II Research Design <Conceptual Orientation>

<Introduction>

The planning of the Cedar Mesa Project was stimulated by discussions at the meetings in 1971 of the Southwestern Anthropological Research Group (Gumerman 1971; Hammond 1971; Longacre et al. 1974) and especially by the papers presented there by Plog and Hill(1971), Judge(1971), Hill (1971b) and Wood (1971). The efforts of this group's cooperative work was focussed on the question, "Why did prehistoric populations locate sites where they did?" (Plog and Hill 1971:8). Although we do address this question in our research and have contributed to the S.A.R.G.'s investigation of it (Matson and Lipe 1978) our orientation in the Cedar Mesa Project is more broadly framed as a study of cultural adaptation to the environment. Since, as stated earlier, the Cedar Mesa Project was largely carried out in accord with its initial formulation, we have made no attempt to retroactively recast the project's orientation into a more modern setting.

In the broadest sense, adaptation is what is necessary to maintain a population of organisms through time in a given environment. If populations are surviving, they are definition adapted in that environment; the question is <how> adapted, by what mechanisms, under what circumstances. Adaptations of human populations differ from other animal populations in that human adaptive behavior patterns are predominantly culturally determined or mediated, permitting a great plasticity of behavior and a kind of "inheritance of acquired characteristics." For studies limited in time and space such as ours, physiological variables can be assumed to be constant, and emphasis placed on the behavioral or cultural ones.

Any aspect of human culture or social organization can potentially contribute to or <subtract> from a population's adaptation. An organized social life is one of the conditions for human survival and reproduction, so that social organization and ideology contribute to adaptation, as well as do technology and economics. In this sense, culture can be viewed as a population's extrasomatic adaptive means (White 1959:8). No matter how efficient the food-getting technology, if the organization of food distribution breaks down, or if the mechanisms of protecting and socializing children fail, the population is in a bad way.

While recognizing that extraction, processing, and distribution of resources from the natural environment does not in itself constitute all of adaptation, this type of adaptive behavior is nonetheless universal and essential. Although we do not assume that environmental relationships must be the major determinants of socio-cultural forms and of change in these forms, we do believe that these relationships exert a powerful influence throughout the culture, and that whatever their source, changes in environmental relationships are likely to have effects in a number of cultural subsystems. The kind and degree of constraints exerted by particular cultural subsystems upon other subsystems, is, of course, a matter for empirical determination in particular cases.

In the Cedar Mesa area, the prehistoric populations had low levels of socio-political complexity, and cultural or environmental changes affecting resource exploitation should have had substantial effects on other aspects of culture and on population size or well-being. We chose to focus our study in the Cedar Mesa region on the "cutting edge" of cultural adaptation--the organization and operation of resource extraction, processing, and distribution.

A region was chosen as the spatial frame for the research. It is reasonablle to assume that prehistoric Anasazi in southeastern Utah generally made use of spatially scattered resources. Therefore, the study area needed to be large and environmentally varied enough to include most or all of the types of resource locations regularly utilized by the occupants of the area during the time periods under investigation. Examination of an environmentally varied region would also allow us to study how cultural manifestations covary with environment. We also knew from previous work that the prehistoric Anasazi communities consisted of numerous small dispersed settlements, rather than large pueblos. The sampling universe for a population of sites (or activity loci) is, of necessity, a region or at least a region-sized geographic unit (Binford 1964). The use of a region-sized area for investigation also allows one to get a better idea of the variation in cultural manifestations in a given environment, rather than presupposing that the archaeological remains at a single locality reflect the entire range, or the modal aspects of the population.

As we argued above, the Cedar Mesa region is a relatively "natural" physiographic, biotic, and climatic unit. It seems probable that during most periods of occupation, it provided most of the resources utilized by the populations that inhabited it. Analysis of movements into and out of the area, as when it was abandoned and reoccupied, present some problems. In any case, one must draw some boundaries somewhere. In the Cedar Mesa case, the southern escarpment provides a clear boundary for agriculturally-based settlements because agriculture is impossible in the lowlands to the south. Likewise, the situation to the north is clear as one ascends to Elk Ridge, but, as mentioned, the east and west boundaries are more arbitrary.

<Adaptation Models>

The most general orienting models for our research are (1) the fundamental niche, as defined for animal ecology by Hutchinson (1957), and (2) the complex adaptive system model of socio-cultural systems, as outlined by Buckley (1967,1968), Campbell (1965), and Wood and Matson (1973), and, in a more general sense, by Bennett (1976), Smith (1984) Kirch (1980). The fundamental or n-dimensional hypervolume niche mod expresses the relationship between a species (in our example, a population) and its environment:

Consider two independent environmental variables X_1 and X_2 which can be measured along ordinary rectangular

> coordinates. Let the limiting values permitting a species S_1 to survive and reproduce be respectively X_1' and X_1'' for X_1 and X_2' and X_2'' for X_2. An area is thus defined, each point of which corresponds to a possible environmental state permitting the species to exist indefinitely. If the variables are independent in their action on the species, we may regard this area as the rectangle ($X_1=X_1'$, $X_1=X_1''$, $X_2=X_2'$, $X_2=X_2''$), but failing such independence, the area will exist, whatever the shape of its sides.
>
> We may now introduce another variable X_3 and obtain a volume, and then further variables $X_4 \ldots X_n$ until all of the ecological factors relative to S_1 have been considered. In this way, an n-dimensional hypervolume is defined, every point in which corresponds to a state of the environment which would permit the species S_1 to exist indefinitely (Hutchinson 1967:416).

The fundamental niche thus is conceived as an n-dimensional hypervolume in which the dimensions consist of environmental variables, and the boundaries of the hypervolume consist of the values or states of these variables that limit the population under study. For example, the niche for settlements of an imagined sedentary prehistoric population might be defined by the dimensions of precipitation, growing season, soil type, soil depth and defensibility of location. (Assuming the population is sedentary and has only one site type makes the switch from population to settlement easy; we will find this transfer is more difficult in practice). The constraining values or states on these dimensions might be, respectively, more than 30 cm (12 inches) of precipitation per annum, more than 130 frost-free days per annum, deep alluvial soils, and defensible site locations.

The niche space is an abstract concept, not an actual physical volume. Points in physical space where the conditions of a particular niche space exist are particular locations in biotope space (Hutchinson 1957: 416). The niche space of any particular population may be actualized by scattered discontinuous locations in geographical space. There may also, of course, be points in the niche space which remain unactualized in particular biotope spaces. Environmental changes may modify a particular biotope space to the extent that it becomes newly inhabitable or newly uninhabitable to a population of given fundamental niche. Changes in climate, or arroyo cutting would be cases in point for agriculturalists on Cedar Mesa. Changing niche volumes can also be the result of changing technological and organizational factors. Thus changing in agricultural techniques would change the niche, as could changes in social organization, whether in response to outside factors or locally initiated.

The formulation of the fundamental niche concept by Hutchinson was in set theory form, with the implication that all points within a niche space are equally favorable. Actually, of course, many of the relevant dimensions are likely to display gradients of favorability (Hutchinson 1957:416; Hudson 1969: 368). That is, there are sub-volumes of the hypervolume that are more optimal than others. Hudson, in adapting the fundamental niche model to the study of human settlement, has shown how this problem can be circumvented by the use of gradients instead of sets (Hudson 1969: Fig. 1) while still preserving the rest of the formulation.

In addition to the heuristic value of the hypervolume niche concept, attempts have been made to empirically discover the dimensions and limits on them for particular populations (Green 1971, Miracle 1974, Makarewicz and Likens 1975). In addition to these inspections of animal populations, Matson (1974) independently attempted to discover the hypervolumes for human populations at various time periods, using Cedar Mesa Project data; a more successful trial is reported later in this volume. In these attempts to "reify" the human niche hypervolume, instead of populations, site types or the set of all site types are the actual entities whose hypervolumes are being investigated. The sites are the material remains of the activities of past populations, and so have a relationship with the actual populations that should be familiar to archaeologists who are used to making inferences about past populations from material remains.

Conceptually, a population's fundamental niche depends, as mentioned above, not only on environmental variables, but also on the given adaptive capacity and strategy. This was recognized by Hudson (1969) in fitting this concept to the analysis of human settlement:

> A change in technology may bring about a change in permissible conditions under which settlement may take place,thus the size of the hypervolume is flexible. For example, commercial grain farming became feasible in the Great Plains with the coming of railroads, thus the transportation limit was eased permitting settlement in the area (Hudson 1969:367).

An understanding of a human population's adaptation in a region therefore requires more than analysis in terms of the fundamental niche concept, which focusses on limits; what is also required is an analysis of the cultural variables in interaction with one another and with the environment. The fundamental niche concept is easily integrated with such a model of socio-cultural systems, the complex adaptive system model (Buckley 1967; Campbell 1965; Wood and Matson, 1973; Matson 1983, 1985).

The chief competitor to this model is the homeostatic model or some version of it (Ross Ashby 1954,1962; Hill 1970a, 1971a, 1977). Wood and Matson have compared these two models in these terms:

> The homeostatic model presupposes that the variables comprising the system must be regulated by homeostatic mechanisms in order to qualify (it) as a system. Conditionality and constraint are the only requisites for defining a system in the complex adaptive system model. The homeostatic model is obviously designed to study structure, while the complex adaptive system model focuses on organization.
>
> By insisting that the source of change is external to the system in question, the homeostatic model poses an implicit dichotomy between a socio-cultural system and its environment. The system and environment are articulated only through inputs from the environment (with respect to systemic change), or, at best, by the coupling of two or more "Ashby machines." The complex adaptive system model is an open system model; hence, it is the <relationship> between the sociocultural system and the environment that is most important, since for continued viability and change, the sociocultural system must map some of the variety and constraints of its relevant environment into its organization.
>
> Systemic change in the viewpoint of the homeostatic model occurs when extra-systemic input overloads the homeostatic mechisms which define the system so that the nature of the relationships among the variables change. After some oscillation, the system is stabilized at a new homeostatic level. Both change and stability are the result of the same set of variables in the complex adaptive system model; so, change may be initiated "internally" or "externally" (to the sociocultural aspect of the system). The system changes continuously through the adaptive process of successive mappings of environmental and systemic variety and constraint into its organization. Implicitly, some parts of the system

may change more rapidly than others, and these rates of change may vary spatially and temporarily.

> ...We suggest that the homeostatic model is little more than a restatement, in systems terminology, of the functionalist, organismic model in sociology and anthropology (cf. Buckley 1967: 11-17).....In fact, we suggest that some implicit variety of the homeostatic model is close to being the dominant model in the field (Wood and Matson 1973: 680-681).

The complex adaptive model, then, is an open systems model that is more general than the homeostatic model. In it, steady-state and homeostatic relationships remain to be empirically determined, rather than being assumed to be the normal state of things. The homeostatic model requires that change originate outside the system; in this context, we run the risk of a self-fulfilling prophecy--that is, if we look hard enough for a changing external variable, we are likely to find one. In general, the adaptive system model seems more appropriate for dealing with change than does the homeostatic model. Futhermore,

> ...if it is true that sociocultural systems are characterized by continuing positive feedback (deviation amplifying) processes as Rappaport (1971:131) and Flannery (1968) have suggested, then the homeostatic model would seem to be singularly inappropriate to deal with these situations (Wood and Matson 1973:682).

We can see how innovations in cultural practices can effect the mapping of the environment and thus the niche space, as in Hudson's example. The niche space, then, is not static, both in terms of its realized location in the environment and in the absolute values along the axis. The geographical realization can change because of environmental changes, either because of climatic shifts, or because of man-caused changes. (We will discuss this in more detail later.) The sociocultural system, on the other hand, has many important aspects that are not reflected in niche space. Even certain "functional prerequisites" such as the provision of enough food are only indirectly reflected in the hypervolume. If a culture does not provide the basic needs in a given niche space, it will go rapidly to extinction, if changes are not made. Such changes would likely lead to changes in the niche space. Thus while many sociocultural changes would result in changes in the hypervolume, some of these would be only indirectly reflected, and other sociocultural changes would not be reflected at all.

<Initial Specific Hypotheses>

Before one can go to specific hypotheses one must prepare the way with respect to assumptions and definitions. The following is the set of assumptions and definitions with which we began somewhat modified from their original presentation (Lipe and Matson 1971a: 132-135). The major assumption is that site location is determined by ease of access to resources.

Sites are defined as locations of material traces of activities. Following Binford (1964), the material traces of a particular activity are referred to as an activity locus; therefore, sites may be though of as bundles of from one to many activity loci.

We assume that existing sites accessible to archaeological investigation on Cedar Mesa represent both a large fraction of the sites that ever existed in the area and an adequate sample. At various times in our analysis below, this assumption will be questioned.

The total number of locations that a prehistoric group used during a few consecutive years comprises its settlement pattern. Intensity of occupation can be thought of as number of person-hours spent there per year, and we assume that a correlation between this value and the quantity of archaeological remains exists.

Important resources for a group are defined by characteristics of the local environment, the technology available, and intergroup relations. Technology, as used here, includes organization of labor and trade. Obviously what constitutes resources, and their importance, may change if any of these factors change.

The settlement pattern will be organized in such a way as to maximize access to these resources (and so in Flannery's terms (1976), to constitute a settlement system).

Sites at which a small number of resource related activities took place will be closely associated with the appropriate resources.

Sites at which a variety of resource related activities took place and sites where non-resource-dependent activities occurrred will tend to be located so as to maximize access (or minimize transportation costs) to a number of sources (Hill and Plog 1971).

The more important a resource, the greater will be the effect of proximity on the locations of multiple-activity and non-resource-dependent activity sites.

In general, intensity of occupation will rise with the number of types of activities carried out at a site.

Sites showing a low intensity of occupation will tend to have some locational correlation with sites having a high intensity of occupation. For example, resource exploitive sites, everything else being equal, will tend to be located in that portion of a resource zone close to the main habitation site.

The archaeological remains from the Cedar Mesa area can be viewed in two ways: (1) as traces of past human activities, and (2) as indicators of social relationships within and among communities. In the first instance, the archaeological materials found at sites can be analyzed as being the results of past behavior or activities. Of course, only activities that leave material traces will be recorded in the archaeological record, and in most cases, only patterned and repetitive activities, that leave recurrent sets of traces, will be recoverable. Some sites may in some sense be single activity loci (Binford 1964), where, for example, chert was quarried, or a particular type of plant food was processed, but many sites will reflect sets of activities. Within such sites, activity loci may be spatially discrete or overlapping. The classification of activities at sites avoids the straitjacket of assigning each site to a particular functional or activity type. This will enable us, in some cases, to examine the resource and cultural correlations or particular types of activity even at multiple activity sites.

The question of social relationships between communities is one that will only occasionally be touched on in this study. This is not to say that these questions are not important, but that they are not the questions we chose to investigate. While our results will have some clear implications for these kinds of questions, in general, our data is not the kind that is very useful for these kinds of questions.

While we will go on to describe and to attempt to account for prehistoric Anasazi adaptation in the Cedar Mesa area within our general theoretical framework, it is clear that more specifics in terms of expectations are needed. As examples of the kinds of inferences that we will make about adaptation in the area and how specific hypothesis were generated, we offer the following account of Basketmaker II and III periods. This account is one developed prior to the field portion of the Cedar Mesa Project, and in many ways acted as a guiding framework for it. This model was developed primarily by Lipe on the basis of his previous work (Lipe and Matson 1971b) and represents only one of many possible reconstructions. Hypothetical reconstructions of this sort are, of course, sources of numerous specific hypotheses that are guides to data collection.

We hypothesized, that the Basketmaker II adaptation in the Cedar Mesa area was at least initially based on casual gardening of maize and squash, and on food collecting, especially of pinyon nuts, Indian Rice grass seeds, banana yucca, deer, bighorn sheep, cottontails and jackrabbits.

Social organization was at the band level, by which we mean that the largest social group that regularly acted as a community was of the order of 4 to 7 nuclear families (Martin 1973). The fundamental niche at this time specifies access to a number of wild plant and animal foods within a relatively small area and hence implies that physiographically and altitudinally diverse areas will be optimal. Access to well-watered soils for gardening is also necessary, as is a sufficiently long growing season. Natural shelters for storage may also be part of the niche. Because only a few foods can be stored, and these only in relatively small amounts, both natural and cultivated plant harvests must be seasonally distributed so that some type of harvesting can be undertaken at many times during the year. Wild animal foods must also be available periodically, because there are no animal domesticates.

In the Cedar Mesa area, gardening would have been carried out on a casual basis in the deep canyons around seeps or springs which were assumed to be the locations requiring the least expenditures of effort. Only maize and squash were grown. The plants were left unattended much of the time. Caves in the canyons provided shelter and dry storage places in the form of cists dug into the natural hardpan. Most of the year was spent in food-collecting activities ranging from the mesa tops to the San Juan Valley. In years of exceptional pinyon harvests, winter shelters and storage facilities were constructed on the mesa tops. Most of the year was spent in groups consisting of only one or two nuclear families, but there were macro-band encampments in the fall during the pinyon harvest and in connection with large-scale rabbit hunts. This adaptive pattern is in considerable detail like that reported for the historic Southern Paiute in southeastern Utah (Kelly 1964; Lipe 1966, 1970).

Once some bands or parts of bands have substantial investment in the canyon setting in terms of regularly used garden plots, constructed storage facilities and ceremonial loci (the caves were favored burial places; some of the abundant pictographs may also have ceremonial significance), the stage is set for a positive feedback process which results in increased dependence on farming. The triggering events could be (1) when population increase puts pressure on the few choice canyon gardening spots, or (2) when the vagaries of the pinyon, grass seed, or animal harvests require extended travel away from the canyon areas, or (3) simply development of more efficient farming techniques. The pinyon crop, which is abundant not more often than every third year or so under good conditions, may skip any given area for a number of years. Any of these developments will produce selective advantages for a band, or at least some components of a band, to either (1) pull up its gardening "anchor" and canyon storage base for a time and return to full-time food-collecting within a larger territory, or (2) bring more land under cultivation to increase the food obtained by farming. The amount of prior investment in the canyon gardens and facilities should help determine which alternative appears to offer the greater advantages. Following Sahlins and Service (1960), it is likely that selection among the possible varieties will favor those that appear to offer the least short term change. In this case, as in Binford's post pleistocene adaptation model (1968), one would assume that varieties which maintained whatever sedentism had already been achieved would be the ones selected.

If the second choice is made, increasing commitment to farming is generated. For example, this would be the case even if the shift was within the canyons, from gardening around seeps or springs to locations watered by floods or pour-offs from the cliffs. This latter type of garden must be attended during the late summer monsoon season, so that when the runoff comes, it can be spread uniformly over the crop area, and prevented from forming rills or gullies that would wash out plants. This, in itself, might require giving up certain late-summer gathering activities, which in turn would generate more dependence on farming and on stored food.

The major change, however, comes with attempts to farm on the mesa top. Here, cultivable soils are much more abundant than in the canyons, but dryer conditions may make removal and control of competing vegetation more important. This is especially critical for rain-fall farming, i.e. farming using only the moisture that falls directly on the field. This is the fall-back strategy even in flood-track areas, since the small mesa-top watersheds cannot be counted on to catch the right number of good showers every summer. Clearing of fields must take place outside the growing season, and the necessity for weeding and for protecting young plants from wind damage increases the commitment of time to farming during the growing season. Futhermore, food and other goods must either be taken to dry caves in the canyon for storage, or storage facilities must be constructed on the mesa top. Either alternative increases the investment of labor in farming and takes time away from food collecting. Given the architectural technology, pit facilities must be built for storage, but these generally can be constructed only in the spring, or possibly in the late summer, times when the ground is moist to a sufficient depth. Prolonged mesa-top stays also promote the construction of living shelters there, probably requiring an additional investment of time outside the growing season. The seasonal decrease in time available for hunting makes the keeping of turkeys more attractive, so this practice is adopted from peoples to the south. Since turkeys are outside their native range, their diet must be supplemented by grown or gathered food, and it may be that pens need to be built to contain them.

If accompanied by factors such as population growth, limitations in useful area or increases in agricultural efficiency, this process should continue to operate, leading, as more land is bought under cultivation, to heavy dependence on agriculture and domestic turkey throughout the region. This may have happened, for example, on Mesa Verde proper. On Cedar Mesa, we originally argued, that in Basketmaker III times, the amount of land opened up by the shift to mesa-top farming was so great and the environment so marginal that population remained sparse relative to land area. Since food collecting territories became reduced to increased dependence on farming, we can see that the niche hypervolume has changed and its volume has shrunk and become oriented around deep soil mesa-top areas. Wild plants and animals, however, remained sufficiently abundant within these reduced territories to make continued food collecting profitable. Settlement continued to be organized around small social units. Had settlement in the Cedar Mesa area been continuous, population might have continued to grow and farming might have become more intensive, but the area was abandoned before this process could work itself out.

The populations apparently moved generally east, particularly after the Basketmaker III abandonment of Cedar Mesa, either to higher areas, such as Milk Ranch Point on southern Elk Ridge or to broad alluvium-filled valleys draining large areas, such as Comb Wash and Cottonwood Canyon. This may be explainable in terms of restructuring of the fundamental niche as a result of the changes in adaptive strategies outline above, or as responses to changes in the environment. The niche for rainfall farmers in this area specifies deep soils of aeolian or alluvial origin, rainfall above 30-35 cm (12 to 14 inches) a year,(for rainfall farming), regular late summer rain and floods (for proper seasonal distribution of moisture and for flood-water farming), a growing season of 130 days or more, and access to non-farming areas for seasonal food collecting. The biotopes where these niche characteristics are optimally expressed shifts from ecologically diverse edge areas such as Cedar Mesa to areas where extensive deposits of cultivable soils and reliable water supply are juxtaposed. Though marginal in growing season, the Milk Ranch Point area has substantially greater rainfall, while the broad alluvial valleys that were mentioned drain large areas and almost always have late summer floods. In this context, then, the abandonment of Cedar Mesa late in Basketmaker III times can be seen as a shift of population to areas that were marginal and thinly populated in Basketmaker II times, but which now have become optimal due to shifts in adaptive capacities and strategies, and/or to climatic shifts.

The preceding hypothetical account owes a good deal to Flannery's treatmeat of cultural stability and change in early Mesoamerica (Flannery 1968). Our initial model of change and adaptation helped us orient our reseach; like most such initial models, it will go through considerable modification by the time our final model arrives at the end of this volume. This conception of adaptation in the Basketmaker II and III periods obviously can be broken down into a large number of specific hypotheses, each with its own "test implications" (Hempel 1966; Hill 1970a) as to what its manifestations should be in terms of archaeological data. Hypotheses derived from from this model, along with other hypotheses about Cedar Mesa adaptations can be found in Lipe and Matson (1971a:135-37), and are repeated below.

Given these definitions and assumptions we can develop specific hypotheses from the previously described Basketmaker II and III model (Lipe and Matson 1971a:135-137).

1. Basketmaker II groups were probably farming in the canyons in the summer and hunting and gathering on the mesa tops much of the rest of the year. Therefore, the settlement system covers both these types of environment.

2. Basketmaker II base camp sites of high intensity occupation and multiple activity nature tend to be located so as to provide access to both the canyon and mesa top environments, generally in the canyon rim areas of the mesa.

3. Because of the primarily hunting-gathering nature of the mesa-top occupation, Basketmaker II sites of all types tend to be associated with the pinyon-juniper woodland areas, but not with areas of deep, cultivable soils.

4. In the canyons, within areas suitable for farming, natural shelters were most often chosen for occupation by Basketmaker II groups because the seasonal nature of occupation and their rudimentary architectural technology militated against investment of large amounts of time in constructing storage facilities and domestic shelters.

5. The shift in settlement pattern between Basketmaker II and III was the result of improved cultigens, development or introduction of dry-farming techniques, and development of improved storage structures, allowing groups to spend most of their time on the mesa.

Because of what we perceived to be a fundamental similarity between Basketmaker III and Pueblo adaptations the next two hypotheses are the same for both.

6. Basketmaker III and late Pueblo II groups were primarily dependent on rainfall farming on the mesa top; therefore the settlement systems during these two periods were largely confined to the mesa top setting.

7. Because of the importance of rain fall farming, both Basketmaker III and late Pueblo II occupational intensity is greatest in and around the areas of deep soils on the divides between drainages on the mesa top.

The following hypotheses do not follow from the Basketmaker II-III developmental model, but were important in orienting our research on the later time periods. The first deals with expected differences between Basketmaker III and Pueblo groups. In the developmental model from Basketmaker II to Basketmaker III we postulated more hunting and gathering in the earlier period than the later. Given a progressively more reliable, and dietary more complete, given the introduction of beans, form of agriculture through time we would also expect Basketmaker III groups to spend more effort on hunting and gathering than later groups. The next hypothesis is directly based on this idea.

8. Basketmaker III groups had a greater dependence on hunting and gathering than did the late Pueblo II groups; this is reflected in the greater variety of sites present in the Basketmaker III period.

The next series of ideas are related to developments within the Pueblo period. Many of the canyons draining from Cedar Mesa have "Cliff Dwellings" present. Given the dating of these sites elsewhere and cursory inspection by 1971 we thought most of these were Pueblo III. We developed the following model as a possible explanation of the late canyon emphasis.

Given a relatively large population on the mesa-top based on rainfall dryfarming in Pueblo II times any shift in climate would probably result in a lower carrying capacity for that technology. One way of de-emphasizing dryfarming would be to concentrate on flood water farming both in the canyons and in the shallow mesa top washes. Given the relatively small areas on Cedar Mesa that fall into these two settings competition for these areas or over food in general would lead to hostilities. This would lead to settlements in densible locations, either in rockshelter settings in the canyons or on rocky prominences on the mesa-top.

The core aspects of this model about developments in Pueblo III times are expressed in more testable fashion as the three following hypotheses (Lipe and Matson 1971a: 136-137).

9. Pueblo III groups were primarily dependent on floodwater farming in the shallow mesa top washes and in the deep canyons. The settlement systems at that time include both mesa and canyon settings.

10. The shift in settlement patterns between late Pueblo II and Pueblo III was due to a deterioration in climate that

made rainfall farming risky.

11. Because of an increase in inter-group hostility during Pueblo III times, defensible site locations became for the first time an important resource.

12. The highest intensities of occupation in Pueblo III times were at canyon bottom sites, and at mesa-top sites located on or around rocky prominences or other defensible places.

<Conclusions>

While recognizing that a frame of reference is essential before some observations may be selected as data out of the infinite number of possible observations, we did not go into the field with only the above hypotheses and with corresponding data requirements. Rather, we collected data on, and sought intercorrelations among, a large number of variables that we judged on the basis of our hypotheses and previous experience to be potentially relevant to understanding cultural adaptation in the area. As correlations emerged, pre-existing hypotheses were modified and new ones created; this report is in many ways the story of that process. By the end of the report, we hope we will have eliminated to the reader's satisfaction a number of hypotheses that seemed plausible at the outset (including a number of the above), and will be able to give some differential weighting to those that remain, as well as, indicating areas that are unresolved. So long as the data and tests applied to a particular hypothesis can be shown to be logically appropriate and empirically valid, it does not matter in what order or by what pathways the data, tests, and hypotheses have come together (Hempel 1966:38).

That we reject a "narrow inductivist" approach (Hempel 1966:11) does not imply that we expect to utilize the Hempel-Oppenheim or Deductive-Normologicial model of scientific explanation (Hempel and Oppenheim 1948; Hempel 1966), as some archaeologists have urged (Fritz and Plog 1970; Watson, LeBlanc, and Redman 1971). The covering laws that can be mustered by anthropology are generally probabilistic in form (though few, if any, can be expressed in terms of explicit probability statements) and the resulting explanations are inductive and probablistic in form (Hempel 1962; 1966:58-59).

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