a course of action which will best project the information potential of the archeological record. This requires archeologists to formulate specific research goals, for without these goals there can be no really satisfactory criteria by which significance is determined. Schiffer and House (1975:163) emphasize this point in their position on archeological significance:

> It is a truism to point out that the significance of something depends to a great extent on the context in which it is being viewed. This is especially true of archeological resources. If one were to measure the significance of archeological resources by their newsworthiness, for example, then only the "earliest," "largest," or "richest" sites or finds would be significant. Although even archeologists have sometimes used similar criteria, a more generally applicable framework for evaluating significance is now evolving. The touchstone of that framework is the declaration that archeological resources acquire scientific or historical significance only as they relate to specific research questions in substantive, technical, methodological, and theoretical contexts.

From this perspective scientific research in contract archeology is not only possible, but essential.

Causal Models of Behavior

Finally, the Zebree research was viewed as an opportunity to develop scientific models of a certain kind, i.e., causal models of behavior. Models of the causal variety have a number of salient features which are well explained in the monograph by Blalock (1964) on causal models in nonexperimental research.

Causal models are based on the assumption that some sort of cause and effect relationships operate in the real world. This assumption allows one to invent hypothetical situations in which variables behave in a predictable manner. A causal model also specifies the nature of deterministic connections between variables. A causal model by definition assumes that variables of one sort cause changes in variables of another sort, i.e., that things happen because they have causes and are therefore deterministic in some sense. One approach to determinism would be to specify a model in which the variables are linked in an absolutely deterministic way. Alternatively, we could take a probabilistic or

statistical approach and specify that a certain variable may be used to estimate the magnitude of another variable. The Zebree research design was structured to accommodate a statistical or probabilistic conception of determinism based on the fact that we were interested in prehistoric systems of behavior which we assumed to be causally complex and incapable of experimental controls.

I might also emphasize the behavioral nature of the research design. Our research at Zebree was directed toward isolating and predicting prehistoric systems of behavior. Our attention was shifted away from artifacts as the primary object of our concern. We were, however, interested in artifacts as a means of inferring past behavior. The artifact-centered, or cultural-historical, conception of research design frequently poses questions which are concerned with the time-space distribution of artifact types, and relatively little concerned with the artifacts' implications for broader ranges of behavior. If we want a more adequate understanding of past behavior, we will have to begin by asking behavioral questions and then translating those questions into concepts which have meaning in terms of artifacts.

In view of the considerations expressed above, we felt it was appropriate to apply the concept of causal modeling to the Zebree project. The foregoing discussion was of necessity very generalized and not intended as a thorough assessment of the many complex philosophical and methodological factors involved in research design. Nevertheless, it is hoped that this brief introduction will render the following research design more coherent.

Research Design for a Causal Model of the Mississippian

Causal Models and Integrated Research Design

The following research design is based on a model of the development of Mississippian society. The model is causal in the sense that it posits explicit causal linkages between a set of theoretical variables and specifies that the linkages between the variables are deterministic in a statistical sense. The latter characteristic of the model has a number of implications for data collection and analysis, including an emphasis on probability sampling within the site context and statistical analysis of artifact classes.

The Zebree research design is also an example of what I refer to as an integrated research design. The concept of "integration" refers to the fact that a research design (cf. Blalock 1964:27, 1969) can be separated logically into three components, a theoretical

language, an operational language, and a mathematical language. The three "languages" of the research design are related to one another through a series of theoretical, methodological, and analytical translations. Figure 5 presents a flow chart of an integrated research design (IRD). The following discussion is oriented around the flow chart.

Causal Language and Research Design

In logical order, the first component of the flow chart is the causal language. This introduces variables and specification of causal linkages between variables, and to the degree that we have defined certain variables and their interconnections, creates a type of theoretical language with which we can construct various sorts of causal imagery. At this level our causal imagery allows us the convenience of being able to think in terms of manageable systems of variables. This is obtained by simplifying phenomena which may actually be quite complex. Nevertheless, explicit causal arguments have the advantage of getting one's theoretical assumptions into the open and providing an ideal model against which empirical findings may eventually be compared.

The causal model selected for the Zebree research is composed of two parts: biophysical hypotheses and behavioral hypotheses. The first type of hypothesis deals with the interconnection of human behavior and biophysical variables. The second type of hypothesis is concerned with explanations of human behavior by reference to other human behavioral variables. These classes of hypotheses are almost certainly related, but we can discuss each separately as a matter of convenience.

Biophysical Hypotheses: During previous work at Zebree a question arose as to the impact that certain environmental variables might have had on the location of the site. Specifically, it was felt that Big Lake, a shallow freshwater lake immediately adjacent to the site, might have come into existence about 1000 years ago and provided certain biophysical resources favorable to Mississippian settlement. This background gave rise to two related hypotheses:

A. If the formation of Big Lake influenced the Mississippian settlement of Zebree, the lake should have come into existence prior to the Mississippian occupation and that occupation should reveal exploitation of lacustrine resources (Morse 1975b).

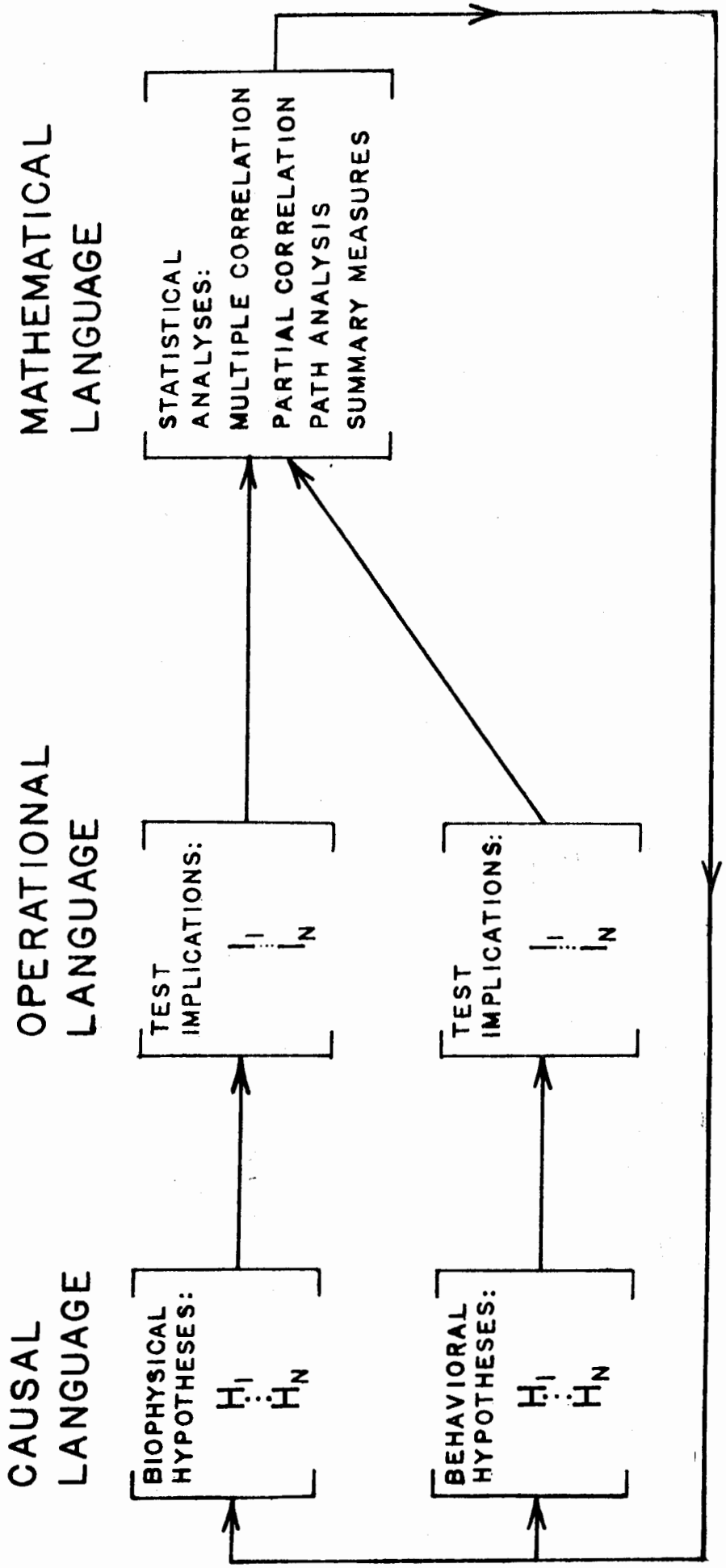

Figure 5. Flow chart of integrated research design.

B. If the lake was important to Mississippian occupation, the site might be expected to show a seasonal pattern of animal exploitation (Smith 1975a).

Behavioral Hypotheses: The behavioral hypotheses were adapted from a model developed by Plog (1974) to explain the transition from Basketmaker to Pueblo societal stages in the American southwest. Plog's model seems appropriate to the Zebree research because it exemplifies an attempt to explain social change by defining a set of variables and then attempting to determine how much of the variance in a given set of these variables can be explained by multivariate statistical techniques.

The causal language employed in the Zebree research design (Fig. 6) consists of a set of four variables (Plog 1974:58): Labor specialization, subsistence energy, social differentiation, and population magnitude. These four variables are used because they have been implicated in a number of anthropological theories dealing with social change and they have been specifically singled out as important variables in numerous articles and papers on the development of the Mississippian. The major theoretical questions are: which of these variables are dependent variables and what is the predictive power of one or more independent variables? There are actually two problems involved here; one is defining which of the variables are dependent variables. Independent variables are conceived as variables which are responsible for bringing about a change in dependent variables. The initial problem of dependent and independent variables is crucial because it obviously has to do with the direction of causality between variables. Once we think we have some idea of causal direction, the question remains as to how well our independent variables will predict or explain the dependent variables. Another way to think of this second problem is the strength of the relationship between variables.

Both of these theoretical problems have very real consequences for the research problem at hand. The fact is we do not know which of the variables mentioned above cause changes in the others. It is possible to construct 24 different causal sequences of variables. This number of sequences is arrived at by calculating 4! (Factorial, 4x3x2x1 = 24), 4 representing the number of variables in each sequence. Figure 2 presents the 24 possible sequences of our 4 variables. Certain of the sequences roughly approximate certain existing anthropological theories of social change. Sequences 1-6 would be roughly compatible with White's Theory (1943, 1949) of the primacy of energy in social change. Sequences 11 and

Variables:

Labor specialization= LS

Subsistence energy= SE

Social differentiation= SD

Population magnitude= PM

Possible variable sequences:

SE → PM → LS → SD (1)
SE → PM → SD → LS (2)
SE → LS → PM → SD (3)
SE → LS → SD → PM (4)
SE → SD → PM → LS (5)
SE → SD → LS → PM (6)

PM → SE → LS → SD (7)
PM → SE → SD → LS (8)
PM → LS → SE → SD (9)
PM → LS → SD → SE (10)
PM → SD → SE → LS (11)
PM → SD → LS → SE (12)

LS → SE → PM → SD (13)
LS → SE → SD → PM (14)
LS → PM → SE → SD (15)
LS → PM → SD → SE (16)
LS → SD → SE → PM (17)
LS → SD → PM → SE (18)

SD → SE → PM → LS (19)
SD → SE → LS → PM (20)
SD → PM → SE → LS (21)
SD → PM → LS → SE (22)
SD → LS → SE → PM (23)
SD → LS → PM → SE (24)

Figure 6. All possible variable sequences of four variables.

12 equate with Carneiro's theory (1970) of population being a major factor in the development of social complexity leading to the state. Sequences 19-24 seem compatible with the notions of Sahlins and Service (1960) about chiefdoms playing a major role in societal evolution.

The variable sequences provide us with a language for devising a number of different theories of the development of the Mississippian. Each of the 24 variable sequences can be considered a separate hypothesis and the entire set as a series of multiple working hypotheses. As the arrows in Figure 6 suggest, we could consider each sequence as a linear causal path. There are theoretical problems with this approach (Plog 1974:154-155) which relate to assumptions about linearity of causal connections in human behavior, but it might be useful to assume linear causality in order to identify independent and dependent variables. Alternatively, it is possible to construct more complex causal paths, including systemic models, and evaluate these with certain multivariate statistical techniques.

Up to this point, our discussion has been entirely in terms of theoretical constructs. We are now faced with the need to translate these abstractions into entities which can be measured and finally translated again into mathematical statements where their truth or falsity can be evaluated probabilistically. The first translation is made with the aid of an operational language. The second translation is made with the aid of a mathematical language.

Operational Language and Research Design

The problem of defining variables falls largely within the province of an operational language. The function of an operational language is to translate ideas from the causal language into referents which can be observed in the empirical world; when this is done, we say that we have an "operational definition." Put another way, an operational language provides a means of measuring a theoretical concept.

In the case of the Zebree research, we will need to devise suitable operational definitions of our four causal variables. The first step is to select categories of archeological remains which are appropriate representations of the causal variables. Predictions concerning what one should find in the real world as a consequence of a theoretical prediction are called test implications. Perhaps the best way to illustrate how an operational language works is to give two brief examples from Zebree.

Test Implications of the Variable "Labor Specialization": Let us suppose that we want to find a measure of the variable LS (Labor Specialization), the variable which refers to the division of labor. The importance of this particular variable is in relation to one theory (Raab 1975a) which suggests that a shift from family-based labor to communal labor organizations may be an important factor in the development of the Mississippian. An argument of this kind could be constructed from variable sequences 13-18 (Fig. 6). What we need, then, is some way of measuring the degree of LS as it may be reflected in the archeological record. This may be done by making certain behavioral assumptions of the following kind:

A. Recurring, or patterned, prehistoric human behavior resulted in the patterned deposition of remains within archeological sites and the patterning within these remains is at least partially detectable with current archeological techniques.

B. Prehistoric people performed different work activities and these different work activites were carried out by means of different artifacts.

C. Work which was relatively specialized, i.e., focused on a relatively limited range of activities, was performed by means of a relatively limited number of artifact types.

Most of us implicitly make these assumptions. My purpose in making them explicit here is to show that these common working assumptions in archeology lead us to a possible solution to our problem of operationalizing LS. If LS is increasing through time, this specialization should be detectable in the patterning of the archeological record. Plog (1974:114-115) suggests that if labor specialization is increasing through time, or from one societal stage to another, we should expect to find that:

A. The amount of space utilized as limited-activity areas within sites and between sites should increase.

B. Within sites, specialization, viewed in terms of functionally specific classes of artifacts, should increase.

I would argue that we can detect patterns of this sort within Mississippian sites and develop quantitative measures of LS. This

approach would not require us to collect different kinds of data than we are presently collecting, only that we look at our data from a more behavioral perspective.

Test Implications of the Variable "Population Magnitude:" More or less arbitrarily, we may take the variable Population Magnitude (PM) as a second example. There have been a number of attempts by archeologists to measure this variable. Perhaps the most frequently used approaches have been based on room counts (Plog 1974: 87-98), or floor area of dwellings (Cook and Heizer 1968), or skeletal populations (Howells 1960). However, estimating prehistoric populations remains something of a general problem in archeology. At Zebree we wanted to find a way to make reasonably reliable estimates of relative population size using information that was generally available from Mississippian sites. It was partly for these reasons that we initiated what I call the Mississippian Midden Project (MMP).

From a behavioral point of view, archeological midden deposits should represent a terminal repository of materials which have passed through "behavioral chains" of the "systemic context" (sensu Schiffer 1972, 1975). It seems theoretically possible to obtain information on PM from midden debris. In order to attain this goal, however, we must be able to make certain assumptions, which are:

A. Other things being equal, the amount of midden material produced should be directly proportional to the number of people producing the midden.

B. We must be able to bring the "other things being equal" assumption under reasonable control, i.e., we must be able to account for the processes which are responsible for creation of midden other than population size. These would minimally include factors affecting preservation of perishable materials, like bone; forces of geological deposition and erosion; differential treatment of perishables which might affect their chances for preservation, such as cooking habits; and time duration of midden deposition.

Let us take a case from Zebree. The Zebree site has three prehistoric components: the Barnes, or late Woodland component; the Big Lake or early Mississippian component; and the Middle Mississippian component. We want to demonstrate that each of these components had different population magnitudes and we want to show this by

using midden deposits as an indicator. Our measure of population will be a relative measure; it is not intended to yield an exact number of persons in each component. Rather, it is intended to tell us if middens reflect a different or similar population base in each time period as indicated by units of midden accumulation.

Our next step is to obtain an estimate of the amount of midden produced in each time period and get a statistically representative sample of midden fill from each time period. All samples taken from the different components must be collected in such a way that they can all be compared in terms of some standard unit of measurement, such as volume and/or weight. It is possible to attain these objectives by taking a widely-dispersed statistically random sample from the site, which can be used with certain computer mapping programs to estimate the amount and location of midden from all three components. Materials recovered from the excavation units can also be used to make critical comparisons of midden composition between components. An alternative method would, of course, be to dig the entire site.

Next we would want to control certain factors which might affect midden accumulation other than population size. Soil samples can be taken to determine if soil pH is differentially affecting preservation of perishables and to see if geological factors producing deposition or erosion are differentially at work in different archeological components. Animal bones can be examined to see if the same species is being treated differentially in different time periods in relation to food preparation or manufacturing processes. The midden deposits from the different components can be also dated as accurately as possible.

Finally, comparisons of midden size and content can be made between components, if it appears that essentially the same kinds of depositional forces were at work in all time periods. Again, we are attempting to implement this specific approach in the Zebree research by means of certain sampling strategies. This approach to measuring population has obvious problems and limitations, but we believe that it is potentially productive of useful results.

Other Implications: Of the two remaining variables, Social Differentiation (SD) and Subsistence Energy (SE), the former may be the most difficult to deal with at Zebree. By SD we mean evidence of social ranking in Mississippian society. Useful approaches to measuring this variable have been developed by Peebles (1971) and Brown (1971) in their treatment of Mississippian mortuary practices.

Unfortunately, relatively few burials were recovered at Zebree. Subsistence Energy (SE) will be another problematic variable at Zebree, but we will have exceptionally fine examples of faunal and floral remains. In conjunction with the paleo-environmental studies of Jeff Newsom and Suzanne Harris, we hope to generate useful information on subsistence.

Mathematical Language and Research Design

Scientists have long faced the problem of describing relationships between the variables of a scientific theory. Usually they wish to describe these relationships in as precise a manner as possible and in a way which will allow the form and strength of the relationship to be evaluated. When we are dealing with very simple theories, these relationships can be represented in a crude way by qualitative descriptions. Once we begin to develop complicated theories, however, we find that we need a much more efficient means of representing relationships between variables. It is for this reason that science has found quantified, or mathematical methods to be indispensable tools.

Statistical models can be the most effective for the problems at hand. Statistical models represent a type of analytical language which we can use to evaluate the form and strength of causal connections between our variables. The purpose of operationalizing our four variables was to convert theoretical variables of our causal language into variables represented by numbers. These numbers can in turn be represented by mathematical models. Once this last step is taken, we are finally in a position to evaluate our theories according to precise mathematical criteria. This is, of course, an idealized description of research and does not mean that something is valid because it is evaluated by "precise mathematical criteria." No matter how precise the mathematics, results can be no better than our theories and the adequacy with which we operationalize them. The emphasis here is on a process of research, not a particular method. Once we have evaluated our model, we are then in a position to decide how successful our research has been and we are then in a position to modify any or all of our theoretical model in light of our new findings. The arrow connecting the mathematical language and causal language of Figure 5 represents this "feedback loop" in the research process.

I will not attempt to explain the specific statistical procedures outlined under the mathematical language section of Figure 5. Concepts like regression analysis have the capability of evaluating the strength of simultaneous causal relationships between a sequence of variables. These methods influence our thinking about the nature

of theoretical linkages between variables, methods of data collection and data analysis. Statistical reasoning seems certain to play an increasingly important role in archeology, as it has already in other sciences, and archeologists who are not conversant with statistical ideas will find themselves increasingly unable to communicate with professional colleagues.

Why This Kind of Research?

At this point I am certain that many would ask why should we want to attempt this kind of research. I suspect that some would feel that the complexity of the model and the unfamiliar concepts are intimidating and apparently unrelated to familiar archeological research problems. Despite this possible reaction, I think there are many good reasons for doing the sort of research outlined above.

I have already mentioned one benefit: group research designs. There is a growing recognition that we need some kind of regional, or group research effort (Gumerman 1971, Struever 1971) in order to test sophisticated theories of behavior. A general theoretical approach of the type presented above would provide a research problem which is abstract enough to allow a variety of specific approaches to operationalizing and ordering variables, yet at the same time is specific enough to give essential guidance to research design.

Secondly, I believe that research designs like the one above are also useful because they force us to get the most we can from our resources. This is really an argument for research efficiency. An explicit research design which seeks to test behavioral hypotheses is likely to yield far more information per unit of time and money invested than a more passively inductive approach. We can always do the descriptive studies that have long characterized archeology, but we also need to move on to more efficient means of investigation.

Third, I believe that it would be an entirely healthy development if archeology could establish more viable links with other social science disciplines. Archeologists might well find an increasingly productive dialogue with researchers in economics, sociology, geography, and political science. Before that dialogue can begin, however, we will have to focus our research on problems dealing with explanations of human behavior, rather than continue the emphasis on artifact-centered studies. This point also bears on my earlier comments on the study of social change. Unless and until archeologists can begin to make significant headway in explaining social or behavioral change, our work will not be of much interest to other scientists.

EXCAVATION STRATEGIES AT THE ZEBREE SITE: 1975 FIELD SEASON

David G. Anderson

Abstract

Excavation strategies employed during the 1975 field season at the Zebree site in Northeast Arkansas included a diverse yet complementary series of recovery procedures, including probability sampling, the use of backhoe transects, and large area block unit excavations. The strategies utilized were part of an integrated project research design and were directed towards testing specific research hypotheses within theoretical, methodological, and practical confines.

Archeological fieldwork cannot be conducted in a vacuum. Field excavations invariably reflect the interaction of an investigator with a particular problem, or series of problems, the answers to which, hopefully, are to be found in the ground. In recent years there has been an increasing call for the development of sound, integrated research designs to guide archeological investigations (Binford 1964, Redman 1973, Plog 1974, Schiffer 1975a). Ideally a project research design should make explicit the goals of the project and the methods to be used to reach these goals.

In the development of research designs, the integration of theoretical models with recovery procedures must be considered. Models are of little value if the data necessary for the testing of hypotheses derived from them cannot be collected. Field strategies developed in conjunction with a project research design should be explicitly stated both in terms of their employment and in their relationship to research problems and hypotheses (Redman 1973:66, 1975:147, Asch 1975:170).

In particular, field strategies should ensure maximum data recovery under the conditions imposed by time and money, and should strive towards productive results; data which are representative, reliable, and relevant to the project hypotheses

(Redman 1973: 62, 63; Binford 1964:139). The explicit statement of strategy should not, however, preclude flexibility or even innovation once in the field. Thus, if the resolution of one or more hypotheses proves infeasible, the entire design and field procedure need not be scrapped and reformulated in mid-stream. Ideally, field strategy should be opportunistic and provide for effective exploitation of unforeseen yet significant discoveries (Brown 1975:156).

In addition to informing on behavioral hypotheses, field strategies must also be developed to inform on natural formation processes or n-transforms (Schiffer and Rathje 1973; Reid, Schiffer and Neff 1975; Schiffer 1975a). These consist of post-depositional natural processes that affect the archeological deposits. In other words, the effect of the natural environment on the archeological materials must be considered. Ideally, the methods for determining this effect should be incorporated into the project research design and operationalized as a part of specific field strategies.

The utilization of a diverse series of field strategies for the investigation of archeological sites has received encouragement in recent years. The Zebree excavations attempted to exploit such diversity. In conjunction with the field operations, processing, and analytical operations were conducted concurrently in the project laboratory, and an effective feedback situation developed in which analytical results were used to guide subsequent field operations.

The field strategies employed, in addition to reflecting the need for the collection of data relevant to the testing of specific hypotheses, derive from a philosophy of multistage fieldwork. Ideally, for instance, according to Redman:

> The methods of excavation can be structured to provide different kinds of data and to direct future work. These should include deep squares or trenches to learn the stratigraphy of the site, broad horizontal or block exposures for features and architecture, and a probability sample of the site in order to have an unbiased quantitative picture of the inventory of features. Sampling can be utilized in making decisions about what dirt should be screened through the finest mesh or what soil should be saved for water flotation in order to recover macrobotanical remains. A reliance of samples of dirt the excavator considers 'rich' might overlook whole categories of evidence and lead

> to a distorted picture of the findings. Probability sampling of dirt excavated would eliminate this possibility of bias. (1973:65-66).

At Zebree, because of limitations of time and money, many separate strategies were utilized simultaneously, instead of in the recommended temporal succession which allows for maximum feedback and restratification.

Initial field activities on the site included the construction of an access bridge over a large drainage ditch, and extensive clearing of vegetation. The site, overgrown since farming in the area was abandoned in 1950, was covered with a dense underbrush. A storage shed for equipment was built on the site at this time, and wells and screens were set up for the washing and wet-screening of material. Once the clearing operations were completed, points for a detailed contour map of the site were shot in which a transit (Fig. 7), and Morse's 1969 grid system and excavations relocated.

Random Excavation Sample

A 1% excavation sample was obtained from a large area of the site through the use of a dispersed probability sample (Fig. 7). The method employed made use of a stratified systematic unaligned sampling strategy. Directions for utilizing this strategy have been clearly presented by Haggett (1966:196-198), and examples of its utilization on archeological sites have been discussed in some detail by Redman and Watson (1970), and by Goodyear (n.d.).

The 1% sample was obtained by selecting a 1-meter sample square from within a grid system employing units 10 meters on a side. Each 10 meter grid block therefore contained 100 1-meter squares, one of which was chosen for excavation using a stratified systematic unaligned selection procedure. In this way, sample squares were selected in a manner which assured maximum dispersion over the site. A total of 55 1-meter units were excavated using this strategy.

The units were to be excavated in natural levels and arbitrary 20 cm levels within natural levels. If no natural stratigraphy could be determined, arbitrary 20 cm levels were utilized throughout the unit. The first 27 pits were excavated in this fashion. In some of the squares, deep midden deposits were encountered. A different strategy suggested by Goodyear and House (personal communication) was therefore adopted for the remaining sample squares. A backhoe trench a meter and a half long and a meter or more deep was placed along the north face of each of the remaining 1-meter units. From this backhoe trench, the stratigraphy within

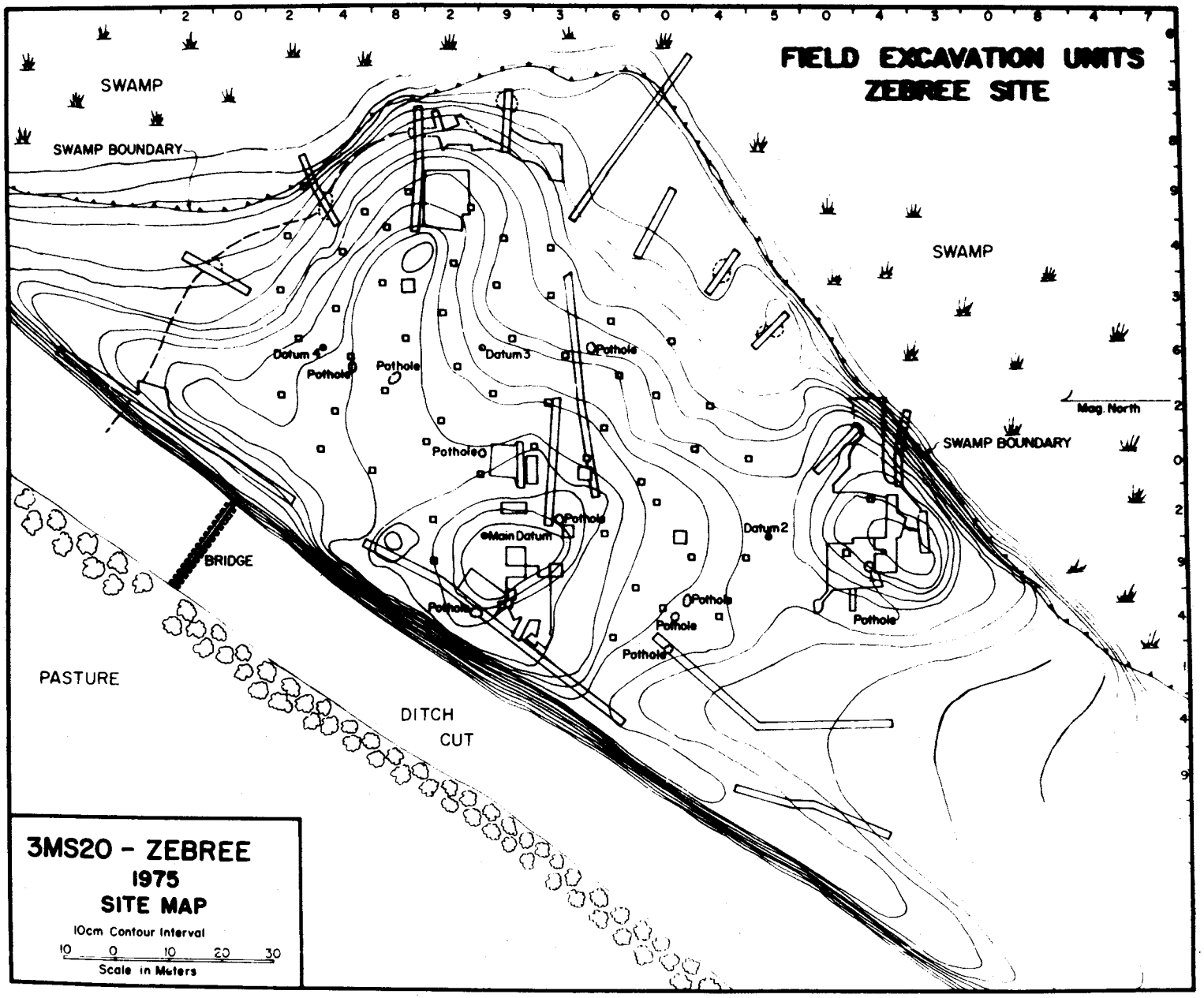

Figure 7. Contour map (10 cm interval) of Zebree site, 3MS20, including all excavations, 1968, 1969, and 1975 field seasons.

the unit could be readily determined and access to lower levels facilitated. A total of 28 units were removed using this trenching procedure.

In the excavation of each sample square a consistent collection procedure was utilized. From each level a 1 gallon flotation sample was collected, taken from the center of the square. These samples called "ZB" or zoological-botanical samples, were removed to the laboratory each day for flotation and analysis. In addition to the "ZB" sample, a "bucket sample," consisting of 2 gallons of earth, was removed from each level. This sample was then weighed and wet-screened through 1/16 inch mesh. The remainder of every level was passed through 1/4 inch screen. In addition to these samples, pollen, soil, and carbon samples were taken from within units where considered appropriate. Detailed field notes where taken from each square, with records kept by level, and profiles were drawn upon completion of the unit.

The use of the sampling and recovery procedure described above followed directly from specific research hypotheses to be tested at Zebree. A major research goal of the excavations was an areal delimination of cultural components and artifact distribution densities within the site. Through the use of a probability sampling procedure the effects of human biases are minimized, and conclusions about population parameters can be made with a greater degree of reliability (Redman 1975:149, Ragir 1967, Binford 1964:139).

The stratified systematic unaligned procedure utilized has a number of advantages for archeological investigation, in addition to ensuring the recovery of a probability sample. The procedure provides for an even sample coverage of the site area while avoiding the "gaps" or clustering effects common to simple random sampling and the problem of periodicity in a systematic random sample (Haggett 1966:196-198). The most significant aspect from an archeological point of view is that the boundaries of the area to be sampled do not have to be rigorously predetermined, nor does the entire sample grid have to be excavated. Any portion of the sample may be examined and still represent a random sample from the areas (grid blocks) examined (Redman and Watson 1970, Redman 1975, Haggett 1966). For the maximum benefit to be derived from the procedure, however, contiguous sampling units should be investigated.

The excavation of the 1-meter units needs to be carefully evaluated before it is applied routinely to future projects, however, because excavation of even one unit in relatively deep midden areas was often time consuming. The use of a short backhoe trench in conjunction with each 1-meter square, to discern stratigraphy and also improve access to the lower levels, did markedly reduce the excavation time.

A detailed cost-effectiveness study needs to be prepared to assay the efficiency of this particular sampling procedure against other strategies. Data recovered by the probability sample will have to be carefully evaluated for its usefulness relative to major research hypotheses. As has been briefly demonstrated, there have been several positive accomplishments along these lines.

Backhoe Transects

The second major field strategy utilized at Zebree involved the use of a backhoe to place test trenches across the site area in both randomly and arbitrarily determined locations (Fig. 7). During the field operations a backhoe and operator were on the site each day and were utilized extensively. Early in the summer it was found that one or two hours' use a day of the backhoe provided enough work to keep several people busy for one or more days. The responsible use of the backhoe was therefore a great challenge, since there was sometimes a temptation to open more area than could be effectively worked and recorded.

Transects 1-meter wide were opened across the site area to delimit the extent of midden. As noted, short trenches were opened along the north face of a number of the 1-meter squares. Additional trenches were opened to locate or delimit features, geological stratigraphy, or to establish profiles for the gathering of soil and pollen samples. A total of 20 long transects and trenches and 28 short trenches were made using this strategy.

Backhoe trenches were excavated in 10-15 cm cuts under the supervision of an archeologist. Cuts were removed to subsoil or until unusual features or materials were observed. Walls and floors were cleaned and profiles mapped, with soil and pollen samples removed as appropriate. Features encountered were drawn on the profiles and removed separately.

The use of the backhoe followed, for the most part, an excavation strategy which has been termed "judgment sampling" (Redman 1975:140). That is, once the site extent had been delimited with backhoe transects, additional trenches were placed where previous excavations suggested their usefulness. Trenches were especially useful in the delimitation of large features or for gathering information on stratigraphy. To some extent, the placement of backhoe cuts on the site was limited by conditions of topography, drainage, and vegetation. Care also had to be taken to leave gaps in the trenches, where necessary, to provide for the efficient movement of vehicles and people across the site.

The major advantage of the backhoe is that it enables an investigator to determine quickly the depth and extent of stratigraphy and large or numerous features, and to move dirt, saving human labor. An obvious disadvantage is that the backhoe may inadvertantly destroy features while uncovering them. When a site is to be totally destroyed, however, as was the case with Zebree, there is little to be gained by not proceeding with a backhoe; better 10 to 20 percent of the site destroyed by the archeologists so they might understand it than all of it destroyed at a later date with no knowledge derived.

Block Unit Excavations

The third major excavation strategy utilized consisted of the excavation of relatively large "block" units. Excavations conducted in this fashion consisted of units from 5 to 10 meters on a side. The previous excavations on the site and the sampling and transect procedures formed the basis for decisions concerning block unit location. Five block units were excavated on the Zebree site during the 1975 field season (Fig. 8).

Block units were excavated two ways. In the first procedure, contiguous 2-meter squares were removed following natural stratigraphy, or in arbitrary 20 cm levels if no stratigraphy was apparent. All material recovered was passed through 1/4 inch screen. The second procedure employed the use of the backhoe to remove overburden. Overburden was removed to immediately above the desired levels, at which point finer recovery techniques were utilized. In both procedures the units eventually were removed to subsoil, with pollen, soil, and flotation samples removed as appropriate. Features encountered were mapped and removed separately.

The use of block unit excavations was oriented towards the recovery of information from features, activity areas, and particular architectural data, such as house floors and pits. The block unit excavations were arbitrarily placed in areas where previous excavations had indicated the desirability of utilizing such a procedure. The judgmental, as opposed to statistically random, placement of these block units, is recognized as an efficient procedure:

> If large units are sampled, the total number that can be excavated will be small - usually so few that whole-site statistical estimates will have enormous standard errors. Consequently, locating large blocks by judgment will be preferable to a probabilistic selection procedure (Asch 1975:185).

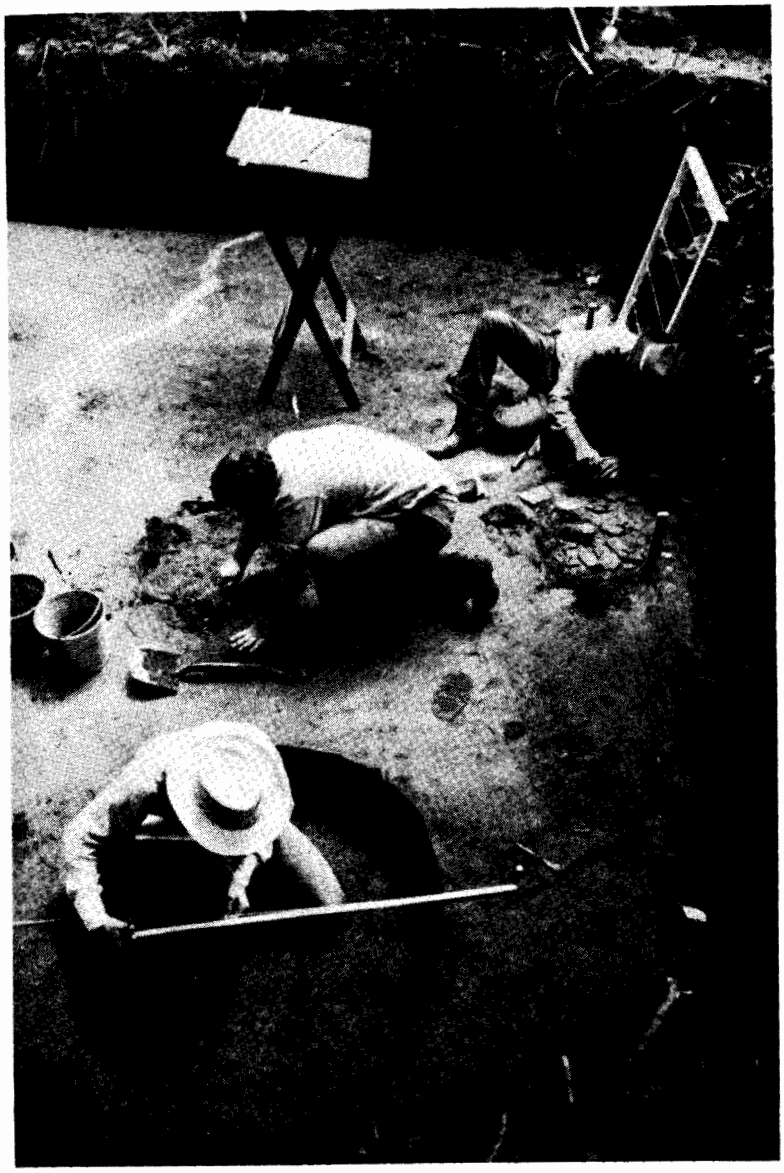

Figure 8. Block unit 3, 3MS20. Feature removal: Morse (upper right) is uncovering fragments of a Barnes cord marked vessel from the bottom of a pit; Cotton (ceter) is removing fill from a small pit to buckets for fine water screening; Anderson (bottom) is recording measurements from a bell-shaped Big Lake phase pit.

The use of power equipment to open large areas and to aid in the delimitation of features within sites, to resolve problems unanswerable by other means, is common in American Archeology (Asch 1975:189; South 1974), and repeatedly has proven to be a valuable procedure when responsibly utilized (South 1971:40; Bass, Evans and Jantz 1971; Lewis 1975).

Feature Removal

In each of the major excavation procedures outlined - the probability sample, the use of transects, and the block unit excavations - a wide range of features were discovered. These included pits, burials, postmolds, and burned clay areas. When these were encountered, the procedures utilized that led to the feature discovery were abandoned and procedures more directly relevant to the recovery of feature data were adopted.

All features were mapped as encountered, and in all cases material from defined feature areas was kept separate from other material. In unusual situations relevant specialists were called in to remove the features.

In the removal of fill from features, careful attention was given to determining the volume of material removed. The quantity of feature fill was recorded in gallons and the material was water-screened through 1/8 inch mesh in most cases. Finer or coarser screening procedures were occasionally utilized; in all cases screen size was recorded along with the volume of material. Pollen and flotation samples were removed from most features, and soil samples were taken from a number of them. Carbon and archeo-magnetic dating samples were taken where conditions warranted their collection.

The recovery of information relating to prehistoric subsistence behavior received high priority, as did information relevant to architectural features such as house floors, palisade lines, and pit form and volume. Careful volume control of both midden and feature fine-screen and flotation samples directly followed from the project's concern with midden formation processes. The use of fine screening reflected interest in the recovery of small classes of artifacts, such as small lithic debris, that could be lost using coarser recovery procedures.

A total of 135 features were found and removed during the 1975 field season, compared to 153 uncovered by Morse during 1968 and 1969. The artifacts and features recovered in 1975 complement those recovered during 1969, and available distributional information on major ceramic artifact categories indicated that patterning noted by Morse (1975b) in and between Areas A and B is confirmed and supplemented by the 1975 data.

Preliminary Results

Through the use of a combination of excavation procedures, over three field seasons, large portions of the site were investigated (Fig. 7). A major accomplishment of the 1975 excavations was the delimitation, through the use of transects, of sections of what appears to be the early Mississippian palisade system. Transects opened in Area B indicate the possibility of an extensive borrow pit, and possibly a village entrance, in this area. Transects placed at the swamp edge and away from the site area enabled both geological and palynological information to be collected for comparative purposes.

In the five large block units, a number of features were located including portions of several house floors and a considerable number of pits. Block units removed from Area B served to delimit further the rich Barnes midden in the lower levels at this end of the site, and, along with the transects, further delimited the major borrow area. Block units near Area A recovered additional information on the rich early Mississippian occupation of that area noted by Morse during his previous excavations.

The 55 1-meter units were removed from the central and northeastern portions of the site within a roughly "L" shaped area. These areas on the site had only been briefly tested, or not tested at all, by Morse in 1968 and 1969. The information collected from this procedure includes dispersed, unbiased midden and artifact samples from a large portion of the site. The data, by virtue of its manner of collection, is amenable to manipulation employing statistical procedures. These procedures are invaluable in testing specific hypotheses related to midden density, artifact distribution, and plow zone-subsoil artifact distributions (cf. Redman and Watson 1970; Binford *et al*. 1970).

An immediate discovery resulting from the use of the probability sample was that the site extended over a much larger area than was previously suspected, and that the midden was much more extensive in many areas than had been anticipated. Information on the site's extent was simultaneously discovered by use of the backhoe, by the cutting of extensive north-south and east-west transects. This technique, while quickly determining the site's limits, provided only rough estimates of the midden/artifact density along the cuts themselves. The random squares were capable of providing a more precise estimate, which, when coupled with transect data, enables somewhat more detailed conclusions about site "density" than might obtain from either technique alone.

One goal of the Zebree investigations was the determination of the overall site boundaries and the delimitation of particular component/occupations within these boundaries. Through the use of ceramic analysis data from the random squares, compiled by Million, it has been possible to obtain computer-generated density maps of temporally diagnostic ceramics within the area sampled probabilistically. These maps indicate a strong clustering of ceramic artifacts, by cultural component, in certain areas of the site. They reinforce, in some cases, previous hypotheses about the site occupation, and have forced a re-evaluation in others.

Using a STAMPEDE computer program, density maps have been prepared for a number of categories of ceramic artifacts. These maps were generated using data from 52 of the random squares from the central portion of the site. The distributions therefore only represent artifact densities within the area sampled and not across the entire site.

Figure 9 represents a printout of late Woodland Barnes ceramics; the contour interval is in 50 sherd increments. The shaded areas represent "hot spots," i.e., locations with large numbers of Barnes sherds. When this printout is related to the site contour map (Fig. 10), the procedure becomes more meaningful. Barnes ceramics are noted in extremely high numbers in several areas. The cluster at the southern end of the site, near Area B, is close to where Morse found large numbers of Barnes artifacts and a possible Barnes house floor during his 1969 excavations. Other clusters generally correspond to higher, better drained locations on the site; an exception to this is the rich concentration in the central area near the swamp boundary.

Refuse disposal practices, primary occupation areas, and natural erosional forces may all be represented by these distributions. Through further examination of all of the artifact categories and other site data some light should be shed on the nature of the formation processes at play (Schiffer 1973, 1975a).

Varney red-filmed ceramics, representing the early Mississippian component, were also plotted (Fig. 11). Referring to the site contour map (Fig. 12), it can be seen that these artifacts have a different distribution from that of the late Woodland ceramics. Varney red-filmed ceramics increase in density from east to west on the site, with a strong peak near the 1969 Area A excavations, where Morse found large quantities of early Mississippian artifacts. The increasing density of this ware as one approaches Area A, and the ditch, lends credance to the present suspicion that large areas of the early Mississippian midden were destroyed by the early 20th century ditching operation.

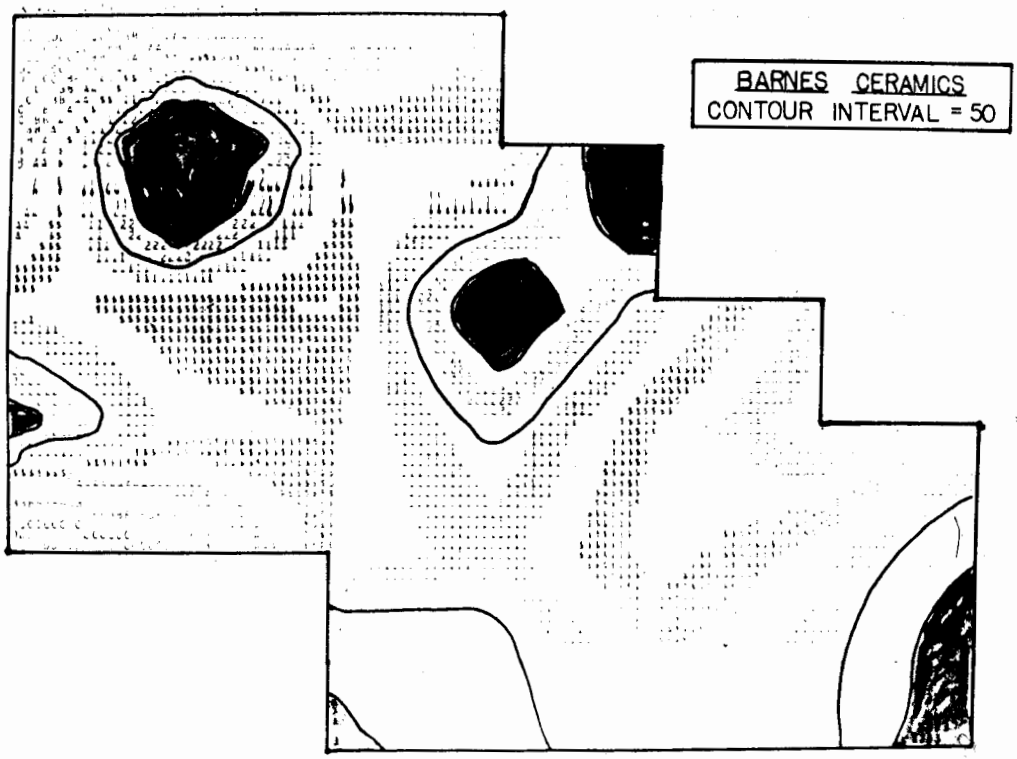

Figure 9. STAMPEDE printout, representing density of Barnes (late Woodland) ceramics, 3MS20. High density areas outlined and shaded.

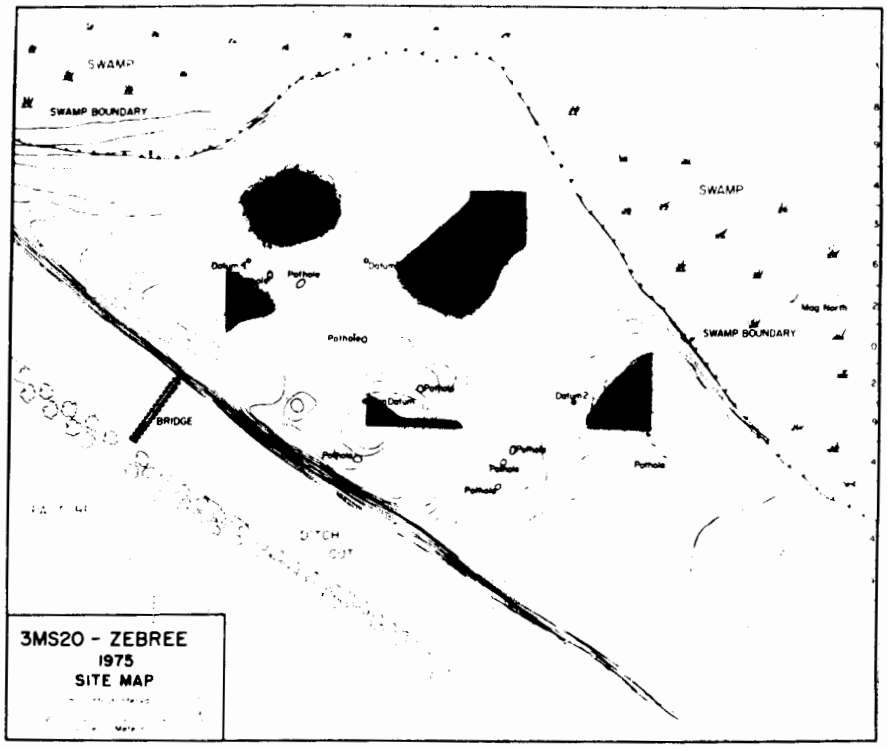

Figure 10. Barnes ceramic distributions, 3MS20. High density areas from printout superimposed on site contour map.

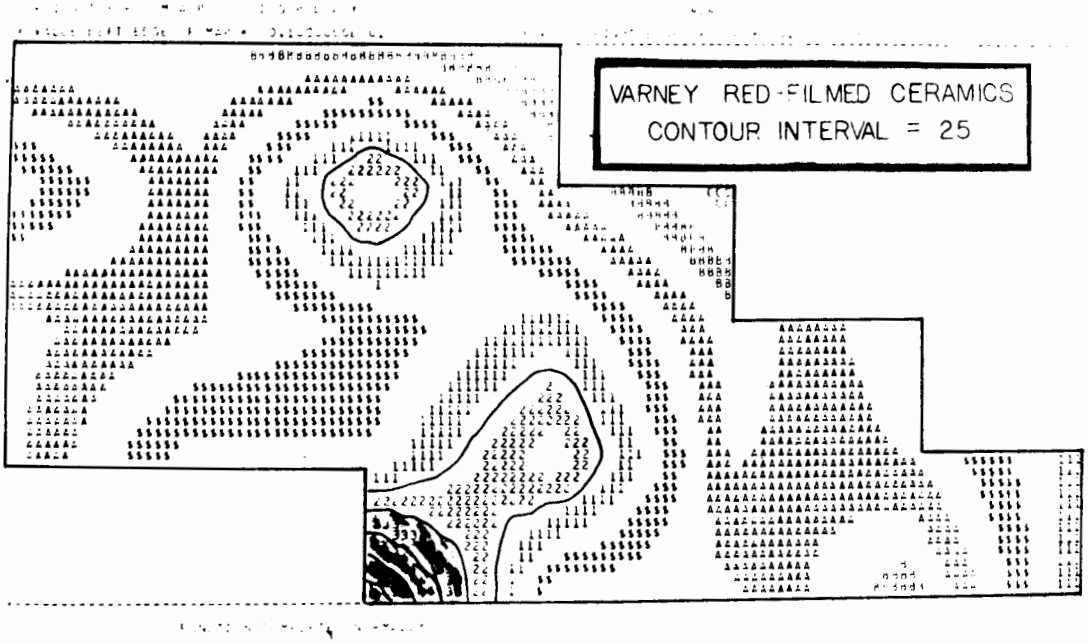

Figure 11. STAMPEDE printout representing density of Varney red-filmed (Big Lake phase, early Mississippian occupation) ceramics, 3MS20. High density areas outlined and shaded.

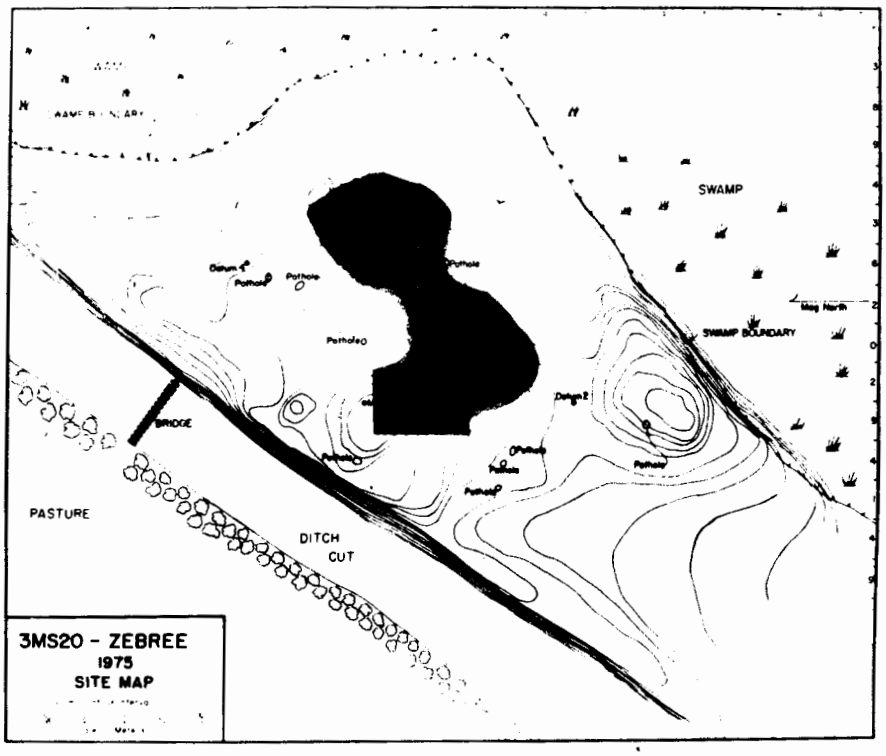

Figure 12. Varney red-filmed ceramic distributions, 3MS20. High density areas from printout superimposed on site contour map.

Through the use of computer-graphics techniques, the distributions and densities of a wide range of data categories are being investigated. Although these procedures at the present are only using data collected by the probability sample, if suitable correction factors can be developed, it may be possible to include the large quantities of data from Areas A and B, gathered by Morse in 1969, and data from the 1975 block units. This would permit the establishment of at least tentative distributional data for most of the site. Several random units were removed from within unexcavated portions of Areas A and B; these are being investigated together with Morse's 1969 data and the block unit data to see if the procedures can be confidently attempted.

Detailed investigation of the Zebree data will continue over the next two years, after which time a final report is due under the conditions of the mitigation contract. The data, once analyzed, will be used to evaluate the various strategies of the 1975 field season. The information recovered from the site by Morse in 1968 and 1969 will be included in this evaluation, and the procedures utilized in these earlier excavations will also be subject to analysis.

PRELIMINARY REPORT ON ZEBREE SITE CERAMICS

Michael G. Million

Abstract

During the field recovery period at the Zebree site, all ceramics from the random squares were classified in addition to selected feature samples. Emphasis was placed on the reconstruction of vessel forms. Replicative experiments were conducted on red slip application and an investigation of pottery clay sources was undertaken.

As a result of time limitations on the Zebree project, the classification of ceramic artifacts from 1 m random squares (note Appendix III) and the reconstruction of vessel forms were given top priority during the summer's processing. Data from random square units will undergo computerized statistical manipulation in the course of analysis. Most reconstructed vessel forms are based on sherds unearthed from pits which were often located by backhoe excavating. In addition to a limited discussion of new information concerning the ceramic assemblages represented at the Zebree site, a generalized description of soil type distribution and probably sources of pottery clay procurement will be presented.

Late Woodland Ceramics

Initial excavations this summer, particularly in the northern portions of the site, revealed considerable amounts of Barnes phase cultural materials, usually, however, in mixed deposits. The extent of this early component occupation is certainly greater than previously anticipated. As a result, a better understanding of Barnes culture in general, and its ceramic assemblage specifically, should be extractable from the now available raw data.

One exciting find has been the recovery of what is probably a portion of a small tetrapodal bowl or jar. This vessel was found with most of a large, sand-tempered cord marked jar in a pure Barnes component feature. To my knowledge, such a tetrapodal form is a unique occurrence for Barnes phase assemblages in this area.

By far the most frequent artifact representing the early component at Zebree are sherds from large, cord marked jars. Aside from a small proportion of small plain bowls, these vessels almost exclusively account for the domestic ceramic containers used by the Barnes peoples. Large jars were usually made with conical bases although flat-based forms do occur. Many jars have an attractive rim fold to strengthen and visually accentuate the lip area. When the limitations of the heavily sand tempered Barnes paste are taken into consideration, the nicely shaped jars built by the late Woodland potters are reflective of genuinely skilled artisans.

The cord markings on most of the vessels' exterior surfaces are a result of shaping the wet paste with a cord wrapped, or less often, a net or fabric wrapped, paddle. The cord serves to prevent the paddle from sticking to the clay, a problem which is much less severe in the shell-tempered, Mississippian pastes. The net and cord impressions are valuable sources of information which deserve further analysis, including replicative experimentation, so that other classes of behavior (i.e. net and cordage manufacturing techniques) might be more fully understood.

Even though Barnes culture is chiefly defined by its sand-tempered ware, a low frequency of two variant Woodland pastes have been recognized at Zebree. These consist of a few grog- and grog- and sand-tempered sherds. Grog is generally defined as crushed sherds or burned clay and is the characteristic temper of the Baytown culture (also late Woodland) which predominates to the south. An explanation of the occurrence of either of these pastes simply cannot be made at this time nor can correlated vessel forms be described because of the small number of sherds recovered. One grog-tempered rim, however, does represent a jar form distinct from the traditional Barnes cord marked jar.

Two artifact categories which most probably are products of the Barnes peoples are sand-tempered fired clay fragments and what have been classified as reddish brown, fired sandy clay fragments. Artifacts of the first category were anticipated in the archeological record and most are explainable as by-products of pottery manufacture, since squeezes and pinches have been recognized. The second class of artifacts is probably the result of several uses of a naturally occurring local fired sandy clay (identical to the clay preferred by mud daubers for nest construction) which fires to a reddish brown color in a relatively clean heat. Larger fragments sometimes appear to be from modeled, brick-like objects which may be some type of hearth support for cooking vessels. However, the majority of these artifacts are small rounded fragments which are not conducive to a functional interpretation.

Early Mississippian Ceramics

Since a thorough description of the Big Lake phase vessel forms has been presented in the initial Zebree report (Morse 1975b), only two ceramic artifacts will be added here. The first is a small Varney red filmed bowl which was reconstructed from one rim sherd that accounted for about 1/4 of the vessel. The bowl is 70 mm in height, 135 mm in diameter at its opening and has a slightly flattened base. It is well slipped on its interior surface and possibly served as a household food container. The second item is the only one of its type known to exist and could be described as a small (approximately 80 x 50 x 15 mm) "spud-like" object which is entirely red slipped with two small perforations (Fig.13). The object was found in an early Mississippian pit associated with portions of two Varney red filmed pans and a Wickliffe thick funnel. It exhibits observable wear along its rounded edge and a hypothesized function is that it was used to scrape salt substances from the interior of Varney pans. Incidentally, the associated pans were found, once reconstructed, to have identical dimensions which strongly supports the hypothesis that these large vessels were necessarily constructed within molds.

One complete early Mississippian pot was excavated from the floor of a pit near the northern edge of the site. This vessel is a small Varney red filmed jar which had been placed upside down and contained two fired clay "balls," each about the size of a large fist. No explanation can be given which will adequately interpret this find except to say that the fired clay objects might have been used as hearth supports or possibly as gaming devices.

A small amount of replicative work was directed toward slip application techniques with partial success. Experiments showed that a mixture of ground hematite (such as that obtainable from some Crowley's Ridge creek beds) and a pure clay slip could be applied to a freshly built vessel without the slip flaking off because of differential drying rates. Furthermore, once the slip and vessel were slowly allowed to lose most of their moisture, the slip could be nicely polished with a smooth stone. It was felt that such a slipped vessel could be fired to change its color from a dull red of its air dry state to the bright red displayed by Varney Red filmed pottery. This change was not achieved due to unsuccessful attempts by the writer to replicate a sufficiently clean and hot firing atmosphere. However, it is assumed that such a slip application technique will be adequate once the prehistoric firing method is experimentally duplicated.

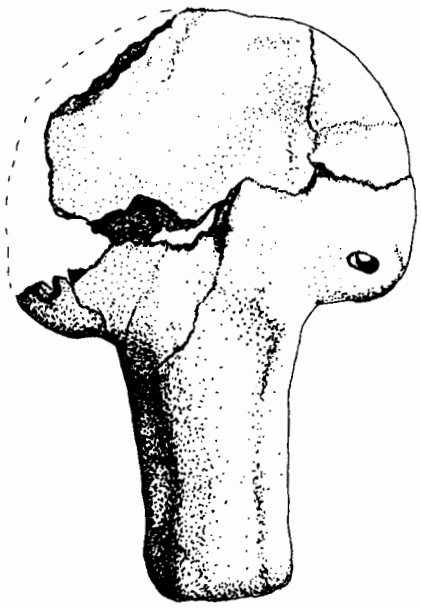

Figure 13. Small ceramic "spud-like" object, entirely red-slipped, with two perforations, from early Mississippian pit, 3MS20. Full scale.

Middle Mississippian Ceramics

Surprisingly little ceramic material was recovered during the summer's excavations which could be definitely attributable to the late components. Only a few sherds were firmly identifiable as Middle Mississippian and these include an Old Town Red, acute angled medium jar rim, at least two Matthews Incised jar rims with strap handles, a notched bowl rim, an Old Town Red constricted neck jar rim with a single row of small cane punctations below the lip and a punctated body sherd. In addition, a few sherds consisting of a fine shell and fine grog paste were recognized (Million 1974).

Miscellaneous Topics

Two subjects will be briefly mentioned which should eventually shed new light on the interpretation of the prehistoric behavior at Zebree. The first concerns the recovery of at least two fired, untempered clay fragments, from two separate locations, which exhibit identical impressions of some type of mat or basket. This perishable object has been preserved, at least in part, due to a fortunate but unexplained sequence of events. The mat or basket seems to consist of groups of three grass stems braided together, probably vertically oriented, and held together and entwined in a horizontal, double wound cord which was placed at 20 mm intervals. The second topic is the occurrence of a small but significant proportion of apparently an intentional addition to the paste. Rims of this variant paste are usually identical to the standard Neeley's Ferry Plain paste (see Morse 1975b) jar rims. Two suggestions can be offered here to explain this practice. An amalgamated Barnes group could conceivably form such a clay mixture. Or, because the sand does increase the vessel's strength and consequently its durability, the paste might be explained by experimentation on the part of Mississippian potters.

Distribution of Soils Near Zebree

The distribution of major soil types in the Zebree site vicinity, as generalized from specific soil classifications by the Soil Conservation Service (Ferguson and Gray 1971) can be discussed with respect to three broad zones of depositions. The area to the west of the site, and mostly above 74 meters above sea level, is characterized by sand, sandy loams, and some silt loams. These are thought to have been laid down by the relatively fast waters of ancient stream channels. Another zone of soils lies roughly between 72 and 74 meters above sea level and contains the Zebree site itself. These soils

are primarily silt loams and silty clay loams which probably supported the majority of the agricultural activities of the prehistoric village occupants. Beginning east of the site, in Big Lake, relatively thick beds of fine grained, back swamp clays have been deposited on the lake floor since the lake was created. These soils are generally formed below 72 meters above sea level. Samples collected of these clays have shown them to vary in color and in coarse vegetable matter content according to elevation. Clays in the shallower portions of the lake tend to be a medium bluish gray and contain an abundance of coarse vegetable matter. The latter is an undesirable inclusion in a clay paste for pottery manufacture. Fortunately, however, in open waters at the lower elevations, a relatively clear, dark bluish gray "naturally processed" clay can be obtained. This clay is not only suitable for pottery manufacture, but it is readily collectable and seems to be a logical clay source for the ceramic industries at the Zebree site.

A VERY PRELIMINARY REPORT ON THE ZEBREE SITE LITHICS

Dan F. Morse

Abstract

Lithics collected in 1975 at the Zebree site complement the 1968 and 1969 collections. Although no new lithic categories have emerged due to this most recent excavation, tests of distributional patterns and projectile point production will be possible with a better controlled sample recovered with finer techniques. The Cahokia microlith industry which exists all over this site was found highly concentrated at a nearby site, bringing up the question of just how the Zebree site equates with the anthropological concept of community.

No new undiscovered categories of lithic material were anticipated in planning research designs in connection with the 1975 excavations. Rather, the development of finer recovery techniques together with the knowledge supplied by Jeff Flenniken that the traditional 1/4-inch mesh screen could provide little or no information about preform and projectile point manufacture dictated that as fine a recovery as possible would be necessary in randomly selected areas of the deposits. In particular we wished to recover evidence of activities pertaining to the Barnes phase occupation which could be matched with a seasonality model of settlement pattern. In addition, we wanted to test the special distribution of microlithic manufacture at the site and needed both a randomly selected sample using the 1/4-inch mesh screen as well as a control finer screen to see what kinds of lithic debris were being missed or misrepresented by "traditional" recovery techniques. The basic hypothesis being tested here was that the microlithic chipping is done in specific areas and would be clustered rather than randomly distributed over the site. On the basis of field observation, this hypothesis would appear to be negated.

The discovery in early 1975 of orthoquartzite outcropping as huge boulders on the west edge of Crowley's Ridge north of Paragould as the obvious source for this material recovered in 1969 at the Zebree site allowed us to segregate all of the appropriate

quartzite collected in 1975. The large number of quartzite pieces recovered surprised us, particularly since most of it was from randomly selected samples and could not be inferred as representing isolated cases. There was a consistent pattern of the procurement of this stone. This pattern fits the model of interaction with Barnes groups thought to be located in the area of outcropping. This is a rare pattern as far as we know at the moment except in the immediate vicinity of the outcropping, presumably due to the fact that this stone fractures uncontrollably in contrast to the even textured cherts known to be available to the Zebree inhabitants. In other words, there does not appear to be any significant technological need for this particular stone.

Support for a lithic lab and for the replication of microliths was lost when the budget was restructured due to the severe limitation of funding. There is no anticipation that replication will be done in the near future and this in turn will retard any meaningful analysis of the microlithic debitage. Furthermore, there is no funding for objective identification of the stone utilized at the Zebree site which means that subjective identification based on the investigator's past experiences with various stone sources will have to suffice. Furthermore, experimentation to determine just what we did recover in respect to the different screen sizes will have to await a time when proper funding can be obtained.

A new site was discovered by a local informant by accident which exists just south of Zebree and hopefully, by virtue of its location, will be protected to a certain extent from the ditching project. Very little debris can be surface-collected at the site but virtually all of it is debitage resulting from the manufacture of microliths from Crescent Quarry chert which outcrops near St. Louis, Missouri. The meagre concentration of sherds, most of which are Barnes ware, brings up the question of the definition of the Zebree community. The "Cahokia site" is actually a composite of several artifact bearing locations which seem to belong to a single community. The possibility that Zebree also is a similar situation now must be considered. Because of the past and anticipated destruction, however, this question may never be satisfactorily resolved.

ENVIRONMENTAL DATA EXTRACTION STRATEGIES ON THE ZEBREE PROJECT

Jeffrey B. Newsom

Abstract

The prehistoric environment of the Big Lake Highlands exists today in only a profoundly modified state. Reconstructing that environment requires an integrated approach. By utilizing several data sources that are appropriate to test implications of pertinent hypotheses, various aspects of the natural environment during the prehistoric occupation in the research universe will be as completely and accurately described as possible.

The reconstruction of prehistoric environments is fundamental to our understanding of prehistoric cultures. It is possible to explain and comprehend the cultures of prehistoric peoples, who functioned as integral components in their ecosystem, without first ascertaining the characteristics of the physical and biotic environments in which those people, through the medium of culture, interrelated.

One of the prime considerations of the research design of the Zebree project focuses on gathering sufficient environmental data, from both archeological and historic contexts, in order to undertake an environmental reconstruction of the Big Lake Highlands, the area in northeast Arkansas that serves to demarcate the geographical extent of the Big Lake phase. Due to the widespread alteration of the original environment of the Big Lake Highlands since the turn of the century, and because of apparent extensive prehistoric occupation of that area, several investigative methods have been adopted. These methods will enable us to describe the prehistoric environment upon which the interpretation of the cultural evidence is contingent, and to test the applicability of certain hypotheses.

Environmental Background

The Big Lake Highlands are situated in the geologic region of the northern part of the Lower Mississippi Valley known as the Eastern Lowlands (Saucier 1970). This is an area comprising four

braided stream surfaces on the west and two meander belts, one of which is relict, on the east. The Big Lake Highlands roughly equate with the southeastern portion of the Malden Plain. Bordering the Highlands on the west is the St. Francis River, which intrudes upon one of the braided stream surfaces and contains in its course Lake St. Francis. On the eastern side, the Highlands are bordered by the Right Hand Chute of the Little River, which alternately borders and intrudes upon a relict braided stream surface and which contains in its course Big Lake (Saucier 1970:2850).

The soil of the Big Lake Highlands is sandy and is within the Amagon-Dundee-Crevasse soil association (Ferguson and Gray 1971). The Dundee soil is considered prime agricultural soil and needs little management. Its only inadequacy is that if frequently flooded, crops cannot be grown well. Sharkey-Steele is the soil association of the immediate Big Lake area, the locale of the Zebree site, and these soils are considered conducive to the development of a woodland terrestrial and wetland aquatic wildlife habitat, suitable for agriculture only if surface drainage is provided.

In the early 1900's, before extensive development, a discontinuous lowland prairie existed on the sandier soils of the Big Lake Highlands (Stephenson and Crider 1916). Apparently this prairie also existed prehistorically, as attested to by the identification of typical prairie faunal remains from the 1969 Zebree excavation (Guilday and Parmalee 1971). Interspersed with the prairie, and bordering the relict braided stream channels and riverine/lacustrine ecosystems, were bottomland hardwood forests of various associational types (Braun 1950). The original biotic communities rarely survive today due to two factors, logging and agriculture, which largely reflect modern economics (Holder 1965). Logging in northeast Arkansas virtually wiped out the virgin floodplain forests by about 1920. Comprehensive flood control and drainage projects, along with technological advances to sustain agricultural development had, by 1960, converted all of the potentially arable land in the Big Lake Highlands to the production of soybeans, cotton, corn, and wheat.

In the Big Lake Highlands today, then, only wetlands and associated woodlands that have been protected by the Federal Government and the State of Arkansas as wildlife preserves survive. An environmental reconstruction, then, is made difficult because of the drastically altered nature of the present environment in the Big Lake Highlands. By utilizing and integrating several environmental indicators from both archeological and historic contexts, along with the ethnobotanical and zooarcheological findings, the Woodland and Mississippian environment of the Big Lake Highlands can be reconstructed. When this is accomplished, a firmer basis for understanding cultural processes and human adaptations to the environment will be established.

Theory - Hypotheses Relevant to an Environmental Reconstruction

Before presenting the methodology involved in reconstructing the prehistoric environment of the Big Lake Highlands, it is necessary to present three hypotheses that have served to guide and give direction to the methods employed for environmental data extraction at Zebree. These propositions are all relevant to understanding and explaining (sensu Hill 1970) the lifeways of the prehistoric inhabitants of Zebree, although by no means are they the only theoretical considerations that have influenced the research design and methodology. However, it is anticipated that the selection of techniques appropriate to their solution will serve to determine their validity in the Big Lake Highland context.

H_1: The origin of the St. Francis and Big Lake Sunk Lands is a result of alluvial drowning of several relict braided stream channels by a crevasse channel of the Mississippi River.

The first hypothesis to be considered, and one that is crucial to the Zebree project, is geomorphological in nature. The origin of the Sunk Lands has generally been attributed to the effects of the great New Madrid earthquake of 1811-1812 (Fuller 1912). However, Saucier (1970) has hypothesized that the origin of the Sunk Lands, of which Big Lake is a major manifestation, occurred when minor streams were forced to reduce their gradient and aggrade their floodplain due to rapid alluviation by the major stream. In the case of the Sunk Lands, it appears that the Mississippi River was diverted to a new course through a low area of the floodplain now occupied by the Left Hand Chute of the Little River, achieving a slightly steeper gradient. As a result, because the crevasse channel interrupted the Right Hand Chute of the Little River and the St. Francis River, these rivers were dammed by development of a natural levee and water was backed up to form the Sunk Lands. This event, thought to have happened between 1000 and 1500 years ago, is of a type that is widespread in the Lower Mississippi Valley.

H_2: Creation of Big Lake during the Late Woodland period could have served as a causal factor in site locations by peoples of the Big Lake phase.

The second hypothesis concerns cultural processes and is related to the validation of the geomorphological hypothesis. Morse (1975a) has noted the striking contrast between the relatively sparse occupation

of the Zebree site in Late Woodland times (ca. 700-900 A.D.) and the extensive settlement of the developing Mississippi Big Lake phase immediately following (ca. 900-1150 A.D.). If Big Lake came into existence sometime around 900 A.D., then it is thought that the new habitat might have attracted Mississipi peoples to the area. Presumably, these Mississippians would have been attracted to the area in order to exploit the important floral and faunal resources that became readily accessible in the lacustrine environment. The intrusion of a strongly structured Mississippi chiefdom upon a weakly structured Late Woodland group residing in the Big Lake vicinity provides an interesting possibility for the study of such cultural processes as social amalgamation and acculturation (Morse 1975a). In addition, behavioral change in the transition from Woodland to Mississippian societal stages will be examined.

H_3: If the prehistoric environment of the Big Lake Highlands was diversified, then the Mississippian occupation of Zebree might reveal a particular pattern of adaptation and organization.

The third hypothesis regards the effect of the environment on human adaptation and subsistence activities. If an environment reconstruction of the Big Lake Highlands can provide suitable information on microenvironmental diversity in the area, then hypotheses on the pattern of animal exploitation by Middle Mississippi groups formulated by Smith (1974) may be tested. Mississippian subsistence patterns discerned from the floral and faunal assemblages of the Zebree site will be compared and contrasted to those predicted by Smith. According to his exploitation model, in a situation where Mississippian groups were exposed to a high degree of microenvironmental variation in a relatively small geographical area, with a corresponding maximization of ecotonal edge interface between the zones, a particular form of adaptation, with concomitant social organization, took place. This adaptation, reflected directly in seasonally oriented and selective exploitation of animal populations, in addition to an intensive agricultural base, can probably be tested with information derived from Zebree. An environmental reconstruction is a first step in this kind of analysis. If the relationships presented by Smith's hypotheses are applicable to the prehistoric situation in the Big Lake Highlands, then the niche occupied by the human component in the ecosystem can be more fully defined and understood.

Methodology - Strategies of Environmental Data Extraction

Various methods of extracting environmental data from the Zebree site were employed in order to provide as much information as possible for chronological purposes, to reconstruct the prehistoric environment during the period of occupation of the Zebree site, and to yield a firm foundation from which to test implications of the relevant hypotheses.

An important extraction strategy from the archeological context was gathering soil samples for pollen analysis from different locales within the site and outside of the area of occupation. Within the site, samples were taken from features and excavation units where circumstances were such that pollen might be well preserved and recovery of significant data was likely, as described by Harris. Outside the site, strata were exposed to allow for pollen samples from the soil profile in undisturbed areas, and core borings were taken in the unexposed strata of the lacustrine clay bottom of Big Lake by James E. King of the Illinois State Museum. Also, samples of the modern pollen rain were gathered on the surface in the site vincinity for comparison purposes.

Soil samples were systematically taken from every level of each random excavation unit in the form of a standard volume Zoological-Botanical sample for flotation of microfloral and faunal remains. These will be analysed by Roth and Harris. All macrobotanical remains, such as carbonized wood and nuts, were carefully gathered for laboratory identification and analysis. These types of botanical remains will prove indispensable as an auxiliary form of evidence to the palynological interpretation for delineating the prehistoric vegetation (Butzer 1971).

Initial dendrochronological studies of the bald cypress undertaken in the Big Lake Highlands by Bowers during the 1975 field season and previously (Bowers 1973) will be utilized for explanatory purposes in the period 1800-1970, for which a master chronology has already been constructed. Subsequent tree-ring studies in the area, along with a chronology already developed for the Mississippi drainage (Hawley 1941) may provide significant information regarding geomorphological and climatological change over a longer, and hence more archeologically germane, temporal span.

From the historic context, the early 19th century vegetation of the Big Lake Highlands will be reconstructed primarily through the use of original U.S. Government Land Office Survey notes and plats (sensu Bourdo 1956). The use of these notes is extremely valuable in reconstructing prehistoric environments, since they

were undertaken before logging and agriculture had effectively altered the pristine vegetation and topography. Therefore, the flora and landforms observed by the original surveyors is essentially that which existed in the Big Lake Highlands during the earliest historic period rather than that which is characteristic of the region since settlement and development (Zawacki and Huasfater 1969). Although the information derived from this source will not necessarily furnish direct representation of the prehistoric environment of the Big Lake Highlands, it is usable for quantitative and qualitative analyses for enhancing interpretation of the data extracted by archeological techniques.

In addition to the Land Survey Records, several other historic sources will be employed. Early travelers' accounts will provide useful information and perspective, as will local county histories pertinent to the area. Contemporary writings on the ecology of Lower Mississippi floodplain biotic communities (Shelford 1954), studies regarding lacustrine plant succession (Gersbacher and Norton 1939), and geological investigations in the research area (Saucier 1970), will supplement and augment the credibility of the interpretation of the environmental data. Finally, vegetation studies done in the Big Lake National Wildlife Refuge (Metcalf 1920) and the Zebree project's vegetation transects in the site vicinity will facilitate interpretation of the information from the various archeological and historic contexts.

PRELIMINARY FAUNAL INVESTIGATIONS OF THE ZEBREE SITE

Eric A. Roth

Abstract

The objective of this paper will be to present the current and proposed research status of the vertebrate skeletal remains recovered from the 1975 Zebree site excavations. These aspects will be dealt with first in regard to general methodology and subsequently as to theoretical approaches.

Introduction

In order to achieve as high a degree of control as possible over the recovery of both faunal and floral material, two basic methodological techniques were applied in the field. The first was that samples were taken from each excavation level and were subjected to water-flotation processes (Streuver 1968a) in order to obtain microfaunal and floral elements.

Also a scheme devised by Thomas (1969) which aims at quantifying the amount of faunal loss inherent in the use of differing screen mesh size was employed. Basically this technique involves the subsequent passing of fill through gradiated screen mesh (1/4", 1/8", and 1/16") and then calculating the amount of skeletal loss for various classes of bone size. In this manner a correction factor or "recovery constant" can be arrived at which then can be utilized in the calculation of relative abundance of species.

In the laboratory all recovered elements from each level were divided into their respective faunal class (mammalia, aves, pisces ...etc.) and their frequencies and weights recorded. These are being identified as to species wherever possible. These frequencies and weights can be utilized to generate SYMAP computer programs (Redfield and Watson 1970) which, when correlated with pottery, may discern separate faunal assemblages for the different archeological components represented in the site. In this way possible changes through time in animal exploitation may be detected. These weights and frequencies will also be employed to calculate the relative abundance of faunal classes represented in the site in three different manners: by bone fragment frequency (Chaplin 1971), by bone weight (Reed 1963), and by the most frequently recovered

skeletal element (Flannery 1968). The results of each technique can then be compared and contrasted.

Turning to the theoretical aspects of the analysis each major class of fauna represented will be treated separately, since each lends itself to different approaches.

Class Mammalia

The mammalian remains will be analyzed from both the ecological and ethological viewpoint. The first will offer insights into the microenvironments utilized while the second approach's objective is to reveal something of the mammalian hunting patterns employed by the prehistoric inhabitants. Of special interest will be a comparison of the Zebree faunal assemblages with the pattern of animal exploitation formulated by Smith (1974) for Middle Mississippian populations.

Class Aves

The emphasis of the avian faunal analysis will be on the use of the abundant migratory waterfowl remains as seasonal indicators of site utilization. Of course the ecology and ethology of the avian assemblages will be investigated with the same objectives as for the mammalia.

Class Pisces

Based on both modern fish population studies (Forbes and Richardson 1920) and historical information (Carlander 1954) such ecological factors as preferred water current and bottom environment of the piscian skeletal assemblage can be determined and will be employed in the reconstruction of the Zebree aquatic microenvironments. In addition to the skeletal remains the site has also yielded large samples of fish scales. These will be examined to enlarge upon the piscian species composition and to determine both the age composition and catch seasonality of the fish population.

Summary

In closing it should be stated that the Zebree site has yielded abundant faunal remains exhibiting excellent preservation, and as such represents an important source of paleo-zoological information. The research potential of this rich source has been furthered considerably by the opportunity to study the remains from the time of initial excavation.

BOTANICAL REMAINS, RECOVERY TECHNIQUES AND PRELIMINARY SUBSISTENCE RESULTS

Suzanne E. Harris

Abstract

Research at the Zebree site has emphasized the recovery of botanical material for use in defining changing patterns of plant utilization at the site through time, and in reconstructing the prehistoric natural environment. Zoological-botanical standard volume samples from the random squares excavation units were taken to assess the botanical element in midden formation. These, plus samples from the majority of features, and from the general level material are currently under analysis.

The recovery of prehistoric floral material was one of the major emphases of research during the 1975 excavations at the Zebree site. This floral material (plus that collected in 1969) is the first collected in the northeast Arkansas area in either the Late Woodland Barnes Phase or the developmental Mississippian Big Lake Phase. These data will be used in a preliminary definition and comparison of the subsistence and plant utilization patterns of these two cultural periods. In a more general context, the floral data will also be used in the study of rates of midden accumulation and intensity of occupation of various areas of the site through time.

Botanical samples were taken in three ways. The first samples were Zoological-Botanical samples (hereafter referred to as Z-B samples) which were standard volume samples taken in #10 tin cans, with a volume of 1 gallon. A Z-B sample was taken from each level below the plow zone of each 1 m random square excavation unit. The samples were taken from the center of each level before any other excavation of the level was commenced, and extended the depth of the level, approximately 20 cm. Z-B samples were also taken from each feature encountered in the random square excavation units. These samples were then processed by water flotation to permit near total recovery of botanical (and faunal) material.

Botanical samples were also taken from the majority of features encountered in the test trenches and block excavations; these were usually 2 gallon (using the buckets of the bucket samples), although sometimes larger samples were taken at the discretion of the excavators, in which case the volumes were noted on the container. These samples were likewise processed by water flotation. Finally, some botanical material was recovered from the water screening and fine screening of general fill of the 1-m squares and the test trench and block excavation features.

Samples for water flotation were transported from the field to the lab for processing. The water flotation was conducted using a wash tub and a 55 gallon drum. The light fraction floating on the water surface was skimmed off with cloth paddles. One, coarsely woven, was used to remove larger pieces rapidly and a second tightly woven one of Indian gauze was used to remove small seeds. In samples, primarily features, containing numerous seeds, these seeds were kept separate from the other botanical materials; in samples where only a few or no seeds were visible it was deemed more efficient to recombine and process them with the rest of the light fraction.

In order to recover all adhering material, both paddles were rinsed with a high pressure hose and their contents strained through India gauze, the same fabric as the finer woven paddle. The rectangle of fabric used as a strainer was then wrapped around the light fraction to form a packet. This packet was then stapled to the newspaper lining of a cardboard box in which the heavy fraction of the same sample was dried.

An average of 20 Z-B samples per day were floated. Generally, fresh water was used for every third sample, and for every sample for the features from the block excavations. Approximately 191 samples from random square levels, 38 samples from features within random squares, and 54 samples from features in test trenches and block excavations were recovered and processed by water flotation.

The light fractions of the flotation samples were rough sorted in the lab for charred botanical material and bone; the heavy fraction was sorted for these categories also (which rarely occurred) and for small flakes which might be indicative of microlith manufacture.

At the present time slightly more than half of the Z-B samples, features from random squares and features from block excavations have been at least rough sorted. First priority in sorting the Z-B

samples has been given to those from the second and third levels, which include most of the midden. The Z-B samples will next be sorted into categories including (but not necessarily limited to) identifiable nuts (primarily hickory and acorn), unidentifiable nutshell, seeds of various kinds, and wood charcoal. These will be identified to genus and where possible, species.

From a cursory examination, the major part of the botanical material from the Z-B samples is wood charcoal. Of the 25 samples that have been sorted for the presence of seeds, 12 contained one or more carbonized seeds assumed to be prehistoric. It is expected that a similar frequency will be obtained when the remaining samples are sorted. Identification of the seeds has not yet begun, but discouragingly, there is only one occurrence of a cultigen, a single corn cupule.

The distribution and densities of identified botanical categories (and/or species) as well as the total weight of botanical material by level will be plotted by a computer program in order to make inferences about the nature and possibly the rate of midden deposition across the site and through time. For example, total weights of carbonized botanical material (as well as total weights of artifact classes and faunal material) will be plotted as a gross measure of the intensity of occupation. A comparison of weight by level will help establish *relative* rates of midden accumulation. Likewise, subsistence activity areas will be plotted using the total weight of subsistence material by excavation unit, and the rate of food to nonfood botanical material. The presence or absence, and frequencies of the various botanical categories will also be plotted.

Features from the random square excavation units, test trenches and block excavations, because of the concentration of material relative to the general midden, are expected to be the most useful source of subsistence data. Those features which are assignable to a single cultural phase based on pottery, have been analyzed. The remaining features will be sorted in a manner similar to that described for the Z-B samples.

In an effort to obtain data rapidly to be plugged in to the computer program, an analysis was made of charred botanical material recovered from the general fill of random square levels and features during water screening. While these were recovered under conditions which might be considered haphazard relative to the Z-B samples, they could be sorted rapidly for presence or absence and for categories of botanical material across the site. And because they were sufficiently large to be caught by a 1/4 inch screen, most

pieces were identifiable, at least to gross morphological categories such as nutshell or wood charcoal. Like the Z-B samples discussed previously, the majority of each sample is wood charcoal, virtually all of which should be identifiable to genus and in some cases species. (Impressionistically, the dominant wood types appeared to be cypress, ash willow/cottonwood, and maple with lesser amounts of oak, hickory, and leguminous wood.) Subsistence remains included acorn, hickory nuts, walnuts, corn, grape, persimmon, and wild bean (Strophostyles).

Preliminary results were obtained for features analyzed for data pertaining to subsistence of the two major cultural phases represented at the Zebree site. This analysis concentrated on those features, all pits, which were associated with pottery of a single phase and which therefore are assignable to a specific phase.

At present, only four pits may be definitely assigned to Barnes and five to the Big Lake phase. Relatively abundant subsistence-related species only occur in one Barnes and two Big Lake phase pits. Analysis of the remaining pits from the site may provide additional unmixed cultural contents.

As mentioned above, no botanical material has been recovered previously from Barnes Phase sites. It was hoped that the Zebree site, in addition to providing the first data on Barnes subsistence, would also yield evidence of cultigens. However, this has not been the case in the features analyzed, nor in the general water screen samples from 15 levels from random squares which are associated solely with Barnes pottery. Thus, at present, the Barnes diet is represented primarily by acorns in all four features and hickory nuts in two features with minimal occurrence of black walnut, grape, and wild bean (Strophostyles). Two features also yielded unidentified carbonized seeds.

The five developmental Mississippi Big Lake phase samples include both a greater quantity and diversity of subsistence material than the Barnes. All of the sample included acorns and hickory nuts, while grape and persimmon occurred in one sample. Two identified charred seeds Chenopodium (probably album) and Polygonum (probably pennsylvanicum) also occurred in one sample. Several other as yet unidentified carbonized seeds were also present.

Corn also occurs relatively frequently, in three of the five Big Lake phase feature samples. An even greater abundance of corn was recovered during the 1969 excavations, but the cultural context, although Mississippi, is unclear. The 1969 corn samples were measured by Leonard Blake of the Missouri Botanical Gardens. Of the 18 cobs measured, six were 12-rowed and six were 14-rowed; the mean row

number was 11.8; the median cupule width was 5.7. No measurements have as yet been made on corn from the 1975 excavations. Blake also reported approximately 1/2 cup of uncarbonized seeds of Gromwell (Lithosperum sp.) or false gromwell (Onosmondium sp.) and notes that these were often used as beads; one fragmentary hackberry seed was also noted by Blake.

No features of unambiguous Middle Mississippi context were located at the Zebree site in 1975. In both the Late Woodland and developmental Mississippi, the predominant subsistence species by weight are hickory and acorn; however, the frequency could relate not only to utilization by the inhabitants of the site, but also to better preservation relative to other subsistence categories. As for the differences in the two components, the presence of the wild bean in the Late Woodland, but not in the developmental Mississippian, the presence of persimmon and walnut in the developmental Mississippian, but not the Late Woodland, are, I suspect, also related to preservation and the small size of samples rather than actual utilization. The absence of cultigens in the Barnes phase samples still leaves open to question the possibilities of agriculture during the late Woodland period in this area.

It was expected that additional information on subsistence, particularly cultigens, could be obtained through analysis of pollen samples from features whose cultural context is well defined based on pottery types. Ten samples were submitted to Dr. Allen Solomon, Department of Geoscience, University of Arizona, to ascertain whether sufficient countable pollen is present in various contexts at the site. Two samples were from Barnes pits (F. 270 and F. 288) and two were from Big Lake pits (F. 257 and 210), one (F. 257) being from the outer rim of a Big Lake vessel found in a pit. One Barnes midden sample and one Big Lake midden sample were also submitted; these were collected in Area B where the two occupation levels are separated by a gap of relatively sterile subsoil (from which a sample was also submitted). We have received a brief notes from Solomon that only one of the samples--that from the rim of the Big Lake vessel--contained sufficient pollen to warrant further analysis in his opinion. Although pollen apparently is present in the other samples, it is not statistically meaningful.

This paper has been a brief preliminary report on the methods of data recovery and analysis of botanical material from the Zebree site and some of the initial results. Through continued analysis along these lines, quantification of the differences in midden composition and formation across the site, as well as better definition of the subsistence patterns of the two major occupations of the site, will be accomplished.

TREE-RING DATING AT THE ZEBREE SITE IN THE BIG LAKE NATIONAL WILDLIFE REFUGE

Lynne Jordan Bowers

Abstract

Tree-ring dating of the bald cypress (Taxodium distichum L Rich.) will be undertaken to help reconstruct environmental conditions which existed at the Zebree site. This species was chosen because of its prevalence in the area and the existence of an earlier tree-ring study for the area using bald cypress. Thirty-five samples were obtained for the present study.

The purpose of the tree-ring study is to aid in the reconstruction of environmental conditions which previously existed at the Zebree site in the Big Lake National Wildlife Refuge. An annual increase in the diameter of many trees produces a ring as seen in cross section. These rings provide a chronological sequence of tree growth (Stokes and Smiley 1968). This sequence is quantitative in that the age of the tree can be established and qualitative as the width of the ring indicates the response of the tree to its environment. The bald cypress (Taxodium distichum L Rich.) was chosen for this project because of previous tree-ring dating of the species in the area (Bowers 1973).

Methods

The collection and processing methods which were followed primarily are those of Stokes and Smiley (1968). Collections of both living and dead specimens were made from two areas within the boundaries of Big Lake National Wildlife Refuge. Thirty-five samples were collected from a recently cut area located approximately 805 meters northwest of the Zebree site known as Area D of the diversion channel area, Ditch 81 structures. Samples were also taken from 10 living trees on the place known as Katy Ray Ridge, 8.5 kilometers southeast of the Zebree site.

Collection

Field notes were kept as to the exact location of the site of collection, depth of water at base of tree, soil characteristics,

associated species, relationship to other trees and physical features of the tree, such as stem diameter at breast height and crown type when available. A Swedish increment borer was used to remove a core 5 mm in diameter from living specimens. Precautions were taken to eliminate the risk of fungal attack at the spot of coring by inserting wooden plugs in the tree after sampling. The borer was rinsed with isopropyl alcohol before insertion into a new tree. A chain saw was used to take wedge-shaped sections from stumps in the area which had previously been cut. Samples were numbered to distinguish the specific site of collection, tree, and core. For example, core 3-5-2 would be Core 2 from the fifth tree on Site 3. The core number indicates the side of the tree from which the sample was teken i.e. 1, north; 2, east; 3, south; and 4, west.

Preparation of Specimens

Each specimen was numbered and the size, type of sample and condition of sample recorded with the field notes on individual file cards. The cores were allowed to air dry for a few days and then mounted. Cores and cross sections were surfaced by sanding with progressively finer grades of aluminum oxide sand paper. When the sanding was finished, cell walls became visible and ring details were quite prominent.

Measuring and Cross Dating

The ring width for each sample is measured with the aid of a dissecting microscope and an Ames Dial indicator to the nearest .001 mm. After a graph of raw ring widths is constructed for each sample, they are compared. When all specimens are aligned, a time period common to all specimens is observed and the specimens dated relative to each other.

This process aids in the detection of missing rings or double rings since the chance of an abnormality occurring in all the specimens during the same year is small. If a specimen does not cross date with the others it is eliminated from further study. A chronology is constructed by averaging the values for each year for all the samples.

Statistical Analysis

After preliminary cross dating and elimination of errors is made visually, the FORTRAN computer program written by Baillie and

Pilcher (1973) will be used to make the following comparisons: between radii of the sample; between samples; between the samples and the chronology constructed previously by Bowers (1973); and between the two chronologies.

Briefly, Raillie and Pilcher's (1973) program is designed to establish the highest correlation between the ring patterns of two different samples. Raw ring widths are first standardized by conversion to a percentage of the mean of the five ring widths of which it is the center value. Then, the data is normalized by taking the log to base e of the percentage figures. The output is in the form of t values to indicate the probability of the obtained correlations.

Summary

The growth of a tree is not simple and is dependent on the genetic make-up, age, and environment of the organism (Billings 1952). Specific tree species are adapted for survival in specific habitats. The bald cypress, which is very common at Big Lake, occurs naturally (more than 90% of natural stands) at elevations of less than 100 feet above sea level and is usually restricted to very wet soils (Fowells 1965). Dickson (1968) found that bald cypress grows best in water-saturated, aerated soil. However, the seeds do not germinate while the site is submerged (Applequist 1959). Also, seed which have been submerged for a year will not germinate (Appelquist 1959). In order for bald cypress to become established in an area, the seed must sprout during a time when the water has receded and the seedling must grow tall enough the first year to stay above the floods except for short periods (Langdon 1958). Seedlings often reach heights of 8 to 10 inches during the first season and 16 to 20 inches by the second year (Mattoon 1916).

The growth rings of the bald cypress at Big Lake should be able to add the following to the reconstruction of environmental conditions:

1) An even aged site (i.e. a uniform age is determined for trees throughout the stand) could indicate the time at which the site was inundated. The seedlings would have established themselves at a time when the site was not flooded.

2) The age dynamics of a mixed site (i.e. trees of varying ages) could indicate intermittent periods of flooding.

EXCAVATIONS AT THE ZEBREE SITE:

A REVIEW OF THE RESEARCH DESIGN

Christopher S. Peebles

I visited the Zebree site for two days in early August, 1975, at the request of the Arkansas Archeological Survey. In the course of this visit I talked extensively with Dan Morse (Project Director), Mark Raab (Field Supervisor), Suzanne Harris (Ethnobotanist), David Anderson (Research Assistant), Michael Million (Ceramic Analyst), and Phyllis Morse (Processing Supervisor). Prior to the visit I had read Dan Morse's Report of Excavations at the Zebree Site, 1969 (Research Report No. 4, Arkansas Archeological Survey, 1975). Additional materials, including the proposed and the final budget, the research proposal for the 1975 excavation, and an outline of additional research objectives, were given to me during my stay at the Zebree site. I believe that these materials, the many conversations with the staff, and two on-site visits have given me sufficient information and background to review the ongoing excavations at the Zebree site.

Constraints

The Zebree research, like all research, is conditioned and constrained by a number of factors. Included in these "givens" and "limits" are available time and money, available manpower, vagaries of weather, research goals, the state of archeological techniques, and the prior knowledge of the site gained from the 1968 and 1969 excavations. The data in hand indicates that the Zebree site is confined to an approximately 3 acre parcel of high ground, and that there are three stratified occupation levels of only partially defined areal extent represented within these 3 acres. The extent of the earliest, Barnes phase (late Woodland) component is not yet known; the second, Big Lake phase (early Mississippi) component covers most of the high ground and is enclosed within a palisade wall; the final, mature Mississippian component consists of a small hamlet which occupies only a limited area of the site. Any research design benefits from the fact that the boundaries and occupational history of the site are reasonably well known, even if only in outline. However, this prior knowledge also means the research design must simultaneously maximize the recovery of data from each of these three components.

The major constraints on the excavation at the Zebree site are time and money. The final budget for the "mitigation" of the

total destruction of the Zebree site is approximately $100,000. This sum is less than one-half that requested by the Arkansas Archeological Survey, and, in my opinion, is less than one-third of the optimum amount. Even given the final sum of $100,000, the amount actually available for excavation and analysis (including the AAS contribution and excluding overhead) is approximately $80,000. The time available for excavation of the Zebree site is even more limited than the funds allocated. At the time I visited the site a total of less than 12 weeks has been granted to excavate the site. Even if this time were sufficient, which it clearly is not, it makes no allowance for the unpredictable nature of the weather in northeast Arkansas.

Therefore, given (1) the size and complexity of the Zebree site, (2) the research objective (discussed below), and (3) the fact that this is a National Register site owned by the federal government, the time and money allocated are insufficient to "mitigate" the total destruction of this site. Moreover, when the extent of senseless site destruction in northeast Arkansas by relic collectors and farmers (cf. Larry Medford, Site Destruction Due to Agricultural Practices in Northeast Arkansas, Research Series No. 3, Arkansas Archeological Survey, 1970) is considered a site such as Zebree becomes a crucial link in our understanding of the late prehistoric period in this area.

Research Design

There are a number of basic questions which must be answered by any terminal excavation at the Zebree site. In outline, these questions are:

1) What is the spatial extent and temporal span of each of the three components represented at the site?

2) What cultural (behavioral) variability is represented in each of the three components? That is, what are the ranges of variability, distributions, and associations of the features, artifacts, and ecofacts encompassed by each of the three components?

3) What are the relationships between the three temporally ordered components? Did the earlier components evolve into the later, or is a site-unit intrusion represented?

4) What was the adaptive niche of each of the three components? That is, what were the relationships between the people who created the three components and the natural environment?

5) What were the relationships between each of the three components and other contemporary socio-cultural systems? Are the settlements represented by these components special purpose? Seasonal? Year round and independent? Year round and part of a larger political entity? Etc.?

Specific questions with material implications must be phrased, and data must be collected to answer these basic questions. Moreover, given that the site cannot be excavated completely, some form of sampling must be used to guide the excavation.

The research design for the 1975 excavations at the Zebree site, in addition to framing several specific questions and presenting a number of testable hypotheses, proposed to acquire data bearing on, and to measure four composite indices for each of, the three components. These indices are (1) population magnitude, (2) subsistence strategy and yield, (3) social differentiation, and (4) labor specialization. Although the research design proper does not spell out how each of these indices are to be constructed from the raw archeological data, my conversations with the staff did clarify the nature of some of the analytical strategies that will be used to build these indices. This area of data recovery and analysis is probably the most risky aspect of the Zebree research design. In general, indices like these require (1) explicit assumptions about the relationship between archeological data and human behavior, (2) explicit statements of the rules of measurement, (3) a statistically adequate sample (see below).

In this case the measurement of subsistence strategy and yield is perhaps the easiest of the four indices to measure. At the Zebree site some percentage of the floral and faunal remains are preserved in the middens; therefore, given some assumptions about deposition, preservation, and the adequacy of this sample of remains, some measure of environmental exploitation and yield probably can be constructed.

An index of population magnitude will be more difficult to construct. The sample of remains from the Zebree site cannot be geared to the discovery and recovery of a statistically adequate sample of features (see below); therefore, the classes of data usually used to estimate population--area under roof, number of pits, number of burials--cannot be used to construct inferences about the population magnitude for each of the three Zebree components. The excavators recognize this problem and propose to use a measure of midden accumulation, bulk, and content. Such an analysis should yield a relative, ordinal measure of comparison between the three components. However, the link between midden and

the size of the population that produced the midden may not be "constant" between the three components.

An index of labor specialization is going to be extremely difficult to construct. There are data from the 1969 excavation which suggest that certain activities may be localized within certain parts of the several components. Moreover, a "Cahokia" microblade industry was found in the early Mississippi component. One hypothesis to be tested is that this tool industry was used to cut and shape shell beads. (Experiments with these microblades [Morse 1975] show that they are efficient implements for working shell). There are also data that suggest local ceramic manufacture in the early Mississippi component and flint working in the Barnes phase component.

If the index of labor specialization is to be a measure of the variety and extent of the various productive activities of each component (e.g., subsistence activities, tool manufacture, craft activities, etc.), then the construction of this index is dependent on the recovery of an adequate sample of the by-products of such behavior. However, if this index is to measure the organization of production (what age/sex/status groups do what, when), and delineate the existence of part-time craft specialization, then there are problems which go beyond the collection of an adequate sample of material remains. Any argument that labor is organized above the co-resident, household level for subsistence and manufacturing activities depends on the demonstration (1) of repetative tasks which involved persons beyond the limits of a household group, and (2) that the variability and context of artifacts point to a limited number of manufacturers. The second point requires that the limits of variability of specialized versus household manufactured pottery and stone tools is known, which it clearly is not.

The index of social differentiation is going to be the most difficult of the four indices to measure. The notion of social differentiation implies that comparisons can be made within and between categories based on age, sex, social personae, and residential unit. That is, (1) a model of the organization of social personae will have to be built up from burials, (2) residence units will have to be analyzed and ranked one against another, (3) differential access by individuals to various resources will have to be assessed, (4) the autonomy of the settlement in relation to other settlements will have to be ascertained. Given the limited time and money available, I do not believe the data to be recovered from the Zebree site will support the construction of an index of social differentiation.

The above remarks should not be taken as a negative evaluation of the attempt to use these indices as part of the Zebree research design. I would argue the reverse: the fact that such indices are included as part of the research design serves to broaden the range of data collected and the techniques adopted to analyze these data. That is, archeological remains, like any other phenomena are given expanded meaning by the fact that additional questions are asked. In this case, the questions about socio-cultural organization and human ecology reflect the contemporary interests of anthropology and insure that a wide range of phenomena relevant to these interests are recognized as data and are collected from the site.

In addition to the collection of data for the construction of these indices, data are being collected from the Zebree site to answer a number of specific questions. The investigators would like to analyze the processes of transition from the late Woodland to the early Mississippi components at the site. They are also exploring the genesis of Big Lake. One of the hypotheses to be investigated is that Big Lake was created at ca. A.D. 900, that this event caused changes in the form and distribution of local biotic communities, and that these local biogeographical changes made the Zebree site a more attractive location for human settlement. Therefore, the change from a small community during the Barnes phase to the large, palisaded early Mississippi Big Lake phase community might be subsumed under the physiographic and ecological changes brought about by the creation of Big Lake. The test implications for the parts of this hypothesis are clear. First of all one would expect major changes in the pollen profile, and soil development in the depositional history of the site at the Barnes-Big Lake transition. Second, one would expect that the availability and thereby exploitation of plant and aquatic animal species would change between the late Woodland and early Mississippi components at Zebree.

The questions about the process of cultural change between the late Woodland and early Mississippi and the early Mississippi and mature Mississippi components at Zebree can be solved only partially with the excavated materials. If as the excavators suspected the Woodland to Mississippi change does in fact represent a site-unit intrusion, a migration, then the source of such a migration and the absence of local (regional) <u>in situ</u> cultural evolution has to be demonstrated. Moreover, if, in fact, the late Woodland and early Mississippi components represent two distinct and contemporary "ethnic" groups, then the interaction between these groups (labeled "acculturation" in the research design) has to be analyzed. In summary, the Zebree site has to be placed in its regional cultural setting.

Sampling

The questions posed in the research design for the Zebree site, singly and together, require for a substantial part of their answer an adequate sample of the remains from each of the three components. Given the limited funds and time available, a fully adequate sample from the Zebree site is unattainable. Therefore, the sampling design must be judged in the light of the constraints under which the excavators had to operate and the compromises which they were forced to make.

The sampling scheme chosen for the 1975 excavation at the Zebree site is a combination of (1) a probablistic, random sample of midden, and (2) a judgemental sample of features. The random sample is made up of a 1 percent stratified unaligned random draw of 1 m^2 test pits: one 1 m x 1 m pit is randomly selected from each 100 m^2 (10 m by 10 m) grid segment of the site. Each 1 m^2 pit is excavated in natural levels, or if no stratification is visible, in 20 cm levels. Two equal-volume samples of matrix are taken from each level of each pit, one for a fine screen wash, the other for flotation. The remainder of the matrix is screened.

The judgemental sample is to employ two and perhaps three techniques for discovery of features. First a random (but not probablistic) series of back hoe trenches are to be cut through the site. Second, large blocks of midden are to be hand excavated in selected areas. Third, time permitting, a large area of the early Mississippi midden will be removed by a bulldozer to expose part of the Barnes phase occupation. The judgemental sample will add approximately 4 percent to the excavated area.

Given the knowledge that the site is to be destroyed and the limited resources available, the use of a mixed strategy of sampling for both discovery and recovery of site content is reasonable and prudent. However, only the 1 percent sample of 1 m^2 test pits has the potential for supporting warranted statistical inference about the site as a whole. Therefore, any relation between the statistics (sample mean and variance) and the parameters for the site (true mean and variance) will have to be based on these squares. The size of these test pits, in turn, limit the analysis to midden contents. That is, the "grain size" of these tests is far too small to be used to support the discovery and analysis of the features. I suspect, however, that this 1 percent sample will turn out to be a good cluster sample of the midden contents.

The ideal sampling strategy for this site would have been a multi-stage sampling scheme in which the site is restratified

and resampled on the basis of knowledge gained from the previous sample (cf. Sampling in Archaeology, James Mueller, ed., University of Arizona Press, 1975). However, such a sampling strategy could not be supported with the available resources. Such a strategy would have required approximately three times the available time and money. In short, not only were the available resources too scanty for complete excavation, but they were too few to support an adequate sampling program.

Sampling in Action: The Excavation

In general and in specific the excavation at the Zebree site--at least on the two days I was there--showed a well organized and well run crew. Nothing is more discouraging than seeing a good research design thwarted and rendered meaningless because of poor, sloppy excavation in the field. Such is not the case at Zebree, and several observations will buttress my general observation.

First, the allocation of funds and people between the field and laboratory seems nearly ideal. On the days I was there, everyone was working at assigned tasks, and these tasks were up to date. My first day in the laboratory was a Friday. That day the fine screen and flotation samples from Thursday were being processed, and the materials from Wednesday which had been processed on Tuesday were being given their initial analysis by the ethnobotanical, archaeozoological, and artifact laboratories.

Second, information about the activities in the various laboratories are passed to the supervisory and field personnel on a daily basis. Thereby, field strategy, especially that which relates to judgemental sampling, could be adjusted on a day-to-day basis.

Third, the level of fieldwork is excellent. When equal-volume samples are called for, they are taken. Field notes are clear and readable; field notes are also kept up to date. Profiles and floors are clean and "readable," even after the difficulties created by heavy rains and high water. Each member of the field crew that I talked to, and I talked to most of this crew, knew what was going on and what he or she was doing.

Conclusions and Recommendations

The 1975 excavation at the Zebree site is a sound, well planned, and well executed salvage project. Given the limited time and

resources, these excavations will produce something near the maximum amount of data possible. The only fault I can find with the research design is that in several areas it is over-optimistic about the statistical adequacy of the data to be recovered. I can find no fault either with the field or laboratory work. It is, in general, excellent.

I do, however, have a somewhat jaundiced view of the resources allocated to the "mitigation" of the total destruction of this large and, I believe, important site. If mitigation is short of total excavation at state-of-the-art recovery practices, then time and money ought to be made available for a multi-stage, statistically adequate sample of features, artifacts, and ecofacts. Anything short of this goal is not mitigation in even the most limited sense of this word. Moreover, mitigation does not end once the data are out of the ground and placed in a laboratory storage drawer. The funding for the analyses of these materials is even more deficient than that allocated for excavation. Given the past history of the excavators and the Arkansas Archeological Survey, I know that an initial report will be written on these excavations. Moreover, I predict it will be a good report. However, the funds to permit extended analysis of these materials would make it an even better report.

THE RESEARCH DESIGN OF THE 1975 ZEBREE PROJECT: A REVIEW

Bruce D. Smith

Introduction

On some of the larger projects undertaken, it is the policy of the Arkansas Archeological Survey to ask several archeologists from outside of the state to review and to comment on the research design employed by survey archeologists.

The following review of the overall research design, excavation-recovery strategy, and data processing-laboratory analysis methodology employed in the 1975 Zebree Project is based upon data obtained from a number of sources:

1) Detailed background reading of the reports by Dan Morse resulting from the 1969 excavations at the Zebree site.

2) Reading of a number of versions of the Proposal for Mitigation of Effect of Corps of Engineers Project on the Zebree site, (May, 1975).

3) Reading of the four-page statement: Research Design - Zebree Mitigation (as of 14 July 1975) by L. Mark Raab.

4) Reading of the four-page statement: Excavation Strategy 1975 Zebree Site Investigations by David G. Anderson.

5) Reading of the three-page outline: Initial Research Schedule for The Zebree Excavation Project.

6) Observation of the Zebree site excavations during the three-day period August 2-4, 1975.

7) Observation of the Zebree data processing and analysis procedures during the three-day period August 2-4, 1975.

8) Most importantly, during the three-day period August 2-4, 1975, there were almost continual detailed open discussions concerning all aspects of the Zebree

research design and involving all people responsible for different phases of the excavation-analysis procedure.

On the basis of the data base described above, I would like to offer answers to a series of basic and important questions. These questions and the answers given will form the review of the Zebree Project.

1) Should the Zebree Site Have Been Excavated?

The Zebree site is an important and in many ways a unique archeological site in terms of our present state of knowledge concerning prehistoric cultural evolution in the eastern United States during the period A.D. 700-1400. The importance of recovering as much data as possible from the Zebree site prior to destruction can not be overemphasized. The past and continuing effort of Dan Morse, Hester Davis, Charles McGimsey, and other Arkansas Archeological Survey personnel to delay destruction is well founded. Indeed, it is difficult to understand why the Corps of Engineers chose not to either delay destruction of the site or to provide further funds for its excavation (the phrase "living up to the letter of the law, but not the intent" comes to mind).

One of the main reasons the Zebree site is important and unique is that it contains an early Middle Mississippi component (A.D. 900-1100). Few sites of this time period have been excavated within the central section of the Mississippi Valley. Since the transition from Woodland to Mississippian is a research problem of interest to many archeologists, the Early Middle Mississippi component at the Zebree site could yield much important data. More specifically, I see four main reasons why the Early Middle Mississippi component at the Zebree site warrants a major research effort.

1) The Zebree microlithic industry involving Dupo or Crescent Quarry chert indicates trade and quite possibly further interaction between the Zebree site and the Cahokia-American Bottoms area during the Fairmount Phase.

2) The Zebree site apparently functioned as a primary settlement within the Big Lake Phase settlement system.

3) The Zebree site was apparently fortified during the Big Lake Phase.

4) The preservation of plant and animal remains at the Zebree site is excellent.

These four factors, while seemingly unrelated, all pertain directly to understanding the prehistory of northeast Arkansas during the period A. D. 900-1100, and more generally to understanding the Mississippian Cultural Tradition. The transition from Woodland to Mississippian (A. D. 800-1000) witnessed an obvious and dramatic shift in subsistence, in social organization, in settlement patterns and systems, and in the nature and extent of interaction between cultural groups within the central section of the Mississippi Valley. Cahokia and the American Bottoms was an area of rapid and significant change during this time period, and is viewed by many archeologists as being an important influence upon a very large geographical area. Information concerning the subsistence strategy of the population occupying the Zebree site (4 above), the role of the Zebree site in the overall settlement system of the Big Lake Phase (2 above), if the site was defended or not (3 above), and the extent and nature of the contact between Zebree and Cahokia, is important, therefore, within the larger context of understanding the overall pattern of cultural evolution in the eastern United States.

Similarly, very little is known concerning the Late Woodland Period in the Central Mississippi Valley in terms of subsistence-settlement patterns. The existence of a Late Woodland component at the Zebree site, therefore, provides an excellent opportunity to obtain comparable information to employ in studying this Woodland-Mississippi transition.

Finally, the Middle Mississippi occupation at the Zebree site is apparently a small occupation of from perhaps 2-6 structures and associated features. Very few Middle Mississippi sites of this size have been excavated in any detail, and their position within larger subsistence-settlement systems is far from understood.

Each of the three separate components at the Zebree site, therefore, represents an opportunity to gather information pertaining to major research problems within the central valley of the Mississippi River; taken together, they represent an important and at the present time unique site. While this assessment of the importance of the Zebree site is mine alone, I feel confident in stating that any other archeologist with an interest and knowledge of the central valley, indeed any archeologist that has read Morse's 1969 Zebree report, has come to a very similar conclusion.

2) Has the Arkansas Archeological Survey hired qualified, competent individuals to conduct the Zebree project?

An effort was made to determine the educational background, professional experience, and competency in specialized areas (i.e. Ethnobotany, Sampling, etc.) of the people responsible for directing

The different phases of the Zebree project. Without going into great detail let me simply state that a crew of highly qualified individuals has been assembled.

a) A high level of expertise is evident in all areas where specialized training is required.

b) There is a good balance of theoretical idealism and realism based on past experience in the northeast Arkansas area.

c) The high quality of personnel does not seem to exist only at the supervisory level. There are a number of experienced graduate students employed as excavators, and even those crew members with less experience seem to be careful and conscientious in their work.

d) There is clearly an open and friendly exchange of ideas, suggestions, and criticisms between members of the excavation crew concerning the direction of the project. The overall research design incorporates the recommendations of all personnel involved in different specialized aspects of analysis. Strategies of recovery of plant and animal remains, for example, were developed by Suzanne Harris (Ethnobotanist) and Eric Roth (Faunal Analyst), and they are also able to direct excavation of any important finds, as well as overseeing processing procedures. This is a far cry from the specialist sitting in a lab receiving a box of animal bones from a site that he has never even seen.

e) The project is well organized, well executed, and the quality of work is well above average.

3) Is the problem orientation of the Zebree site well conceived?

This is a difficult question to answer without going into some detail, and the following discussion will necessarily be lengthy. The following comments concerning the problem orientation of the Zebree project are based both upon the written sources cited above and lengthy discussions concerning the ideas put forth in the sources.

The problem orientation of the Zebree project can be most easily discussed in terms of three general problem area headings: 1) bio-physical, 2) behavioral, 3) other (as defined in data source 5). Each of these general problem areas will be considered in order.

1) Biophysical Problem Area. The single general problem to be considered under this heading is the relationship (if any) that existed between the formation of Big Lake and initial establishment of the Early Middle Mississippi component at the Zebree site. The hypothesis is as follows: the Early Middle Mississippi component at the Zebree site was established soon after the formation of Big Lake, and that the lakeside location of the Zebree site allowed access to important floral and faunal resources. This general hypothesis has been previously suggested, but not tested: "I think that the Banks site, and perhaps many other meander belt Middle Mississippi sites, were established in oxbow lakes areas quite soon after they were formed by shifts in the meander pattern of the river, and that the establishment of these sites represented expansion into newly-formed, unexploited niche areas" (see Phillips, Ford, and Griffin 1951:300). These oxbow lake areas, such as the Banks site stage 13 meander, represented newly available, prime environmental locations for Middle Mississippi groups to settle (Smith 1975a:167). It will be interesting, therefore, to see if it is in fact possible to determine the relative validity of this general hypothesis in reference to the Early Middle Mississippi occupation at the Zebree site. I see a number of problems, however, in the interpretation of data in relation to this hypothesis.

a) I wonder what "marker flora and fauna" (test implication a.) would be associated with the formation of the lake that would not have already been present in the environment (perhaps to a lesser degree) prior to the formation of the lake? About the only potential marker species I can think of would be "rafting" species of waterfowls (such as the lesser scaup and canvasback duck) that prefer broader expanses of water. This question can also be expanded to consider the availability of pottery clay (test implication d.).

b) Any attempt to reconstruct change in the biotic community through time on the basis of a corresponding shift in species selection by Zebree inhabitants (test implication c.) would seem to imply the assumption of uniform exploitation of the species available in the environment.

While I have some questions concerning the extent to which the test implications stated would in fact support the hypothesis, the general problem of the relationship between lake formation and the establishment of the Zebree site (component II) is certainly worth pursuing, and it is hoped that a convincing argument supporting the formulated hypothesis can be developed.

2) Behavioral Problem Area. A number of alternative hypotheses concerned with explicating the development of Mississippian cultural systems are set forth under this general problem area heading. The

importance of this general problem area is well recognized by archeologists in the eastern United States. There has in fact been an almost constant discussion of the evolution of Mississippian cultural systems out of a Woodland base over the last 25 years. The emergence of the Mississippian cultural adaptation is recognized as a primary research problem in the eastern United States. This interest in the Mississippian emergence has also accelerated within the last five years, with a variety of models of Mississippian development being proposed. It has also been clearly recognized that detailed, careful excavation of sites such as the Zebree site is very necessary for the development of such models of Mississippian emergence: "It is only through repeated attempts to formulate and refine a multivariant model of Mississippian development that the process of emergence of the Mississippian cultural adaptation will be adequately understood. Hopefully, it will be possible to formulate such models as more information concerning settlement pattern shifts, population growth, etc. becomes available for the period A. D. 700-900" (Smith 1975b:32).

The important variables that are isolated by L. Mark Raab in the formulation of alternative hypotheses dealing with the emergence of Mississippian cultural systems are four in number: subsistence energy, population magnitude, social status differentiation, and labor specialization. These four variables are among those that have been incorporated into a number of attempts to model the Mississippian emergence over the last ten years (Smith 1975b:30). Certainly an understanding of the relationship and interaction between these variables must form an integral part of any attempt to gain an understanding of the development of Mississippian cultural systems.

This general problem area of Mississippian emergence, then, is of great importance and great interest to archeologists, and information recovered from the Zebree site will be of value in attempting to understand this cultural process. Further, the four variables isolated by Raab are generally acknowledged as being involved in this cultural process.

I must, however, admit to having serious doubts as to the value and applicability of the path analysis model proposed by L. Mark Raab to analyze the relationships that existed between the four variables under consideration.

The research procedure as described consists of first starting out with all of the possible ordered combinations of the four variables being considered (E, P, SD, LS). These 24 possible linear, one way causal chains are then reduced to the four most likely valid chains. The criteria for reducing the total possible 4-element chains

from 24 to 4 are not explicitly stated. Considering only four possible chains, it might well be possible (theoretically) to determine which of the four is the most probable in comparison to the other three "finalists," but this does not tell one much concerning its relative strength in comparison to the 20 other possible sequences that were not considered. The first assumption made, therefore, is that none of the other 20 possible sequences would provide a better solution than the 4 finalists (Blalock 1972:444-445).

The second assumption that is made is that there are no further variables that may have played an important role in the process being studied. The system described is a closed system; it assumes that no outside variables will have any significant influence on the value of the variables being considered (Blalock 1972:445-446). Variables such as trade, warfare, technology, for instance, are not included as relevant variables in the process being studied.

The third assumption implicit in the model is that the causal links in the chain are one way. That influence flows one way in the chain, without variables influencing or affecting the status of any variables occurring earlier (to the left) in the causal chain. It is interesting to note that in his rather brief application of this procedure Plog (1974:149-150, 154-155) comments on the validity of such an assumption: "Unfortunately, Blalock assumed that he was dealing with nonrecursive systems, that his variable systems were not characterized by feedback. Since this assumption grossly violates our assumptions about sociocultural phenomena, I will attempt to circumvent it in applying Blalock's techniques to the data at hand" (1974:155).

Plog's attempt to apply multiple correlation analysis to archeological data (in the southwest) for somewhat similar reasons differs from Raab's attempt in a number of other ways. The sample size that Plog used in his analysis, while not approaching the suggested minimum of 100 cases (Kerlinger and Pedhazur 1973:446), is certainly much larger than the sample size (N = 3) available at the Zebree site. Any regression analysis involving four variables and only three cases would have such a low reliability as to be meaningless. Plog was working with data obtained from a large number of sites; Raab is working with data obtained from one site (3 components).

A fourth assumption that Raab makes is that weak causal linkage between variables can be established (and spurious relationships avoided) through temporal ordering. If, for example, the variable energy increases prior to a change in the value of other variables, this would tend to support those hypotheses where E starts off the causal chain. This in turn is based on the assumption that there

are no outside variables involved, and equates temporal ordering with causal linkage.[1] If you are willing to accept these four initial assumptions concerning the applicability of path analysis to the study of cultural process (I am not willing to grant any of them), let us turn to the more mundane problems of "operationalization" of the variables. The problems involved in operationalizing (quantifying) each of the variables are numerous and complex. Let us consider, for example, a single variable: energy. Operationalizing this variable involves accurate measurement of energy capture by human populations occupying the Zebree site during the Woodland, Early Mississippi, and Middle Mississippi periods of occupation. If energy input can in fact be quantified accurately enough, the values obtained could then be plugged into the linear causal chains hypothesized, and correlation analysis could be attempted.

Any comparison of energy values obtained from different components at the Zebree site, or comparisons from site to site, however, involves a number of assumptions, including:

1) Uniform rates of midden accumulation,

2) Uniform preservation of plant and animal remains from different components,

3) That the sample of materials recovered is a representative sample of the total population of materials in the ground,

4) That the total population of materials in the ground is a representative sample of the actual energy input.

A specific example may serve to illustrate the possible sources of bias involved. Let us say that an increase in energy from Woodland to Early Middle Mississippi is observed at the Zebree site in terms of an increase in plant and animal remains per cubic unit of midden. Is this apparent increase in energy input real? Or is it a result of:

1) poor preservation of materials in Woodland context?

2) the Woodland occupation being seasonal (perhaps during the summer, with plants and animals exploited during this season of the year being less likely to be preserved)?

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[1]This discussion of the problems inherent in the path analysis model is based in part on discussions with Donald Graybill, Department of Anthropology, University of Georgia. His comments and suggestions are appreciated.

3) faster midden accumulation during the Woodland period?

4) excavation of a Woodland occupation area not associated with plant and animal processing and disposal?

5) Woodland populations preparing and disposing of plant and animal materials in ways that would reduce the probability of preservation and recovery?

These operationalization problems are compounded by the fact that like other eastern lowlands sites the midden at the Zebree site is largely disturbed, and plant and animal remains can not always be assigned to components I, II, and III with any great degree of confidence (almost Apple Creekish).

Variables of social differentiation, population, and task specialization will similarly be difficult to operationalize. Few undisturbed house floors have been identified, and less than 20 burials have been recovered (there is a possibility that the Zebree burial area was destroyed by ditching operations in the 1920's).[2]

It is also quite possible that the Woodland, Early Middle Mississippi, and Middle Mississippi settlements at the Zebree site each occupied very different positions or niches within larger settlement-subsistence systems. Therefore, any meaningful statements concerning change in the status of variables such as energy, status differentiation, etc. from Woodland to Mississippian should be based on a regional viewpoint, rather than in terms of Zebree I → Zebree II → Zebree III.

These comments concerning the problems and sources of bias inherent in any attempt to quantify variables such as energy are not meant as criticisms of the Zebree project. They are problems that all archeologists working in the eastern United States have to deal with.

There will also be a certain amount of difficulty involved in determining the temporal placement of changes in the status of different variables, which is important (according to the research design) in establishing weak causal linkages between variables. If, for instance, a change in the value of the energy variable did in fact occur 50 years prior to any other variable change, could this be recognized, considering the disturbed nature of the midden?

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[2]It should be remembered that the on site visit was made about halfway through the field reason and that additional data pertaining to social differentiation, task specialization, etc., were recovered after the visit upon which this review is based.

4) Are the methodological strategies employed by the Zebree project well conceived?

In any overall research design the general problem areas, specific multiple working hypotheses, and methodological strategy employed in actual excavation of an archeological site should be integrated and logically related. Excavation strategies should be derived from the problem orientation of the research design. The excavation strategy employed at the Zebree site is an excellent example of this principle. Developed by D. G. Anderson and others, the excavation strategy was well conceived, and is clearly designed to recover data relevant to the problem areas defined.

The stratified, non-aligned sample of 1-meter square test pits over those areas of the site not excavated by Morse in 1969 should provide information concerning variation in midden thickness, intensity of activities in different areas of the site, and relative size and intensity of use of different site areas through time. Even though back hoe preview trenches are being employed to speed the excavation of these test pits, the total site area uncovered by this method may be so low (less than one half of one percent) as to limit the effectiveness of this procedure. This is a function of limited time rather than inadequate or incorrect planning, however.

The backhoe cuts and transects should allow accurate determination of changes in midden thickness, determination of density of features in different parts of the site and accurate delineation of the palisade ditch.

The wide area contiguous block excavation units should allow further recovery (in addition to Morse's 1969 excavations) of data relating to associations between features, feature outlines, activity areas, etc. It is hoped that time will allow further expansion of the Morse 1969 block examination of the Late Woodland component. In summary, the triple approach excavation strategy consisting of a systematic, stratified, random sample of previewed one meter squares, deliberate and random trench transects, and block excavation units was formulated through input from a number of individuals, was well conceived, and is being followed within a framework of flexibility and adjustment to feedback provided by recovered data.

The zoological-botanical samples (ZB samples), which consist of a one-gallon soil sample taken from the center of each 1-meter square for each 20 cm layer were suggested by the ethnobotanist (S. Harris) and faunal analyst (E. Roth). Subsequent flotation and fine screening of these ZB samples is producing good representative

(hopefully) samples of plant and animal remains, and along with materials recovered from features, should allow as accurate a picture as is possible of Late Woodland and Mississippian subsistence patterns at the Zebree site. Certainly it represents the most systematic, careful, fine scale recovery of organic matter ever attempted or achieved on a Mississippian site of this size.

The methodological experiments in the recovery of plant materials, and the efforts by Eric Roth to determine the relative bias introduced into faunal recovery because of screen mesh size (based on Thomas' work in the southwest and Paynes' work in the Old World) will also be of great interest to specialists in the two fields.

Summary

In summary, the Zebree project was and is necessary, in light of the obvious importance of the site. The crew assembled is highly compentent and highly motivated. The excavation strategy and recovery techniques employed are well conceived. The general problem areas chosen for study are important in the larger context of eastern North American prehistory. The theoretical model chosen to interpret the relationships existing between "universal" variables has a number of built in problems, and quantifying the "universal" variables will be a difficult task.

Finally, it should be pointed out that a large measure of the responsibility, and a large measure of the credit, for the Zebree project rests with Dan F. Morse, who has overall direction of the project. Morse has managed to assemble a qualified excavation team and to deal with an unending sequence of logistical and bureaucratic problems, and at the same time to provide continual input into all phases of the project. The report of the 1975 excavations should make an excellent companion to Morse's report on the 1969 season at Zebree (Morse 1975), and hopefully will include a variety of different (perhaps even conflicting) interpretations of the site (even after editing).

COMMENTS ON DR. BRUCE SMITH'S REVIEW OF THE ZEBREE PROJECT

by

L. Mark Raab

Bruce: the following comments are as brief as possible and referenced to specific parts of your report. All of my comments apply to your treatment of the Behavioral Hypotheses, pages 9-12 of the review.

Criticism 1:

You are quite correct about the fact that there are 24 possible combinations of the 4 variables of the research design. In fact, I had each of 24 paths, drawn schematically, before me while I was writing the research design. This error has been corrected in existing manuscripts. The other criticisms in this paragraph, however, seem to be part of a misunderstanding which resulted from a lack of clarity on my part.

I do not intend to test only 4 of the 24 paths. Four paths were singled out for special attention because they more or less approximate 4 existing anthropological theories of social evolution and it would be interesting to see how these paths stand up to testing in relation to the other 20 possibilities. On a logical basis the more strongly that a particular path is supported, the less probable are the remaining paths. So, the assumption is not made that 4 of these paths are more likely, only more interesting in relation to existing theories. In the interest of space I have not presented the 4 paths discussed above, though I can do so if there is interest in them.

Criticism 2:

It simply is not true that I assume no other variables other than the 4 included could be involved in the Mississippian. While the model contains only 4 variables, it is not the case that I rule out the effect of other variables. The issue here, it seems to me, is whether the model seems likely to improve our knowledge of the Mississippian. It seems to me that any scientific theory could be criticized for not including more relevant variables, but such criticism may be unreasonable if it fails to consider certain faetors.

(1) A scientific theory (or model, if you prefer) is a balance between two epistemological extremes. On the one hand, a good theory presents a scheme of variables and relationships which is reduced to simple enough terms that it can be tested and grasped mentally in a more-or-less holistic manner. On the other hand, the theory must not be so oversimplified that it generates truisms or other trivial information. Whether this balance has been achieved must be determined by a community of scientists. The research design of the Zebree project is an attempt to strike a reasonable theoretical balance.

(2) We must keep in mind that there is an empirical aspect to the usefulness of any scientific model. It seems to me that we cannot legislate beforehand whether a given approach will yield useful results, although we may certainly have opinions and impressions about the likely outcome of a given approach. Ultimately the usefulness of a theory depends on what it will predict and how it measures up to theoretical alternatives in a theory. In short, the wisdom of making certain simplifying assumptions depends in part on the outcome of testing.

The model could be criticized for being too simplistic. It seems to me, however, that your criticism is not that the model is too simplistic, but rather that I have ruled out the possibility that other factors could be involved. It is true that I am willing to make certain simplifying assumptions in the model, but that is definitely not the same thing as casually dismissing the possibility that other variables may be at work in the phenomenon under study. The difference between the two is nicely set out in Blalock (1964: 1-26). What I am suggesting in the Zebree research is that we start with some assumptions and see how far they will take us; the ultimate justification of these assumptions, however, depends on empirical results.

Criticism 3:

There seems to be considerable misunderstanding on this point. Specifically, the confusion seems to reside in the use of inter- and intrasite data. In Plog's research (1974), which the Zebree research design is patterned after in certain respects, much of the analysis is based on comparison of various types of sites selected from a total of 325 sites.

Accordingly, much of Plog's analysis involves intersite comparisons where the statistical N's (sample sizes) are some fraction of 325. It must be emphasized here that the sample N's are being generate by intersite comparisons. The sample N's at Zebree, however, will be generated from intrasite data. An example of the latter may be in order.

Suppose that we want to argue that there is a relationship between the Variables P (population) and LS (labor specialization) which is mediated by E (subsistence energy) and SD (social differentiation). The strength of the predicted relationship is measured by second-order partial correlation coefficients which regress P on LS, while (in effect) holding E and SD constant. Let us assume further that we have measured these variables in some way: P= grams of subsistence refuse per unit measure of midden deposit per time unit of deposition, LS= coefficients of variability in assemblages of stone tools, E= volume of storage pits per population unit per time unit and SD= numerical ranking of mortuary programs which reflect social differentiation. It should be clear from this example that no matter how we measure these variables we will be able to generate hundreds, if not thousands of observations, and the N's in the correlation matrices will in most cases be much greater than the recommended minimum of 100 cases. There will undoubtedly be very real problems in measuring the above variables (or any variables at a similar level of abstraction), but there is no problem obtaining large enough N's for statistically meaningful results (the statistics may be proper and still not measure anything, of course).

As you suggest, there is the question of how representative the Zebree data may be in relation to the Mississippian as a whole. That question may be asked about any piece of research which is done on one or a few sites. This question probably cannot be answered until there has been extensive research on many Mississippian sites utilizing a similar theoretical perspective. These problems granted, it still seems important that we begin developing better theoretical models even if we have to do it one site at a time.

Criticism 4:

Again, I think there are several confused issues here. Once more I direct attention to the comments under criticism 1 above about the "assumption that there are no outside variables involved"--I simply do not make that assumption.

I agree entirely that simple, one-way models of behavior are inconsistent with what we know about human behavior. The question is how do we go about developing systemic models of behavior from constellations of variables we do not know how to place in proper causal order? Plog is vague on this point. A possible solution which I propose is path analysis. Path models have the capability of modeling systemic behavior, if we can make some assumptions about causal ordering. All I am suggesting is that correlation analyses of linear variables chains may give us some hints as to

how to set up the proper systemic models by indicating which variables seem to explain the most variance in other variables. It should be clear that path analysis is capable of much greater analytical sophistication than correlation matrices composed of linear chain variables.

On the general problem of operationalization, I grant you that there are great difficulties. Nevertheless, I don't think the problems are quite as severe as your analysis suggests. I think, for example, that at least the first 3 of the 4 assumptions mentioned in paragraph 2, page 11 can probably be met within the context of the Zebree research design. Again, too, I would suggest that the ultimate decision regarding the value of a given measure must await the empirical outcome of testing. It is of the utmost importance that we try to measure our variables. Even our failures should be instructive.

REFERENCES CITED

Applequist, M. B.
1959 Longevity of submerged tupelo gum and bald cypress seed. LSU Forestry Notes #27

Asch, David L.
1975 On sample size problems and the uses of nonprobabilistic sampling. In Sampling in archeology, edited by James W. Mueller, pp. 170-191. University of Arizona Press, Tucson.

Baillie, M. G. L. and J. R. Pilcher
1973 A simple cross dating program for tree-ring research. Tree-Ring Bulletin 33:7-14.

Bass, William M., David R. Evans, and Richard L. Jantz
1971 The Leavenworth Site cemetery: archeological and physical anthropology. University of Kansas Publications in Anthropology Number 2.

Billings, W. D.
1952 The environmental complex in relation to plant growth and distribution. The Quarterly Review of Biology 27(3):251-265.

Binford, Lewis R.
1964 A consideration of archaeological research design. American Antiquity 29:425-441

1972 An archaeological perspective. Seminar Press, New York.

Binford, Lewis R., Sally R. Binford, Robert Whallon, and Margaret Ann Hardin
1970 Archaeology at Hatchery West. Society for American Archaeology Memoir 24.

Blalock, Hubert M., Jr.
1964 Causal inferences in nonexperimental research. University of North Carolina Press, Chapel Hill.

1969 Theory construction. Prentice-Hall, New York.

1972 Social statistics. McGraw-Hill, New York.

Bourdo, E. A., Jr.
1956 A review of the general land office survey and of its use in quantitative studies of former forests. Ecology 37: 754-768.

Bowers, Lynne Jordan
1973 Tree-Ring dating of the bald cypress (Taxodium distichum [L] Rich.) in the lower Missisippi Valley. Unpublished M.S. Thesis, Department of Biology, Arkansas State University, Jonesboro.

Braun, E. L.
1950 The deciduous forests of Eastern North America. Blakistron Co., Philadelphia.

Brown, James A.
1971 The dimensions of status in the burials at Spiro. In Approaches to the social dimensions of mortuary practices, edited by James A. Brown, Society for American Archaeology Memoir 25:96-112.

1975 Deep-site excavation strategy as a sampling problem. In Sampling in archaeology, edited by James W. Mueller, pp. 155-169. University of Arizona Press, Tucson.

Butzer, Karl W.
1971 Environment and archeology. Aldine, Chicago.

Carlander, H. B.
1954 History of fish and fishing in the Upper Mississippi River. The Upper Mississippi River Conservation Committee.

Carneiro, Robert
1970 A theory of the origin of the state. Science 169:733-38.

Chaplin, R. E.
1971 The study of animal bones from archaeological sites. London, Seminar Press.

Cook, Sherburne F. and Robert F. Heizer
1968 Relationships among houses, settlement areas, and population in aboriginal California. In Settlement archaeology, edited by K. C. Chang, pp. 79-116. National Press.

Dickson, Richard Eugene
1968 Effects of aeration, water supply and mineral nutrition on growth and development of tupelo gum (Nyssa aquatica L.) and bald cypress (Taxodium distichum [L] Rich.) Unpublished Ph.D. Dissertation, University of California, Berkeley.

Ferguson, Dick V. and James L. Gray
1971 Soil survey of Mississippi County, Arkansas. United States Department of Agriculture, Soil Conservation Service, Washington.

Flannery, K. V.
1967 Vertebrate fauna and hunting patterns. In The Prehistory of the Tehuacan Valley, Vol. 1, edited by R. S. McNeish, pp. 132-177. University of Texas Press, Austin.

Flenniken, J. Jeffrey
1975 Test excavations of three archeological sites in Des Arc Bayou Watershed, White County, Arkansas. Report submitted to the Soil Conservation Service, Little Rock, Arkansas, and on file at the Arkansas Archeological Survey, Fayetteville, Arkansas.

Forbes, S. A. and R. A. Richardson
1920 The fishes of Illinois. Illinois Natural History Survey, Springfield.

Fowells, H. A.
1965 Silvics of forest trees of the United States. Agricultural Handbook 271, U.S. Department of Agriculture.

Fuller, M. L.
1912 The New Madrid earthquake. United States Geological Survey Bulletin 494.

Gersbacher, E. Oxford and E. M. Norton
1939 Typical plant succession at Reelfoot. Journal of the Tennessee Academy of Science, 14:230-238.

Goodyear, Albert C., III
1975 Hecla II and III, an interpretive study of archeological remains from the Lakeshore project, Papago Reservation, south central Arizona. Arizona State University, Anthropological Research Paper 9.

n.d. An archeological survey of the proposed Camden beltway. Institute of Archeology and Anthropology, University of South Carolina, Columbia. (Manuscript in preparation)

Guilday, John E. and Paul W. Parmalee
1971 Thirteen-lined ground squirrel, prairie chicken and other vertebrates from an archeological site in northeastern Arkansas. The American Midland Naturalist 86:227-229.

Gumerman, George J. (ed.)
1971 The distribution of prehistoric population aggregates. Prescott College, Anthropological Reports 1.

Haggett, Peter
1966 Locational analysis in human geography. St. Martin's Press, New York.

Hawley, Florence
1941 Tree-Ring analysis and dating in the Mississippi drainage. Occasional Papers in Anthropology, 2, University of Chicago.

Hill, James
1966 A prehistoric community in eastern Arizona. Southwestern Journal of Anthropology 22:9-30.

1970 Prehistoric social organization of the American Southwest: theory and method. In Reconstructing prehistoric Pueblo societies, edited by William A. Longacre, pp. 11-58. University of New Mexico Press, Albuquerque.

1973 The methodological debate in contemporary archaeology: a model. In Models in archaeology, edited by David A. Clarke, pp. 61-107. Methuen, London.

Holder, Trusten H.
1965 Disappearing wetlands in eastern Arkansas. Arkansas Planning Commission, Little Rock.

Howells, William W.
1960 Estimating population numbers through archaeological and skeletal records. In The Application of Quantitative Methods in Archaeology, edited by Robert F. Heizer and Sherburne F. Cook, pp. 158-176. Viking Fund Publications in Anthropology 28.

Kerlinger, Fred N. and Elazar J. Pedhazur
1973 Multiple regression in behavior research. Holt, Rinehart and Winston, New York.

Landon, Gordon O.
1958 Taxodium. Agriculture Handbook 271 FS-206:671-677. U.S. Department of Agriculture, Washington.

Lewis, Kenneth
1975 Archeological investigation at the colonial settlement of Long Bluff (38DA5), Darlington County, South Carolina. Research Manuscript Series 67. Institute of Archeology and Anthropology, Columbia, South Carolina.

Marshall, Richard A.
1965 An archeological investigation of interstate route 55 through New Madrid and Pemiscot Counties, Missouri, 1964. University of Missouri, Highway Archaeology Reports 1, Columbia.

Mattoon, W. F.
1916 Water requirements and growth of young cypress. Society of American Foresters Proceedings 11:192-197.

Metcalf, F. P.
1920 Field report on Big Lake, Arkansas. Manuscript on file at Big Lake National Wildlife Refuge, Manila.

Medford, Larry D.
1972 Agricultural destruction of archeological sites in northeast Arkansas. Arkansas Archeological Survey, Research Series 3: 41-82.

Million, Michael G.
1975 Ceramic technology of the Nodena Phase peoples. The Southeastern Archeological Conference Bulletin 18:201-208.

Morse, Dan F.
1968 Preliminary report on 1968 archeological excavations at the Big Lake National Wildlife Refuge. Manuscript on file with the Arkansas Archeological Survey, Fayetteville.

1969 Preliminary report on archeological investigations at the Zebree site (3MS20), Summer, 1969. Manuscript on deposit with the National Park Service and the Arkansas Archeological Survey, Fayetteville.

1971 Two recent microblade core discoveries in Mississippi County, Arkansas. The Arkansas Archeologist 12:1-8.

1973a The 1973 field school excavations at Upper Nodena. Field Notes 106:3-8.

1973b Nodena. Arkansas Archeological Survey, Research Series 4.

1974 The Cahokia microlith industry. Newsletter of Lithic Technology 3:15-19.

1975a The penetration of Northeast Arkansas by Mississippian Culture. Paper presented at the 1975 Southern Anthropological Society meeting, Clearwater Beach, Florida.

1975b Report of excavations at the Zebree site, 1969. Arkansas Archeological Survey, Research Report 4. Fayetteville.

Morse, Phyllis A. (editor)
1974 The 1974 University field school in archeology June 3-July 12. Field Notes 117-118:1-13.

Mueller, James W. (editor)
1975 Sampling in archeology. University of Arizona Press, Tucson.

Peebles, Christopher S.
1971 Moundville and surrounding sites: some structural considerations of mortuary practices II. In Approaches to the Social Dimensions of Mortuary Practices, edited by James A. Brown, pp. 68-91. Society of American Archaeology, Memoir 25.

Phillips, Philip, James Ford and James Griffin
1951 Archaeological survey in the lower Mississippi alluvial valley 1940-1947. Papers of the Peabody Museum of Archaeology and Ethnology, Vol. 25.

Plog, Fred T.
1974 The study of prehistoric change. Academic Press, New York.

Raab, L. Mark
1974 A report of archaeological investigations at Santa Rosa Wash, Southern Arizona: phase I. Manuscript, Arizona State Museum, Tucson.

1975a An ecological model of middle Mississippian society. Paper presented at the 1975 Southern Anthropological Society Meeting, Clearwater Beach, Florida.

1975b Research design: Zebree mitigation (as of 14 July 1975). Paper presented at the Central Lowland Archeological Society and Symposium, 2 August 1975. Manila, Arkansas.

Ragir, Sonia
1967 A review of techniques for archaeological sampling. In A guide to field methods in archaeology, edited by Robert F. Heizer and John A. Graham, pp. 181-194. The National Press, Palo Alto, California.

Redman, Charles L.
1973 Multistage fieldwork and analytical techniques. American Antiquity 38:61-79.

1975 Productive sampling strategies for archaeological sites. In Sampling in archaeology, edited by James W. Mueller, pp. 147-154.

Redman, Charles and Patty Jo Watson
1970 Systematic intensive surface collection. American Antiquity 35:279-291.

Reed, C. A.
1963 Osteo-archaeology. In Science in archaeology, edited by D. Brothwell and E. Higgs, pp. 204-216. Basic Books, New York.

Reid, J. Jefferson, Michael B. Schiffer, and Jeffrey M. Neff
1975 Archaeological considerations of intrasite sampling. In Sampling in archaeology, edited by James W. Mueller, pp. 209-224. University of Arizona Press, Tucson.

Sahlins, Marshall
1961 The segmentary lineage: an organization of predatory expansion. American Anthropologist 63:322-345.

Sahlins, Marshall and Elman R. Service
1960 Evolution and culture. University of Michigan Press, Ann Arbor.

Saucier, Roger T.
1970 Origin of the St. Francis sunk lands, Arkansas and Missouri. Geological Society of America Bulletin, 81:2847-2854.

1974 Quaternary geology of the lower Mississippi valley. Arkansas Archeological Survey, Research Series 6.

Schiffer, Michael B.
1972 Archaeological context and systemic context. American Antiquity 37:156-165.

1973 Cultural formation processes of the archaeological record: application at the Joint site, east-central Arizona. Unpublished Ph.D. dissertation, Department of Anthropology, University of Arizona.

1975a Archaeology as behavioral science. American Anthropologist, 77:836-848.

1975b Cultural formation processes of the archaeological record: a general formulation. Paper presented at the 8th Annual Meeting of the Society for Historical Archaeology, Charleston, South Carolina.

Schiffer, Michael B. and John H. House
1975 The Cache River archeological project: an experiment in contract archeology. Arkansas Archeological Survey, Research Series 8.

Schiffer, Michael B. and William L. Rathje
1973 The efficient exploitation of the archaeological record: penetrating problems. In Research and theory in current archaeology, edited by Charles L. Redman, pp. 169-179. John Wiley and Sons, New York.

Shelford, V. E.
1954 Some lower Mississippi valley flood plain biotic communities: their age and elevation. Ecology, 35:126-142.

Smith, Bruce D.
1974 Middle Mississippian exploitation of animal populations: a predictive model. American Antiquity, 39:126-142.

1975a Middle Mississippi exploitation of animal populations. University of Michigan, Museum of Anthropology, Anthropological Papers, 57.

1975b The emergence and expansion of the Mississippian cultural adaptation: a subsistence strategy viewpoint (in press).

South, Stanley A.
1971 Exploratory archaeology at Holmes' Fort, the blockhouse, and jail redoubt at Ninety Six. The Conference on Historic Site Archaeology Papers 1970 5:35-50.

1974 Methodological phases in the archeological process. The Conference on Historic Site Archaeology Papers 1972 7:138-145.

Stephenson, Lloyd W. and Albert F. Crider
1916 Geology and ground waters of Northeastern Arkansas. Water Supply Paper, No. 399. United States Geological Survey, Washington.

Stokes, Marvin A. and Terah L. Smiley
1968 An introduction to tree-ring dating. University of Chicago Press, Chicago.

Struever, Stuart
1968a Flotation techniques for the recovery of small scale archaeological remains. American Antiquity 33:353-362.

1968b Problems, methods and organization: a disparity in the growth of archaeology. In Anthropological archaeology in the Americas, edited by Betty Meggers, pp. 131-151. The Anthropological Society of Washington, Washington, D. C.

1971 Comments on archaeological data requirements and research strategy. American Antiquity 36:9-19.

Thomas, D. H.
1969 Great Basin hunting patterns: a quantitative method for treating faunal remains. American Antiquity 34:

Vivian, R. Gwinn
1970 An inquiry into prehistoric social organization in Chaco Canyon. In Reconstructing prehistoric Pueblo societies, edited by William Longacre, pp. 59-83. University of New Mexico Press, Albuquerque.

White, Leslie
1943 Energy and the evolution of culture. American Anthropologist 45:335-56.

1949 The science of culture, a study of man and civilization. Farrar, Strauss, New York.

Willey, Gordon R.
1953 A pattern of diffusion-acculturation. Southwestern Journal of Anthropology 9:369-384.

Williams, Stephen
1954 An archeological study of the Mississippian culture in southeast Missouri. Unpublished Ph. D. dissertation, Department of Anthropology, Yale University.

Zawacki, A. A. and G. Hausfater
1969 Early vegetation of the lower Illinois Valley. Illinois State Museum, Report of Investigations 17.

CONTRIBUTORS

DAVID G. ANDERSON is a graduate student and survey assistant at the University of Arkansas. He received a B.A. in anthropology at Case Western Reserve University. He was recently employed by the Institute of Archeology and Anthropology at the University of South Carolina where he did survey, excavation, and data analysis in both historic and prehistoric sites. He was a field assistant on the Zebree project and will use Zebree data as the basis for his M.A. thesis.

LYNNE J. BOWERS is an instructor in zoology at Shelby State College in Memphis, Tennessee. She received her M.S. in botany from Arkansas State University, Jonesboro, doing research on tree-ring dating of the bald cypress in the Lower Mississippi Valley. She has continued her research in dendrochronology and a complete report on her corings from Big Lake will be included in the final Zebree report.

SUZANNE E. HARRIS is a Ph.D. candidate at the University of Michigan. She has done extensive work on the Powers Phase project in Southeast Missouri and was recently involved in the survey of the Little Black watershed for the University of Missouri and test excavations at the Lilbourne site. Her research interest is ethnobotany and she was ethnobotanical laboratory supervisor on the Zebree project. A detailed report of her analyses will be in the final Zebree volume.

DAN F. MORSE is the Survey Archeologist for northeast Arkansas and an associate professor in anthropology at the University of Arkansas and at Arkansas State University. He has done intensive research in northeast Arkansas for nine years and conducted two previous tests at the Zebree site in 1968 and 1969. Earlier he has worked in Georgia, Tennessee, Illinois, Michigan, Wisconsin, and Idaho. His Ph.D. is from the University of Michigan. Morse is the director of the Zebree project.

PHYLLIS A. MORSE is a Ph.D. candidate at the University of Michigan. She has worked in Georgia, Tennessee, and Arkansas. She is a research associate for the Arkansas Archeological Survey and was an instructor at Arkansas State University in 1975. She was processing lab supervisor on the Zebree project and is currently supervising the sorting and identification of the finely screened samples from the project.

JEFFREY B. NEWSOM is a graduate student in anthropology and a survey assistant at the University of Arkansas. He received a B.A. degree in anthropology from the University of Kansas. He was a field assistant at Zebree and will use the environmental interpretations for his M.A. thesis.

CHRISTOPHER S. PEEBLES is Curator of the Division of the Great Lakes in the Museum of Anthropology, University of Michigan. His review of the Zebree project was particularly invited because of his research interests in WPA excavations in the southeast and theoretical investigations into chiefdoms. His Ph.D. is from the University of California at Santa Barbara.

L. MARK RAAB is a Survey Archeologist, Arkansas Archeological Survey, and assistant professor in anthropology at the University of Arkansas, Fayetteville. His research interests include archeological theory, southeastern and southwestern U. S. prehistory, cultural ecology and statistics. He has conducted research for Arizona State University, the Arizona State Museum and Auburn University and joined the Survey in July, 1975. Raab was field supervisor for the Zebree project. He will help supervise the writing of the M.A. theses using data from the Zebree site. He expects a Ph.D. from Arizona State University in the spring of 1976.

ERIC A. ROTH is a graduate student in anthropology at the University of Toronto; his major research interest is zooarcheology. He received a B.A. in anthropology from the University of Missouri. He was recently employed by the Illinois State Museum and was zooarcheology lab supervisor on the Zebree project. A final report on his zooarcheology of the Zebree site will be included in the final volume on the project.

BRUCE D. SMITH is assistant professor in the Department of Anthropology at the University of Georgia. He has worked extensively in southeast Missouri, studying the Mississippian exploitation of animal populations. His review of the Zebree project was particularly requested because of his zooarcheological research. His Ph.D. is from the University of Michigan.

Advisory Council
On Historic Preservation
1522 K Street N.W. Suite 430
Washington D.C. 20005

MEMORANDUM OF AGREEMENT

WHEREAS, the U.S. Department of the Army, Memphis District, Corps of Engineers, proposes to construct Ditch 81 Extension (Item 2) as authorized in H. D. 308/88/2 (Vol. I); and,

WHEREAS, the U.S. Department of the Army, Memphis District, Corps of Engineers, in consultation with the Arkansas State Historic Preservation Officer, has determined that this undertaking as proposed would have an adverse effect upon the Zebree Homestead Site, a property included in the National Register of Historic Places; and,

WHEREAS, pursuant to Section 106 of the National Historic Preservation Act of 1966, the U.S. Department of the Army, Memphis District, Corps of Engineers has requested the comments of the Advisory Council on Historic Preservation; and,

WHEREAS, pursuant to the procedures of the Advisory Council on Historic Preservation (36 C.F.R. Part 800), representatives of the Advisory Council on Historic Preservation, the Corps of Engineers, and the Arkansas State Historic Preservation Officer have consulted and reviewed the undertaking to consider feasible and prudent alternatives to satisfactorily mitigate the adverse effect; now,

THEREFORE:

It is mutually agreed that implementation of the undertaking, in accordance with the attached letter of June 11, 1975, from Colonel A. C. Lehman, District Engineer, Memphis District, Corps of Engineers, will satisfactorily mitigate any adverse effect on the above mentioned property.

Robert R. Garvey, Jr. (date) 1975
Robert R. Garvey, Jr.
Executive Director
Advisory Council on Historic Preservation

A C Lehman 15 July 1975
(date)
Corps of Engineers, Memphis District
Department of the Army

MEMORANDUM OF AGREEMENT
Zebree Homstead Site, Arkansas
Corps of Engineers

6-27-75 (date)
Arkansas State Historic Preservation Officer

7/4/75 (date)
Clement N. Silvestro
Chairman
Advisory Council on Historic Preservation

LMMED-PR 11 June 1975

Mr. Robert R. Garvey, Jr., Executive Director
Advisory Council on Historic Preservation
1522 K Street, N.W., Suite 430
Washington, D.C. 20005

Dear Mr. Garvey:

I am requesting that the Advisory Council comment on the Memphis District plans for an undertaking in connection with the construction of Item 2 of Ditch 81 in Mississippi County, Arkansas. I have been advised by the State Historic Preservation Officer and the Arkansas Archeological Survey in Arkansas, that this work will have an adverse effect on an archeological site which is on the National Register of Historic Places, to wit, the Zebree site.

The Zebree site is a prehistoric Indian village which was occupied by at least three different cultural groups over a period of perhaps 500 years (circa A.D. 600 - A.D. 1100). Previous test excavation established the significance of the site, particularly in the information contained concerning the first appearance of the Mississippian culture in this central part of the Mississippi Alluvial Valley. This is currently the only known site which contains the wealth of well-preserved information on this period of vast cultural change, from basically horticulture economy, to incipient agriculture.

As the only known site of its type for this area there is great potential in the information that may be derived from its scientific excavation.

The Extension of Ditch 81, Item 2, the work on which has been delayed for a year in order to provide time for mitigation, will pass directly through the site destroying the vast majority of it, according to an on site inspection by Memphis District personnel and Dr. Morse of the Arkansas Archeological Survey. All reasonable alternatives have been considered, including realignment of the ditch, but both the Corps and the Archeological Survey agree that only the proposed mitigation is both economically and scientifically feasible.

LMMED-PR 11 June 1975
Mr. Robert R. Garvey, Jr.

The Memphis District and the Arkansas Archeological Survey have each tendered to the other a proposed plan of mitigation. A copy of each of these documents is inclosed and I do not anticipate any difficulty in reaching mutual agreement as to their final form. Basically the mitigation proposal will include:

a. Work to be performed by the Arkansas Archeological Survey, a State agency and accredited through the State's University system.

b. Salvage and data interpretation of the archeological and historic resources of the Zebree Homestead Site.

c. A final report basically covering (1) the design of excavation, (2) descriptive inventory of cultural remnants, (3) conclusions reached and significance of data, (4) bibliography, (5) roster of project personnel and respective qualifications.

d. The report will be made available to the (1) National Park Service, (2) Advisory Council on Historic Preservation, (3) State Historic Preservation Officer for Arkansas, (4) Arkansas Archeological Survey, (5) Smithsonian Institution, (6) Office of the Chief of Engineers and the (7) Library of Congress. The report is to be submitted to the Corps of Engineers by December 1977.

e. Recovered materials will remain in the care of the Arkansas Archeological Survey Coordinating Office at the University of Arkansas Museum in Fayetteville or in the laboratory of the Survey station at Arkansas State University in Jonesboro.

f. All field work is to be accomplished by the 13th week, measured from date of receipt of Notice to Proceed; at the end of the 15th week the Contractor shall inform Memphis District that construction of Ditch 81 Extension, Item 2 may proceed as authorized. Care will be taken to protect any undisturbed portions of the site which are not required for authorized channel and embankment construction.

I trust that this letter, along with the previously mentioned documents will be helpful. In addition, I am inclosing the preliminary case report as requested by the Advisory Council on 18 March 1975.

A-E Coordinator

Martin/gpr/3857 LMMED-PR

LMMED-PR 11 June 1975
Mr. Robert R. Garvey, Jr.

A signed copy of this letter, along with copies of the documents, have been forwarded to Mr. Lou Wall, Assistant Director of Compliance.

Please advise if I can be of further help.

Sincerely,

A. C. LEHMAN
Colonel, Corps of Engineers
District Engineer

3 Incl
1. Proposed Contract
2. AR Surv Proposal (4 Jun 75)
3. Case Report

Copy furnished:
Mr. Lou Wall
Advisory Council on Historic Preservation
P. O. Box 25085
Denver Service Center
Denver, Colorado 80225
w incl

Grosso LMMED-PR

Morga LMMED-PP

Davidson LMMED-E

Dodson LMMED

for Williamson LMMSD

Adelman LMMOC

Maj Oppenheim LMMDD

Col Lehman LMMDE

Budget for mitigation of adverse effects
on Zebree site
1 July 1975-31 Dec 1977

Salaries and Wages	Survey	Corps	
Project Director	$ 9,570		
Field Supervisor		$ 4,438	
Two field-research assistants	6,475	6,475	
12 field crew, (2 mo.)		9,600	
Lab supervisor		6,860	
3 Lab assistants-specialists, (2 mo. each)		4,367	
8 lab crew		8,400	
Editor (2 wks.)		420	
Clerk typist (part time)		1,126	
Photographer (part time)		1,380	
Draftsperson (part time)		750	
TOTAL, salaries and wages	16,045	43,816	
Overhead (84% sal and wage)	13,478	36,804	
	$ 29,523	$ 80,620	$ 80,620

Other		
Per diem, supervisory personnel	6,600	
Rental of Lab headquarters	300	
Equipment rental	3,500	
Mileage	1,675	
Miscellaneous small equipment and supplies	3,000	
10 Radiocarbon dates	1,000	
Specialized analysis (pollen, soil, faunal, ethnobot.)	2,250	
Publication of final report	3,000	
	$ 21,325	$ 21,325
		$101,945

H. S. Vorsanger
Secretary, Board of Trustees

Charles R. McGimsey III
Director

Date June 4, 1975

APPENDIX C

ZEBREE CERAMIC ARTIFACT CLASSIFICATION
JULY-AUGUST 1975

Recorder: _____

Date: _____

3MS20 _____ One Meter Sample Unit _____ Recovery Method

_____ Excavation Unit _____ 1/4 Inch Screen _____

Area _____ Waterscreen _____

Feature No. _____ Vertical Location _____ Date _____

NOTE: Sherds from 1/4" samples have been further processed through a 1/2" screen. Materials passing through screen weighted _____ and have been placed in dead storage. Catalog No. _____.

* Component 1 Woodland Occupation

A. Sherds Totals _____ No. /wt. _____ Body/Rim Index _____

Barnes Paste Body Sherds _____No./wt._____
Rim Sherds _____No./wt._____

Baytown Paste Body Sherds _____No./wt._____
Rim Sherds _____No./wt._____

Body Sherd Categories

Cord Marked _____
Plain _____
Fabric Imp. _____
Chk. Stamped _____
Other _____

Basal Sherd Categories

Conical, plain _____
Conical, CM _____
Flat, plain _____
Flat, CM _____
Other _____

Rim Sherd Categories

1. Cord Marked Rims _____
   A. "Crosshatched" CM _____
   B. Linear CM _____
   C. CM w/ plain lip _____
   D. CM Rim Folds _____
2. Plain Rims _____
   A. w/ CM body _____
   B. w/ Rim Folds _____
3. Total Rim Folds _____
4. Other Rims _____

5. Estimation of Vessel Forms Represented by Rim Sherds

   Jar _____, Large _____, Small _____, Bowl _____
   Other (list)

B. Manufacture By-Products. List and describe.

C. Other Component 1 ceramic artifacts. List and describe.

D. Reconstructed vessels described on Artifact Cards. Catalog below.

E. Comments

Recorder:_____

Date:_____

3MS20 _____ One Meter Sample Unit _____ Recovery Method

_____ Excavation Unit _____ 1/4 inch screen _____

Area_____ waterscreen _____

Feature No. _____ Vertical Location _____ Date _____

*** Component III Middle Mississippian Occupation

Total Sherds _____No./wt._____ Rim Sherds _____No/wt._____

Body Sherds _____No./wt._____ Body/Rim Index _____

A. Body Sherd Categories

Neeley's Ferry Plain _____
Matthews Incised _____
(Manly punctated) _____
Punctated _____
Red Filmed _____
Other (list) _____

B. Appendage Fragments

Strap Handle _____
Loop Handle _____
Lug _____
Effigy _____
Other (list) _____

C. Rim Sherd Categories

1. Jar Rims
   A. Plain _____
   B. w/ notched lip _____
   C. Matthews incised _____
   D. Other (list)
2. Bowl Rims
   A. Plain _____
   B. Scalloped _____
   C. Other (list)
3. Bottle Rims _____
4. Other (list)

D. Other Component III ceramic artifacts. List and describe.

E. Reconstructed vessels described on artifact cards. Catalog below.

F. Comments.

Ceramic artifacts not assignable to a Specific Component

A. Neeley's Ferry Plain Ware Total Sherds _____No./wt._____

Body Sherds _____No./wt._____

Rim Sherds _____No./wt._____ Body/Rim Index _____

Estimation of vessel forms represented by Rim Sherds

Jar _____, Large _____, Medium _____, Small _____

Bow _____ Other (list)

B. Other (list)

Recorder:_____

Date: _____

3MS20 _____ One Meter Sample Unit _____ Recovery Method

_____ Excavation Unit _____ 1/4 inch screen _____

Area _____ waterscreen _____

Feature No. _____ Vertical Location _____ Date _____

** Component II Big Lake Phase

A. Neeley's Ferry Plain Ware Total Sherds _____ No./wt._____

Body Sherds _____No./wt._____ Body/Rim Index _____

Rim Sherds _____No./wt._____

Estimation of vessel forms represented by Rim Sherds

Jar _____, Large _____, Medium _____, Small _____

Bowl _____ Other (List)

B. Varney Red Filmed Ware Total Sherds _____No./wt._____

Body Sherds _____No./wt._____ Body/Rim Index _____

Rim Sherds _____No./wt._____

Estimation of vessel forms represented by Rim Sherds

Jar _____, Large _____, Medium _____, Small _____

Pan _____

Bowl _____, Large _____, Small _____

Hooded Bottle _____ Other (List)

Slip Application

Body Sherds	Interior_____	Exterior _____	Both _____
Rim Sherds			
Jar Rims	Interior_____	Exterior _____	Both _____
Bowl Rims	Interior_____	Exterior _____	Both _____
Pan Rims	Interior_____	Exterior _____	Both _____
Hooded Bottle Rims	Interior_____	Exterior _____	Both _____

C. Wickliffe Thick Ware Total Sherds_____No./wt._____

Body Sherds _____No./wt.

Upper Rims _____No./wt. Minimum Funnels Rep._____

Lower Rims _____No./wt.

D. Manufacture Byproducts. List and describe.

E. Pottery Discs

VRF _____, _____% Perforated NFP _____, _____% Perforated

Barnes_____, _____% Perforated WT _____, _____% Perforated

F. Utilized Sherds

Barnes CM _____ VRF _____

Barnes Plain _____ Wickliffe Thick _____

NFP _____

G. Other Component II Ceramic artifacts. List and describe.

H. Reconstructed vessels described on artifact cards. Catalog below.

I. Comments