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WILLOW SMOKE AND DOGS' TAILS: HUNTER-GATHERER SETTLEMENT SYSTEMS AND ARCHAEOLOGICAL SITE FORMATION

Lewis R. Binford

Hunter-gatherer subsistence-settlement strategies are discussed in terms of differing organizational components, "mapping-on" and "logistics," and the consequences of each for archaeological intersite variability are discussed. It is further suggested that the differing strategies are responsive to different security problems presented by the environments in which hunter-gatherers live. Therefore, given the beginnings of a theory of adaptation, it is possible to anticipate both differences in settlement-subsistence strategies and patterning in the archaeological record through a more detailed knowledge of the distribution of environmental variables.

An old Eskimo man was asked how he would summarize his life; he thought for a moment and said, "Willow smoke and dogs' tails; when we camp it's all willow smoke, and when we move all you see is dogs' tails wagging in front of you. Eskimo life is half of each."

THIS MAN WAS CAPTURING IN A FEW WORDS a way of life now largely vanished from man's experience: mobile man pursuing food, shelter, and satisfaction in different places in his environment. This paper is a discussion of patterns that I have recognized through direct field study as well as long-term research in the historical and ethnographic literature dealing with hunting and gathering adaptations. I am interested in what, if anything, renders differences in man's mobility patterning, and in turn the archaeological "traces" of this behavior in the form of spatial patterning in archaeological sites, both "understandable" and "predictable."

The posture adopted accepts the responsibility for a systemic approach. That is, human systems of adaptation are assumed to be internally differentiated and organized arrangements of formally differentiated elements. Such internal differentiation is expected to characterize the actions performed and the locations of different behaviors. This means that sites are not equal and can be expected to vary in relation to their organizational roles within a system. What kind of variability can we expect to have characterized hunting and gathering adaptations in the past? What types of organizational variability can we expect to be manifest among different archaeological sites? Are there any types of regular or determined variability that can be anticipated among different archaeological sites? Are there any types of regular or determined variability that can be anticipated among the archaeological remains of people whose lives might be characterized as "willows smoke and dogs' tails"?

The archaeological record is at best a static pattern of associations and covariations among things distributed in space. Giving meaning to these contemporary patterns is dependent upon an understanding of the processes which operated to bring such patterning into existence. Thus, in order to carry out the task of the archaeologist, we must have a sophisticated knowledge and understanding of the dynamics of cultural adaptations, for it is from such dynamics that the statics which we observe arise. One cannot easily obtain such knowledge and understanding from the study of the archaeological remains themselves. The situation is similar to conditions during the early years of the development of medical science. We wish to be able to cure and prevent disease. Do we obtain such knowledge through the comparative study of the symptoms of disease?

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The symptoms are the products of disease. Can they tell us about the causes of disease? In a like manner the archaeological record is the *product* or derivative of a cultural system such that it is symptomatic of the past. We cannot hope to understand the causes of these remains through a formal comparative study of the remains themselves. We must seek a deeper understanding. We must seek to understand the relationships between the dynamics of a living system in the past and the material by-products that contribute to the formation of the archaeological record remaining today. In still more important ways we seek to understand how cultural systems differ and what conditions such differences as a first step toward meaningful explanation for patterns that may be chronologically preserved for us in the archaeological record. As in the earlier analogy with medical science, once we know something of the disease and its causes, we may codify the symptoms to permit accurate diagnosis. Similarly, in the archaeological world when we understand something of the relationship between the character of cultural systems and the character of their by-products, we may codify these derivatives to permit the accurate diagnosis from archaeological traces of the kind of cultural system that stood behind them in the past. These are not easy tasks to accomplish.

It has been my conviction that only through direct exposure to dynamics—the ethnoarchaeological study of living systems—does the archaeologist stand the best chance of gaining sufficient understanding to begin the task of giving meaning to the archaeological record, in short, of developing tools or methods for accurately diagnosing patterned variability.

My most extensive experience with living systems has been among the Nunamiut Eskimo (Inuit) of north-central Alaska. For this reason I will base my discussion of a “diagnostic approach” to settlement pattern on some of my Eskimo experiences. I will compare that understanding with a number of different settlement systems as documented ethnographically by others. I will then proceed to discuss how settlement systems may vary among hunters and gatherers living in different environments. In the course of these discussions, I will consider the types of archaeological sites generated in different environments as well as some of the probable spatial arrangements among such sites. Good diagnosis is “theory dependent.” I will therefore be concerned with the factors that condition or “cause” different patterns of intersite variability in the archaeological record.

COLLECTORS AND FORAGERS

In several previous discussions of the Nunamiut I have described them as being “logistically organized.” I have frequently contrasted their subsistence-settlement system with that of the San or “Bushman” peoples, whom, I have designated foragers.

Foragers

Figure 1 illustrates some of the characteristics of a foraging system (this figure is largely based on the /Gwi San as reported by Silberbauer [1972]). Several points should be made here regarding the characteristics of foragers. My model system as shown in Figure 1 illustrates seasonal residential moves among a series of resource “patches.” In the example these include the “pans” or standing water sources, melon patches, etc. Foraging strategies may also be applied to largely undifferentiated areas, as is frequently the case in tropical rain forests or in other equatorial settings. One distinctive characteristic of a foraging strategy is that foragers typically do not store foods but gather foods daily. They range out gathering food on an “encounter” basis and return to their residential bases each afternoon or evening. In Figure 1, residential bases are represented by solid black dots along tracks indicated by double dashed lines. The circles around each residential base indicate the foraging radius or the distance food procurement parties normally travel out into the bush before turning around and beginning their return trip. Another distinctive characteristic is that there may be considerable variability among foragers in the size of the mobile group as well as in the number of residential moves that are made during an annual cycle. In relatively large or “homogeneous” resource patches, as indicated by cross-hatching on the right of Figure 1, the number of residential moves may be increased but the distances between them reduced, resulting in an intensive coverage of the resource “patch.” On the other hand, if

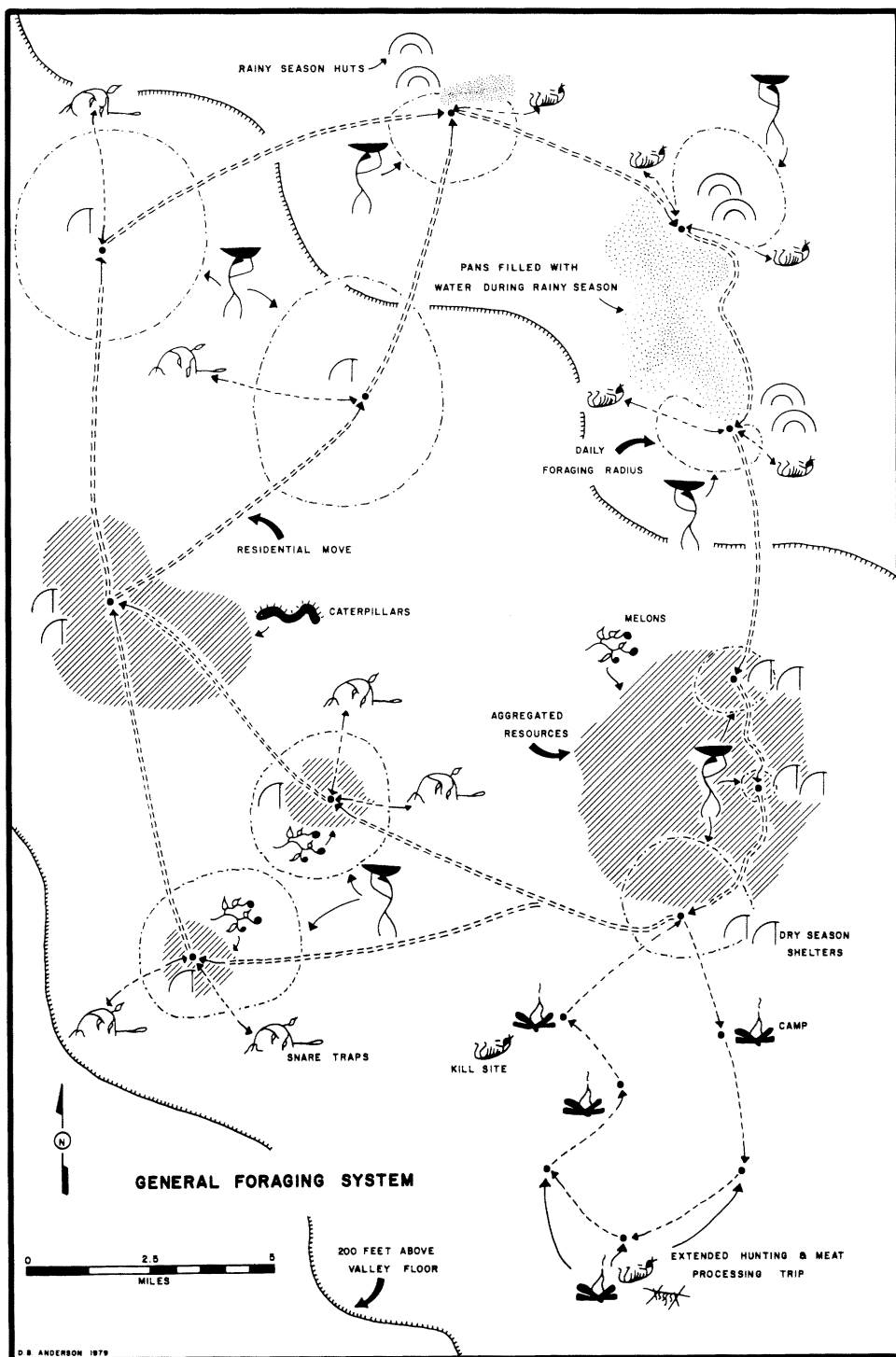


Figure 1. Characterization of a foraging subsistence-settlement system.

resources are scarce and dispersed, the size of the mobile group may be reduced and these small units scattered over a large area, each exploiting an extended foraging radius. This situation is indicated by the multiple residential bases on the lower left side of the "seasonal round" shown in Figure 1. I might point out that when minimal forager groups (that is 5-10 persons) are dispersed, there is frequently a collapse of the division of labor, and foraging parties will be made up of both male and female members involved in procuring largely identical resources.

Perhaps the use of the desert San as a model for foraging strategies is somewhat misleading, since the most exclusive foragers are best known from equatorial forests. Table 1 summarizes some of the information from equatorial groups on numbers of residential moves, average distances between moves, and total distances covered during an annual cycle. What can be seen from Table 1 is that there is considerable variability among foragers in the duration of stay at different sites. For some extremely mobile foragers such as the Punam, as reported by Harrison (1949), residential sites would be extremely ephemeral; one could expect little accumulation of debris and very low archaeological "visibility." There is another characteristic which may vary among foragers to further condition the "visibility" of the archaeological record: that is the relative redundancy of land use from year to year. One gains the impression, from descriptions of such groups as the Punam (Harrison 1949), the Guayaki (Clastres 1972), and other highly mobile foragers, that camps are not relocated relative to locations of previous use. The resources exploited are scattered but ubiquitous in their distribution and are not clumped or specifically localized as might be the case in deserts where waterholes are limited in number and discretely placed. Under the latter conditions we might expect more year to year redundancy in the occupation of particular places. Extreme examples of limited locations for critical resources may result in what Taylor (1964) has called *tethered nomadism*, indicating extreme redundancy in the reuse of identical places (water sources) over long periods of time. Such spatial discreteness tends to "tie down" the settlement system to specific geographical areas while other areas would be occupied little and rarely used because of their distance from such limited and crucial resources. We might think of a typical forager pattern of land use as looking like a daisy—the center is the residential base, and foraging parties move out, traversing search loops which resemble the petals of the daisy. Figure 2 illustrates this actual pattern as recorded by John Yellen (1972) for a mobile group of Dobe !Kung.

In recognition that there is an alternative strategy which may be executed occasionally by peoples who are basically foragers, I have indicated a different pattern in the lower right-hand corner of Figure 1. We might think of this as a hunting trip where several men leave a residential

Table 1. Summary of Group Sizes and Annual Mobility for a Number of Equatorial and Subequatorial Groups of Hunter-Gatherers.

Group Name	Modal Group Size	Number of Annual Residential Moves	Mean Distance between Sites (miles)	Total Circuit Distance Covered Annually	References
Penum	65	45	4.2	195	Harrison 1949:135
Semang	18	21	7.1	150	Schebesta 1929:150
Mbuti	120	12	8.3	100	Bicchieri 1969:149
Siriono	75	26	14.2	370	Holmberg 1950
Guayaki	50-20	50	3.7	220	Clastres 1972:150
Aeta	45	22	8.0	178	Vanoverbergh 1925:432
Hadza	—	31	8.2	256	Woodburn 1972:194
Dobe !Kung	25	5	14.8	75	Lee 1968:35
G/wi	55-18	11-12	16.8	193	Silberbauer 1972:297

Note. These values are estimates from either the observers and interviewers or calculations made by me from indirect information provided by such authors.

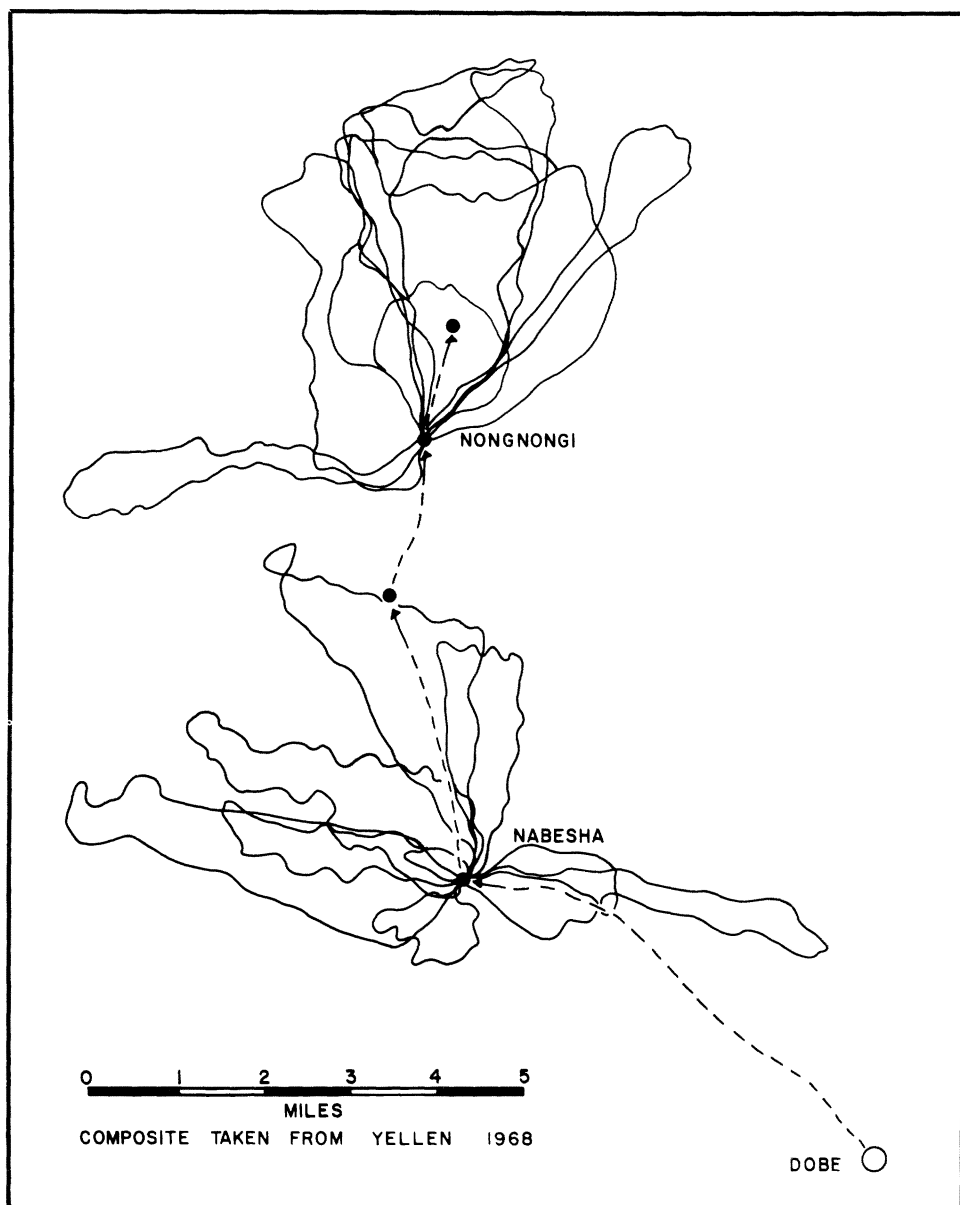


Figure 2. Actual map of foraging trips made by !Kung San around base camps.

base, establishing overnight camps from which they move out in search of game, frequently using what I (Binford 1978b) have termed an encounter of strategy. If they succeed in their hunting endeavors, and if the body size of the animal is large or the distance to camp is great and the temperature is warm, they may elect to dry the meat in the field and transport processed meat back to camp. This possibility is indicated by the little drying rack in the lower right-hand corner. They may then elect to return to the base by the original route or, if more meat is needed, they are more likely to return by a new route where they may even have further success in hunting. This little hunting trip represents a different type of strategy. It is a specialized work party, in this case made up of men, who establish camps for their own maintenance away from the residential base

camp where they live. They may conduct special activities which may be only very rarely conducted in the residential base camp. This type of strategy may leave a very different kind of archaeological record and one we will explore in more detail in the next model.

Before going on, however, it may be useful to summarize something of our expectations regarding the archaeological remains of foraging strategies. The first point to be made regarding the archaeological remains of foraging strategies is simply that there are apt to be basically two types of spatial context for the discard or abandonment of artifactual remains. One is in the *residential base*, which is, as we have seen, the hub of subsistence activities, the locus out of which foraging parties originate and where most processing, manufacturing, and maintenance activities take place. I have indicated that among foragers residential mobility may vary considerably in both duration and the spacing between sites; in addition the size of the group may also vary. These factors would condition the character of the archaeological record generated during a single occupation. I have suggested that foragers may be found in environmental settings with very different incidences and distributions of critical resources. In settings with limited loci of availability for critical resources, patterns of residential mobility may be *tethered* around a series of very restricted locations such as water holes, increasing the year to year *redundancy* in the use of particular locations as residential camps. The greater the redundancy, the greater the potential buildup of archaeological remains, and hence the greater the archaeological visibility. Thus far, I have basically reiterated some of the generalizations Yellen (1977:36–136) formulated from his experiences with the Kalahari Bushman, as well as some of the arguments I (Binford 1978b:451–497) derived from my observations of Nunamiut Eskimo residential camps.

The further characteristics of the *residential base* will become clearer in contrast with the other type of archaeological occurrence that foragers are apt to produce: the *location*. A *location* is a place where extractive tasks are exclusively carried out. Since foragers generally do not stockpile foods or other raw materials, such locations are generally “low bulk” procurement sites. That is to say, only limited quantities are procured there during any one episode, and therefore the site is occupied for only a very short period of time. In addition, since bulk procurement is rare, the use, exhaustion, and abandonment of tools is at a very low rate. In fact, few if any tools may be expected to remain at such places. A good example of a *location* generated by foragers, a wood-procurement site, is described by Hayden (1978:190–191).

As a rule, they are spatially segregated from base camps and are occupied for short durations (usually only a matter of hours at the most) by task-specific groups; . . . the lithic tools employed are generally very distinctive and the assemblages highly differentiated in terms of proportional frequencies compared to base camp assemblages . . . the tools used are often obtained locally near the procurement site, and are generally left at the site after the activity is accomplished. . . . if one walked extensively among the mulga grove, one could see an occasional chopping implement, usually left at the base of a decaying mulga trunk. Rarely were there more than two chopping implements, and the overall density must have been about one chopping implement per 2500 m² or less.

Under low-bulk extraction or low redundancy in localization, the archaeological remains of *locations* may be scattered over the landscape rather than concentrated in recognizable “sites.” Understanding such remains would require data-collecting techniques different from those archaeologists normally employ. So-called “off-site” archaeological strategies are appropriate to such situations. Given that long periods of time are involved and certain resources are redundantly positioned in the environment, we might anticipate considerable palimpsest accumulations that may “look” like sites in that they are aggregates of artifacts; however, such aggregates would commonly lack internal structure and would be characterized by accretional formation histories. Very important research into this type of archaeological distribution was initiated in this country by Thomas (1975). Further provocative investigations of so-called “off-site archaeology” are currently being pursued by Robert Foley (personal communication) of the University of Durham in the Amboseli area of Kenya.

What can be summarized is that foragers generally have high residential mobility, low-bulk inputs, and regular daily food-procurement strategies. The result is that variability in the contents of residential sites will generally reflect the different seasonal scheduling of activities (if any) and

the different duration of occupation. The so-called "functionally specific" sites will be relatively few; given low-bulk inputs and short or limited field processing of raw materials such locations will have low visibility though they may well produce considerable "off-site" archaeological remains if long periods of land use are involved. Basically this type of system has received the greatest amount of ethnoarchaeological attention (e.g., Bushmen and central desert Australian Aborigines).

Collectors

In marked contrast to the forager strategy where a group "maps onto" resources through residential moves and adjustments in group size, logistically organized collectors supply themselves with specific resources through specially organized task groups.

Figure 3 illustrates some of the distinctive characteristics of a collector strategy. The model is generalized from my experiences with the Nunamiut Eskimo. In contrast to foragers, collectors are characterized by (1) the storage of food for at least part of the year and (2) logistically organized food-procurement parties. The latter situation has direct "site" implications in that special task groups may leave a residential location and establish a field camp or a station from which food-procurement operations may be planned and executed. If such procurement activities are successful, the obtained food may be field processed to facilitate transport and then moved to the consumers in the residential camp.

Logistical strategies are labor accommodations to incongruent distributions of critical resources or conditions which otherwise restrict mobility. Put another way, they are accommodations to the situation where consumers are near to one critical resource but far from another equally critical resource. Specially constituted labor units—task groups—therefore leave a residential location, generally moving some distance away to specifically selected locations judged most likely to result in the procurement of specific resources. Logistically organized task groups are generally small and composed of skilled and knowledgeable individuals. They are not groups out "searching" for any resource encountered; they are task groups seeking to procure specific resources in specific contexts. Thus we may identify specific procurement goals for most logistically organized groups. They go out to hunt sheep at the salt lick, or pursue big caribou bulls along the upland margins of the glaciers in July. They are fishing for grayling or white fish. They are not just out looking for food on an encounter basis.

This specificity and "specialization" in procurement strategy results in two types of functional specificity for sites produced under logistically organized procurement strategies. Sites are generated relative to the properties of logistical organization itself, but they are also generated with respect to specific types of target resources.

For foragers, I recognized two types of site, the *residential base* and the *location*. Collectors generate at least three additional types of sites by virtue of the logistical character of their procurement strategies. These I have designated the *field camp*, the *station*, and the *cache*. A field camp is a temporary operational center for a task group. It is where a task group sleeps, eats, and otherwise maintains itself while away from the residential base. Field camps may be expected to be further differentiated according to the nature of the target resources, so we may expect sheep-hunting field camps, caribou-hunting field camps, fishing field camps, etc.

Collectors, like foragers, actually procure and/or process raw materials at locations. However, since logistically organized producer parties are generally seeking products for social groups far larger than themselves, the debris generated at different locations may frequently vary considerably, as in the case of group bison kills on the Plains (see Frison [1970] or Wheat [1967]) or spring intercept caribou kill-butcherer locations among the Nunamiut such as the site at Anavik (Binford 1978b: 171–178). Sites of major fish weirs or camas procurement locations on the Columbia plateau might be examples of locations with high archaeological visibility as opposed to the low-visibility locations commonly generated by foragers. Such large and highly visible sites are also the result of logistically organized groups, who frequently seek goods in very large quantities to serve as stores for consumption over considerable periods of time.

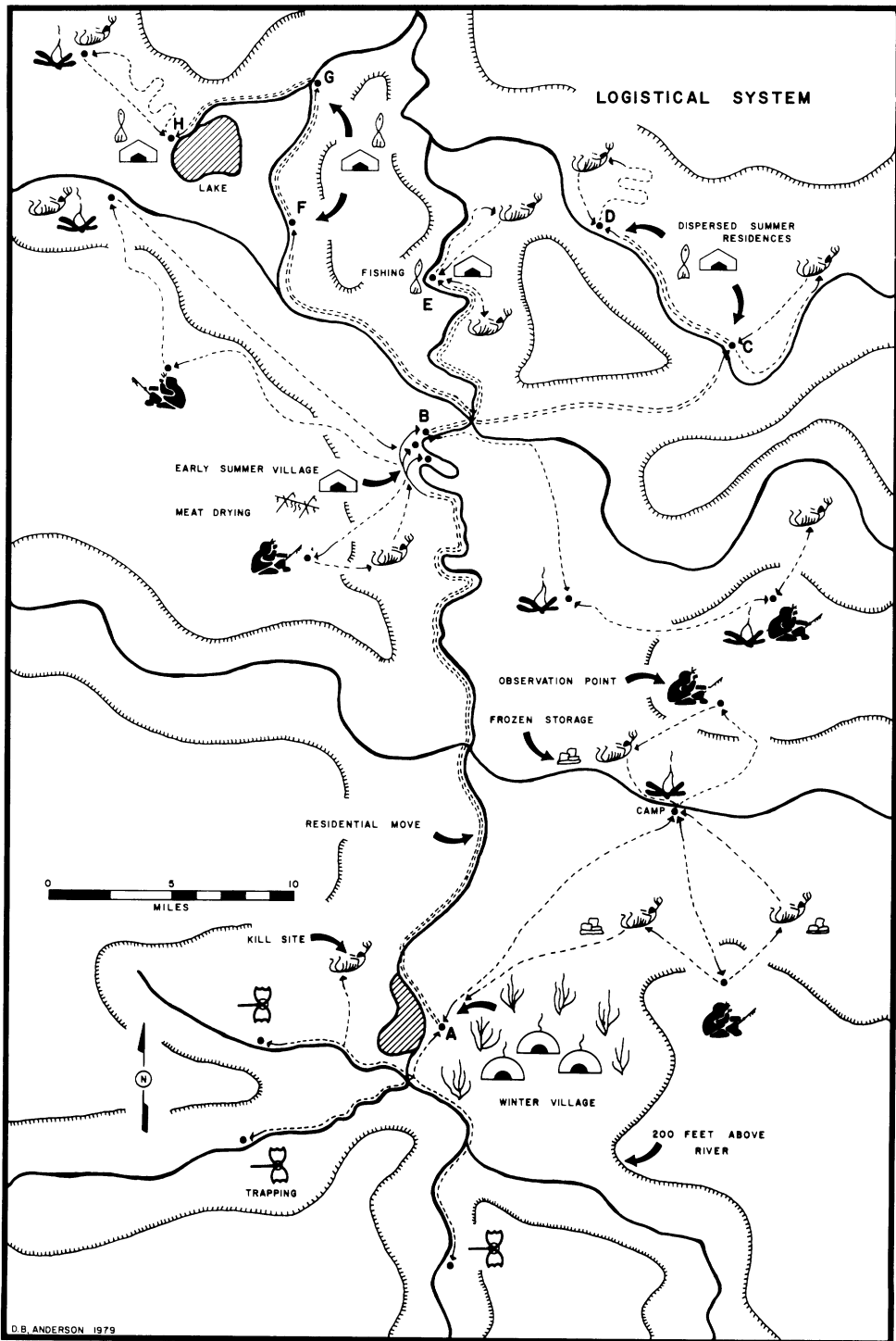


Figure 3. Characterization of a collector subsistence-settlement system.

Stations and *caches* are rarely produced by foragers. *Stations* are sites where special-purpose task groups are localized when engaged in information gathering, for instance the observation of game movement (see Binford 1978b) or the observation of other humans. *Stations* may be ambush locations or hunting stands from which hunting strategy may be planned but not necessarily executed. These are particularly characteristic of logistically organized systems, since specific resource targets are generally identified and since for each target there is a specific strategy which must generally be "informed" as to the behavior of game before it can be executed.

Caches are common components of a logistical strategy in that successful procurement of resources by relatively small groups for relatively large groups generally means large bulk. This bulk must be transported to consumers, although it may on occasion serve as the stimulus for repositioning the consumers. In either case there is commonly a temporary storage phase. Such "field" storage is frequently done in regular facilities, but special facilities may be constructed to deal specifically with the bulk obtained (see Binford 1978a:223-235). From the perspective of the archaeological record, we can expect *residential bases*, *locations*, *field camps*, *stations*, and *caches* as likely types of sites generated by a logistically organized system. Within each class we can expect further variability to relate to season and to the character of the resource targets of logistically organized task groups.

There is still an additional source of variability, since all the logistical functions may not necessarily be independently located. In some situations one might be able to use the field camp as an observation point, in others it may equally serve as a hunting stand. On occasion kills (*locations*) may be made directly from a hunting stand, and the meat may be processed and temporarily cached there. Many other combinations can be imagined. *The point is simple, the greater the number of generic types of functions a site may serve, the greater the number of possible combinations, and hence the greater the range of intersite variability which we may expect.*

Against this background it is perhaps instructive to follow out some of the conditions modeled in Figure 3. Beginning with the winter village (site) at the lower center of the map, several conditions are indicated. The winter village is a cluster of relatively substantial houses located in a stand of willows (winter fuel). To the left of the village a series of expeditions are indicated; these are carried out by special trapping parties for the purpose of obtaining fur for winter clothing. To the right of the village are a series of site types: a *field camp*, where a hunting party is maintained while away from the residential camp; a *station*, or *observation site*, which is occupied and used basically for collecting information on game presence or movement; and several *locations*, kill sites and cache locations, which might also represent archaeological accumulations. With early summer a residential move is indicated (site B); this move results in a change in housing and a dependence upon dry rather than frozen meat as was the case in the winter village. From such a site, logistically organized parties may range out considerable distances to hunt such game as caribou or mountain sheep. *Field camps* and *stations*, like observation points and a variety of kill *locations*, might be generated. We see additional complexity caused by the differential combination of functions at different locations. For instance, to the far right of the map is a combined field camp and observation point; in other situations these functions might be spatially separated. In the upper part of the map an additional residential move is suggested. This move is accompanied by a reduction in group size as the local group breaks down into family units, each establishing independent residential camps having slightly different logistical patterning.

It should be clear by now that we are not talking about two polar types of subsistence-settlement systems, instead we are discussing a graded series from simple to complex. Logistically organized systems have all the properties of a forager system and then some. Being a system, when new organizational properties are added, adjustments are made in the components already present such that residential mobility no longer plays the same roles it did when the system had no logistical component, although important residential moves may still be made. Given basically two strategies, "mapping on" and "logistics," systems that employ both are more complex than those employing only one and accordingly have more implications for variability in the archaeological record. It should be clear that, *other things being equal, we can expect greater ranges of intersite variability as a function of increases in the logistical components of the subsistence-settlement system.*

DISCUSSION

Thus far I have been talking about the patterning that I have perceived in the way hunters and gatherers are organized for subsistence purposes. I have been offering certain analytical and descriptive suggestions as to things one might look for in characterizing hunter-gatherer adaptations. I have been attempting to justify a particular way of looking at hunter-gatherers and suggesting that there are some interesting empirical patterns manifested by hunter-gatherers when they are looked at from the perspectives advocated.

Can we now begin the important task of building an explanation for the variability presented? Can we begin to understand the particular adaptive conditions which human groups differentially face by virtue of coping with different environments? Can we understand which conditions would favor "mapping on" versus "logistically organized" strategies? Beginning with a more specific question, are there any clues to the factors that favor or select for a foraging or logistical strategy? If we assume that technological and social characteristics contribute to making up the means and organization of production, we wish to know if there are not some basic "determinants" conditioning the distribution of differing "modes of production" (that is, the characteristic mixes of technology and social organization organized for subsistence purposes). Put another way, since systems of adaptation are energy-capturing systems, the strategies that they employ must bear some relationship to the energy or, more important, the entropy structure of the environments in which they seek energy. We may expect some redundancy in the technology or means, as well as the organization (labor organization), of production to arise as a result of "natural selection." That is the historical movement toward an "optima" for the setting. Put another way, technology, in both its "tools" sense as well as the "labor" sense, is invented and reorganized by men to solve certain problems presented by the energy-entropy structure of the environment in which they seek to gain a livelihood.

Given this viewpoint we would expect that a foraging mode of production would serve men well in certain environmental conditions, but not necessarily in all. What might some of these conditions be? Are there any environmental settings where we might expect foraging strategies to offer "optimal" security for groups of hunter-gatherers? I think it is fair to suggest that although most people view seasonal mobility of residential locations as being responsive to differences in food abundance, most have little appreciation for the environmental conditions which structure food abundance from the perspective of the human consumer. Perhaps Hollywood can be blamed for the widespread idea that "jungles" are food rich while deserts and arctic settings are food poor. In turn most laymen and beginning ecology students alike expect the greatest residential mobility in arctic and desert settings and most "sedentism" among non-food-producers in equatorial settings. Simply as a means of provocative demonstration I have adopted as a basis for further discussion data from Murdock (1967) regarding settlement patterns. Murdock rated 168 cases of hunters and gatherers as to their degree of residential mobility. Each group was scaled from one to four as follows (see Murdock 1967:159): (1) fully migratory or nomadic bands, (2) seminomadic communities whose members wander in bands for at least half of the year but occupy a fixed settlement at some season or seasons; (3) semisedentary communities whose members shift from one to another fixed settlement at different seasons or who occupy more or less permanently a single settlement from which a substantial proportion of the population departs seasonally to occupy shifting camps; and (4) compact and relatively permanent settings.

These 168 cases are summarized in Table 2, which cross tabulates Murdock's estimates of residential mobility against a measure of environmental variability developed by Bailey (1960), called "effective temperature" (ET). This measure simultaneously describes both the total amount and yearly distribution of solar radiation characteristic of a given place. Stated another way, ET is a measure of both the length of the growing season and the intensity of solar energy available during the growing season. Since biotic production is primarily a result of solar radiation coupled with sufficient water to sustain photosynthesis, we can expect a general relationship to obtain between ET value and global patterns of biotic activity and hence production. Other things being equal, the higher the ET value, the greater the production of new cells within the plant or pro-

Table 2. Cross Tabulation of Settlement Pattern as Evaluated by Murdock (1967) and ET (Effective Temperature) Values as Calculated from World Weather Records.

Effective temperature	Fully Nomadic (1)	Semi-Nomadic (2)	Semi-Sedentary (3)	Sedentary (4)	Total	Index Value
25	2	0	0	0	2	
24	1	0	1	0	2	
23	3	1	0	0	4	
22	2	0	0	0	2	
21	1	1	0	0	2	
Sub-total	9 (75.0%)	2 (16.7%)	1 (8.3%)	0	12	1.33
20	1	1	1	0	3	
19	3	1	0	0	4	
18	2	1	0	0	3	
17	1	0	0	0	1	
16	2	1	0	0	3	
Sub-total	9 (64.2%)	4 (28.5%)	1 (7.1%)	0	14	1.42
15	2	11	2	0	15	
14	1	10	1	5	17	
Sub-total	3 (9.3%)	21 (65.6%)	3 (9.3%)	5 (15.6%)	32	2.31
13	3	17	4	4	28	
12	1	15	8	1	25	
Sub-total	4 (7.5%)	32 (60.3%)	12 (22.6%)	5 (9.4%)	53	2.33
11	2	15	9	3	29	
10	3	6	3	4	16	
Sub-total	5 (11.1%)	21 (46.6%)	12 (26.6%)	7 (15.4%)	45	2.46
9	5	3	1	1	10	
8	0	1	1	0	2	
Sub-total	5 (41.6%)	4 (33.3%)	2 (16.6%)	1 (8.3%)	12	1.91
Grand total	35 (20.8%)	84 (50.0%)	31 (18.4%)	18 (10.7%)	168	

ducer component of the habitat. This means that in a very simplistic sense we might expect "food rich" environments when ET is high and "food poor" environments when ET is low.

Table 2 illustrates some provocative facts. We note that "fully nomadic" strategies characterize 75% of the hunter-gatherer cases located in a fully equatorial environment (ET 25-21); high mobility is also found in 64.2% of the cases in semitropical settings. In warm temperate settings we note a drastic reduction of hunter-gatherers who are "fully nomadic" (only 9.3%), and in cool temperate settings the number is still further reduced (7.5%). Then as we move into boreal environments the number of fully nomadic groups increases slightly (11.1%), and in full arctic settings it increases drastically (reaching 41.6%). Thus we see that mobility, as measured by Murdock's categories, is greatest in equatorial settings, where we have the highest production in the world, and in arctic settings, where we have the most consistently low production. Summarizing the data from Table 2 another way, we observe the greatest concentration of sedentary and semi-sedentary hunters and gatherers in the temperate and boreal environmental zones and the least in equatorial and semiequatorial settings. This empirical pattern shows that mobility among hunter-gatherers is responsive to conditions other than gross patterns of "food abundance." This is indicated by the disproportionate occurrence of reduced mobility in the cooler, less productive environments.

I suggest that since mobility is a "positioning" strategy, it may well be most responsive to structural properties of the environment, that is to say the particulars of food distribution that are not directly correlated with the more intuitively appreciated conditions of food abundance.

A clue to the types of problems that different strategies solve is perhaps best sought in the contrasts between the two basic strategies themselves. *Foragers move consumers to goods with frequent residential moves, while collectors move goods to consumers with generally fewer residential moves.* The first strategy, that of "mapping on," would work only if all the critical resources were within foraging range of a residential base. Logistical strategies (by collectors) solve the problem of an incongruous distribution among critical resources (i.e., the lack of a reliable supply of a critical resource within the foraging radius of a residential base camp presumably located with regard to an equally critical resource). *Under conditions of spatial incongruity it must be appreciated that a residential move will not solve the problem.* A move toward one location reduces the access to the other. *It is under this condition that a logistical strategy is favored.* Hunter-gatherers move near one resource (generally the one with the greatest bulk demand) and procure the other resource(s) by means of special work groups who move the resource to consumers.

In the case of *temporal incongruity*, a storage strategy is the most likely means of solving the problem. One seeks to extend the time utility for one of the resources beyond its period of availability in the habitat. This is accomplished generally by either drying or freezing. *Storage reduces incongruous temporal phasing of resources, but it may increase the problem of spatial incongruity.* Spatial incongruity may be exacerbated in that storage accumulates considerable bulk in one place, which increases the transport costs of a residential move in favor of other resources that might be "coming in" or located some distance away. With increases in storage dependence there will be an expected increase in the logistical component of a settlement system. Finally, if the argument is made that incongruity among critical resources, whether temporal or spatial, is a condition favoring logistical strategies and a reduction and change in the role of residential mobility, it must also be realized that any condition which either (1) increases the numbers of critical resources and/or (2) increases the climatic variance over an annual cycle will also increase the probability of greater incongruities among critical resources.

Let us consider two logical expectations arising from this postulate. The law of requisite variety states that for maximum stability, the variety of homeostatic responses required in any system is equal to the variety of environmental challenges offered to it. We can expect, therefore, that the more unstable the thermal environment, the greater the number of operative homeostatic mechanisms, and hence the greater the number of critical resources, other things being equal. As the number of critical resources increases, there is a related increase in the probability that a lack of congruence will occur in their distributions. *Therefore, the greater the seasonal variability in temperature, the greater the expected role of logistical mobility in the settlement or "positioning" strategy.*

Given an equatorial environment in which species may exhibit patterns of differential production over an annual cycle, but the interdigitation of differing schedules among species ensures that there will be continuously available foods, a foraging strategy works very well. In temperate and still colder settings, such continuously available food is reduced as a function of decreases in the length of the growing season. Human groups attempting to "make a living" must therefore solve the "over-wintering" problem. Basically three methods are available: (1) exploiting species who have themselves solved the over-wintering problem (that is hunting other animals); (2) storing edible products accumulated largely during the growing season; or (3) storing animal resources accumulated during periods of high density and hence availability. *Although we must recognize that storage may not always be feasible, the degree to which it will be practiced can be expected to vary with decreases in the length of the growing season.* The degree to which storage is practiced will, in turn, increase the likelihood of distributional incongruities and hence condition further increases in logistically organized settlement systems with attendant reductions in residential mobility, at least seasonally. Both of these conditions are related to environmental reductions in the length of the growing season and to the implications of this for man, both in terms of foods and of other temperature-regulated resources. *This means that there is an environmental convergence of conditions acting simultaneously to increase the number of critical resources and to increase the conditions favoring storage.* Given the arguments presented here, we should therefore see a reduction in residential mobility and an increase in storage dependence as the length of the growing season decreases.

It should be pointed out that both of these expectations are supported empirically. As was previously indicated in Table 2, there is a marked increase of cases classified as semisedentary and seminomadic in environments with ET less than 16°C. Stated another way, we see increases in seasonal sedentism, with attendant increases in logistically organized food procurement inferred, in such environments.

Figure 4 illustrates the relationship between ET and storage dependence as estimated by Murdock and Morrow (1970) for a sample of 31 ethnographically documented hunters and gatherers. Storage dependence is indicated by an ordinal scale distributed from one to six, where six indicates the greatest dependence upon storage. What is interesting in this small sample is that there is a clear curvilinear relationship between increased dependence upon storage and decreasing ET values, measuring decreases in lengths of growing season. It is notable that storage is practiced only among hunters and gatherers in environments with ET values less than 15 (i.e., in environments with growing seasons less than about 200 days). Exceptions to the general trend are interesting and perhaps instructive. In warm environments there are only two exceptions, the Andamanese and the Chenchu. It is my impression that the Andamanese are miscoded while the Chenchu are demonstrably in the process of adopting agriculture. Exceptions on the "cold" end of the distribution are the Yukaghir, Yahgan, Slave, Copper Eskimo, and Ingalik. I believe the Yukaghir to be miscoded, as well as the Ingalik, while the other cases are probably truly exceptional in being more mobile and not putting up stores for winter in appreciable amounts. Additional cases of cold-climate groups who do not put up appreciable stores might be the Micmac, Mistassini Cree, Igloodik and Polar Eskimo, and some groups of Copper and Netsilikmiut Eskimo, as well as some temperate cases like the Tasmanians. Many of these groups might be technically foragers with relatively high residential mobility, nevertheless they are foragers of a different type than most equatorial foragers.

As has been pointed out, equatorial foragers move their residences so as to position labor

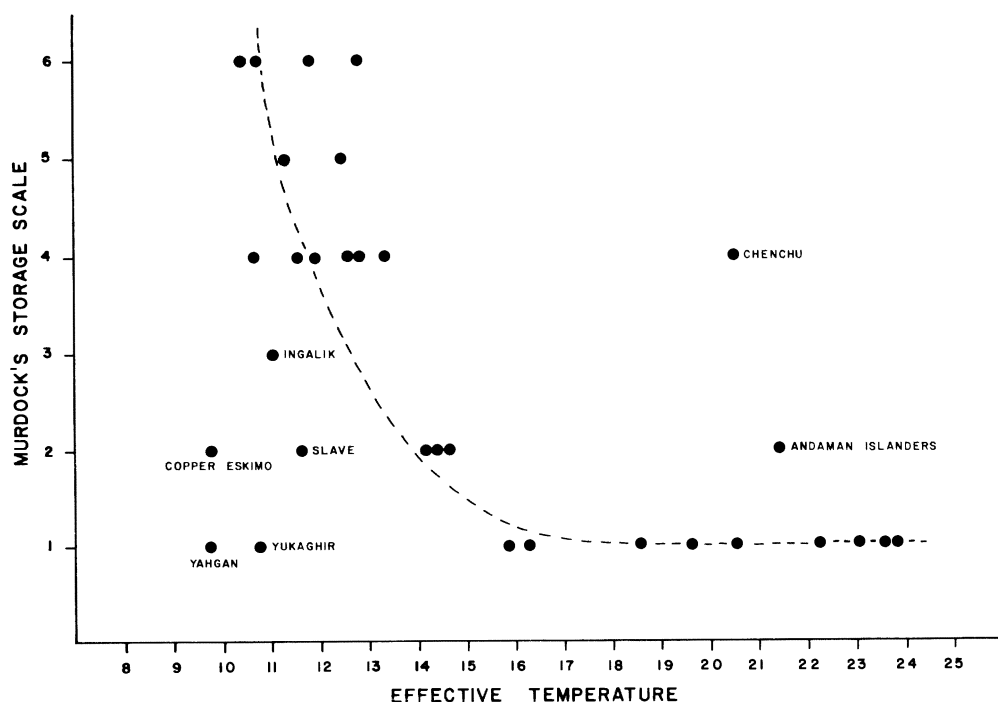


Figure 4. Graph of the relationship between storage dependence and effective temperature.

forces and consumers with respect to food-yielding habitats considered in spatial terms. The cold-environment foragers are what I tend to think of as serial specialists: they execute residential mobility so as to position the group with respect to particular food species that are temporally phased in their availability through a seasonal cycle. Leaving such interesting issues aside for the moment, it should be clear that there are definite geographical patterns to the distribution of environmental conditions that pose particular problems for hunter-gatherers. Some of these specifiable problems may be well solved or at least effectively dealt with through *logistically organized production strategies*. Such strategies answer the problem of incongruous distributions of critical resources. Incongruous distributions may occur spatially and may be further exacerbated by storage strategies. Storage always produces a high bulk accumulation in some place, which then has an increased likelihood of being incongruously distributed with respect to other critical resources such as fuel, water, shelter, etc. High bulk stores necessitate the determination of the relative cost of transporting consumers and stored goods to the loci of other critical resources versus that of introducing these other resources to the storage location through a logistically organized productive labor force.

I should point out that if there are other factors that restrain mobility, such as increased numbers of social units in the area, competition among multiple social units for access to similar resources, etc., then we can expect an accompanying increase in logistically organized production. This is not the place to take up such important issues as the origins of agriculture and other density dependent shifts in both mobility and productive strategy, but I simply wish to point out that *with any condition that restricts residential mobility of either foragers or collectors, we can expect (among other things) a responsive increase in the degree of logistically organized production.*

CONCLUSIONS: SETTLEMENT SYSTEMS AND INTERASSEMBLAGE VARIABILITY

The above discussion obviously has significant implications for our understanding of archaeological assemblages, their variability, and their patterning. I have argued elsewhere that we may think of an assemblage as a derivative of "some organized series of events characteristic of a system" (Binford 1978a:483). An assemblage that is the accumulated product of events spanning an entire year is rather gross and may be referred to as *coarse-grained* in that the resolution between archaeological remains and specific events is poor. On the other hand an assemblage accumulated over a short period of time, for instance a two-day camp, represents a *fine-grained* resolution between debris or by-products and events. Having made the above distinctions I previously argued:

1. Insofar as events are serially differentiated, and the composition of assemblages are responsive to event differences, the more fine-grained the assemblage, the greater the probable content variability among assemblages.
2. The factor which regulates the grain of an assemblage is mobility, such that high mobility results in fine-grained assemblages, whereas low mobility results in coarse-grained assemblages. (For further discussion see Binford 1978b:483-495.)

In reference to the initial condition, "the degree to which events are serially differentiated," it was argued that from a subsistence perspective the major conditioner of event differentiation is seasonal variance in the basic climatic variables: rainfall and solar radiation. It was therefore suggested that interassemblage variability "can be expected to increase with decreases in the length of the growing season" and/or "decreases in the equability of rainfall distribution throughout a seasonal cycle, given moderate to fine-grained assemblages" (Binford 1978b:484).

The earlier arguments had reference primarily to *residential* mobility. In this paper I have explored something of the interaction and the determinants for differential degrees of residential versus logistical mobility. I have suggested here that there are two basic principles of organization employed by hunters and gatherers in carrying out their subsistence strategies. They may "map on" by moving consumers to resources, or they may move resources to consumers "logistically." I have suggested that the relative roles played by these two organizational prin-

ciples in any given subsistence system will also condition the nature and character of archaeological intersite variability generated by the system. Foragers who practice primarily a "mapping on" strategy will generate basically two types of sites: the *residential base* and the *location*. Variability among forager systems will derive primarily from differences in the magnitude of residential mobility and environmental differences conditioning different subsistence activities through a seasonal cycle.

Collectors who tend toward a greater reliance on the logistical strategies can be expected to generate additional types of archaeological sites. That is, in addition to the *residential base* and the *location* we can expect *field camps*, *stations*, and *caches* to be generated. It was also argued that the character of residential bases, as well as that of locations, may well be expected to change in accordance with the relative degree of logistically organized activity characteristic of a system.

I then turned to the interesting question of what conditions the relative roles of "mapping on" versus "logistical" strategies in a subsistence-settlement system? It was argued that logistically based strategies are a direct response to the degree of locational incongruity among critical resources. It was further argued that the number of critical resources increases as climatic severity increases, and that the relative dependence upon stored foods increases as the length of the growing season decreases. It was pointed out that these characteristics are linked, and both tend to vary with geographical variability in the length of the growing season. *Therefore, as the length of the growing season decreases, other things being equal, we can expect increases in the role of logistical strategies within the subsistence-settlement system.* It was also pointed out that any other conditions that restrict "normal" residential mobility among either foragers or collectors also tend to favor increases in logistically organized procurement strategies. We would therefore tend to expect some increase associated with shifts toward agricultural production.

I can now integrate my earlier arguments regarding the factors conditioning interassemblage variability at residential bases with the arguments made in this paper regarding variability in the archaeological record stemming from organizational differences in the roles of mapping on and logistical strategies in the subsistence-settlement behavior of groups living in different environments. It was argued earlier that as seasonal variability in solar radiation or rainfall increased, given assemblage responsiveness to event differentiations, there would be an increase in residential interassemblage variability. This is assuming a roughly constant assemblage grain. In this paper it has been argued that under the same conditions increased logistical dependence with an accompanying reduction in residential mobility would be favored. This situation would have the effect of increasing the coarseness of the assemblage grain from such locations. *Increased coarseness, in turn, should have the effect of reducing interassemblage variability among residential sites of a single or closely related system occupied during comparable seasons. It would be coarseness, in turn, should have the effect of reducing interassemblage variability among residential sites of a single or closely related system occupied during comparable seasons. It would of course also have the effect of increasing the complexity and "scale" of assemblage content referable to any given uninterrupted occupation, assuming, that is, a responsiveness of assemblage content to event differentiations.*

The overall effect of what appears to be opposing consequences is normally some seasonal differentiation in the relative roles of residential versus logistical mobility. For instance, in some environments we might see high residential mobility in the summer or during the growing season and reduced mobility during the winter, with accompanying increases in logistical mobility. The overall effect from a regional perspective would be extensive interassemblage variability deriving from both conditions. We may also expect minor qualitative difference among assemblages from the winter villages (in the above examples). These are likely to be categorically different from mobile summer residences which would be highly variable and constitute a "noisy" category. Comparisons among winter residences would clearly warrant a categorical distinction of these from summer residences and they would be a "cleaner," less noisy category of greater within-assemblage diversity. Summer sites would be more variable among themselves but also less internally complex.

The point here is that logistical and residential variability are not to be viewed as opposing principles (although trends may be recognized) but as organizational alternatives which may be employed in varying mixes in different settings. These organizational mixes provide the basis for extensive variability which may yield very confusing archaeological patterning.

The next step in the arguments presented in this paper treats the production of special-purpose sites. It was suggested that with logistical strategies new types of sites may be expected: *field camps, stations, and caches*. It was further argued that the character and visibility at locations also changes in the context of increased use of logistical strategies. *We may therefore argue that, other things being equal, we may anticipate regular environmentally correlated patterns of inter-site variability deriving from increases in the number and functional character of special-purpose sites with decreases in the length of the growing season.* In addition to such quantitative changes, given the more specialized character of resource "targets" sought under logistical strategies, we can expect an increase in the redundancy of the geographic placement of special-purpose sites and a greater buildup of archaeological debris in restricted sections of the habitat as a function of increasing logistical dependence (for a more extended discussion of this point see Binford 1978b:488-495).

This last point addresses a subject not discussed in depth in this paper, namely, the long-term land-use strategies of hunter-gatherers in differing environmental contexts. This paper has primarily dealt with short-term organizational and strategy differences. "Short-term" here essentially means the dynamic of yearly cycle. I have argued that there are environmental factors conditioning variability in short-term mobility and land-use strategies among hunters and gatherers. I have not seriously considered the possibility that hunters and gatherers would ever remain *sedentary* as a security-seeking strategy unless forced to do so. I am aware of many arguments that essentially appeal to what I term the "Garden of Eden" principle, namely, that things were so "wonderful" at certain places in the environment that there was no need to move. I find that a totally untenable *opinion*, and one which can be countered easily by scholars who understand ecological relationships. This does, however, imply that an understanding of short-term strategies as discussed here is insufficient for treating patterning which derives from variable redundancy in geographical positioning of the total settlement-subsistence systems. A detailed consideration of the factors that differentially condition long-term range occupancy or positioning in macro-geographical terms is needed before we can realistically begin to develop a comprehensive theory of hunter-gatherer subsistence-settlement behavior. The latter is of course necessary to an understanding of archaeological site patterning.

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