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A STUDY IN CULTURAL CHANGE

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THE STRUCTURE AND EVOLUTION OF THE GEOGRAPHIC SYSTEM:
A STUDY IN CULTURAL CHANGE

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THE STRUCTURE AND EVOLUTION OF THE GEOGRAPHIC SYSTEM:
A STUDY IN CULTURAL CHANGE

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The basic concern of this dissertation is a consideration of the problem of how the cultural characteristics of different places change through time and how this produces both regional convergence and regional divergence. In order to do this a structural model is developed which systematically illustrates how a collection of sixty-seven interrelated variables influence the rate at which within-place cultural change occurs. The various elements of this model, which affect such primary processes as cultural innovation, establishment, expansion, contraction, elimination, and between-place diffusion, are inventoried, discussed at length, and fit together into a general scheme of evolutionary development. Some of the more important variables in this model include population, homogeneity, diversity, urbanization, accessibility, attractiveness, emissiveness, outside encroachment, drift, and the propensity to adopt dispersed propagules. The structural model is then translated into spatial terms by showing how areal differentiation will occur among thirteen separate places located on a hypothetical circular plain. Starting with an original hearth area situated in the center of this circular plain, the spatial model shows how outward migration and the subsequent occupance of new areas, coupled with the evolutionary processes described in the structural model, will produce within-place change as well as between-place divergence. These processes are traced through six time periods.

Between-place divergence manifests itself through lineage change. Cultural lineages are the basic evolutionary units of geographic regions. They exist within all occupied areas and connect all such places together through the medium of evolutionary distance. These lineages evolve in ways that are quite similar to biological species. It is through such lineages that geographic evolution takes place. Spatial assemblages built from these lineages are called phyletic regions. Such regions are frequently quite different from formal (or physiognomically derived) regions. Both the structural and the spatial models describe the within-place and between-place processes that contribute to changes within these lineages. They also reconcile synchronic with diachronic processes and indicate how these lineages develop spatially. These two models, which together describe the evolution of cultural lineages, constitute the geographic system

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Chapter 1

GEOGRAPHIC CHANGE

It had always been a source of discomfort to find that many of the works on social structure and cultural change seemed to be so utterly alien to my own patterns of thought. Many sociologists, like Parsons and Smelser, seemed to be talking about the same general processes that geographers (myself in particular) were interested in, but their explanations and theories just did not seem to fit into the informal scheme of place change that had gradually evolved in my own thinking. Much of what the sociologists were talking about seemed to have little relevance to problems of geographic change. Similarly, much of location theory refused to fit into an evolutionary or historical scheme of things. Central place theory did, because (through its effect on diffusion) it had a great deal to do with regulating the rate of between-place differentiation, but agricultural and industrial location theory did not. In order to resolve this problem I began to envision a large diagram which would show how certain processes contributed to geographic evolution and how these processes affected one another. It was hoped that such a diagram would eventually lead to a simulation model of how things worked within and between different places. Such a model would have value in explaining the process of differentiation, or more specifically, convergence and divergence. As chapter 10 shows, I have made a beginning toward this goal.

It may one day be possible for one geographer to become sufficiently familiar with a great number of different landscapes and regions that he could offer many cross-regional generalizations of great theoretical importance. This goal has so far been proved illusory. At the same time, however, it may be possible for a single individual to become intimately familiar with a vast number of processes that operate within all regions simultaneously. An investigation of such processes is the subject of this work.

This thesis is a theoretical rather than an empirical work. As such it owes its very existence to a large body of experimental and observational facts. Until now, most of these disconnected facts have existed in relative isolation. This work has gathered a number of them into a single, rational, coordinated system. As d'Abro has noted (1950:343), this gathering process has been highly important in the development of all sciences.

This topic has taken me into many uncharted areas where there are no landmarks or roadmaps. Out of necessity I have created much of my own terminology and organization. Little was available from other quarters. Through lenses of my own making I have seen a part of the symmetry that must exist around us and have tried to record it. As such, this thesis can perhaps best be seen as an outline for a life's work. Every heading and subheading listed in the body of this undertaking can one day be expanded into a major study. In the absence of any unified theory that attempts to combine many different findings into a consistent structure, this thesis has evolved into a general inquiry into the nature of geographic change--specifically, what are the processes that contribute to place differentiation and how do they work?

David Harvey in his book Explanation in Geography (1969:v) remarked that one of his reasons for writing it was self education. Writing the book provided a means of organizing his thoughts on the subject so that they would form a coherent and understandable system. Presumably, when he understood the nature of geographic explanation, he had his book. The same general desire has guided my own inquiries into the subject of geographic change.

What is needed in geography, and what has been absent since the days of William Morris Davis and Ellsworth Huntington, is a formal, conceptual scheme capable of unifying the various strands of thought regarding spatial change. No one knows how the various ideas in geography relate to one another. Such an endeavor takes years of study, and even then there is little agreement. No one has made an effort to systematically piece together a number of seemingly unrelated processes into one structure capable of showing how geographic phenomena come into existence, function, and eventually disappear.

It is one thing to assert that all things are interrelated and that things closer together are more interreleated than things farther apart. It is something quite different to show exactly how they might be interrelated. Most of us are like the blind men trying to discover the elephant's shape by feeling small parts of it. Each blind man grabs hold of the nearest piece of elephant and proclaims that this is the animal's true nature. In this thesis an attempt has been made to see the whole elephant and to describe the vision in such a way that others might see it too. It has frequently been said that places are too complex to be portrayed in any single scheme. Not knowing the task was impossible, I went ahead and ate the entire elephant.

STRUCTURE AND PROCESS

Within each place there are spatial patterns that exist at any given moment in time. The way in which these patterns carve up the landscape constitutes the traditional core of geography. These patterns, however, are the result of processes that occur between given moments in time (Figure 1.1). If these processes occur within a fairly restricted time period we say they are synchronic. These are the processes that appear to operate about us constantly. For most purposes we can assume that they are instantaneous. It is not necessary for decades or centuries to pass before we can see such processes in operation. If it takes a great deal of time for certain processes to unfold, we say they are diachronic. These processes operate between different time frames.

All synchronic processes exist as part of some kind of a system within the same time frame. They operate in conjunction with other simultaneous processes. The causal chain, or network of processes, can be seen in diagramatic form, somewhat like that shown in Figure 1.2. Here, each process is seen as linked to a number of other processes. At the same time, however, observe that not all the processes are directly connected. Some of the processes are causes while others might be called effects (although when viewed from different perspectives each process can be a cause and an effect at the same time). Each process can also have multiple causes or produce multiple effects, as is illustrated in Figure 1.4

When these processes are linked together through time it will become apparent that any given landscape pattern is something in motion, that is to say, something changing from one time period to

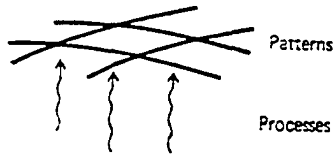


Figure 1.1 (Nostrand 1968:16)

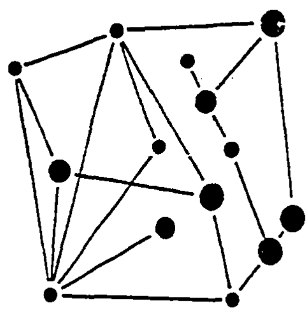


Figure 1.2 (Picker 1965:171)

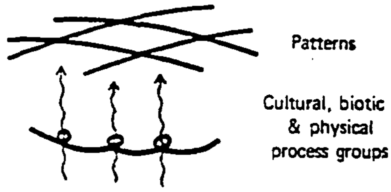
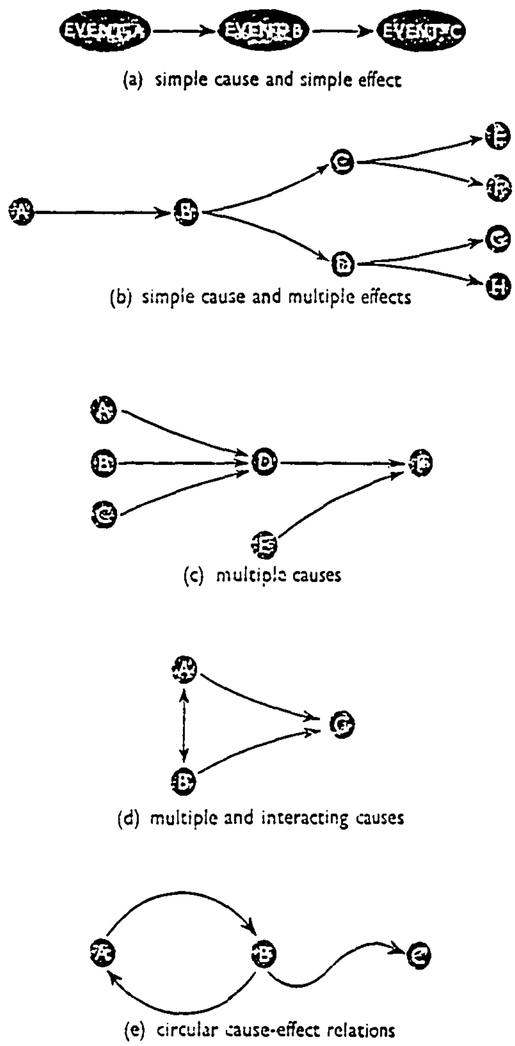


Figure 1.3 (Nostrand 1968:1.7)



Different types of cause and effect relations

Figure 1.4 (Grant 1963:24)

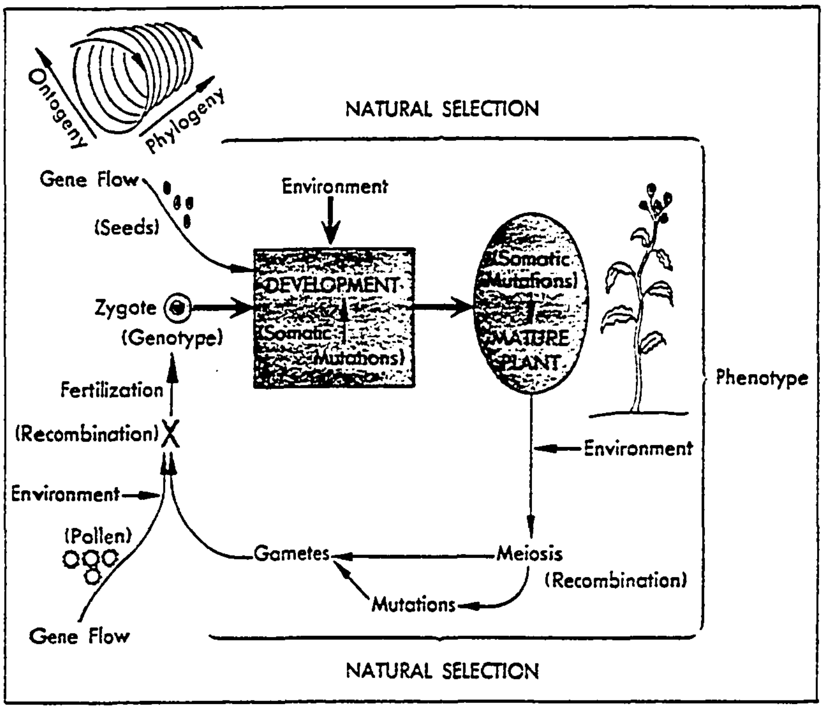
the next. A comprehensive view of these changing patterns, as they are being molded by a great number of interlocking processes, will produce a diagram like that shown in Figure 1.3.

The landscape evolves as things within it evolve. All geographic phenomena, or lineages, exhibit cycles of development and the causal chains of Figures 1.2 and 1.4 can best be imagined as some sort of a coil. Within this coil, processes repeat themselves from one time period to the next. Figure 1.5 shows such a coil as it pertains to botanical organisms. A similar schematic diagram explaining cultural geographic evolution will be developed in the chapters below.

WITHIN, BETWEEN, AND BEYOND-PLACE PROCESSES

Geographic processes can be classified into three main groups. These include within, between, and beyond-place processes. Within-place processes are those that occur wholly within particular places. Most of the chapters in this thesis (3 through 10) will describe within-place processes. Beyond-place processes are those that are external to any one given place. These processes do not occur in any specific outside places, but instead occur in all outside places simultaneously. Some of the outside forces contributing to isolation (discussed in chapter 8) are typical of beyond-place processes. Between-place processes are those occurring between two specific places. The gravity model is an example of something that deals with between-place processes.

A good illustration of how within-place and beyond-place processes differ can be found in the distinction between within-place spatial extent and beyond-place range. Spatial extent refers to the area within which a given geographic element is found. This is often referred to



Schematic representation of how the major forces of evolution interact. A zygote, the first cell of the organism, is the result of the fusion of two gametes. It will develop into a mature plant through the complex and little-known process of development (indicated in the sketch as a "black box"). The various environmental factors will determine which of the genetic potentialities of the genotype are finally expressed in the phenotype, the mature plant. Natural selection is manifested in that some genotypes (zygotes) will die during development because of their genetic composition, environmental factors, or both, whereas other genotypes will produce sterile phenotypes, or phenotypes with reduced fertility. The mature plant produces in turn the gametes that will fuse with other gametes to produce a new generation of zygotes. During meiosis and fertilization new combinations of genes are produced, the process known as *recombination*, that result in novel genotypes. Genes can mutate at any stage in the cycle; however, only those mutations that are transmitted through the gametes will have any lasting effect on evolution. Finally, through the introduction of pollen and seeds from other populations, gene flow takes place. Every complete cycle is known as *ontogeny*; a series of ontogenies is a *phylogeny*.

Figure 1.5 (Solbrig 1970:19)

as its spatial distribution. A spatial distribution, however, is something that can exist either within or beyond the confines of any one given place. In order to distinguish between these two variations of the same pattern, and the distinction will become important in the chapters to follow, different terms must be used. Spatial extent will therefore refer to within-place distributions while range will refer to beyond-place (world-wide) distributions.

These two distributions may, although not necessarily, coincide. Because range characteristics are features of populations as they exist in world-wide space, they are not uniquely geographic in nature. This is because they are of great interest to scholars in other disciplines as well. These characteristics do, however, become uniquely geographic when they describe a population or a portion of a population existing entirely within the boundaries of specific places.

Figure 1.6 shows the difference between an element's within-place spatial extent and its beyond-place range. In this diagram three separate places and the range of some particular element are indicated. In place A the spatial extent of the element is at a maximum, that is to say, it is found everywhere and its within-place distribution is ubiquitous. In place B the element only in the upper half of the circular plain and its distribution is more localized. When an element's spatial distribution is at a minimum, only one individual will exist. In place C the element has no spatial extent at all, since it is completely absent.

Changes in both the range and the spatial extent of an element involve the processes of spatial expansion and spatial contraction. While an element's range expands or contracts a related phenomenon

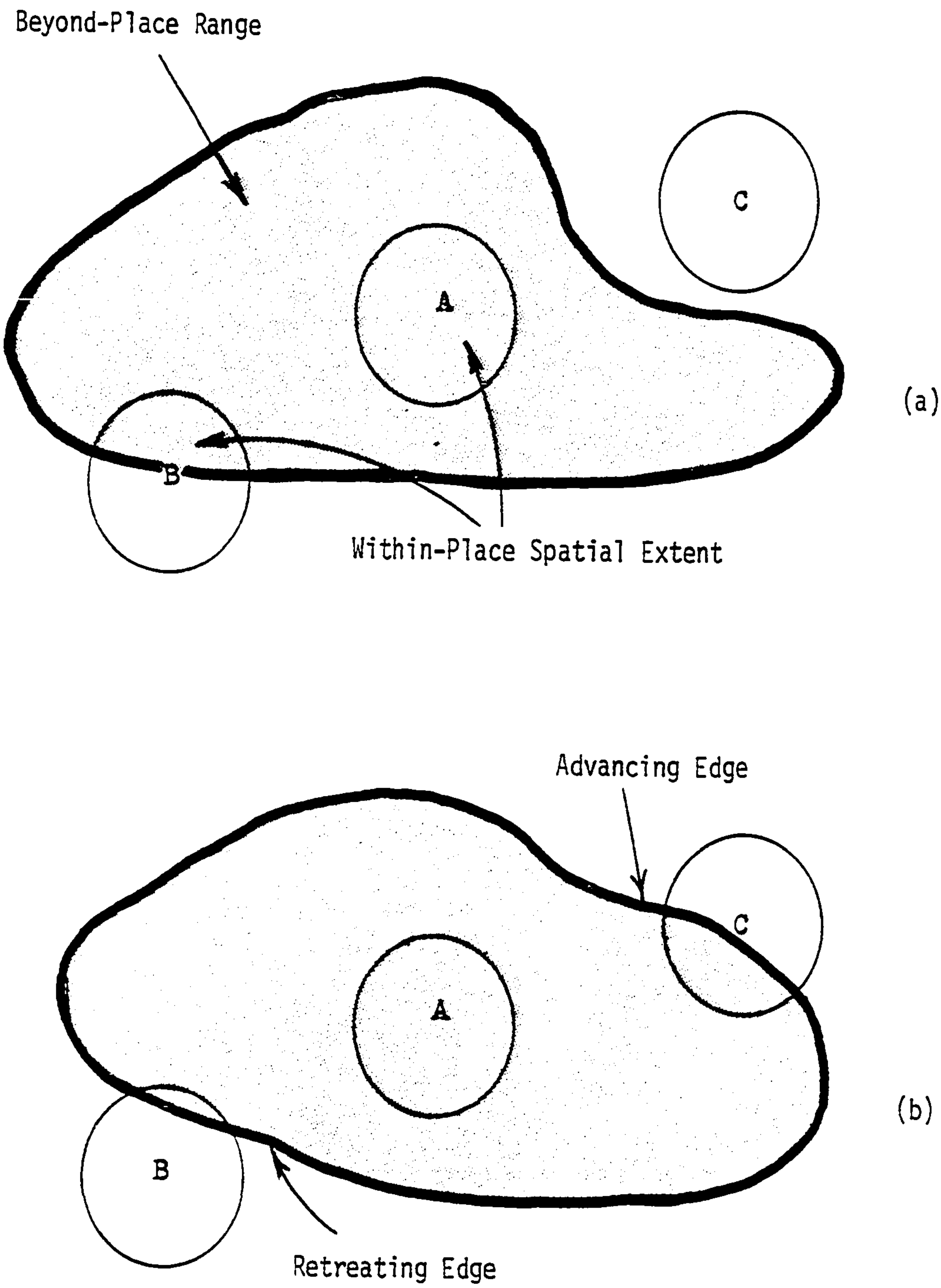

Beyond-Place Range
C
A
B
Within-Place Spatial Extent
(a)
Advancing Edge
C
A
B
Retreating Edge
(b)

Figure 1.6

occurs at the same time. This is the process of advance and retreat. All geographic distributions have edges, or borders. In many situations these edges are called frontiers. Edges can advance, retreat, or remain static.

A number of processes (including numerical expansion, between-place diffusion, and the migration of individuals) can expand the range of an element by causing it to be found within a larger area. The same processes can also cause the edge of an element's range to advance into areas where it was formerly absent, as when the edges of the element shown in Figure 1.6b advances into place C. Figure 1.7, which shows the world-wide distribution of Russia during various periods of history, provides a typical example of advancing borders and beyond-place range expansion.

An advancing edge, however, does not necessarily coincide with an expanding range. It is entirely possible that while a distribution's leading edge is advancing into previously empty areas, another edge is retreating. In this situation the areal extent of an element's range may remain unchanged. This phenomenon is depicted in Figure 1.6b, where an advance into place C is accompanied by a retreat in place B. If the retreat on one edge of an element's range is more rapid than an advance on another edge, the range will actually be contracting. A historical example of this process appears in Figure 1.8, which shows how the world-wide range of Buddhism contracted when it disappeared from India, Indonesia, and parts of Central Asia, even though it was in the process of advancing into China and Japan.

In Figure 1.8 the expansion and contraction of Buddhism inside of

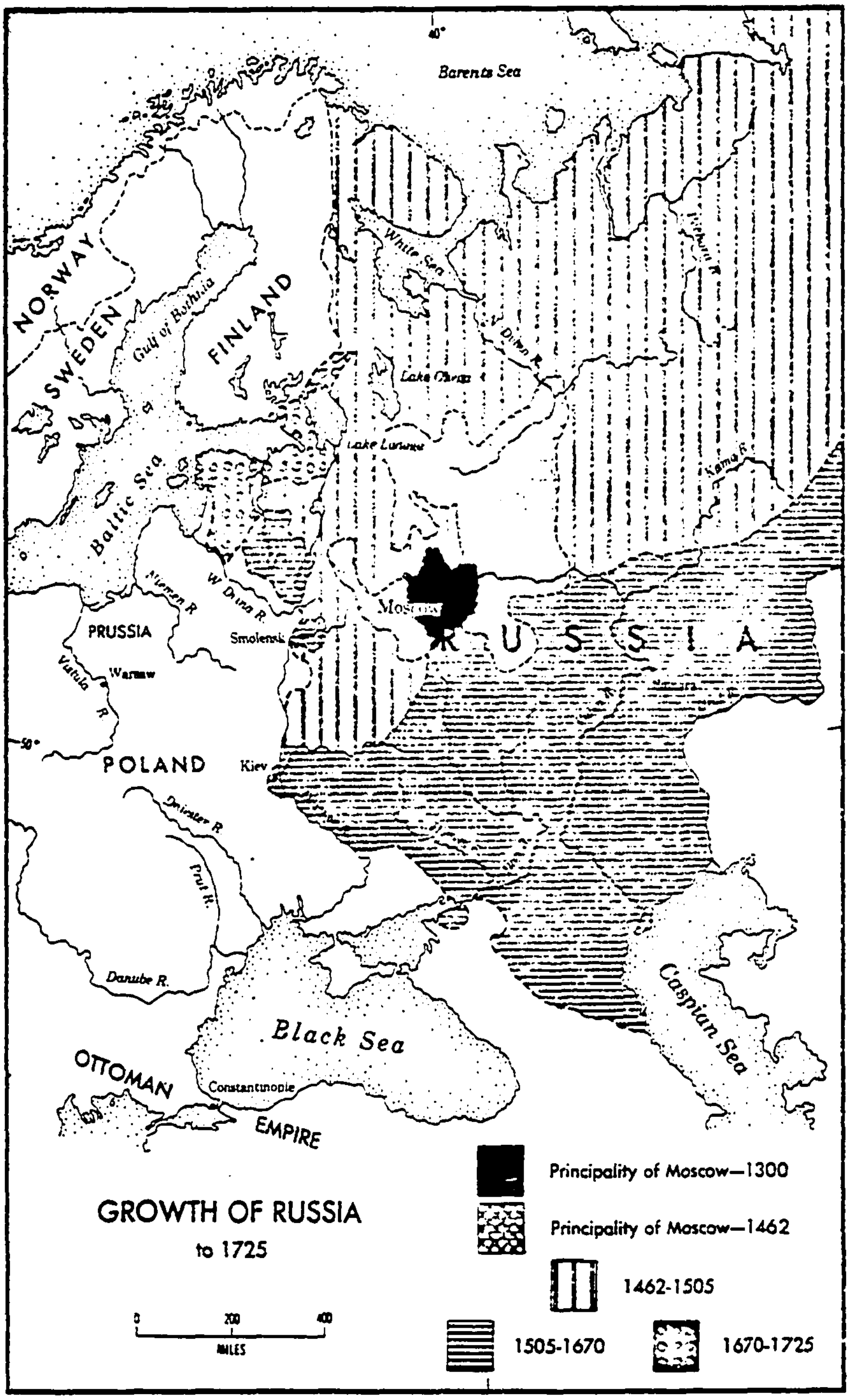


Figure 1.7 (Lyon, Rowen and Hamerow 1969:531)

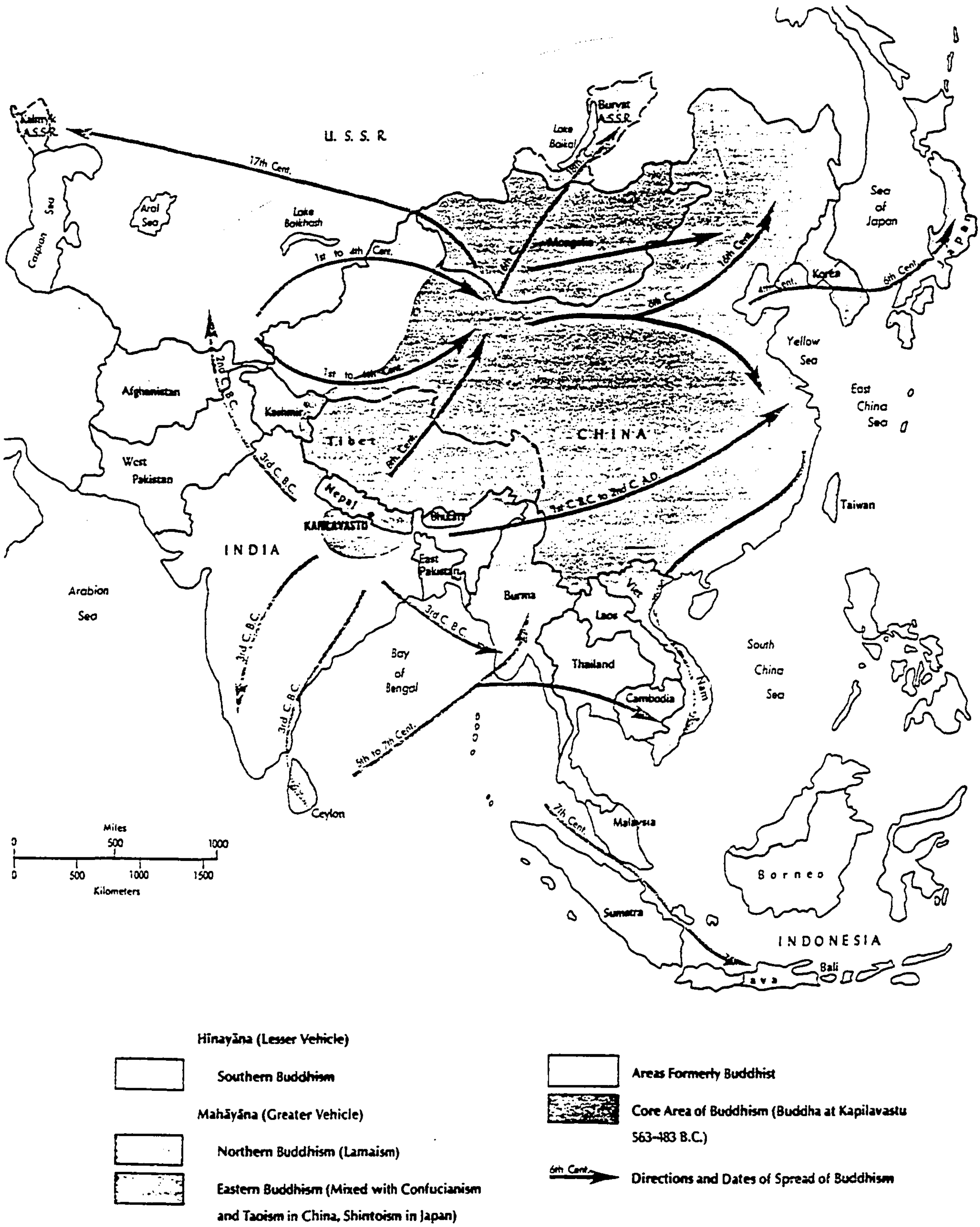


Figure 1.8 (Broek and Webb 1973:161)

India is a within-place process. The diffusion of Buddhism from India to China is a between-place process. The expansion of Buddhism as a whole is a beyond-place process. In this thesis we will be concerned primarily with the kind of between-place and within-place processes depicted in Figure 1.9.

CHANGE AND DIRECTION

When places change they do so at different rates and in different directions. The causes of directional change include those that are found internally and those that are introduced from the outside. Some internal causes are ecological in nature. These promote adaptive changes, which are changes resulting solely from conditions existing within the cultural and physical environment. Environmental determinists and cultural ecologists are interested in these processes. Other kinds of internally caused change are random and non-adaptive in nature. These changes do not happen in response to any particular stimuli, although they may be restricted and channeled in particular directions by local ecological conditions.

External determinants of the direction of change involve the process of between-place diffusion. When this happens, selected elements from external ecological conditions promote local change. These elements can be individuals, ideas, or artifacts.

Many theories of change, when they deal with specific direction, consider it in terms of specific past and future conditions. Is the population in a given place changing from permissive conditions to regimented conditions? Is it moving away from collectivism and moving toward individualism, or from puritanism toward licentiousness and

Between-Place Within-Place

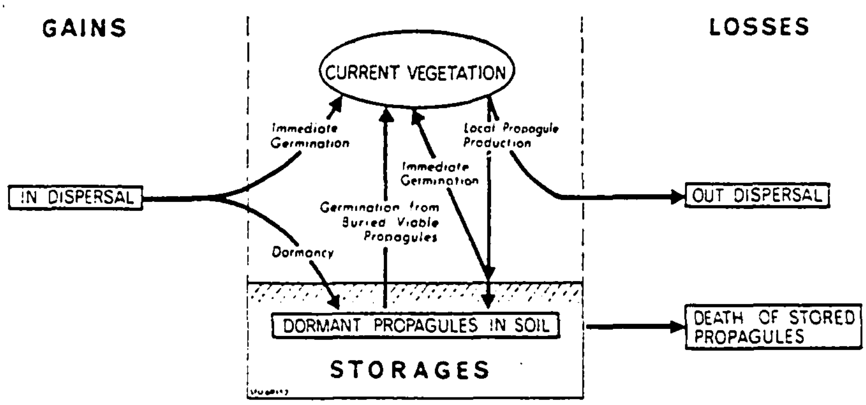


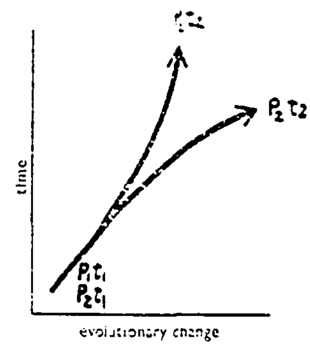
Figure 1.9 (Kellman 1970:2)

perversion? Any number of characteristics could be included in such a list.

Parsons (1964:480) described his major thecretical work as a scheme identifying the major structural components of the social system. He was interested in showing how these components interacted with each other and changed through time. However, his approach did not lend itself well to more than one society, since it is unlikely that any one system would be applicable to all places. Parsons himself admitted that this would be an impossible task (1964:151). At the same time, he emphasized that for there to be a theory of change, there must be initial and terminal patterns that can be used as points of reference (1964:483). The process of change in the socialization of the child, for instance, leads from something to something.

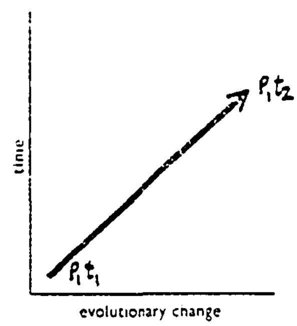
Directionality in geographic evolution can be defined in much the same way, that is to say, it must be an exercise in comparison. Places change in relation to something. Unless comparisons are made, it is not possible to identify the direction in which geographic change is occurring.

Several kinds of directionality are possible. A number of different places can be compared with each other (Figure 1.10) or one place can be compared with itself during an earlier time period (Figure 1.11). In the former case, diverging, converging, or parallel evolution can be identified (Figure 1.12). In the latter case it is possible to identify evolution in some particular direction as well as movement away from or toward some earlier condition--which will be called outward and inward evolution (Figure 1.13). It is also possible to identify convergence or divergence with some ideal pattern. This applies to both within-place and between-place comparisons.



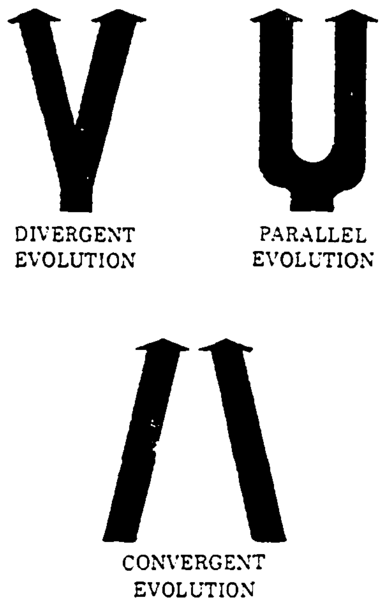
Between-Place
Comparison

Figure 1.10



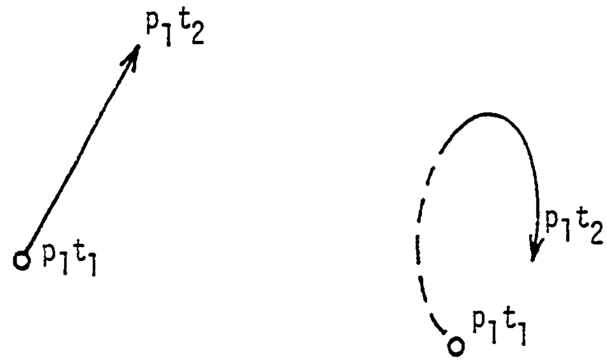
Within-Place
Comparison

Figure 1.11



Patterns of evolution. In divergent evolution, one stock splits into two, which become more and more unlike as time passes. In parallel evolution, two related species evolve in much the same way for a long period of time, probably in response to similar environmental selection pressures. Convergent evolution occurs when two groups that are not closely related come to resemble each other more and more as time passes, usually because they occupy similar habitats and have adopted similar environmental roles.

Figure 1.12 (Keeton 1967:386)



Outward Evolution　　　Inward Evolution

Figure 1.13

When comparing two separate places, it may be that divergence has been more common, but instances of parallelism and convergence do exist. Diverging evolution is where places become increasingly different. Converging evolution is where places experience a reduction in the number of differences between them. From different starting points, two cultures exhibit convergence if they are inventing and adopting similar forms and patterns more rapidly than they are discarding them. Parallel evolution occurs when the cultural distance between them is neither increasing nor decreasing. Parallelism requires either that the rate and direction of evolution in the two places remain constant, or that the rate and direction shift in tandem.

It might be expected that two places where change occurs slowly are more likely to retain their similarities than if the change is more rapid. When changes occur, however, there are so many possible directions that the probability of several different places moving in the same direction is actually quite small.

The direction of evolution within a single place will usually be outward. Inward evolution is rare. Reactionaries will occasionally try to reverse particular trends and change things back to what they were during earlier time periods, but such efforts are futile and there are no examples of this kind of endeavor succeeding for very long. Static or unchanging conditions result in an absence of evolution.

Geographic evolution, as will be used in this study, refers only to comparative direction and is entirely relative. It is not intended that any evaluative connotations be attached to this term. Geographic evolution does not imply that places have changed in a linear and progressive fashion or that there are any stages through which places or cultures pass. It is an evolution of direction, rather than of specific form.

Convergence and divergence are also neutral terms. These two processes are apolitical, they do not discriminate between good and evil, and they do not involve the idea of progress or regression. They only distinguish between things that are increasingly similar and things that are increasingly different.

The idea of local accumulation, however, is something that might be taken seriously. It may not be certain that things become better, but they do tend to become more plentiful.

RELATIVE CHANGE

Convergence and divergence exhibit both absolute and relative aspects. Apparent and actual convergence or divergence can sometimes give entirely different impressions of what is going on.

To illustrate this, imagine that the points in Figure 1.14 represent different places as they might appear in a taxonomic space of two dimensions. In these diagrams, the farther the distance between points, the greater the differences.

In Figure 1.14a the taxonomic distances are shown between five different places at time t_1. Figure 1.14b shows that at time t_2 each place has exhibited cultural divergence from every other place, which is to say, their similarities have decreased through time. This is actual, or absolute, divergence. In linguistics this might be typical of a number of different speech communities becoming increasingly unintelligible to each other. Speakers of a dialect located in place A might have been able to understand individuals from the other four places at

Separation of raisins in a hypothetical loaf of raisin bread that is 12 inches in diameter when it is placed in the oven (a), and grows to 24 inches in diameter at the end of 1 hour (b).

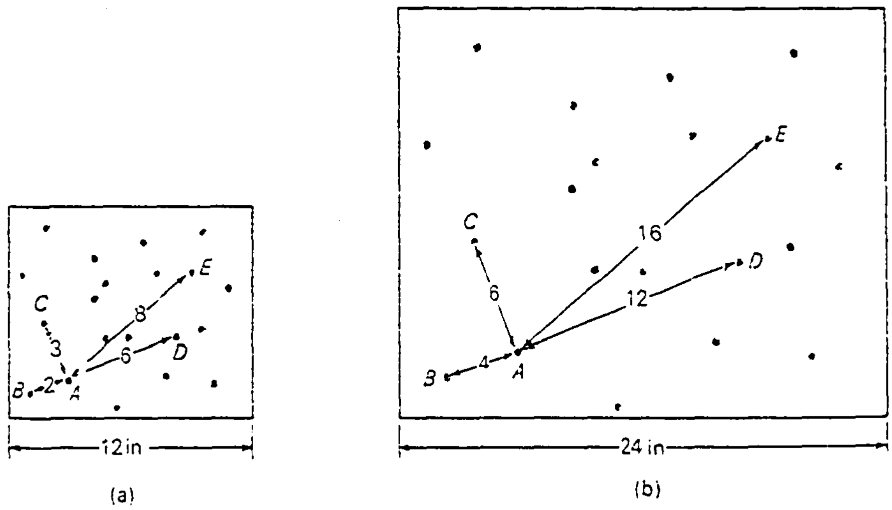


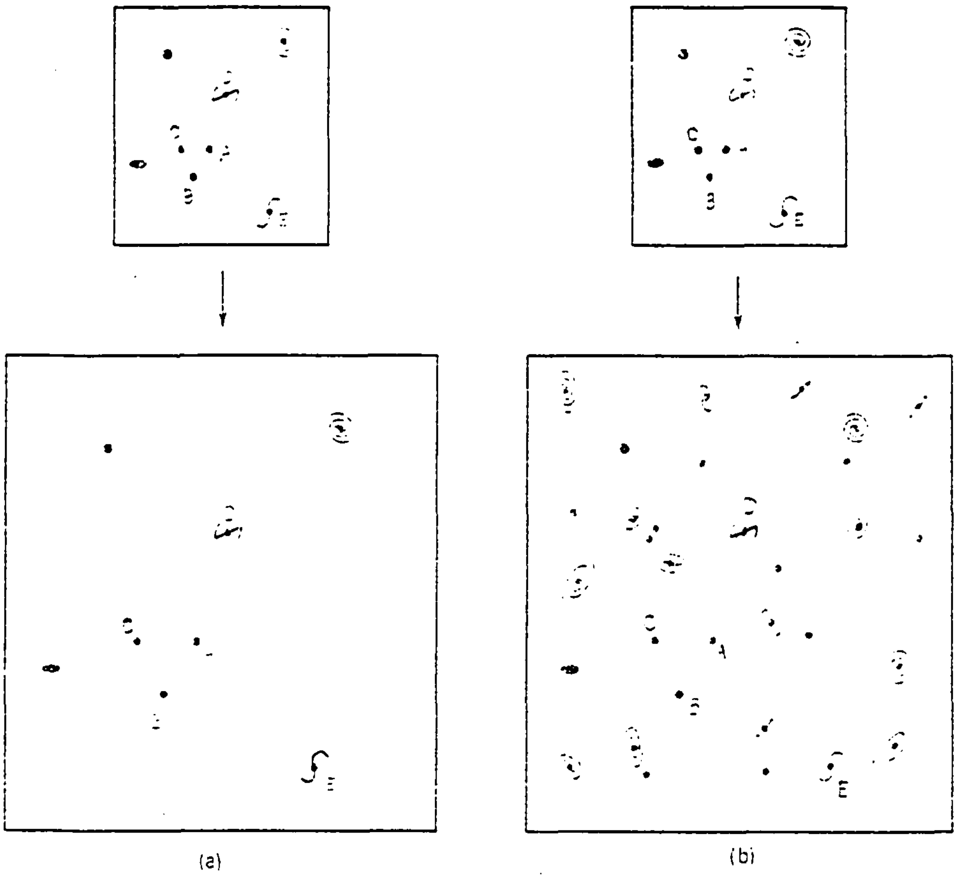
Figure 1.14 (Abell 1969:648)

time t_1, but at time t_2 this mutual intelligibility may have been lost. This is in fact just what happened to the various provincial dialects of Latin after the fall of Rome. Now, in other aspects of culture it may be that even though the magnitude of between-place change has been just as great, it is less dramatic because the absolute yardstick available for languages (mutual intelligibility) does not exist. Italian culture, for instance, may always have been more like Iberian culture than, say, Egyptian culture. In this situation, actual divergence between places may have been great while apparent divergence was minimal.

In Figure 1.15 another illustration of apparent vs. actual change is presented. Here, the phenomenon of phylogenetic development has been added. Figure 1.15a represents the sequence of events shown in Figure 1.14. In Figure 1.15b, however, new places (or cultural units) have appeared between time t_1 and t_2. These new cultural units have evolved out of those existing at the earlier time.

As might be expected in such situations, cross-fertilization (between-place diffusion) has produced a few places with characteristics that blend the features of several different original places. This in itself might give the impression that cultural divergence has occurred, but such is not necessarily the case.

In Figure 1.15a, like 1.14a, the actual cultural distances between places has changed radically while the comparative distances have remained the same. In Figure 1.15b the actual cultural distances between the original places has increased although the actual distance between places in general has stayed about the same (hence no actual convergence). Furthermore, since new cultural units have evolved in the taxonomic spaces between the older units, there has been apparent as well as actual diver-



In the evolving cosmologies (a), the density of matter in space thins out as the universe expands; in the steady-state cosmology (b), new matter is created spontaneously, and the density of the universe remains constant.

Figure 1.15 (Abell 1969:656)

gence among the older units. Whether or not the newer units represent situations of apparent convergence is difficult to say, since they did not exist at the earlier point in time.

COMPARATIVE RATES OF CHANGE

Another form of relative change affects the degree of divergence between two or more places. This involves comparative rates of change. Even in the absence of any indications of evolutionary direction, if it can be demonstrated that among groups having common ancestors some groups are changing faster than others, then it can be shown that divergence is taking place. Much of the divergence between English and German, for instance, has resulted from German having changed more slowly than English (Sapir 1949:170). Similarly, Lithuanian, which is the most conservative member of the Indo-European language family, has diverged from other Indo-European languages simply by virtue of its slower rate of change (Sapir 1966:27). This process is independent of any inherent directional change.

There are certain problems connected with interpreting this process. Figure 1.16 shows a number of hypothetical situations where different places have evolved in different directions from a common origin. Common origin in this case would be where two different places were originally inhabited by individuals with the same culture. Great Britain and New England, or Normandy and Quebec would be examples.

In Figure 1.16a the length of each arrow indicates how fast internal change has occurred within places p_1 and p_2, while the angle of the two lines indicates the degree to which evolution in p_1 and p_2 has taken different paths. In Figure 1.16b, place p_3 has evolved in the same

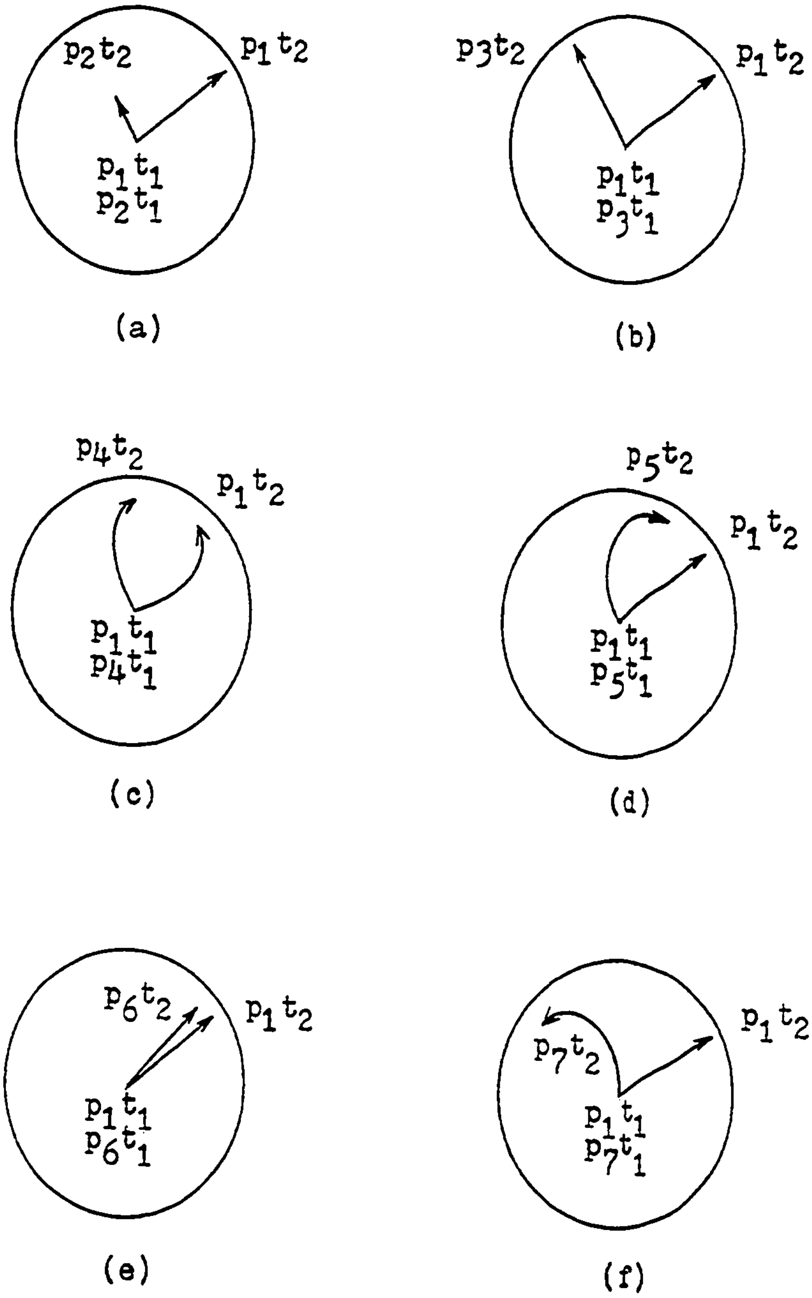

p2t2
p1t2
p1t1
p2t1
(a)
p3t2
p1t2
p1t1
p3t1
(b)
p4t2
p1t2
p1t1
p4t1
(c)
p5t2
p1t2
p1t1
p5t1
(d)
p6t2
p1t2
p1t1
p6t1
(e)
p1t2
p7t2
p1t1
p7t1
(f)

Figure 1.16

direction as p_2 but it has changed at a much faster rate. As is shown, p_3's rate of change has been as rapid as that of p_1. Furthermore, by measuring the distance between the tips of the arrows in Figures 1.16a and 1.16b it can be shown that divergence between p_1 and p_3 has been greater than between p_1 and p_2.

If it is assumed that after two groups have separated and have migrated away from a place of common origin the direction of change within each group is always different, then the amount of time since separation coupled with the rate of change within each place can serve as a rough index of divergence. This would be true, however, only if each group developed in isolation. In actuality, diffusion and the independent local innovation of similar elements will foster a certain amount of convergence. In Figure 1.16c, for example, the initial headings of change are the same as those shown in Figures 1.16a and 1.16b, but diffusion between p_1 and p_4 has altered the direction of change in both places.

Figure 1.16c shows a great deal of mutual influence. If, however, influences move in just one direction (say, from p_1 to p_5 as is reflected in Figure 1.16d), there will be convergence, but only because the direction of evolution in the "weaker" of the two areas has been altered.

The exchange of elements through diffusion can occur only where mutual compatability exists. Differing rates of change, such as exists between p_1 and p_2 in Figure 1.16a can create a situation where elements dispersing between the two become less and less appropriate for local adoption. The reasons for this will be discussed in chapter 7.

It may be that continuous between-place diffusion insures that the rate and direction of evolution in different locations does not become too dissimilar. Such a situation is illustrated in Figure 1.16e, which shows a similar rate and direction of change occurring in two different places. In the absence of continuous diffusion, however, the longer the two groups have been separated, and the greater the isolation has been between them, the greater should be their differences.

Cultural evolution is normally a very slow process, yet in the historical development of all lineages there are periods of stability separated by periods of crisis and very rapid change (Cohen 1970:74; Koestler 1973:515). The rates of change shown in Figure 1.16 are therefore to be taken as average rather than constant values.

FORMAL AND PHYLETIC PROCESSES

Convergence and divergence can result from both formal and phyletic processes. The words _formal_ and _phyletic_ are terms of comparison. They describe the kind of similarity that exists between two or more places. If the similarities result from common origins, they are phyletic similarities. If they are not, the similarities are formal.

Formal similarities result from causes operating separately within different regions. Ecological conditions and local political conditions are examples of this. Phyletic similarities are those resulting from diffusion between different regions.

Local phylogenies develop through the transmission of cultural elements from one generation to the next. This is the socialization process discussed below. These elements can also be transmitted from one place to another, either as individual ideas and artifacts or as complexes of ideas and artifacts belonging to migrating individuals.

When migrules enter the local stream of transmission from generation to generation, an act of between-place cross-fertilization has occurred. This serves to bring two places closer together in taxonomic space and produces cultural convergence. This can occur during the initial settlement of a region or at any time thereafter. As will be pointed out in chapter 6, this initial settlement can be of overwhelming importance to a place's later development. The phyletic similarities that come into existence at this time between a place of origin and a place of colonial establishment tend to overshadow any later cross-fertilizations that might occur from other places.

Specific geographic elements can be designated formal or phyletic when they are compared with similar or identical elements in other places. If an element is unique to one particular location and has never existed anywhere else in either its original form or as a later permutation, it is a formal element. Initially, all innovations are of this type. Any resemblance between this element and elements found elsewhere is due to correspondences in outward form only. These are formal resemblances. Whatever similarity exists is due to independent innovation. It is possible for identical elements to evolve quite independently in different locations, but this is rare.

If an element initially appears in one region and then diffuses to another, it is a phyletic element. If such an element arrives in a new region during its initial settlement, or during a colonization movement involving the extermination of or the fusing with an autochthonous group, it is not only a phyletic element but also a cognate element (when comparisons are made between the parent and the colonial areas).

Cognates are things which are "born together" at the same time and in the same place (Laird 1962:51). When cognate elements are handed down through successive generations they can experience different kinds of change within each location. They still, however, retain their status as cognates.

If elements diffuse into a new region after that region's initial settlement and after its basic cultural pattern has formed, the migrules become borrowings or loan elements. Both cognates and common borrowings are phyletic elements. The words luddite and petrol, for example, are loan words in American English that have been borrowed from British English. The words mountain and valley, on the other hand, are cognates that came to America with the original English settlers. They are also cognates which have not changed in either location. Examples of cognates that have changed include words like valor, harbor, and labor, which are not only pronounced differently in the standard dialects of Britain and the United States (val-uh/val-urr, lay-buh/lay-burr), but are also spelled differently. The British spelling of these words is valour, harbour, and labour while in the United States the u has been dropped. Note that spelling and pronunciation are completely separate lineages, which can exhibit cognate relationships quite independent of each other.

To summarize, elements that arise in different places due to independent innovation are formal elements. They contribute to formal resemblances between places. Elements that diffuse between different places are phyletic elements. These contribute to phyletic resemblances. The establishment and numerical expansion of local innovations, in addition to the numerical contraction and elimination of elements that have never been exported, are formal processes. The forces that contribute to between-place diffusion and to the elimination of both imported and exported elements are phyletic processes.

Chapter 2

FORMATIONS, REALMS AND CULTURAL SPECIES

FORMAL AND PHYLETIC REGIONS

The Distinction Between Formal and Phyletic Regions

A primary element in the theory of differentiation is the distinction between phyletic regions and formal (or phenetic) regions. These are areal classification systems based on different criteria. These two contrasting modes of analysis are important in understanding the different aims of the synchronic and diachronic parts of this thesis.

Although both classification systems are based on regional similarities, they are not based on the same kind of similarities. Phyletic regions are concerned with similarities reflecting common origins, while formal regions are concerned with visible resemblances. The visible similarities that formal regions are based on do not necessarily reflect common origins. Formal classifications can utilize any kind of data other than phylogenetic data. This means that formal classes rest largely upon morphological data. Although similar morphologies may reflect common evolutionary lineages, this is not always true. They may also result from similar ecological conditions.

The distinction between these two modes of classification seems to have originally been made by von Humboldt, who expressed the idea that vegetation could be classified into physiognomic units based on the growth-form of plants, and into communities based on the areal association of certain species (Whittaker 1962:4).

Sack (1972:70) discussed Schaefer's assertions about morphological (static and non-temporal) laws in geography. The morphological laws that Schaefer sought to establish would apply only to formal regions. The type of geography that Schaefer was interested in would not include the study of phyletic regions or the time relationships that they reflect. Phyletic regions would be more closely connected with the kind of work done by the Sauer, or California, school of geography. It is hoped that the various interconnected models in this thesis will be compatible with both traditions.

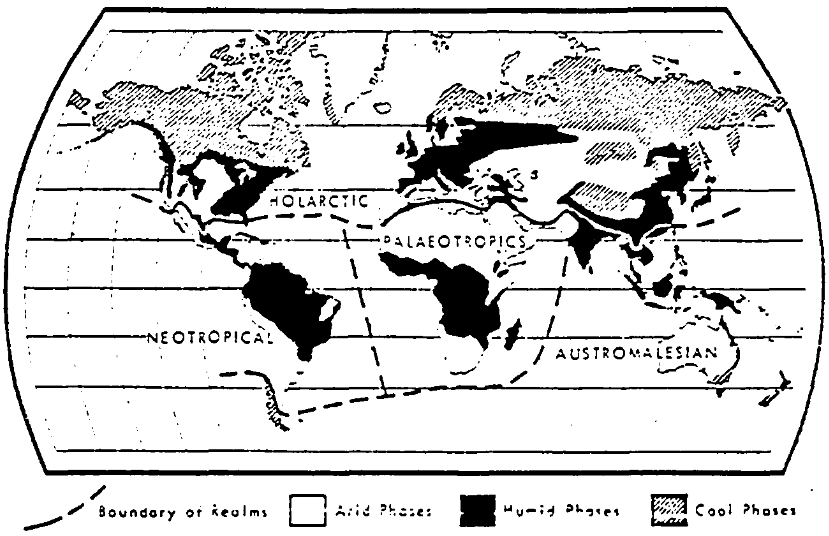
Phyletic Regions

Floristic Realms

A phyletic region reflects a history of genealogical descent and movement. Figure 2.1 shows a map divided into phyletic (or phylogenetic) regions. Each region represents the species content of an area. Phyletic regions are delineated by groups of species more or less associated with each other over large areas (de Laubenfels 1970:56).

Biological Phylogenies

Examples of these processes are usually taken only from the biological realm, since this is the only area of experience where the species concept is solidly entrenched. Figure 2.2 shows how the concepts of species and phylogenetic line are often visualized. When biological phylogenies are represented in space, they produce maps showing patterns of origin, diffusion and speciation like the one shown in Figure 2.3.



Floristic realms and their phases.

Figure 2.1 (de Laubenfels 1970:27)

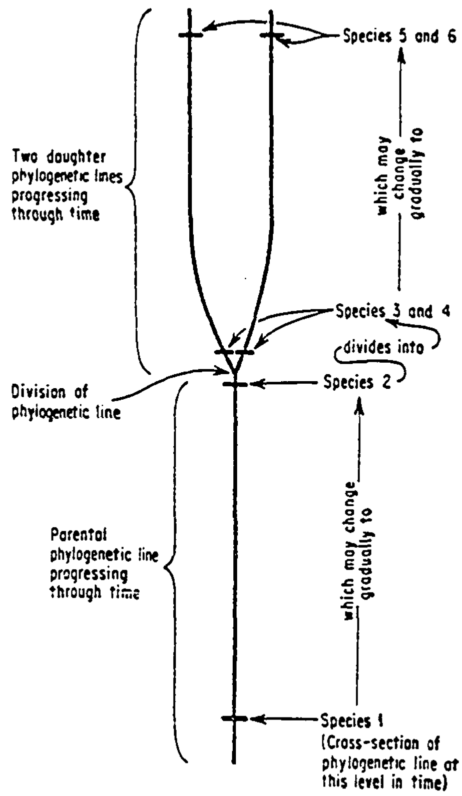
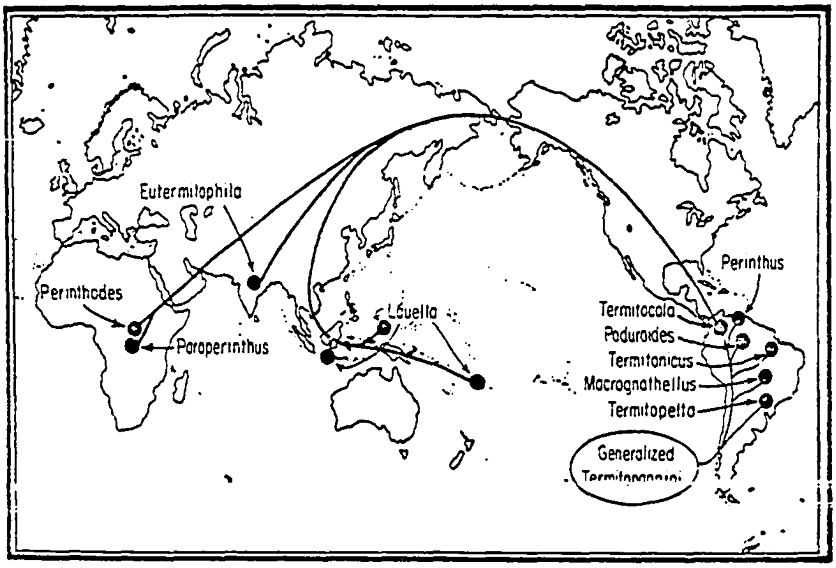


Diagram of hypothetical phylogenetic line to illustrate the relationship between phylogenetic lines and species.

Figure 2.2 (Ross 1962:116)



Distribution of the genera of the subtribe Perinthina of the family Staphylinidae. Lines indicate the phylogeny and paths of dispersal. (After Seevers.)

Figure 2.3 (Ross 1962:313)

When man is considered as a species, similar patterns can be seen. Figure 2.4 shows a hypothetical version of man's early speciation and spread. Figure 2.5 shows a similar but more recent pattern. The dispersal patterns shown in Figures 2.3 through 2.5 constitute the raw material from which phyletic regions are constructed (after the various species in an area have been classified into genera and phyla).

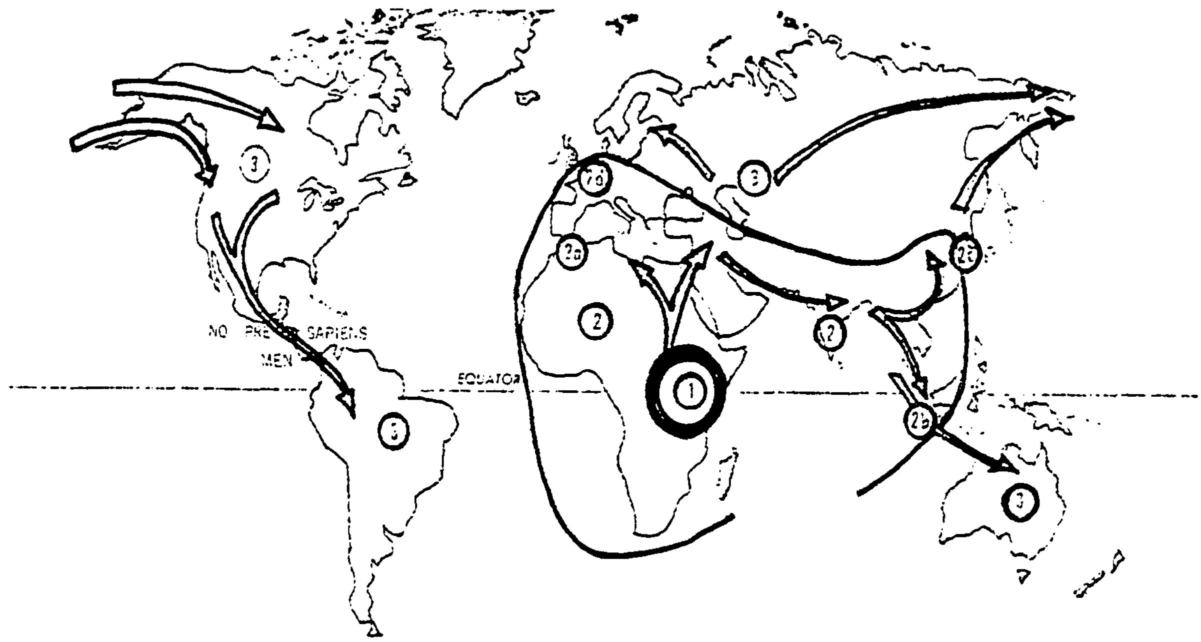
Cultural Phylogenies

Although the concept of speciation is usually confined to the organic world, a comparable process can be found in the cultural world. As Figure 2.6 shows, cultural phenomena can exhibit patterns of origin and dispersal which are strikingly similar to the ones shown in Figures 2.3 through 2.5. More importantly, they exhibit differentation in addition to movement. This notion of differentiation is important. Many cultural origin and dispersal studies can be found in the geographic literature, but only some of them involve differentiation. As will be shown below, this differentiation process is similar, if not identical, to the process of organic speciation. Moreover, if phyletic regions are to be found in cultural geography, they must be based on the concept of cultural phylogeny.

Formal Regions

Vegetation Formations

Figure 2.7 is an example of a map divided into formal regions. "Formal" is used here in the same sense that it is in the term "formal" logic (with its connotation of arrangement) or as in the root of the term "formula" (which adds the idea of exactitude to the notion of



(1) AUSTRALOPITHECUS (2) HOMO ERECTUS a TERNEFINE b JAVA c PEKING d NEANDERTHAL (3) HOMO SAPIENS

The Spread of Mankind over the World

Figure 2.4 (Carter 1964:10)

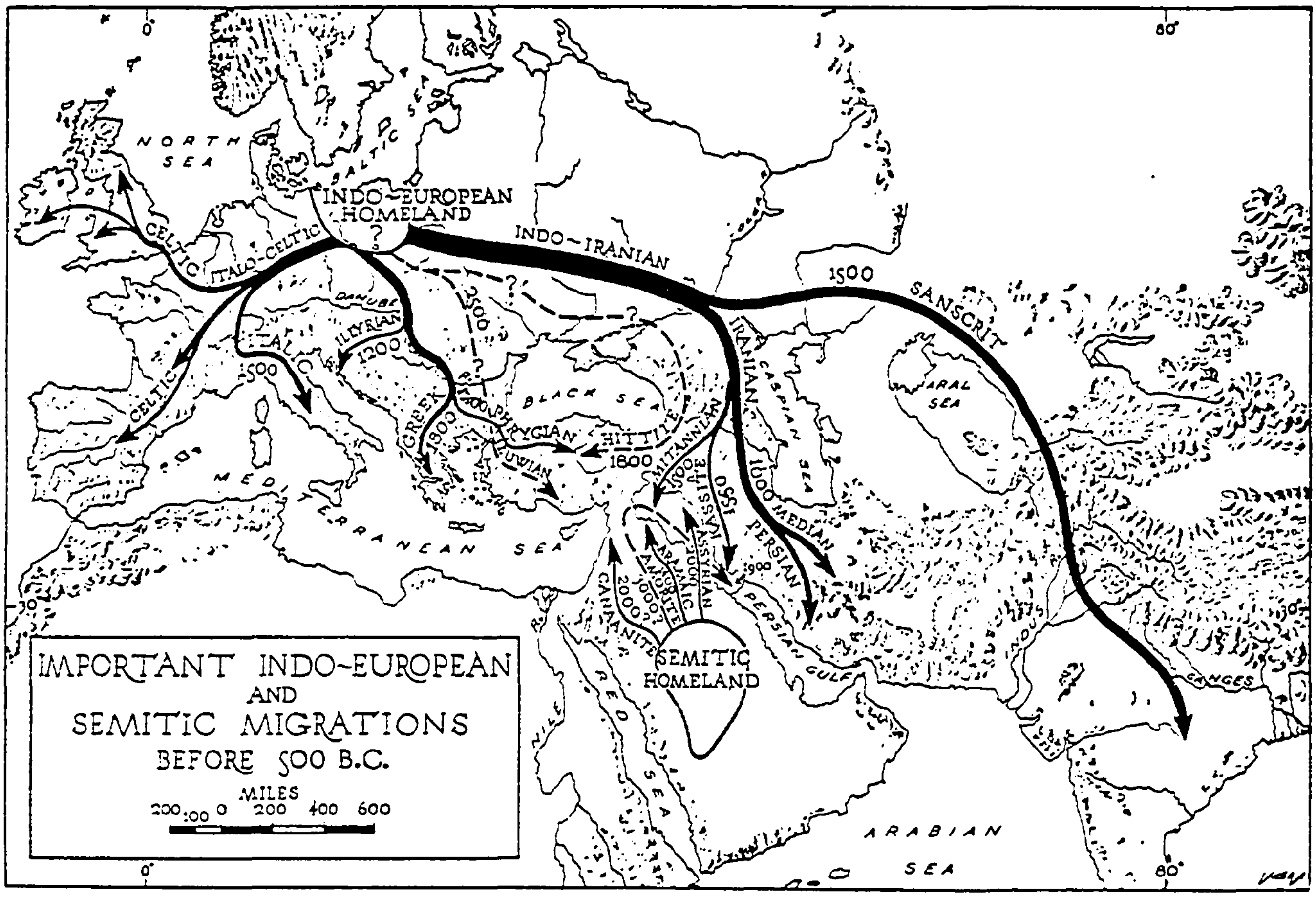


Figure 2.5 (Jones 1960:98)

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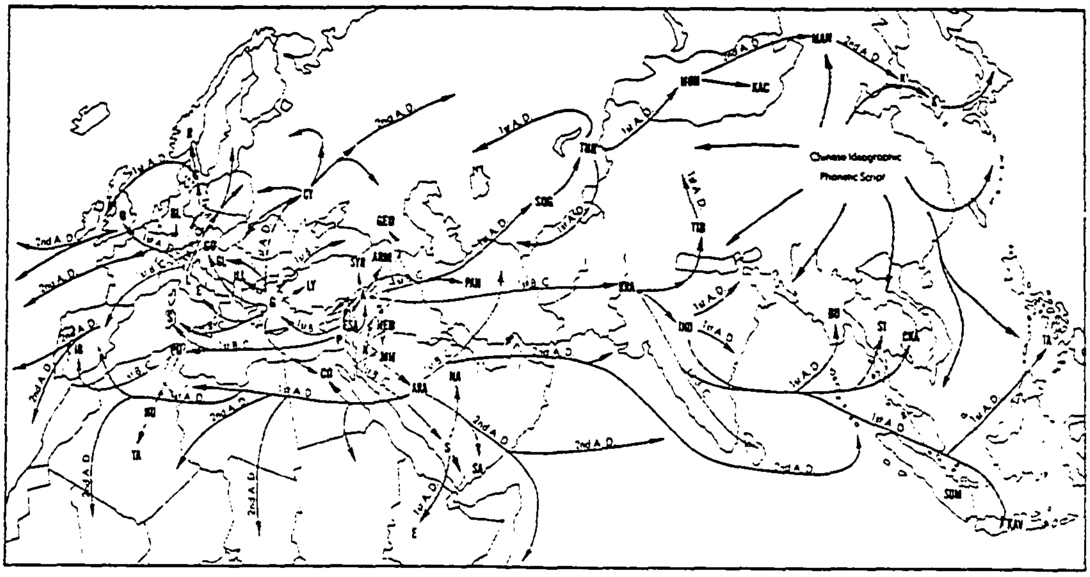
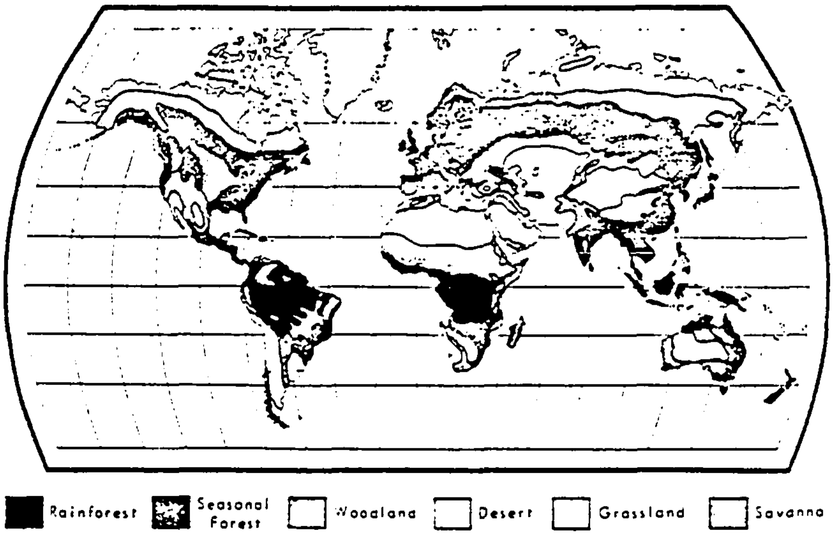


2nd B.C. — Second Millenium B.C.
1st B.C. — First Millenium B.C.
1st A.D. — First Millenium A.D.
2nd A.D. — Second Millenium A.D.

ESA	Early Semitic Alphabets	BU	Burmese
S	Sabean	SI	Siamese
E	Ethiopic, etc.	KAV	Kavi
SA	South Arabian	SUM	Sumatran
NA	North Arabian	TA	Tagalog
A	Aramaic	P	Phoenician
N	Nabataean	PU	Punic
ARA	Arabic	NU	Numidian
SYR	Syriac	TA	Tamachek
ARM	Armenian	IB	Iberian
GEO	Georgian	S	Sardinian
HEB	Hebrew	G	Greek
MH	Modern Hebrew	LY	Lydian, etc
PAH	Pahlavi	CY	Cyrillic
SOG	Sogdian	GL	Glagolithic
TUR	Turkic, etc.	GO	Gothic
MON	Mongol Alphabets	ILL	Illyrian
MAN	Manchurian	CO	Coptic
K	Korean	E	Etruscan
KAC	Kacika	L	Latin
BRA	Brahmi	BL	Black Letter Latin
IND	Indian Alphabets	R	Runic
TIB	Tibetan	O	Oghamic
CHA	Cham		

The Diffusion of the Alphabet

Figure 2.6 (Broek and Webb 1973:57)



Vegetation formations.

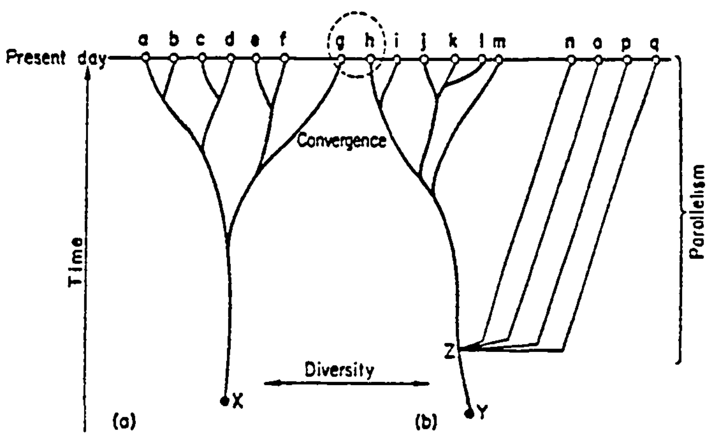
Figure 2.7 (de Laubenfels 1970:101)

arrangement). It is not meant in the sense of being the opposite of "informal." Formal regions are not delineated on the basis of unique species. The boundaries of formal regions and the boundaries of individual species rarely coincide (de Laubenfels 1970:106).* A formal region represents an aggregate of forms, rather than species (or other classes such as genera or phyla). Differences between formal regions represent functional divisions of the world (de Laubenfels 1970:115). A formal region reflects a history of local adaptation and evolutionary stages. Whereas a phyletic region indicates relationship by descent, formal regions show degrees of resemblance or affinity.

Causes of Formal Regions

In the absence of chronological or historical data, it is extremely difficult to identify the causes of formal resemblances when they are encountered. Because of parallelism and convergence (Figure 2.8) widely separated areas may contain phenomena with similar morphological characteristics. As was mentioned above, these similarities may or may not be the result of common lineages. Where it can be ascertained that they are not the result of common lineages the tendency of scholars has been to look for independent causes to account for the convergence or parallelism. In studies of human systems, environmental determinism, racial determinism and diffusionism have each been offered as explanations for convergent and parallel evolution. With the exception of diffusionism, each of

*More recently, de Laubenfels has indicated that in a few cases they do coincide.



(a) Convergence, shown by *g* and *h* which come from different phyletic lines, *X* and *Y*. (b) Parallelism, shown by *n*, *o*, *p* and *q* which have a common origin at *Z* and have subsequently evolved in parallel.

Figure 2.8 (Heywood 1967:19)

the explanatory models are ecological in the sense that they are concerned with in-place developments that result from in-place causes. Diffusionist models of explanation have been only indirectly ecological in that origin and movement are ultimately influenced by in-place causes.

FORMAL AND PHYLETIC CLASSIFICATION

Differences Between Formal and Phyletic Classes

Formal regions and phyletic regions are based on different methods of classification. In formal classifications there can be many "correct" solutions, depending on the tastes and the objectives of the taxonomist. The advantage of a phyletic classification is that there is theoretically only one correct solution--that which accurately describes the genealogical descent of a group of phenomena. The different approaches to classification result in different maps. Figures 2.1 and 2.7 are both based on plant distributions. Figure 2.1 (floristic realms) reflects a classification based on taxonomic units (species and genera) while Figure 2.7 (vegetation formations) reflects one based on forms, appearances or structures. These forms may be common to a number of different species. Realms reflect lineages and traditions, while formations reflect ecological conditions.

The differences between the classification systems that produce phyletic regions and formal regions have been discussed extensively in other sources (Hartshorne 1939:305-311, Whittaker 1962, Grigg 1965:472-74, Sokal and Sneath 1963:7, Heywood 1967:17-22, Kuchler 1967:30-38, 56-58, Harvey 1969:332, Neill 1969:287, Strahler 1970:212).

Ultimately, it might be argued, both formal and phyletic classification systems are based on morphological similarities. Formal classifications proceed directly from these similarities and make no further claims as to the "naturalness" of the classification. Phyletic classifications also proceed from morphological similarities, but place great weight on those similarities which point to common origins. Among plants and animals, for instance, those similarities that have to do with the reproductive systems are more important than other similarities. These features acquire their importance by virtue of the fact that phyletic descent is not known at the outset.

Crowson (1970:58-59) has discussed the difficulties faced by the palaeontologist and the systematists of modern organisms, and the differences exhibited by these two schools in their approach to phyletic classification. Both groups of scholars try to construct lineages on the basis of morphological similarities. Palaeontologists have an advantage in that they work with specimens exhibiting temporal progression. Their specimens, however, are vastly inferior to those studied by the systematists of modern organisms. As a rule, systematists of living plants and animals are much more cautious in their phylogenetic theorizing than are palaeontologists. Both schools, however, work primarily with the morphological similarities among their specimens and build phylogenies from this kind of data. Historians have a somewhat different problem. They can construct lineages without having to consider morphological similarities. In fact, information about the similarities existing among a number of related groups is frequently not available from historical records. Instead, similarities must be inferred from the knowledge that certain human groups descended from the same common ancestors.

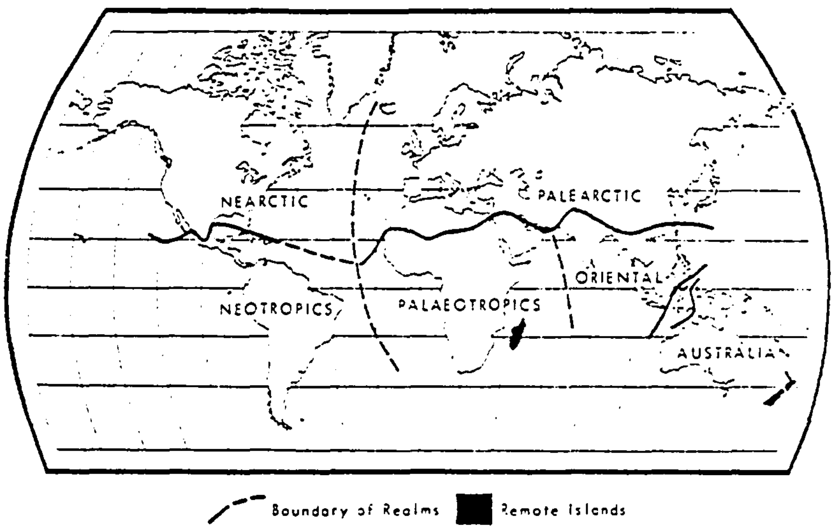
Can Both Classification Systems Adequately Measure Regional Differences?

Faunal Realms

The cartographic end products of phyletic and formal classification systems are phyletic and formal regions. A major difference between the two is that phyletic regions reflect relative differences between the species that exist within each area and formal regions do not. Figure 2.9 shows the world distribution of faunal realms (which are phyletic regions). The degree of similarity between each faunal realm is shown in Figure 2.10. The regions in both Figure 2.1 and Figure 2.9 were produced by noting the presence or absence of different taxonomic units (species, genera, families) within a large number of different areas. Two places, for instance, might not contain the same species, but they may have members of the same genus or family. Regions having the same species are more similar than regions having the same genera but different species. Regions which contain species from the same genus are more similar than regions whose species are entirely unrelated. In this way a hierarchical measure of similarity can be produced. The diagram in Figure 2.10 can also be constructed in the form shown in Figure 2.11. Figure 2.11, however, does not convey a sense of taxonomic distance quite as well.

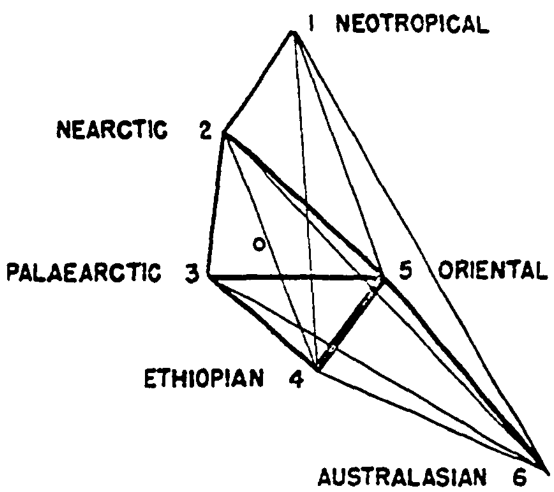
Vegetation Formations

A map depicting a formal classification, such as the vegetation formations shown in Figure 2.7, can also be shown in diagramatic form. Figure 2.12 shows the classifications used to construct the regions in Figure 2.7. Figure 2.13 shows the subdivisions of one of the classes



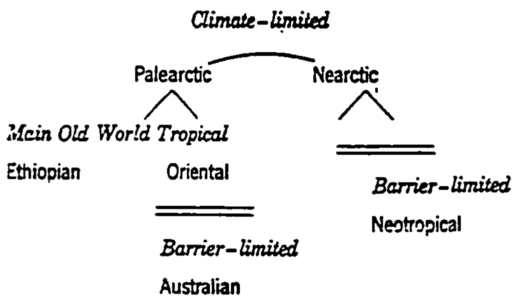
Faunistic realms including the larger remote islands.

Figure 2.9 (de Laubenfels 1970:49)



The "Darlington Chain." Graphical depiction of the resemblances of the major Sclater-Wallace regions, as measured by families of extant mammals.

Figure 2.10 (Preston 1962:422)



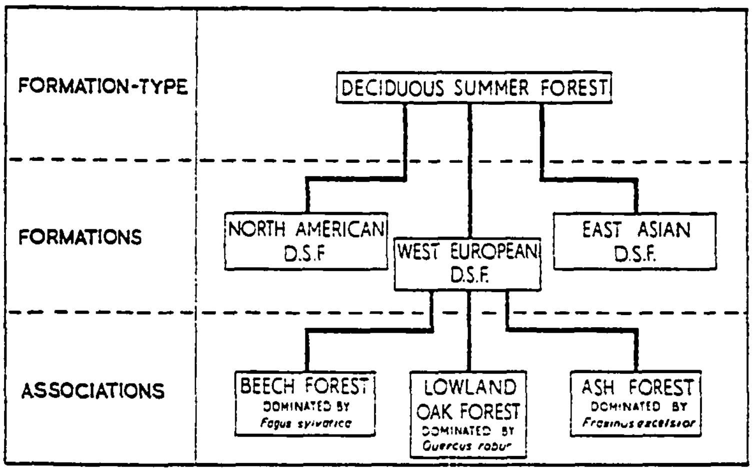
Diagrammatic arrangement of the faunal regions.

Figure 2.11 (Darlington 1957:426)

THE FORMATION CLASSES

I Forest Biochore	
	1. Equatorial rainforest
	2. Tropical rainforest
	3. Monsoon forest
	4. Temperate rainforest
	5. Summergreen deciduous forest
	6. Needleleaf forest
	7. Evergreen-hardwood forest (Sclerophyll forest)
II Savanna Biochore	
	8. Savanna woodland
	9. Thornbush and tropical scrub
	10. Savanna
	11. Semidesert
	12. Heath
	13. Cold woodland
III Grassland Biochore	
	14. Prairie
	15. Steppe
	16. Grassy tundra
IV Desert Biochore	
	17. Dry desert
	18. Arctic fell field

Figure 2.12 (Strahler 1970:229)



The hierarchy of climatic climax communities.

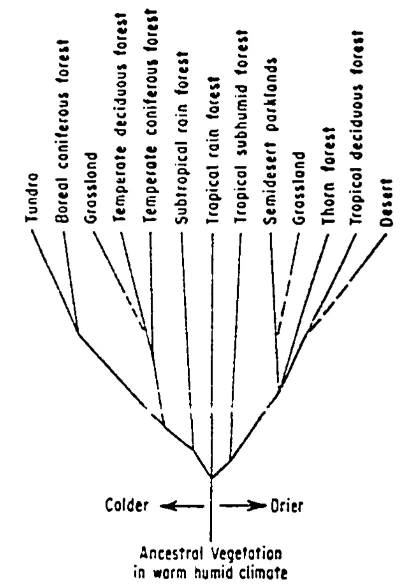
Figure 2.13 (Eyre 1968:14)

listed in Figure 2.12. The major difference between the two types of classification comes when one wishes to compute the degree of similarity between regions. In Figure 2.12, for instance, is there a greater degree of similarity between an equatorial rainforest and a needleleaf forest than there is between an equatorial rainforest and a savannah woodland? Is a savannah woodland more like an equatorial rainforest than a prairie? Such distinctions would be difficult to come by and would be highly subjective, due to the qualitative nature of the classes. As Figure 2.10 shows, however, this problem is easily solved for phyletic regions.

In trying to answer such questions for formal regions, attempts have been made to construct phylogenies for entire formations (Figure 2.14). In so doing, patterns of diffusion have been hypothesized that show both the movement and differentiation of the formations (Figure 2.15). The pattern in Figure 2.15 bears the same relationship to the map in Figure 2.7 that the patterns in Figure 2.3 bears to the map in Figure 2.1.

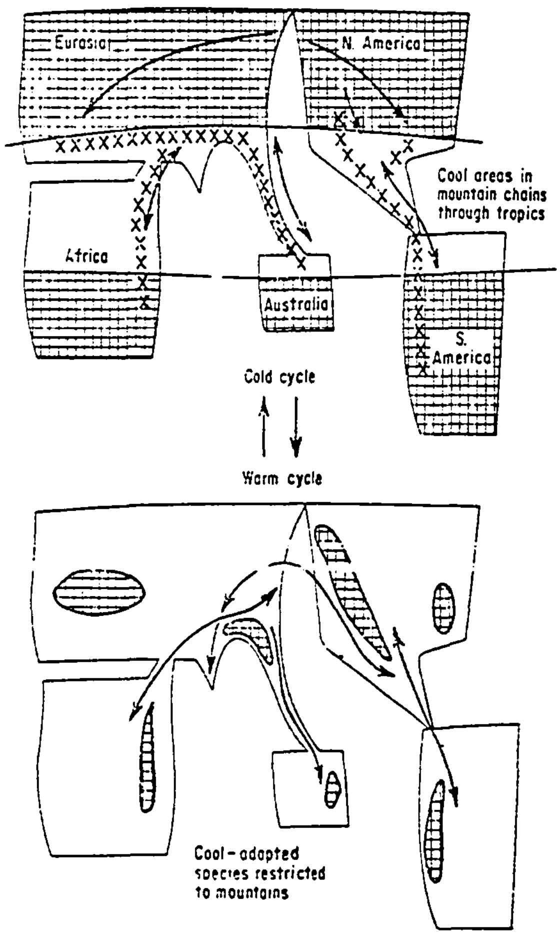
Superiority of Phyletic Classes as Indicators of Regional Difference

The classes in Figure 2.9 (faunal realms) can be ordered in such a way that the degree of similarity between each class is readily apparent. This has been done in Figure 2.10. That this is possible derives from the fact that the classification systems in Figure 2.10 and 2.11 are based on species rather than morphological similarities. The degree of similarity that areas exhibit based on the classes shown in Figure 2.12 (vegetation formations) can only be dichotomous, that is, they can be of the same type or of a different type. To show that some



Tentative suggestion of the phylogeny of the major terrestrial biomes.

Figure 2.14 (Ross 1962:322)



Differential dispersal opportunities for temperate versus tropical biotas during cold and warm periods of the earth. Arrows in the top drawing indicate dispersal paths of cool-adapted species, and the arrows in the figure at the bottom indicate dispersal paths of warm-adapted species. Note the restriction of dispersal of tropical species between the New and Old Worlds during cold periods and the isolation of temperate species during warm periods.

Figure 2.15 (Ross 1962:308)

formations are more similar than others, reference must be made to some related feature, such as climate, which is more amenable to measurement. Figure 2.16 shows how such similarity measures might be made.

When different species on different continents exhibit similar form and structure, one may hypothesize that convergence has taken place. As Whittaker has indicated (1962:8), the physiognomic convergence of vegetation in widely separated regions (such as on different continents) is one of the major phenomena of plant geography and it is one of the major justifications of the physiognomic (formal) approach to plant studies. This convergence may be imperfect, however, simply because different floristic realms do not contain the same species. As to the real identity or equivalence of these formations when they are found in widely separated areas, Whittaker feels that they are questionable (1962:61).

Formal and Phyletic Classes in Human Geography

Returning to the sphere of human affairs, the same kinds of classification (formal and phyletic) have been made for culture as have been made for plants and animals. Most regional classifications in human geography have been formal rather than phyletic. Agricultural regions result from formal classification systems. Figure 2.16 shows an agricultural classification system based on formal criteria. Again, how similar is a region of irrigated crops to a region of cereal grains? Do these two regions exhibit greater similarity to each other than they do to regions of slash and burn cropping? As with vegetation formations, the answer is arbitrary and depends on the system used.

Other types of formal regions in human geography include economic

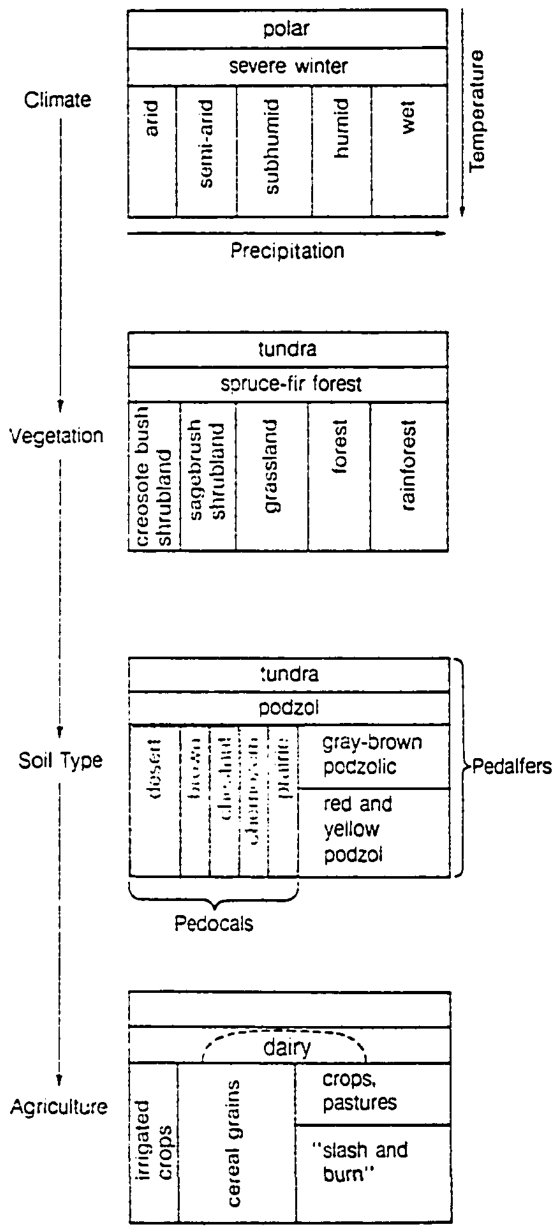


Figure 2.16 (Laporte 1975:310)

regions and regions formed on the basis of economic development (unless one wishes to assign some sort of phyletic relationship to areas in similar stages of economic growth), urban regions, land-use regions and regions based on commodity flows.

Most of the regions and distribution patterns that have emerged from works in location theory are of the formal type. These include the spatial patterns that result from forces producing central places (Wheatly 1971, Wittfogel 1957), from forces producing central place hierarchies (Losch 1954, Philbrick 1957, Stine 1962, Skinner 1964, Christaller 1966), from forces producing land-use patterns within and around central places (Burgess 1925, Hoyt 1939, Dunn 1954, Knos 1962, Alonso 1964, von Thunen 1966, Hoover 1968), and from combinations of these forces (Isard 1956).

Figure 2.17 shows an example of formal regions in human geography. These regions have been produced by forces similar to those which produce central place hierarchies. All such regions identified from morphological similarities alone are formal regions and are therefore analogous to the vegetation formations shown in Figures 2.7, 2.13, and 2.16.

Phyletic regions in human geography include culture realms, such as those shown in Figure 2.18 and maps showing the expansion and contraction of political units such as might be found in a historical atlas. In geography, culture realms have usually been made impressionistically. In general, they have followed the procedure used in constructing formal regions--areas containing similar cultural features have been grouped together. Degrees of similarity, however, are often so apparent that classification of these regions into genera and phyla seems natural.

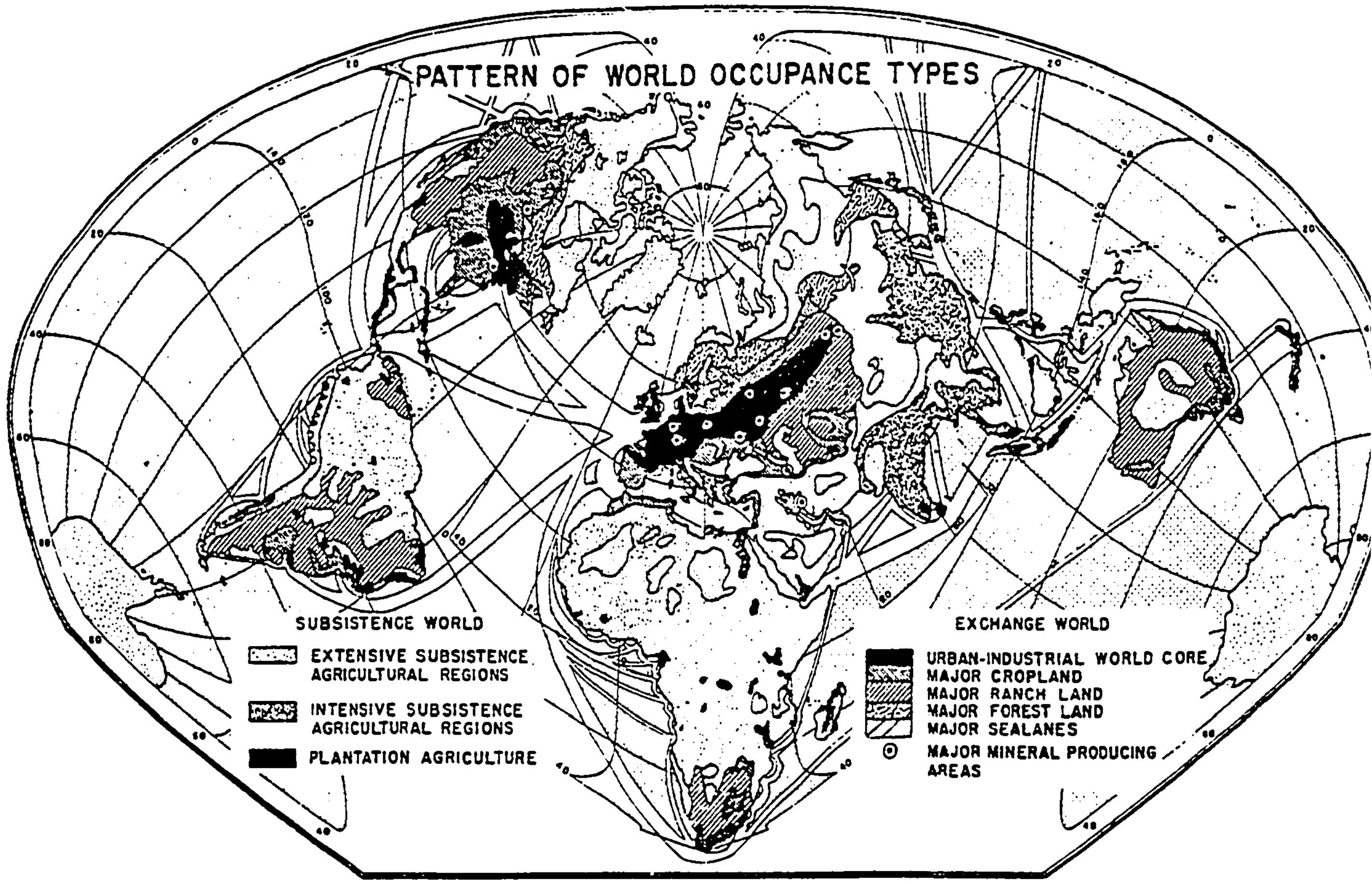
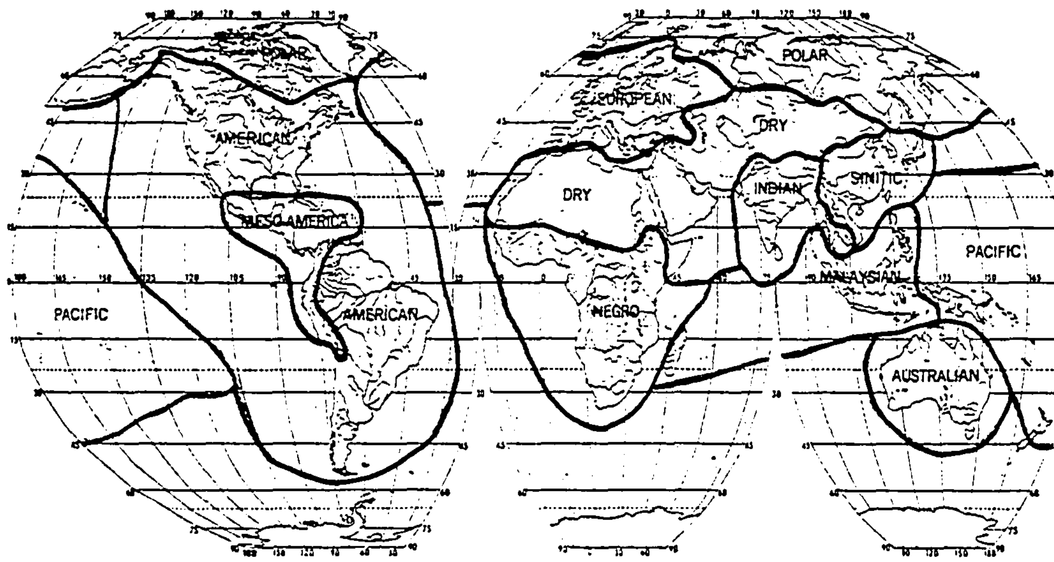
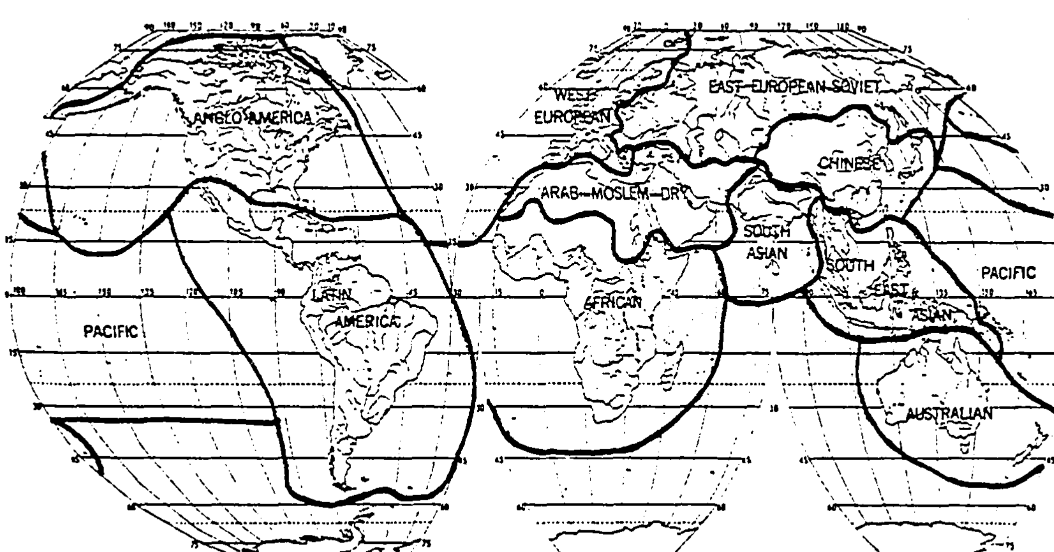


Figure 2.17 (Philbrick 1957:334)



Culture worlds, A.D. 1450.



Culture worlds, A.D. 1970.

Figure 2.18 (Spencer and Thomas 1973:53)

One senses, for example, that Anglo-America and Central Europe share certain family characteristics which are absent when one compares Anglo-America with East Asia.

In contrast, formal regions are not so easily classified. When one looks at Figure 2.17, an uneasy impression exists that another set of criteria might produce a different pattern which would be just as good. Does plantation agriculture really resemble subsistence agriculture more than ranch land or forest land? In what absolute way are they similar? Since they have not evolved out of the same thing, they cannot be compared on any absolute scale.

The similarity that culture realms bear to the floral and faunal realms shown in Figures 2.1 and 2.9 exists because they all are based on the species content of the various areas. The delineation of culture realms has always involved applying the species concept to aspects of human culture--although this has never been explicitly recognized.

Areas within the same culture realm tend to share related religious and linguistic traditions. These cultural traditions, or lineages, are born, evolve and change into other traditions in much the same way that organic species do. To view them as direct equivalents, however, several objections must be met.

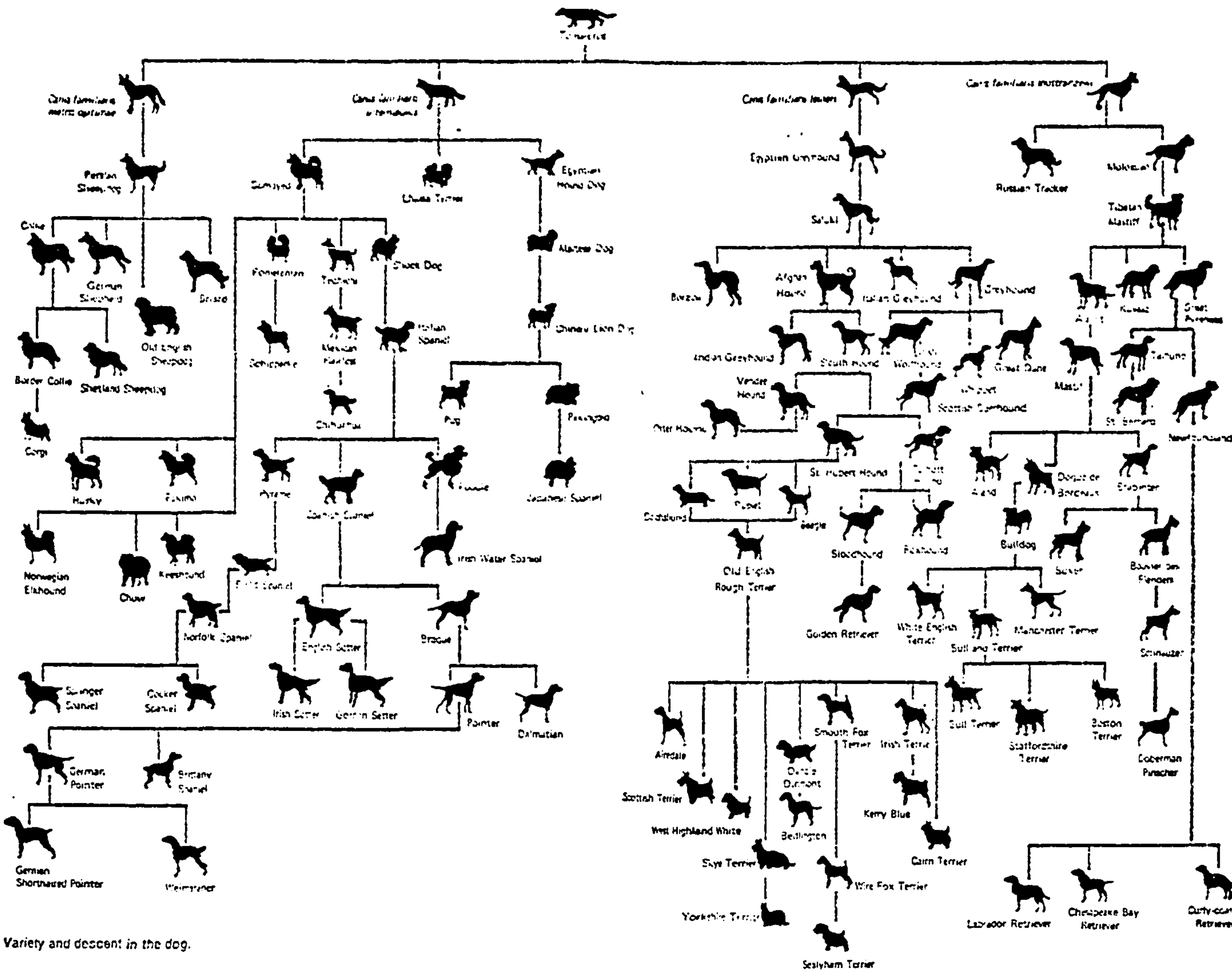
Nineteenth century social Darwinists tried to view human culture as something akin to an evolving organism. They floundered, however, when they tried to find in the qualitative differences between cultures evidence of evolutionary advancement. The proof of human cultural advance existed solely in lists of various ethnic groups graded on a scale ranging from lower savagery to enlightenment. These scales turned out to be spurious and are now seen only as examples of unrestrained ethnocentrism. Had they been interested only in differentiation, rather than qualitative ascent, they would have been on stronger grounds.

CULTURAL SPECIES

Opposition to the Concept of Cultural Speciation

Marvin Harris has remarked that the most decisive difference between cultural and biological evolutionary mechanisms is that there is no equivalent of speciation in the realm of culture (1971:153). He points out that no matter how much two cultures may diverge, contact between them always results in the exchange of some culture traits. His reluctance to make analogies between biological and cultural evolution stems from the ways that phenomena in these two realms expand or contract their ranges and differentiate through time. He sees the process of diffusion in cultures and biological populations as essentially different. He says that while cultural changes are freely communicated between human populations, changes within biological species diffuse through the medium of sexual reproduction. Due to speciation, the spread of changes between different biotic populations is effectively eliminated. The same observations have been made by Stebbins (1965:7) and Buettner-Janusch (1966:40).

Harris views phylogeny as the result of the capacity of biota to differentiate to the point where gene exchange no longer takes place. Phylogeny, since it implies speciation, is therefore an inapplicable concept in the study of culture change (1968:652). Figure 2.19, however, is a phylogeny. It is also one that does not involve speciation.



Variety and descent in the dog.

Figure 2.19 (Goldsby 1971:18)

What Constitutes a Species?

Zoological Species

In zoology, a species is defined on the basis of interbreeding. A species is a population or group of populations of interbreeding animals that are reproductively isolated from other such groups (Buettner-Janusch 1966:40). This is fairly straightforward and on this basis Harris is justified in pointing out that since cultures "interbreed" freely through diffusion and acculturation, "species" in human cultures cannot exist. It might be pointed out, however, that members of different species do in fact interbreed, as in the case of horses and donkeys. A further and more restricted definition of species overcomes this difficulty by requiring that members of the same species must produce fully fertile offspring (Crowson 1970:28). As Whittaker (1962:2) has noted, however, the past few decades have seen the most profound changes in the species concept. Traditional definitions of species are no longer taken for granted.

Botanical Species

In botany, the situation regarding species is anything but clear (Ross 1974:57). Crosses between different individuals may produce fertile offspring in varying degrees. Furthermore, the fertility of the third generation may be different. In one case, two individuals may produce offspring of whom 80% are fertile. Elsewhere, other individuals may produce offspring of whom only 20% are fertile. How does one classify two different individuals after they have mated and produced offspring of whom only half are fertile? Are the two parents of the same or of different species? Even within the same species, crosses between certain subpopulations may not produce fully fertile offspring (Figure 2.20). R.J. Johnston (1968) has discussed the problems of subjectivity in taxonomic procedures. In many instances, the decision as to what are and what are not separate species is based on elegance and aesthetics, rather than on a priori statistical criteria.

Another problem arises when the method of reproduction is considered. Figure 2.21 shows the major breeding systems in the organic world. What criteria of interbreeding can be used for organisms that reproduce asexually? Vegetative reproduction, internal fertilization, cloning, hybridization and introgression are processes that make the identification of species solely on the basis of interbreeding and the production of fertile offspring a hazardous undertaking (Grant 1971: 151-320, Crowson 1970:27-37).

Botanists have used the idea of hybrid species for decades. Ross (1974:100) feels that this has been due to the ease of crossbreeding plants (as opposed to animals). Because of this he points out that zoologists (and by inference many anthropologists) have largely ignored the concept of hybrid species. Little effort has therefore been made toward investigating this phenomenon in animals. Stebbins (1959) also discusses this point. In the plant world, hybridization between distinct species, and even between different genera, is common (Sneath and Sokal 1973:352). This leads to the evolution of new lineages. The belief that cultural "species" can be regarded as hybrid lineages will be explored in later chapters.

Among plants, at least, there are many intermediate possibilities between things belonging to separate species and the idea of species

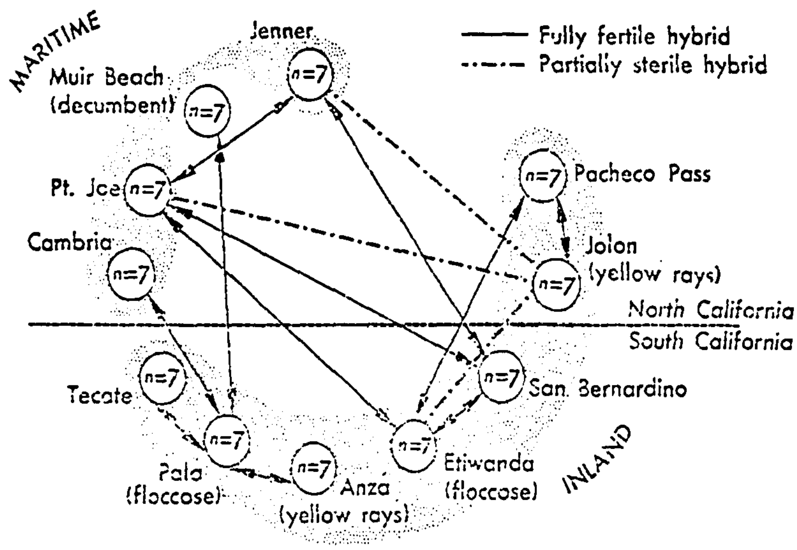


Diagram of intraspecific crosses within the species *Layia platiglossa*. Note also how certain populations have acquired novel morphological characters. Nevertheless, there are only incipient sterility barriers. [From J. Clausen, *Stages in the Evolution of Plant Species*, copyright 1951 by Cornell University. Used by permission of Cornell University Press.]

Figure 2.20 (Solbrig 1969:60)

Major Breeding Systems in Plants and Animals

A. Asexual:

- Parthenogenesis and apomixis
  - Seasonal (animals)
  - Facultative (plants)
  - Pseudogamy (mostly plants, some animals)
  - Obligate (plants and animals)
- Vegetative reproduction
  - With or — mostly plants, some animals
  - without sexual reproduction — some animals and plants

B. Sexual:

- Complete inbreeding (plants and a few animals)
- Close inbreeding (plants and animals)
- Outbreeding
  - Animals
    - monogamy
    - polygamy
    - polygyny
    - promiscuity
    - (with or without numerical inequality of the sexes)
  - Plants
    - dioecism
    - heterostyly
    - protandry, protogyny
    - mechanical prevention of self pollination
    - multiallelic genetic self-incompatibility

Figure 2.21 (Solbrig 1969:71)

possesses a significant element of gradation.

There are many different ways of defining species. Crowson (1970:27) identifies five major methods which include those using museum, ecological, physiological, genetic and palaeontological criteria. Some of these are not at all concerned with the ability to interbreed. When the superorganic is being considered, use of the botanical model is certainly just as valid as the zoological model. Does intellectual reproduction resemble gene flow among animals more than plants? The answer, of course, is that it does not.

Sopher (1972:323) uses the idea of "cultural speciation" and, given the qualification that this does not necessarily preclude cross-fertilization and the exchange of cultural elements between different populations, his usage does not seem unreasonable. Because species can be defined in many different ways, an unwillingness to entertain the idea of cultural speciation becomes untenable. An avoidance of the terminology used to describe biotic evolution is also unreasonable. Polak, Kluckhohn, Huxley and Kroeber have supported this position (in Tax and Callender 1960:211-19). Cultural species may not be absolute and impermeable entities, but organic species are not either.

Like Durkheim, who argued that there is no equivalent in the social realm to reproduction in animal life (Timasheff 1955:116), Wagner and Mikesell (1966:27) have remarked that the plant world offers no counterparts of learning and communication. It would be argued, however, that the communication process, carried on between a performer and a witness, is the method by which ideas replicate themselves. In the cultural realm, communication is a reproductive act.

Similarity Between Organic and Cultural Evolution

Cultural Species and the Organic Analogy

The organic analogy has been used in several different ways in the past. According to Spengler (1932), civilizations were like biological organisms in that they exhibited youth, maturity, senescence and death. Ratzel regarded the state as something living which needed a sufficient amount of space for growth. The state was an organism in motion. It expanded in area until it met its natural limits. This living space (lebensraum) was seen as the equivalent of a biological habitat (Dickenson and Howarth 1933:198, Dickinson 1969:71, James 1972:223).

The functionalist organic analogy, worked out by Radcliffe-Brown, Spencer, Hobbes and many others, holds that social structures and biological structures are similar in that the set of relationships among an organism's parts constitutes its morphology or physiology (Harris 1968:526).

We are not concerned with making these sorts of analogies. Rather, we intend to use analogies that help to explain the changes in culture which lead to place differentiation. Many spatial processes operating in the organic realm operate in the cultural realm as well.

Cultural Lineages

The notion of cultural species can be used at many different scales. At the most basic level it will be applied to realms of thought which exhibit boundaries, inherit their characteristics from preceeding generations, spread their elements through natural selection and migration, experience some degree of inhibition in the spread of their elements to other lineages, and exhibit phyletic differentiation through the processes of recombination, hybridization, mutation, selection and drift.

These processes as they operate in the biological world are illustrated in Figure 1.5 and are discussed in Heywood (1967:7), Grant (1971:39), Solbrig (1970:18-29), Ross (1974:56-118), Buettner-Janusch (1966:42-45), Mayr (1963:281-297) and Birdsell (1972:387-420). As will be seen, the botanical system shown in Figure 1.5 bears some resemblance to the structural model that will be developed below. The evolutionary processes in Figure 1.5 are the same ones operating in cultural evolution.

Childe (1951b:166-179), Berreman (1960:788), Tax and Callender (1960:207-43), Nisbet (1965), Moore (1965), Stebbins (1965), Sorre (1966:45) and Sopher (1972:323) discuss the applicability of biological processes to cultural evolution. Realms of thought that satisfy the requirements mentioned above include such things as intellectual schools, traditions and systems which have exhibited spatial differentiation and have left records of change through time. Cultural lineage is perhaps a better term than cultural species, since ideas themselves are not living things. Instead, they exist within and are transmitted by living things.

Each tradition, lineage or bounded system contains a myriad of associated ideas, beliefs and practices. In their smallest and most reduced form, these ideas comprise the basic elements of each lineage. These unit elements are the atoms or genes of each tradition. Among these elements are the organizing principles which create ideational and behavioral structures. Grammar, for instance, is as much an element of culture as vocabulary. The dispersal and diffusion of these elements, either through long-range communication or through the migration of individuals, corresponds to the gene flow shown in Figure 1.5. As will be shown below, some of these systems have received enough documentation through history that phylogenies can be constructed for them. These systems include religions, languages, and traditions of thought in philosophy, literature, law and science. Also included are cultural practices such as writing, art, architecture, music and technology, and institutional groupings such as political movements, fraternal orders and corporations. For a phylogenetic treatment of a number of corporate "species" see Elliott (1970). Examples of a number of these cultural lineages will appear as part of the phylogenetic model in part III.

Kroeber has noted the similarity between cultural and biological phylogeny (in Tax and Callender 1960:224). Each cultural tradition experiences a line of development which includes internal change through time. These changes involve a continual hybridization process, called borrowing or acculturation. Quite often the hybridization process occurs during the birth of a lineage. Most religions, for instance, have begun in this manner. See Elliott (1974) for an account of this phenomenon. Each tradition is passed down from one human generation to the next. Replication between generations is imperfect and, as with biota, this transition or enculturation process is a major source of change (Weinreich 1968:184, Harris 1971:150, Jakobson 1972b:305).

The configuration of traditions within a place (or within a smaller entity such as a human family or an individual) acts as a semi-permeable barrier to borrowing and hybridization. The Swiss ethnographer Richard

Weiss (1962) has given an excellent description of this process. These boundary mechanisms are important to speciation. If hybridization between two lineages were continuous and massive, they would eventually merge (Ross 1974:60). The degree to which this has not occurred within cultural lineages indicates the degree to which boundaries have been maintained and the degree to which the diffusion of elements between cultural "species" has been inhibited.

Cultural species (things with boundaries and the other characteristics mentioned above) can be identified on many different levels simultaneously. In addition to the intellectual and corporate systems listed above, there are also such things as ethnic groups and nation states which reflect temporal evolution (diverging, parallel and converging) along with territorial advances and retreats. Assemblages of these entities within places of various sizes can be seen as associations and communities in much the same way that students of vegetation have used these terms to describe plant communities. Culture realms are the cartographic expressions of these phyletic assemblages shown at their highest level of abstraction.

Chapter 3

NUMBER AND NUMERICAL EXTENT OF IDEAS

PRIMARY CATEGORIES OF GEOGRAPHIC PHENOMENA

Geographic place characteristics fall into three categories: individuals, ideas, and artifacts. Anything described in human geography can be classified into one of these three groups. Geographic processes involve the movements and transformations of things in these categories. Although variables from all three of these categories will appear in the structural model, the primary emphasis will be on ideas. This has been done for the sake of brevity. Individuals will appear in the model as an aggreate (population) and as a process (inward and outward migration of individuals). Artifacts will be represented by a variable called resources. Increases and decreases in population and changes in the level of artifacts are external to the model and will not be described in this thesis.

IDEAS

Two aspects of ideas appear in the structural model: number (NumId) and numerical extent (NExtId).* To envision what is meant by number and numerical extent, we must conceive of a large list of all the ideas and bits of information held by each individual living within a place.

*Abbreviations appearing within parentheses refer to the summary diagram at the end of this chapter.

This would represent the number of different ideas, at all levels of abstraction, that exist within that place. The numerical extent of each of these ideas would reflect how many individuals held or believed in each idea. It also reflects how many individuals have knowledge of each bit of information. Numerical extent (as opposed to spatial extent) is a quantitative measure of proportion. Number (NumId) is a measure of presence or absence.

The number of ideas in a place is influenced by the processes of establishment and elimination. Numerical extent is affected by these same two processes but is also affected by numerical expansion and numerical contraction. The magnitudes of each of these variables will go up or down depending on how rapidly the other processes of the model are operating.

Diversification of the local inventory of ideas occurs when new ideas come into existence. This is the process of establishment (EstId). This happens when local innovations are adopted and when innovative ideas are introduced from the outside. All of these ideas will be new wants, new beliefs, and new bits of information. The processes leading to the establishment of new ideas will be discussed in chapter 6.

Ideas undergo numerical expansion (NExpId) when they are acquired (adopted) by additional members of a local population. Numerical extent increases when many individuals acquire a single additional idea, when one individual acquires many additional ideas, and when many individuals acquire many additional ideas. The rate at which ideas are expanding within any given place is the same when one individual acquires five additional ideas as when five individuals acquire one additional idea.

The numerical contraction of ideas (NConId) occurs when one or more individuals give up or discard ideas. This does not mean that these ideas are disappearing locally. It only means that they are disappearing from particular individuals. Complete local disappearance does not happen until all members of a population give up an idea. When this happens, elimination occurs.

Elimination (ElimId) contributes to the simplification of the local inventory of ideas. Elimination occurs when an idea experiences local extinction. Elimination, therefore, results ultimately from the contraction process. When the numerical contraction of an idea continues to its final termination, the idea undergoes total contraction. The relationship between the total contraction of an idea and its elimination from the local inventory of ideas will be discussed in chapter 10.

Each idea, then, goes through a kind of life cycle. Birth, or establishment, is followed by growth, shrinkage, and death. In later chapters we will explore some of the variables that affect the rate at which each of these processes might be expected to occur. Initially, however, the structural model begins with these four processes. As the magnitude of each one of these processes changes through time, both the number and the numerical extent of ideas will change also. Formulas 3.1 and 3.2 illustrate these relationships. The abbreviations used in these formulas are explained in the summary diagram at the end of the chapter.

KINDS OF IDEAS

Although ideas, like anything else, can be combined into any conceivable number of categories, three categories will appear in the structural model. These categories, all of which affect different

$$\boxed{\mathrm{NumId}_{t_2}} = \boxed{\mathrm{NumId}_{t_1}} + \mathrm{EstId}_{t_1-t_2} - \mathrm{ElimId}_{t_1-t_2} \tag{3.1}$$

$$\boxed{\mathrm{NExtId}_{t_2}} = \boxed{\mathrm{NExtId}_{t_1}} + \mathrm{EstId}_{t_1-t_2} + \mathrm{NExpId}_{t_1-t_2} - \mathrm{NConId}_{t_1-t_2} \tag{3.2}$$

aspects of geographic change, include Knowledge, Skills, and Abilities (KSA), Desires, Wants, and Needs (DWN), and Opinions, Attitudes, and Beliefs (OAB). In the structural model these categories are shown as depending on numerical extent for their magnitudes. As the numerical extent of each ideational element changes, so also will the magnitudes of various wants, needs, opinions, and beliefs. Just how much this will occur, however, is impossible to determine.

These ideas constitute the cultural makeup of local individuals. Just as different types of individuals leave their imprint on a place, so also do their ideas. Religion, for example, is an organizing theme for many ideas. Areas inhabited by people of one religious tradition are different from areas inhabited by people of other religious traditions. Religion has an impact not only on how people act but also on the appearance of the landscape. These are both geographic phenomena, but in the evolutionary development of an area, the landscape is a product while the causal agents of change are the ideas themselves.

The elements of the structural model that have been described thus far are shown in Figure 3.1. This diagram summarizes all the relationships discussed in this chapter. Causal relationships are indicated by the solid arrows. All arrows in the model point from independent (predictor or causal) variables toward dependent variables (effects). Most of the relationships shown will be assumed to be linear. They are also assumed to be probabilistic, so that as each predictor variable increases in intensity, it is likely that the intensity of each effect will also increase.

The exact magnitude of each increase or decrease is impossible to tell, since it is assumed that in each geographic location rates will be different. We do not know the weights that should be assigned to each of these variables. Neither do we know the exact rates at which change in one variable produces change in another. Like the gravity model, each relationship contains empirically derived constants. Even when we discover some of these place-specific constants it does us no good because the constants change from one location to the next. At best, we might be able (some day) to derive a range within which the constants would fluctuate from place to place. The weighting of variables would then take on the form of probabilities. There might be, for instance, a high probability that one variable would have three times the weight of another, and a low probability that it would be weighted by a factor of one or two. This is the greatest amount of accuracy to which we might aspire, although it will not be attempted in this study.

Also, in many instances the effect of several causal variables is not known when they are operating simultaneously. We may have evidence, for instance, that linear relationships exist between _a_ and _b_, and between _a_ and _c_. The effect on _a_ of _b_ and _c_ together, however, may not be linear. Since many of these multiple effects have not been adequately investigated, the structural model should be seen primarily as a heuristic device, although in chapter 11 an attempt will be made to operationalize a simplified version of it.

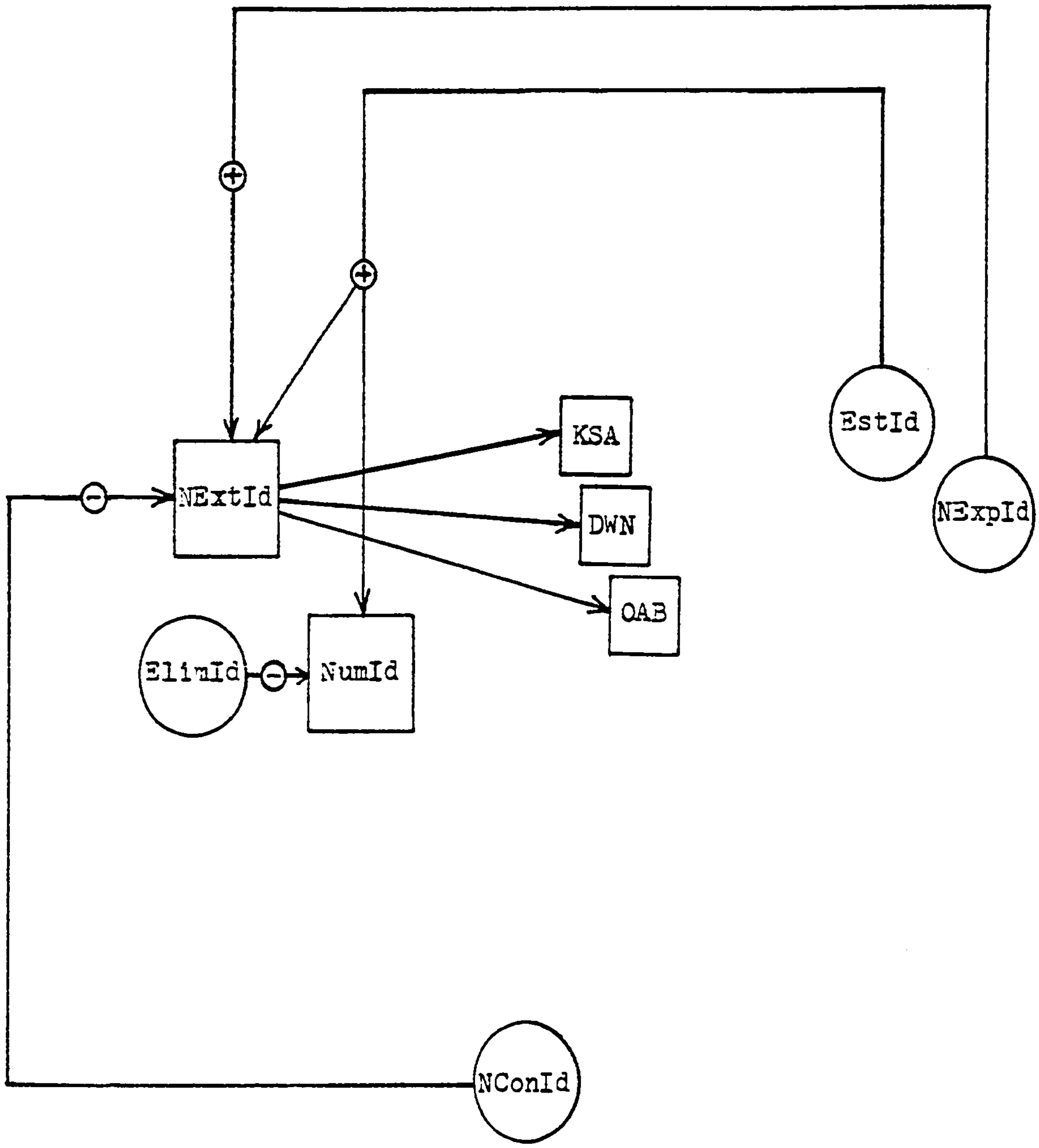


Figure 3.1

NExtId	Numerical extent of ideas within a place at time t_1
NumId	Number of different ideas within a place at time t_1
KSA	Knowledge, Skills, and Abilities at time t_1
DWN	Desires, Wants, and Needs at time t_1
OAB	Opinions, Attitudes, and Beliefs at time t_1
EstId	Number of ideas established within a place between time t_1 and t_2
NExpId	Numerical Expansion of ideas within a place between time t_1 and t_2
NConId	Numerical Contraction of ideas within a place between time t_1 and t_2
ElimId	Number of ideas eliminated from a place between time t_1 and t_2

Chapter 4

HOMOGENEITY AND DIVERSITY

DIVERSITY CONCEPTUALIZED

Diversity refers to the size of a place's geographic inventory. Places inhabited by a greater variety of different types of individuals exhibit greater diversity. The more ideas a place has, the greater is its diversity. Diversity can be visualized as a stack of disks where each disk represents an idea, an element of knowledge, a type of skill, or any other geographic characteristic that might be used to describe a given place. Many of these characteristics can be artifacts or other tangible features of the landscape. However, since the structural model is concerned mainly with ideas it will be assumed that diversity as a variable will pertain only to ideas. The same will hold with homogeneity. If something exists anywhere within the boundaries of a place, a disk representing that element will be found in the stack. The stack of circles shown in Figure 4.1 indicates how this vision of diversity might appear. It is quite unmeasurable in the concrete, but it is understandable in the abstract.

Ideas or bits of knowledge are added to the inventory through communication, adoption, and belief. Configurations, or the culturally-received mental structures used by individuals to organize their unit ideas, are also part of this inventory. Organizing themes can migrate

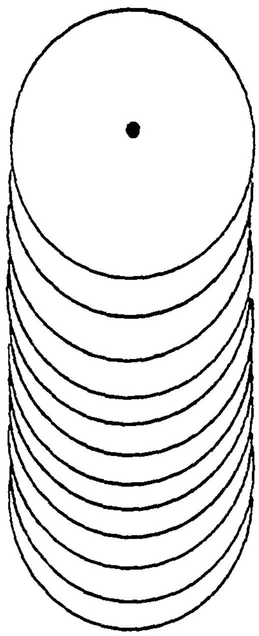


Figure 4.1

between places and different cultures in exactly the same way that other non-material culture traits can. As far as the inventory is concerned, organizing themes and individual culture traits are the same.

The geographic inventory at each place can be represented by billions upon billions of these circles stacked on top of one another. These circles stand for everything from linguistic usages and political beliefs to sexual preferences and food avoidances. As new ideas are added to the inventory through the establishment process, new circles are added to the stack. As the stack gets higher, the geographic inventory gets more extensive. A greater amount of diversity is reflected in a higher stack.

FACTORS INFLUENCING LEVEL OF DIVERSITY

The level of diversity within a place is affected by at least two factors. These include population and the degree of urbanization. As the population of a place increases, the complexity of that place's society also increases, particularly with regard to the division of labor and class stratification (Durkheim 1964:260, Harner 1970:69, Owen 1968:418, Smith 1973:143, Spencer 1876:473, Steward 1972:206, White 1949:378, Wagner 1964:75). Similarly, an increase in urbanization has been seen to coincide with an increase in sociocultural diversity (Eisenstadt 1964:383, Steward 1972:211).

These relationships are not direct, however. Urbanization and population may have a great deal of influence on diversity but this exists through their effect on the processes of establishment and elimination. A direct connection between these variables is therefore not shown in the structural model. Without being able to see such direct links, we can only observe that these variables seem to change in tandem, always maintaining a definite relationship with each other, not unlike Leibniz' monads.

A major phenomenon resulting from establishment and elimination is a change in the composition of the element stack shown in Figure 4.1. Such qualitative change can occur without affecting the height of the stack at all. The level of diversity, for instance, can remain unchanged while individual elements disappear and others take their place.

Figure 4.2 illustrates a qualitative transformation where the diversity of a place remains constant. In this diagram each element in the geographic inventory is represented by a geometric shape. At time t_1 three different elements are part of the inventory (a circle, a square, and a triangle). The level of diversity is three units since each element is different. If they were all the same, the level of diversity would be one unit.

At time t_2 one of the elements has disappeared (the circle) and one has become established (the crescent). Qualitative change has occurred but the level of diversity has not been altered. Diversity remains fixed at three units. In this example, the rate of establishment has exactly equaled the rate of elimination.

In Figure 4.3 a different situation is shown where transformation does lead to a change in diversity. In this diagram the initial condition at time t_1 is represented by three circles. This means that three things exist but they are all the same. The level of diversity is therefore one unit.

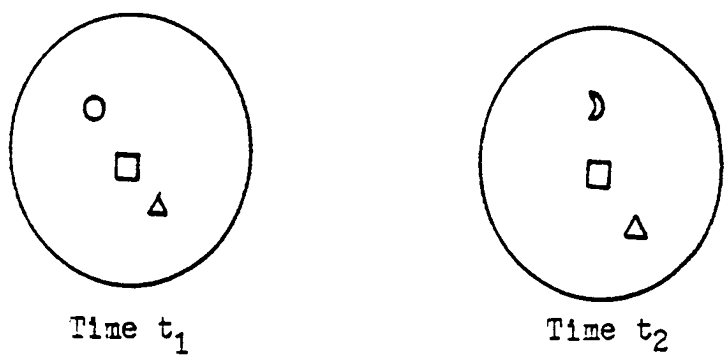


Figure 4.2

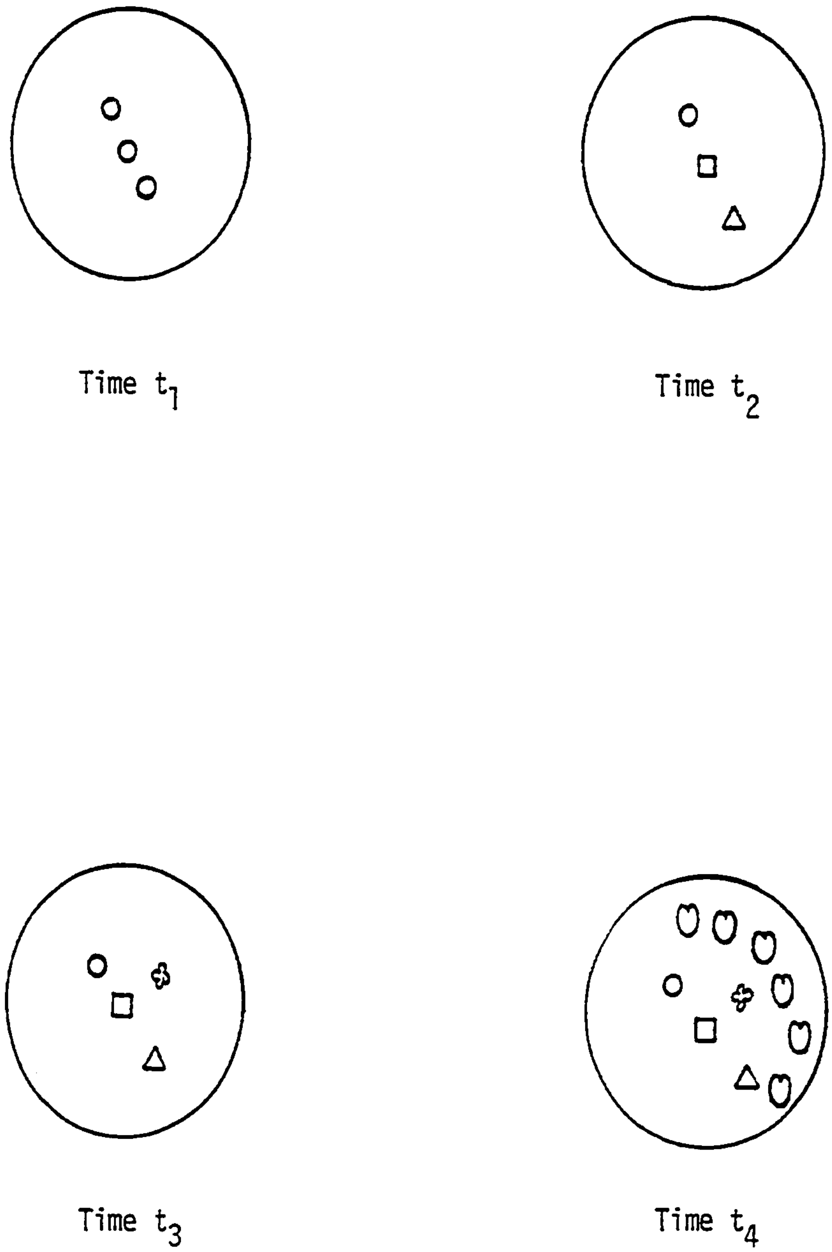


Figure 4.3

At time t_2 two of the circles have been eliminated, having been replaced by a square and a triangle. As in Figure 4.2, the level of diversity is now three units. At time t_3 and t_4 more elements have been added to the inventory, increasing its diversity from three units to four, and then from four to five. Note that at time t_4 six hearts have been added to the inventory. However, since they are all the same, the inventory's diversity is raised by only one unit.

Each time new elements are added to the inventory and there is a net gain in the number of different elements, diversity increases. In Figure 4.1 this process can be represented by the addition of new circles to the element stack. When these newly established elements reproduce themselves (through socialization) or when they are adopted by more individuals in the population, nothing new is added to the geographic inventory and diversity remains the same. This is not to say that there has been no change. It is apparent that some kind of change has taken place even though it does not involve diversity. It is to this problem that we now turn.

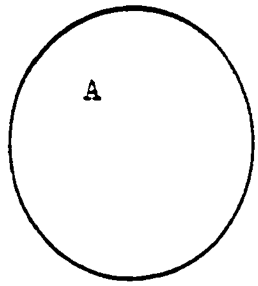
HOMOGENEITY CONCEPTUALIZED

Even though the diversity of a place does not change when the population of an internal element expands or contracts, the homogeneity of a place does. Homogeneity, like diversity, is a concept involving a simultaneous relationship between all place characteristics. Each element is held by a specific proportion of the total population. Whenever an element's population changes, its proportion of the geographic inventory changes (provided that the population of everything else in the inventory remains the same). At the same time, the proportion of each other element changes in relation to the whole inventory, and the overall level of within-place homogeneity is altered. An illustration of what we mean by overall within-place homogeneity is provided in Figure 4.4.

Each circle in Figure 4.4 represents a part of some hypothetical place's geographic inventory. In this situation the part shown might represent a population of individuals. Each circle is divided into segments identified by capital letters. Each segment represents a specific category of individual within that population, such as an ethnic group or a social class. Each of these groups has a number of ideas that are unique and groups of individuals can very often serve as surrogates for groups of ideas.

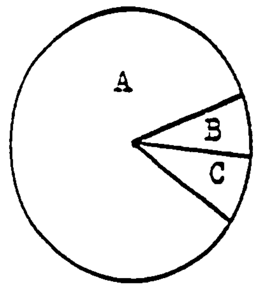
The extent to which each class of individuals constitutes a large or a small proportion of the entire population is indicated by the amount of the circle covered by its particular segment or wedge. In Figure 4.4b, for instance, most of the population is made up of individuals from group A. Groups B and C constitute small minorities. A population may be divided into formal categories, such as those shown in Figure 2.12, or into phyletic categories, of the sort shown in Figure 2.11. Geographic elements can thus be seen as subdivisions of entire classes of things. They can also be seen as unique objects existing within an unclassified sea of other unique objects.

If the element stack shown in Figure 4.1 is combined with an indication of the extent to which each element is numerically distributed within a given place, Figure 4.5 results. If Figure 4.5 represents a group of non-exclusive ideas (where the adoption of one



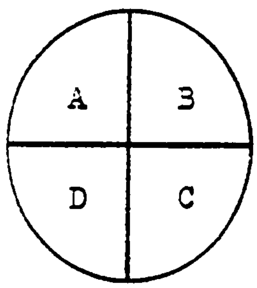
Complete
Homogeneity in j

(a)



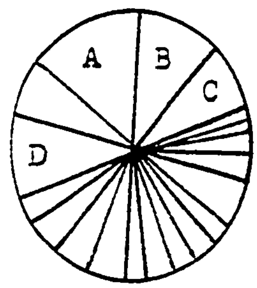
High
Homogeneity in j

(b)



Low
Homogeneity in j

(c)



Very Low
Homogeneity in j

(d)

Figure 4.4

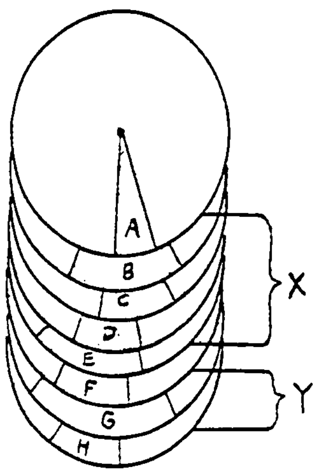


Figure 4.5

does not prevent the adoption of others), the proportion of the population holding a particular unit idea will be indicated by the width of the adoption wedge on each circle (where each circle represents a single idea). In this diagram unit idea A is, for example, held by fewer individuals than is unit idea B.

As more individuals come to incorporate unit idea A into their own personal belief system (or individual inventories), the wedge on that particular circle will get wider and wider. This will reflect the process of within-place numerical expansion (NExp). When that particular adoption wedge finally covers the entire circle, unit idea A will be held by the entire population.

Although each element in Figure 4.5 is shown as a separate circle, groups of circles can be combined into bundles representing classes of elements. Two such bundles are identified as X and Y in Figure 4.5. X and Y might, for example, represent religious and political affiliation. They might also represent various competing word usages within a linguistic community, where object X can be referred to using one of five different words (A, B, C, D or E), and object Y can be identified with one of three different words (F, G or H). When the elements within each bundle are non-exclusive, the adoption wedges can add up to more than 100%. When the elements are exclusive (meaning that the adoption of one element by an individual prevents that individual from holding other elements within a bundle at the same time), the adoption wedges within each bundle will add up to 100%. The wedges in Figure 4.4 are typical of this situation.

When a place's element stack is divided into bundles, as is reflected in the summary diagram at the end of this chapter, each bundle will show a range of variation about a norm. As norms shift through time, the adoption wedges of some elements will become wider and the wedges of other elements (reflecting the process of numerical contraction) will become narrower. When an adoption wedge narrows to zero, the element disappears and elimination occurs.

As ideas, artifacts and types of individuals are eliminated from a place's inventory, circles are removed from the stack. Reductions in the height of the element stack reflect a decrease in the size of a place's inventory and a decrease in its level of diversity. In this way, homogeneity and complexity are complementary processes.

Each ethnic group or social class has a large number of unit ideas which tend to belong to it rather than to other groups. The ideas identified as A and H in Figure 4.5 may be characteristic, say, of group A in Figure 4.4b. This group can expand at the expense of other groups by having a higher birthrate, a higher rate of in-migration or by killing off some of the individuals in the other groups. As group A increases its proportion of the total population, it can be expected that adoption wedges A and H in Figure 4.5 will become wider. Adoption wedges A and H can also widen when other groups incorporate the ideas and practices of group A into their own inventories through acculturation, intermarriage, and other processes of hybridization.

FACTORS INFLUENCING LEVEL OF HOMOGENEITY

A highly homogeneous population will exhibit many traits shared by a large proportion of the population. A large number of elements shared by a small proportion of the population will be indicative of a low degree of homogeneity. At the same time, a few elements common to everyone in a population will offset a larger number of elements held by a few small groups. The same thing holds when members of a population are seen as belonging to several different groups. A population where 90% of the individuals are part of group A and 10% are part of group B (Figure 4.6a) is more homogeneous than a population where the proportions are 80% and 20% (Figure 4.6b). These percentages will yield a measure of homogeneity according to formula 4.1. When many traits are being considered, all measures of homogeneity should be added together and the sum should be divided by the total number of traits. This will yield an index number that represents an average for all traits considered.

According to Formula 4.1 the population in Figure 4.6a exhibits a homogeneity of 82% while that of Figure 4.6b is 68% homogeneous. A population in which two groups constitute exactly half of the total will be 50% homogeneous. In Figure 4.6c the majority of the population comprises 90% of the total, but the remaining 10% is distributed among four other groups. This, according to Formula 4.1, results in a homogeneity of 81% which is slightly less than the situation depicted in Figure 4.6a (where a single group made up the entire 10%), but it is more than the situation shown in Figure 4.6b (where the majority comprises only 80% of the total). In addition, homogeneity is higher in Figure 4.6c than it is in Figure 4.6d (where the population is also made up of five separate groups, but where homogeneity is only 40%). The formula is thus weighted slightly in favor of high adoption percentages and low diversity.

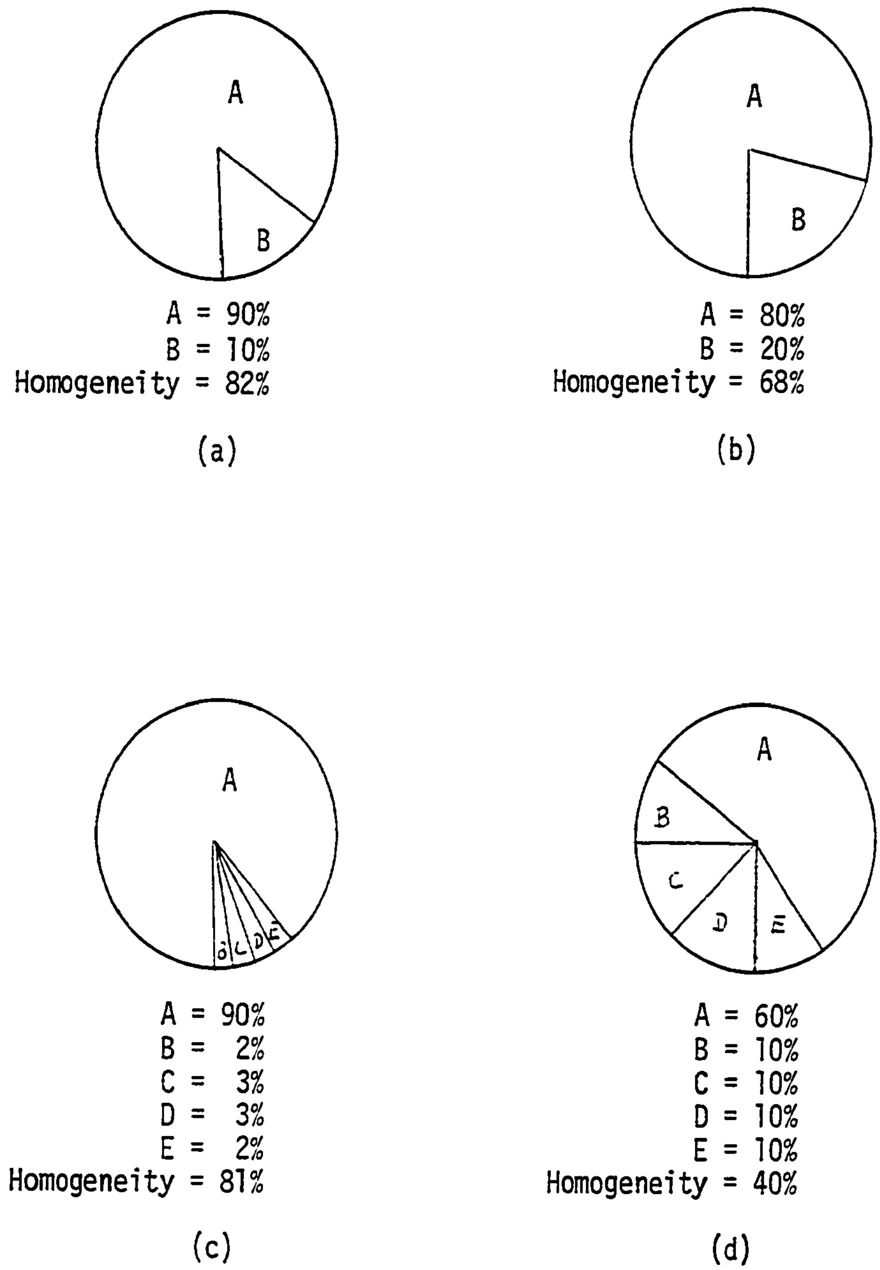

A
B
A = 90%
B = 10%
Homogeneity = 82%
(a)
A
B
A = 80%
B = 20%
Homogeneity = 68%
(b)
A
B
C
D
E
A = 90%
B = 2%
C = 3%
D = 3%
E = 2%
Homogeneity = 81%
(c)
A
B
C
D
E
A = 60%
B = 10%
C = 10%
D = 10%
E = 10%
Homogeneity = 40%
(d)

Figure 4.6

$$\text{Homo} = \frac{\sum_{i=1}^{n} P_i^{2}}{100\left(\sum_{i=1}^{n} P_i\right)} \tag{4.1}$$

Where P = Percentage of a place's population exhibiting a given characteristic or possessing a given idea (size of each wedge shown in Figure 4.6)

i = Each group (individual wedges shown in Figure 4.6)

When the concept of homogeneity is applied to regional analysis it often refers to many different things. It can refer to the overall homogeneity within a place. Here, referring back to Figure 4.5, one might envision a single large stack of elements representing all of a place's characteristics along with the adoption wedges showing how widespread these characteristics are. If the diameters of the circles are proportional to the populations they represent, the diameter of the stack will be large when it represents a large place and small when it represents a small place.

The concept can also be used when referring to the homogeneity existing within individual settlements located within a place, the homogeneity between settlements located in a place, the homogeneity between a place's subregions, and the homogeneity between different types of subregions found within a place (as between urban areas and rural areas). Most studies dealing with homogeneity are concerned with one of these categories, but the distinction between them is seldom recognized.

Homogeneity between different subregions can be seen as a series of stacks, one for each area. Since each stack represents only a part of a place, their diameters will be much smaller than one representing the entire area. In this example, the notion of homogeneity becomes a measure of similarity between subregions, where the proportion of each element in each subregion is compared with the proportions found within each other subregion.

We are not, however, interested in comparing subregions within places, but instead are interested in comparing internal levels of homogeneity between entire places. This requires that we view homogeneity as a description of an entire place, that is to say, each place must be seen as having a single element stack representing all of its disparate elements without regard to where they are located internally. If 60% of a place's population exhibits characteristic A, for instance, it makes no difference whether that characteristic is evenly distributed, is clustered in cities or is restricted to one small corner of a place's territory. As far as homogeneity is concerned, the adoption wedge for element A still registers a magnitude of 60%.

Like diversity, homogeneity is indirectly related to the level of urbanization and the size of a place's population. However, this relationship is not linear and it depends very much on historical circumstances.

POPULATION

In their inventory of experimental findings in the social sciences, Berelson and Steiner (1964:648) reported that smaller and more primitive societies tend to be more homogeneous than large societies. As Wagner (1964:78) has put it, internal specialization is greatly restricted by the small size of subsistence groups. It has also been noted that large populations are associated with cultural heterogeneity (Taylor 1969:36). These are not new ideas. Long ago they were espoused by Herbert Spencer (1876:473), who believed that large populations were not only more complex than small ones but were also more highly differentiated. He saw in the transition from homogeneous to heterogeneous societies evidence of the evolutionary progress of human civilization as a whole. We will not, however, make the claim here that anything like "progress" exists or that it is associated with levels of homogeneity. As has been pointed out above, we are interested in the evolution of place differences and not the evolution of cultural advancement.

URBANIZATION AND EVOLUTIONARY CHANGE

A rather complex relationship can be seen between urbanization and homogeneity. It involves several factors which are intimately related to different levels of urbanization and begins with the rise of urbanization itself.

In his study of patrilocal bands in Baja California, Roger Owen (1968:416-418) found a considerable amount of linguistic and cultural diversity existing within each band. He attributed this to a large number of extra-tribal marriages, which he felt was a consequence of extremely low population densities (and the absence of urbanization in its most primitive sense). After centuries of living next to each other, the likelihood that individual bands could select mates from neighboring bands without violating incest taboos was probably slight. Selecting partners from bands located in distant places seems to have been the solution to this dilemma. Also, according to Birdsell (1966: 52) the frequency of intertribal marriages decreases as tribal populations increase.

Because of this extensive exogamy, Owen concluded that all such bands characterized by low population densities and low levels of cultural complexity are hybrid groups, both linguistically and culturally. The existence of these hybrid groups contributes to very low levels of within-place homogeneity, linguistically and culturally.

The process of between-place hybridization discussed by Owen is illustrated in Figures 4.7a, 4.7b, and 4.7c. In these diagrams, bands in three different places (symbolized by triangles, squares and circles) are shown exchanging mates with bands in other places. In Figure 4.7c the within-place homogeneity is, as Owen points out, quite low.

Owen also argued that higher population densities in his study area led to the development of village life. A similar connection between increased population and the emergence of agricultural villages has been found in medieval Europe (Blum 1971:160).

According to Owen this shift to sedentary village life led directly to a reduction in the number of hybrid groups, since larger populations now allowed for the selection of mates from within the group or village. Reduced hybridization with outside areas resulted in a lowering of the dialect and cultural variability within each village and an increase in the amount of within-place homogeneity. Owen felt this to be consistent with the reduction of within-group differences often seen in modern societies when there are increases in population density. Figure 4.7d reflects this reduced amount of hybridization associated with an increase in population. The homogeneity within each place is now shown to be quite high.

Although Owen's explanation does account for increasing amounts of within-place homogeneity, it also accounts for decreasing amounts of between-place similarity. According to Sopher (1972:326) greater regional diversity is another result of this rise of village living.

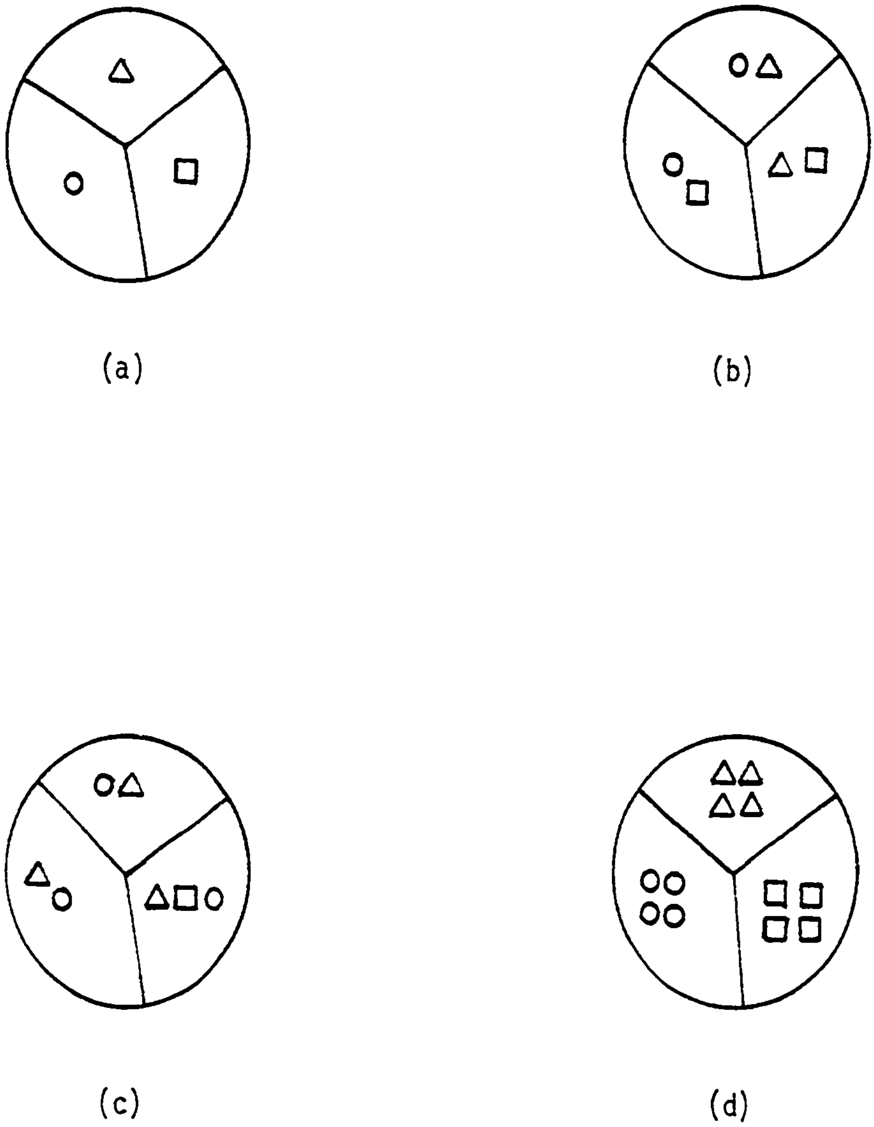


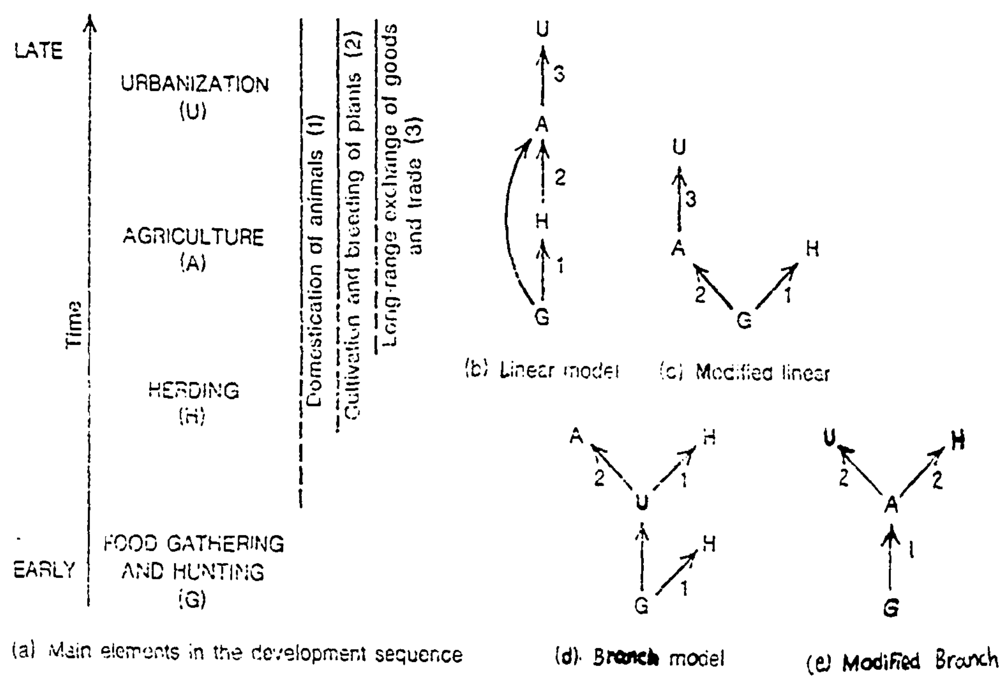
Figure 4.7

As Figure 4.7d shows, even though each place is now internally homogeneous, they are also quite different from one another. In Figure 4.7c the places were quite similar to each other, while their internal homogeneity was low.

This paradox brings out an important distinction to be made between the concepts of homogeneity and similarity. As was stated above, homogeneity is a characteristic of within-place phenomena. When between-place phenomena are being considered, the concept of similarity applies. Much confusion can be avoided if this seemingly trivial distinction is remembered.

If one wished to consider the combined homogeneity of all three places shown in Figure 4.7, it would be necessary to regard the whole circular plain as a single place. If this were done it could be shown that the level of homogeneity within the entire plain has not changed from one diagram to the next since each group consistently comprises one third of the total population.

The transition, then, from wandering bands and seasonal camps to permanent villages is accompanied by a sharp drop in between-place similarity and a rise in the level of within-place homogeneity. That this transition has been associated with the rise of agriculture has been postulated by Braidwood (1960:3), MacNeish (1964:29) and others. Sauer (1952:23), on the other hand, feels that agriculturalization occurred after the establishment of permanent settlements. Childe (1951a:63) holds that there is no necessary sequence associated with these two developments. Figure 4.8 illustrates several views on how urbanization developed.



The position of cities in the developmental sequence. Figure (a) shows the traditional main stages and processes in the developmental sequence. Figures (b), (c), (d) and (e) provide alternative models of the place of the cities in human development.

Figure 4.8 (Haggett 1975:272)

The connection between the agricultural revolution and a dramatic rise in population is well known and it is unlikely that a rise in village living and an increase in urbanization are independent of improvements in agricultural technology. It follows that as the agricultural and urban revolutions diffused throughout the world, human populations greatly increased (Brown 1961:47). The association between agricultural technology and population size is illustrated in Figure 4.9. It can also be postulated that during the initial spread of agriculture and urban living, a spread of increased within-place homogeneity occurred as well.

As agriculturalization spread, urban life styles became more widespread in some places than in others. In these places the high level of within-place homogeneity created in the transition from camps to permanent settlements should have declined slightly. The reason for this involves another aspect of urbanism.

In many relatively homogeneous societies where the level of urbanization is low (reflecting the presence of agriculture but the absence of industrialization), cities exist as enclaves of heterogeneity. In these places cities are set apart as distinct entities exhibiting greater internal specialization in cultural and economic affairs (Eisenstadt 1964:383, Wagner 1964:79).

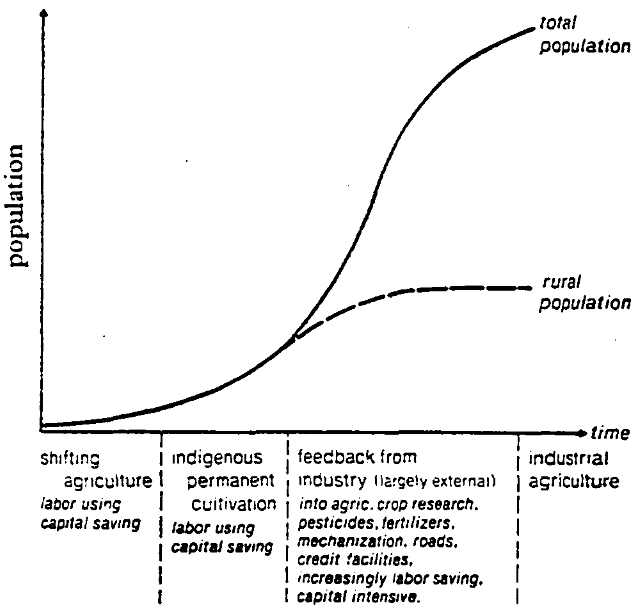
The existence of cities within agricultural regions can therefore reduce the total amount of within-place homogeneity and places which exhibit higher levels of urbanization during pre-industrial times can be expected to have slightly lower levels of homogeneity. The absolute level of homogeneity should, however, remain fairly high until the coming of the industrial revolution.

Industrialization is usually accompanied by an increase in agricultural productivity and a sharp rise in the population (Brown 1961:51). Industrialization also coincides with an abrupt increase in the degree of urbanization so that high levels of industrialization coincide with high levels of urbanization (Berelson and Steiner 1964:604, Brown 1961:37, Davis and Gordon 1954:8). The connection between these processes can be seen in Figure 4.9.

In countries beginning to industrialize it has been found that at the outset, urbanization tends to sharpen the differences between various groups within the population. This applies equally to differences between urban and rural groups and to differences between groups located within cities (Berelson and Steiner 1964:605, Hoselitz 1960:225, Cipolla 1967:30).

With industrialization comes improved transportation facilities which create greater possibilities for concentration and agglomeration within urban areas. Dispersed local crafts are gradually replaced by factories located in urban areas (Beaujeu-Garnier 1966:64). Migration brings individuals from different areas into the cities in search of work. With increasing urbanization, new urban functions tend to differentiate the population within each city and town into specialized classes and sociocultural groups (Steward 1972:211).

The resulting mixture of many disparate elements following the onset of industrialization reduces the level of homogeneity within each urban place. It also reduces the similarity between urban and rural groups and this reduces the overall level of within-place homogeneity.



The development continuum from agriculture to industry.

Figure 4.9 (Hodder 1968:167)

Steward (1972:211) has remarked that while new urban functions are causing the population within urban areas to differentiate, they are also creating greater similarities between different towns. This, however, is the situation shown in Figure 4.7c when the entire circular plain is seen as a single place. The overall level of within-place homogeneity does not change when internally differentiating urban areas are becoming more similar to one another. This is a between-place process which does not really involve the concept of homogeneity at all.

Following a downswing in homogeneity brought on by industrialization, the forces of homogenization will in time cause the trend to reverse itself.

Urbanization eventually tends to even out various aspects of culture and behavior within urban areas (Berelson and Steiner 1964:606). As different groups are absorbed into the urban community a generalization of culture occurs. As a result of functional interdependence and continuous between-group contact, homogeneity in such things as values, dialect, religious practices, recreation and production processes tends to increase within cities (Freedman et al. 1956:369). Homogeneity of language, for instance, develops in situations where rapid communication exists and where all parts of a community are in contact with all the others (Swadesh 1971:291). These conditions are enhanced in urban areas.

Urban-rural similarities will also tend to increase as modern transportation and communication facilities speed up the diffusion process between rural groups (Berelson and Steiner 1964:628).

One illustration of this association between the level of industrialization (which covaries with the level of urbanization) and the double transition from high to low and back again to high levels of homogeneity is shown in Figure 4.10. Recalling Formula 4.1 it can be shown that the level of homogeneity on either end of the economic development scale in Figure 4.10 is higher than it is in the middle. Whether this process takes a generation or a thousand years to complete itself is not known, unfortunately.

The relationship between urbanization and homogeneity would seem, therefore, to be greatly affected by systematic shocks caused by rapid shifts in a place's way of life. It might be expected that such shocks would not only result from massive economic change but might also occur after other kinds of upheaval such as migrations, invasions, wars, plagues and revolutions.

We are now faced with an uncomfortable contradiction. It seems that urbanization is sometimes associated with high levels of homogeneity and sometimes it is not. On the one hand urbanization has a leveling influence, gradually erasing differences between internal groups. On the other hand it is a differentiating force, abruptly reducing internal homogeneity through the creation of many new groups and functions.

When urbanization (village and town living) is absent, homogeneity is very low. With the coming of agriculturization, we find the rise of urbanization. The level of urbanization then increases, but it is still comparatively low. Under these conditions (which characterize pre-industrial societies) homogeneity is high. When industrialization occurs, the level of urbanization increases radically and high levels of urbanization come to be associated with high levels of industrialization. This time, however, high levels of urbanization coincide

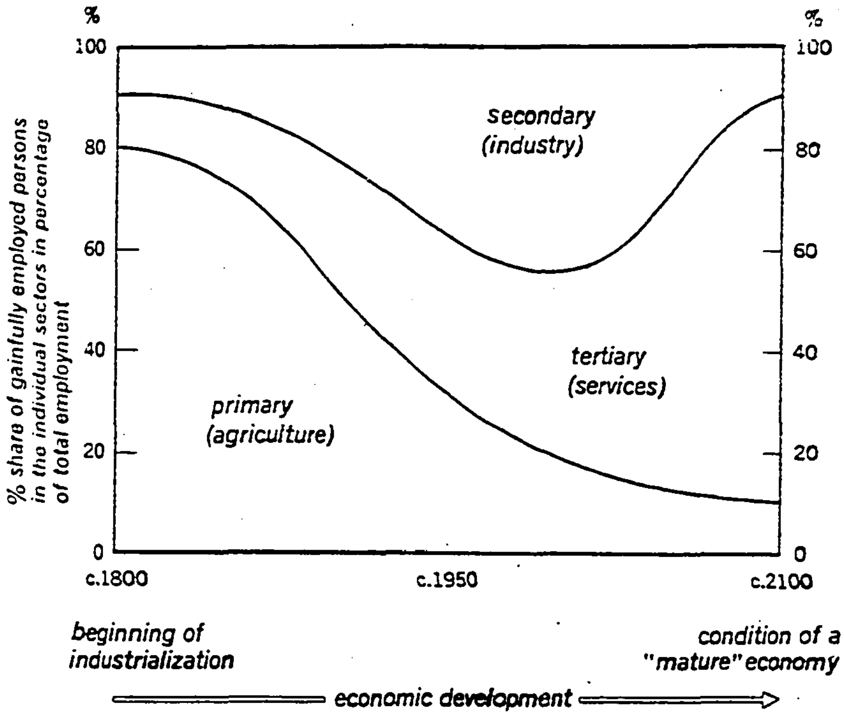


Figure 4.10 (Eliot Hurst 1972:16)

with lower levels of homogeneity. Then, as these high levels of urbanization persist, homogeneity increases so that in post-industrial societies, highly urbanized places are once again associated with high levels of homogeneity.

Figure 4.11 is a suggestive attempt to illustrate how different levels of within-place homogeneity are associated with increasing amounts of urbanization. At the same time, homogeneity will be affected by increasing amounts of agriculturalization, industrialization and population (which tend to covary with urbanization). Temporal duration might have been shown as another covarying element on the horizontal axis of Figure 4.11 except that the other conditions are not found everywhere at the same time. Instead, they characterize different places at different times. In the 15th century, for instance, the agricultural revolution had not yet spread into Australia or Alaska. Even today there are places which have failed to receive the benefits of agriculturalization. We cannot say, therefore, that with the absolute passage of time, the level of homogeneity will be high or low.

In the end, it is necessary to conclude that we cannot really predict the level of homogeneity from the level of urbanization because the relationship between them is nonlinear and tenuous. A relationship does exist but it fluctuates with time and economic circumstances. It is possible, however, to measure homogeneity directly so that homogeneity itself becomes one of the primitive elements in the structural model. This becomes of great importance in chapter 7 where it will be shown that innovation and homogeneity are closely related.

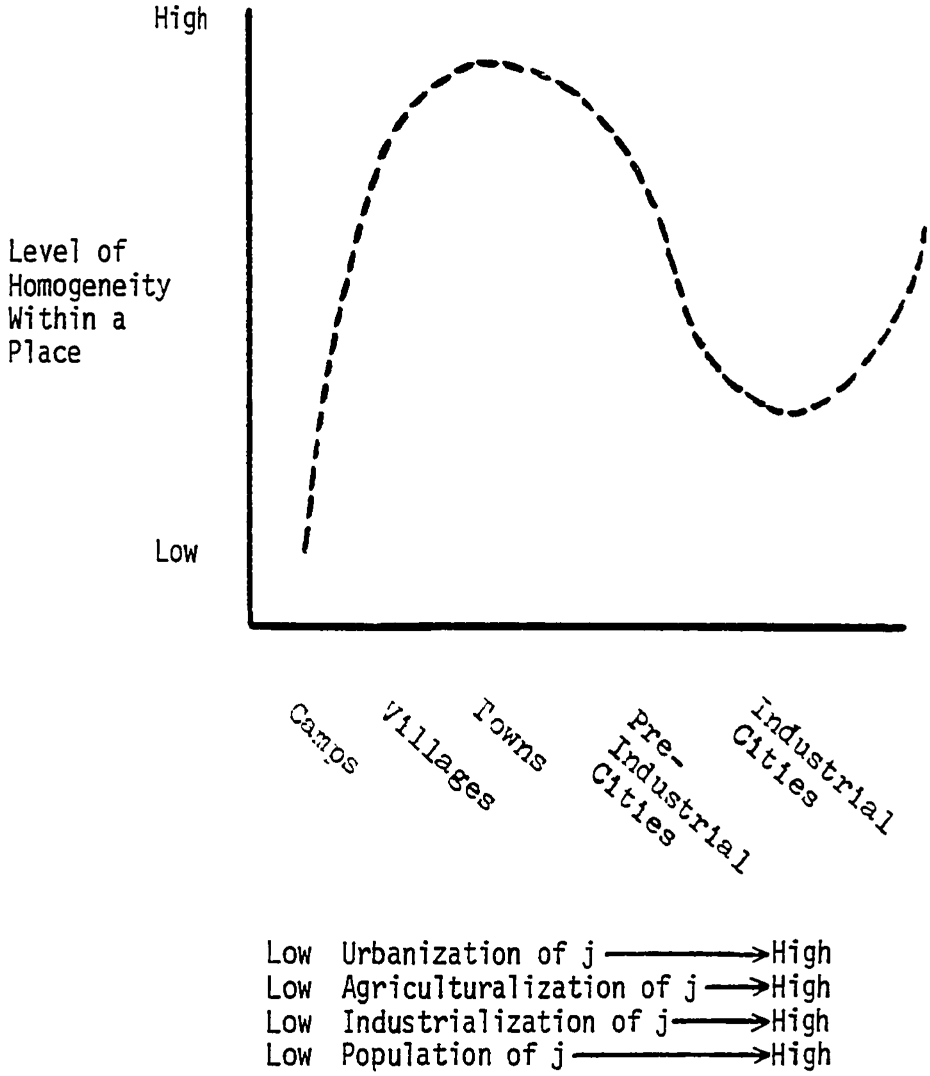

High
Level of
Homogeneity
Within a
Place
Low
Camps
Villages
Towns
Pre-
Industrial
Cities
Industrial
Cities
Low Urbanization of j → High
Low Agriculturalization of j → High
Low Industrialization of j → High
Low Population of j → High

Figure 4.11

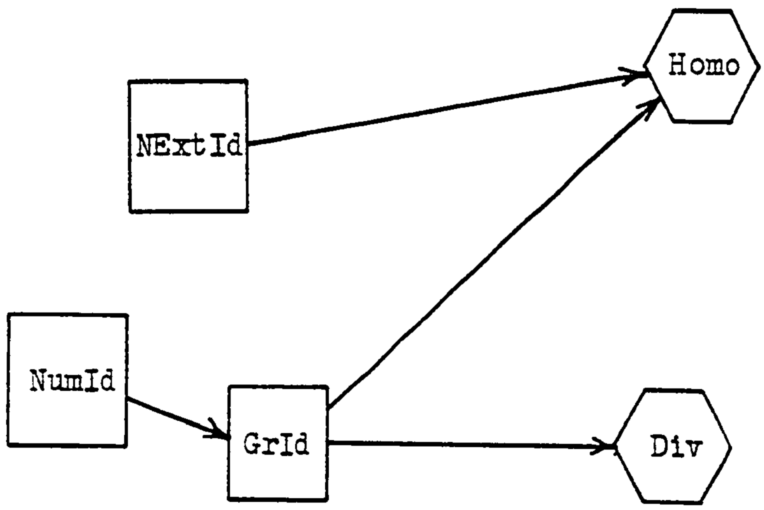


Figure 4.12

Homo	Level of homogeneity in a place at time t_1
Div	Level of diversity in a place at time t_1
NExtId	Numerical extent of ideas within a place at time t_1
NumId	Number of different ideas within a place at time t_1
GrId	Number of different groups of ideas in a place at time t_1

Chapter 5

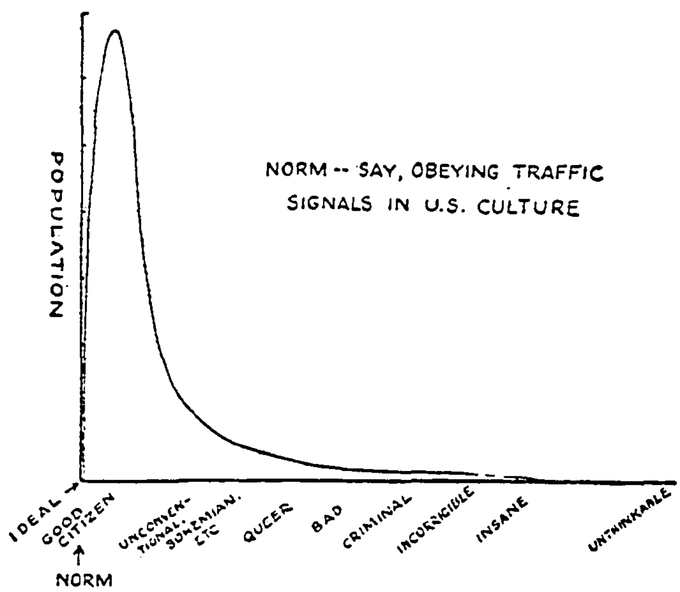
VARIABILITY AND NORMS

As a phenomenon, variability is illustrated by the range and magnitude of departures from a norm. A norm can be identified for individual elements or for large aggregates of elements. A norm is usually defined on the basis of some measure of centrality within a frequency distribution, usually the mode.

Each norm exists within a range of variation, which is a measure of deflection in either direction from the average or most representative form (Swadesh 1971:10). Ideally, these variations will exhibit the bell-shaped curve of a normal distribution, though this need not always be the case.

The curves shown in Figure 5.1 represent ranges of variation about a norm. Each curve is bounded by limits which contain the range of variation (see Geertz 1959:1010 and Voget 1975:424 for further discussions of these properties as they apply to cultural phenomena).

There are many individuals in a population whose usages and practices depart widely from these shifting norms. They are called deviants. Both saints and criminals are deviants. Deviants are rejected by their fellows while conformers are more popular. The closer individuals conform to current norms, the better liked they will be



Cultural Norm: an Example

Cultural Mode: an Example

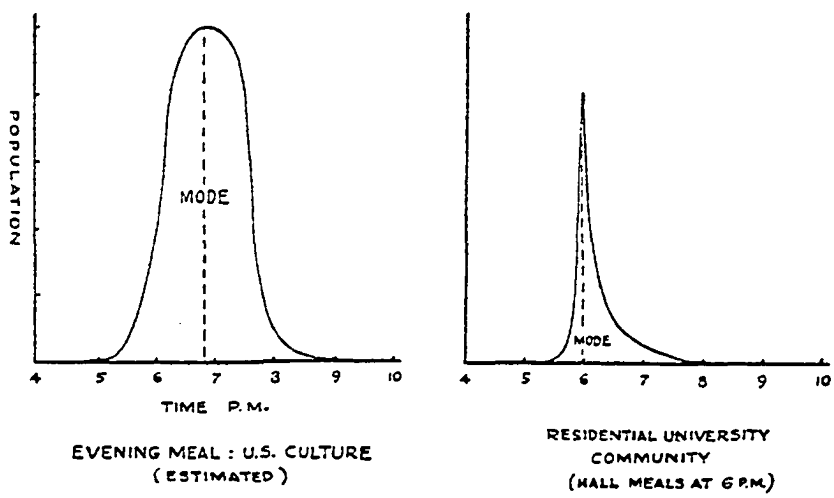


Figure 5.1 (Keesing 1958:162)

(Argyle 1957:155). Social approval within places restricts the number of deviants so that frequency distributions like the ones shown in Figure 5.1 tend to be highly leptokurtic.

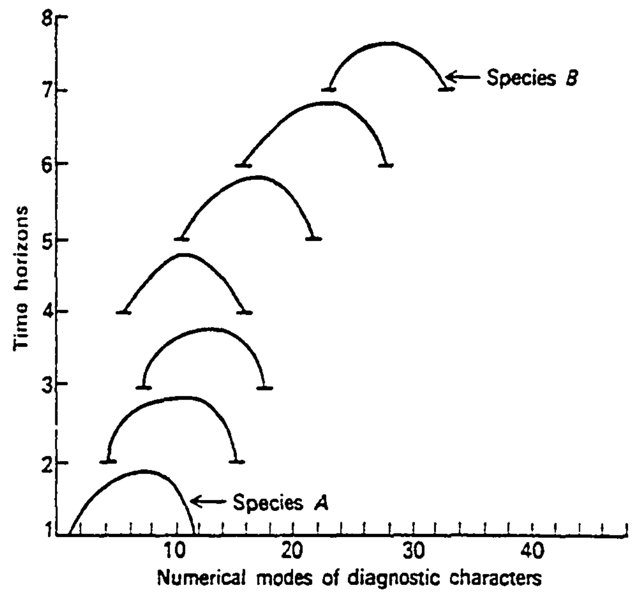
DIRECTIONAL CHANGES

Variability can come about as a result of the biological mechanisms of mutation and recombination or the comparable cultural mechanism of innovation. Not all variability within a lineage or a population involves change, but all changes involve variability (Weinreich 1968:188).

Change involves selection after variability has come into existence. It is selection of some sort that is responsible for directional movement since variation about a norm will not change the norm except by destroying it (Eggan 1963:354).

Directional change in culture results from some choices being made at the expense of others. This is independent of the rate at which things change (discussed in earlier chapters). Figure 5.2 illustrates the process of directional change as the transformation of both a norm and a range of variation through time. Such modifications represents departures from all kinds of norms. Cumulative variations take on directional orientations which become visible through hindsight when the history of a lineage is investigated.

Directional changes occur within all aspects of culture. They are particularly well-documented in such areas as literature, art, science, technology, language, philosophy, and religion. In all of these lineages, usages can be seen in terms of ranges of variation about a norm.



Diagrammatic representation of possible changing character modes in successive populations of a phylogenetic line or lineage starting with species *A* and progressing to species *B*.

Figure 5.2 (Ross 1974:59)

Internal directional change is occasionally referred to as drift, although this should not be confused with the kind of drift described in chapter 9 which is a random process associated with sampling error and small populations. Where the term drift has been used to describe the slow and imperceptible change that linguistic and other cultural norms exhibit through time, it would seem to be synonymous with the process of evolution in general, except that drift does not appear to involve the processes of conscious adoption or inward diffusion.

Sapir (1949:218) has described cultural drift as a complex series of changes in a society's selected inventory of element-traits. It involves additions, losses, changes of emphasis, and changes in structure. Although he regarded linguistic and cultural drift as non-comparable and unrelated processes, languages and other cultural lineages do change in remarkably similar ways. As Aberle (1960:10) points out, furthermore, Sapir did not reject the comparison so much as he rejected the notion that the direction of drift within a linguistic lineage is causally related to changes in other lineages. As far as he could tell, they were largely independent of each other. Linguistic change, then, did not depend on changes in such areas as religion and art, although periods of unusually rapid cultural change did seem to correspond to periods of accelerated linguistic change (Sapir 1912:241).

Harris (1971:132) has stated that the processes of linguistic change have little in common with the kinds of change that occur in other domains of nature. He argues, for instance, that there is no analogue of the principle of natural selection in historical linguistics.

Sopher (1972:323) agrees with this and points out that adaptive pressure on language seems to be slight. Yet Sopher does see other processes that operate similarly in different realms. He feels, for example, that the spatial aspects of human genetic differentiation and breeding resemble other spatial patterns of face to face information exchanges. Whether or not the changes in language and other cultural lineages are subject to the same causes is irrelevant, however, if we are searching for similar processes.

According to Murdock (1949:198) linguistic change exhibits close parallels to the evolution of social organization. As examples he cites a limitation on the possibilities of change, a strain toward consistency, shifts in equilibrium, compensatory internal readjustments, and resistance to any influence from diffusion that is not in accord with the overall direction of movement. Similar views have been expressed by Kroeber and Kluckhohn (1952:189), by Herskovits (1952:581), and by Eggan (1963:347).

Temporal Shifts

When change occurs, it does not occur at random, with some individuals changing in one direction while others are developing in other directions. The changes fall into certain patterns called shifts. These changes, which begin when the norm of a particular element starts to disintegrate, exhibit orderly patterns of directional movement (Hall 1950:171, Weinreich 1968:187).

In linguistics the effects of directional change have been extensively documented. Such change has occurred in morphology, syntax, vocabulary, meaning, phonetics, and phonemics. These changes occur much more rapidly to sounds, words, and meanings than to grammar or structure. Grammar and structure tend to be more persistent over time (Keesing 1958:371). Most changes are very gradual, but their long-term consequences can be immense. Slight readjustments or unsettlements in usage can bring about profound linguistic changes in the course of several thousand years (Sapir 1949:174). Comparable processes operate in other realms of culture as well.

Sound Shifts

Sound shifts resulting from phonetic and phonemic drift (as illustrated in Figure 5.2) have produced a great deal of linguistic change through time. To the extent that isolating mechanisms have been in effect, these shifts have also led to differentiation between languages.

One of the more well-known examples of this type of shift has been described by Grimm's Law, which states that the "p", "t", and "k" sounds in Indo-European, preserved as such in Latin and Greek (piscus, tres, centum), have changed to "f", "th", and "h" in the Germanic languages (fish, three, hundred).

Grimm's Law describes a series of consonant shifts. The same process also affects vowels. Some examples of English vowel shifts include those that occurred during the Great Vowel Shift in the fifteenth century. The following examples are representative of this particular shift: nahme changed to name, dayd to deed, gaese to geese, ween to wine, stawn to stone, gose to goose, and hoose to house (Hall 1950:172, Baugh 1957:287)* When this shift occurred, all

*In IPA these Middle English forms are shown as name, dɛd, ges, win, stɔn, gos, and hus.

the long vowels in Middle English changed in the same direction. Linguists identify this direction as being towards a higher position of articulation in the mouth (Hall 1950:171). Countless examples of similar sound shifts can be found in Bloomfield (1933), Jesperson (1938), Sturtevant (1947), Sapir (1949, 1966), DeSaussure (1959), Whatmough (1960), Laird (1962), Lehman (1962), and Hall (1967).

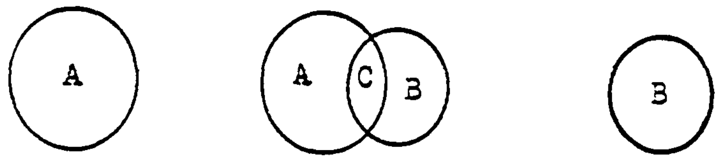
Semantic Shifts

Linguistic change has also manifested itself in semantic shifts. When this process takes place a word's meaning changes so that its original connotation is lost. That the term "poppycock", for instance, originally meant "soft manure" illustrates a common process familiar to most.

Frequently, semantic shifts are accompanied by phonetic shifts and the resulting differences between earlier and later forms are apparent only to philologists. Figure 5.3 illustrates a combination of these two processes. In this diagram, A and B are two words with different meanings and somewhat different sounds. Whatmough (1960:77) uses an example of the Latin word <u>testa</u> (pot) and the French word <u>tete</u> (head). Etymologically, <u>tete</u> derives from the earlier word <u>testa</u>. The phonetic similarity between the two terms is quite evident.

In the transition from A (where the earlier form is in use) to B (where the later form is used) there is an intermediate stage, C, during which time either meaning might be used. As time progresses, A is used less frequently and B is used more frequently until the transition is complete. In the example given by Whatmough, the word "pot" was originally used as a peripheral (and perhaps humerous)

In the transition from (A) to (B) there would be an intermediate stage (C) in which either meaning might appear, with a gradual decreasing frequency of (A) and a rising frequency of (B).



But (B) starts as merely peripheral to (A)

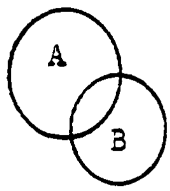


Figure 5.3 (Whatmough 1960:78)

synonym for "head". Gradually the slang term came to be used more and more frequently until it gradually came to replace the "correct" term.

As this semantic transition was progressing, phonetic shifts also occurred, and by the time Latin had differentiated into its various Romance descendants, the word for "head" had lost all connections with the earlier word for "pot". The earlier word for head (caput) had long since disappeared.

Figure 5.3 also illustrates a three-phase process that applies to more rapid forms of linguistic change. First an individual learns an alternate speech pattern. For some unspecified time he is familiar with and uses both forms. Then one of the forms becomes obsolete (Weinreich 1968:184).

The same sequence of events seems to occur when new sounds and meanings are borrowed from other languages. Malkiel (1968:15) has observed that a lengthy period of bilingualism is necessary before any sizeable diffusion of elements from one dialect or language to another can happen. As borrowed forms are adopted within a population, the language as a whole can experience a series of infinitesimal shifts in its inventory of sounds, meanings and vocabulary. The whole process leads to evolutionary change.

More recent examples of semantic shift might include the words "ghetto", "pig", and "fascist". Whereas "ghetto" originally referred to certain neighborhoods in eastern European cities that were surrounded by walls and were guarded by soldiers who prevented any of the inhabitants from leaving, it now refers to any neighborhood in the

United States inhabited primarily by individuals of African descent. "Fascist" used to refer to anyone who believed in a modern industrial dictatorship, the more or less private ownership of the means of production, militarism, and the racial superiority of one's own people. It now seems to refer to anyone who is violently disliked. "Pig" used to refer to an animal that Moslems and Ethiopians found particularly revolting. It is now used to refer to members of the constabulary.

Meanings change through time. Sometimes new meanings drive old ones out of existence. Sometimes they do not. It could be that Gresham's Law describes the usage of words in a speech community in much the same way that it describes the flow of money within an economic community. Bad words and bad meanings might drive good ones out of circulation. Bad words would be those that have come to be applied to so many different things that they have lost the ability to refer to anything specific at all.

In religious lineages shifts in meaning are also widespread. This process is exemplified in the history of the Jewish holiday, Passover. In Hebrew the word for this holiday is Pesach. Schauss (1965:495) points out that Pesach was originally a nature festival celebrating the ripening of crops after the winter rains of the Mediterranean region (Sopher 1967:20). It was later altered into a historic holiday celebrating the Exodus of the Jews out of Egypt. When Christianity evolved out of Judaism, many Jewish customs were retained. The observance of Pesach was one of these. In Christianity, however, Pesach survived with a changed meaning. It continued to be observed at the same time of year, but it became a celebration of the crucifixion and resurrection of Jesus. The continuity of form is reflected in the word for this holiday in Latin and Greek (Pascha), Italian (Pasqua), Spanish (Pascua), French (Paques), Norwegian (Paske), and Russian (Paska). In England and Germany the name of Pesach was changed to Easter and Osterfest, which reflected linguistic survivals from the earlier Teutonic religious traditions (with changes of meaning). Interestingly, the Anglo-Saxon and Germanic festivals honoring the dawn goddess (Eastre in the Anglo-Saxon dialects and Ostern in the German dialects) celebrated the end of winter and the coming of spring.

Form Shifts

When semantic shifts occur, the outward form of an element remains the same while its meaning changes. When form shifts occur, the outward appearance of something changes while its function or meaning stays the same. When individuals gradually cease calling something gasoline and begin calling it petrol or oatmeal, a form shift is taking place. In this situation the word "gasoline" is not undergoing a change in outward appearance or sound. Instead, there is a shift in preference to another form that is entirely different from the original one.

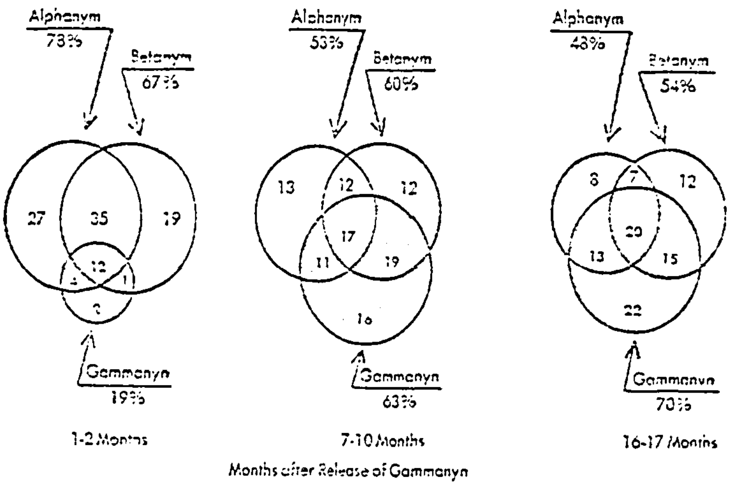
Gasoline has many functions. One of these is to serve as a fuel in internal combustion engines. If this function gradually comes to be served by methane gas, then gasoline will have been replaced by something with the same function but a different form.

In the economic realm, shifting preferences among those who purchase goods and services produces a pattern of change identical in operation to shifting preferences in the linguistic and behavioral realms. Figure 5.4, for instance, shows how one particular product captured 70% of the market in four small Illinois towns. As the new product gained in popularity, the others gradually lost ground. Carried to its logical conclusion, we might find the older products finally being driven out of the market place altogether. The numerical expansion of one element would then have caused the numerical contraction and eventual elimination of two others having the same purpose and function.

Note the similarity between Figures 5.4, 5.3, and 5.2. Shifting preferences among available products in the economic realm has resulted in the development of a new norm in Figure 5.4. Shifting preferences among vocabulary elements in Figure 5.3 also results in a new norm. In both of these examples, the norm is the element with the widest usage.

Functional Shifts

Another way in which norms shift through time is through changes in function. Functional changes occur when the outward appearance of something (its form) persists while its purpose or function changes. The function of most religions, for example, includes such things as providing metaphysical explanations, justifying group values and customs, enhancing group solidarity, placating fears, and offering rationalizations for the existence of evil. Religion also keeps the poor from murdering the rich. These functions can change and others



GRADUAL SUPERSEDENCE OF TWO EXISTING DRUGS BY A NEW DRUG, GAMMANYN

Figure 5.4 (Rogers 1962:92)

can take their place.

Many religions have food taboos. The original function of these beliefs may have been to keep people from poisoning themselves on unfamiliar or improperly prepared food. Gradually these taboos acquired other functions, among them being the prevention of contact and interbreeding with other groups. Today, in most of the English-speaking world at least, various governmental agencies have assumed the role of protecting the public from unclean or tainted food. In many places, then, food avoidance patterns that derive from particular religious beliefs about cleanliness have become redundant. Those that persist do so because their secondary functions have survived and continue to place restrictions on commensality and intermarriage. What were latent functions have become primary functions.

Another example of a shifting functional norm can be seen in the changing role of the domesticated horse. Horses used to provide transportation. In the industrialized world they now provide entertainment.

Structural Shifts

Structural shifts involve changes in the way that various elements are organized in relation to one another. In language this refers to changes in such things as grammar, morphology and syntax.

Linguists classify languages into different structural groups according to how they resemble each other in such characteristics as word order, method of modifying roots, use of prefixes and suffixes, method of fusing and juxtaposing, use of internal transformations, use of stress, and use of tone. From these features different types of linguistic structure can be identified. Different languages are thus often said to be isolating, agglutinative, inflective, symbolic, prefixing, suffixing, fusional, analytic, synthetic, polysynthetic, pure-relational, or mixed-relational (see Sapir 1949:122-143 for an explanation of these terms). These are all formal categories which have nothing to do with phyletic descent--a distinction noted by Radcliffe-Brown (1968:164).

When entire languages shift from one of these types to another, structural change occurs. The different categories themselves define the direction of change. Structural change also occurs when isolated parts of a language undergo these shifts.

Other aspects of culture exhibit structure in much the same way that languages do. One can speak of the structure existing within such things as religion, commerce, government, kinship, social control, law, communication, education, warfare, science, and play. Each of the societal subsystems can be categorized into formal types. Directional change then manifests itself by shifting toward or away from one of the identified forms.

Religion provides one illustration of how these subsystems can be classified into structural types. Sopher (1967:4) has categorized religions into simple ethnic, compound ethnic, complex ethnic, universalizing, and segmental systems. At the same time, religions can be pantheistic, polytheistic, monotheistic, dualistic, atheistic, or animistic. William James (1902) identified sacramental, prophetic, and mystical types of religions.

Entire cultures can also exhibit structure. They are frequently divided into formal categories based on these structural characteristics. Sometimes these categories are associated with a theory of history, sometimes not. Benedict (1959:79) identified Dionysian and Appollonian cultures while Spengler (1932) saw Appollonian and Faustian. Freud distinguished between oral, anal, phallic, and sadistic social structures, while Talcott Parsons characterized different societies as having achieved or ascribed patterns of status, universal or particularistic patterns of social mobility, and specific or diffuse social relationships (Parsons 1964:101-110, Voget 1975:441).

Sorokin (1962) categorized societies according to whether they were ideational or sensate and saw historical change as the oscillation of societies back and forth between these two extremes. Other scholars have found introverted and extroverted societies (Sapir 1966:170); tradition-directed, inner-directed, and other-directed societies (Riesman 1953:23); achievement-oriented, affiliation-oriented, and power-oriented societies (McClelland 1967:43,438); and theonomous, heteronomous, and autonomous societies (Tillich 1972:xxiii).

During the last century, when Social Darwinism was enjoying its greatest influence, it was common for scholars to identify successive stages of cultural evolution. Retardation, savagery, barbarism, civilization, and enlightenment were terms frequently used to label these stages. Quite often these terms were purely descriptive in nature and were used to buttress the notion that societies evolved in a unilinear and progressive fashion. For most developmental evolutionists of this period, the direction of cultural change was upward. Evolution was thus advancement and improvement. Because of this it was a common practice to define each stage on the basis of various structural elements arranged along a scale ranging from primitive and simple to advanced and complex. Passing from one stage to the next represented major structural shifts in the culture of different groups. Cultures passed from something to something, and directionality could be inferred from the conditions that were thought to exist before and after each shift. This led to the identification of many different kinds of structural change, which might have been perfectly acceptable even today had they not been so rigidly tied to notions of cultural advancement and sequences of upward progress.

One of the leaders of this school was Lewis Henry Morgan. In his book _Ancient Society_ (1877:389) he identified two primary types of social organization, which he called _societas_ (ancient society) and _civitas_ (modern civil society). Change from _societas_ to _civitas_ involved a major structural shift from organization based on personal relationships and kinship to organization based on property rights and place of residence. Maine (1963:165) found a similar kind of structural shift occurring when societies based on status relationships (where rights and obligations were defined by one's position in a family) evolve into societies based on contract relationships (where rights and obligations were independent of family ties).

Redfield's (1947) distinction between folk and urban societies, as well as the shift from _gemeinschaft_ (family and village social organization) to _gesellschaft_ (city and state social organization) described by Tonnies (Timasheff 1955:98), the shift from organic to mechanical solidarity described by Durkheim (1964:260), and the distinction between natural and political commonwealths made by

Hobbes (1939:177) were all similar to the schemes of Morgan and Maine.

Other well-known versions of structural change include Auguste Comte's progression from theological to metaphysical and positivistic systems; Herbert Spencer's sequence of change from communal to militaristic and industrial forms of social organization; Griffith Taylor's successive stages of theocratic, geocratic, and weocratic forms of culture; W. W. Rostow's transition from traditional to mature and mass-consumption societies; Karl Marx's stages of primitive communism, feudalism, capitalism, and socialistic communism; and Thorstein Veblin's peaceable, predatory, status, emulative, and pecuniary stages of culture (Veblin 1934:197, 215, 305, 390; Voget 1975: 191; Taylor 1951:4; Rostow 1963:4-11).

Most of these schemes are out of favor today because of their association with the idea of progress and improvement, which implied evaluative standards. As Collingwood (1972:321) has pointed out, however, social and cultural evolution would never have become an objectionable concept if it had referred only to the modification of things in an orderly sequence (i.e., one thing after another).

A major objection to studies that generate developmental classifications is that the whole approach is teleological. As Myrdal (1968:1851) has pointed out, such an approach assumes a purpose while at the same time presenting an inevitable sequence of stages as evidence that this purpose is being fulfilled. Each writer has a different destiny in mind and each one adjusts his theory and gives illustrations to fit these preconceptions.

Structural classifications are based on how individuals organize their behavior in particular places. Embedded within these organizing structures are individual behavioral elements and culture traits. When structural shifts occur, the relationships between these elements are transformed.

Many scholars are concerned only with these structures and tend to ignore individual elements. Malinowski (1969:33), for one, has pointed out some of the difficulties in analyzing culture on the basis of individual traits. He argues that most traits cannot be isolated as real things since they do not appear independently of each other. Boats, for instance, can have blunt, round, or sharp sterns, but bluntness, roundness, and sharpness cannot exist alone even though these designs are culture traits capable of being transferred between different places. Malinowski felt that to treat culture in terms of these individual elements was to court error. Instead he relied on functional explanations and preferred to analyze culture on the basis of observable processes linking these traits together. Malinowski was no Platonist.

Stemming in large part from Malinowski and other leading functionalists, there are many today who will claim that places and cultures are not simply the sum of their elements but are instead the linkages and interactions of these elements. Elements do, however, exist independently. To paraphrase Anselm, they exist in the understanding. From here they can pass to other individuals as ideas transmitted by ephemeral performances. Structures are also ideas existing in the understanding. Even though they organize and connect billions upon billions of other ideas and elementary bits of data into workable wholes, they are in the end nothing more than cultural elements themselves. The only difference is that structural patterns exist on successively higher and higher levels of abstraction. At the highest levels of abstraction they form metaphysical paradigms and cosmologies. Structural elements at all levels of abstraction can be transmitted between places and between members of a population in much the same manner as single cultural traits, except it probably happens far less frequently. If the interactions of culture traits and behavioral elements are really just other culture traits and behavioral elements, then places and cultures are indeed the sum of their elements.

Paradigm Shifts

Thomas Kuhn (1971) has written about paradigm shifts as something that happens when there are revolutionary changes in scientific thought. He was primarily concerned with how change occurs within scientific communities, but he readily admitted (1971:208) that the same processes applied to other communities as well. He noted that historians of literature, music, art, and political development have been concerned with the same revolutionary breaks in style, taste, and institutional structure.

Paradigms, to expand somewhat on Kuhn's (1971:43,175) definition, are hierarchies of knowledge, technique, theory, belief, value, and commitment shared by members of scholarly communities held together by common jargons and informal communication networks. These constantly changing communities form a hierarchical structure with individuals belonging to a number of them simultaneously. Within each community there are concrete past achievements that become part of its hierarchy of beliefs, values, and techniques. These past achievements serve as models or examples for the solution of problems. They also serve to identify which problems will be investigated. An individual can become a member of a community by acquiring its paradigms and accepting its commitments. At the highest level of abstraction these paradigms are world views that blend imperceptibly into metaphysics.

Paradigm shifts take place when individuals switch their allegiances from one body of theory to another. This can occur when problems change or when existing theories fail to explain new phenomena as well as some of their competitors. The position of the competitor is crucial. Without a competitor, a paradigm shift does not occur.

Taking a neo-Kantian position, Kuhn (1971:113,150) points out that paradigms are prerequisites to perception itself. Individuals with different paradigms literally see different things. When new paradigms are constructed, old terms and concepts form new relationships with one another. After discovering oxygen, for instance, Lavoisier lived in a world different from that of his contemporaries (Kuhn 1971:118).

A paradigm shift is a conversion experience which involves changing perceptions. Like a gestalt shift, it cannot be forced and it must happen all at once or not at all. This abrupt shift happens within individuals. Within groups, there is a gradual shift in allegiance from one paradigm to another. As the new one is adopted the old one is discarded. This frequently occurs when the holders of old paradigms die out and are slowly replaced by younger individuals who adhere to new paradigms (Kuhn 1971:151,158). The process is the same as the one shown in Figure 5.4.

Orientation of Shifts

When there are temporal shifts in norms and ranges of variability there are also directional shifts. This is not to say that such changes are unidirectional and non-reversible or that they are necessarily predictable.

There are two kinds of direction that evolutionary change can take. As was pointed out in the last chapter, these include inward and outward evolution (where movement is toward or away from previous conditions within the same place) in addition to convergence and divergence (where movement is toward or away from conditions existing in other places). There is also a third kind of directional movement that describes specific tendencies and is independent of the first two (although it may coincide with the first two). It is this kind of directional heading that individuals writing on cultural change usually try to identify. Three representatives of the many alternative directional orientations suggested in the literature will be presented here: least effort, rationalization, and elegance.

Least Effort

Zipf's principle of least effort has occasionally been used to explain why things change in particular directions. This principle holds that in situations allowing alternatives we choose those procedures that result in the least amount of probable work (Zipf 1949, 1947:627).

In linguistics this can lead to such things as slurring ("an" for and, "wadduh" for water, "gotcha" for got you), clipping ("lab" for laboratory, "gym" for gymnasium, "bus" for omnibus), and the formation of contractions ("isn't for is not, "didn't" for did not). Examples like these can go on indefinitely. In geography this principle has led to such formulations as Hotelling's ice cream vendor model, Reilly's law of retail gravitation, and von Thunen's rings. It is also implicit in the gravity model.

The Augustinian view of human nature assumes, however, that men always act rationally--a position that is no longer accepted (see Pareto 1935:148, Simon 1952, and Pred 1967:8-10). Even though Zipf's principle appears to have some merit, it does not seem to have made much headway in either social theory or linguistics and has been largely ignored by scholars in these disciplines (Greenberg 1968:265, Timasheff 1955:202).

Rationalization

Another possible heading that change might take is in the direction of rationality. This is the classic position taken by Max Weber, who stressed that man has constantly through time rationalized and made subject to calculation and prediction what in earlier ages had been regarded as chance occurrences.

Examples of this directional trend include such things as the elimination of magical procedures in religion, the displacement of personalized systems of justice by the impersonalized codified systems of the modern world, the decline of musical spontaneity in favor of the precise and rigid notational standardizations of modern symphonies, the rise of modern accounting systems, and the growth of modern corporate bureaucracies (Weber 1958:26, Coser 1971:233).

A similar position has been taken by Galbraith, who has made the growing ability of modern corporations to reduce risk and to increase their capacity to control and predict their own destinies through rigorous planning and acquisition of their own sources of capital a central thesis of his book The New Industrial State (1967). Elsewhere, Parsons (1964:499) has written that when social systems change, the idea that they change in the general direction of rationality has a considerable amount of validity.

Elegance

A third possible orientation of change is in the direction of elegance. This may seem to border on mysticism, but such an impression is not intended. Elegance involves aesthetic appeal and it is one important factor in the acceptance of new ideas and theories (Kuhn 1971:156). Elegant directions are those which involve the extension of a society's values into wider and more comprehensive contexts. Elegance also involves symmetry in the sense that the ideas, beliefs, and motives for behavior that people harbor must be consistent with each other. If they are not, agreements are difficult to come by, priorities are vague, and the possibility of internal dissension is increased.

Aesthetic judgments are also part of the perception process. As Kuhn (1971:195) and Lowenthal (1961:250) have pointed out, appropriately programmed perceptual mechanisms have survival value. The person who believes he is a poached egg, for instance, is at a distinct disadvantage when it comes to survival in most environments. Appropriate actions insure survival in hostile environments. Decisions and choice precede action and aesthetic judgments are part of the decision process.

At the lowest level of abstraction, perceptual mechanisms exist as fight/flight, approach/avoidance, Ayer's (1946:102-114) bah/hurrah, and Pepper's (1958:267) appetition/aversion reflexes. These reflexes are primitive aesthetic judgments. Judgment occurs in terms of good/bad, true/false, beautiful/ugly, and dangerous/benign. Reflexes like these, based on conditioning, have considerable survival value in Skinner's (1965:55) opinion.

At the highest levels of abstraction, perceptual mechanisms exist as cosmologies and world views (Jackson 1952:7, Lowenthal 1961: 242, Tuan 1971:21). A cosmology may be more or less unconscious or it may be highly formalized in the guise of some religious or political tradition. Once established, cosmologies become manifest in the aesthetic and evaluative judgments of their adherents (Tuan 1967:7).

The construction of cosmologies and theories that explain the unknown result from the same urges that produce works of art. Art here is to be taken in its commonly accepted meaning, although in its broadest sense, all artifacts, whether ephemeral or durable, utilitarian or non-utilitarian, are works of art.

As an illustration of how this can happen, consider the ability of the human brain to receive and process vast amounts of information about the outside world. That this has been a major factor in human survival is fairly well agreed upon. It has become so much a part of us that we now require this kind of stimulation all the time for proper functioning. Prolonged sensory deprivation leads to disorientation and madness, while sensory deprivation during infancy can lead to mental retardation. The habits of judgment and aesthetic creation have also become ingrained. So much so in fact, that they have become activities engaged in for their own sake.

Mace (1968:292) has discussed such reversals of the means-end relationship and points to an analogy with the domesticated cat, which has all of its bodily needs provided for but which still chooses to pass much of its time prowling for young birds and mice. For the cat, hunting has become an aesthetic activity. It no longer kills to live, but instead lives to kill. The behavior that once insured its survival still continues even though survival has now been insured through other means. So with man. The search for elegance and the aesthetically appealing has become an end in itself, thus injecting an element of instability into things as they are at any given time. It is possible that what we call art is deeply involved with the satisfaction of a biological need (Mace 1968:285).

Aesthetic judgments are socially determined. What constitutes elegance in any given situation is a matter of agreement and the collective weight of local opinion. What constitutes art can also be a matter of agreement (Dickie 1971:102). Kuhn (1971:161) has shown that shared agreement is of immense importance in the definition of scientific truth. Perry (1954:13) identifies value in much the same way, that is, observable facts of shared interest (for or against) determine whether something is good or bad, beautiful or ugly, valuable or worthless.

That aesthetic judgments are socially determined has enhanced survival. Shared values add an element of predictability to social situations (Kluckhohn 1951:400). Within-group predictability has enhanced social cooperation which in turn has contributed to group survival. Things that are a matter of agreement have been selected through time as things that have either enhanced survivability themselves, or have been held by groups that have survived for other reasons.

As Figures 5.2 and 5.4 show, agreement can change through time. Agreement also varies spatially. According to Simpson (1966:35) this may have survival value. In the natural world, organic species can survive under changing conditions because variability within them already exists. Similarly, adaptive change within cultural systems is facilitated if they vary among themselves before conditions change. Variability between places in such things as values, ethical standards, and notions of elegance is thus desirable and in the long run possibly necessary for survival.

Creation of Strain

If everything moved in the direction of least effort, rationality and/or elegance, then all parts of a system might maintain constant relationships with one another and change would be a fairly smooth process. Unfortunately, change in one part of a system immediately sets up small situations of disorder, strain, and conflict with other parts of the system.

Inconsistency

One example of conflict and disorder can be found when the mechanization of industry eliminates the need for certain kinds of workers. The resulting unemployment becomes a point of strain in a society. In the words of Alvin Gouldner (1971:76-78) these workers also become useless people. If this occurs in a place where the population adheres to a utilitarian ethic, then there is a tendency to take these useless people and either eliminate them or rehabilitate them so that they become useful once again. This in turn may conflict with other social imperatives, such as the right to privacy or the right to a sense of dignity and individual worth. The society then finds itself on the horns of a dilemma in that it cannot at the same time satisfy two ethical commitments that were originally compatible or mutually supportive, but are now in conflict.

Conflicting parts of the American constitution provide many such examples of this kind of dilemma as do inconsistencies between codified rules of behavior and the kind of behavior that happens in actual situations. Within religious communities, inconsistencies and conflicts can result from changes in such things as personal needs, economic interests, political goals, ethnic and class differences, and social mobility among different groups within the community (Yinger 1970:233).

In the history of science similar inconsistencies arise when new situations or new discoveries cannot be explained by existing theories. Kuhn refers to these situations as anomalies. When anomalies inside a given area of inquiry start to multiply, a period of conflict or strain begins. During this time there are shifting allegiances between competing theories. Kuhn refers to this as a period of crisis that precedes a scientific revolution.

Lag

Temporal shifts will also produce lag. According to Ogburn (1928:200) paradoxes, inconsistencies, and strain arise when change in one part of the social system lags behind change in other parts. Thorstein Veblin put the matter more strongly. In his view (1934:191) cultural institutions are the product of past processes and are adapted to past circumstances. They are therefore never in accord with existing conditions.

Some examples of this occur when protective legislation for workers lags behind a rapidly developing factory system or when political reapportionment lags behind shifts in the population (Timasheff 1955:205). It is also fairly well established that opinions and beliefs change much more slowly than actual behavior (Berelson and Steiner 1964:576).

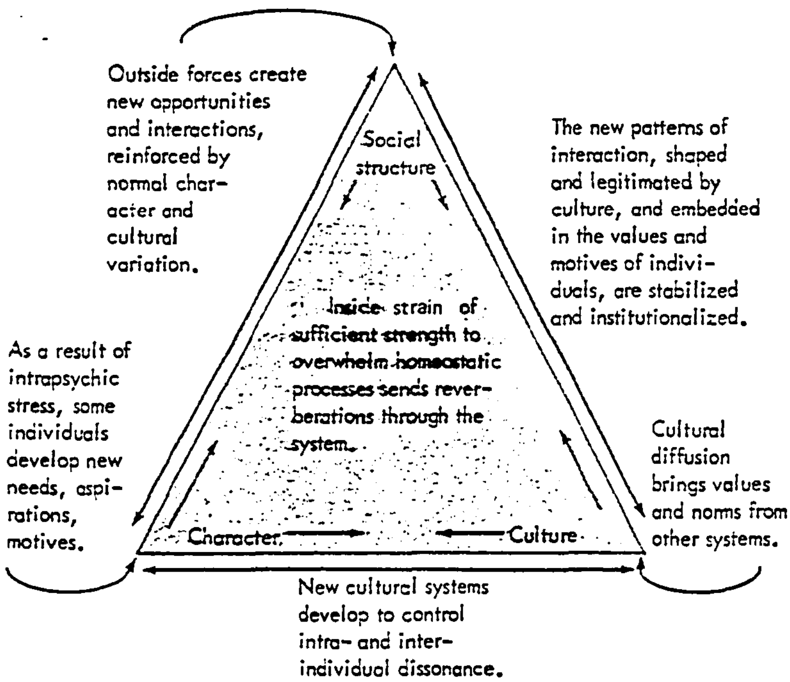
Ogburn felt that lag was initiated when changes occurred in the realm of material culture (production and exchange). Like Marx, Veblin, and Sumner, he believed the nonmaterial aspects of culture (customs and beliefs) changed at a much slower rate and lagged behind technological changes and changes in the economy. The material culture of Western society, for instance, has changed enormously since the Industrial Revolution, yet many family, social, and political institutions remain in the form they had prior to the Industrial Revolution. These may have been compatible with conditions existing in the pre-industrial world, but a number of them are not suited to the material culture of today. The social disharmony that results is a consequence of cultural lag.

This form of technological determinism has not been universally accepted. Sorokin (1962:356) for one, argued against the proposition that changes occur first in material culture and that non-material culture lags behind. At the same time, he presented evidence that changes occur first in the fields of religion and social organization. Kroeber (1944), like Hart (1949:13) went further and found no correlation at all between changes in different aspects of culture. If the structural model as presented in this dissertation is any guide, it should be apparent that any element of culture can be at different times both an independent and a dependent variable in the process of change.

Strain

All of these inconsistencies, anomalies, paradoxes, conflicts, disharmonies, and conditions of disorder lead to strain (Figure 5.5). Strain is manifested in such phenomena as poorly socialized individuals and the upsetting of existing patterns of social coexistence. Many scholars consider strain between the various elements of a social system to be the major disturbing force promoting change. Others do not. Parsons (1964:493), for example, did not regard strain as a primary change agent itself, but saw it rather as the point where preservative forces acting to re-establish previous states of equilibrium clash with forces promoting transition to new structures. This view, however, assumes that equilibrium is a normal condition, which is not at all certain. Sorokin's principle of immanent change is of interest in this respect.

According to Sorokin (1962:589) the second part of Newton's law of inertia (that a material body in a state of motion will move in a linear direction at a uniform rate simply because it is in a state of motion) has been neglected in discussions of cultural change. He points out that it is usually assumed that any cultural phenomena is in a state of rest or static equilibrium, and remains so until some external force causes it to change. Instead, Sorokin feels change is an immanent consequence of a system's being a going concern. Its



A field interpretation of social change

Figure 5.5 (Yinger 1970:391)

functioning makes change inevitable and it changes by virtue of its own forces and properties. It cannot help changing, even if all its external conditions are constant. External conditions act as agents of deflection rather than of impetus.

It may thus be possible for changing social systems to move in the direction of equilibrium without ever attaining it. Parson's forces that promote the re-establishment of earlier states of equilibrium would then become forces promoting the return to a previous direction of change.

Direction of Readjustment

As Veblin once noted (1934:201), change in one part of the social fabric can provide a motive or impetus for change in other parts through an internal striving for harmony. The aesthetic part of human behavior seems to dislike chaos or paradox and efforts to overcome cultural inconsistencies appear everywhere. There seems to be, at least in the West, a pronounced reaction against cognitive dissonance (Festinger 1957:265, Parsons 1964:499). The more that people are subject to social inconsistency, and the more that their attitudes and beliefs are out of harmony with each other, the more they are likely to change some of them (Berelson and Steiner 1964:578).

Strain arising between elements of coexisting religious and political systems, for instance, may bring about the alteration of one system to conform with the other. This took place in the United States during the nineteenth century when the Mormons, in responding to pressures from the American government, discovered (in the words of

Bertrand Russell) that their divine revelation about polygamy was no longer binding. After a readjustment in belief took place, Utah was admitted to the union as the 45th state. Inconsistency and disharmony can also bring about a new synthesis, much in the manner of the Hegelian dialectic.

The history of science is a record of the emergence of paradoxes and of their being worked out. The inability of a body of theory to account for certain persistent and crucial observations can bring about the abandonment of an existing paradigm in favor of a new one. The abandonment of alchemy, the Ptolemaic universe, the phlogiston theory, and Neptunist geology are cases in point (Kuhn 1957, Conant 1950, Geikie 1962:215-263, Dampier 1971:50-52).

Occasionally the paradoxes arising from conflicting theories are resolved through the creation of new theories having broader and broader application (Figure 5.6). Our propensity to organize, to correct, to regularize, and to create consistency is well documented in the development of scientific thought. The same tendency can also be found in the history of art, literature, and ideology. Any given synthesis, however, can never be regarded as final since it is not possible to know what anomalies will appear in the future (d'Abro 1950:399). Perry (1954:135) has transformed this impulse toward the harmonizing of conflict into an ethical principle.

Sapir (1949:186) noted two basic forces of linguistic change. These included a general trend in one direction and a readjusting or preservative tendency that sets in when the fundamental phonetic and morphological patterns of the language are threatened. The

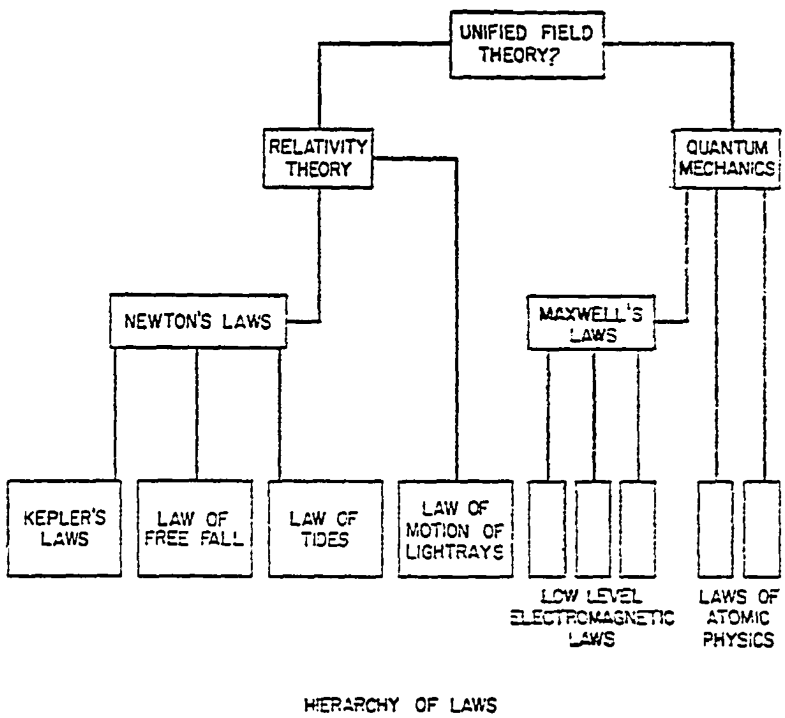


Figure 5.6 (Kemeny 1959:168)

speech of each individual in a language community exhibits slight variations from everyone else, particularly in phonetics. What keeps these speech forms from diverging too greatly within the community is that each person unconsciously corrects himself whenever his speech violates the community's consensus of usage (Sapir 1949:148). This consensus is imposed by the social role of communication (Swadesh 1971:8). If a person's speech habits become too idiosyncratic, then nobody can understand what he is saying. This unconscious correction occurs in all other aspects of culture as well.

Pareto also emphasized the importance of the readjustment process. He felt that within every society there are inner forces maintaining an overall pattern. These forces insure that change occurs evenly within a community. They also tend to correct impulses for change that cross some invisible threshold separating moderate and acceptable from radical and unacceptable alternatives. When a social system is subjected to inconsistency and strain these forces work toward the restoration of some kind of equilibrium (Timasheff 1955:160). The preservation of useful features is one possible function of this readjusting tendency (Weinreich 1968:142). In some situations change is too great for these readjusting processes to overcome. This is most likely to occur when the original impetus is reinforced by changes in other parts of the system (Yinger 1970:389).

According to James Feibleman (1946:158-179) the evolution of entire civilizations can be explained by this regularization impulse. A civilization begins with the acceptance of certain first principles which represent crucial events and ideas associated with its founding.

Thereafter, the society in question moves toward the ultimate consequences of these first principles (Feibleman 1946:335-340, Cairns 1973:482). When these principles have been worked out to their logical conclusions, the culture reaches its height. Frequently these conclusions are contradictory or paradoxical. When this happens, strain mounts within the system. Corrections and adjustments designed to erase the absurdities then follow.

Humor is a common response to incongruity, and a society's attitude toward comedy is often a sign of how extensive its paradoxes and incongruities are (Cairns 1973:483). Comedy, by criticizing disorder, indirectly affirms how things should really be. Presumably, a civilization of advanced age, having worked out most of its paradoxes, would be devoid of humor and comedy.

When there begins to be a scarcity of untried consequences, the culture loses its energy and its momentum. Decline then sets in. Kroeber (1944:763) and Sorokin (1962:729) have expressed the same idea. Like Davis' geomorphic cycle, however, few lineages get the chance to reach "old age". They are all rejuvinated or destroyed by various processes which include diffusion, cultural hybridization, foreign conquest, and assimilation long before they might reach senescence (Feibleman 1946:156). There would also be an unending supply of paradoxes to be worked out, since they would be coming into existence continuously.

Figure 5.7 illustrates one view of how the readjustment process affects long term change. It might be kept in mind, however, that gradual and imperceptible change is probably more common than sudden readjustments (Uitti 1969:251). If gradual change occurs in the

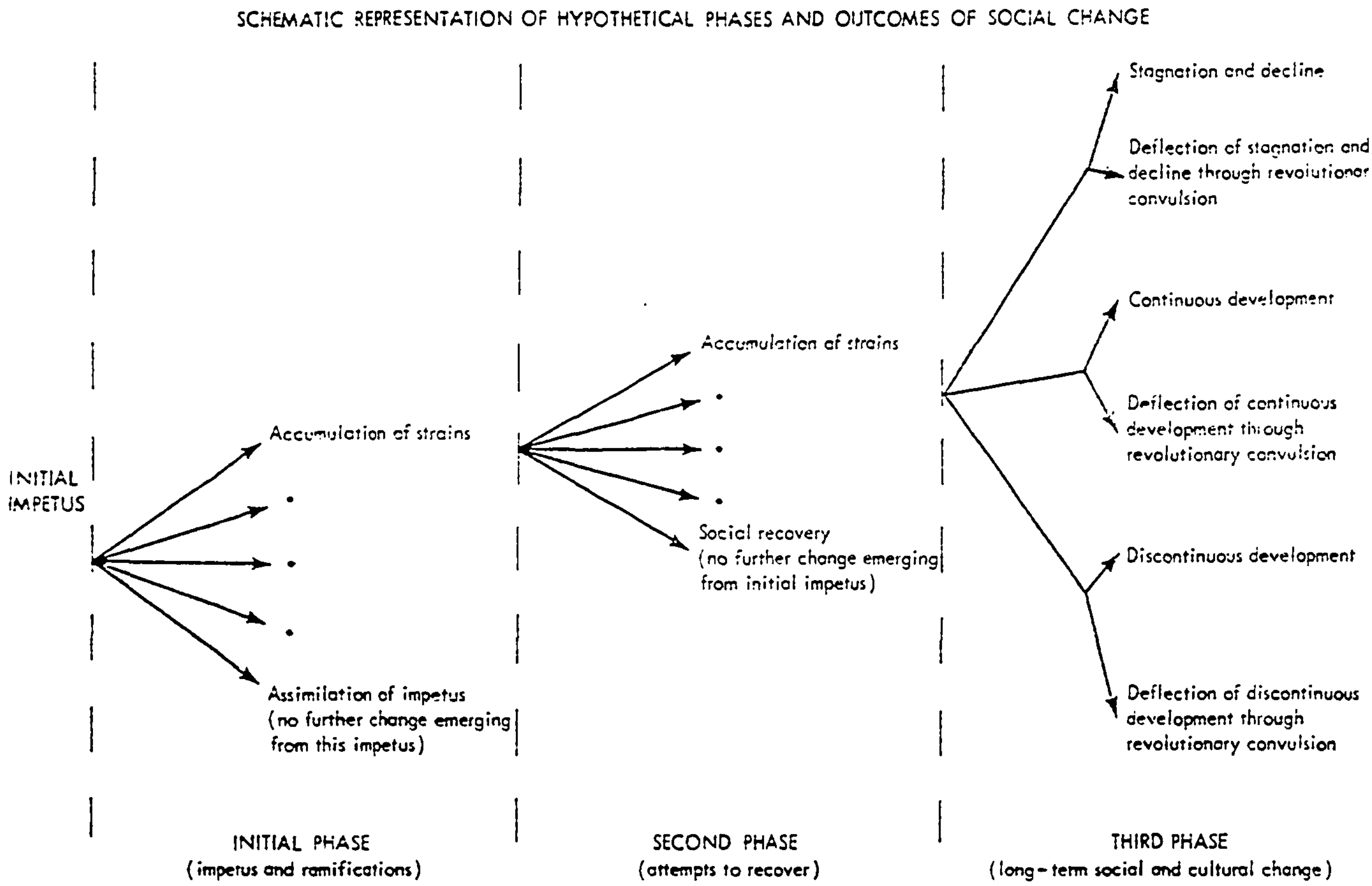


Figure 5.7 (Smelser 1968:277)

direction of least effort, rationality, and elegance, then readjustments occur in the direction of consistency, wider application, harmony, symmetry, agreement, and consensus of usage. At the same time, the direction of change can be inward or outward. These two alternative headings depend on comparisons with earlier conditions rather than on absolute standards. In the absence of any evidence to the contrary we can assume that most change proceeds in an outward direction. This would be in addition to whatever absolute headings change might take.

Harris (1971:134) has commented that we can never assume that a population is aware of the nature of its own institutions or the directions in which they are changing. The people who lived during Rome's decline and fall, for instance, had no idea that it was falling.

Harris sees a kind of blindness associated with movement toward the future. Koestler (1973:15) compares this movement to that of a sleepwalker. In discussing the history of scientific thought, Kuhn (1971:139) notes that there is a widespread tendency to make it look linear, unidirectional, and cumulative. In the succession of theories, however, he finds no coherent direction at all. Instead, there are many instances of reversion to previously discarded theories (1971: 105). Parsons (1964:499) and Watson (1969:ix) make the same observations. Koestler (1973:15, 513) notes the zig-zag course of scientific thought. This has included delusional pursuits, regressions, and periods of amnesia.

The progress of science, language, religion, and other cultural lineages have not manifested movement toward anything except outwardness and consistency. We can observe how lineages have changed in the past, but we cannot as yet predict their future courses, although some thinkers like Marx and Tielhard de Chardin have claimed this ability. Figure 5.8 gives some indication of the kinds of directional change that have been presented in various theories of history.

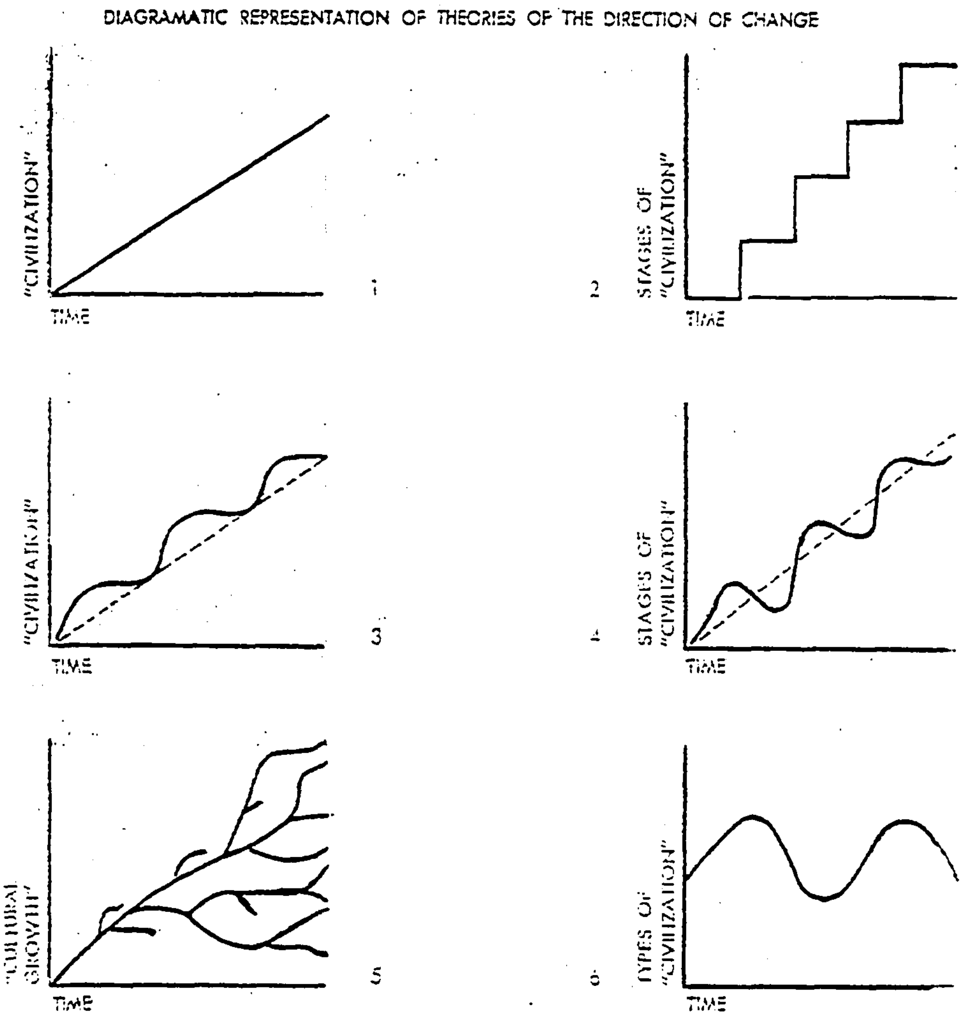


Figure 5.8 (Moore 1963:38)

Chapter 6

ESTABLISHMENT OF IDEAS

SELECTION

Innovation and borrowing increase the range of variability within a place. Once variability exists, selection can occur. It is the differential selection of various elements within a place that leads to evolutionary change.

Many possibilities exist to explain why some variants are selected by individuals in a population and others are not. Barnett (1953) and Taylor (1969) suggest a number of factors which affect conscious choice. These include such things as advantages and penalties accruing from acceptance, compatibility with already existing cultural patterns, advocacy, personality of an advocate, and personal relationships existing between potential adopters and an advocate. The reasons for unconscious choice are less apparent.

Innovation is the ultimate source of variability. Variations can be introduced into a place from the outside or they can be innovated locally. Selection occurs when they are adopted or rejected.

Innovations are works of art that have not been witnessed before. Most of what we do can be regarded as art in the sense that we do things which others must evaluate. In the final analysis this evaluation is an aesthetic act upon which survival depends (see Mace 1968:292 and Pepper 1958:662-73, 1969:184-86 on the survival theory of value). In the words of Kuhn (1971:195,96) appropriately programmed perceptual mechanisms have survival value. These mechanisms have been selected for their success over time. The most successful perceptual mechanisms, like the most successful innovations, have been those which have tended to increase population size and energy production. As Harris points out (1971:152) this has been true because larger and more powerful social entities have tended to replace or absorb smaller and less powerful ones.

Artistic works are usually thought of as comprising only a small fraction of human activity. It is not clear, however, that there is anything separating the work of a painter or a novelist from that of an engineer, an auto mechanic or a garbage man. They are all doing things. These things can be unique or repetitive, difficult or easy, challenging or routine. The things being done are performances.

Some performances are ephemeral, that is to say, once they are completed nothing remains of them but a memory. Other performances yield artifacts. A distinction can be made between doings and creations, but they are both performances.

A tour guide, a bank clerk, a night club singer and a Salvation Army drummer perform in front of witnesses. Their actions are subject to evaluation by an audience. In a slightly different way, the actions of a brick layer and a sculptor are judged by finished artifacts. Performances witnessed by others are judged to be good or bad, valuable or worthless, original or imitative, dangerous or harmless, attractive or repellent. The only distinction that can be made among these various performances is that they are judged on the basis of different criteria. An outstanding thief, for instance, exhibits qualities differing from those of an outstanding general or a successful poet.

Performances diffuse through dispersal and adoption. Those which are judged positively are more likely to be adopted than those receiving negative evaluations. Artifacts diffuse by being passed from hand to hand. Adoption occurs through possession. Ephemerals diffuse through repetition.

Many performances possess symbolic content. When these performances are witnessed, ideas can pass between individuals, thus carrying out an act of cultural reproduction. Ideas diffuse through the spread of material performances (artifacts such as books, magazines, pictures and signs). They also diffuse through the repetition of ephemeral performances (speeches, conversations, radio broadcasts, concerts, plays).

Some performances are original and innovative. Most are not. It might be expected that where originality is prized, change will be more rapid. Innovative performances can become established or they can die before establishment. Those which become established are bought, consumed, believed, used, replicated, worshipped, initated or otherwise adopted by individuals other than the innovators. Adopted innovations tend to be passed on to others. They need not be passed from an innovator to an imitator, however. They can also be introduced into a new area by a propagator (see Redlich 1953:302 on the importance of these middlemen).

The establishment of innovations can be divided into two components. These include the inward diffusion of new ideas ($DifIn_{ji}$) and the establishment of local innovations (EstLIn). As Formula 6.1 indicates, the overall establishment of innovations is determined by the intensity of these two component processes.

ESTABLISHMENT AND ADOPTION

In the geographic literature, adoption usually refers to a purposeful human act associated with the diffusion process. Confusion sometimes exists, however, as to whether the word diffusion refers to a numerical or a spatial process since one can occur without the other and the term is usually applied to both. In either process the act of adoption is the point of transfer. Diffusion does not occur until after adoption. Unless adoption takes place, all movement is without issue.

Movement without establishment or adoption is called dispersal. Information, for instance, can be dispersed outward in all directions via radio and television. If nobody receives the messages adoption has not occurred even though dispersal has taken place. It is as if thousands of dandelion seeds failed to take root after having been scattered by the wind. Where human decisions are not involved (as in, say, the diffusion of plants) this transfer point is usually referred to as establishment or colonization, with the completed process being called migration. Both adoption and establishment signify that something has successfully diffused from one place to another. Since human beings cannot simultaneously occupy the same spot, diffusion between individuals implies diffusion between places (no matter how minute the distance).

$$\underset{t_1-t_2}{\mathrm{EstId}} = \underset{t_1-t_2}{\mathrm{EstLIn}} + \underset{t_1-t_2}{\mathrm{DifIn}_{ji}} \tag{6.1}$$

In this sense, establishment and adoption have identical meanings, although adoption is the more inclusive term. All establishment is adoption but not all adoption is establishment since things that pass between individuals within the same place have already been established there.

The distinction between the two terms is important when considering innovative and non-innovative phenomena. Also involved are the effects of these phenomena on spatial and numerical processes. One such numerical process is expansion. As will be discussed more fully in chapter 9, expansion involves adoption but not the adoption of innovations. When innovations are adopted, they become established. Non-innovative things can only experience adoption, since they have already been established. On the other hand, all external things which are diffusing into a place (whether innovative or not) undergo establishment.

In order to reduce ambiguity, the continued adoption of something within a place should be referred to as expansion rather than diffusion. This within-place process can be either numerical or spatial expansion. Numerical expansion can occur when something is being adopted by an increasing number of individuals. While this is happening, the spatial extent of the element being adopted can remain constant. Spatial expansion occurs when the boundaries of the element are advancing and its spatial extent is increasing.

Once an innovation has diffused into a new place, continued inward diffusion is an example of numerical expansion. At the same time, the continued inward diffusion of replications of the same element (other members of a population) no longer brings something new since this element is no longer innovative or unique. How, then, is this continued between-place diffusion to be regarded? Before they become established the propagules are new in the sense that they have not been in the place before. Once the act of diffusion has been consumated they are no longer new because they now exist within the place. There need be, however, no initial distinction between the arrival of innovative and non-innovative elements, and we can regard all between-place movements as diffusion. The process is the same. Dispersal continues and if conditions suitable for adoption persist, repetitive establishment proceeds in exactly the same way as it does with new arrivals. The distinction between things that are new and things that are not new is important only as regards internal processes. These within-place processes occur only after establishment.

The term "establishment" has been chosen so that a single term will be appropriate for and descriptive of a process that happens in both the natural and the cultural realms. It has occasionally been said that diffusion processes in the natural world cannot be compared with diffusion in the cultural world because the elements of choice and conscious adoption exists only in the cultural world. This is only partly true. If we choose a more abstract term that describes only the act of taking root (becoming a part of the physical or cultural landscape), then it will accurately take into account the two different methods by which this occurs. In both the physical and cultural worlds a migrating element must be compatible with conditions already existing in a new place. In both realms there are forces which oppose and forces which encourage this process of taking root. Even though the physical and cultural processes involved are quite different, they are wholly comparable when a measure of compatibility is made. Just as the apple tree cannot diffuse into areas where freezing temperatures are seldom encountered, so also has bull fighting failed to diffuse into areas where cultural attitudes condemn the sport as something cruel and inhuman. In both cases the propagules are incompatible with existing conditions and are therefore inappropriate for adoption and establishment. Adoption occurs only in the cultural realm, but establishment can occur in both the cultural and physical realms. Establishment also happens to innovative and non-innovative phenomena.

COMPONENTS OF ESTABLISHMENT

Inward Diffusion of Outside Innovations

As Formula 6.1 indicates, one of the major sources of new ideas is outside places. When outside innovations diffuse into a place the effect is the same as when local innovations are adopted. The rate at which innovations might be expected to arrive from outside places will be covered below in chapter 8.

Establishment of Local Innovations

The rate at which local innovations are being established depends on the frequency of indigenous innovation (InRa) and the propensity of the local inhabitants to adopt the innovations (PrAd). In places where there are more innovations there are more opportunities for new ideas to be adopted than in places where the innovation rate is low. At the same time, if the local propensity to adopt (environmental suitability) is low, few innovations will be accepted. As

Formula 6.2 indicates, these two variables work in opposition to one another.

$$\mathrm{EstLIn}_{t_1-t_2} = \frac{\mathrm{InRa}_{t_1-t_2}}{\mathrm{PrAd}_{t_1}} \qquad (6.2)$$

Local Innovation Rate

Innovation is the process whereby variations in place characteristics come into existence. All mutations and recombinations are innovations. Hybridization and acculturation are frequently part of the innovation process. All innovations are things that did not exist before. This process will be discussed in more detail in the next chapter.

Propensity to Adopt

The propensity to adopt is one of the most important parts of the structural model since it affects not only qualitative and quantitative change within places, but also convergence and divergence between places. Actual adoption is called establishment. The propensity to adopt is one of its contributing factors. The propensity to adopt estimates the likelihood that something will be adopted, established, bought, consumed, or imitated.

The propensity to adopt is equivalent to the notion of environmental suitability. Among migrating plants, one of the primary factors associated with the success of a species when it colonizes a new area is the suitability or amenability of the new environment for that particular species. This includes such things as moisture, temperature, soil quality and competition from other species. In the cultural realm, environmental suitability entails other qualities. The propensity to adopt an element appearing for consideration within a place (at its point of entry, as it were) is unique to each place. It is also unique for each element dispersed into a place from the outside.

The propensity to adopt also plays a role in the act of consumption and the acceptance of things that are expanding within a place (both numerically and spatially).

The propensity for adoption increases as two of its four major determinants increase. These determinants include the variety and intensity of local demand (Dem) and the forces of imposition (ForImp), which tend to support the adoption of specific elements. Acting against these positive determinants are the forces of resistance (ForRes) and the window effect (WinEff), which determine which specific elements are appropriate for adoption (or establishment). Formula 6.3 illustrates the relationship between the propensity to adopt and these four determining factors.

$$\text{PrAd}_{t_1} = \text{Dem}_{t_1} \times \frac{\text{ForImp}_{t_1}}{\text{ForRes}_{t_1}} \div \text{WinEff}_{t_1} \qquad (6.3)$$

Demands

The variety and intensity of demands include an extremely large number of elements arrayed across the whole spectrum of social, political, commercial, religious, intellectual, and technological characteristics of a place. These elements include such diverse things as the need for more educational facilities, more consumer products, more wealth, more machines, better entertainment, less corruption, more prestige, more security, less chaos, better food, more gadgets, more enlightenment, and less painful ways of avoiding damnation. All aspirations, desires, wishes, and cravings are part of this factor.

Demand is influenced by at least three variables in the structural model. These include population (Pop), income (Inc), and desires, wants, and needs (DWN). Formula 6.4 shows how a place's level of demand is related to these variables.

$$\text{Dem}_{t_1} = \text{DWN}_{t_1} \times \frac{\text{Inc}_{t_1}}{\boxed{\text{Pop}_{t_1}}} \times \boxed{\text{Pop}_{t_1}} \qquad (6.4)$$

Population

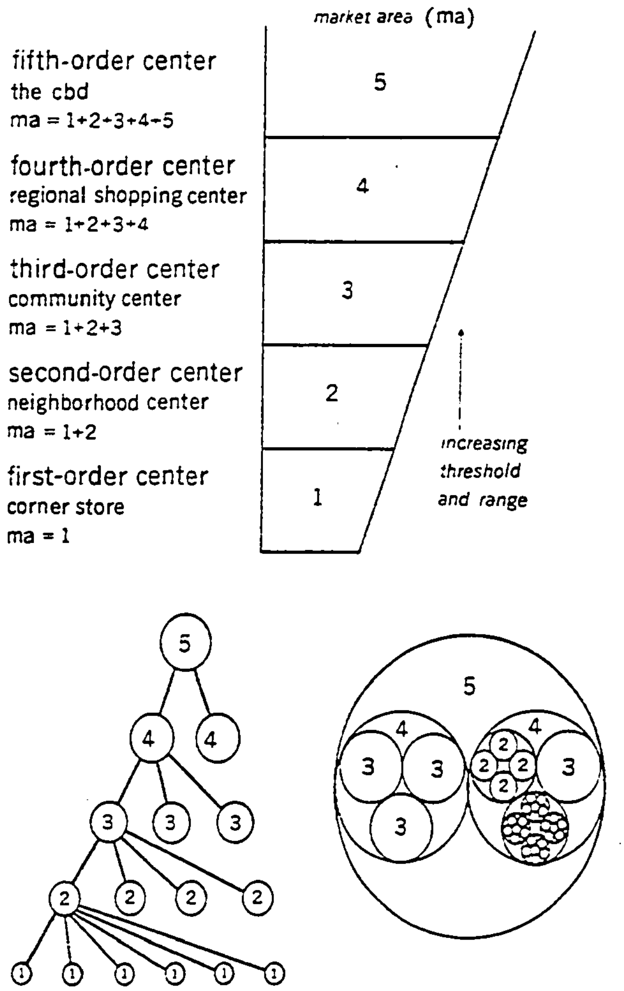
The notion that a place's level of demand increases as its population increases follows from certain assumptions of central place theory. In general, it has been pointed out by central place theorists that higher order central places tend to contain a larger number of higher order functions than lower order central places. They will also exhibit the same kind of lower order functions that lower order central places do, but they will have more of them (see Figure 6.1). Since higher order central places tend to have larger populations than lower order places, and the number of functions a place has reflects the variety of different demands that exist there, larger places will tend to have a greater variety of different demands.

A place with a larger population will also exhibit a higher demand level simply because it is larger. A larger number of individuals will generally have more requirements than a smaller number of individuals. However, this is not always true. This is because not all individuals have the same requirements and not all individuals have the same amount of wealth. The effect of income must also be considered.

Income

If income is held constant, the level of demand in a large population will be higher than in a small population. A greater income will, however, increase the intensity of local demand so that it is possible for a small rich population to have a higher and more varied demand level than an impoverished large one. The notion of income elasticity also insures that the variety of demands is greater in areas with high incomes.

A place's income level will be defined as the total amount of production that occurs between two instants of time. This involves the production of durable as well as ephemeral artifacts. To this must be added the total number of artifacts diffusing into an area



Hierarchical nesting of tertiary centers within a place

Figure 6.1 (Eliot Hurst 1972:204)

from the outside during the same time period. A similar definition has been used by Forrester (1971:113).

Desires, Wants and Needs

Demand levels also depend on the ideas themselves. Each individual in a population has an immense range of desires, wants, needs, aspirations and dreams (DWN). These may be conscious or unconscious. Most of them will never be fulfilled since their adoption is limited by income level. The desires remain, however, and they have some effect on what ultimately comes into being.

Unfortunately, it is difficult to measure these desires or find other variables that will account for their magnitudes. One exception is the phenomenon of income elasticity.

As a place's income increases, the desire for particular artifacts will increase within that place. These are items that exhibit high income elasticity. At the same time the demand for other artifacts will decrease (these also exhibit high income elasticity). For some artifacts, the level of desire will remain constant no matter how much income levels change. These artifacts possess low income elasticity.

Desires, wants, and needs are not static elements in the structural model. Like everything else, they change through time. Why they change, and why they affect adoption levels has been the subject of much investigation in the social sciences. One extremely important aspect of this variable is the need to imitate. A number of findings have pointed out that such needs are not random. Instead, they follow certain repeated patterns, such as the need or propensity to imitate kinship groups, peer groups, and prestige groups.

Imitation

In the closing years of the last century, Gabriel Tarde formulated his three laws of imitation (Capretta 1967:120). The first of these, the Law of Descent, held that socially inferior individuals imitated their social superiors. The second was the Law of Geometric Progression, which described the rapid spread of rumors and fads from their places of origen. The third law described a general tendency to prefer things originating in one's own culture over things originating in foreign cultures. This was the Law of Internal Preference.

Imitation is still generally thought of as an important social force. According to Handy (1969:49), for instance, the values held by an individual are strongly influenced by the values he judges other people to hold, while Skinner (1965:311) believes that the process of imitation helps to explain why people participate in groups. He points out that behaving like others behave and using words that others use are quite likely to be self-reinforcing acts. They are, in other words, more likely than not to be positively reinforced. The classic behaviorist position holds that acts receiving this positive reinforcement (either consistently or irregularly) are likely to be repeated.

As a directional force, imitation causes specific individuals and groups to adopt some of the behavioral traits of other individuals and groups. In this process several groups have been found to be particularly influential. These include kin groups, peer groups, neighboring groups, and prestige groups.

Kinship Groups

Kin groups influence individuals through the transition or socialization process. Children receive their basic programming by imitating their parents. Their opinions, attitudes, and beliefs are learned early in life and tend to correspond to those of their parents until well into adulthood. This is particularly true in the case of religious and political beliefs (Berelson and Steiner 1964:562). Furthermore, if reinforcement from kin groups is constant and continuous throughout an individual's life, and if there is no interference with this from other sources, his views and beliefs are unlikely to change at all (Berelson and Steiner 1964:575).

Kinship groups, however, are not the only ones influencing individuals during their formative years. Other groups, particularly peer groups, affect the socialization process in many ways.

Peer Groups

In linguistics there is a growing body of empirical evidence showing that the dialect pattern and accent of an individual is altered during childhood from that of his parents to that of his peer group. Children, for some unknown reason, do not preserve the speech characteristics of their parents so much as they tend to take on the speech habits of the peer group they associate with during their pre-adolescent years. The transition seems to occur between peer groups of slightly different age levels with the older group influencing the younger one (Weinreich 1968:145). This explains why the children of immigrants acquire the speech habits of the neighborhoods they grew up in rather than the foreign accents of their parents.

Other cultural patterns are similarly affected. The same peer groups that compete with kinship groups in the realm of speech also influence the opinions and attitudes of individuals undergoing socialization. Among young people, in fact, it seems that the more important a given attitude or belief is to a particular individual, the more likely he is to imitate his peers rather than his parents (Berelson and Steiner 1964:566).

Prestige Groups

According to Kuhn's (1971:153) analysis of scientific revolutions, individual scholars embrace new theories and paradigms for all sorts of reasons. One of these is the prestige of the innovator. Even the nationality and reputation of those he has studied under can have a role in whether or not a new idea is accepted. Only infrequently does it seem that new ideas are evaluated solely on their own merits.

Many other kinds of change are imitated if they originate among individuals having high prestige. Linguistic change is no exception.

Sound shifts originate in restricted subgroups, according to a number of studies describing these changes in New York City and Martha's Vineyard (Labov 1972). The speech patterns of these subgroups became particularly vulnerable to change when their separate identities and relative isolation became weakened and they began to feel social pressures from outside their immediate circle. Succeeding generations responding to the same pressures carried the changes of their parents farther along in the same direction. Change in one linguistic variable always led to readjustments in other aspects of speech and these in turn initiated other changes.

The factor that seemed to account most for the spread of any particular sound change was the status and prestige of the group where the change originated (Labov 1972:286). If the values of the originating subgroup were imitated by other individuals in the community, the sound shifts spread. If the change did not originate in a high status group, it was frequently stigmatized by the leading group in the community. This stigmatization then initiated an irregular process of correction toward the model of the leading group. Sound changes originating in the group with the highest status became prestige models imitated by others in the community.

Foster (1962:29) has noted that most social and economic change begins among the upper classes and then spreads downward to the lower classes and then outward into peripheral areas. Weinreich (1968:176-80), Hall (1950:144), Redlich (1953:313), and Lehmann (1973:121) have also made the observation that changes most frequently originate in the highest ranking or most prestigious groups. This need not always be the case, however, as we know that many modern languages have evolved out of lower class or rustic dialects. Afrikaans and all of the Romance languages are examples of this. Similarly, new religions often receive their most enthusiastic support among the lower classes during their formative years.

Forces of Imposition

Theories of change that emphasize the conflict between opposing interests are concerned almost exclusively with the forces of imposition and resistance, as well as other activities designed to resolve incompatible goals within and between places.

The forces of imposition include such processes as imperialism, colonialism, legislation and war. The activities of missionaries, educators, bureaucrats, salesmen, vigilantes and other advocates are important elements in the imposition process. Forces of imposition often include significant elements of coercion. More subtle forms of imposition also exist, such as the manipulation of demand through advertising and image-building (see Galbraith 1967:198-203, 1975:133). All active agents of change operate as forces of imposition. Semple and Brown (1976:10) make the distinction between propagator and non-propagator supported expansion one of the primary subdivisions of their diffusion model. Propagator supported expansion or diffusion is one of the forces of imposition. These forces are unique to each place and to each element subject to the adoption process.

The forces of imposition, like the forces of resistance described below, could conceivably have been included as part of demand, wants and needs. Wants and needs, however, can exist without external pressure (external in the sense that they are external to the adopting individuals). This external pressure can come from something within a place, such as local police, or from outside phenomena, such as foreign missionaries and military forces.

Change agents who affect the direction of change fall into two categories: agents of persuasion and agents of imposition. Both of these groups manipulate various sorts of stimuli designed to bring about a desired kind of behavior in others. In this case the desired behavior is the adoption of specific changes.

Agents of persuasion (which can be either individuals or groups of individuals) operate through the subtle processes of argumentation and conversion. Missionaries and merchants use these kinds of persuasion in many instances. As Kuhn (1971:94) has pointed out, these processes also have an important role in the adoption of new theories and paradigms.

Agents of imposition use less subtle means of eliciting desired kinds of behavior. These individuals use force to direct change. Armies of occupation and colonization are highly coercive agents of imposition.

Forces of Resistance

The forces of resistance include such things as inertia and vested interests. Vested interests usually act to preserve certain existing conditions (see Parsons 1964:492 and Veblin 1934:191). Highly entrenched traditions and customs are vested interests in much the same way that political and business interests are. They all resist and prevent change. Individuals and institutions having vested interests in things as they are, will make every effort to maintain the status quo. This happens even when old institutions are no longer in tune with existing conditions.

Two major vested interests are not usually seen as vested interests at all. These include the general desire for order and coherence mentioned earlier, as well as the tendency toward preservation that seems to operate in languages and other cultural lineages (Sapir 1949:

186). These two forces help to keep various social and institutional structures from disintegrating overnight. These are the driving forces behind the readjustments that occur after periods of strain and cultural crisis. They also act to prevent strain and crisis before they occur.

Another major force of resistance is competition. For something to become established in an area its rivals must not be too strong. Plants and animals which migrate or expand their ranges face competition from other species for the available resources. If the competition is too great they will not be able to take root or to reproduce themselves. Ideas also face opposition from competitors. The expansion of Christianity in northern Africa has, for instance, been quite slow due to the strength of its main rival there, Islam. In the south of Africa, competition from tribal religious systems has been weaker and Christianity has been able to expand more rapidly.

Most of the forces of resistance are highly unique to each place and for this reason they defy a priori measurement. The degree to which elements are resisted depends largely on the elements being considered. One measurable quality, however, has been associated with the strength of resistance to new ideas. This is the amount of homogeneity existing within an area (Homo). Heterogeneous societies tend to possess larger amounts of secularism and tolerance than homogeneous ones and these are qualities which tend to reduce opposition to change. In addition, it has been found that individuals living in homogeneous social environments tend to hold their opinions, attitudes and beliefs more intensely than persons living in heterogeneous environments. Homogeneity, then, increases resistance to change (Berelson and Steiner

1964:567,615). This relationship is shown in Formula 6.5, which indicates that when the homogeneity of a place increases, the forces of resistance increase.

The Window Effect

According to Kroeber (1948:367) individuals innovate only when and if their cultures permit. They make only the specific innovations that their cultures allow and the range of what is allowed is very narrow. This range of tolerance produces the window effect (WinEff).

The window effect determines whether or not a given element is compatible with conditions already existing within a place. The prospective element can be dispersed into a place from the outside or it can be invented locally. The window effect reflects the aesthetic evaluation of things offered for adoption, imitation or consumption. The window effect also includes a time reference.

The term window has been used in ballistics to denote the speed and angle of incidence that a space vehicle must attain in order to safely re-enter the earth's atmosphere. If the angle is too low, the vehicle ricochets off the upper layers of the atmosphere and returns back into space (much in the same way that a flat rock can be skipped across the surface of a lake). If the angle is too steep, the vehicle burns up in the atmosphere. The narrow range of conditions which will permit a safe re-entry constitutes the window.

When referring to a critical time period during which a space vehicle can be launched, one can also speak of a launch window. If a launch does not take place during this critical time period, it

$$\left\langle \begin{matrix}\text{ForRes} \\ t_1\end{matrix} \right\rangle = \left\langle \begin{matrix}\text{Homo} \\ t_1\end{matrix} \right\rangle \times \left\langle \begin{matrix}\text{DWN} \\ t_1\end{matrix} \right\rangle \times \left\langle \begin{matrix}\text{OAB} \\ t_1\end{matrix} \right\rangle \tag{6.5}$$

$$\left\langle \begin{matrix}\text{ForImp} \\ t_1\end{matrix} \right\rangle = \left\langle \begin{matrix}\text{DWN} \\ t_1\end{matrix} \right\rangle \tag{6.6}$$

*DWN and OAB refer to specific ideas in this example and not to an overall level must wait until suitable conditions once again reoccur. Similarly, a new idea must be introduced during a critical time period in order to survive.

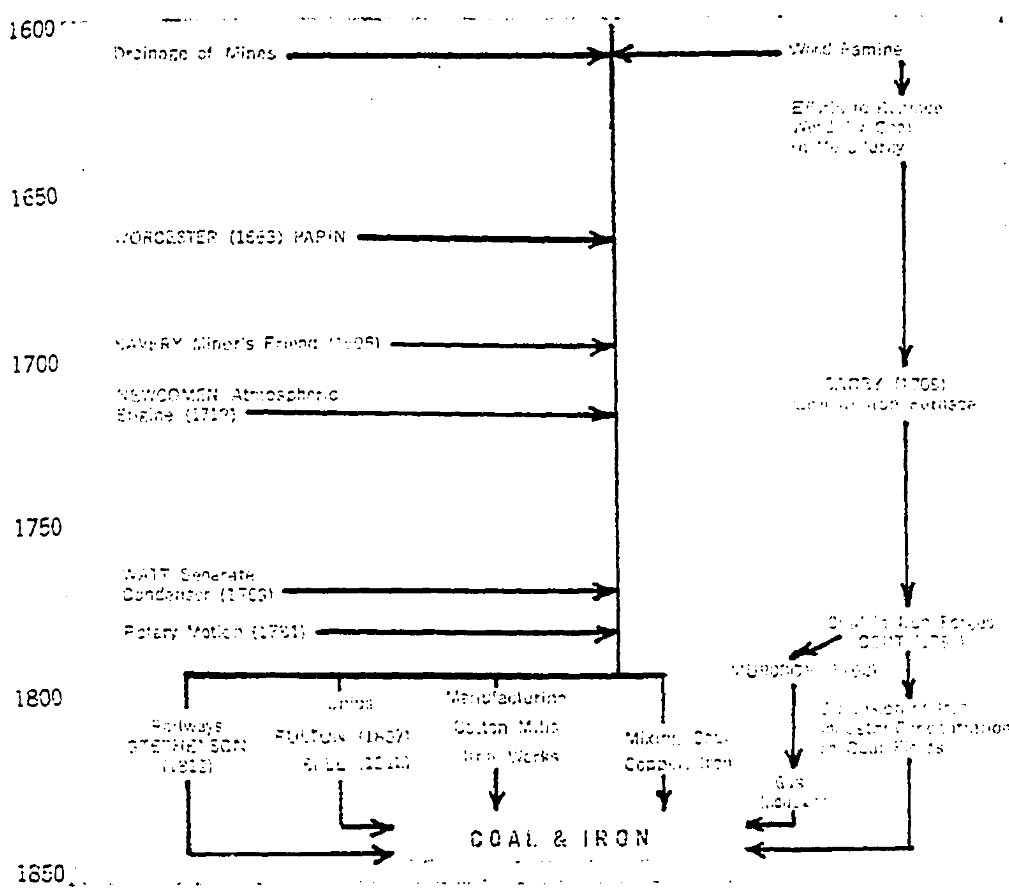
In the evolution of a cultural lineage, the window effect becomes critical in determining whether certain variants are selected by the system or are rejected. A new element is appropriate for adoption if it makes its appearance during a critical time period. If an innovation misses its window by appearing too early or too late, it is likely to be ignored. Ideas that appear before their time are incompatible with their surroundings. They do not fit within the existing cultural matrix.

Many of the inventions of Leonardo da Vinci, like Gregor Mendel's system of genetics, Alfred Wegener's theory of continental drift, and Ikhnaton's system of monotheism, are well-known examples of ideas that were either too advanced to be understood by contemporaries and were subsequently forgotten, or were not accepted until years later. As Bronowski has pointed out (1973:385), when Mendel published his work no one had any notion of what he was talking about, and his system remained in oblivion for 34 years. Similarly, Cezannes, Gauguin, Van Gough, El Greco and Millet were not appreciated by the art world until after they had died. El Greco's work had to wait some 300 years before its greatness was recognized. Ideas that appear too late, or after their time has passed, are often ridiculed and labeled gothic, neanderthal or coelocanthic (we thought it had died but apparently it still lives). Most elements which are incompatible with their surroundings are not imitated, adopted or consumed, and are never heard from again. They disappear leaving no trace of their existence.

The window effect is similar to Smelser's value-added model (1968:210), which makes an analogy between social change and the manufacturing of automobiles. Each stage in the manufacturing process, from the smelting of iron ore to the marketing of the vehicles themselves, adds its value to the final cost of the finished product. None of the stages in the sequence can add its particular value, however, until all prior stages are completed. As is the case with social change, no single stage can be effective unless it occurs at some specific point in the sequence.

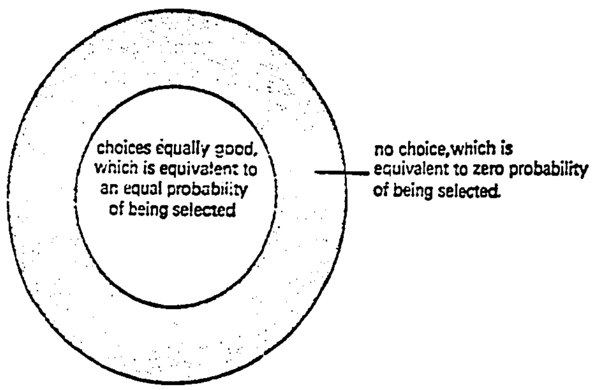
Figure 6.2 illustrates this concept with a different example. This diagram shows that a certain sequence of events during and before the industrial revolution was necessary before steam power could be fully developed. Some of these events were technological in nature, others were not.

Ecological conditions are also part of the window effect. Just as the structural elements of a place's culture can inhibit the adoption of certain ideas, so also can a place's environment. As an example of this, Wagner and Mikesell (1962:20) have indicated how, on the basis of ecological conditions, the world can be divided into regions of possibility and regions of impossibility. These are zones where specific geographic processes are possible and zones where they are unlikely to occur. This is the classic position of possibilism illustrated in Figure 6.3



Stages in the development of steam power in England leading to application in the Industrial Revolution.

Figure 6.2 (Dicken and Pitts 1963:257)



Schematic representation of the concept of possibilism.

Figure 6.3 (Chisholm 1975:40)

The Founder Effect

The founder effect (sometimes called boatload drift) is another source of selection and change in local variability. It is a random force that has little to do with adaptation. Its operation can be seen in some patterns of differentation in both genetic and cultural lineages. The founder effect occurs when small groups wander away from a parent population and become isolated. Different kinds of migration as well as some of the reasons why migration occurs will be discussed below in chapter 8. The founder effect also results when a large population is reduced to a small remnant through the action of some catastrophe. Plagues, invasions, and natural disasters like floods, droughts, earthquakes, and volcanic eruptions can all produce this effect.

All remnant groups are small random samples of an original population. The genetic as well as the cultural variability of each one of these groups is different from the parent body. The differences are then replicated in succeeding generations. Ross (1974:88), Birdsell (1972:407), Buettner-Janusch (1966:409), MacArthur and Wilson (1967), and Mayr (1966) have all given general descriptions of the founder effect.

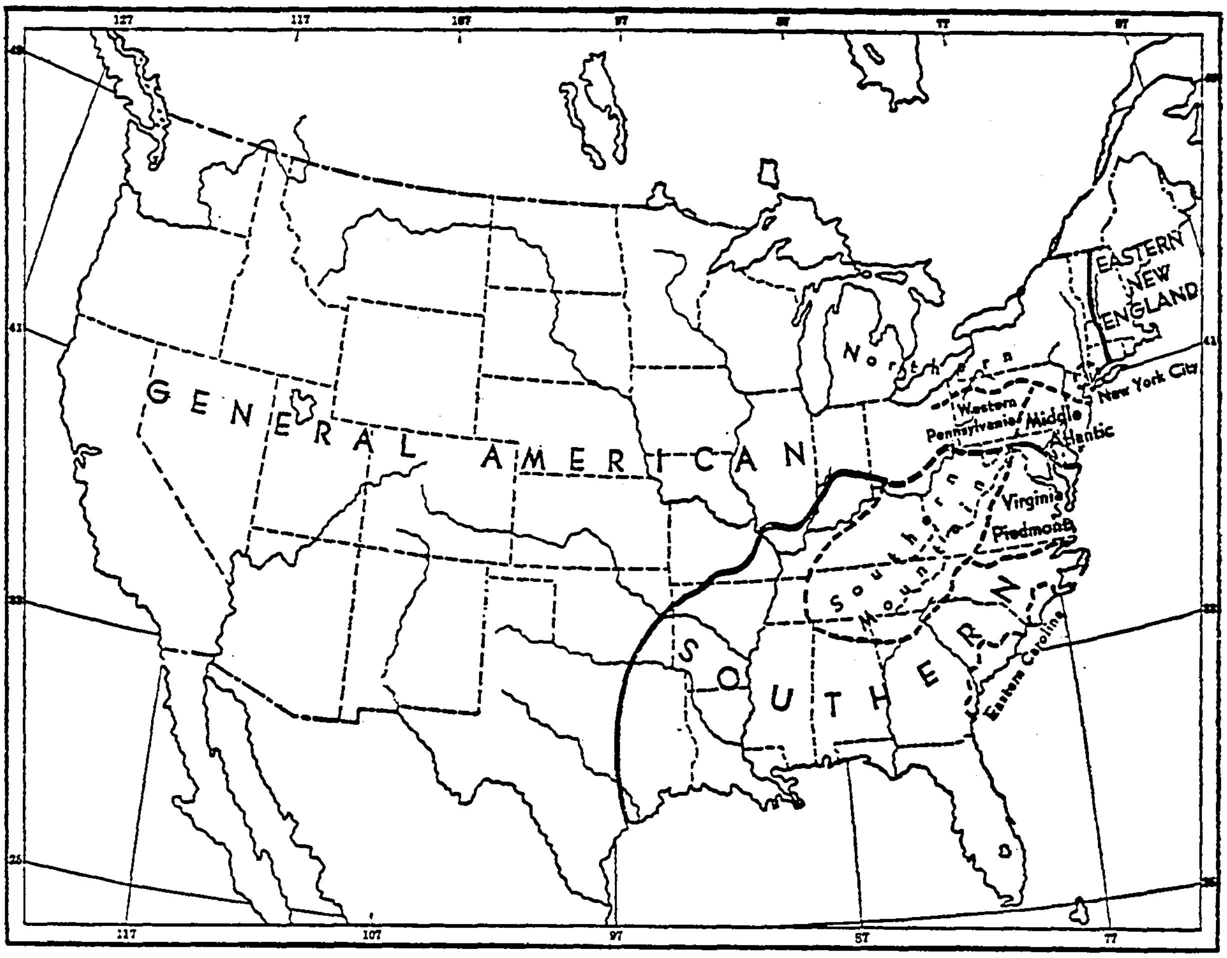
Zelinsky's First Effective Settlement principle (1973:13), which holds that the first group able to permanently occupy an area essentially creates that area's later cultural pattern, is another expression of the founder effect. The only apparent difference is that Zelinsky's principle includes the stipulation that the initial settlers, in addition to influencing their own descendants, greatly affect the culture of later arrivals into the area (providing that there are not too many of them).

An illustration of both the founder effect and Zelinsky's First Effective Settlement principle can be seen in the dialect patterns that have evolved in American English. An investigation of the districts in England from which the earliest American migrants came will give some insight into the origin of these dialects (Kurath 1928:385-95).

Figure 6.4 shows the dialects of American English as they exist today. Three major dialect areas can be identified: New England, Midwestern (sometimes called Midland, General American, or Hollywood Broadcasting Standard), and Southern (sometimes called Coastal or Plantation Southern). Some would make some of the dialects of New York City into a fourth major category. Of these, the New England and the Southern dialects share a number of common features which are not found in the Midwestern form of American English, particularly the broad a and the dropping of the r. In these characteristics they resemble the King's English more than they do Midwestern American.

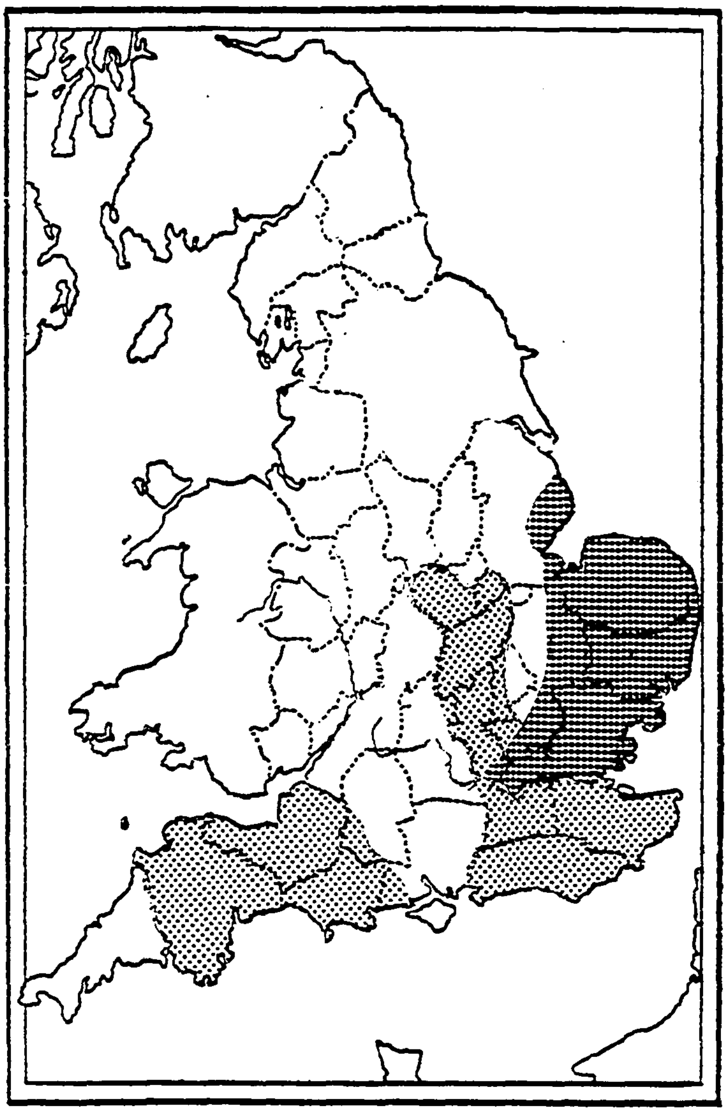
An investigation into the origins of the colonists who came to America before 1700 reveals that New England and Virginia were settled largely by persons from the south and southeast of England, with nearly two-thirds of the early settlers around Massachusetts Bay coming from East Anglia, one of the major strongholds of English Puritanism (Baugh 1957:408). Figure 6.5 shows the primary areas from which the original American colonists came.

Differences between the speech patterns of New England and Virginia



THE DIALECTS OF AMERICAN ENGLISH

Figure 6.4 (Baugh 1957:438)



EARLY ENGLISH EMIGRANTS TO AMERICA

Main Emigrant Areas

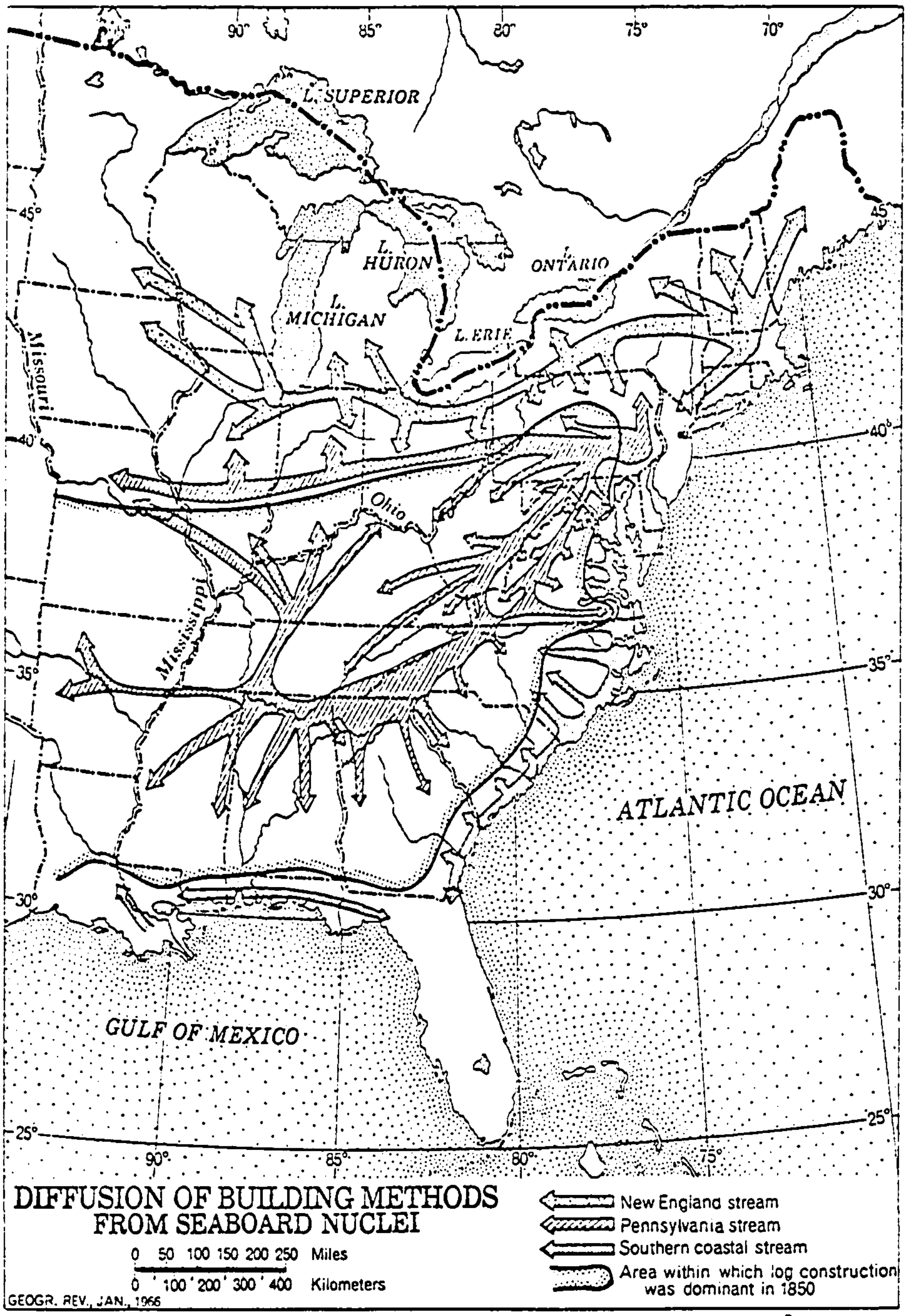
Secondary Emigrant Areas

Figure 6.5 (After Hibbert 1974:30)

are often attributed to class differences rather than to place of origin, although migrants from the south Midlands and the west of England seem to have been more numerous in Virginia than in New England (Baugh 1957:444). New England speech seems to have been based on middle class patterns found in the south of England (particularly East Anglia) during the 17th and 18th centuries, while the patterns found in Virginia seem to have been derived from the pronunciation habits of upper class Londoners during the late 17th century (Guralnik and Friend 1966:xxviii). The middle colonies, on the other hand, received their speech habits from the north of England.

A large proportion of the original migrants to the middle colonies were northerners. Prominent among these colonists were Quakers from the north Midlands and the Scotch-Irish, who spoke a northern variety of English (Baugh 1957:445). Some of the earliest English-speaking colonists along the Delaware River near what was to become Philadelphia were, for example, Quakers from Yorkshire (Baugh 1957:408).

The speech patterns of the middle colonies, due to historical accident and accident of geographical location, proved to be more influential west of the Appalachians than either the New England or the Virginia patterns. The influence of the middle colonies, especially Pennsylvania, can be seen in Figures 6.6 and 6.7 which show American diffusion patterns prior to 1850 as reflected in the spread of distinctive house-types and in the spread of ideas from the eastern seaboard into the interior. The heavy presence of the Scotch-Irish in western Pennsylvania, as well as their heavy representation among settlers all along the western frontier, helped to carry the kind of English spoken



Diffusion of building methods from seaboard nuclei, and areas of predominantly log and frame construction as of 1850. Routes are diagrammatic. Variation in width of streams suggests strength of diffusion.

Figure 6.6 (Kniffen and Glassie 1966:60)

The movement of ideas in the Eastern United States

Figure 6.7 (Zelinsky 1973:81)

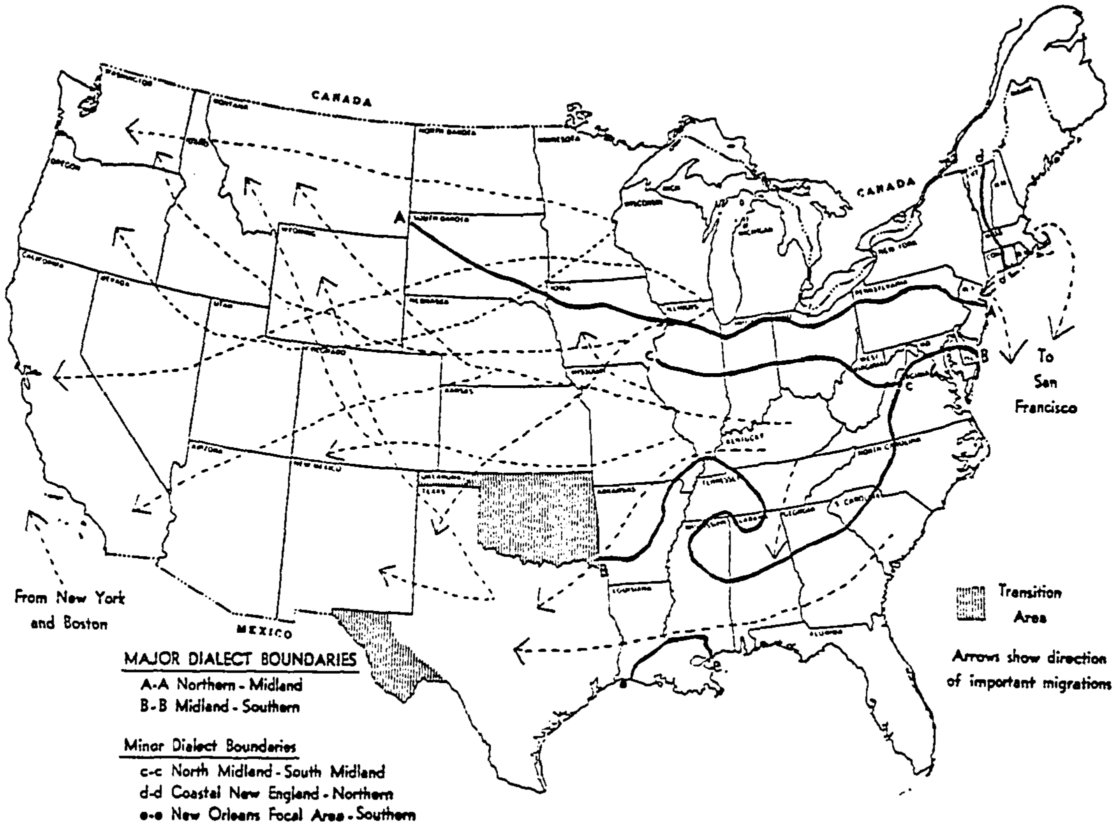
in the middle colonies into the newer territories of the West (Baugh 1957: 445). Figures 6.8 and 6.9 show two versions of how this process continued across the entire continent.

That General American Midwestern English is a variant of the speech found in northern England can be seen as the result of many instances of the founder effect. The first effective settlers of each new territory established their speech patterns as the standard to which later arrivals (many of them initially speaking languages other than English) gradually had to conform.

If all of the dialects in England were mixed together, they would form one large population with many norms and ranges of variation. Just as is the case in genetics, a small sample taken from this large population would produce an offspring population with norms and ranges of variation that would be quite different from the original one. This is what occurred during the initial settlement of the United States and the process continued as the frontier of settlement moved west. The results can be seen in modern day American dialect patterns.

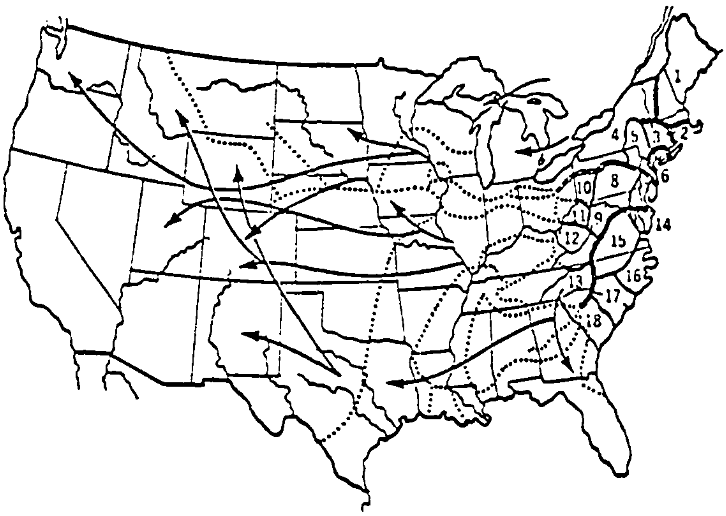
The same processes of selection that altered English speech patterns in America affected other aspects of English culture as well. As Leighly (1937:137) has observed, pioneers bring to new areas an entire range of ideas and values. These are then established in the landscape in different proportions from that found in the place of origin.

Even though English institutions prevailed in all the American colonies, by the mid-eighteenth century none of them were quite like their counterparts in England.



AmE dialect areas. Reprinted from *Dialects-U.S.A.* (National Council of Teachers of English, Champaign, Ill., 1963) by Jean Malmstrom and Annabel Ashley. By permission of Jean Malmstrom and The National Council of Teachers of English. Copyright 1963 by The National Council of Teachers of English.

Figure 6.8 (Peters 1968:64)



DIALECT AREAS OF THE UNITED STATES*

Atlantic Seaboard Areas (after Kurath). Tentative Dialect Boundaries. Arrows indicate direction of migrations.

THE NORTH

1. Northeastern New England
2. Southeastern New England
3. Southwestern New England
4. Inland North (western Vermont, Upstate New York & derivatives)
5. The Hudson Valley
6. Metropolitan New York

THE MIDLAND

North Midland

7. Delaware Valley (Philadelphia)
8. Susquehanna Valley
10. Upper Ohio Valley (Pittsburgh)
11. Northern West Virginia

South Midland

9. Upper Potomac & Shenandoah
12. Southern West Virginia & Eastern Kentucky
13. Western Carolina & Eastern Tennessee

THE SOUTH

14. Delmarva (Eastern Shore)
15. The Virginia Piedmont
16. Northeastern North Carolina (Albemarle Sound & Neuse Valley)
17. Cape Fear & Peedee Valleys
18. The South Carolina Low Country (Charleston)

*Prepared by Mrs. Raven I. McDavid for *The Structure of American English*, by W. Nelson Francis. Copyright © 1958. The Ronald Press Company, New York.

Figure 6.9 (Martin and Rulon 1973:192)

> "The heritage of English ideas that went with the institutions was so rich and varied that Americans were able to select and develop those that best suited their situation and forgot others that meanwhile were growing prominent in the mother country" (Blum et al. 1963:59).

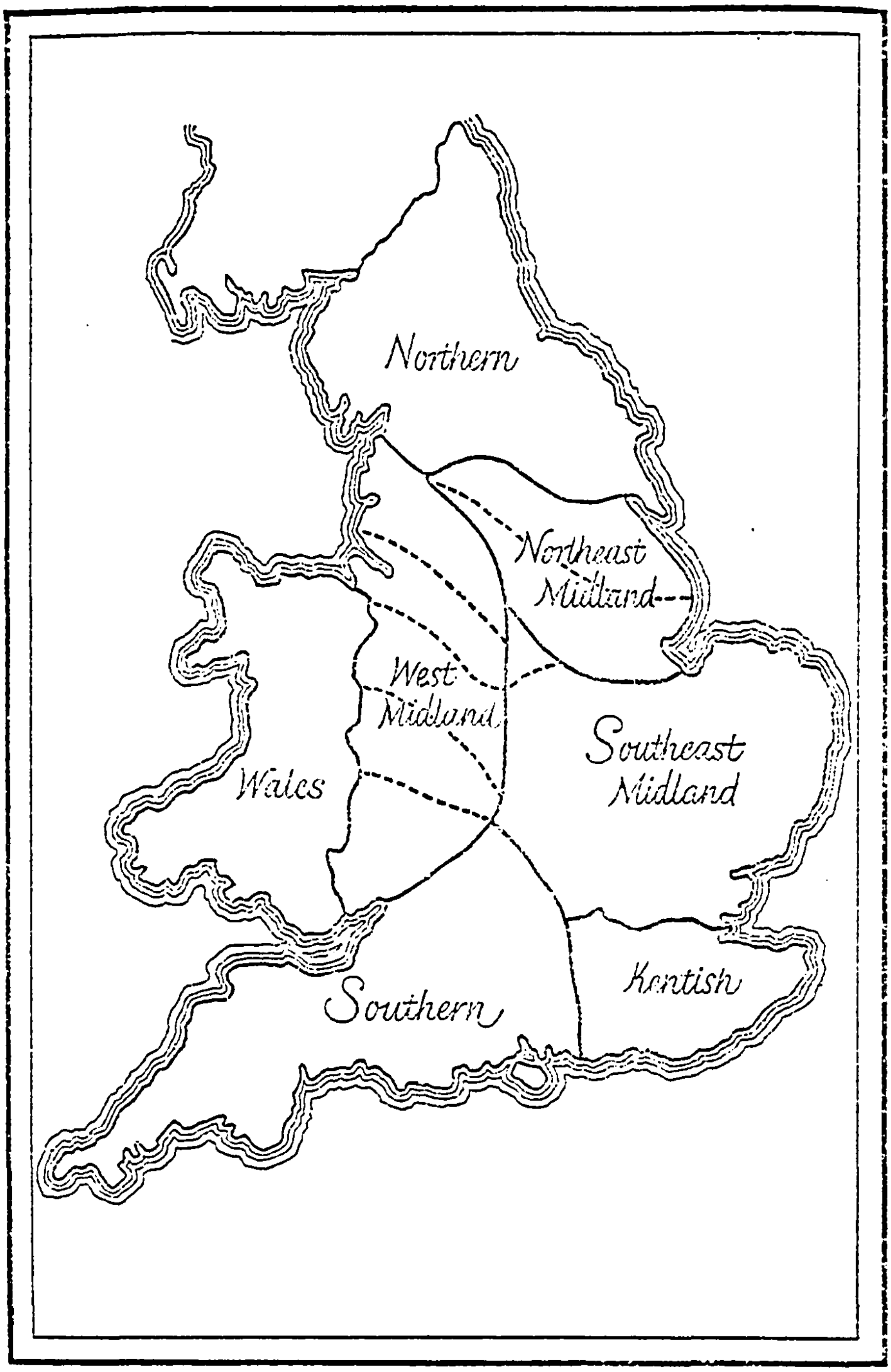
Many ideas, attitudes, and beliefs became widespread in the colonies which remained unimportant in England. The evolution of these differences had many causes, but one of the most important was the founder effect as it applied to spheres of culture other than language.

By going farther back in time, we can see the same processes producing the various English dialects that contributed to the American pattern. Figure 6.10 shows the different forms of Old and Middle English that gave rise to the dialects of Modern English. Note that some differentiation has occurred down through the centuries, but the basic pattern seems to have been set during the initial settlement of England by tribes from the North German Plain.

Figures 6.11 and 6.12 indicate where the Old and Middle English dialect areas were located, while Figure 6.13 shows where on the European continent these dialects originated. The early Northumbrian and Mercian dialects were found in the areas north of the Thames. This is the region originally settled by the Angles and the two dialects are often referred to as the Anglian dialects (Baugh 1957:60). Kentish evolved from the dialect of the Jutes who settled to the south and east of London. The Saxons settled all around the Jutes, forming the kingdoms of Essex, Sussex, and Wessex (Figure 6.14). The Primary settlements of the Saxons were, however, to the south and west of the Thames (Baugh 1957:60). We do not know how much the speech of the

Old English		Middle English	Modern English
	West Saxon	Southern or SW	SW provincial dialects
	Kentish	Kentish or SE	SE " "
Anglian	Mercian	E. Midland	Standard ModE (in various forms)
		W. Midland	Western provincial dialects
	North-umbrian	Northern	Scottish and Northern English dialects

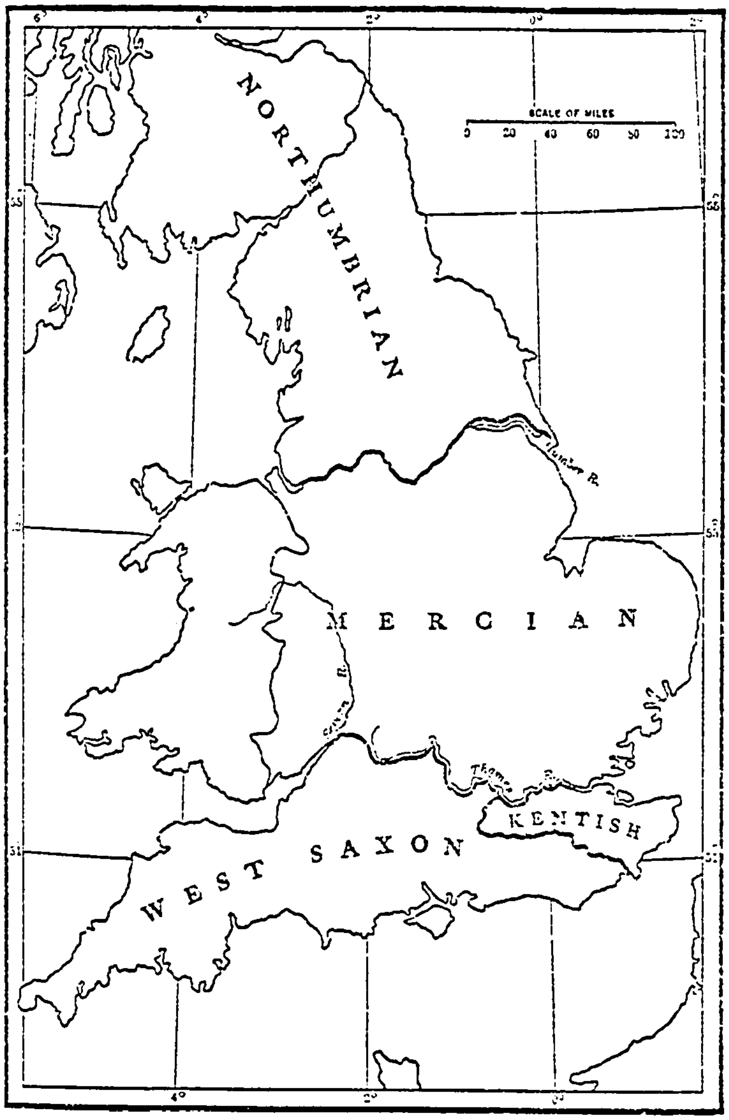
Figure 6.10 (Bloomfield and Newmark 1963:210)



Middle English Dialect Areas.

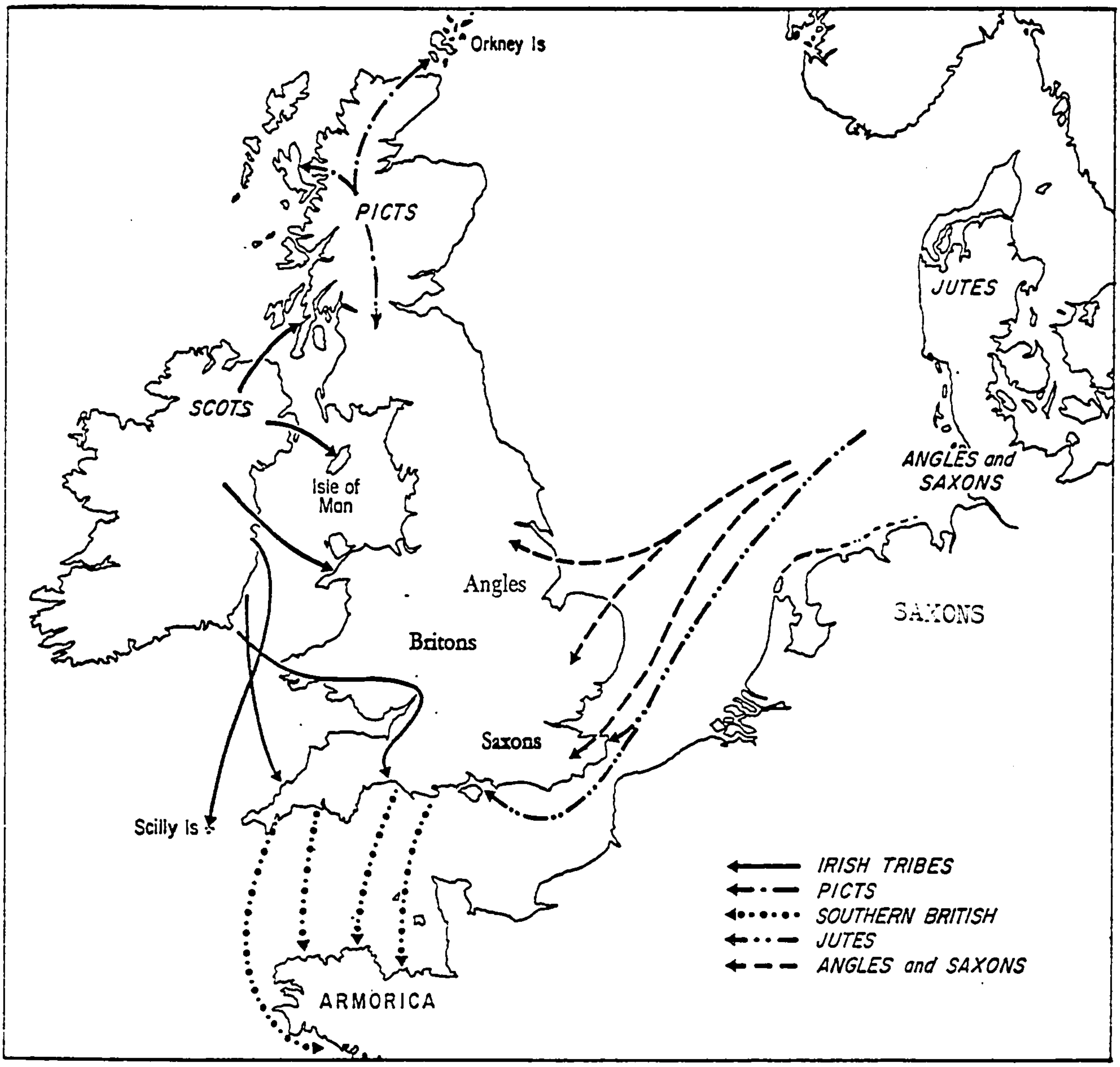
Taken, slightly adapted, from Samuel Moore, *Historical Outlines of English Sounds and Inflections*, revised by Albert H. Marckwardt, Ann Arbor: George Wahr, 1960, p. 112,

Figure 6.11 (Bloomfield and Newmark 1963:208)



THE DIALECTS OF OLD ENGLISH

Figure 6.12 (Baugh 1957:61)



Map showing the invasions and migrations into Britain in the fourth to sixth centuries

Figure 6.13

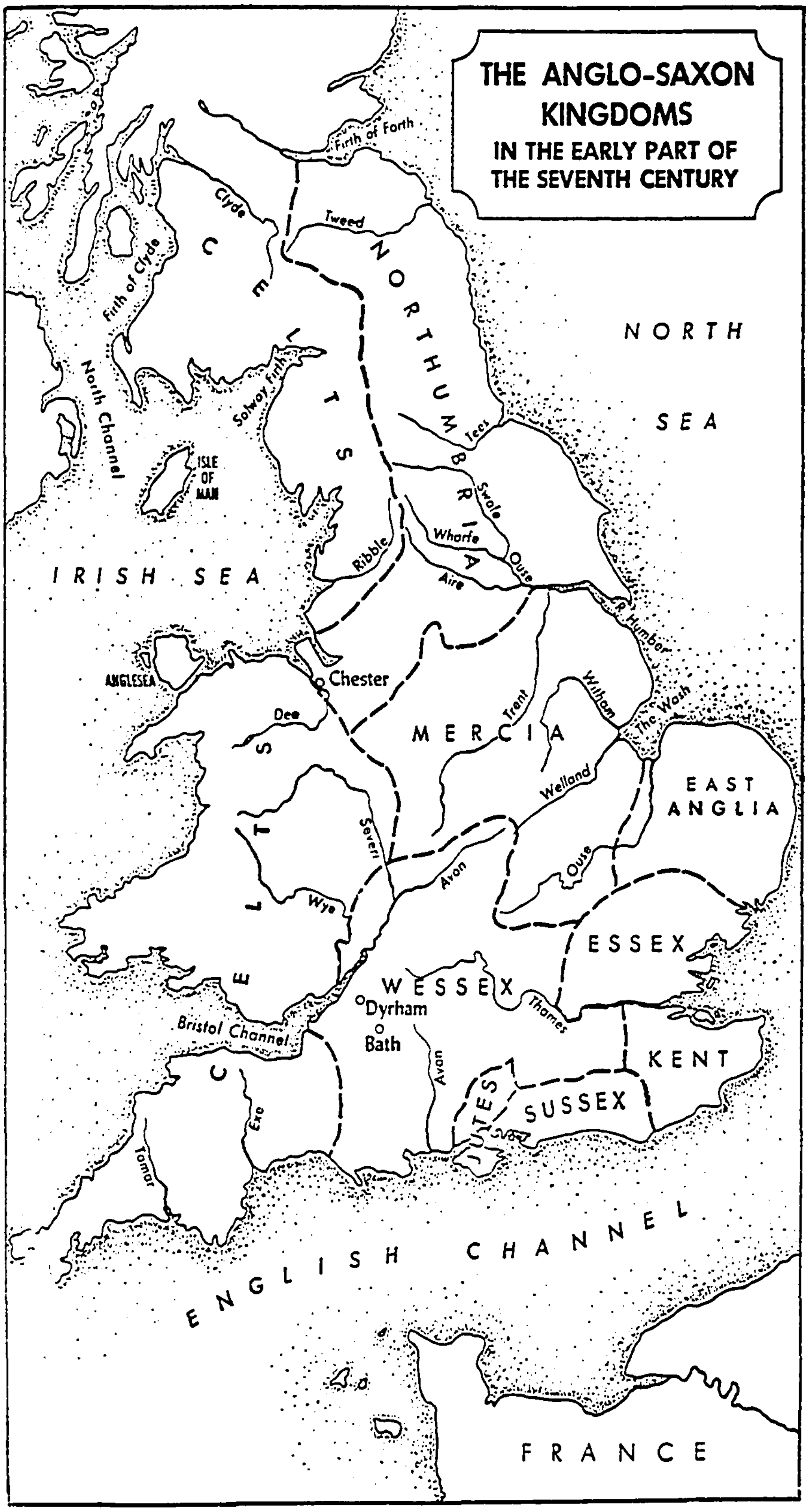


Figure 6.14 (Lunt 1956:41)

Angles diverged from that of the Saxons, but the differences were probably not great (Baugh 1957:60).

Several hundred years after the Anglo-Saxon Migrations, Danish and Norwegian invaders seized many of the Anglian districts in the north (Lunt 1956:38). Much of this region, which later came to be known as the Danelaw, experienced very heavy Norse settlement (Figure 6.15). For centuries thereafter, Danish and Anglian dialects existed side by side (Baugh 1957:118).

The Anglian dialects resembled the language of the Danes in a number of ways in which the Saxon dialects did not. The two even seem to have been somewhat mutually intelligible (Baugh 1957:112, Jesperson 1938:84). This accelerated the rate of grammatical change in the north so that in districts where the Danes had settled, the language came to be several centuries in advance of the south (Jesperson 1938:84). The cultural patterns found in the Danelaw also differed in many respects from those of the Anglo-Saxon districts and for over two hundred years the Danish region possessed an individual character that marked it off from the rest of England (Lunt 1956:48). This unique character survives even today and thousands of Danish words and structural elements can still be found in the English dialects of the north and east (Baugh 1957:114).

Northern speech patterns thus diverged farther and farther from those in the south, although in Middle English the language differed almost from county to county (Baugh 1957:228). The East Midland dialects gradually came to occupy a middle position between the conservative southern dialects and the radical northern ones (Baugh 1957:

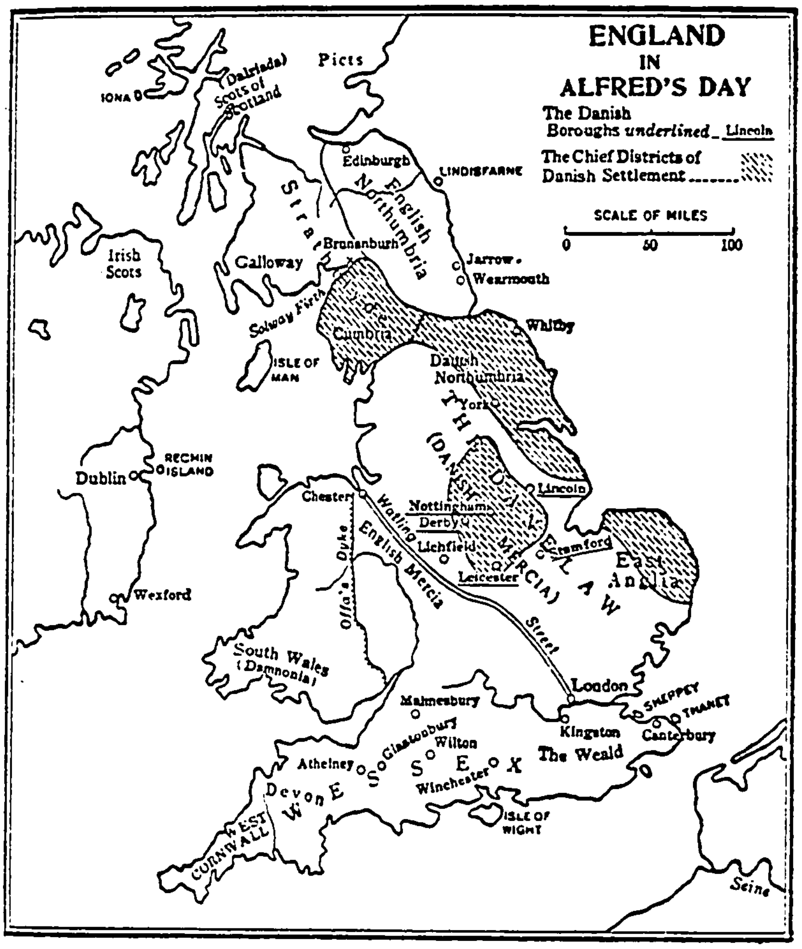
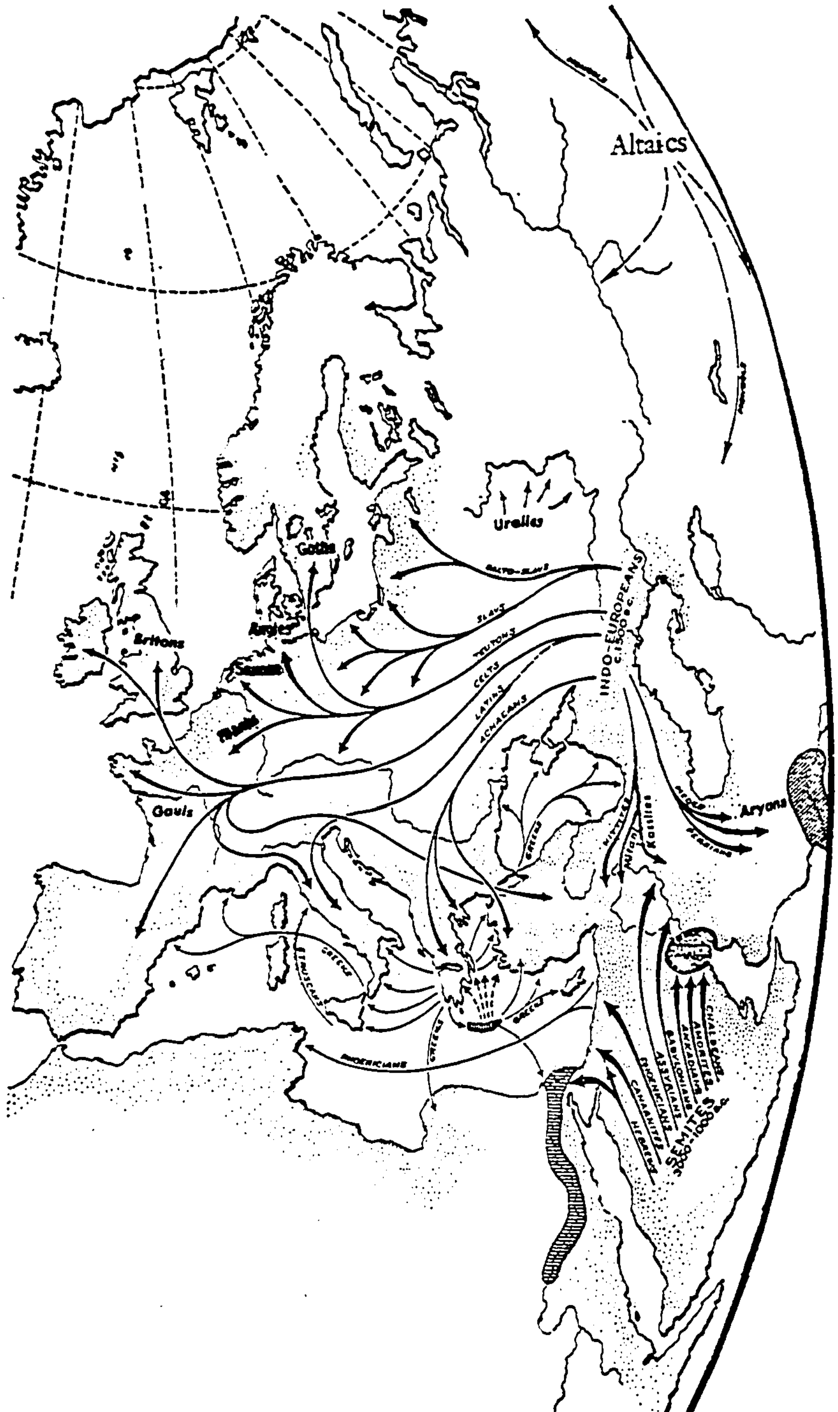


Figure 6.15 (Langer 1962:165)

231). It is from one of these East Midland dialects, the London dialect, that the modern standard evolved. Beginning as a Southern dialect, it gradually became a Midland dialect while at the same time, because of London's position as the political, financial, and publishing capital of Britain, it slowly gained acceptance as the standard form of Modern English (the King's English). Other varieties of East Midland have continued in use as local provincial dialects (Bloomfield and Newmark 1963:211).

The place of origin of the Teutonic forebearers of the Anglo-Saxon tribes is shown in Figure 6.16, although the location north of the Caspian Sea is a matter of some dispute. Many scholars place the original Indo-European homeland in the general vicinity of modern day Poland and Lithuania (see Figure 2.5 above). It is to be expected that in the course of a thousand years of wandering through eastern and central Europe, the founder effect produced innumerable examples of abrupt linguistic shifts among the Germanic tribes who migrated away from the original Indo-European community. Figure 6.17 shows how these tribes may have become differentiated after their movements began.



MIGRATIONS OF PEOPLES, 1500-200 B.C.

Figure 6.16 (Fisher 1969:12)

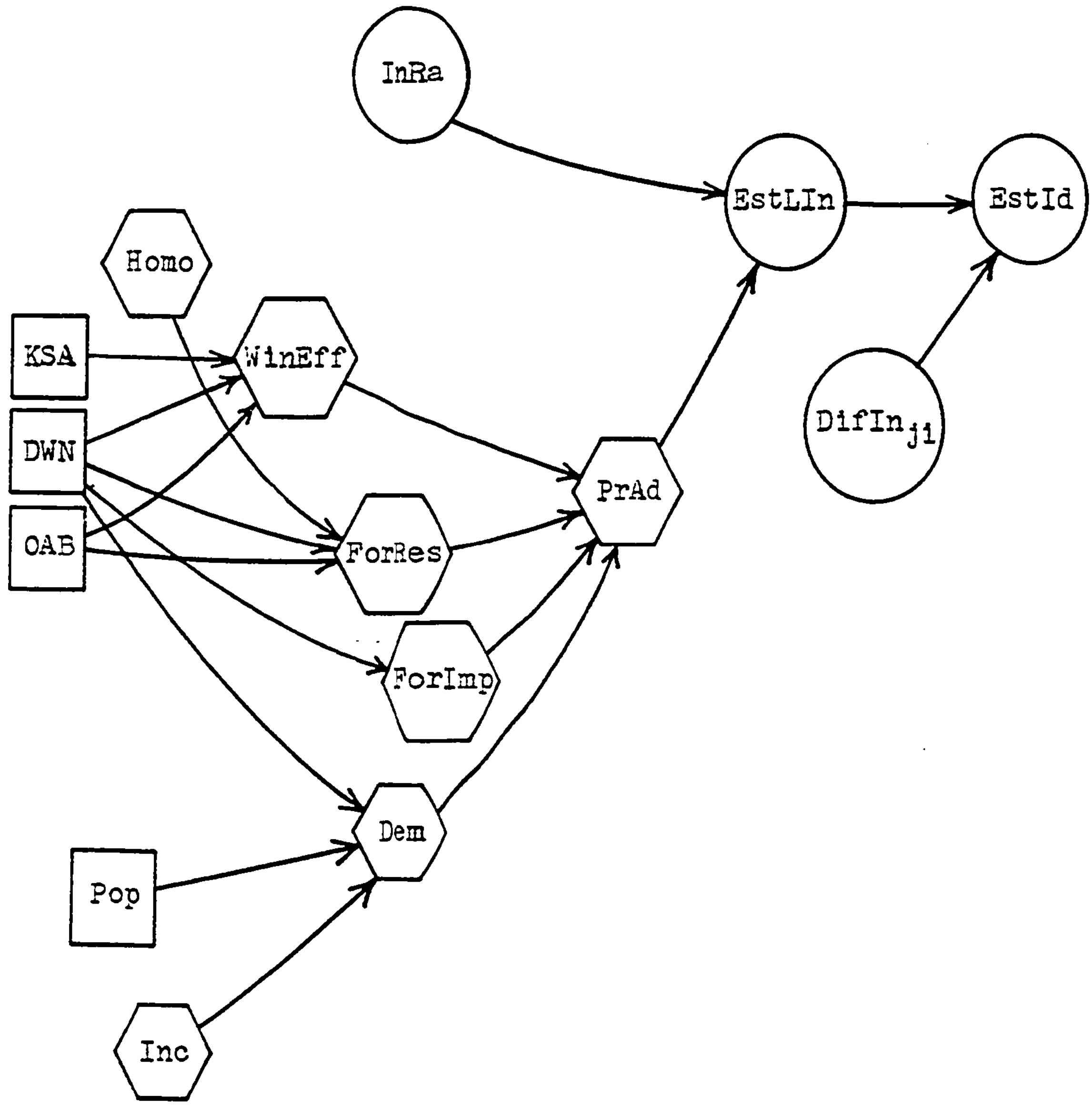

InRa
EstLIn
EstId
Homo
KSA
WinEff
DWN
DifIn$_{ji}$
PrAd
OAB
ForRes
ForImp
Dem
Pop
Inc

Figure 6.17

EstId	Number of ideas established in a place between time t_1 and t_2
EstLIn	Number of local innovations established in a place between time t_1 and t_2
$DifIn_{ji}$	Number of innovations diffusing into a place from place j between time t_1 and t_2
InRa	Innovation rate (number of innovations in a place between time t_1 and t_2)
PrAd	Propensity of individuals in a place to adopt a given element at time t_1
WinEff	The window effect at time t_1
ForRes	Forces of resistance at time t_1
ForImp	Forces of imposition at time t_1
Dem	Level of demand in a place at time t_1
Homo	Level of homogeneity in a place at time t_1
KSA	Knowledge, skills, and abilities in a place at time t_1
DWN	Desires, wants, and needs in a place at time t_1
OAB	Opinions, attitudes, and beliefs in a place at time t_1
Pop	Population at time t_1
Inc	Level of income in a place at time t_1

Chapter 7

PROCESS OF LOCAL INNOVATION

FREQUENCY OF LOCAL INNOVATION

Innovation (InRa) is a force that increases variability. It operates through the processes of recombination and mutation. In the sphere of ideas this includes all phases of the creative process, whether this be discovery, invention or improvement. It does not necessarily have to involve something better or more advanced. To be an innovation it is only necessary that the element be original.

Local innovation is a within-place process. Novelties that come into a place from the outside are part of the diffusion process. Extreme diffusionists claim that virtually all within-place qualitative change comes from diffusion and that local innovations are extremely rare. One of the foremost representatives of this school of thought was G. Elliot Smith, who believed all human advancement could be traced (through the diffusion process) back to ancient Egypt.

It will not do, however, to base a theory of within-place change on such claims since we cannot avoid asking why innovations occur in the first place. Regardless of how many innovations have dispersed throughout the world, each one has a beginning somewhere. Although we may not be able to explain why particular innovations originate in certain places, it is possible to estimate the number of innovations that might be expected in one place when compared to another.

The process of establishment encompasses everything that adds new things to the landscape. These can be durable artifacts, ideas, ephemeral artifacts (performances) and new types of individuals. Innovation, which involves only the appearance of new ideas, precedes establishment. In addition, the establishment of new ideas comes before the production and establishment of new artifacts.

Shifts in values, life styles, technology, mores, tastes, etiquette, marketing procedures, farming methods, administrative regulations, political beliefs, religious customs, recreational habits, legal practices, economic policies and grammatical usages are all innovations if something new comes into existence.

The appearance of new types of individuals is not properly part of the innovation process since individuals arise out of physical rather than mental processes. Shifts in birth rates, crime rates, and marriage rates, as well as fluctuations in business cycles, the occurrence of political revolutions, and the ebb and flow of other ongoing activities are also not innovations. Such changes in collective behavior are not innovative if they are merely changes in the proportion of things already in existence, although they may be the effects of prior innovation and they may precede subsequent innovation.

Sanders (1962:76) has discussed the difficulty in measuring inventiveness. He found a number of problems in trying to separate the rate of invention from the speed of adoption and the extent of use. He noted that some scholars do not distinguish between these processes at all.

To Hornell Hart, an invention was a new configuration of objects and forces which resulted in a new product or process (1931:525). Ogburn regarded inventive activity as a permutation of previously existing elements (1928:82). Barnett (1942:16) saw inventive activity as the borrowing of forms and principles from one functional context and the substitution of them into others. Innovation required the insight of someone who found new applications for well-known principles. Kuznets (1962:24) argued that invention occurs when individuals take existing knowledge about the material universe and form new combinations.

The process of invention, however, need not be exclusively concerned with aspects of either the material universe or material culture. New ideas are inventions in exactly the same way that new artifacts are. As Herskovits (1945:152) has noted, the individuals who devised the method of counting descent on one side of the family were just as influential on the course of history as the individuals who invented tents and canoes. Any small shift in behavior or belief can involve innovation. Although many of them may seem too insignificant to warrant being called inventions or innovations by themselves, a great number of them over long periods of time can result in massive amounts of change.

MODES OF INNOVATION

As Ross (1962:109) has noted, the rate of change within a place has two distinct aspects--the occurrence of variation and the survival of a certain number of the variants. Although variation is normally thought of as occurring within populations and species, it also occurs within places. It is this place-bound variation, as well as the selective pressures associated with it, that this thesis is considering.

Variation arises through a number of processes that include mutation, recombination, and hybridization. Mutation is the appearance within a place of something entirely new. Local innovation is the force producing geographic mutations. Recombination is the rearrangement of elements already existing within a place. Here, even though the individual elements are not new, the relationships between them are. The form of the elements may remain the same, but their function and the structure holding them together may change. Geographic recombination, like mutation, is also a product of local innovation. Hybridization is similar to recombination and mutation except that it involves the incorporation of external elements into a place. Diffusion is thus a force contributing to geographic hybridization.

Selection is what happens when these variants survive. Most surviving variants can probably be seen as advantageous, though there is no necessary reason why this should be so, either immediately or at a later date. Most surviving variants are probably neutral, with some of them becoming detrimental as external circumstances change.

Variants that survive are those which establish themselves in new areas and expand within these places. Selection occurs when establishment takes place and when expansion takes place. Selection also occurs when the reverse processes take place--contraction and elimination.

Mutation

When people think of the innovation process they usually think of it as mutation. Mutations may be conscious or unconscious. In all cases they are aberrations, that is to say, things that are unusual and previously unheard of. One major source of mutation is the imperfect replication of cultural elements and structures between generations.

This transition process, often called socialization or enculturation, is a critical period during which much variability comes into existence. Socialization is the process whereby an individual learns the cultural patterns of his society. While most of the socialization process occurs during childhood, it continues during an individual's entire lifetime (Taylor 1969:148). The replication of cultural patterns from one generation to the next is always imperfect. Because of this, many small variations enter the cultural system at the point of transition.

Recombination

Three processes can be included under the heading of innovative recombination: hybridization, acculturation, and stimulus diffusion. In various unknowable amounts, each of these processes contributes to the phenomenon of innovation.

Hybridization

Ideational (or cultural) hybridization is the process whereby the attributes of two or more parent bodies are fused and reorganized within a descendant body. Hybridization happens when different plant species successfully breed together and produce offspring that are different from the two parents. The same thing can occur among human groups, as when two parents from different ethnic or physical groups breed and produce offspring. The offspring will form a separate group which combines the physical features of both parents. In the same way, parents from different cultures can produce ideational hybrids among their offspring. These hybrids would combine, to varying degrees, ideas taken from both parents.

If these hybrids are unlike anything that has ever existed before, they are novelties themselves and their appearance contributes to the establishment process. If similar hybrids continue to appear within a place, their coming into existence no longer contributes to establishment (since this only occurs once) but instead contributes to numerical expansion.

Hybridization can create conditions that encourage further innovation. The blending of elements from different traditions can create many paradoxes and inconsistencies which must be worked out during later time periods. The solutions to these problems are very likely to be innovations themselves--ones that would never have occurred if the prior hybridization had not taken place. It is in this sense that hybridization must be thought of as a contributing factor in the innovation process as well as a manifestation of it.

At least three different processes contribute to hybridization and must be considered part of it. These include analogy, external borrowing, and substratum borrowing.

Analogy

Analogy is one of the major processes promoting the rise of new forms. It is a regularization process sometimes called analogical replacement or internal borrowing. Analogy is the process whereby one form of a language becomes more like another. Analogy describes what happens when less common or irregular forms are altered so that they come to resemble more familiar ones (Baugh 1957:195, Arlotto 1972:134).

Analogy is the kind of change that occurs when a child says foots, oxes, sticked, and breaked instead of feet, oxen, stuck, and broke. In English this has been a major source of new word forms, with thousands of words having been transformed in this fashion. Examples include the substitution of words like days, cows, eyes, shoes, and brothers for the now archaic forms dawes, kyne, eyen, shoen, and bretheren. At present there are many such words in transition. These include the alternate versions of the plural form of hoof (hooves and hoofs), the past tense of wake (woke and waked), and the past tense of dive (dove and dived). Our usage of these words is fluctuating and eventually we will come to favor one competing form over the other (Figure 5.3 again). In this manner, new analogical creations will gradually spread throughout the population. If the new forms succeed in driving out earlier forms and pass into common usage, then linguistic selection will have occurred (Weinreich 1968:186, Arlotto 1972:134).

Gradual change in other lineages also sets up small situations of disorder. These invite similar responses, sometimes deliberate, sometimes unconscious, to correct, regularize, and to tame things. Analogical replacement is a manifestation of this impulse. It is one response to the internal strain between elements in a system.

External Borrowing

In language studies, the term borrowing usually refers to the conscious adoption of foreign loan words into native vocabularies. Frequently, hybrid forms are produced when a borrowed root is combined with a native root, a native prefix, or a native suffix. In Middle English, for instance, words like commonweal, battleax, and gentleness appeared in the language. These combined French loan words with Old English endings (Baugh 1957:215). Thousands of such compound hybrids made their way into the English language during the 13th and 14th centuries.

External borrowing is an extremely common process which affects not only vocabulary elements, but all other aspects of culture as well. All ideas and durable artifacts are potential loan elements. The rate and direction of external borrowing involves the process of between-place diffusion, which will be covered in the next chapter.

Substratum Borrowing

One of the causes of directional change is the influence of a substratum. A substratum is a cultural lineage that was held by a population before a later one was adopted or was imposed upon them. In the course of conforming to a new pattern, certain elements of the former lineage will persist and will be incorporated into the new one (Arlotto 1972:154, Cohen 1970:107, Yinger 1970:92). This process is similar to acculturation and it frequently leads to syncretism (the hybridization of elements from different cultural lineages).

Foreign systems are sometimes superimposed on native populations.

This is often achieved through force though it need not be. Cohen (1970:84) sees substratum influence as a reaction to the forceful obliteration of a native system by a newly arrived language, religion, or other kind of lineage. This reaction brings about a modification of the dominant system through the substitution of elements from the substratum into the recently established ruling system. The disappearance of the dominated lineage is not complete and the evolution of the dominant lineage is accelerated.

As an illustration of this, some scholars believe that certain features of the ancient Celtic language of Gaul "seeped through" to the new language imposed by the Roman conquerers of that region. As a result, French is sometimes described as a descendant of Latin with a Gaulish substratum (Arlotto 1972:154). Sopher has discussed the same phenomenon with respect to religious substrata. In Northern Europe, ancient Druidic and other Indo-Germanic customs associated with the arrival of mid-winter and the arrival of spring resurfaced years later within Christianity after it had been imported from the south (Sopher 1967:21). Many Northern European customs associated with the celebration of Easter and Christmas are substratum elements surviving from pre-Christian times.

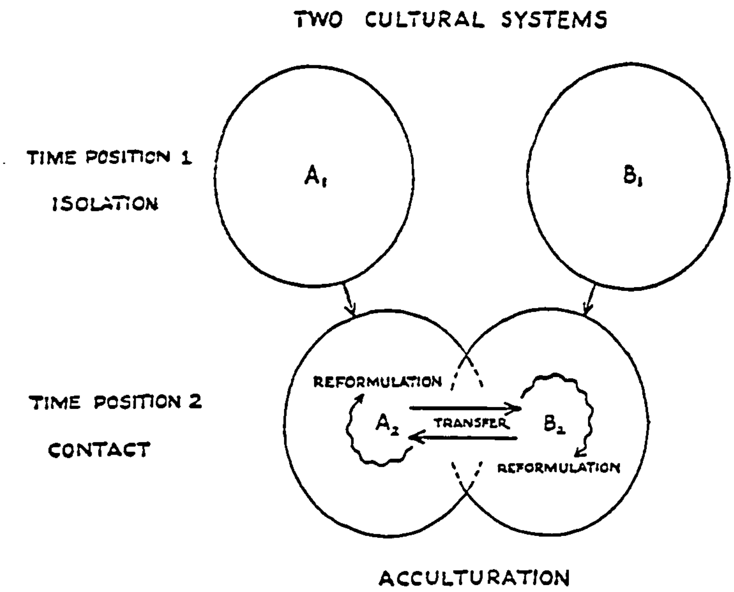
New World Catholicism has been influenced by many such substratum survivals. The African substratum has been particularly important in the form of Christianity existing in Brazil, Cuba, and Haiti (Herskovits 1937, Bastide 1972:128-168), as the Indian substratum has been in Mexico (Wolf 1965) and other parts of Latin America (Madsen 1960:29).

Acculturation

The process of acculturation contributes to the internal change of all subgroups located within a given place (Figure 7.1). It is one of the processes whereby culture undergoes hybridization. When local subgroups are being modified through the borrowing and reinterpretation of ideas and artifacts originating in other subgroups, acculturation is taking place (Bidney 1970:360, Kroeber 1948:425, Taylor 1969:155, Keesing 1958:28, Herskovits 1938).

When acculturation occurs, one or two intermediate groups are formed (through hybridization). These groups are slightly different than they were before. They in effect become new entities, although in the literature on the subject they are almost never seen as separate groups. During subsequent time periods the old patterns coexist with the new. If acculturation continues, the groups adhering to the old patterns will eventually disappear. Sometimes one group will become acculturated while another will be unaffected by the process. In this situation, the transfer shown in Figure 7.1 is one way. The acculturated group would then converge with the other group while diverging from its former self.

Acculturation involves the continuous first hand contact of different groups located within the same place. Whereas the processes of between-place diffusion and within-place numerical expansion involve adoption and transfer, acculturation can involve the additional phenomenon of alteration and reformulation. When this happens, elements which have been transferred between adjacent or intermingled groups



Acculturation: the Basic Model. The two cultural systems, previously isolated (time position 1), come into contact (time position 2). Each can be spoken of as undergoing acculturation, or the whole may be spoken of as an acculturation process.

Figure 7.1 (Keesing 1958:28)

can be changed in meaning, form or function within the receiving group. Reinterpreting a transferred element allows it to fit more easily into different contexts (Herskovits 1952:594, Keesing 1958:399).

Stimulus Diffusion

The first determinant of the frequency of local innovation is the amount of stimulus diffusion that a place is experiencing. Stimulus diffusion occurs when an innovation is brought into existence through some outside stimulus. An idea or an artifact may be invented (or reinvented) as a result of an outside idea serving as a catalyst (Spencer and Thomas 1969:191).

Stimulus diffusion can also be called idea diffusion or stimulus invention since, as Kroeber has noted (1948:368), it involves equal amounts of diffusion and invention.

The diffusion of writing has often been used as an example of stimulus diffusion. Some students of epigraphy have argued that writing originated first in the Middle East and later diffused to China (see Diringer 1962:71). At the same time, other scholars have pointed out that since Chinese ideaograms bear little resemblance to cuneiform characters it is likely that Chinese writing is an autochthanous development. Without commenting on the plausibility of either of these two claims, it should be noted that a third possibility exists in which both of these interpretations could be true. This third possibility is stimulus diffusion. Even though a specific style of writing may not have diffused from Mesopotamia into China, it is possible that the idea of writing did. In this case, the idea that meaning could be conveyed through written symbols could have stimulated the creation of a native system, which would have been totally unique in appearance. A similar argument has occasionally been made for the diffusion of iron metallurgy (see F. Jones 1966:11).

DETERMINANTS OF INNOVATION FREQUENCY

In searching the literature on innovation, nine variables have been found that help to explain local innovation frequencies. These include homogeneity, urbanization, diversity, isolation, knowledge and skills, needs, population, leisure, and the window effect. At various times, individual writers have put forward one or two of these variables as the primary cause of innovation frequency. In reality, we have no idea as to how these variables should be weighted and which ones are more important than others. In addition, it is by no means certain that the list is complete. Formula 7.1, therefore, should be regarded as only a tentative suggestion as to how these variables affect local innovation. Each of these variables will now be discussed individually.

Homogeneity

The first factor influencing the probable rate of local innovation is the amount of homogeneity that a place exhibits. Homogeneity (Homo) is a measure of variability as it applies to such things as ethnic groups, functional groups, social classes, ideas, and artifacts.

Berelson and Steiner (1964:615) have reported that the occurrence of social change is more likely in heterogeneous societies than homogeneous ones. They cite more ideas, more conflicts of interest, more

$$\mathrm{InRa}_{t_1-t_2} = \frac{\mathrm{Urb}_{t_1} \times \mathrm{Div}_{t_1} \times \boxed{\mathrm{NumId}_{t_1}} \times \boxed{\mathrm{KSA}_{t_1}} \times \boxed{\mathrm{Pop}_{t_1}} \times \mathrm{Leis}_{t_1} \times \boxed{\mathrm{DWN}_{t_1}}}{\mathrm{Homo}_{t_1}} \tag{7.1}$$

groups with different persuasions and a greater number of different points of view as explanations for this phenomenon. The relationship between homogeneity and innovation is therefore an inverse one so that as homogeneity increases, the frequency of innovation decreases. This has been reflected in Formula 7.1. The variables helping to explain the level of within-place homogeneity have been identified above in chapter 4.

Urbanization

The second factor affecting the frequency of innovation is the level of urbanization (Urb). It has been widely recognized that cities are focal points of change. As Berelson and Steiner (1964:570) have noted, one of the major features of residence affecting the development of beliefs and attitudes is whether or not an individual lives in a rural or an urban location. One prominent difference between these two areas is that social change is likely to be more intense within cities than in the countryside. There tends to be less behavioral change and more stability in rural areas (Berelson and Steiner 1964:606).

In addition to social and economic change, technological innovation also tends to originate in the cities. In the opinion of Lloyd and Dicken (1972:105), locations which have the highest potential for generating new technical knowledge are the ones where individuals communicate with each other more frequently. Such areas tend to be cities. That people who invent things tend to be city dwellers rather than rural people has also been noted by Thompson (1962:257) and Wagner (1964:81). Only later do the innovations of these individuals spread to rural areas (Foster 1962:29). This seems to be true for all kinds of innovations and improvements, including those dealing with rural concerns--such as agricultural equipment and chemical fertilizers (Berelson and Steiner 1964:610).

As the level of urbanization increases, therefore, the probable rate of innovation will also tend to increase.

Diversity

Another factor influencing the frequency of innovation is the degree of local diversity (Div). Diversity refers to the number of different groups of ideas in a place and it includes the same things that are considered in discussions of homogeneity (ethnic groups, functional groups, social classes, ideas and artifacts). Since diversity and the various factors contributing to it have already been discussed in chapter 4, little space will be devoted to it here.

The connection between complexity and innovation is similar to the one between homogeneity and innovation. According to many writers, the rate of change in any culture is a function of the diversity of the culture, so that the greater the complexity the faster the change (Hart 1931:667, Ogburn 1928:104, Feibleman 1966:284, Allen et al. 1957: 49, Berelson and Steiner 1964:616, Sanders 1962:66, Freedman et al. 1956: 330). This is a variation of the idea that the rich get richer while the poor get poorer. Ideas breed new ideas and inventions begat new inventions. The smaller the local storehouse of elements, the more remote is the possibility of new combinations. If the local inventory of things grows, new combinations will appear with increasing rapidity.

Among hunting and gathering peoples, where the level of cultural diversity is relatively low, there is little opportunity for improving on nature through inventive activity. The reason for this, as Wagner has stated (1964:64), includes the lack of an adequate base of technology to start with as well as the fact that mistakes can easily be fatal for the entire group. In many ways (though not all) such groups have changed very little for long periods of time. Among early societies such low rates of change seem to have been the rule (Dobzhansky and Montague 1947:89-90). At one time this was attributed to early man's lack of intelligence. According to Sauer (1952:9), however,

> "It was not his brain that held ancient man back; it was the little he had to think about for so long. Ideas must build upon ideas and such accumulation. . . appears to have been very slow for a very long time."

During the last 25,000 years or so, man's configuration of ideas and artifacts has changed more rapidly. It is now growing in complexity at an exponential rate (Freedman et al. 1956:330, Harris 1971:155, Lowie 1917:78, White 1949:385, Hart 1931:84). Inventive activity and the accumulation process is also growing at an exponential rate.

It has often been stated that cultural change and technological advancement are related to the communication process because improvements and change depend on the accumulation of ideas (Swadesh 1971:223). This has frequently been associated with the diffusion of ideas between groups. According to Taylor (1969:157), for instance, cultural contact with outsiders increases local rates of change because potential innovators have available to them not only the ideas of their own culture, but those of other cultures as well. The crucial element promoting these changes, however, is not diffusion. Instead, it is the process of accumulation, which occurs when a place's level of diversity is increased.

Isolation and Number of Ideas

It has often been said that physical isolation produces backwardness. According to Ratzel (1896 Vol. I:83) people who are remote from the great streams of traffic inevitably suffer cultural impoverishment. Ellen Churchill Semple echoed this view by noting that remote and inaccessible places are condemned to eternal retardation (1911:144). More recent scholars have made similar observations, although the words "backward" and "retarded" have been replaced with the notion that isolated places change more slowly and are not as complex as more exposed places (Taylor 1969:156, Foster 1962:25, Berelson and Steiner 1964:652, Kroeber 1948:419, Spencer and Thomas 1969:224, Hoebel 1958:607, Broek and Webb 1973:342, and Wilbanks 1972:436).

Physical isolation reduces the number of ideas coming into a place and this ultimately affects the local rate of change by lowering the size of the available information pool on which selection operates (Sopher 1972:323). The crucial element in this variable, then, is not the location of a place in geographic space, but rather the number of ideas that exist there (NumId). In most cases we could therefore assume that as isolation increased, and as the size of the local inventory of ideas decreased (as a consequence of lower inward diffusion rates), innovation rates would also decrease. Conversely, as isolation gives way to exposure, innovation rates would tend to increase. The relationship may not be completely linear, however. As Carl Sauer (1948:77) has put it, extreme isolation does tend to retard cultural growth, but at the same time great accessibility exposes an area to repeated outside invasions which tend to stifle the innovation process. According to

Sauer, areas where innovation and change occur most rapidly need to be somewhat protected from the outside world, but they also must have access to the flow of ideas from other places.

Knowledge, Skills, and Abilities

Mental resources are the raw materials out of which innovations arise. High levels of such qualities as education, literacy, intelligence, creativity, brilliance, originality and the local inventory of knowledge will improve the conditions under which innovation can occur. All such resources are ideas held by local individuals. Many of these ideas can be described as special skills and abilities, which are part of the category entitled "Knowledge, skills, and abilities" (KSA). Knowledge as a geographic element is found in two separate states. Some of it is unrecorded and exists only in the minds of individuals. Another part of it is recorded. Recorded knowledge exists as the symbolic content of durable artifacts. Because of this, the ideas of individuals are potentially immortal. Some knowledge exists in both states simultaneously. Skills and abilities exist only in the unrecorded state and become manifest only through performances, which may produce either durable or ephemeral artifacts.

Some of these skills are necessary for the production of durable artifacts. Others are necessary for the production of new ideas. It is the latter which contributes to the rate of local innovation.

Desires, Wants, and Needs

Functionalists generally rely very heavily on the concept of need to explain why particular innovations come about. Malinowski, who has perhaps been most closely identified with this position in recent years, wrote at length on the kind of needs that produce particular kinds of cultural response. Some of these needs are in response to biological requirements while some arise from standing cultural requirements. Figure 7.2 shows a brief summary of Malinowski's ideas on the subject.

Malinowski has also asserted (1969:118) that the form of a thing is determined by its functional context. The same idea has been expressed in the field of architecture by Frank Lloyd Wright, except that here the principle has been transformed from one of observation to one of design.

A major set of needs, which seems to come into play when inconsistencies and strain disrupt the harmonious functioning of a society, involves a general desire for perceptual coherence and a widespread human urge to explain. Levi-Strauss (1967:5) and George Dickie (1971:94) have remarked on the universal nature of this logico-aesthetic tendency of human behavior to classify and categorize everything within the sphere of human contact. It is this tendency that brings about alternate paradigms and structural innovations during periods of crisis and conflict.

The desire for order and coherence occasionally produces ideas that do not seem to satisfy any obvious need. In the history of scientific discovery, for instance, the practical value of most ideas do not become apparent until years after they are born (Koestler 1973:515).

Needs can encourage the development of technological innovations. They can also encourage the development of new ideas and ways of looking at things. A man whose business has failed and who is hungry for the first time in his life comes to see the logic of Marxist arguments.

(A) BASIC NEEDS	(B) CULTURAL RESPONSES
1. *Metabolism*	1. *Commissariat*
2. *Reproduction*	2. *Kinship*
3. *Bodily Comforts*	3. *Shelter*
4. *Safety*	4. *Protection*
5. *Movement*	5. *Activities*
6. *Growth*	6. *Training*
7. *Health*	7. *Hygiene*

Figure 7.2 (Malinowski 1969:91)

Rollo Handy (1969:153), who advocates a need approach to value theory, points out that needs evolve like everything else. Technological advances produce new needs and, as needs change, societal values change. According to many scholars, like Murdock, Parsons, Marx, Durkheim and Pareto, cultural needs are essential to innovation. Others, such as Thorstein Veblin, have held the reverse--not that necessity is the mother of invention, but rather that invention is the mother of necessity (Veblin 1934:152-53, Herskovits 1945:152, Yinger 1970:233). Ogburn's views (1928:116) were quite different. In his opinion it was doubtful whether definite wants were important at all in determining specific cultural forms. Malinowski (1969:118) argued that artifacts and implements arise as they are needed and are altered in form and function according to new needs and new local circumstances. He felt that the elements of culture do not arise out of random inventiveness or borrowing, but are determined by basic needs and the possibilities of satisfying them. Similarly, Eisenstadt (1964:385) has written that innovations can be viewed as acceptable solutions to latent problems or needs within various places.

As with many such controversies, the opinions advanced are usually neither wholly true nor wholly false, and since the idea that local needs lead to innovative responses is not unreasonable, it will be included in this part of the structural model. Accordingly, as Formula 7.1 shows, greater need contributes to higher frequencies of innovation.

Several aspects of need play a role in the innovation process. A demand for the control of soil erosion, for example, led to the innovative idea of contour ploughing. It cost farmers nothing to adopt this new method. Although economics was certainly involved in finding a solution to the erosion problem, a consideration of what farmers might be willing to pay for such a solution was not what prompted this innovation, as opposed to, say, the invention of a new kind of tractor.

Similarly, the innovative systems created by such individuals as Mohammed, Calvin, Joseph Smith, Adam Smith, Darwin, Marx and Einstein were in response to a very different set of demands from the ones that led to the inventions of individuals like Robert Fulton, Thomas Edison, Alexander Graham Bell and Henry Ford. The latter group created new commodities and invented new ways of making artifacts for other individuals to buy. Their innovations satisfied an economic demand for new artifacts and new performances. The former group responded to a demand for new ideas.

Population

Population (Pop) also influences local rates of innovation. In the world of plants and animals, there is a correlation between the size of a breeding population and the number of genetic combinations that natural selection can act upon (Ross 1962:113). A larger population can produce a larger number of recombinations and mutations than a smaller one. The potential range of variation is so great, however, that even in the largest populations it is almost impossible for every conceivable combination to occur.

In the realm of ideas it has also been found that there is a strong positive relationship between population size and innovation (Hudson 1972:152, Taylor 1969:36). The findings of Thompson (1962), Pederson

(1970), Pred (1966), Feller (1971) and Carneiro (1967) support this conclusion.

The connection between population size and innovation exists simply because there are more opportunities in large populations for ideational recombination and mutation to occur than exists in places where the population is small.

The population of a place is one of the more important elements in this model because it can be measured. The strength of many other elements can be estimated (through various causal links) either wholly or partially by the size of the population.

No intermediate causal links are necessary in order to estimate the population of a place. Population is either given, or estimated directly. Where census reports are absent, population can sometimes be estimated using the techniques developed by Westfall (1969) and Birdsell (1966).

Leisure

A connection between leisure time and inventive activity has sometimes been seen by some scholars. According to Sauer (1952:21), for example, needy societies and those living on the brink of starvation are not particularly inventive. Such societies lack the leisure time necessary for activities like reflection, experimentation, and discussion. Societies living on the margins of subsistence need to spend all their time providing for their immediate survival.

If we accept this generalization, then some relationship must exist between income (defined above as production) and innovation. Places with low incomes would then be more likely to exist on the margins of survival than would places with high incomes. The relationship between income (Inc) and leisure (Leis) would not be linear, however, as we know that individuals in so-called primitive societies, when they are not living at the margins of survival, have a great deal of leisure time; more so in fact than individuals in modern industrial societies (Harris 1971:218). Accordingly, the relationship between income and leisure, and between leisure and invention, might hold at the lowest income levels, but not as incomes rise above the margins of subsistence.

The Window Effect

The role of the window effect in the creative process involves the appearance of unique opportunities which encourage specific innovations. The window moves through time, opening opportunities for the discovery of some phenomena and taking away opportunities for the discovery of others. Ross (1962:2) has written that the rapid succession of discoveries in electricity, anatomy, physiology, histology, and embryology during the first half of the nineteenth century is not strange since people had been on the verge of making them for years. Each discovery provided clues for the solution of the next problem. The Darwin/Wallace theory of evolution, Henry Ford's assembly line techniques, and the religious syntheses of Mohammed the Prophet and Paul the Apostle are other well-known examples of ideas that arose at the right time in the right place.

Some scholars believe that if these individuals had not lived, others would have formulated similar ideas at about the same time, much in the same way that the calculus was invented simultaneously by Leibniz and Newton. Ogburn (1928:90) lists 148 inventions and discoveries made independently by two or more people, although George Carter (1975:483) and others would argue strongly that many of these are not really examples of independent innovation at all.

The principle of the window effect is expressed in the Greek term _kairos_, which refers to the time when some action is possible or impossible (Tillich 1972:1). _Kairos_, as opposed to _chronos_, which refers to the kind of time measured by a clock, conveys a sense of readiness, a sense that the time is ripe for something to happen. Another form of this idea appears in Chinese political thought as the Mandate of Heaven. When natural disasters and civil disorders increase, it is a sign from heaven that the ruling dynasty has lost the Mandate. By the same token, the founder of a new dynasty, by engaging in successful revolution, proves to the world that he has received the Mandate of Heaven. Like ancient priests who used their powers to save the world from total destruction during eclipses of the sun, the idea was useful to those holding canonical office and was difficult for outsiders to refute.

The idea must be used with caution, however, because of its circular nature. How do we know, for example, that a particular idea is one whose time has come? Because it was adopted. Why was it adopted? Because it was an idea whose time had come. Theories of cultural lag and cultural need share this same weakness as does the notion of adaption and many functionalist explanations of change. How do we know that something has adapted itself to its surroundings? Because it has survived. Why has it survived? Because it has adapted itself. Why has something else survived? Because it serves a function. How do we know it serves a function? Because it has survived.

Generating and Inhibiting Effects

The window effect is tied to the simultaneous maturation of many different lineages. If one lineage within a place changes too rapidly or too slowly, cultural lag sets in. As was mentioned above, cultural lag is frequently seen as a creative force when tied to the concept of readjustment. It can also be a retarding force when the lagging sector prevents change in other parts of the system, societal needs notwithstanding.

The steam engine, for example, was invented in Alexandria by Hero sometime during the second or third century A.D., yet it remained a toy until other areas of technology caught up with it during the Industrial Revolution. These other areas of technology were, in a sense, exhibiting cultural lag, thus inhibiting further improvements of the steam engine.

Kemeny (1959:191) has discussed the role of the developmental state of mathematics as a retarding agent. Einstein's unified field theory is, for instance, entirely untestable at the present time because mathematicians are unable to solve the special problems it poses. Similarly, Kemeny feels that progress in the social sciences has been stifled because neither the calculus nor elementary mathematics are really applicable to the kinds of data encountered in the social sciences. Elementary mathematics is used when the number of objects to be analyzed is small. The calculus is used when the number is immense, say from five billion up. The range stretching from five thousand to fifty thousand observations is where most of the problems faced by social scientists are found. The kind of mathematics needed to solve problems in this intermediate range, however, are still undeveloped (Kemeny 1959:249). The social sciences are thus having to wait for progress in mathematics before they can advance.

As was mentioned above, however, we can see these trends only through hindsight. We are moving through time (or it is moving past us) with the future to our backs. The past rushes out in front of us and the past is all that is visible. It might be, for instance, that the mathematical problems posed by certain bodies of knowledge are not solvable. At present we simply do not know whether they are or not.

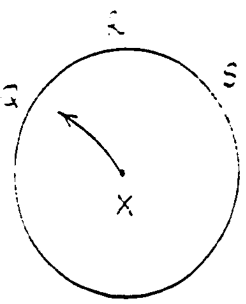
The Principle of Limited Possibilities

It is possible that there are no specific agents of active change at all and that random drift is the only active impulse initiating change. Once initiated, change within any given society would then be limited only by its own basic systematic characteristics (Eisenstadt 1964:376). If this assertion is valid, then the principle of limited possibilities (advocated by such scholars as Toynbee, Rostovtzeff, Lowie, Goldenweiser, Murdock, and Sumner) might apply in situations of change. This principle holds that instead of changing endlessly, each culture will be confined to a limited number of alternatives determined by the unique circumstances of its surroundings and its cultural past (Harris 1968:624). Unlimited variation in culture is not really possible. Since the number of alternatives available to any given group is probably limited, it might be expected that many instances will occur where the same thing has been invented within different places quite independently.

To illustrate this proposition, Figure 7.3a shows an element changing its form from something represented by X to something represented by Q. In this diagram, change toward form R or S may have been equally possible. In Figure 7.3b, however, change in the direction of form Q and form R has been prevented by the kind of limiting factors mentioned above. There was nothing preventing change in the direction of S, although alternative headings were possible. Figure 7.3c shows a more extensive range of limiting conditions. Random drift can initiate outward evolution but the range of possibilities available to the element indicated, when it changes in form, function, or structure, is restricted to the open portion of the circle.

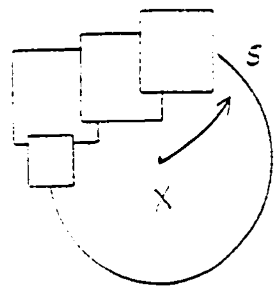
Different places can exhibit similar or dissimilar limiting conditions (such as level of technology, form of political organization, or type of environment). The arrangement of limiting conditions in Place p_3, for example, might yield the pattern shown in Figure 7.3d. This is quite different from the situation shown in Figure 7.3b. Its limiting conditions are quite similar, however, to the ones shown in Figure 7.3c. It should be expected, then, that directional change in Figure 7.3d will resemble directional change in Figure 7.3c more than it will resemble directional change in Figure 7.3b. Rates of change can be affected in a similar way.

Active change might thus be imagined as a kind of Brownian motion occurring within the uncovered area of each circle shown in Figure 7.3.



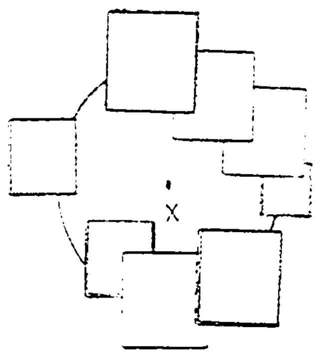
Place p_1

(a)



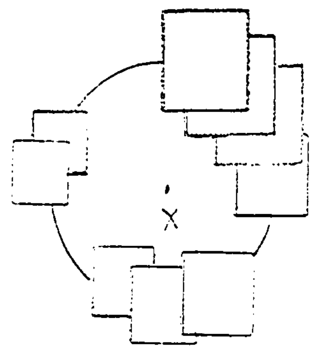
Place p_2

(b)



Place p_2

(c)



Place p_3

(d)

Figure 7.3

Changing limitations would then appear as positional shifts of the squares located on the circumference of any given circle.

Ecological Conditions

Many factors involved in processes of change act less as active agents of change than they do as passive agents of deflection. The influence of the natural environment is a classic case in point. The environment is widely considered to be a permissive or prohibitive agent rather than a creative or causative one (Thomas 1925:314, Lowie 1937:259, Platt 1948:352, Tatham 1951:151, Broek 1965:24, Hawley 1950:90, Lewthwaite 1966:8, Kaplan and Manners 1972:78).

Steward (1972) has gone farther than most in arguing that the natural environment plays a definite role in shaping a society's social and economic institutions. This role, however, is active only among sparsely populated groups possessing hunting and gathering economies. In more complex societies, economic and social institutions come to outweigh environmental factors in the development of technology (Kaplan and Manners 1972:91).

Existing Structures

As Kluckhohn (1960:124) has observed, all languages impose a special way of looking at the world and interpreting experience. Within the structure of each language can be found an entire range of unconscious assumptions about how things happen and how the world is put together. Up to a point, an individual sees and hears what the grammatical structure of his language allows him to.

As an illustration of this, the subject-verb-object structure in English and other Indo-European languages frequently makes it seem like processes are animate objects. Thus in English we get "it is raining" and in French we get "il fait pleuve" (it makes rain) for processes that don't involve an "it" at all. In contrast, the same phrase in Chinese would be 下雨 "hsia-yu" (falls rain).

English has often been described as the language of pragmatism and the man of action, while German has been characterized as the language of analysis and of mathematical precision. How these structures can affect perception is illustrated by the story about a group of learned men of different nationalities who, after observing a cageful of rats in a laboratory, offered different explanations of what was happening. The Americans saw the rats running about aimlessly while the Germans saw them sitting and thinking.

This is the Sapir-Whorf hypothesis, which holds that meanings and structure are not so much discovered in experience as they are imposed by our linguistic patterns (Voget 1975:574). Although this theory in its more extreme forms is no longer advocated, it has generated a great deal of research on how different peoples categorize things.

Within a language itself, the various grammatical and morphological characteristics will restrict the inventory of possible variations (Jakobson 1972b:305). The range of sounds used in a particular language will, for instance, restrict the coinage of new words to those made up of those specific sounds only. In English it would be extremely difficult to incorporate words from Khoisan which contain one of the click phonemes. In the same manner the structural characteristics of other cultural lineages will restrict the appearance of certain elements as innovations. Novel uses for cowhide, for example, are less likely to be thought of in India than in Mexico.

In academic circles, new interpretations seem to emerge first in the minds of younger individuals and among those who are either marginal or new to particular fields. Kuhn (1971:144) suggests that this is because they are less committed than their older colleagues to the world view and procedural dictates embedded in the existing paradigms of those fields.

Statelessness has often been regarded as a limiting condition for technological advance (Kaplan and Manners 1972:100). Technological factors in turn establish limits on other structural aspects of a culture. Along these same lines, Feibleman (1946:330) has argued that a stable social order, while not guaranteeing innovative developments in culture, does allow it.

Harrison Brown (1961:227) has written about a hypothetical set of structural (and ecological) limitations that might come into existence if our planet's industrial technology were ever to be destroyed (by war or some other catastrophe). The absence of machine technology would in itself set limits to any future recovery simply because the resources upon which this technology must be built would no longer be available without the use of highly sophisticated machines in the first place. Instead of existing near the surface in readily accessible amounts, deposits of iron, copper, coal, and oil would be deeply buried in the earth and would therefore be inaccessible to those not already possessing a high level of technology. Certain options of future development would have been eliminated.

Brown feels that if we ever lost our present technological capacity, the best we could then hope for would be to eventually regain the level of civilization enjoyed during the early 18th century. In this and similar examples, the presence of certain characteristics may not actively cause certain things to happen, but the presence or absence of something may prevent specific developments from taking place. Under such conditions, local innovation rates would tend to be lower.

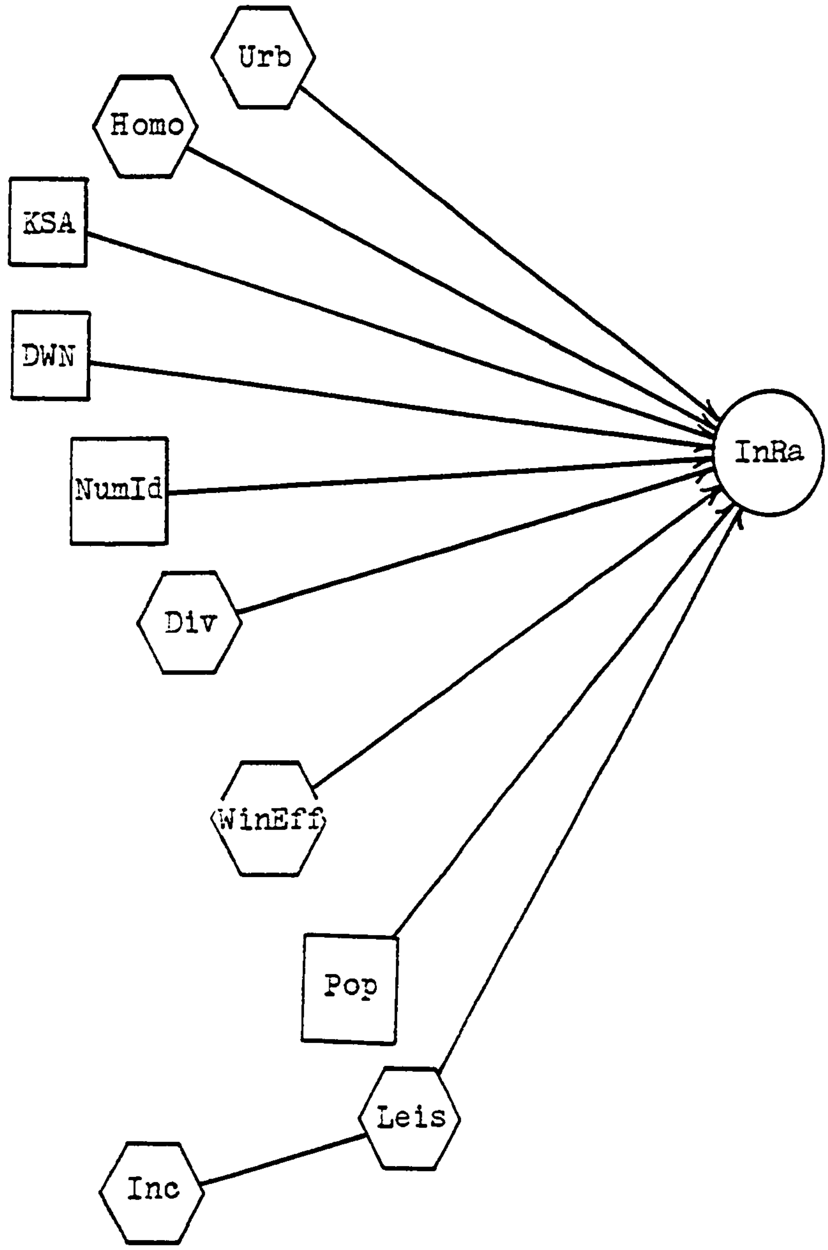


Figure 7.4

InRa	Innovation rate (number of innovations in a place between time t_1 and t_2)
Urb	Level of urbanization in a place at time t_1
Homo	Level of homogeneity in a place at time t_1
KSA	Knowledge, skills, and abilities in a place at time t_1
DWN	Desires, wants, and needs in a place at time t_1
NumId	Number of different ideas within a place at time t_1
Div	Level of diversity in a place at time t_1
WinEff	The window effect at time t_1
Pop	Population at time t_1
Leis	Level of leisure in a place at time t_1
Inc	Level of income in a place at time t_1

Chapter 8

INWARD DIFFUSION OF INNOVATIONS

INWARD DIFFUSION OF INDIVIDUALS, IDEAS, AND ARTIFACTS

The establishment of innovations in a place depends not only on how many inventions derive from local sources but also on how many come in from the outside. Qualitative change can emerge from either direction. The probable rate at which new ideas and artifacts are diffusing into a place depends on the rate at which things in general are being established there--innovations as well as things which are not innovative.

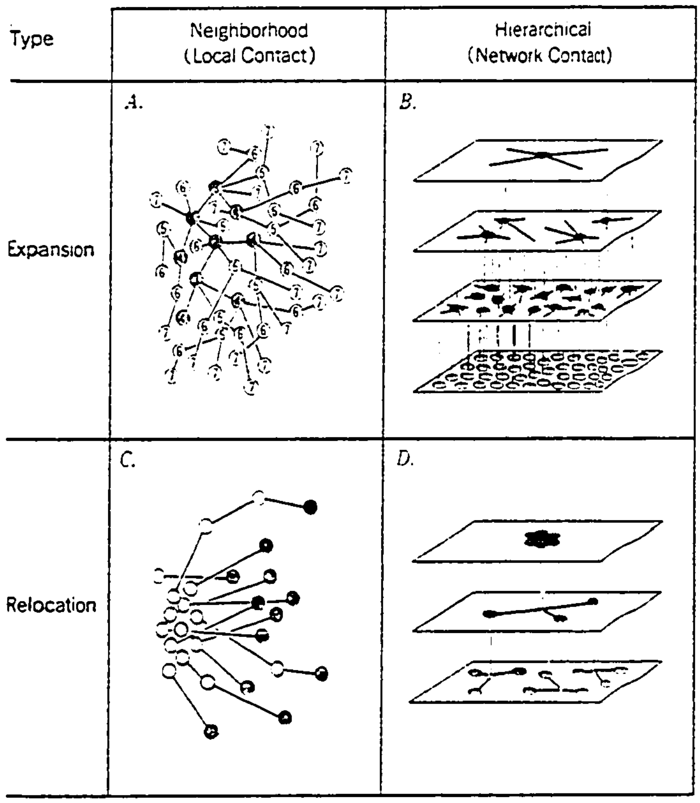
Separating innovative from non-innovative migrules (things which already exist within a place) is necessary because they contribute to different kinds of change. Innovative migrules contribute to qualitative change while non-innovative ones (as will be shown below in chapter 9) only contribute to quantitative change. We can estimate the rate at which things in general are being established in a place but we cannot at the same time relate this to a distinction between the establishment of innovative and non-innovative elements. We can only assume that a high rate of overall establishment (Dif_{ji}) will result in high inward diffusion rates for both innovative migrules ($DifIn_{ji}$) and non-innovative migrules ($DifId_{ji}$), as well as for the in-migration of individuals ($MigI_{ji}$) and the inward diffusion of artifacts ($DifAr_{ji}$). Formula 8.1, therefore, shows that the rate at which innovations are diffusing into a place from the outside (j_1, j_2. . j_n) is wholly dependent upon the rate at which ideas in general are diffusing inward, which in turn is dependent on the rate at which things in general (individuals, ideas, and artifacts) are diffusing inward. In Formula 8.1 the fraction 1/n indicates that only some of the migrules are ideas and only some of the in-migrating ideas are innovations.

$$\text{DifIn}_{ji} = 1/n\ \text{DifId}_{ji} = 1/n\ \text{Dif}_{ji} \qquad (8.1)$$

Ideas are not only transmitted directly (as when someone shouts over a fence into some neighboring place or when radio messages are broadcasted), but also are transmitted indirectly when individuals and artifacts diffuse between places. Both individuals and artifacts can carry ideas into new places. Note, therefore, that in the summary diagram at the end of this chapter the diffusion of ideas from one place to another depends in part on the diffusion of individuals and artifacts as well as on direct transmission.

Modes of Between-Place Diffusion

Diffusion between two separate places occurs in a number of different ways. Before discussing how between-place dispersal and establishment affect change rates it will be necessary to identify the spatial characteristics of diffusion itself. Many classifications of the diffusion process exist and Figure 8.1 is a fairly typical example. Such classifications, however, do not deal fully with the kinds of



Types of diffusion Examples of each type of diffusion include: (*A*) neighborhood spread of a rumor or disease, (*B*) spread of a national fad, (*C*) shift of frontier homesteads, (*D*) migration to a metropolis.

Figure 8.1 (Kolars and Nystuen 1974:128)

diffusion that produce different kinds of change. It has therefore been necessary to look at diffusion from a slightly different perspective. Four major types of diffusion will be identified. These include linear diffusion, radial diffusion, frontal diffusion, and hierarchical diffusion.

Linear Diffusion

The first kind of diffusion that can produce change is linear diffusion. This is the kind of diffusion that is mapped by showing lines of movement from a point of origin to a point of establishment. The spread of something along transportation routes is an example of linear diffusion. Figures 8.1a and 8.1b provide examples of this.

Radial Diffusion

Radial diffusion occurs when things are seen as moving in circular waves away from a central point. If, in Figure 8.1a, all the circles showing the same time sequence (2,3,4 etc.) were connected by a line, the result would show a very irregular set of contours spreading out from the place or origin. This would be an example of radial diffusion. If at a later point in time each place in the diagram were to send out its own radial diffusion waves, the effect would be somewhat like that shown in Figure 8.2. However, as each place emits its own radial diffusion waves it also receives waves from other places. As is illustrated in Figure 8.3, such outward and inward movement can happen simultaneously.

A major difference between linear and radial diffusion is that linear diffusion occurs along lines while radial diffusion occurs

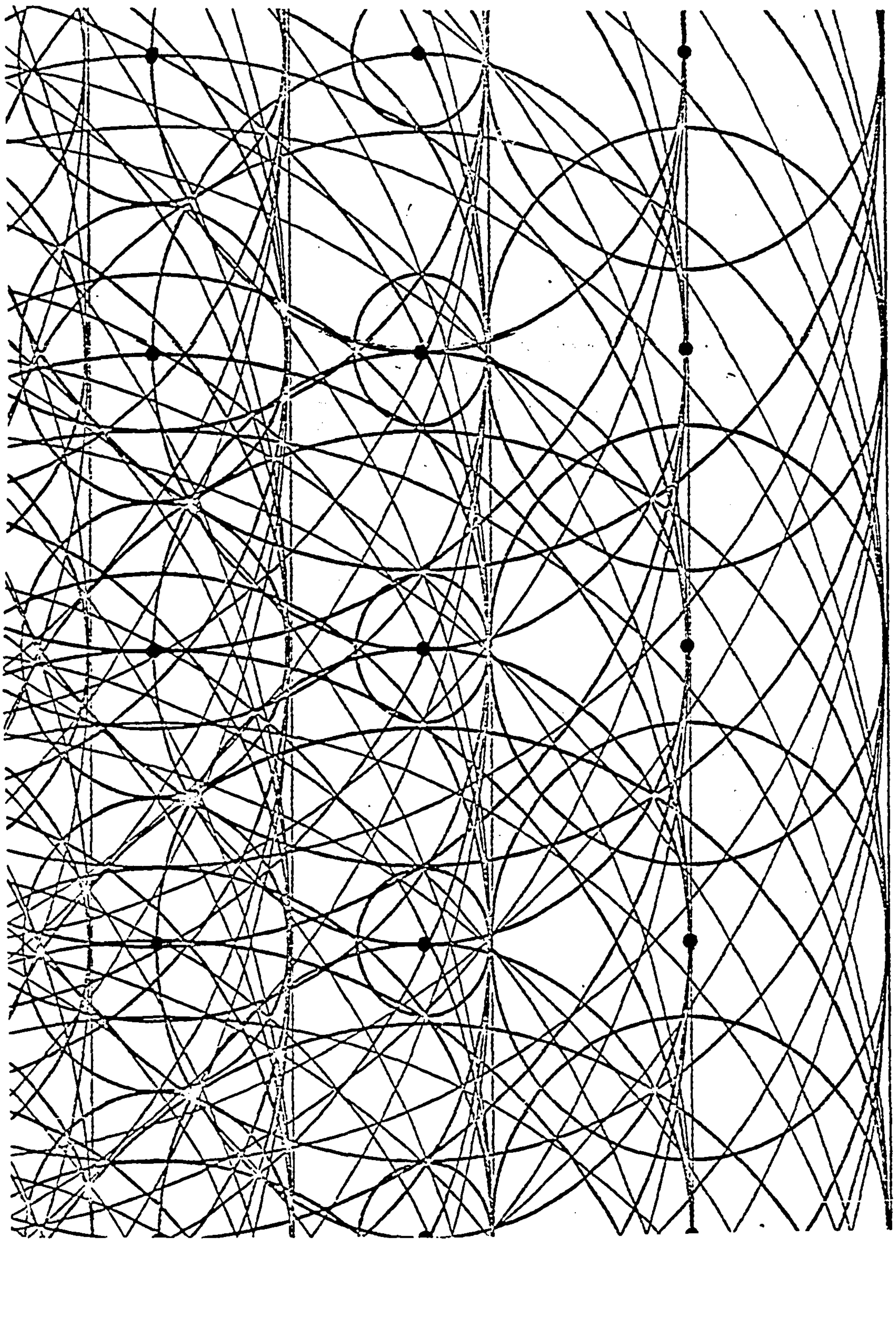
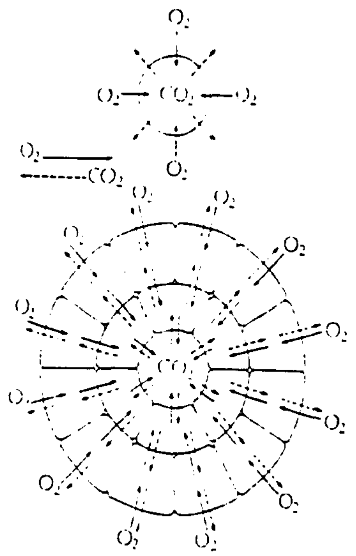


Figure 8.2 (Weisskopf 1968:66)



Diffusion of Gases: O_2 and CO_2

Figure 8.3 (Birdsell 1972:97)

through areas. Another difference is that radial diffusion occurs when things spread out in concentric rings from a middle place while linear diffusion may occur when things spread outward along a single path in one direction only.

Frontal Diffusion

Frontal diffusion is a variant of radial diffusion. It occurs when a diffusion wave moves in one direction only. It also occurs when the leading edge of a diffusion wave passes through an entire place. Figure 1.6 provides an illustration of this. Whereas radial diffusion is primarily a process of outward movement, frontal diffusion is a process of both inward and outward movement. Furthermore, when a radial diffusion wave arrives at a place from somewhere else, it does so as a diffusion front. This can readily be seen in Figure 8.2.

Hierarchical Diffusion

Hierarchical diffusion occurs when things move between places occupying different levels in a hierarchy. Figure 8.4 shows a typical hierarchy. Figure 8.5 shows the same hierarchy as it might appear on a map. As quite apparent in Figure 8.5, many places that are near each other in linear space are at a great distance from each other in hierarchical space. Similarly, places that are found in the higher levels of a hierarchy tend to be much closer together in hierarchical space than they are in linear space.

In hierarchical space, migrules and propagules can move in two directions: down the hierarchy and up the hierarchy. Downward movement has often been called cascade diffusion while upward movement can be

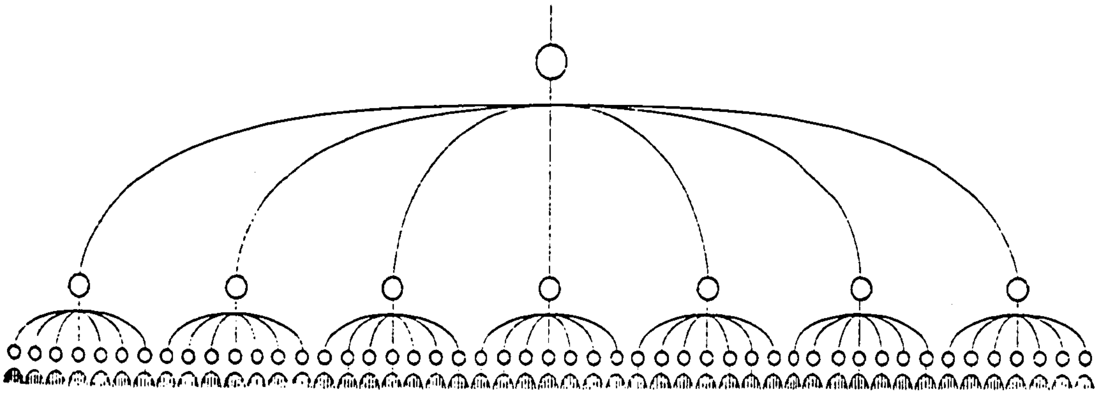


Figure 8.4 (Kolars and Nystuen 1974:101)

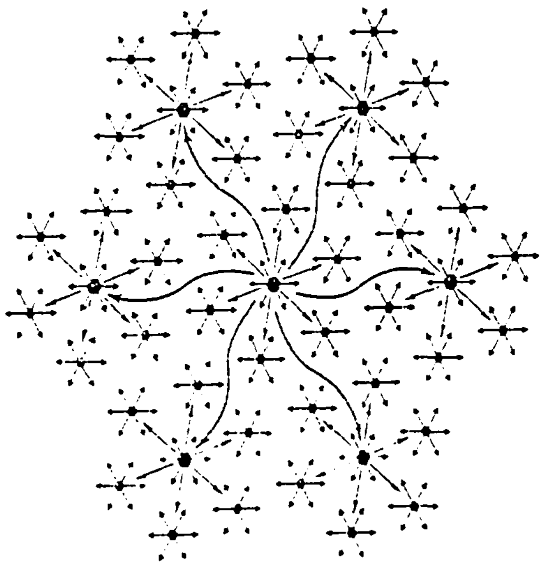


Figure 8.5 (Kolars and Nystuen 1974:101)

called buoyant diffusion.

Cascade Diffusion

Innovations and other diffusion elements tend to move from higher order centers in a hierarchy to successively lower order centers (Hudson 1972:137, Lloyd and Dicken 1972:143, Riddell 1970:129). This includes the widely observed tendency of innovations to spread outward from cities into rural areas (Foster 1962:29, Berelson and Steiner 1964:610). Figure 8.5 illustrates this directional tendency. In a given hierarchy, innovations are likely to occur first in those places having the most contact with other hierarchies (Pedersen 1970:207). Such places are those exhibiting the least amount of isolation. These are usually places at the top of national hierarchies, such as port cities and national capitals.

As a reflection of their hierarchical status, small places tend to adopt diffusing elements later than near-by larger places. When this happens, it is because larger places tend to occupy higher levels in hierarchical space. This phenomenon has been observed within national urban hierarchies as well as between entire countries. In Latin America, for instance, small countries such as Bolivia, Ecuador, Guayana, Paraguay, and Guatemala tend to adopt diffused elements later than their larger neighbors (Pedersen 1970:242).

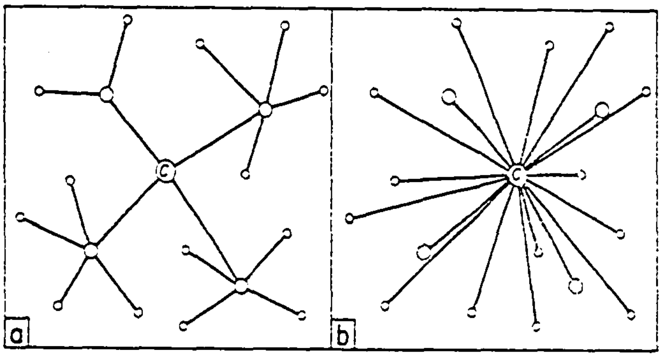
Pedersen also found evidence (1970:247) that the old Spanish colonial administrative hierarchy influences diffusion patterns in South America today. He felt the links between the Spanish viceroyalties from the sixteenth to the nineteenth centuries were channels of communication that remained in operation after independence from Spain. Messages from Spain moving down through this old administrative hierarchy would be an example of cascade diffusion. Where the pattern persists, it represents movement through a kind of international cultural hierarchy.

Splash and Droplet Diffusion

Hierarchical diffusion is not an exclusive process. As Figure 8.6 shows, movement within a hierarchy can be accompanied by linear as well as radial diffusion. If, for example, cascade diffusion is combined with the kind of radial movement shown in Figure 8.2, the pattern shown in Figure 8.7 results. This illustrates the process of splash and droplet diffusion.

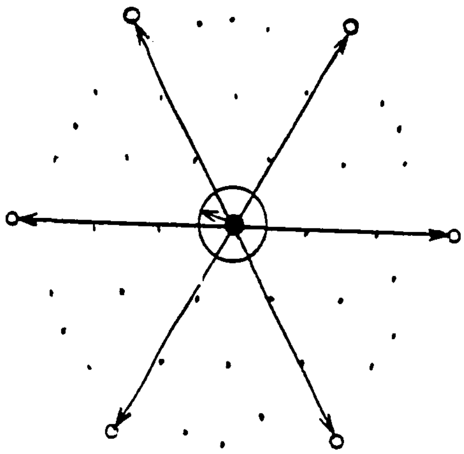
In this example, hierarchical and radial movements are taking place simultaneously. Elements that originate in the highest order center of the hierarchy radiate outward at time t_1 while also moving down to the next lower order center. At time t_2 the diffusing elements have passed down to the third order centers in the hierarchy. At the same time, radial diffusion has started in the second order centers and has progressed one more increment of distance away from the first order center. Further expansion via both modes of diffusion is shown for times t_3 and t_4. Many of the lower order places will receive the hierarchical diffusion front at about the same time the radial diffusion front arrives from the higher order centers (assuming that things move at a constant rate and that there are no barriers).

According to Abler, Adams, and Gould (1971:395) when diffusing

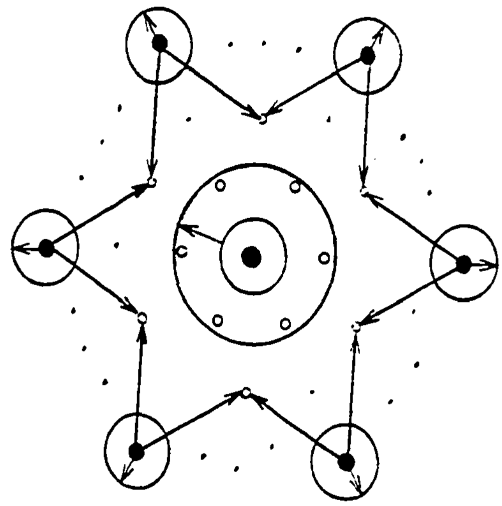


Within an urban hierarchy, when a good or service is delivered, the interactions between the dominant center and subordinate centers may be indirect (a) or direct (b).

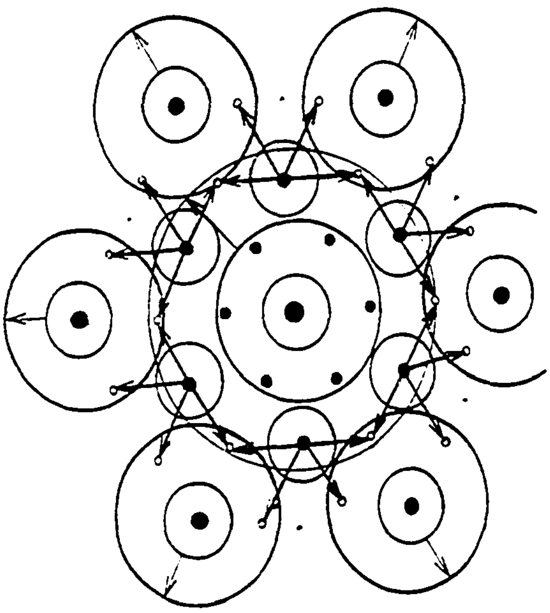
Figure 8.6 (Abler, Adams, and Gould 1971:265)



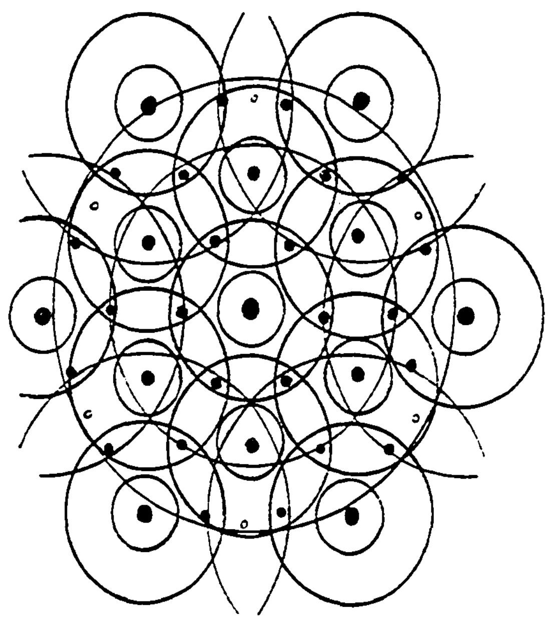
(a) Time t_1



(b) Time t_2



(c) Time t_3



(d) Time t_4

Figure 8.7

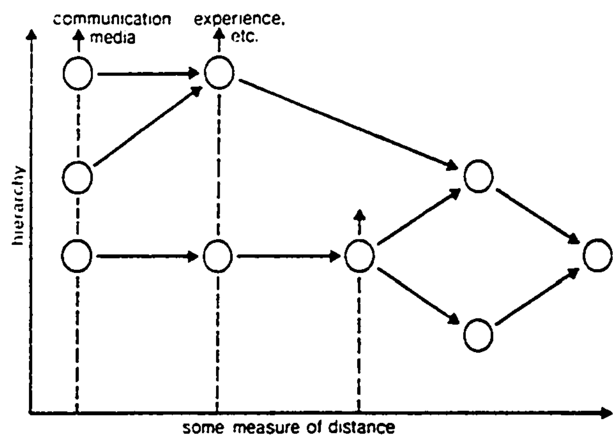
elements first begin to spread hierarchical processes are more important. Later, however, non-hierarchical processes become more prominent. This combination of processes operates on both national and international scales. Before the twentieth century, international diffusion operated mainly through linear processes. In this century, however, diffusion on the international level seems to function more through a world hierarchy of major urban centers, particularly during the early phase of a propagule's movement. After the initial patterns of adoption have been established, the effects of linear and radial diffusion increase and eventually overpower the effects of hierarchical diffusion (Abler, Adams, and Gould 1971:433,437).

It would seem, then, that the splash and droplet pattern combining hierarchical, linear, and radial movement is a more realistic portrayal of the diffusion process as it occurs between different places.

Buoyant Diffusion

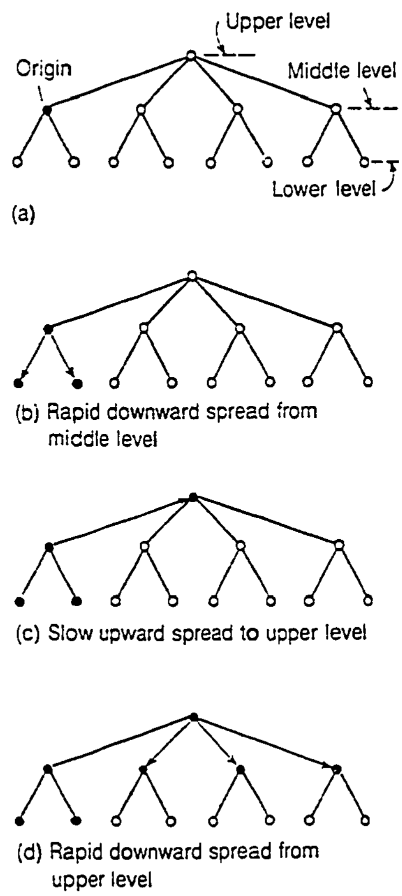
That traits diffuse downward through a hierarchy has frequently been demonstrated. But it is also true that the same kind of traits will diffuse upward as well. This upward diffusion is called buoyant diffusion. Figure 8.8 shows another view of the splash and droplet process as it occurs in the presence of both cascade and buoyant hierarchical diffusion.

There is some question as to whether elements diffuse upward and downward at the same rate. Haggett (1972:349) indicates that traits diffuse slowly up a central place hierarchy and diffuse rapidly downward. Figure 8.9 illustrates this rate differential. Hudson (1972:138) offers



Communication of information through a settled landscape.

Figure 8.8 (Eliot Hurst 1972:311)



Hierarchic diffusion. This is a hypothetical example of the spread of an innovation from a middle-order origin to other centers in a three-level hierarchy.

Figure 8.9 (Haggett 1972:349)

an explanation. He feels that since large places are likely to possess more information and a greater variety of information than small places, contact with a large place is more likely to result in an exchange of something new than is contact with a small place. Other things being equal, big places also tend to have more prestige than small places and this very often seems to determine the direction and intensity of diffusion (Redlich 1953:313; Weinreich 1968:176,179,180; Labov 1972:286; Lehmann 1973:121).

On the other hand, the migration of individuals up a hierarchy may be easier than migration down a hierarchy (Haggett 1972:353). This tendency will work in opposition to the processes shown in Figure 8.9. There is also evidence that hierarchical diffusion operates differently in countries having different levels of economic development. In industrial countries, innovations tend to spread rapidly down the urban hierarchy, thus conforming to the pattern in Figure 8.9. Conversely, in non-industrial countries, innovations are adopted in capital and port cities, but do not diffuse to lower centers in the urban hierarchy or to rural areas (Pedersen 1970:203).

Differences in the predominant direction of hierarchical diffusion may also be related to the maturity of an area. In the United States during the last century, innovation waves had their origins in the East. After the closing of the frontier, many innovations appeared in the West and diffused Eastward, presumably up a hierarchical gradient of central places (Abler, Adams, and Gould 1974:446).

Hierarchical diffusion can also be affected by regional income levels, which might be independent of the size of a place. The diffusion of certain traits, such as consumer goods, through an urban hierarchy would tend to cease in the larger places in regions with low incomes (Pred 1967:96). In this case there is differential selection, and the rapid downward spread of a trait from an upper level to all lower-order places (as shown in Figure 8.9) would not occur at all.

ESTABLISHMENT OF PROPAGULES

The structural model distinguishes between the establishment of propagules (Dif_{ji}) and the establishment of things generated locally (NExpLId and EstLIn). One major difference between these two categories of things is that locally generated elements have two sources (local innovation and local communication--as will be shown in chapter 9), while propagules have only one source--inward diffusion.

A propagule is something that disperses from one place to another. Some propagules become established in new places. These elements are then called migrules. Migrules are elements which have diffused or migrated. Other propagules do not become established. These are unsuccessful propagules (ones which have failed to diffuse). The process whereby propagules become established is sometimes called ecesis.

Propagules, whether they are innovative or not, must become established in a new place before they can contribute to qualitative or quantitative change. Two factors influence the rate of this establishment process. The first involves the rate at which elements from the outside are being dispersed into a place (Dis_{ji}). The second involves the propensity of individuals within a place to adopt the dispersed elements (PrAdP). Increases in either of these variables will result in higher rates of establishment and diffusion (Formula 8.2).

$$Dif_{ji} = \frac{Dis_{ji}}{PrAdP} \tag{8.2}$$

Inward Dispersal

Inward dispersal involves the rate at which things move into a place from the outside. This does not mean dispersal from any one particular place, but instead means dispersal from all outside places simultaneously. The intensity of inward dispersal depends on two complementary but completely independent forces, and a third which contains aspects of the first two. The first two can best be described as magnet-like forces and fan-like forces. The first concerns properties within a place while the second concerns forces originating outside a place. The two sets of forces must be considered separately.

When things disperse into a place as a result of magnet-like forces they are drawn, so to speak, by the place itself. This power, which is found only within the place itself, is called attraction (Att_i).

Fan-like forces reside entirely in outside places. When inward dispersal results from fan-like forces the things in motion are being propelled toward a place, rather than being drawn into a place. A fan, for instance, will blow leaves toward a tree. The tree has nothing to do with this movement and is completely passive in the matter. If the tree was not there, the fan would still blow the leaves over that particular site. The fact that the tree is missing does not affect the arrival of the leaves at all. The only difference is that if the leaves move over an empty site they will not be intercepted. The same distinction exists as regards places in general. By themselves, fan-like forces produce encroachment (Enc_{ji}).

Formula 8.3 shows the relationship between inward dispersal and

$$Dis_{ji} = Att_i \times Enc_{ji} \qquad (8.3)$$

the two forces of attraction and encroachment. When inertia is overcome, movement is initiated and dispersal occurs. How much is actually dispersed into a place depends on the strength of these two forces.

Unique initiating factors make up a third component of inward dispersal. These factors resemble both attraction and encroachment, yet they are somewhat different because they combine aspects of both. Like the two components of attraction and encroachment, an increase in these unique forces will contribute to an increase in dispersal.

Attractiveness

Although we cannot specify which outside conditions contribute to dispersal rates into particular places, we can identify certain properties of the places themselves which will tend to influence the rate of inward dispersal. If we can do this for each place, we have acquired one way to estimate local rates of change. The attractiveness of a place is just such a property. Migration theorists and location theorists usually incorporate this property into their schemes.

There are two determinants of attractiveness: resources and population. As the population of a place increases and as the quality and amount of resources existing within a place increase, the total attractive force at that place increases (Formula 8.4).

Population

The influence of population size on the level of attraction (within-place generated potential for inward movement) follows the reasoning of the gravity model, which holds that a larger population will

$$Att_i = \boxed{Pop_i} \times Res_i \tag{8.4}$$

tend to attract more things into a place than a small population (see Warntz and Wolff 1971:216-20, Pederson 1970:216, Bramhall 1960, Carrothers 1956).

The geographic gravity model, like its Newtonian prototype, considers only mass and distance in forming an estimate of the attractive force existing between two entities. The importance of population (the equivalence of mass) in determining the attractive force of a place is fairly well established. The Newtonian model assumes, however, that qualitative characteristics do not influence the force of gravitation. While theoretically correct as regards planetary bodies, it is certainly untrue for geographic places. Other attributes besides size influence the attractiveness of a place and one has been incorporated into the structural model.

Resources

Resources can be defined traditionally by referring to the natural environment within a place. Natural resources are perhaps the ones that are the most visible in any given location. They are also the ones that have received the greatest amount of attention in the geographic literature. Other resources also make contributions to the attractive force of a place. Many of these resources are invisible to the naked eye. As Galbraith has noted (1967:245) a good educational system and a well-qualified work force will attract industry into an area. This, and other observations like it, are truisms. Any place characteristic that enhances or encourages movement into a place from the outside can be defined as a resource.

Examples of attractive resources include such things as an agreeable climate (as in Hawaii and Florida) which attracts tourists and vacationers, and extensive mineral deposits (such as those found in Montana and Alaska) which attract wealth-seeking industrialists and laborers. Other resources include such things as power (concentrated in places like Washington, Moscow and the Vatican) which attracts supplicants and petitioners; intellectual activity (as is found in Berkeley and Cambridge) which attracts scholars and book salesmen; industry (as is found in Detroit and Pittsburgh) which attracts job-seekers and raw materials; the promise of salvation or good health (as is offered in Mecca and Lourdes) which attracts pilgrims; and the prospect of entertainment and debauchery (as is promised in Las Vegas) which attracts a wide variety of hedonists, pleasure-seekers and predators.

Encroachment

Encroachment, as was pointed out above, is a product of fan-like forces. The term itself has been chosen over several other alternatives which include recipient, beneficiary, reception, advent, coming, arrival and induction. All of these terms approximate what is meant but none of them quite embody the meaning of the word encroachment (which does tend to support T.S. Eliot's remark that there are no synonyms in the English language).

When things encroach upon a place they do so of their own will. They are not drawn, so to speak, by the place itself. When they are drawn by a place it is due to the attractiveness of the place. Attractiveness is an internal quality of a place, encroachment is not.

The extent to which any given place (place i) is encroached upon by any other place (place j) is related to their mutual isolation ($Isol_{ij}$), the intensity of outward dispersal at place j ($ODis_j$), and the directional specificity of the things being dispersed out of j (DirSp). As Formula 8.5 shows, when the amount of outward dispersal from j increases, and when the amount of isolation between the two places decreases, the amount of dispersal from place j to place i increases. The reasoning follows from the gravity model. Directional specificity is unique for each element and this makes generalizations about its intensity impossible. It has therefore not been included in Formula 8.5.

$$Enc_{ji} = \frac{ODis_j}{Isol_{ij}} \qquad (8.5)$$

Outward Dispersal

Each outside place emits a different number of propagules and depending on the proximity of i and j, those places that emit more propagules will tend to emit more of them in the direction of place i. The variables that contribute to the intensity of outward dispersal from place j are the same that contribute to outward dispersal at place i. These will be discussed in chapter 10.

Directional Specificity

Emissiveness has a significant component of directional specificity.

Quite often, things moving away from a place are more likely to be directed toward some outside locations than toward others. The emissive force of the Vatican is, for example, more intense when directed toward Spain than when directed toward China. The emissiveness of Madagascar, when reflected in the outward flow of vanilla, is directed primarily toward the United States.

Directional specificity also affects attraction. Arabs look to Texas when they want oil machinery, Americans look to Paris for culinary expertise, and much of the western world looks to Los Angeles for entertainment.

Between-Place Isolation

The extent to which two places are geographically isolated from each other affects the amount of movement between them. Accessibility is frequently used as a synonym for geographic isolation. As might or might not be self-evident, isolation can be partial or complete. Figure 8.10 illustrates the degrees of isolation that can exist between two places.

In Figure 8.10a, two places are completely isolated from each other. There is no movement between them. The populations within the two places are also isolated from each other. If this isolation has existed for a long time, the characteristics of these populations are probably different. Figure 8.10b shows partial isolation where there is some exchange of individuals, ideas, and artifacts between the two different areas. The movement of things between the two areas also shows that the populations are not completely isolated from each other.

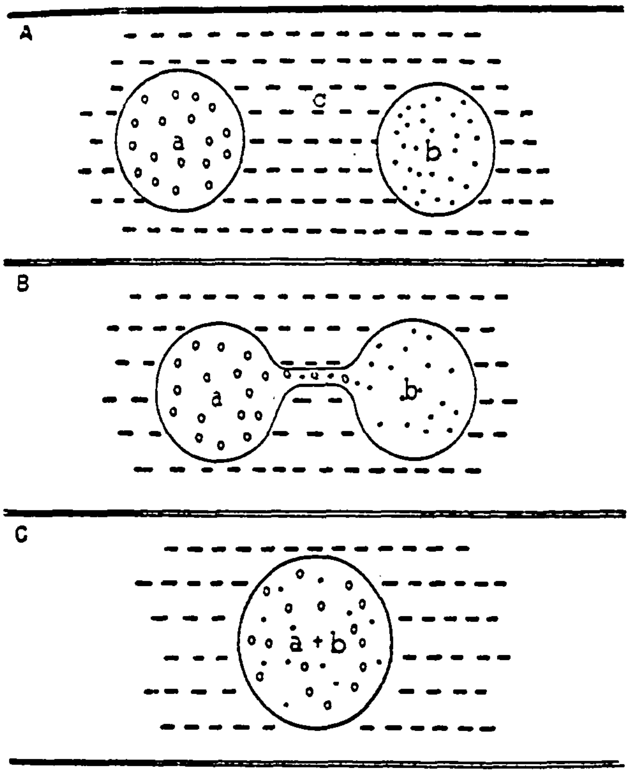


Diagram of various kinds of geographical isolation. A. The two populations *a* and *b* are completely isolated from each other by the unsuitable intervening area *c*. B. The nature of the intervening area *c* permits a certain amount of dispersal (gene flow) between populations *a* and *b*. C. Individuals of species *a* and *b* coexist in random distribution in the same area (sympatrically) without any traces of spatial isolation.

Figure 8.10 (Mayr 1963:287)

Figure 8.10c shows an absence of geographic isolation between the two populations. It also shows them coexisting within the same place. The two groups may be socially isolated from each other but they are not geographically isolated.

As Formula 8.6 shows, between-place isolation ($Isol_{ij}$) has two components in the structural model. These involve between-place distance (D_{ij}) and between-place barriers (Bar_{ij}). When the distance between two places is great and there are many barriers between them, the accessibility between the two places is low. High isolation in Formula 8.6 is reflected in a high index number.

$$Isol_{ij} = D_{ij} \times Bar_{ij} \tag{8.6}$$

Between-Place Distance

In the structural model, the distance between i and j is determined from several different measures. These include the spatial distance between i and j (SpD_{ij}), the travel time distance between i and j ($TrTiD_{ij}$), and the cost distance between i and j (CoD_{ij}). These do not by any means exhaust the possible ways of calculating distance, but they do represent some of the more important ways of doing so. Travel time distance and cost distance involve alternate technologies. However, as one travels farther and farther back in time, alternate means of transportation become fewer and these additional measures will gradually coincide with spatial distance. Formula 8.7 shows how these various ways of measuring distance are combined to form an overall scale.

Spatial Distance

Spatial distance combines three different ways of measuring the distance between two different places. These are identified as linear distance (LiD_{ij}), graphic distance (GrD_{ij}), and hierarchical distance (HiD_{ij}). As these individual measures of distance increase, so also does the more generalized measure of spatial distance (Formula 8.8).

Linear Distance

Linear distance is a straight line measure between two places. In Figure 8.11 linear distance from the central location (place i) is represented by three concentric rings (dashed lines). In this diagram, places j_1 through j_3 are equidistant from place i.

Graphic Distance

Graphic distance is a measure taken along routes of movement. Whereas linear distance extends equally in all directions, graphic distance is confined to specific networks (Figure 8.12) and communication channels (Figure 8.13).

In Figure 8.11 the two channels of communication represent routes of movement. When linear distance is averaged with graphic distance, places that were equidistant from the central location become nearer or farther away. Place j_1, for instance, is now closer to place i than place j_2, which in turn is closer to place i than place j_3.

Figure 8.14 shows how a transportation network might appear

$$D_{ij} = \frac{SpD_{ij} + TrTiD_{ij} + CoD_{ij}}{3} \tag{8.7}$$

$$SpD_{ij} = \frac{LiD_{ij} + GrD_{ij} + HiD_{ij}}{3} \tag{8.8}$$

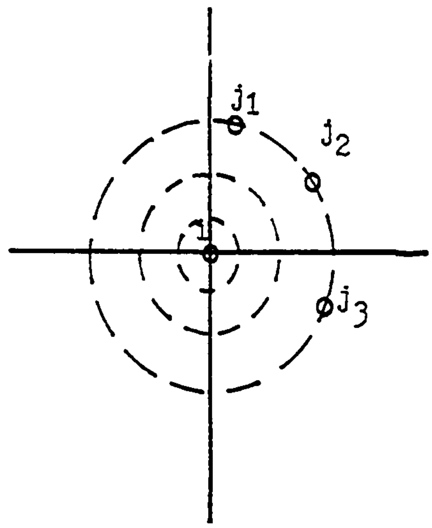
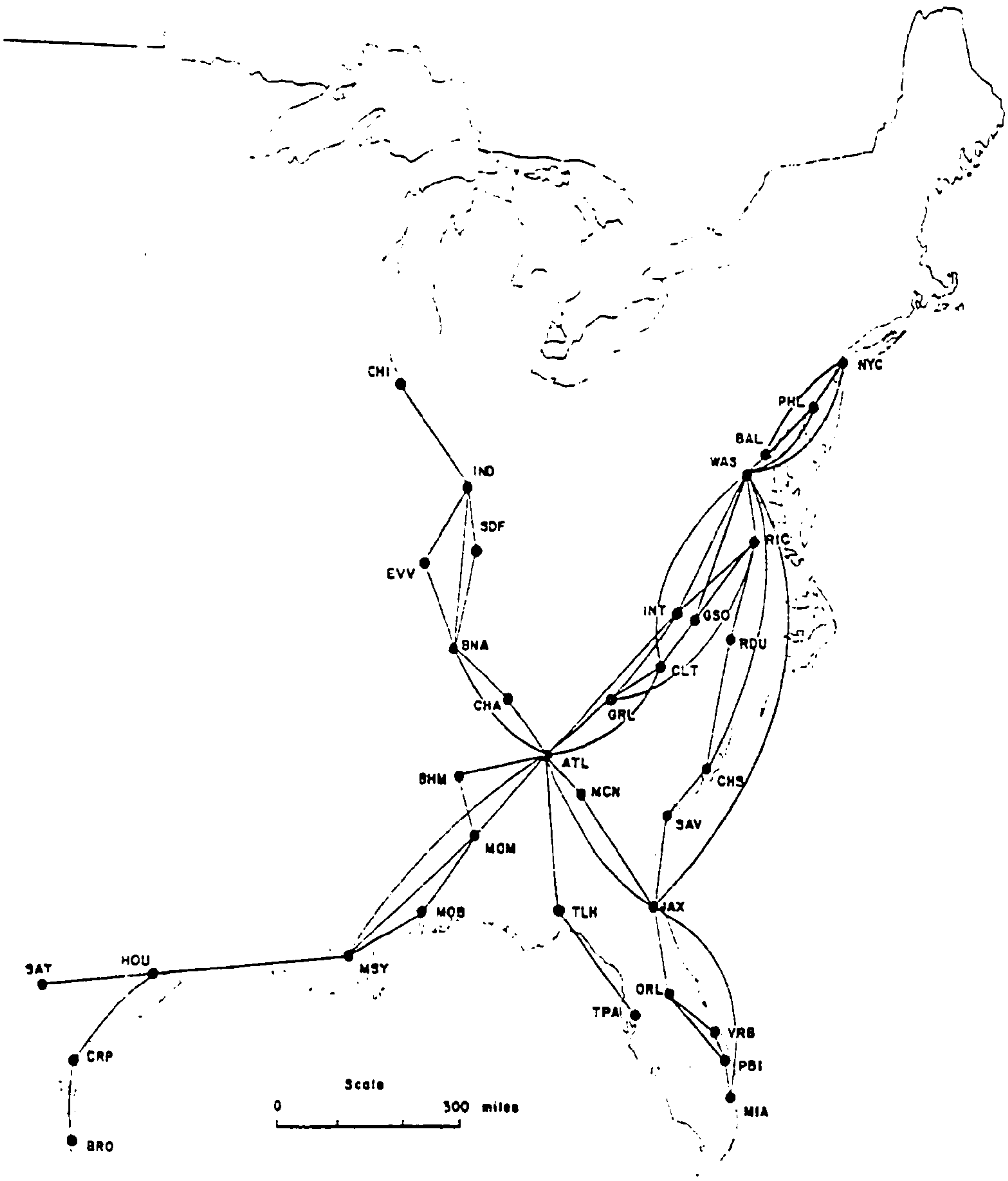


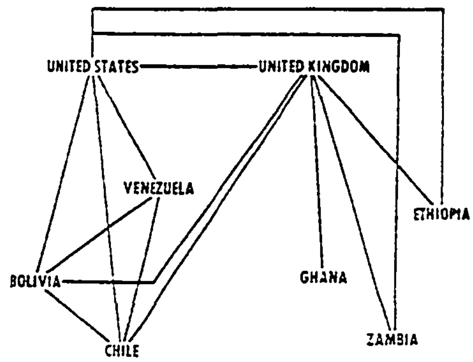
Figure 8.11



Eastern Airlines 1943

Source: The Official Guide of the Airways, January 1943

Figure 8.12 (Elliott 1970:124)



A segment of the internation diplomatic network. The more developed nations—the United States and the United Kingdom—tend to be more connected; they are more attractive from the viewpoint of the trading and political interests of the underdeveloped nations and they also provide, by their large numbers of embassies, the possibility of communication between nations that do not formally exchange ambassadors: Chile and Ghana, therefore, communicate via London and Washington.

Figure 8.13 (Cox 1972:147)

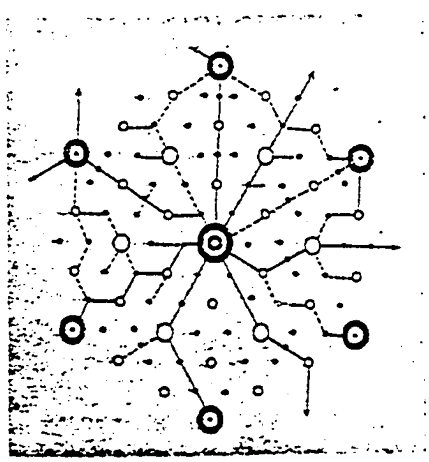


Figure 8.14 (Haggett 1972:335)

within a system of central places. Graphic distance between any two places would be measured along these routes.

Hierarchical Distance

Hierarchical distance (HiD_{ij}) is a third component of the spatial distance between two places. Hierarchical distance is more complex than linear distance because two places may belong to a number of different hierarchies at the same time. This is a characteristic it shares with graphic distance.

Most theories of diffusion hold that the rate of diffusion between two places depends in part on the number of intervening links between them in a hierarchy (Pedersen 1970:203, Hudson 1972:139). These intervening links are determined by the hierarchical status of the places in question as well as by the shape of the hierarchy itself. This is complicated, however, by the fact that the hierarchical distance from i to j may not be the same as the distance from j to i. This happens when cascade diffusion is more intense than buoyant diffusion. This is not always the case, however, and in many circumstances the reverse is true. Sometimes buoyant diffusion is more intense than cascade diffusion. In the structural model, therefore, it will be assumed that there is no appreciable difference between the rates of cascade and buoyant diffusion.

Two kinds of hierarchical distance are included in the structural model: central place distance (CPD_{ij}) and administrative distance (AdD_{ij}). Hierarchical distance represents an average of these two measures (Formula 8.9).

$$HiD_{ij} = \frac{CPD_{ij} + AdD_{ij}}{2} \qquad (8.9)$$

Central Place Distance

Central place distance is a measure of hierarchical distance within a central place hierarchy. It is measured by counting the number of links between any two locations in a central place hierarchy. These locations are best visualized as points, although they can also be areas. Figure 8.20 below illustrates how central place distances can be calculated.

How far apart two places are in a central place hierarchy depends on the nature of the hierarchy itself (CPHi). When measured from a single place (place i in the structural model) it can also depend on the hierarchical status of the other places ($HiSt_j$).

Central Place Hierarchy

The forces that produce central place hierarchies in the landscape and the geometric patterns that result are the subject of studies in land use and location theory. These theories logically extend the causal sequences of the structural model, but because they are fairly well-known to geographers and because any explanation would be lengthy, they will not be covered here. The geometries of several theoretical central place hierarchies are shown in Figure 8.15.

Figure 8.16 shows one attempt at identifying an actual central place hierarchy within the United States. All of these hierarchies are based on economic criteria.

Once a central place hierarchy has been identified, central place distances can then be measured. Each link in the hierarchy connects a number of lower order centers with a higher order center. These

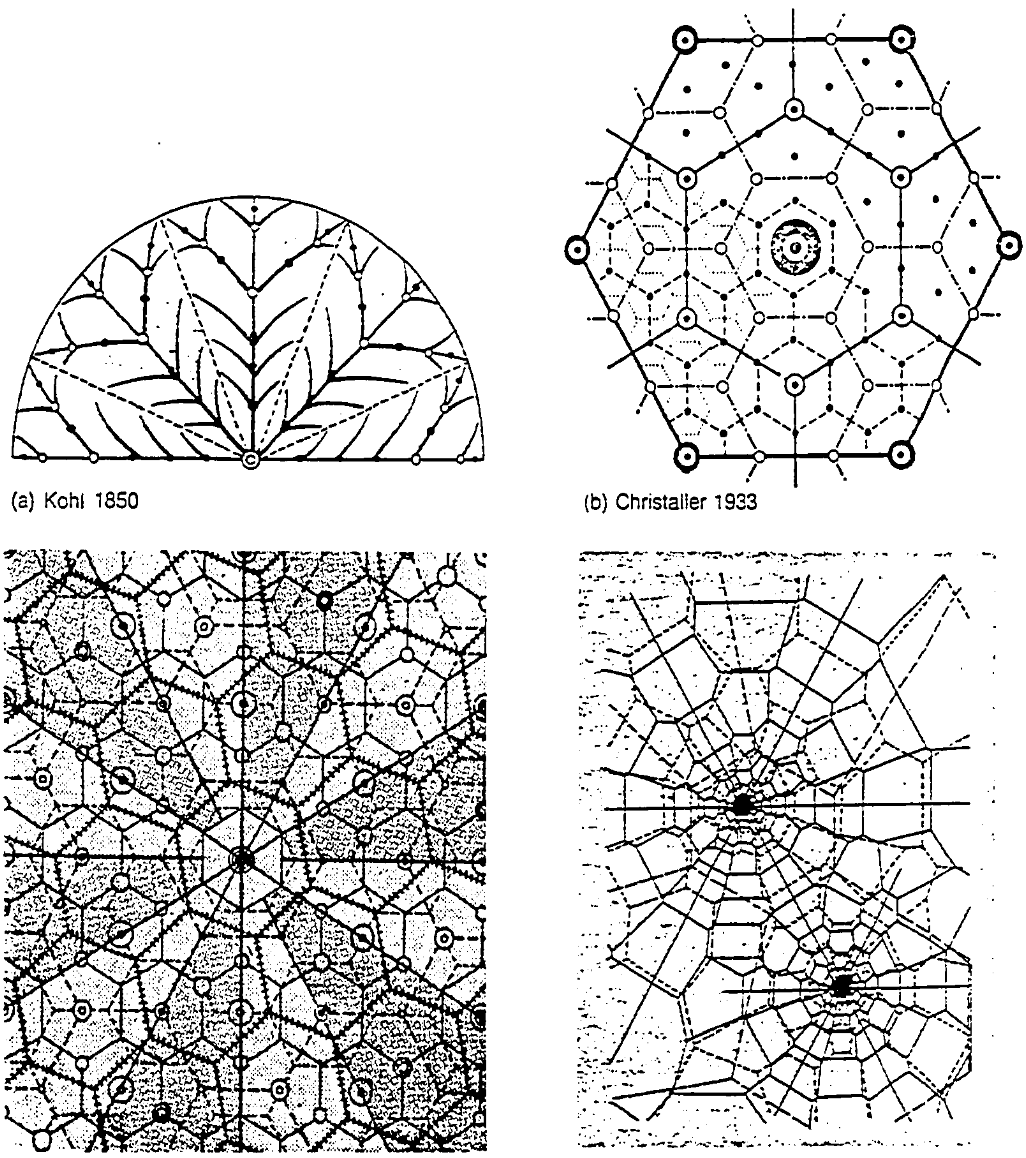


Figure 8.15 (After Haggett 1972:335)

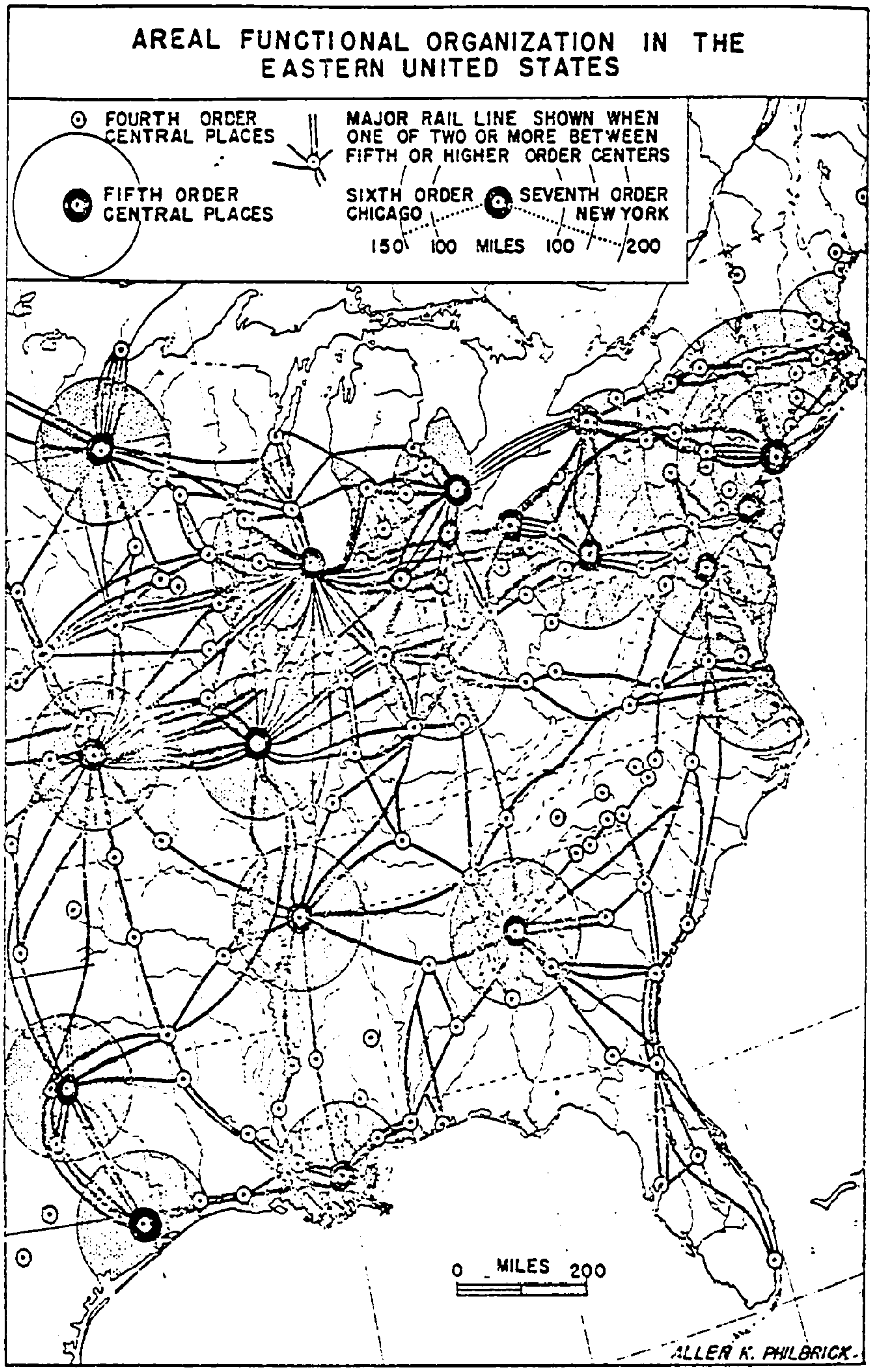


Figure 8.16 (Philbrick 1957:330)

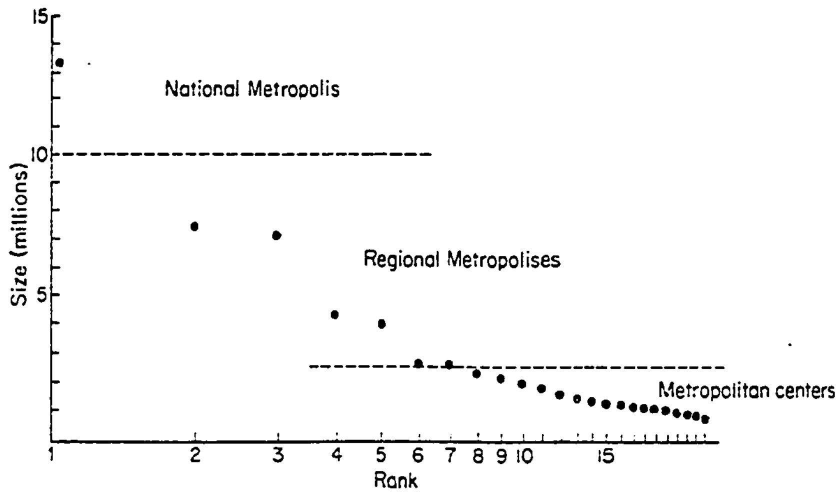
links can be quite independent of actual linear distance. They can also be independent of graphic distance. An example of this can be seen when comparing Figure 8.15b with Figures 8.5 and 8.14.

Hierarchical Status of Other Place

One determinant of the central place distance between i and j is the hierarchical status of j ($HiSt_j$). As the hierarchical status of j increases, the central place distance between i and j should decrease.

The reasoning behind this assertion is shown in Figures 8.18, 8.19, and 8.20. Figure 8.18 shows an idealized hierarchy with each place identified as a first, second, third, or fourth-order center. In this diagram, the largest and highest order center is place number 41. As a general rule, higher-order central places in an economic hierarchy will tend to be larger than lower-order central places. The higher-order central places will also tend to be less numerous. Both of these generalizations follow from the rank-size rule (Figure 8.17). If it is assumed that cascade and buoyant diffusion are operating at the same rates, then counting the links between any two places in the hierarchy will give an estimate of the hierarchical distance between them.

Figure 8.19a shows the central place distance from place 11 to all other points in the hierarchy. The size of each j (first, second, third, or fourth-order central place) is shown on the y axis, and the distance (number of intervening links) from place 11 to each j is shown on the x axis. The results show that the average number of links from place 11 to all other first-order centers is five (Figure 8.20). To all



First-, second-, and third-order trade centers and trade areas in the United States

Figure 8.17 (Abler, Adams, and Gould 1971:375)

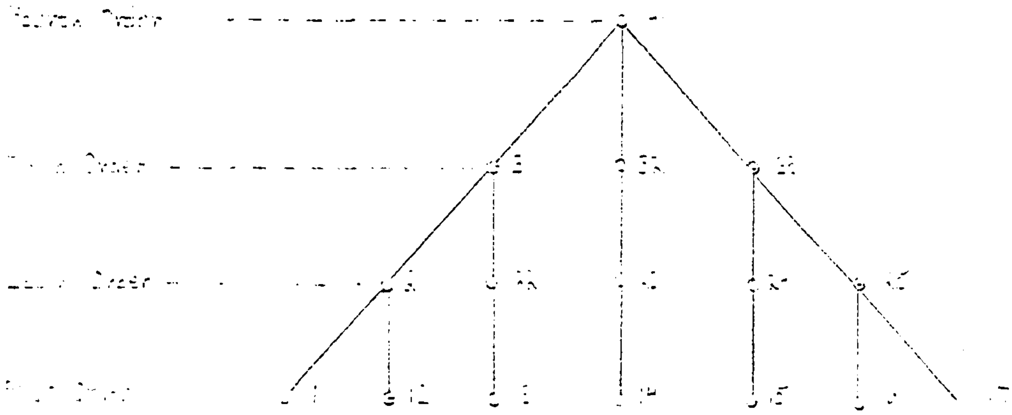


Figure 8.18

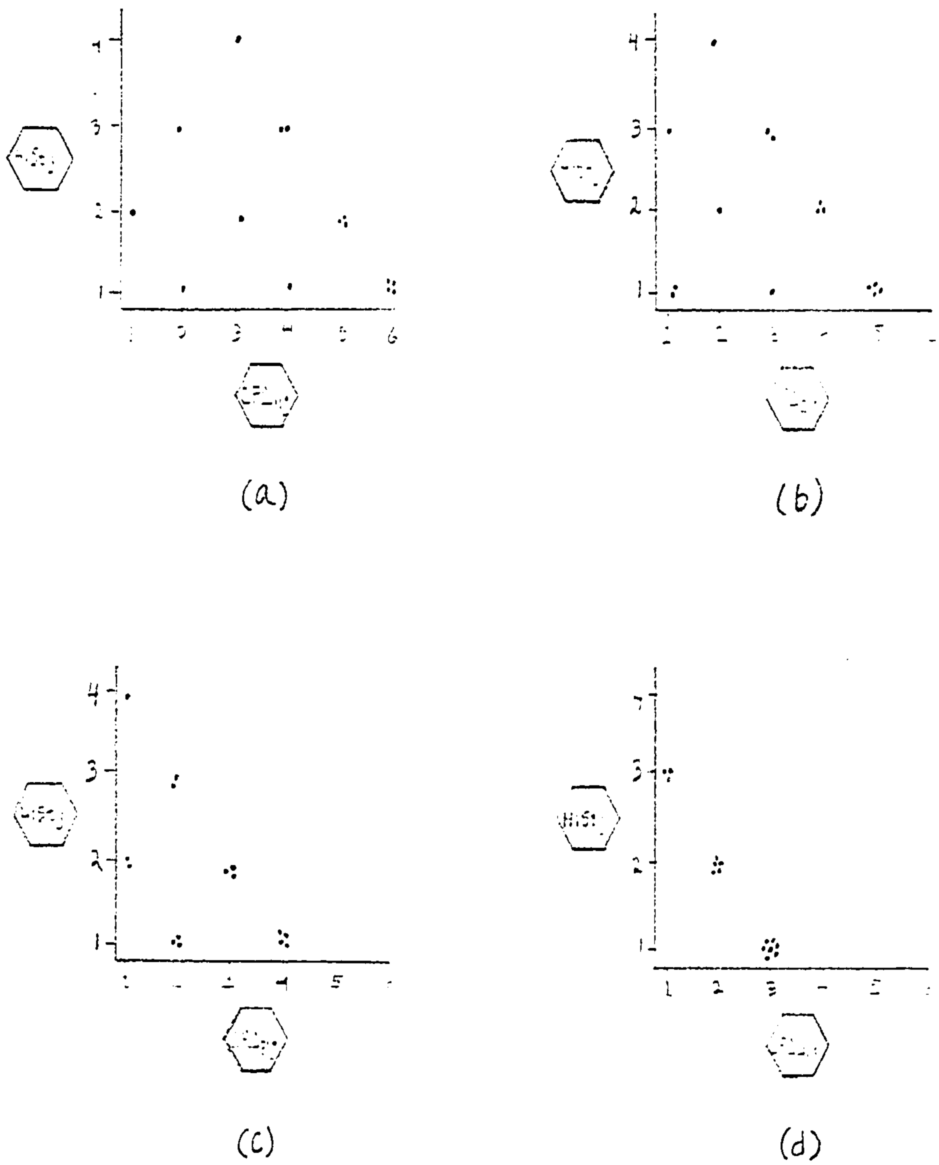


Figure 8.19

$HiSt_j$	Average Number of Links to j from Place Number: 11	21	31	41	Combined Average (Four Places)	X - Y
1	5.00	3.80	3.30	3.00	3.62	(98 - 27)
2	3.57	3.50	2.30	2.00	2.84	(10 - 19)
3	2.50	2.20	2.00	1.00	2.18	(24 - 11)
4	3.00	2.00	1.00	.00	2.00	(6 - 3)

X = Total distance from i (places 11, 21, 31, 41) to places within each level of the hierarchy (1, 2, 3, 4).

Y = Number of measurements from i to each j.

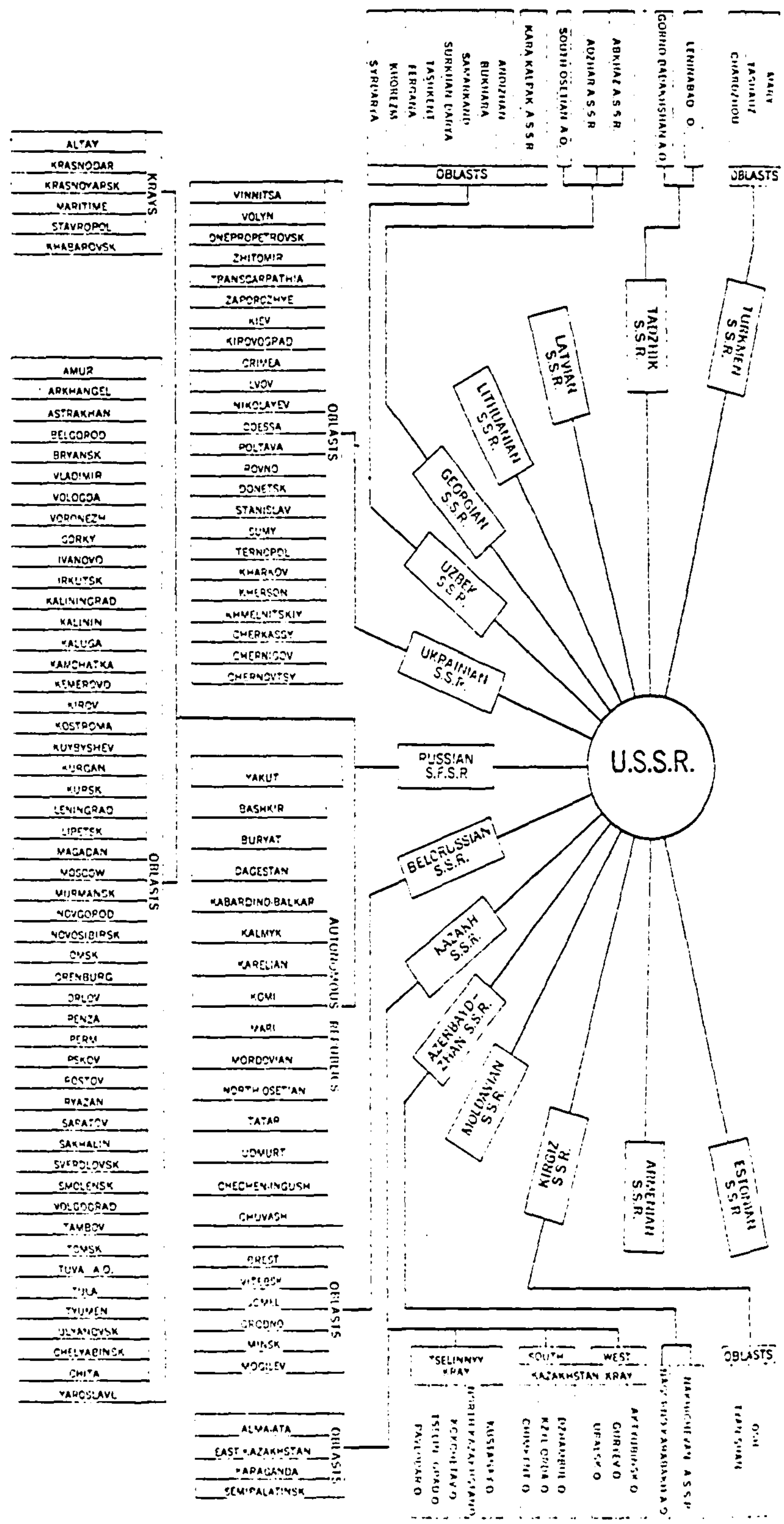
Figure 8.20

second-order centers the average number of links is 3.8, to third-order centers the average is 3.3, and to the fourth-order center there are three links. If this procedure is repeated and the number of links to each j is calculated from several different locations, the same pattern appears. Figures 8.19b, 8.19c, and 8.19d show the results of three such counts where i is successively located at places 21, 31, and 41. Figure 8.20 indicates the average number of links between i and points at each level of the hierarchy when i has been represented by four different points. The combined average in Figure 8.20 shows an inverse relationship between the population of j and the central place distance separating i and j. This relationship is independent of the location or size of i. If the number of lower order centers at each level in the hierarchy is increased, the effect becomes more pronounced.

Administrative Distance

Another form of hierarchical distance is administrative distance ($AdDis_{ij}$). Whereas central place distance involves an economic hierarchy, administrative distance is based on governmental jurisdictions. The same method that was used in calculating central place distance can be used to calculate administrative distance. Figure 8.21 is an example of an administrative hierarchy, while Figure 8.5 is an example of diffusion within an administrative hierarchy.

Many other forms of hierarchical distance are possible. However, only administrative and central place distance will appear in the structural model.



Political subdivisions of the U.S.S.R.

Figure 8.21 (Lydolph 1964:23)

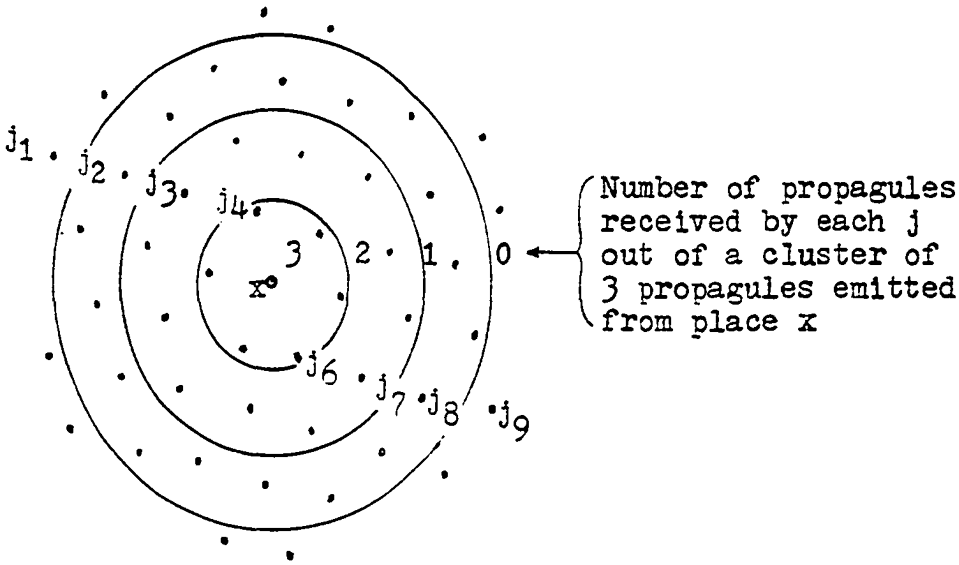
Travel Time and Cost Distance

As was indicated in Formula 8.7, there are at least two other forms of distance besides spatial distance. These include travel time distance ($TrTiD_{ij}$) and cost distance (CoD_{ij}). The first of these involves the least amount of time it takes to get between two places while the second involves the smallest amount of money that must be spent in order to get between the same two places.

The mileage between Memphis and New Orleans, for instance, is about the same as that between Memphis and Tulsa. In the last century, however, one could travel from Memphis to New Orleans by riverboat and get there in much less time than it would take to get from Memphis to Tulsa (there being no riverboat to Tulsa). In this situation, New Orleans would be closer to Memphis than Tulsa would be. On the other hand, if one were to choose the cheapest available transportation available, the distance from Memphis to either of these two cities would be approximately equal. Both these forms of distance must be taken into consideration when estimating rates of between-place dispersal.

Distance Decay

As the distance increases from a point of origin (place x in Figure 8.22a), certain phenomena occur which reduce the intensity and ultimately kill the outward movement of a dispersing propagule. The effects of these phenomena will be reflected in a maximum distance to which a particular element will disperse away from an emanating point. There will also be a decline in the number of propagules received as the distance from this central emanating point increases (Figure 8.22). This is the distance decay function illustrated in Figures 8.23 and 8.24.



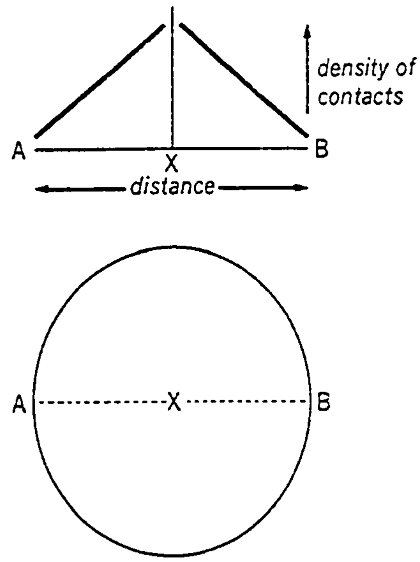
(a)

Probability of receiving each combination of propagules from place x

Propagule #	123	12-	1-3	-23	1--	-2-	--3	---
Places in first ring	1.00	.00	.00	.00	.00	.00	.00	.00
Places in second ring	.00	.33	.33	.33	.00	.00	.00	.00
Places in third ring	.00	.00	.00	.00	.33	.33	.33	.00
Places in fourth ring	.00	.00	.00	.00	.00	.00	.00	1.00

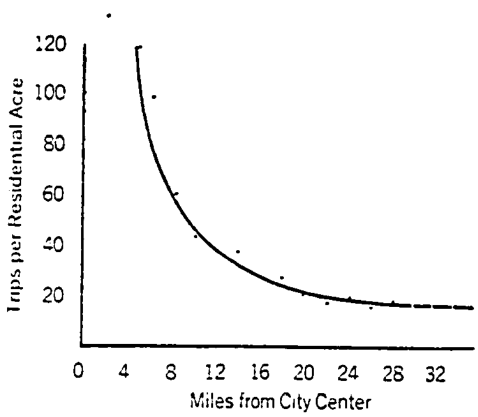
(b)

Figure 8.22



An information field. The circular decay of information with increasing distance from the individual.

Figure 8.23 (Eliot Hurst 1972:75)



Frequency of commuter travel as a function of distance (Adapted from *Chicago Area Transportation Study*, vol. 1, parts of fig. 32, p. 61, published by the State of Illinois, 1959)

Figure 8.24 (Kolars and Nystuen 1974:59)

If diffusion waves spread throughout entire landscapes without weakening, the diffusion process would not be a factor in between-place differentiation. We do find, however, that diffusion is affected by the phenomenon of distance decay so that diffusion waves generally become weaker as the distance from a point of origin increases. At some point the outward spread of a diffusing element stops.

This process can be interpreted in two different ways. In Figure 8.22a the rings surrounding the middle place (place x) represent the maximum spread of three different elements, each one being subject to different amounts of distance decay. In this situation three elements will have dispersed as far as the boundary of the first ring, and one element will have reached the third ring. If the elements are numbered from one to three, place j_6 will receive all three elements, place j_7 will receive elements one and two, while place j_8 will only receive element number one.

If, on the other hand, the rings in Figure 8.22a only represent the number of propagules received at each location, then all three elements will spread as far as the boundary of the third ring and it will not be possible to say which particular ones will be received by places in the second and third rings. Place j_7, for instance, will receive two propagules, which can be elements number one and two, one and three, or two and three; while place j_8 (which receives only one propagule) can receive element number one, two, or three. The probabilities associated with each of these outcomes are shown in Figure 8.22b. In all situations, Place j_9 will not receive any of the dispersing elements.

Areas like j_9 that lie beyond the range of expanding diffusion waves become relic areas (Lehmann 1973:121). Relic areas are generally found in places with limited accessibility. Accessibility can be limited for cultural, political, or geographical reasons. An example of this phenomenon has been observed in the Netherlands, where vocabulary innovations diffuse outward from Amsterdam and Antwerp, but fail to reach certain remote places near the periphery of the country. These areas tend to retain a number of linguistic forms from earlier generations that have been driven out of use in the larger cities by successful innovations (Lehmann 1973:123).

It has also been observed that places with smaller populations tend to adopt fewer diffusing traits than larger places. This reflects the operation of a hierarchical distance decay function. Pedersen (1970:208) has described such a process within the urban hierarchy of Chile.

The hierarchical distance decay function works in much the same way it does where other kinds of distance are involved. As the hierarchical distance between i and j increases, there are forces that come into play which decrease the intensity of diffusion between these places (Figure 8.25). If propagules diffusing downward in a geographic hierarchy are consistently prevented from spreading down any one particular branch, then all the places on that branch will begin to exhibit hierarchical isolation. This will ultimately contribute to their becoming relic areas.

Changes in Distance

Because different technologies create different kinds of distance

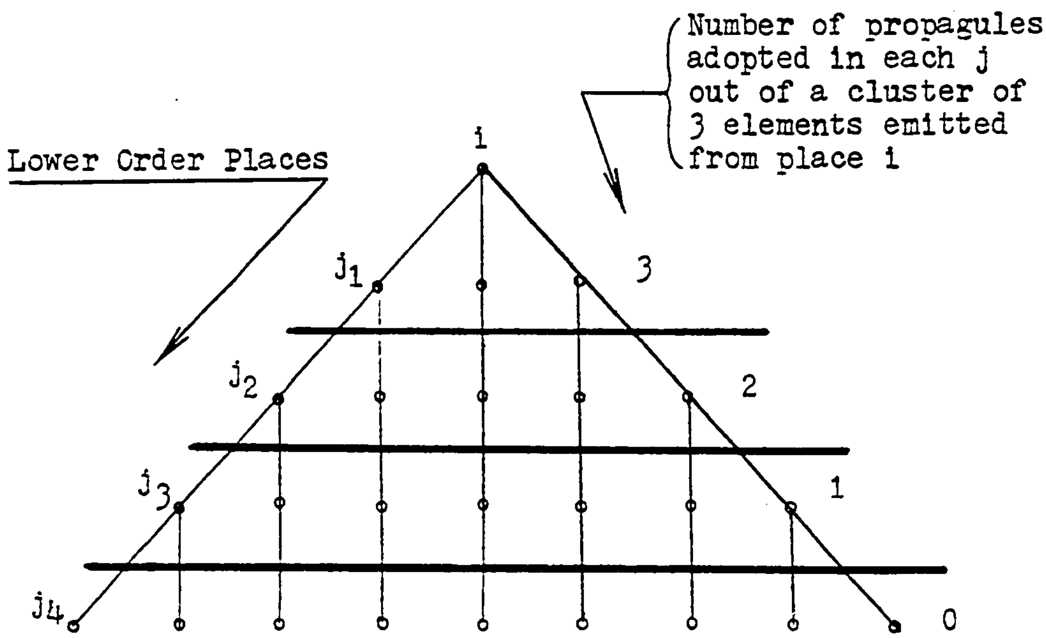

Number of propagules adopted in each j out of a cluster of 3 elements emitted from place i
Lower Order Places
i
j_1
j_2
j_3
j_4
3
2
1
0

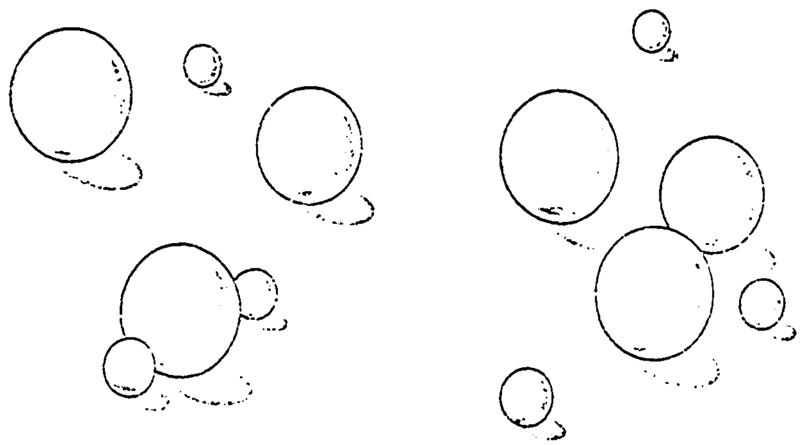
Figure 8.25

it is possible for the distance between places to change through time. This usually happens when new technologies bring about new and faster methods of transportation. When this occurs it does not generally bring all places closer together uniformily. Instead, some places are brought closer to each other while others are unaffected. In Figure 8.26, for instance, an improved method of transportation has reduced the distance between the larger places while the smaller places have become relatively farther apart. Such changes can also occur when barriers between places are introduced or are removed. Following technological revolutions, the amount of friction that distance exerts on diffusing elements can be expected to decline. This has been demonstrated within the United States (Clayton 1977:179).

Between-Place Barriers

Barriers will reduce the intensity of diffusion between two places. In the gravity model an index number representing a barrier is placed in the denominator along with the distance between two places. If population is held constant, an increase in either the strength of a barrier or the between-place distance will reduce the intensity of diffusion. The gravity model always specifies relationships between i and j. Barriers between i and j specifically are shown as Bar_{ij} in the structural model.

At least two kinds of barriers can exist between specific places. These include cultural barriers ($cBar_{ij}$) and topographic barriers ($TopBar_{ij}$). Formula 8.10 shows how cultural and topographic barriers produce an overall measure of between-place barriers.



(a) Geographic location (b) Imploded location

This figure illustrates the process of "implosion." Note the convergent movement of the three largest cities (the size of the spheres is proportional to the size of the cities) in comparison with the divergent movement of the three smaller ones.

Figure 8.26 (Haggett 1975:330)

$$\mathrm{Bar}_{ij} = \mathrm{cBar}_{ij} + \mathrm{TopBar}_{ij} \qquad (8.10)$$

The number of cultural barriers between two places depends largely on the number of different cultural groups (cGr_{ij}) situated between them (Birdsell 1966:52). As these increase, the likelihood that a diffusing element will be rejected before it ever gets to i or j increases as well. Other examples of cultural barriers will be discussed below.

Intuitively it would appear that the number of alien cultural groups located between i and j would increase as the distance between them increased and in at least one study (Howells 1966:533) a moderate relationship between these two variables (r=.60) has been found. It is not necessary, however, to rely on distance as a surrogate measure for these intermediate groups since they can be counted directly.

Cultural Barriers

Cultural barriers contribute to obstructive isolation when they cause dispersing elements to be halted or deflected. This occurs when specific groups, for whatever reason, refuse to adopt certain propagules. When the non-adopting groups occupy strategic positions with regard to the further transmission of arriving propagules, they cause other places to lie within a diffusion shadow. Places situated within these diffusion shadows experience obstructive isolation.

One reason given for the failure of the domesticated pig to diffuse into sub-Saharan Africa, for example, is that its dispersal was stopped by a cultural barrier. Pig raising spread into the upper Nile quite early, but the people of Ethiopia, who have regarded the pig as unclean for thousands of years, refused to eat them or to keep them

(Simoons 1967:23).

Since the Ethiopian highlands have been a major corridor through which propagules have dispersed into sub-Saharan Africa, anything that the Ethiopians refused to accept would not be transmitted any further. This may have happened to the pig in addition to many other elements.

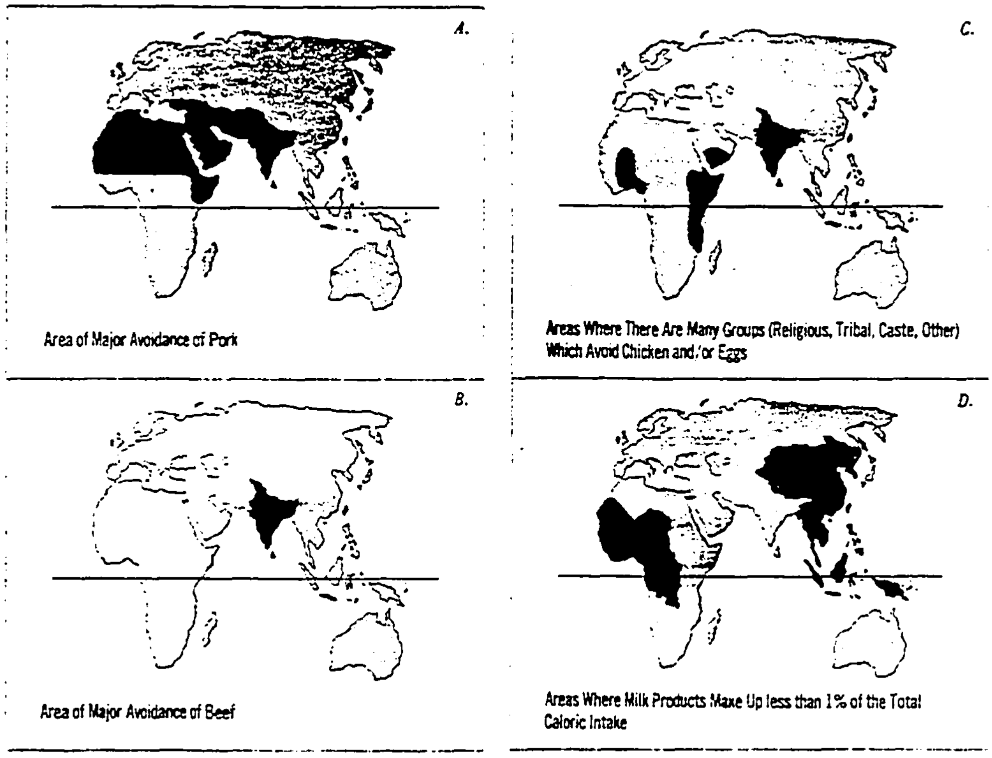
Places in southern Africa, then, have for centuries existed in obstructive isolation from the rest of the world due to Ethiopia's role as a cultural barrier. Figure 8.27 shows the distribution of other such food avoidances which can act as cultural barriers.

Other kinds of cultural barriers can also exist. During periods of dynastic decline and disunity in China, the nomadic tribes of central Asia constituted a cultural barrier. During such periods these Altaic peoples were able to prevent a considerable amount of movement between China and the Mediterranean. The rise of Srivijaya and other southeast Asian states resulted partly from this situation in central Asia, which obliged Chinese and Western merchants to travel by sea rather than by land (Cady 1964:35).

During periods of unity in central Asia, such as existed during the Mongol era, a substantial portion of the seabourne commerce between east and west was diverted back to the overland caravan routes, thus contributing to the decline of the southeast Asian trading empires (Cady 1964:152).

Cultural barriers, therefore, like topographic barriers, do not have to be permanent phenomena and can change with time.

A similar situation used to exist with respect to the diffusion



Four food avoidance areas These represent very general regions of food avoidance; within them are subgroups with entirely different preferences and avoidances.

Figure 8.27 (Kolars and Nystuen 1974:188)

of information within the United States. In the early 19th century, incoming ships from Europe would be met in the outer harbors of American ports by small boats owned by local publishing interests rushing to pick up British newspapers. These newspapers would then be edited and selected stories would be picked out for reprinting. Many such stories appeared in the major papers of the largest cities along the eastern seaboard. These eastern papers would then be sent by mail to outlying communities. Publishers in these places would then reprint selections from the papers of the large eastern cities. The entire system consisted in choosing bits and pieces from a few established newspapers in major American and European urban centers (Bagdikian 1971:9). Each time the diffusing newspapers were edited, the original information was diminished. This editing process served as an isolating device with each editor performing the role of a small cultural barrier to those places which would later receive only the information which he chose to pass on.

If a migrating element is adopted, two things can happen. The element can be passed on intact to the next place or it can in some way be altered so that in effect it becomes a new element. If diffusion ceases, the migrating element has met a barrier. If diffusion continues but the migrule is altered, it has passed through a cultural filter. The effect is similar to a message being garbled in transmission. The more groups a given element must pass through to reach its destination (cGr_{ij}), the more likely it is that the element will be different at its final destination from what it was originally.

The process producing this phenomenon is acculturation. As Hudson has commented (1972:155) this is how new traits come into being during the diffusion process.

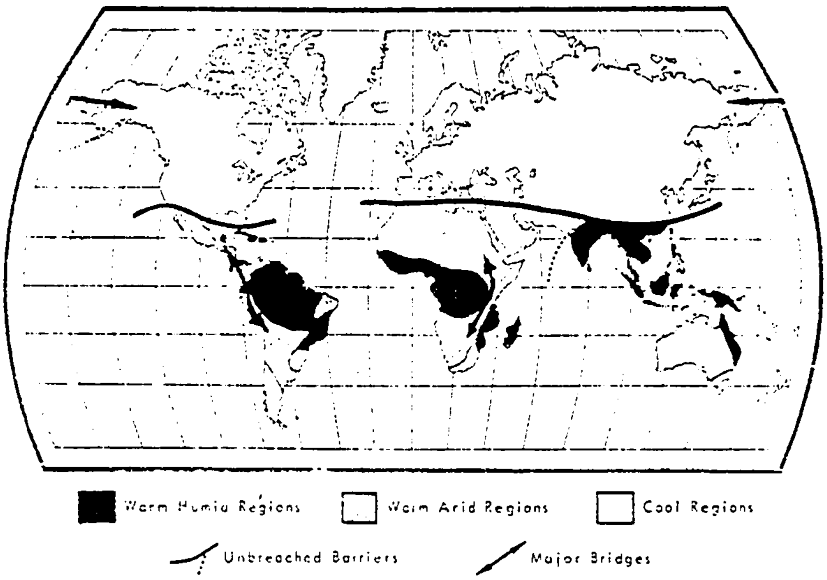
Topographic Barriers

Figure 8.28 gives an example of major topographic barriers affecting the spread of biota. Some of these barriers have also retarded the movement of human groups and the ideas they carry.

In trying to explain why levels of technology in sub-Saharan Africa lagged behind that of western Europe in the 19th century, Philip Curtin (1969:24) attributes much of the cause to the Sahara Desert which functioned as a topographic barrier isolating the south from the north. As Curtin explains, sub-Saharan Africa was cut off from north Africa for a period lasting from somewhere in the 4th millenium B.C., when the increasing desiccation of the Sahara began to radically limit north-south movement, to sometime during the 1st millenium B.C., when improved transportation techniques made crossing the desert possible once more. The period of extreme obstructive isolation lasted some three thousand years.

Where different groups have remained isolated behind physical barriers for long periods of time we might expect to find a great deal of cultural divergence. This divergence should be closely associated with the barriers in question.

In linguistics it has been found that languages and dialects differentiate from one another in all situations of reduced contact (Swadesh 1971:219). Reduced contact occurs when (among other things) topographic barriers intervene between different places. If a population



Major climatic barriers and bridges for the spread of biota. There is no passage for warm biota across the cool regions nor for humid biota between Africa and Asia, as well as for arid biota from Australia to other regions.

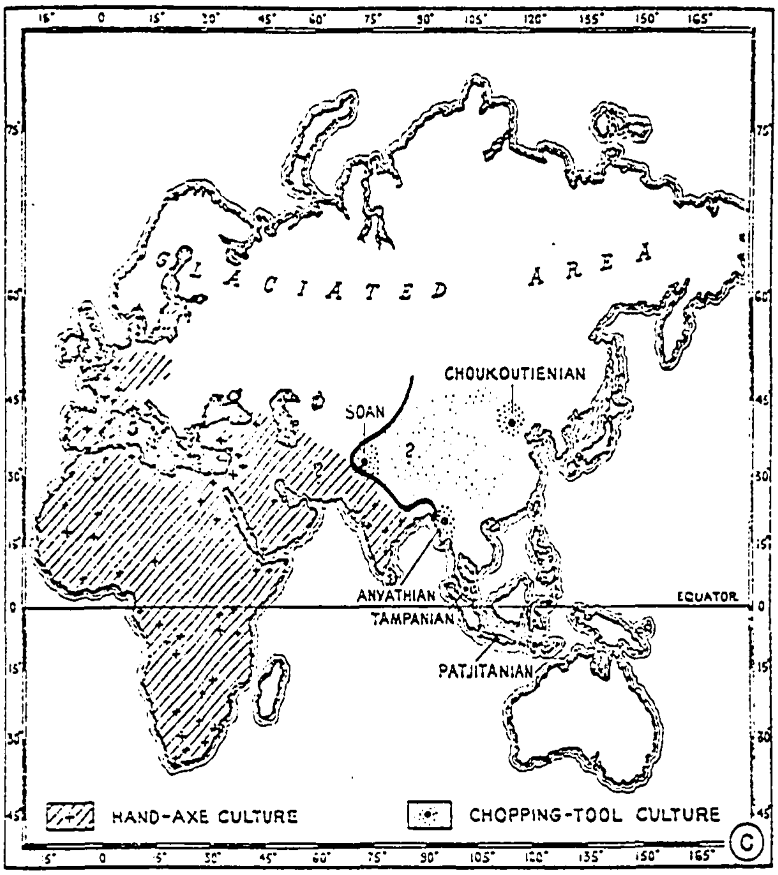
Figure 8.28 (de Laubenfels 1970:61)

separates into two parts, differences between them will appear in proportion to the amount of contact that remains. Similar processes occur in other realms of culture.

Movius' line is a prominent example of this correspondence between obstructive isolation and cultural divergence (Figure 8.29). Movius' line, like Sclater's line and Wallace's line, is a geographic frontier separating regions of distinct evolutionary development (see Movius 1944). This line corresponds to the mountains separating eastern Asia from western Asia. As Broek has pointed out (1944:177,78), these rugged and heavily forested north-south mountain ranges of Indo-China have acted as barriers to east-west migration and have encouraged instead a linear north-south pattern of migration.

During the Pleistocene, fairly self-contained archaeological traditions evolved on either side of the Himalayas. Originally the toolmaking traditions in both regions were the same. Divergence between the two, which began as early as the First Interglacial Period, could only have begun after they had become isolated from each other. The isolation in this case was produced when contact between the eastern and western sides of the Eurasian land mass across the mountains of central and southeast Asia was reduced--possibly by climatic change.

Movius' line also coincides with what Burkill (1952:21) has called the Cupuliferous boundary. As Burkill has observed, no species of the Cupuliferae nor of the Coniferae have crossed this boundary from one region into the other. Migrating peoples from eastern Asia have also largely failed to breach this barrier, which separates the



Distribution of two principal cultures in the mid-Pleistocene. From Movius 1949, *The Lower Palaeolithic Cultures of Southern and Eastern Asia*, p. 409, Map 4. © Copyright American Philosophical Society. Used by permission of H. L. Movius, Jr., and the American Philosophical Society.

Movius' Line

Figure 8.29 (Darlington 1957:630)

Mongoloid realm from the Caucasoid realm. This boundary is a topographic barrier.

Another more sophisticated example of the connection between obstructive isolation and cultural divergence is found in Levison et al. (1969). In this study wind and current patterns in the South Pacific were programmed into a computer in such a way that the probability of accidental drift voyages between various pairs of island groups could be ascertained. One of the procedures used is shown in Figure 8.30.

In this study it was found that the wind and current patterns tended to form environmental boundaries insofar as drift voyages across them would have been unlikely during the period of the Malayo-Polynesian expansion (Figure 8.31). If this expansion was due in part to accidental rafting, then these boundaries would have existed as isolating mechanisms for a long time. It was found that some of these environmental divides did in fact coincide with long standing cultural boundaries such as the one between the Gilbert Islands of Micronesia and the Ellice Islands of Polynesia. The connection between obstructive and cultural isolation was thus partially substantiated.

Propensity to Adopt Propagules

Among plants, the dispersal of propagules into new areas is opposed by the forces of elimination, which are both random and contingent upon the receiving environment (J. Sauer 1969:592). Cultural propagules face similar forces of elimination, although with the addition of human choice the process of establishment becomes more complex. The propensity to adopt propagules includes not only the negative forces

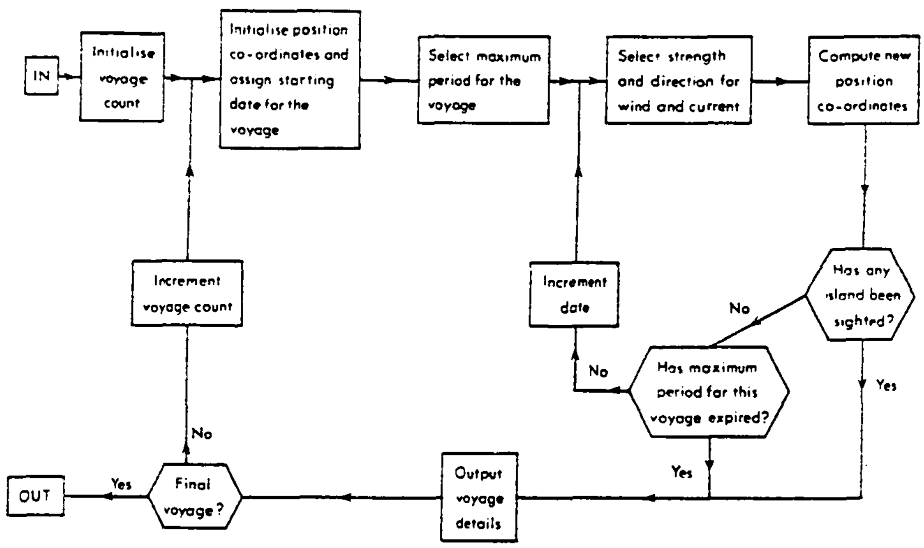
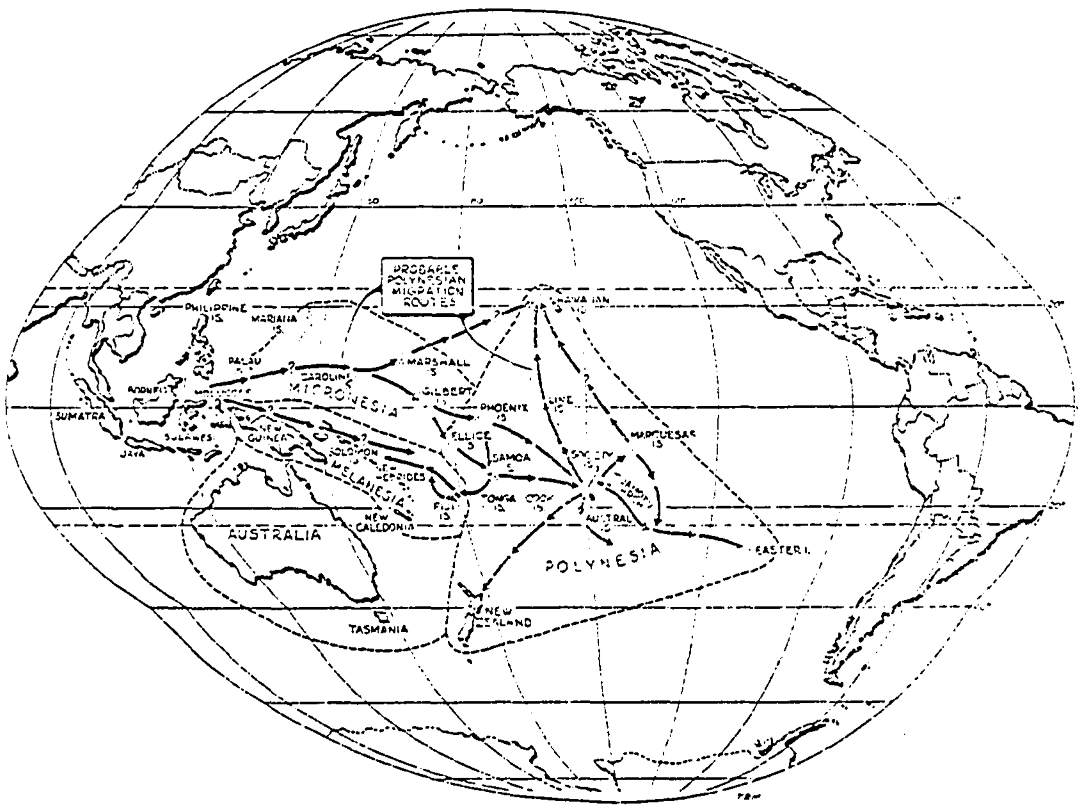


Figure 8.30 (Levison et al. 1969:1521)



Pacific World: pre-European Realms and Polynesian migrations

Figure 8.31 (Russel, Kniffen and Pruitt 1969:515) promoting elimination, but also positive forces which encourage the establishment of certain propagules.

When a propagule, whether it be an artifact, an idea or an individual, is dispersed into a new area, it must meet with a favorable environment in order to survive. If this environment is favorable, there is a high probability that the propagule will be adopted. The environment which a propagule encounters is the same one faced by a locally generated element. It might seem, therefore, that the same factors influencing the propensity to adopt local innovations would determine the rate at which propagules are being adopted. This is true, except that there is one additional factor which does not affect the adoption of locally generated elements. This is the degree to which a place is culturally isolated.

If a place is radically different from other places, it can be expected that for this reason alone fewer elements from the outside world will be appropriate for local adoption. This may indirectly affect the rate of local innovation but it has no bearing on whether local innovations will be accepted or not.

Local innovations, as was pointed out in chapter 6, are subject to the forces of imposition, the forces of resistance and the window effect. Propagules must contend with the same forces plus the increased likelihood that they will exhibit a greater amount of variation and will be rejected more frequently than locally innovated elements.

The possible taint of foreign origin does not adhere to native innovations. Symbolizing certain cultural elements or behavior traits as alien exerts a degree of control over the inward flow of information. As Sopher points out (1972:324) this is one mechanism through which ongoing cultural patterns are maintained. It is also a survival mechanism related to the process of aesthetic choice. If some places have more opportunity than others to view foreign elements as alien, it can be attributed to their more remote positions in cultural space.

The extent to which a place is culturally isolated refers to remoteness in taxonomic space rather than geographic space. Cultural isolation can be visualized by means of a multidimensional diagram reflecting the degree of similarity between different places (Figure 8.32). In this diagram the two axes represent cultural characteristics which have been measured in each place. These can be both formal and phyletic characteristics.

Similar places share nearby positions in the taxonomic space. In Figure 8.32 all places except j are relatively close together and the position of j is quite remote. Since j is very different from all other places, it is culturally isolated. Isolation in this sense is a measure of differentiation or divergence.

The diagram in Figure 8.32 can be expanded to any number of dimensions. The degree to which a place is isolated will be reflected in the Euclidian distance from that place to all the others in the taxonomic space.

We now must distinguish between physical and cultural isolation. Although the two are related, they are different phenomena. Both forms of iosolation affect diffusion rates, but they do so for different reasons. Physical isolation is external to the place being considered

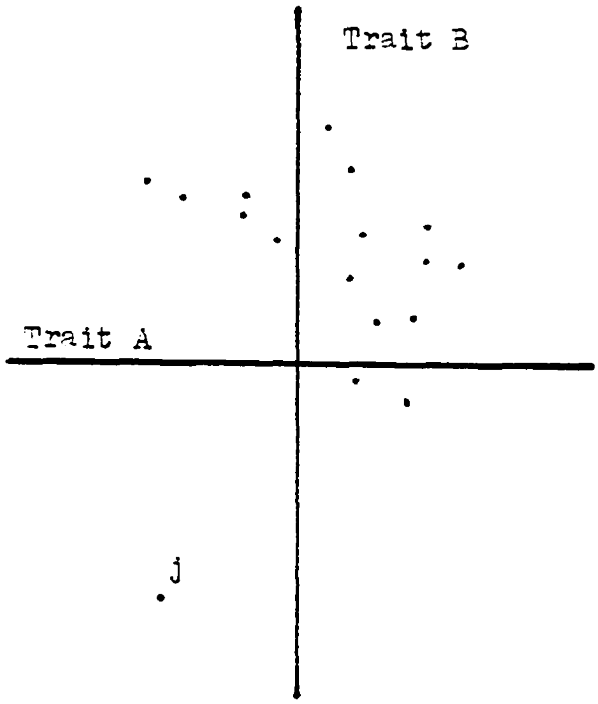


Figure 8.32

while cultural isolation is internal. Physical isolation is anything which retards dispersal into a place. Cultural isolation is that which impedes adoption after things have already arrived.

Cultural isolation is analogous to reproductive isolation among organisms (see Grant 1963:353). Where cultural isolation coincides with physical isolation within particular places (as in urban residential neighborhoods delineated on the basis of income), an analogy with ecological isolation can be made. Vertical stratification and residential segregation define various economic and social niches. These cultural niches have the same isolating properties that ecological niches have in the world of plants and animals. Religions are particularly virulent mechanisms of isolation.

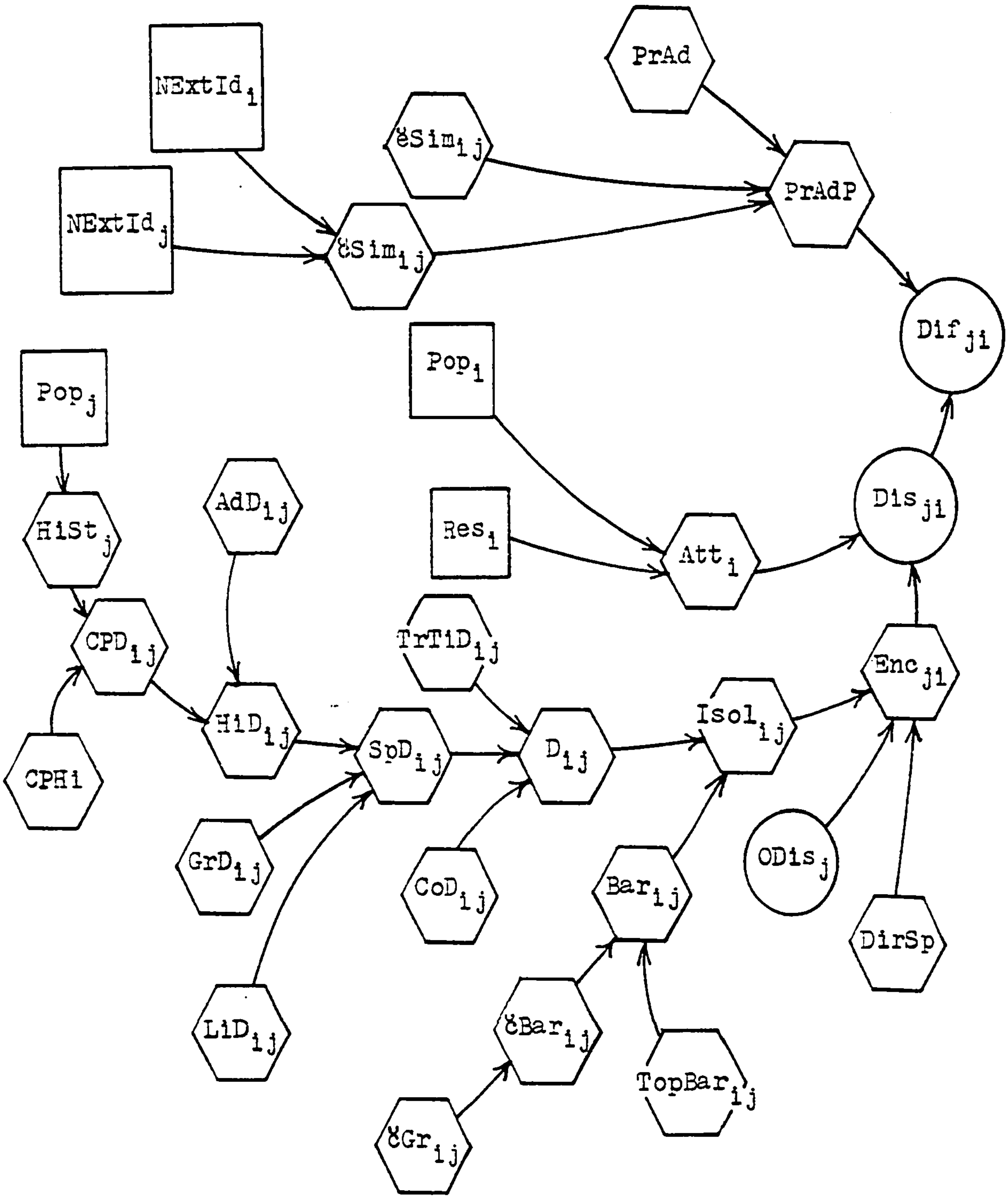
The fact that one place is predominantely Moslem while another is largely Christian (or Buddhist) results partly from the chance occurrences of history. Such differences reduce the contact which might otherwise occur between these places. As Sopher has pointed out (1972:324), ethnic boundaries of this sort act as semi-permeable filters to the flow of information.

The isolation resulting from these factors can further intensity cultural isolation within other lineages. In the urban Middle East, for instance, neighborhood dialects are arranged largely according to religious affiliation. Lack of contact between groups for religious reasons encourages the further differentiation of these dialects. In India dialects are arranged along religious and caste lines as well as along lines defined by a hierarchy of locations ranging from local villages through rural regions to large urban centers (Gumperz 1958: 669,76,80). It has often been said that these dialect differences arise out of the partial isolation produced by various religious, economic and social differences. The relationship, however, is probably circular.

The manner in which these religious, linguistic and other cultural differences produce isolation through retarding the flow of information has been amply documented by Richard Weiss in his study of cultural boundaries in Switzerland (1962). Why cultural areas and boundaries develop where they do, however, is to some unknown extent unpredictable.

As Figure 8.32 indicates, cultural isolation reflects similarities and differences between places. In order to estimate the degree to which any two places are culturally isolated from each other, it is necessary to measure their existing similarities. If two places are quite similar, it is then likely that more of the propagules dispersing between them would be adopted than would be adopted when propagules disperse between highly dissimilar places. This relationship is illustrated in Formula 8.11, where large amounts of cultural (and ecological) similarity will reduce the overall propensity to adopt to a lesser degree than small amounts of similarity. An example of how this variable might work in a simulation procedure will be given in chapter 11.

$$PrAdP = PrAd \div \frac{2}{eSim_{ij} + cSim_{ij}} \qquad (8.11)$$



PrAd
$NExtId_i$
$\dot{\delta}Sim_{ij}$
$NExtId_j$
δSim_{ij}
PrAdP
Dif_{ji}
Pop_i
Pop_j
AdD_{ij}
$HiSt_j$
Res_i
Att_i
Dis_{ji}
CPD_{ij}
$TrTiD_{ij}$
Enc_{ji}
$Isol_{ij}$
HiD_{ij}
SpD_{ij}
D_{ij}
CPHi
GrD_{ij}
CoD_{ij}
Bar_{ij}
$ODis_j$
DirSp
LiD_{ij}
δBar_{ij}
$TopBar_{ij}$
δGr_{ij}

Figure 8.33

Dif_{ji}	Number of elements diffusing from place j to place i between time t_1 and t_2 (establishment of propagules)
Dis_{ji}	Number of elements dispersing from place j to place i between time t_1 and t_2
Att_i	Level of attractiveness at place i at time t_1
Pop_i	Population of place i at time t_1
Res_i	Resource level of place i at time t_1
Enc_{ji}	Extent to which place j is encroaching upon place i between time t_1 and t_2
$ODis_j$	Number of elements dispersing away from place j between time t_1 and t_2 (outward dispersal)
DirSp	Directional specificity of elements dispersing away from place j between time t_1 and t_2
$Isol_{ij}$	Isolation between places i and j at time t_1
D_{ij}	Distance between places i and j at time t_1
SpD_{ij}	Spatial distance between places i and j at time t_1
LiD_{ij}	Linear distance between places i and j at time t_1
GrD_{ij}	Graphic distance between places i and j at time t_1
HiD_{ij}	Hierarchical distance between places i and j at time t_1
CPD_{ij}	Central place distance between places i and j at time t_1
CPH_i	Central place hierarchy affecting places i and j at time t_1
$HiSt_1$	Hierarchical status of place j at time t_1
Pop_j	Population of place j at time t_1
AdD_{ij}	Administrative distance between place i and j at time t_1
$TrTiD_{ij}$	Travel time distance between places i and j at time t_1

CoD_{ij}	Cost distance between places i and j at time t_1
Bar_{ij}	Barriers between places i and j at time t_1
$cBar_{ij}$	Cultural barriers between places i and j at time t_1
cGr_{ij}	Number of cultural groups located between places i and j at time t_1
$TopBar_{ij}$	Topographic barriers between places i and j at time t_1
PrAdP	Propensity of individuals in place i to adopt propagules from place j at time t_1
PrAd	Propensity of individuals in place i to adopt specific ideas at time t_1
$eSim_{ij}$	Ecological similarity between places i and j at time t_1
$cSim_{ij}$	Cultural similarity between places i and j at time t_1
$NExtId_i$	Numerical extent of ideas in place i at time t_1
$NExtId_j$	Numercial extent of ideas in place j at time t_1

Chapter 9

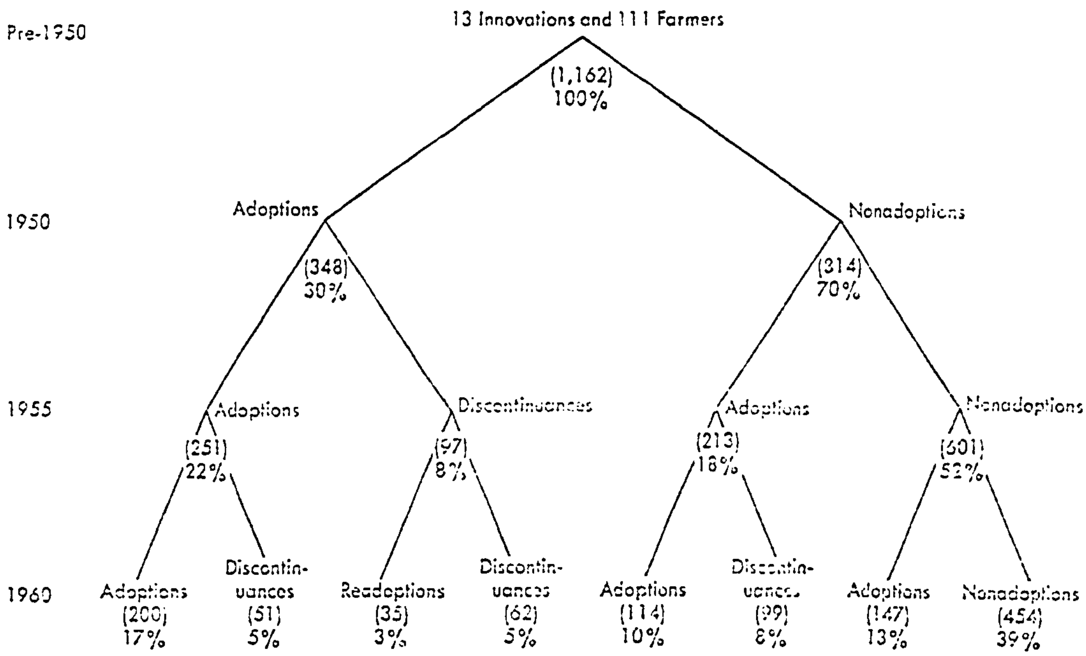
NUMERICAL EXPANSION OF IDEAS

EXPANSION VS. DIFFUSION

Numerical expansion (NExpId in the structural model) is a diffusion process that takes place entirely within a given area. This kind of diffusion is sometimes called secondary diffusion in order to distinguish it from primary or between-place diffusion. Within-place diffusion need not be analyzed in spatial terms, although a spatial dimension will always be present when between-place diffusion is being considered.

Figure 9.1 shows why not all diffusion processes need be seen in spatial terms. In this diagram the number of within-place adopters has been recorded but their locations have not. In fact, for all save geographers, diffusion is perhaps more often visualized in such non-spatial terms. The only pattern that Figure 9.1 reveals is the changing numerical distribution of a group of elements within a given place. As can be seen, this occurs through numerical expansion (number of adoptions) and numerical contraction (number of discontinuances). Numerical expansion, therefore, involves number rather than spatial position.

Numerical expansion increases the numerical extent of an element by increasing its frequency or by causing it to be held by a larger number of individuals.



INNOVATION-USE TREE FOR 13 INNOVATIONS THAT WERE ADOPTED AND DISCONTINUED BY 111 KENTUCKY FARMERS

Figure 9.1 (Rogers 1962:94)

Figure 9.2 gives four different examples of numerical expansion. In Figure 9.2a the spatial distribution of the element remains the same while its numerical distribution has increased. In Figure 9.2b, even though the element has reduced its within-place range (spatial extent) by retreating to one side of the circular plain, it has still exhibited numerical expansion since it has become more numerous. Figure 9.2c shows how numerical expansion can occur simultaneously with spatial contraction. Figure 9.2d shows a situation where numerical expansion and spatial expansion are taking place at the same time. Numerical expansion, therefore, is independent of frontier advancement or range expansion.

Numerical expansion includes such things as the growth of a political party or the spread of some particular religious belief. It also includes many of the things that are included in the process of economic growth. Economic expansion involves the spread of particular products and techniques. Commercial products expand when they are purchased by increasing numers of individuals. Purchases may or may not involve consumption. This distinction is important when such things as stockpiles and business inventories are being considered.

Some products, like food and fuel, are consumed. This means that they are destroyed shortly after purchase. The numerical extent of these artifacts must therefore be measured in terms of sales. If they are being sold at the same rate that they are being consumed, the numerical extent of these elements will remain static. Increased sales during some particular time period, then, indicates numerical expansion.

Other products, such as books and art objects, are not destroyed

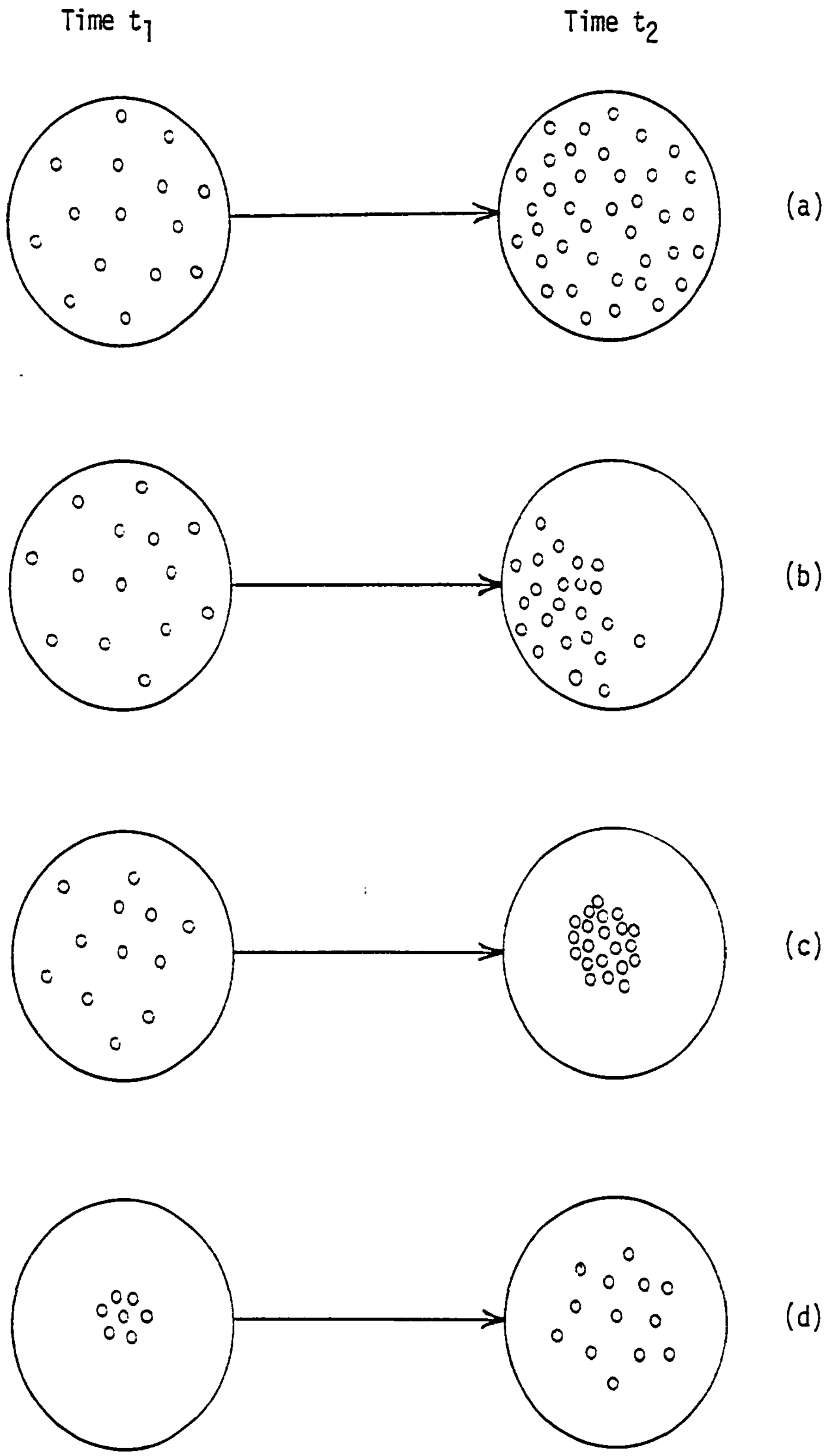


Figure 9.2

in the act of consumption. The numerical extent of these artifacts can therefore be measured by counting the number of them in existence (which does not depend on how many of them are being sold at any one time).

Ideas, beliefs and modes of behavior can also exhibit numerical expansion. This occurs when increasing numbers of individuals within a place adopt particular ideas. Ideas can be transmitted when performances are directly witnessed (dances, conversations, speeches, concerts, demonstrations) and then the material artifacts resulting from certain kinds of performances are directly witnessed (paintings, books, signs, films). Many performances transmit little in the way of ideas (street-sweeping, truck-driving, dish-washing, farming, clerking, selling). The same is true of many artifacts (garden tools, breakfast food, furniture).

Numerical expansion can be active or passive. Among plants and animals it is sometimes said that two distinct processes, one evolutionary and one geographic, produce the expansion and contraction of individual elements within regions. An element (like hair color or some particular behavioral trait) can expand and become more widespread if it appears within or as part of more and more members of a given species. The increased frequency of dark pigmentation within various moth populations living in England after the industrial revolution is a classic example. This is an evolutionary process involving natural selection, but it does not necessarily involve an increase in the number of individuals within a species.

Numerical expansion also occurs when the species itself multiplies and becomes more numerous within an area. This is often called a geographic process. This so-called geographic process is, however, an evolutionary process when the subject is the evolution of a region.

Specific elements are expanding in both of the above situations. In the first case the element expands within a given region by virtue of its having become more common within a specific population (which is composed of individuals). Here the trait expands without the species becoming more numerous (Figure 9.3a). In the second case, the trait expands as a result of the population itself having become more numerous (Figure 9.3b).

One might refer to this second process as passive expansion, while the first could be called active expansion. They are both evolutionary involving natural selection. The first involves selection between different elements within a population and the second involves selection between different populations within a region.

In the cultural realm, numerical expansion and contraction occur in the same way. Particular elements diffuse or expand throughout an area when they are transmitted to or are adopted by an increasing number of individual (active expansion). These elements also expand when groups of individuals carrying them increase their numbers (passive expansion).

Individuals can only expand actively. Ideas and artifacts can expand either actively or passively. Populations, which are composed of individuals as well as categories of individuals, ideas and artifacts, can expand either way.

Diffusion research in geography has often focused on the spread of innovations. Numerical expansion, however, does not involve innovation

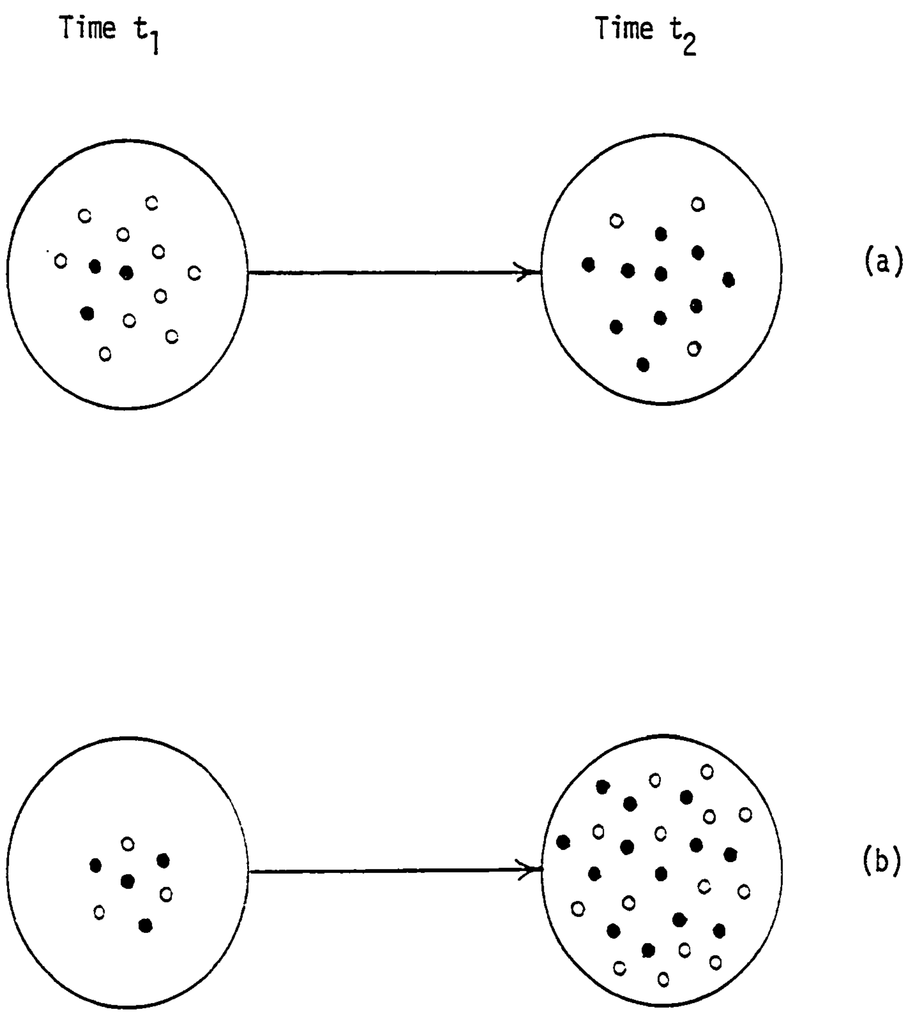


Figure 9.3

(except insofar as the establishment of an innovation increases the numerical extent of that element from zero to something more than zero). There is nothing in the structural model corresponding to the internal diffusion of innovations. There is only innovation, the establishment of innovations, and numerical expansion. The reason for this lies in our inability to distinguish between the expansion of an "innovation" and the expansion of something that is "not an innovation". The effect on any given landscape is the same.

There are only two possible ways in which the internal expansion process might be divided into an innovative and a non-innovative phase. The first involves a dividing line between insignificant and widespread adoption, and the second involves how long it has been since an expanding element was invented or introduced into a new area. Both alternatives are unsatisfactory.

It might be argued that the divide between insignificant and widespread adoption could be arbitrarily set at the point when more than 50% of a population adopts an expanding element. Before this point the element could be considered innovative and new. After this point it could be considered non-innovative and traditional.

Unfortunately, many elements never are adopted by 50% of a population. Moreover, the adoption level does not necessarily have anything to do with the impact that an expanding element has on the place characteristics of any given area. As Bagdikian has pointed out (1971:xxxv) fewer than 20% of the population in the United States have ever flown in an airplane. This particular element, however, has radically changed many aspects of the American landscape. Another example is the telephone. It wasn't until World War II that 50% of the homes in the United States had telephones, yet communication patterns in this country had been significantly altered long before the 1940's.

Consuming traditional products and doing things in traditional ways are not innovative acts at all. But if traditional activities become more widespread, they contribute to geographic change in exactly the same way that "innovations" do when they become more widespread.

Is the diffusion of an innovation something qualitatively different from the numerical expansion of anything else? It does not appear to be. The creation of a new product or a new way of doing something is an innovation. If it is copied and becomes a fixture in the landscape (either permanently or temporarily) it undergoes establishment. This contributes directly to qualitative change since something now exists within the area which did not exist previously. How many adoptions must occur before the innovation can be regarded as something which has established itself? Any number greater than one is arbitrary. After establishment, the spread of an element no longer involves innovation. Instead, it involves an increase in the number of adherents, users or copiers. The act of creation and the spread of elements are unrelated.

Everything in the landscape has been invented at one time or another. If an innovation is adopted and becomes established, it is then transformed into a tradition. The construction of the first oil well was an innovation. Thereafter, oil wells <u>per se</u> were no longer innovations, but as more and more of them were built they became more common within the region and the landscape changed accordingly. Similarly, an increase in the demand for cheese will alter the landscape through an increase in the number of cheese-eaters, cheese-makers and cheese-manufacturing facilities.

The fact that the first oil well was invented several thousand years after the first cheese does not mean that the numerical expansion of one of these elements is changing the landscape in a way that is any different from the way that the landscape is being changed by the expansion of the other. There is no good reason why older inventions should be treated differently from more recent inventions when geographic change is being considered.

FACTORS INFLUENCING RATE OF EXPANSION

Two processes can be identified that contribute to the rate of numerical expansion within a given place. As is indicated above, numerical expansion refers to the number of things which are added to a place's inventory (such as might occur when pieces of coal are added to a huge coal pile) and the number of things which are adopted by local individuals (which might be seen as being analogous to adding coal to individual parts of the coal pile). A single idea adopted by a large number of individuals is the same as adding one chunk of coal to a large number of individual parts of the big coal pile. A large number of ideas or artifacts acquired by a single individual is the same as adding many chunks of coal to a single part of the big coal pile. Adding individuals to a place's population is the same as adding more parts to the coal pile.

Since numerical expansion is a process and not a state, it does not really exist at any particular instant of time. Instead, it exists during an interval between two instants of time. All processes in the structural model correspond to or are influenced by other processes which occur during the same interval of time (between time t_1 and t_2 in most cases). Processes can also be influenced by states that exist at the instant when a given time interval begins. The level of something at time t_1 (an instant) will, for example, influence what happens during the interval immediately following t_1. This in turn will influence the level of something at a later instant of time (time t_2 for example).

The variables affecting the rate of numerical expansion are all within-place processes which occur between time t_1 and t_2. These include the numerical expansion of local ideas (NExpLId) and the rate at which ideas are diffusing into a place from the outside (DifId). As Formula 9.1 indicates, as both of these variables increase in magnitude, the overall rate of numerical expansion increases as well.

$$\text{NExpId} = \text{NExpLId} + \sum_{j=1}^{n} \text{DifId}_{ji} \qquad (9.1)$$

As has been stated before in earlier chapters, we have no idea how these variables affect numerical expansion when they are all operating together. We also have no idea as to which of the variables are more important and how each of them might be weighted. However, by assuming that the relationships are linear and by weighting all of the variables equally, we take a central position which has the advantage of minimizing error. This position is quite realistic when it is understood that from place to place each variable is likely to be weighted much differently.

Inward Diffusion of Ideas

In addition to things which are internally generated (NExpLId), things can be added to local inventories through the inward diffusion process ($DifId_{ji}$). As has been discussed earlier (chapter 8), propagules (things coming in from the outside) can be individuals, ideas and artifacts. When these incoming elements represent something new, they are innovations. If they are not new to a place, they are non-innovations. If a particular product is continually being imported into one place from another, each individual item adds to the inventory of the receiving place. This process contributes directly to numerical expansion, as Formula 9.1 has already indicated.

The various factors influencing the rate of inward diffusion (innovative as well as non-innovative) have been discussed above in chapter 8 so they need not be dealt with here.

Expansion of Local Ideas

After an element has been established it can experience expansion or contraction, although when it does so it is no longer an "innovation" and is therefore subject to the same rules that govern things which are usually thought of as "non-innovations". The adoption and expansion of a newly-invented food (Fruit X for example) will be affected by the same variables that determine how much the consumption of apples and oranges will expand within a given population (apples and oranges being things which are in no way innovations).

The numerical expansion of ideas deriving from local sources depends on three variables: the local communication rate (ComRa), the propensity to adopt (PrAd), and the local drift rate (DrRa). The effect of these three variables on numerical expansion is shown in Formula 9.2. Socialization and acculturation are part of the expansion process.

$$\mathrm{NExpLId} = \mathrm{ComRa} \times \mathrm{PrAd} \times \mathrm{DrRa} \tag{9.2}$$

Local Communication Rate

The rate at which locally generated elements are adopted within an area depends on how fast they are being communicated among individuals within a population (ComRa). Internal communication is an offering or presentation process in which ideas and artifacts are offered for consideration, retention or adoption. Where this process operates at a high intensity, the adoption process is enhanced (Formula 9.2).

In much of the literature this process is indiscriminately referred to as "interaction". This is, however, one of the more meaningless terms that has found its way into geography. Interaction of what and how? Does it refer to things that talk to each other? Does it refer to things which pass within six feet of each other? Does it refer to things that eat one another?

The term "internal communication" is more explicit in that it refers to the first half of an exchange or transferal process. The rate at which things are being communicated within a given areal unit is influenced by four aspects of place that have been discussed above: urbanization (Urb), homogeneity (Homo), the numerical extent of ideas (NExtId), and population (Pop). Formula 9.3 shows how these variables affect the local communication rate.

$$\mathrm{ComRa} = \mathrm{Pop} \times \mathrm{Urb} \times \mathrm{Homo} \times \mathrm{NExtId} \qquad (9.3)$$

Urbanization

The effect of urbanization on the communication rate is similar to the effect of urbanization on the innovation rate. In general, the larger the size of an urban center and the greater the amount of urbanization within a given region, the higher will be the rate of internal communication (Abler, Adams, and Gould 1971:209, Lloyd and Dicken 1972:143). Ideas tend to circulate at a greater rate in urban areas than in rural areas because there are simply more opportunities for face-to-face exchanges of information.

Homogeneity

The rate of internal communication will also be affected by the amount of internal homogeneity that exists within a given place. A high level of homogeneity will encourage communication while a low level will retard it.

This relationship follows from observations that diffusion between members of the same social class and functional group is more likely to occur and occurs with a higher frequency than diffusion between members of different classes and groups (Brown and Cox 1971:553). As an example of this, Gumperz (1958:679-681) has described how in India friendship (and therefore more frequent communication) tends to follow rather than cross caste lines. Homogeneity itself increases as the number of different groups becomes smaller and as the size of the dominant group increases (see chapter 4).

Numerical Extent of Ideas

As was explained in chapter 3, the numerical extent of ideas refers to how widespread each idea is within a given place. As ideas become more numerous, and as they become more widespread, the potential for the exchange of these ideas with individuals not previously exposed to them increases. Although it may not be possible to measure this variable directly, one other variable in the structural model can serve as a generalized surrogate. This variable is population size.

Population

The size of a place's population will influence the rate at which things are being communicated between individuals. As the population increases, the potential amount of communication also increases (Abler, Adams and Gould 1971:209). A larger population will increase the number of individuals involved in the communication (or "interaction") process and the potential exchange of information, ideas and artifacts will increase.

Propensity to Adopt

The effect of environmental suitability (also called propensity to adopt) on the establishment of local innovations has been discussed above in chapter 6. As was indicated in that chapter, the extent to which local innovations can become established depends partly on the suitability of the local environment for those innovations (PrAd). Some innovations are adopted and become established. Others are rejected and disappear.

Environmental suitability also affects the process of numerical expansion. After a geographic element has undergone establishment, it can undergo either numerical expansion or numerical contraction. If, after its initial establishment, the element experiences a reduction in its numerical extent, it immediately disappears. If, on the other hand, it begins to expand, the now non-innovative element must continually overcome the same kind of obstacles that it faced during the establishment process when it encountered potential adopters. If the environment is hostile or if the local population is unresponsive, fewer representatives of a given geographic element will be adopted locally (or otherwise added to the local inventory) and the rate of numerical expansion will consequently be retarded. If the propensity to adopt is high, however, adoptions and additions to the local inventory will be higher. Expanding elements, then, are constantly being subjected to evaluation and choice.

Drift

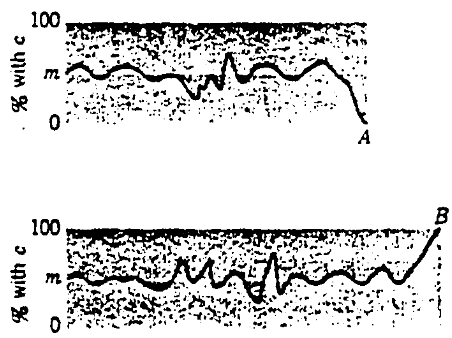
In considering the problem of convergence and divergence Zelinsky once stated (1973:68) that if all possible data on local inventions, diffusion of innovations and other aspects of culture change were gathered, a great deal of unexplained variation would remain. Much of this seemingly unaccounted for change would appear to be due to a number of extremely small, gradual shifts in behavior and thinking largely at the level of the subconscious. These minute shifts are the outcome of a selection process known as drift (also called the Sewall Wright effect). This process seems to have received the greatest attention in the fields of genetics and historical linguistics. When it operates, it is due largely to accident rather than to any adaptive value of the elements or traits involved.

Buettner-Janusch (1966:506) has given a hypothetical example of genetic drift within a population of 100 individuals, 95 of whom have trait _a_ and 5 of whom have trait _b_. The probability is high that accidents (or anything else which might prevent reproduction) will eliminate a significant proportion of the 5 individuals with trait _b_ without greatly affecting that part of the population having trait _a_. These accidents will reduce the number of _b_ genes in the population. Since these accidents are not related to the properties of the environment or the genes themselves, they are chance occurrences. Birdsell (1972: 405) explains genetic drift in terms of sample size, showing that statistical events in small populations (like variance about a norm) are apt to fluctuate much more widely about an expected value than they are apt to in large populations. Accordingly, genetic drift has often been called sampling error, which can be defined as the variation introduced by taking small samples. Figure 9.4 is an example of how drift affects both expansion and contraction.

It is tempting to make an analogy between the process of genetic drift and a similar process of cultural drift, and we shall do so here. The analogy is not an improbable one since not all physical processes operate according to rules that are totally different from cultural processes.

Sopher has noted (1972:323) that human breeding practices, for instance, seem to follow the same spatial rules that govern other cultural exchanges. The number of marriages contracted between people living in different places is often cited as an example. The frequency of these marriages is often directly related to the population of the two places and the distance between them (Birdsell 1972:368), Cavalli-Sforza 1969:34, Gould 1969:16, Morrill and Pitts 1967:422, Clarke 1952: 22). Since marriage is a good indicator of who will breed with whom, we have a perfect example of a physical process (interbreeding) acting in a manner quite similar to a cultural one (pair-bonding).

Berreman (1960:788) points out that both cultural change and change in genetic lineages result from identical processes--variability, selection and transmission through time. Selection results in the survival of some variants and the elimination of others, and drift is one of the processes through which selection operates. According to Eggan (1963:349) linguistic and cultural drift are processes which do indeed resemble the process of genetic drift. Herskovits (1952:593)



Schematic drawings to illustrate random fluctuation of an allele (c) about the mean (m) in small breeding populations. At point A, *no members of the population would have c, that is, all would have c^+; at* B, *all members would have c, and none would have c^+. If the population were large, the numerical fluctuations would be small and would have little or no effect.*

Figure 9.4 (Gardner 1972:387)

describes cultural drift as the process whereby some variants come to be more important than others in a particular population at a particular time. This favoring of some variants and disfavoring of others is always seen as an extremely gradual and largely unnoticeable process (Eggan 1963:347, Hall 1950:173, Sapir 1949:150).

In linguistics, Sapir (1949:155) has ascribed the major differences between languages (phonetic pattern and morphology rather than vocabulary) to this autonomous drift of language. He feels that it is not only due to unconscious selection but is also cumulative and directional in nature. The directional aspects of drift were discussed above in chapter 1. Sapir also indicates (1949:206) that there is no convincing evidence that the structures of different languages (as opposed to their vocabularies) have been influenced by diffusion or any of the other processes which Zelinsky alluded to above.

Drift does not affect the establishment process, since it is assumed that a mix of elements already exists. Drift only changes the proportions of these elements within a population through the processes of numerical expansion and contraction. As was true of hybridization, we have no way of knowing which elements are expanding and which are contracting, and we cannot say that one of these processes is likely to be stronger than the other. We can only assume that drift is contributing to both processes in approximately equal measures.

The rate at which drift is occurring is determined by two variables which are highly prominent in the structural model--accessibility and population (Formula 9.4).

$$DrRa_{t_1-t_2} = \frac{1}{\mathrm{Log}\ \boxed{Pop_{t_1}} \times Acces_{t_1}} \tag{9.4}$$

$$Acces_{t_2} = \sum_{j=1}^{n} Dis_{ji\ t_1-t_2} \tag{9.5}$$

Population

In the organic world various theories have been proposed concerning the rate at which evolutionary change occurs. Some have held, for example, that the rate of change should be faster among organisms with short life cycles than among those with longer life cycles. There is no conclusive evidence, however, that individual size, longevity, number or any other discernable feature of a given species is related to its rate of evolutionary change (Simpson 1944). According to Ross (1974:95) one can only assume that evolution operates differently within each group and that individual rates must be determined for each species.

Similar theories have appeared in the social sciences. Sorokin (1962:565) has discussed a number of theories holding that the rate of change in small lineages* (such as states, religious denominations, corporations and other kinds of human organization) is always faster than the rate of change in large lineages. He feels, however, that these generalizations are vague and that little weight should be placed on them.

On the other hand, it is widely recognized that the rate of genetic drift is high in very small populations and becomes lower as the population becomes larger (Birdsell 1972:406, Keesing 1958:71, Eggan 1963:349, Cavalli-Sforza 1969:31, Buettner-Janusch 1966:406). It is also widely held that in large populations the effects of drift are negligible (Birdsell 1972:411, Buettner-Janusch 1966:409). Wright (1963:384) has estimated that in order for drift to operate effectively, breeding populations must not exceed several dozen. If these populations number in the hundreds, differentiation through drift is relatively slight.

*As has been discussed above, lineages are the cultural equivalents of biological species.

As was shown in chapter 6, one form of drift (called boatload drift) seems to operate within small cultural units as well. When small groups of individuals migrate away from a given place, the amount of cultural variability within the migrant groups will be different from that of the parent population. Many elements present in the larger population will be absent in the smaller one and many elements which are of negligible importance in the parent group can be quite prominent in the migrating one. Furthermore, accidents can substantially reduce certain elements already in short supply among the migrants. Knowledge of mathematics could, for example, be totally wiped out in one of these incipient cultures if the only mathematician in a migrating group were to sicken and die.

Sapir (1949:218) spoke of cultural drift as a complex series of changes in a place's inventory (additions, losses, changes of emphasis and relation). If we accept the idea of cultural drift, and Eggan (1963:349), Murdock (1949:198), Herskovits (1952:593) and Sopher (1972: 323) apparently believe it to be a valid one, its direction cannot be predicted but its magnitude sometimes can.

In human groups drift does not operate within the total population of a society, but instead operates within much smaller breeding populations. A city of several million, for instance, really consists in a large number of small, overlapping breeding (or communicating) populations which number only a few thousand each (Birdsell 1972:407, Levi-Strauss 1953:535). It is within small groups such as these that we might expect to find linguistic and cultural drift operating. It is understood that the process is quite slow and unfolds over many generations.

Unfortunately, we do not know the point at which a population is small enough to allow cultural drift to begin. Accordingly, the most we will assume is that drift, if it operates at all, is likely to operate only within the least populated places.

The relationship, then, between population (Pop) and the rate of drift within any particular place (DrRa) is the exponential curve produced by Formula 9.4.

Accessibility

Eggan (1963:349) has indicated that isolation is another condition necessary for the functioning of genetic and cultural drift. It is also necessary for the formation of dialects and regional sub-cultures through the process of differentiation (a process which involves drift and which will be discussed below in chapter 11). Since slight isolation does not seem to produce the desired effect (Wright 1963:384), the relationship between accessibility and drift is the one appearing in Formula 9.4.

Accessibility itself, like isolation, is defined by the total amount of inward dispersal (from all outside places) occurring during a previous time period. This relationship is illustrated in Formula 9.5.

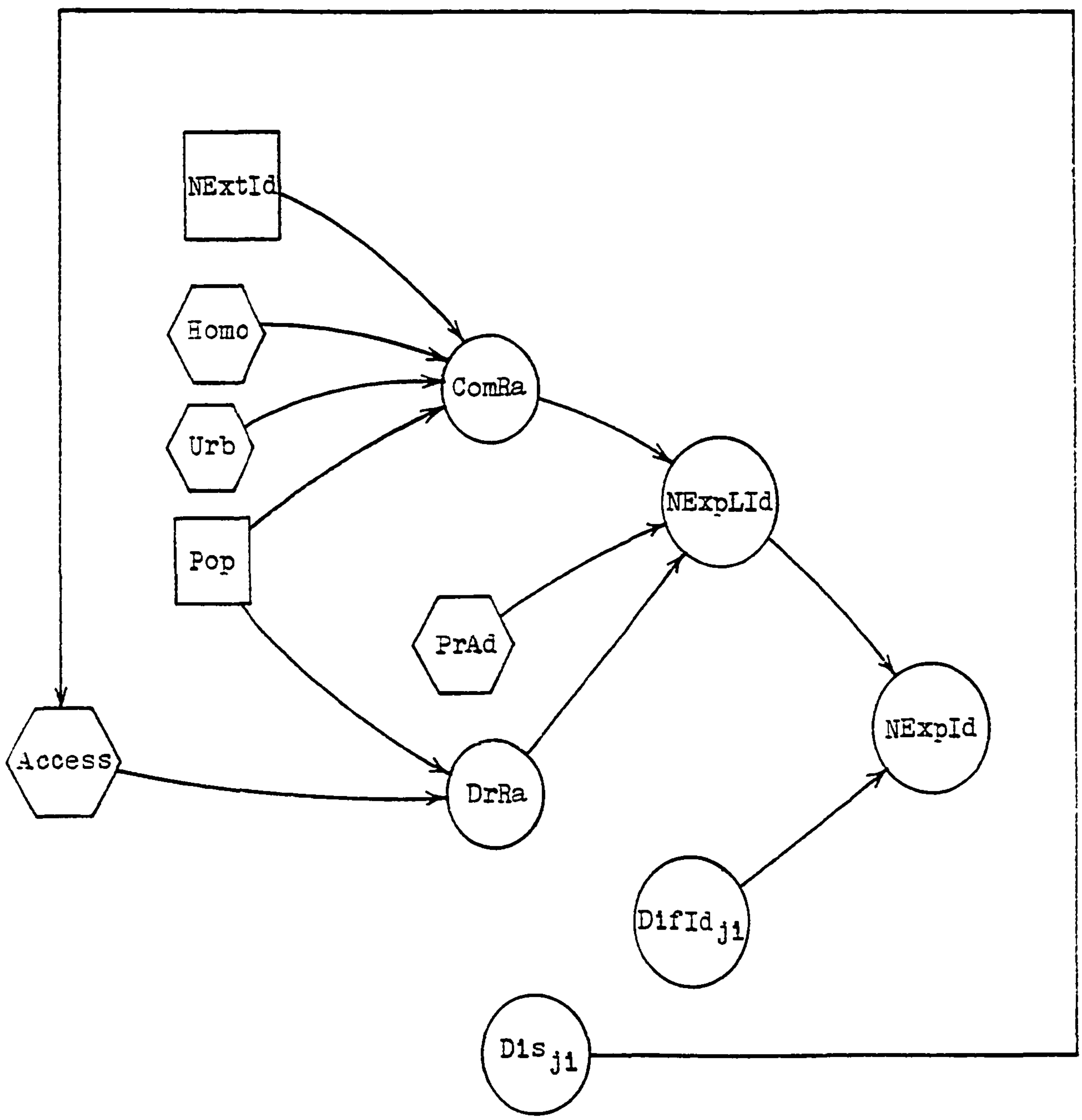

NExtId
Homo
Urb
Pop
ComRa
NExpLId
PrAd
Access
DrRa
NExpId
DifId$_{ji}$
Dis$_{ji}$

Figure 9.5

NExpId	Rate of within-place numerical expansion of ideas between time t_1 and t_2
$DifId_{ji}$	Number of ideas diffusing from place j into place i between time t_1 and t_2
NExpLId	Rate of within-place numerical expansion of local ideas between time t_1 and t_2
ComRa	Rate at which ideas are being communicated between individuals within a place between time t_1 and t_2
NExtId	Numerical extent of ideas within a place at time t_1
Homo	Level of homogeneity within a place at time t_1
Urb	Level of urbanization within a place at time t_1
Pop	Population of a place at time t_1
PrAd	Propensity of individuals within a place to adopt ideas at time t_1
DrRa	Drift rate within a place between time t_1 and t_2
Access	Accessibility of a place at time t_1
Dis_{ji}	Number of ideas dispersing into a place from place j between time t_0 and t_1

Chapter 10

CONTRACTION AND ELIMINATION OF IDEAS

Numerical contraction (NConId) is the process whereby things become fewer in number. Although much of the diffusion literature in geography describes the expansion process, particularly as it pertains to the adoption of innovations, the contraction process must also be considered. Contraction has an equal role in changing the appearance of a place through time, as Formula 3.2 has already indicated.

Whereas expansion involves adoption and the addition of things to a place's inventory, contraction involves discardation, discontinuance and the subtraction of things from place inventories. Addition and subtraction must not be confused with the establishment and elimination processes. These refer to the initial appearance and the final disappearance of entire classes of things (automobiles in general, for instance, as opposed to specific individuals owning automobiles).

Figure 10.1 shows how numerical contraction (which might also be called negative diffusion) can be visualized. Note that numerical contraction must not be confused with spatial contraction. In Figure 10.1b, for example, the element in question has undergone numerical contraction while at the same time having undergone spatial expansion.

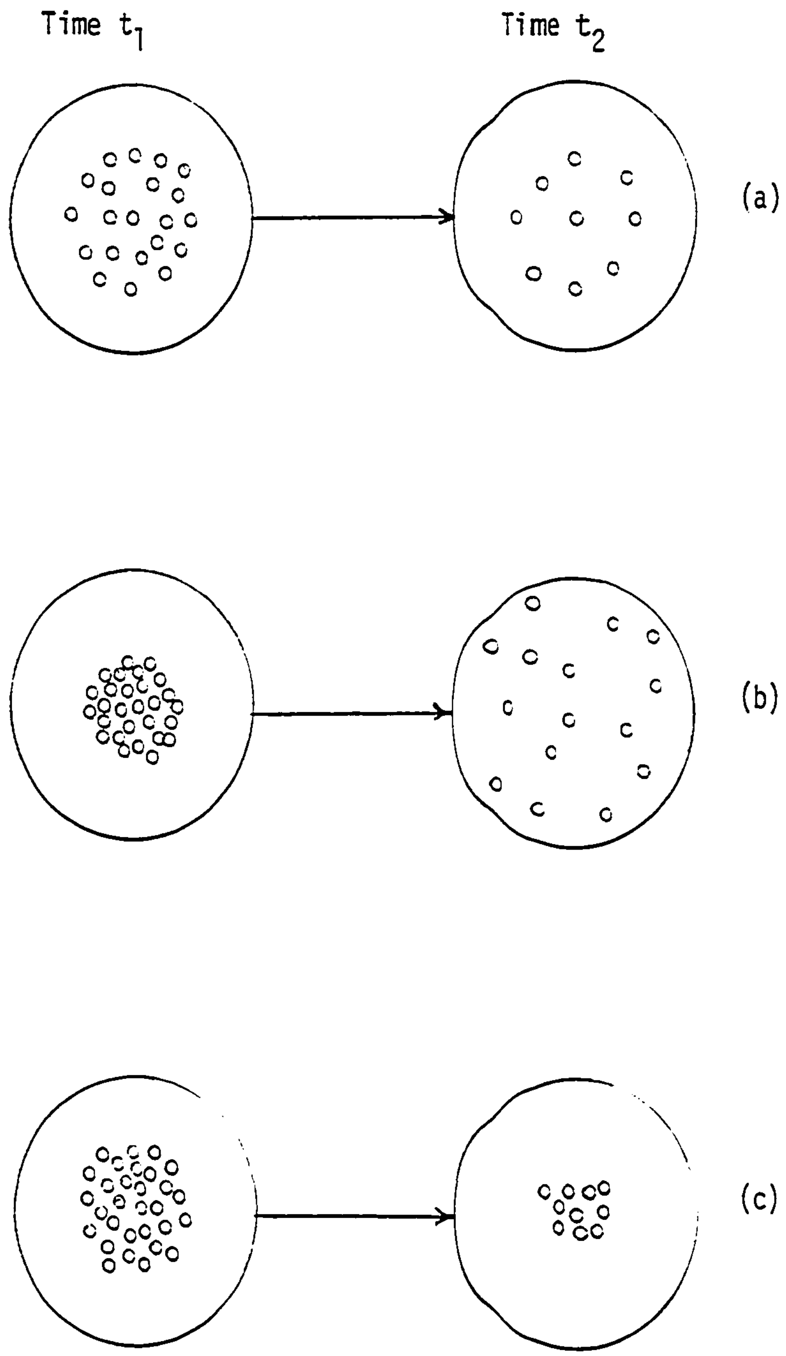


Figure 10.1

NUMERICAL CONTRACTION OF IDEAS

Numerical contraction is influenced by at least three processes, which include substitution (SubId), drift (DrRa), and the numerical contraction of individuals (NConIn). As Formula 10.1 indicates, as each of these variables increases, the rate of idea contraction increases as well. As with most of the formulas in this thesis, we do not really know what weights should (or can) be assigned to each of these variables. To find out would involve years of study. Formula 10.1, therefore, should be regarded as more suggestive than anything else.

$$\text{NConId} = \text{SubId} \times \text{NConIn} \times \text{DrRa} \qquad (10.1)$$

Substitution

Substitution takes place when individuals adopt some elements at the expense of others. In many cases, the adoption of one element causes the discontinuance of another. Shifting allegiances among different religions and political groups are examples. If an individual chooses to be a member of one group, he cannot at the same time be part of another. Other examples can be seen where one product increases its sales at the expense of a competitor. If an individual chooses to consume one product, he quite often will not at the same time consume a different one that serves the same function. A sale made by Ford, for example, usually means a sale lost by Chevrolet.

Where residential neighborhoods in contemporary Anglo-America are undergoing changes in ethnic composition, one group moves out while another is moving in. Here, the expansion of one group contributes to the contraction of another. Substitution is thus directly related to the process of numerical expansion.

All expansion, however, does not result in substitution. Even though many things are dropped in favor of more appealing forms (like the use of a more colorful word or a more efficient insecticide), there are still many things which expand without driving alternate forms out of existence. If this were not so, the size and diversity of geographic inventories would never change. Yet, as has been noted above in chapter 4, diversity seems to have consistently increased through time. Instead, the rate of substitution (and consequently the rate of contraction) must be somewhat slower than the rate of expansion.

As was shown above in chapter 9, the propensity to adopt (PrAd) has a direct influence on the rate of numerical expansion. A high propensity to adopt allows for a high rate of expansion if the other variables involved are high. We cannot say, however, that a low propensity to adopt has an effect on the rate of contraction. The propensity to adopt only affects expansion. We might consider a propensity to discard or to discontinue, but there has been no research done on this topic. The closest we can come to it is through the process of substitution.

As the rate of numerical expansion increases, therefore, substitution is likely to increase also, but at a slower rate (how much slower we can only guess since this subject has never been investigated). Formula 10.2 shows the probable relationship between expansion, establishment (also a quantitative process) and substitution.

$$\text{SubId} = .n\ \text{NExpId} + .n\ \text{EstId} \qquad (10.2)$$

Drift

As Figure 9.2 indicated, drift has as much an effect on contraction as it does on expansion. The results of drift are also likely to be much more dramatic in the case of contraction, specifically when contraction continues to its ultimate end; elimination. As was mentioned before, drift can have no effect on the establishment process, but through the action of contraction, it can produce elimination. How this occurs will be illustrated in the next chapter.

Numerical Contraction of Individuals

The numerical contraction of individuals occurs when individuals in a population disappear from a place. This can occur through outward migration (OMigIn) or through death (DeRa). In either situation, the number of individuals in a place is reduced. Normally, this reduction in numbers is matched by births and inward migration. However, when individuals die or leave, they take their ideas with them. Whenever a single individual disappears from a place a whole series of ideas suffer the same fate. If the last individual possessing a certain piece of knowledge dies or leaves, then elimination of that idea from the local inventory of ideas occurs at the same time. Cultural evolution, therefore, does not only proceed via substitution (where new ideas drive old ones out of the market place through the agency of persuasion) but also via the death rate. Kuhn (1971:151) notes, for example, that new ideas in the academic world frequently replace older ideas not because the opposition becomes convinced that the new ideas are better and more accurate, but because the opposition eventually dies out. This leaves a new generation to grow up holding the new ideas (received via the agency of communication, adoption, and numerical expansion). Formula 10.3 shows these two variables as they affect numerical contraction of individuals.

$$\text{NConIn} = \text{DeRa} + \text{OMigIn} \tag{10.3}$$

As Formula 10.4 indicates, the number of deaths within any given place is ultimately dependent upon the size of the population. Larger populations will tend to have more individuals dying during any given time period than small populations. At the same time, the number of individuals undergoing out-migration is dependent primarily on the overall rate of outward dispersal (ODis). Formula 10.5 indicates this relationship.

$$\text{DeRa} = \boxed{\text{Pop}} \tag{10.4}$$

$$\text{OMigIn} = \text{ODis} \tag{10.5}$$

OUTWARD DISPERSAL

The outward dispersal of individuals, as Formula 10.5 indicates, is governed by only one variable--total outward dispersal. This variable is also the sole determinant of two other processes which involve the outward dispersal of ideas (ODisId) and the outward dispersal of artifacts (ODisAr), both of which were discussed in chapter 8 and 9.

As was true of inward diffusion (Dif_{ji}) the factors which are known to be associated with outward dispersal rates do not affect the outward dispersal of any particular thing--just things in general. Given the three major categories that geographic phenomena have been divided into (individuals, ideas and artifacts), the most we can say about the outward dispersal process is that it contributes equally to the outward movement of all elements.

When inward diffusion occurs, ideas and artifacts as well as individuals are added to a place's geographic inventory. Directly or indirectly, the inward movement of things within each of these three categories will contribute to numerical expansion (NExpId). The outward movement of things in only two of these categories, however, will have an effect on numerical contraction--the outward dispersal of artifacts (ODisAr) and the outward migration of individuals (OMigIn).

Unlike the inward flow of ideas, the outward flow of ideas (and other ephemerals) has no effect at all on a place's geographic inventory. Ideas can be communicated to other places, but this does not result in a reduction of the number of ideas in the original place. Although the outward dispersal of ideas does not affect the rate of within-place change, it is not irrelevant. As will be shown below in chapter 11, the movement of ideas between places has an effect on convergence and divergence.

Outward dispersal is the process whereby things in general pass out of and move away from individual places. Just as inward dispersal and inward diffusion result from the quality of attractiveness, outward dispersal results from the quality of emissiveness (Emis). Outward dispersal is also influenced by the quality of vagility (Vag), as Formula 10.6 indicates.

$$\mathrm{ODis}_i = \mathrm{Emis}_i \times \mathrm{Vag} \qquad (10.6)$$

The propensity to adopt, which is a major factor in the inward diffusion process, has no effect on the process of outward dispersal. This is a major difference between the two processes. It also accounts for the absence of the term "outward diffusion" in the structural model.

As was explained in chapter 8, the distinction between inward dispersal (Dis_{ji}) and inward diffusion (Dif_{ji}) involves the difference between things which are successful and things which are unsuccessful in establishing themselves in new locations. The critical factor is environmental suitability, which is also referred to as the propensity to adopt at the receiving location (PrAdP).

Although this factor is important in explaining the rate of inward movement and its effect on the rate of numerical expansion, it has little bearing on the rate at which things depart from a place. Outside places may or may not adopt things undergoing outward dispersal. But this has no effect on whether or not numerical contraction occurs. If an outward dispersing propagule fails to establish itself in a new location and dies, a loss is still experienced at the place of origin. The term "outward diffusion" is therefore redundant and has not been used in the structural model since outward dispersal completes the process of departure (insofar as it produces change within the original location).

For the same reason, outward dispersal is not affected by isolation in the same way that inward diffusion is. Even though a highly isolated place may be emitting things which never find their way to other places, things can still be moving away. This is much like saying that a candle in the middle of a deserted barn may not be warming anyone, but it is nevertheless still giving off heat.

Emissiveness

Emissiveness is the opposite of attractiveness. Whereas attractiveness is a quality which draws things in, emissiveness is a force which pushes things out. Emissiveness is a local quality. It does not involve the qualities of outside places. As is illustrated in Formula 10.7, emissiveness is affected by the local population (Pop_i), the level of local resources (Res_i), the numerical extent of local ideas ($NExtId_i$), and local prestige ($Pres_i$).

$$\mathrm{Emis}_i = \boxed{\mathrm{NExtId}_i} \times \boxed{\mathrm{Pop}_i} \times \boxed{\mathrm{Res}_i} \times \mathrm{Pres}_i \tag{10.7}$$

Many unique historical conditions will affect a place's level of emissiveness. Most of the factors which promote outward movement, such as poverty, plague, famine, war, trade and other historical aspects of place, are extremely complex, although some scholars have tried to explain them through the use of unicausal arguments.

Occasionally the environment is cited as a major causal agent for the movement of peoples. Huntington (1907), Sears (1935), Jones (1964: 55-61), Childe (1950:25) and Bryson (in Alexander 1974:152), for example, have argued that dramatic changes in the earth's climate have been responsible for many important migrations during the past several thousand years. Others, like Brown and Moore (1970) and Wolpert (1968), have stressed the role of the human decision-making process.

A great number of unique historical factors will promote emissiveness. Many will also retard it. In China during the Ch'ing dynasty, for instance, the overseas migration of Chinese peasants was looked upon with disfavor by the Manchu government (Chang 1968:89). Consequently, the movement of people out of China during the 19th century was much lower than it might have been otherwise. Similarly, high caste Brahmans and other Hindus for several centuries refused to leave India, as to do so would cause them to lose their caste status (Moreland and

Chatterjee 1967:394).

Desires and needs also contribute to emissiveness, though not in any predictable fashion. New Englanders in the 19th century provide an example of how needs can promote outward movement. During this period in American history, many people in New England felt a need to bring salvation and enlightenment to distant peoples. Consequently, hordes of missionaries were emitted from Boston and other nearby cities. Similarly, the Germans were taught in the 1930's to feel a need for lebensraum (see Dickinson 1969:71, van Valkenburg 1951:109 and von Maltitz 1973:63 for discussions of this influential idea). A practical use for the lebensraum theory was soon found which led to the emission of German infantry regiments and panzer divisions into neighboring countries (applied geography at its finest).

Population

The effect of population on emissiveness is derived from the gravity model. Places with more individuals are more likely to give off information, messages, and migrants than places with few individuals.

Resources

Resources that contribute to emission include such things as fertile soil, high amounts of rainfall, and a skillful labor force. These resources will contribute to the emission of agricultural products from an area if the technology permits and if the inhabitants choose to exploit their resources in this manner.

Many of the resources that contribute to attraction will also contribute to emission. The industrial resources of Detroit, say, not only attract raw materials and unemployed workers, but also cause vast quantities of manufactured products to be emitted from Detroit. Other emissive resources include prestige and intellectual activity (as might be found in Berkeley and other major university centers) which increase the rate at which ideas and opinions are emitted. The prestige of Paris, particularly in the realm of women's fashions, is an emissive resource. Power (like that found in Washington, Moscow and the Vatican) is an emissive resource when it contributes to the flow of orders and directives down a hierarchy.

Quite often the lack of certain resources will increase the intensity of emissiveness. Famine, for example, caused Ireland to emit Irishmen in the 1840's and unemployment in the 1950's caused Puerto Rico to emit Puerto Ricans. Emissive resources, then, can include some very negative things--phenomena which are not usually thought of as resources at all.

Since both the absence and the overabundance of any given resource can contribute to high levels of emissiveness, it cannot be said that as the quality and the amount of resources increase within a given place, its level of emissiveness increases also. Instead, resources (like demands, wants and needs) can affect emissiveness only insofar as they are unique historical circumstances.

Numerical Extent of Ideas

As with population size, the number of ideas a place harbors can influence the rate at which ideas leave that place. Places that generate more ideas can be expected to emit more ideas.

Prestige

Great cultural centers tend to have a greater amount of emissive force due to their higher social standing and prestige. Foster (1962: 29) has noted that the cultural innovations of urban areas, for example, tend to become prestigous more often than innovations arising in rural areas. Linguistic innovations arising in Boston and Florence, to give another example, have frequently diffused into their surrounding territories largely because of the prestige of these places (R.A. Hall 1950:144). The prestige of a place may be independent of its size and position in a trade hierarchy.

Vagility

In the natural realm a large sun or star may on account of its great mass exert an intense gravitational force on neighboring bodies, thus drawing them inward. At the same time it may be radiating either a large or a small amount of energy, depending on how intensely its internal fires are burning. Radiation (emissiveness) and gravitation (attractiveness) are separate phenomena which do not affect each other as far as we know.

Similarly, we can think of a place's attractive power as involving its mass (local population) and the distance to other places. We can also think of a place's emissive power as involving the intensity with which the things to be emitted are being produced (without regard to how far it is to other places). Thus, a situation can exist where even though a place may possess a great deal of mass in the form of a large population, the population may be composed of inert, unthinking, highly traditional peasants who contribute little towards the outward movement of such things as new ideas, cleverly constructed artifacts and adventurous foreign travelers. On the other hand, a place possessing a very small population may be inhabited by a large number of innovators, tradesmen and artisans who regularly engage in activities associated with outside contact. The qualitative characteristics of a place's population, therefore, can often be more important than its size in determining how much will be involved in outward movement. The qualitative characteristic which describes the capacity for dispersal is vagility.

Vagility is the ability of individuals within a species to disperse (Ross 1974:69). As used in the structural model, a highly vagile element (be it an idea, an artifact or an individual) will have a higher dispersal rate and its radius of dispersal will be greater than an element which is less vagile. In botany and zoology species are described as having high or low vagility. Species with high vagility tend to expand their ranges more rapidly than other species.

As a determinant of the intensity of emission, vagility is a qualitative measure which applies to the specific things being emitted. Highly desirable things, for instance, should have higher vagility than things which are less desirable (gold as opposed to lead). Cultural immobilia, as described by Leighly (1937:34), are things in the landscape which have no vagility. High income individuals and highly curious or highly aggressive individuals will be more vagile than impoverished or unimaginative individuals. Regardless of what is being considered, be it ideas, individuals or artifacts, things do exhibit differences in their capacity to disperse. Ullman's concept of transferability (1956:868) is similar to vagility.

So important is this factor that Sauer (1969:584) has attributed to it the major reason for the well-known biotic impoverishment of oceanic islands. He feels that the unusually small number of species found on these islands (when compared to continental areas of similar size) as well as the absence of many major taxonomic groups, can be largely explained by the filtering process which occurs when species having different dispersal capabilities undergo long range migration.

Vagility can also be conferred upon elements undergoing outward movement, and place characteristics are often responsible for this. Things from high prestige areas, for instance, are much more desirable and are adopted much more readily than things from low prestige areas (Foster 1962:29, Hall 1950:29). This kind of movement, however, must apply to a great number of outside places, rather than to a few specific ones.

ELIMINATION OF IDEAS

As was indicated above in chapter 3, qualitative change involves not only the addition of new elements to a particular geographic inventory, but also the elimination of elements already contained within it. Elimination refers to the change that occurs when the last remaining representative of some given place characteristic dies or disappears. Before this event takes place, the element exists within a place and comprises part of its inventory of distinguishing characteristics. After this event, the element is no longer found there and that place's inventory is reduced by one element.

This is not to say that the element has become extinct. This only occurs when the element's entire range (throughout the world) is reduced to the point of disappearance. When extinction takes place, an element experiences elimination in the last place on earth where it is found. It can be eliminated in other places without becoming extinct, but when it is eliminated in its last refuge it does become extinct. Elimination is a place-related process, whereas extinction is a range-related process.

The rate at which things are being eliminated depends ultimately on the rate of numerical contraction. Places that have a higher rate of numerical contraction are likely to have more eliminations from the inventory than places where the rate of numerical contraction is low.

Numerical contraction is a process which must be distinguished from spatial contraction. The two are not the same. Spatial contraction occurs when an element's range (either throughout the world or within a specific place) becomes smaller. Shrinking acreage and retreating borders are associated with spatial contraction. Numerical contraction takes place when a specific class of individuals, ideas or artifacts are becoming fewer in number. This can occur without spatial contraction. Similarly, spatial contraction can occur without numerical contraction. It is this latter situation which dictates that elimination will be affected only by numerical contraction.

Although contraction does not necessarily lead to elimination, when carried to its ultimate end it does. Unlike expansion, contraction cannot continue indefinitely. At some point the last representative of a class disappears and contraction ceases.

Although we cannot predict how intense contraction will be within any specific class of things, it is possible to estimate for different places the rate at which things in general are contracting. The variables associated with high rates of contraction exhibit between-place differences. In places where these variables are more intense there is a greater probability that contraction and therefore elimination will be high than in places where these variables are less intense. More possibilities for elimination exist in places where the contraction rate is high than in places where it is low.

As Formula 10.8 shows, elimination involves a running tally of each element. When the numerical extent of any given element reaches zero, elimination has occurred and that element is removed from the inventory. Note that in this situation contraction must exceed expansion.

$$\mathrm{Elim}_{t_1-t_2} = \boxed{\mathrm{NExtId}_{t_1}} - \mathrm{NConId}_{t_1-t_2} + \mathrm{NExpId}_{t_1-t_2} = 0 \qquad (10.8)$$

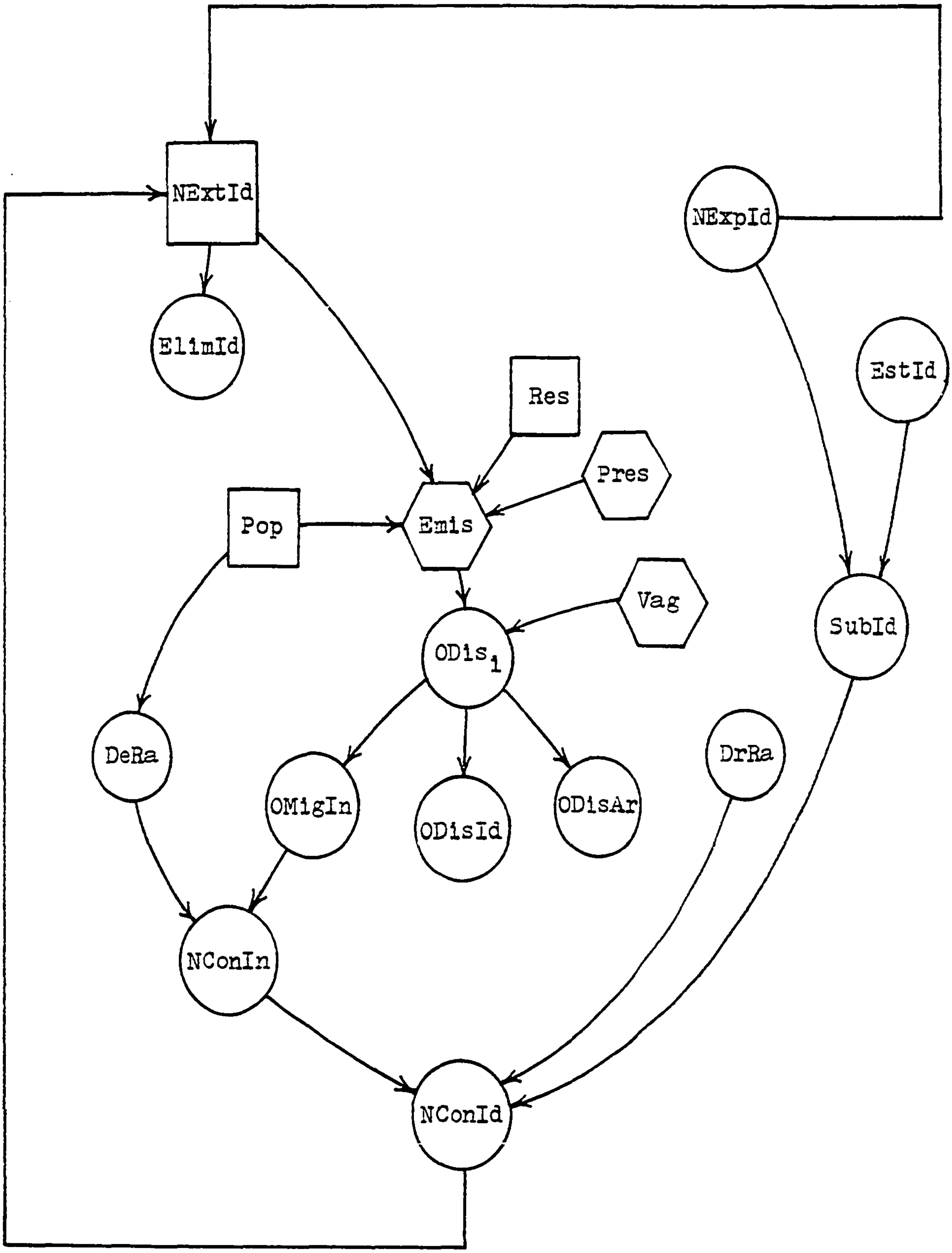

NExtId
NExpId
ElimId
EstId
Res
Pres
Pop
Emis
Vag
SubId
ODis₁
DeRa
DrRa
OMigIn
ODisId
ODisAr
NConIn
NConId

Figure 10.2

ElimId	Number of ideas eliminated from a place between time t_1 and t_2
NExtId	Numerical extent of ideas within a place at time t_1
NConId	Rate at which ideas are undergoing numerical contraction within a place between time t_1 and t_2
NConIn	Numerical contraction of individuals within a place between time t_1 and t_2
DeRa	Number of deaths within a place between time t_1 and t_2
Pop	Population of a place at time t_1
OMigIn	Number of individuals migrating away from a place between time t_1 and t_2 (out-migration)
ODisId	Number of ideas dispersing out of a place between time t_1 and t_2
ODisAr	Number of artifacts dispersing out of a place between time t_1 and t_2
ODis	Rate at which things are dispersing out of a place between time t_1 and t_2
Vag	Vagility of things undergoing outward dispersal between time t_1 and t_2
Emis	Emissiveness of a place at time t_1
Pres	Prestige of a place at time t_1
Res	Level of resources within a place at time t_1
DrRa	Rate of drift within a place between time t_1 and t_2
SubId	Rate at which ideas are being substituted within a place between time t_1 and t_2
EstId	Rate at which ideas are being established within a place between time t_1 and t_2
NExpId	Rate at which ideas are undergoing numerical expansion between time t_1 and t_2

Chapter 11

SPATIAL DIFFERENTIATION

The theory of differentiation involves comparing two places, i and j. The degree to which they have differentiated depends on how fast and in what direction change within them has occurred. It also depends on how different they were to start with. The starting point can be either total similarity or total uniqueness.

From some past condition the two places can change in three possible ways. Their similarities can increase, decrease or remain the same. Figure 1.12 illustrates these three different evolutionary processes as they relate to changing place characteristics. There are no other alternatives. During different time periods, however, these processes can reverse themselves.

In order to identify degrees of resemblance, we must visualize a situation where calculations are made from i to each j (Figure 11.1). These measurements will indicate the degree to which each j resembles i. Small numbers will indicate few differences and large numbers will indicate many differences.

This scale might be seen as the first column in a triangular matrix showing the differences between all observed places (Figure 11.2). By definition, the index number of i itself is unity, since i is identical to i. The trace of the matrix will also be filled with ones. From these minimum amounts, other j's will exhibit higher index numbers

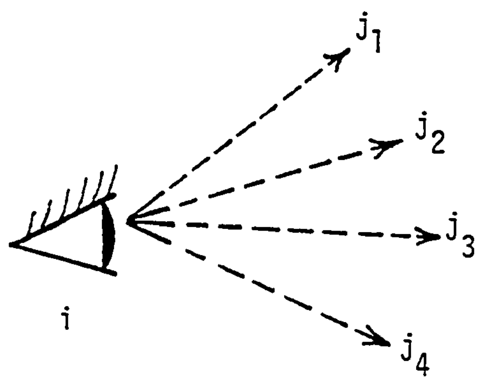


Figure 11.1

$$
\begin{array}{cccccccc}
 & i & j_1 & j_2 & \cdot & \cdot & \cdot & j_n \\
i & 1 & & & & & & \\
j_1 & 2 & 1 & & & & & \\
j_2 & 3 & 2 & 1 & & & & \\
\cdot & \cdot & \cdot & \cdot & \cdot & & & \\
\cdot & \cdot & \cdot & \cdot & \cdot & \cdot & & \\
\cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \\
j_n & 8 & 7 & 6 & \cdot & \cdot & \cdot & 1
\end{array}
$$

Matrix of Differences
Between All Observed
Places

Figure 11.2

representing increased dissimilarity. The highest index number will identify the place which differs the most from i.

Spatial differentation begins with the initial occupance of a region. This includes the establishment of a population in an initial site and the later migration of daughter populations to other sites. Differentiation within later sites occurs when they acquire unique characteristics as a result of their founding. Through time, all places will become different from the initial hearth. The processes contributing to this have been discussed in previous chapters. Each place will also diverge from all other places that descend from the same initial hearth. Differentiation occurs when elements are added to and subtracted from each place's inventory of geographic characteristics.

To illustrate how this occurs through time and space, a simple model of place differentiation has been developed. In this chapter, the model will show how a hypothetical island with a hypothetical pattern of migration and settlement can be expected to differentiate through time. The processes through which this occurs include within-place change as well as between-place differentiation. In this chapter it will be shown how some of the processes discussed in earlier chapters can be translated into spatial terms.

First, a simple model of differentiation will be created where only a few processes are operating. Then, as the basic processes are reviewed and worked out, certain assumptions will be relaxed and more of the factors discussed in previous chapters will be incorporated into the model. In this way we will be able to see how the spatial evolution of an imaginary island might progress in an increasingly complex fashion.

DIFFERENTIATION UNDER CONSTANT RATES OF CHANGE

In the beginning it will be assumed that a single island exists in the middle of a large ocean. There are no other islands. This island is flat and circular in appearance. In the middle of this island a single population evolves at place p_{101} (see Figure 11.3). This population is small and completely homogeneous. Such a population might be an extended family or a tribe. There are no other groups and no other occupied places on the island during this initial period.

While the population at place p_{101} is evolving, within-place change occurs uniformly throughout the group. As long as all members of the group remain at place p_{101} they will continue to share the same characteristics. There will be temporal divergence (from conditions existing at p_{101} during earlier time periods), but no spatial divergence within the place itself. Within-place change will proceed according to the processes shown in Figure 11.4, which incorporates some of the previously mentioned processes.

Because of substitution (SubId) it can be assumed in Figure 11.4 that even though change occurs within the group, the number of ideas (NumId) remains constant from one time period to the next. As has been explained, innovation and the adoption of innovations increases the number of ideas found locally. If this is matched by substitution, however, we can show the spatial model as it might operate when rates of change are constant. Like Einstein's special theory of relativity, this will serve as an introduction to a more general model where rates

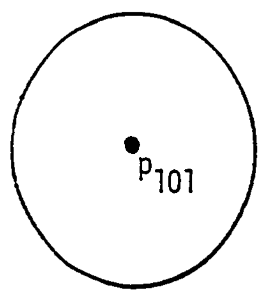


Figure 11.3

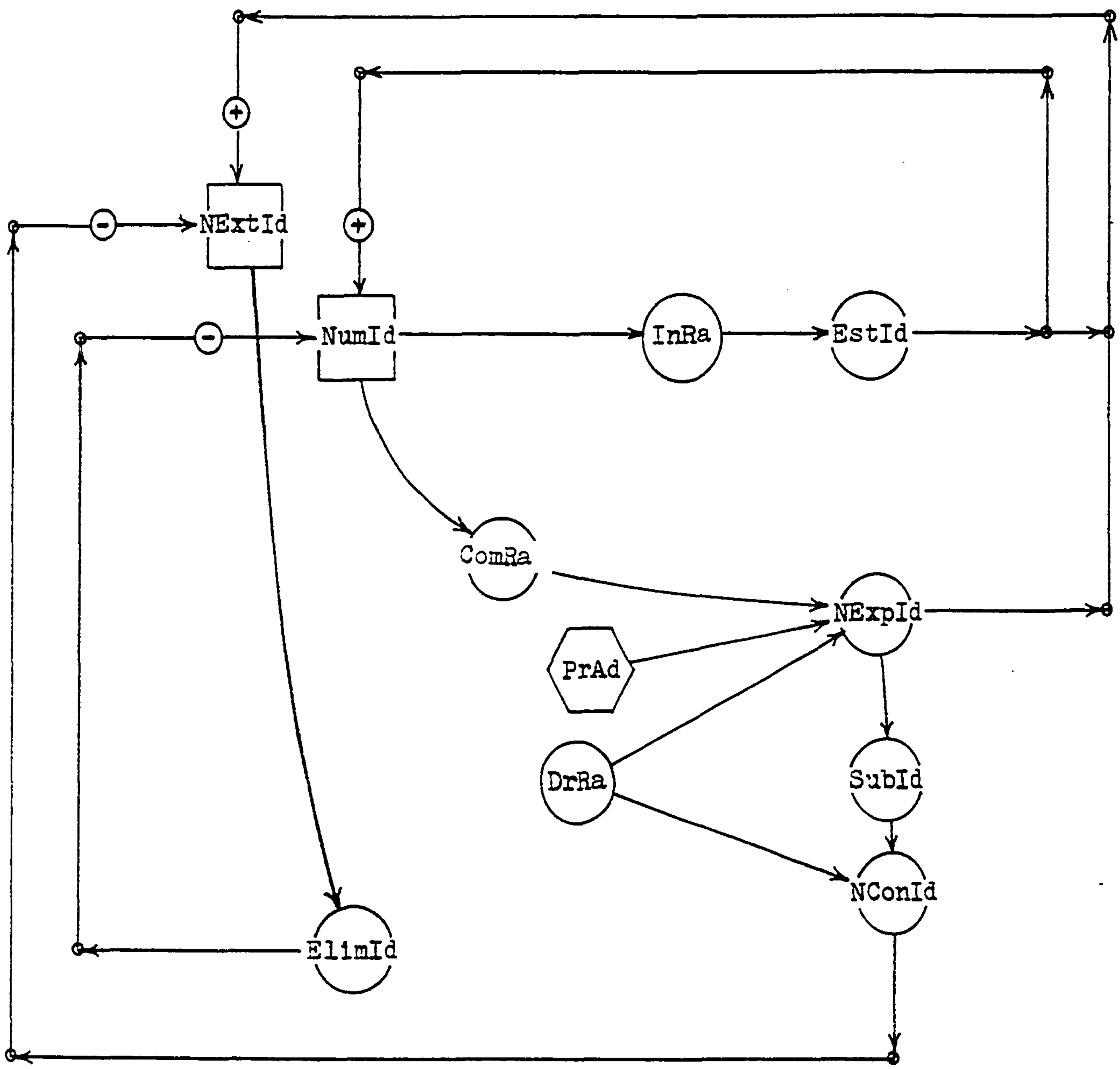

NExtId
NumId
InRa
EstId
ComRa
NExpId
PrAd
DrRa
SubId
NConId
ElimId

Figure 11.4

NExtId	Numerical extent of ideas
NumId	Number of ideas
InRa	Innovation rate
EstId	Establishment of ideas
ComRa	Local Communication rate
PrAd	Propensity to adopt
NExpId	Numerical expansion of ideas
DrRa	Drift rate
SubId	Substitution of ideas
NConId	Numerical contraction of ideas
ElimId	Elimination of ideas

of change vary. If we assume that other major variables in the model (like population and homogeneity) remain constant, we can then show how two resultant processes (establishment and elimination) will produce differentiation through time.

If we assume that the population at place p_{101} possesses 10 elements at time t_1, any given change rate will cause this to increase or decrease through time. Figure 11.5 shows an original geographic inventory of 10 elements, numbered from 0 to 9. If it can be said that during every time period 1 of these elements will be lost due to drift and substitution, then after 4 time periods 4 elements will be lost. If at the same time we postulate that the innovation rate proceeds at the rate of one innovation per time period (with each innovation being adopted) then after 4 time periods there will be 4 new elements in existence.

As Figure 11.5 shows, at time t_5 six of the original ten elements will remain, while 4 new ones will be added. The similarity, then, between place p_{101} at t_5 and p_{101} at t_1 (according to Formula 11.12) is .60. Note that at time t_5 only the 6 remaining elements existed at t_1. The 4 elements added later are unique to the later periods. Since 4 elements have been added while 4 have been subtracted, the actual size of the inventory remains the same (e.g., 10 elements) and a condition of equilibrium exists. The process illustrated in Figure 11.5 is within-place divergence, the same phenomenon discussed in earlier chapters.

	Additions to the Geographic Inventory of Place P_{101}	Subtractions from the Original Geographic Inventory of Place P_{101}
t_1		01234 56789
t_2	1	-1234 56789
t_3	11	--234 56789
t_4	111	---34 56789
t_5	1111	----4 56789
	P_{101}	P_{101}

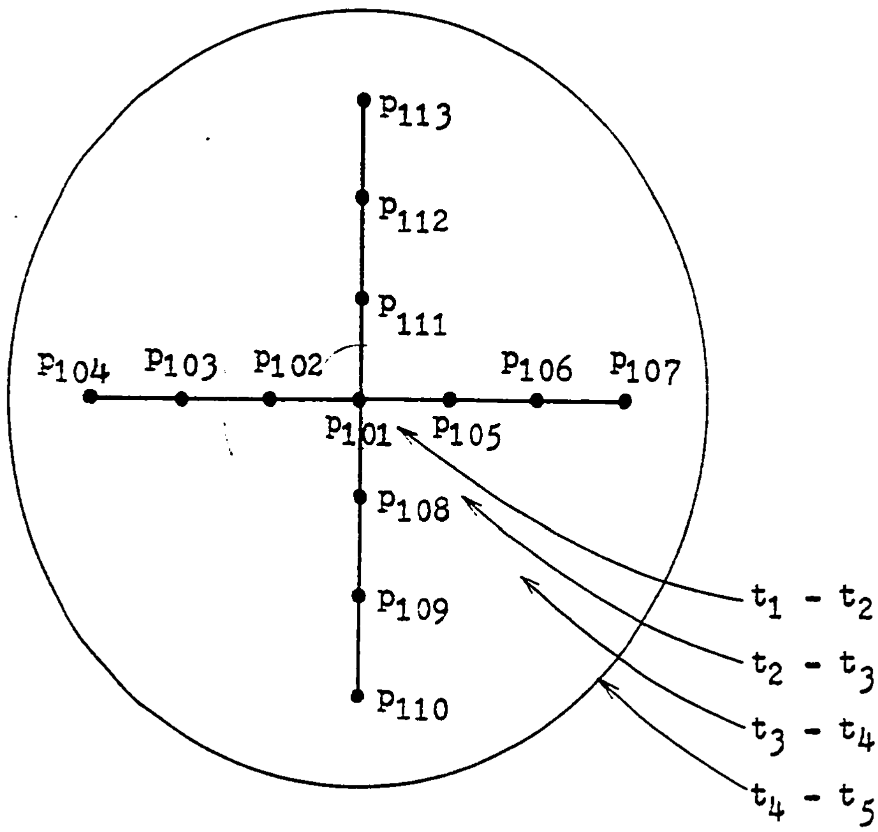
Figure 11.5

Outward Migration

Adding new places to the circular plain shown in Figure 11.3 will introduce a configuration of places where between-place processes can be illustrated. Here, we will witness the beginnings of between-place divergence.

At time t_1 it will be assumed that the population at place p_{101} has established itself and that it possesses the same characteristics shown in Figure 11.5. From time t_1 to t_2 place p_{101} experiences one increment of evolutionary development. During this period some elements will be lost and some will be added. From time t_2 to t_3 outward migration from the central hearth occurs. Further outward migration from these newly-settled areas will occur between t_3 and t_4, and from t_4 to t_5 (see Figure 11.6). At time t_5 the migration sequence ceases and the greater part of the plain is occupied. The settlements have been designated p_{101} through p_{113}.

Although many patterns of migration are possible, such as those shown in Figures 11.7 and 11.8, it will be assumed for purposes of simplicity that the pattern shown in Figure 11.6 is the one that has taken place. Also assumed is that when migration occurs, the population of the home area remains constant. Although this has been assumed for the sake of simplicity it can be justified by pointing out that the time periods used are not years or months. Instead, they are to be regarded as arbitrary increments of indeterminate length and equal duration. In the real world, when migrants leave an area, the population in the original area will drop, but this may be followed by a rapid growth due to the more favorable ratio between individuals and the available



p_{113}
p_{112}
p_{111}
p_{104}
p_{103}
p_{102}
p_{106}
p_{107}
p_{101}
p_{105}
p_{108}
p_{109}
p_{110}
$t_1 - t_2$
$t_2 - t_3$
$t_3 - t_4$
$t_4 - t_5$

Figure 11.6

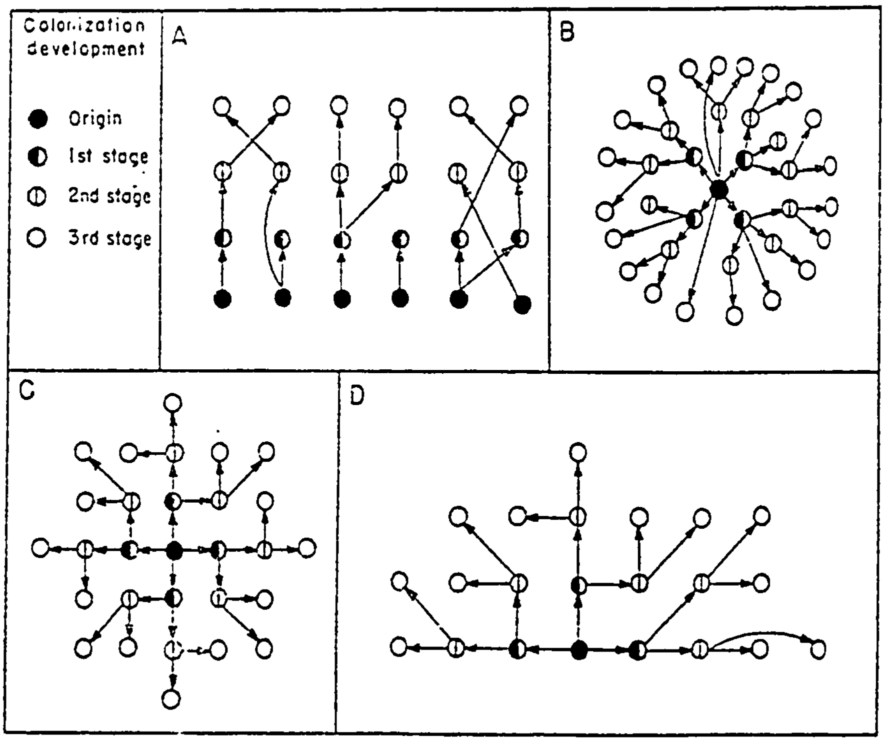
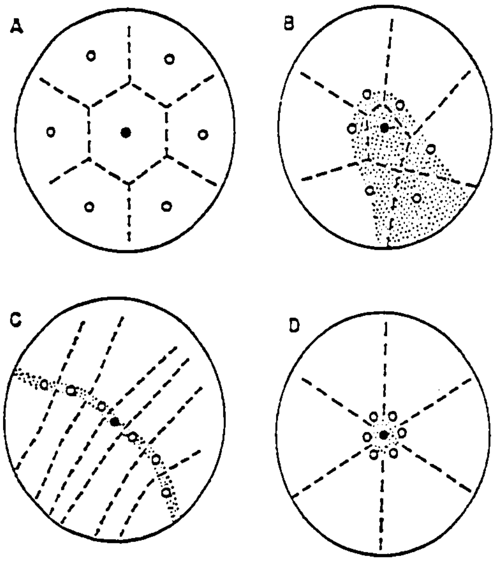


Figure 11.7 (Bylund 1960:226)



Sequence of settlement patterns associated with an increasingly localized resource.

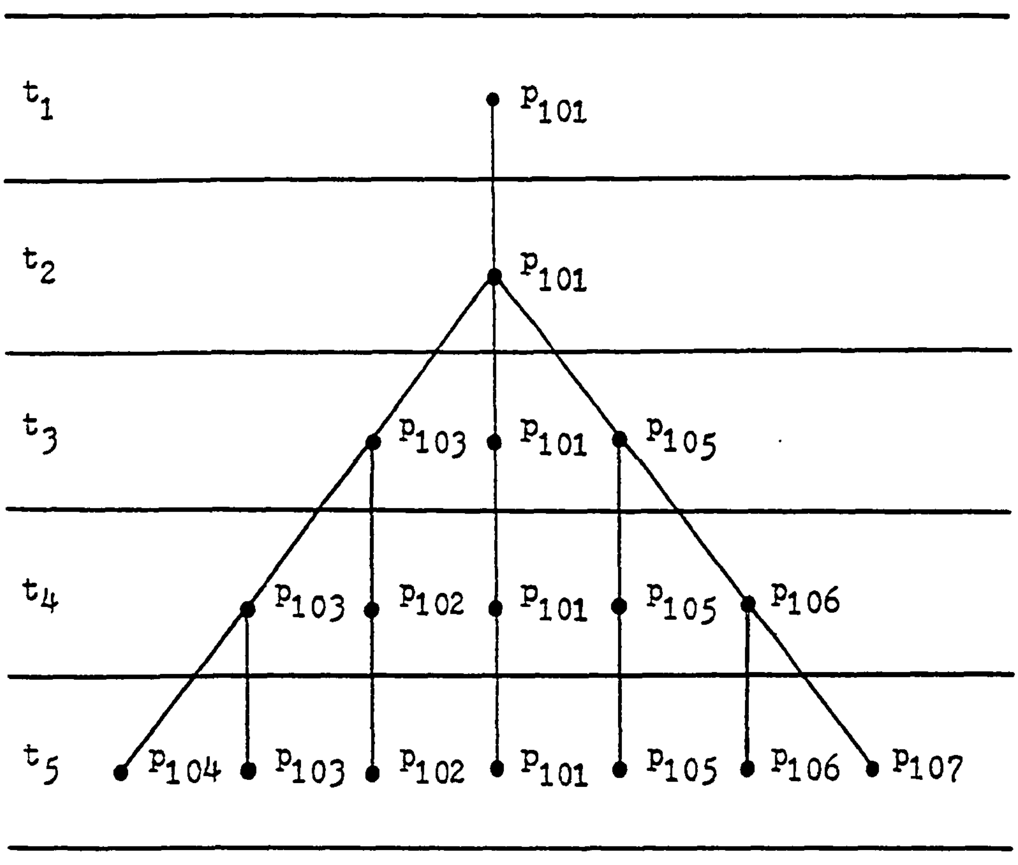
Figure 11.8 (Haggett 1966:95)

resources. Hence, after a generation or two, the populations of both the parent area and the daughter colony will be approximately equal (both populations having grown to the maximum allowable size permitted by the resource base). In Figure 11.6 it has been assumed that the resource base is the same everywhere.

Viewing the migration pattern in cross-section, so that the temporal sequence can be shown, produces the pattern appearing in Figure 11.9. Here, the horizontal axis represents a cross-section of the circular plain (from p_{104} to p_{107}) while the vertical axis represents temporal duration.

Initially, we will assume that each occupied place is completely isolated from all the others. Diffusion, therefore, is not taking place between the various locations. We will also assume, initially, that the population and other characteristics of each place are the same. This will enable us to see how differentiation will proceed when all places are changing at the same rate, as self-contained units. Later, this assumption will be relaxed.

When an original population separates and part of the original settlement occupies a different location, within-place change continues as before. However, it does not do so uniformly, as is shown in Figure 11.10a. Instead, even though change is occurring everywhere at the same rate, the direction of change is not necessarily uniform. When isolation appears as a variable in the change process, the situation shown in Figure 11.10a no longer holds. Instead, the situation shown in Figure 11.10b comes into existence. Figure 11.11 shows a more vivid example of migration, isolation, and divergence (the same process shown



t1
t2
t3
t4
t5
p101
p101
p103
p101
p105
p103
p102
p101
p105
p106
p104
p103
p102
p101
p105
p106
p107

Figure 11.9

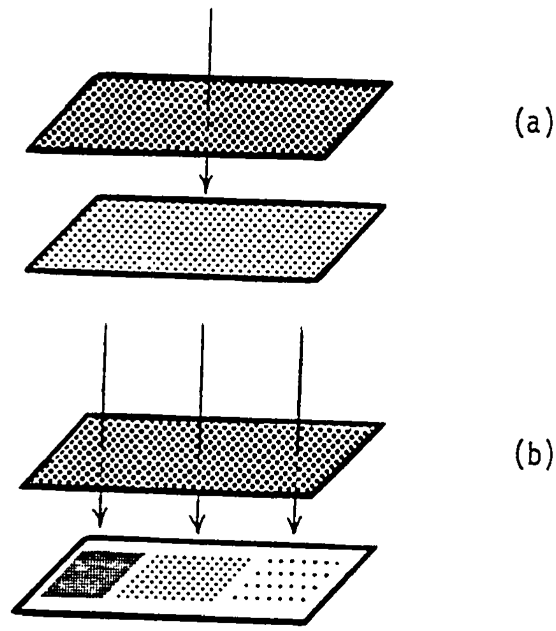
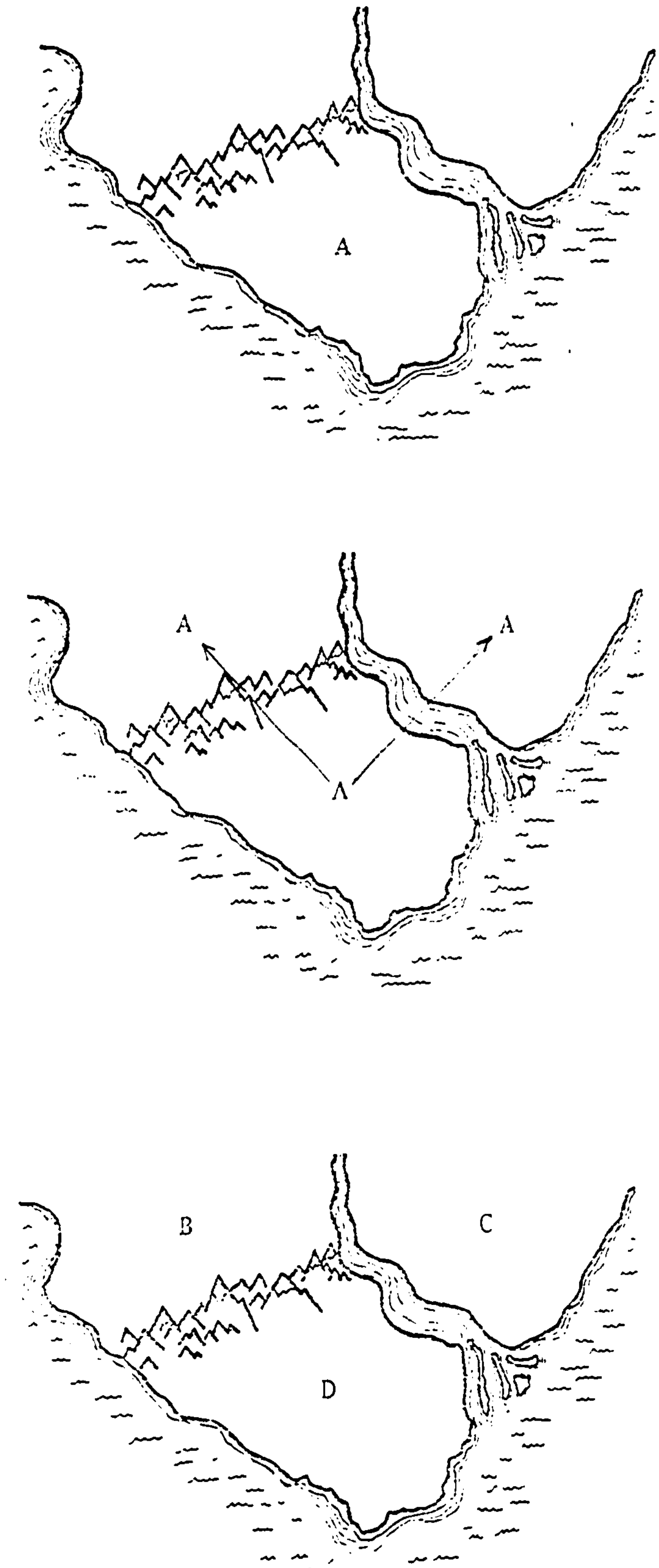


Figure 11.10



(a)

(b)

(c)

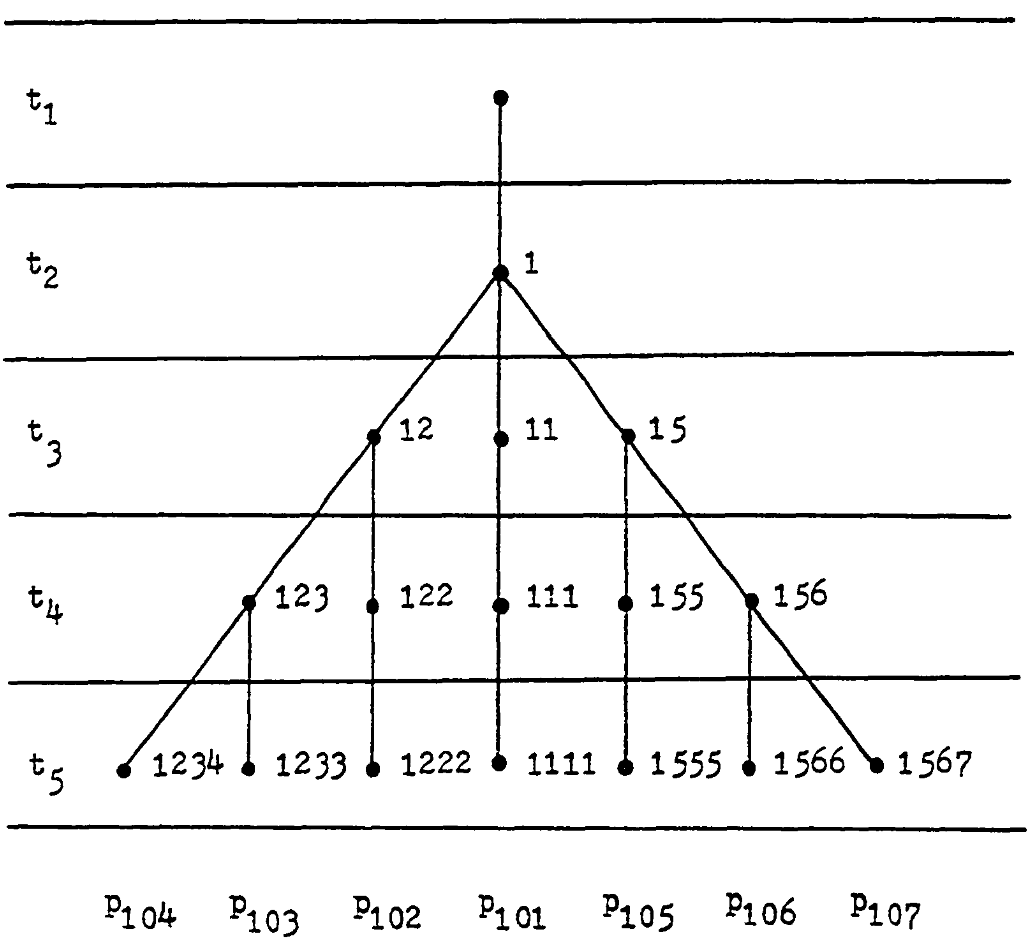
Figure 11.11 (Arlotto 1972:7)

in Figure 11.10b). Here, the population designated as A does not change everywhere to B. Instead, it changes to B, C, and D. The same thing will occur on the circular plain.

Process of Addition

Following migration, differential change proceeds via the additive and subtractive processes illustrated in Figure 11.5. Figure 11.12 shows how the additive process can be conceptualized when a number of different places are involved. Additions to each geographic inventory are symbolized by a sequence of numbers. These are shown for each place during successive time periods. It has been assumed that one innovation occurs at each place during each time period and that these innovations are widely adopted within each place. Because it has been assumed that each place is isolated, the innovations do not spread to other places. It has also been assumed that added elements owe something of their origins to the conditions existing within each place. It is partly for this reason and partly for the purpose of illustration that these additions are identified with numbers matching the identification numbers of the places where they originated (p_{101}, p_{102}, etc.).

As movement occurs, elements originating in one place are carried to new places by migrating individuals. These elements then become place characteristics of the new locations. Subsequent additions are labeled with the number of the place where they arose. At place p_{101}, for example, additions are identified with the number "1". Each addition becomes a new locational characteristic of that site. By time t_5 there have been 4 such additions at p_{101}. These are reflected in the sequence "1111" (all additions to the inventory at p_{101} having



t_1
t_2
t_3
t_4
t_5
1
12
11
15
123
122
111
155
156
1234
1233
1222
1111
1555
1566
1567
p_{104}
p_{103}
p_{102}
p_{101}
p_{105}
p_{106}
p_{107}

Figure 11.12

originated at p_{101}). In the absence of diffusion, the rate at which these additions occur is ultimately dependent on the local innovation rate.

At place p_{104} the number sequence "1234" indicates that in addition to the element originating at place p_{101} (element "1") two more have been added at places where the ancestors of the occupants of p_{104} had lived in the past. One more element (element "4") has been added at place p_{104} itself.

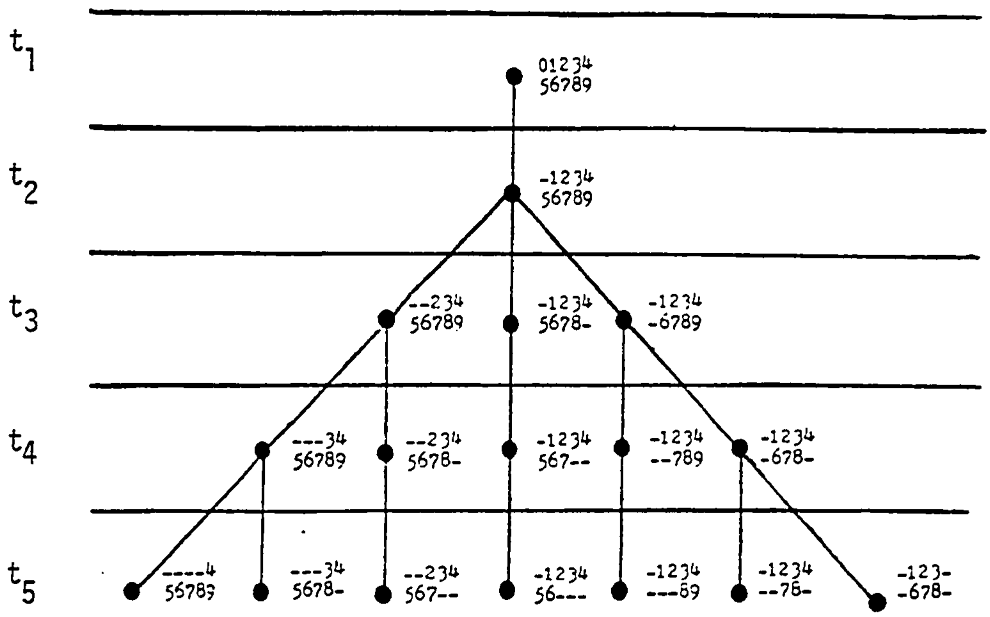
Note that the similarity between each location, indicated by the extent to which the number sequence of each place correlates with neighboring sequences, increases as the phylogenetic connection with other locations becomes closer. At time t_5, for instance, 75% of the additions found in place p_{104} are found in p_{103}, 50% are found in p_{102}, and 25% are found in place p_{101}, p_{105}, p_{106}, and p_{107}. As Figure 11.13 shows, the probability of each degree of resemblance is 100%.

Process of Subtraction

While addition is occurring, the process of subtraction is also taking place. This process, shown in Figure 11.14, involves losses from a previously existing ancestral inventory. Whereas Figure 11.5 showed subtraction within one place, Figure 11.14 shows it happening simultaneously within all places. Subtraction depends ultimately on the substitution rate and on the rate of drift. Subtraction involves fewer possible outcomes than the additive process. When addition occurs, new elements originate out of a universe of things not yet in existence. This universe is potentially infinite. On the other hand, the universe from which things can be subtracted is quite limited. Losses from an

When compared to place p_{104}:	p_{104}	p_{103}	p_{102}	p_{101}	p_{105}	p_{106}	p_{107}
Probability of 1.00 similarity	1.00	.00	.00	.00	.00	.00	.00
Probability of .75 similarity	.00	1.00	.00	.00	.00	.00	.00
Probability of .50 similarity	.00	.00	1.00	.00	.00	.00	.00
Probability of .25 similarity	.00	.00	.00	1.00	1.00	1.00	1.00

Figure 11.13



(a)

When compared to place p_{104}:	p_{104}	p_{103}	p_{102}	p_{101}	p_{105}	p_{106}	p_{107}
Probability of 1.00 similarity	1.00	.14	.03	.01	.01	.01	.01
Probability of .83 similarity	.00	.86	.43	.21	.21	.21	.21
Probability of .66 similarity	.00	.00	.54	.54	.54	.54	.54
Probability of .50 similarity	.00	.00	.00	.24	.24	.24	.24

(b)

Figure 11.14

inventory are confined to those elements that already exist.

In Figure 11.14a the locational characteristics of place p_{101} at time t_1 are represented by ten elements. These are the same elements shown in Figure 11.5. At time t_2 one element (trait "0" has been lost. The absence of this trait is then transmitted to the next generation. However, since migration occurs between t_2 and t_3, the next generation exists not only at place p_{101}, but also at p_{102} and p_{105}.

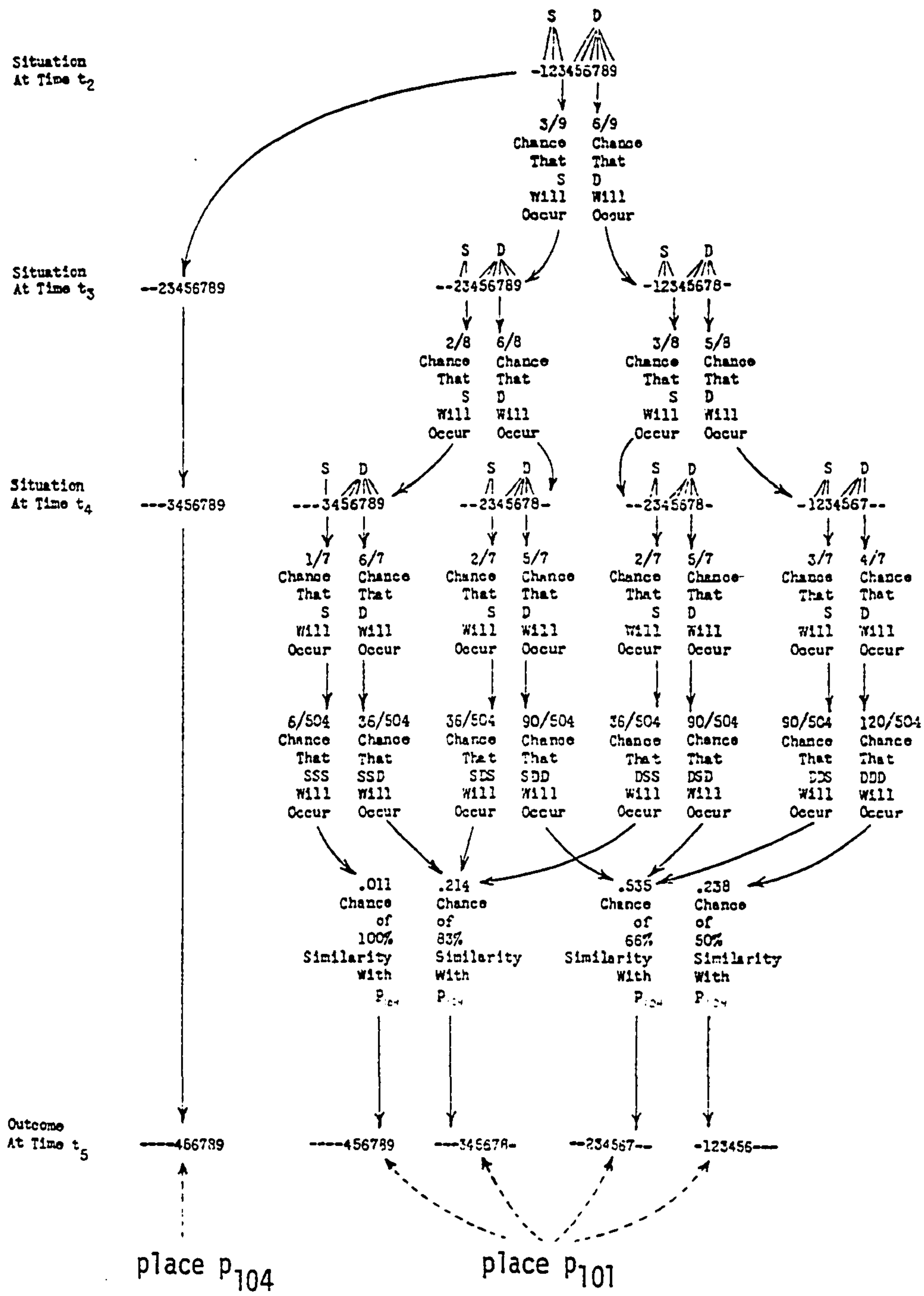
After two more increments of time the inventory of each place has been reduced to six out of the original ten elements. A ratio of similarity between each place can then be calculated based on the number of common traits remaining in each location. Each place bears the same relationship to the original ancestor in that 6/10 of the original complement remains. The occupants of each place, therefore, have a similarity ratio of .60 with the ancestral group. Compared to each other, however, there are differences. Place p_{104}, for example, has five out of the six elements existing in place p_{103}. These two places therefore have a similarity of .83. In addition, p_{104} has four of the six elements found in p_{102} (.66 similarity) and three of the six found in places p_{101}, p_{105}, p_{106}, and p_{107} (.50 similarity). When comparing p_{104} to itself the similarity is 1.00.

Ideally, place p_{103} should exhibit the closest resemblance to p_{104}, followed by p_{102}. Places p_{101}, p_{105}, p_{106}, and p_{107} should show the least amount of similarity since they are the most remote from the standpoint of migrational phylogeny. However, this ideal is only the result of probabilities and many degrees of similarity are possible. Even so, some degrees of similarity are more probable than others and some, due to the recency of phylogenetic divergence, are impossible.

The matrix of probabilities shown in Figure 11.14b results from computing the likelihood that some or all of the four elements absent in place p_{104} at time t_5 will be lost in each of the other places. The procedure used to determine the likelihood that the subtractive process will produce each of four different degrees of similarity between p_{104} and p_{101} after three increments of time is illustrated in Figure 11.15.

In Figure 11.15, trait number "0" is missing in place p_{101} at time t_2. As was the case in Figure 11.14a, this loss has been marked with a dash. Since p_{101} at t_2 is ancestral to both p_{104} and p_{101} at t_5, this element will be absent in both places at t_5. Also, since traits 1, 2, and 3 will ultimately be subtracted from the inventory at p_{104}, parallel evolution will occur if the same three traits are dropped in p_{101}. This sameness has been identified in Figure 11.15 with the letter "S". Divergence will occur if different traits are dropped in p_{101} (traits other than 1, 2, and 3). In Figure 11.15 this occurrence has been identified with the letter "D". The probability during each time increment that either of these two events (S or D) will occur can then be calculated. The results shown at the bottom of Figure 11.15 are obtained by multiplying together the probability of each outcome during each time increment. Note that the same outcome can often occur via several different pathways. When the 1-3-3-1 pathway sequence shown in Figure 11.15 is expanded through many more time periods, the sequence will take the form of the binomial coefficient (which can be derived from Pascal's triangle).

The procedure is similar to computing the probability that certain cognates will be lost in different languages through time. Counting



Situation At Time t_2
Situation At Time t_3
Situation At Time t_4
Outcome At Time t_5
-123456789
3/9 Chance That S Will Occur
6/9 Chance That D Will Occur
--23456789
-12345678-
2/8 Chance That S Will Occur
6/8 Chance That D Will Occur
3/8 Chance That S Will Occur
5/8 Chance That D Will Occur
---3456789
--2345678-
--2345678-
-1234567--
1/7 Chance That S Will Occur
6/7 Chance That D Will Occur
2/7 Chance That S Will Occur
5/7 Chance That D Will Occur
2/7 Chance That S Will Occur
5/7 Chance That D Will Occur
3/7 Chance That S Will Occur
4/7 Chance That D Will Occur
6/504 Chance That SSS Will Occur
36/504 Chance That SSD Will Occur
36/504 Chance That SDS Will Occur
90/504 Chance That SDD Will Occur
36/504 Chance That DSS Will Occur
90/504 Chance That DSD Will Occur
90/504 Chance That DDS Will Occur
120/504 Chance That DDD Will Occur
.011 Chance of 100% Similarity With
.214 Chance of 83% Similarity With
.535 Chance of 66% Similarity With
.238 Chance of 50% Similarity With
----456789
----456789
---345678-
--234567--
-123456---
place p_{104}
place p_{101}

Figure 11.15

the number of existing cognates is one way of determining how closely different languages resemble each other. Glottochronologists have done a great deal of this and some of their results are shown in Figure 11.16. These scholars have assumed that the basic vocabularies of all languages change at a rate of 19% every thousand years (Keesing 1958:371). This rate was established by comparing the histories of a great number of recorded languages. Extending this assumption to languages without recorded histories produced the map shown in Figure 11.17. This map was based on an assumption that all languages were at one time part of an original community thousands of years ago and that divergence took place according to the number of centuries that each community has been isolated from neighboring communities following out-migration. Such divergence proceeds according to the dendritic lineage shown in Figure 11.18. The assumption that the loss rate is constant from language to language is the same as what has been assumed in Figure 11.14.

If the matrix of probabilities associated with the subtractive process shown in Figure 11.14b is combined with the matrix of probabilities associated with the additive process shown in Figure 11.13 so that a ratio can be computed between the number of identical elements existing in p_{104} and each other place on the circular plain at t_5, the matrix shown in Figure 11.19 will result.

Once this is done, a differentiation surface based on the combined matrix can be drawn which will show at time t_5 the probable extent to which each place on the circular plain will differ from place p_{104}. Figure 11.20 shows the differentiation surface most likely to evolve

Centuries of Divergence

French			
.20	German		
.175	.185	Russian	
.165	.15	.135	Welsh

Percentage of Cognates

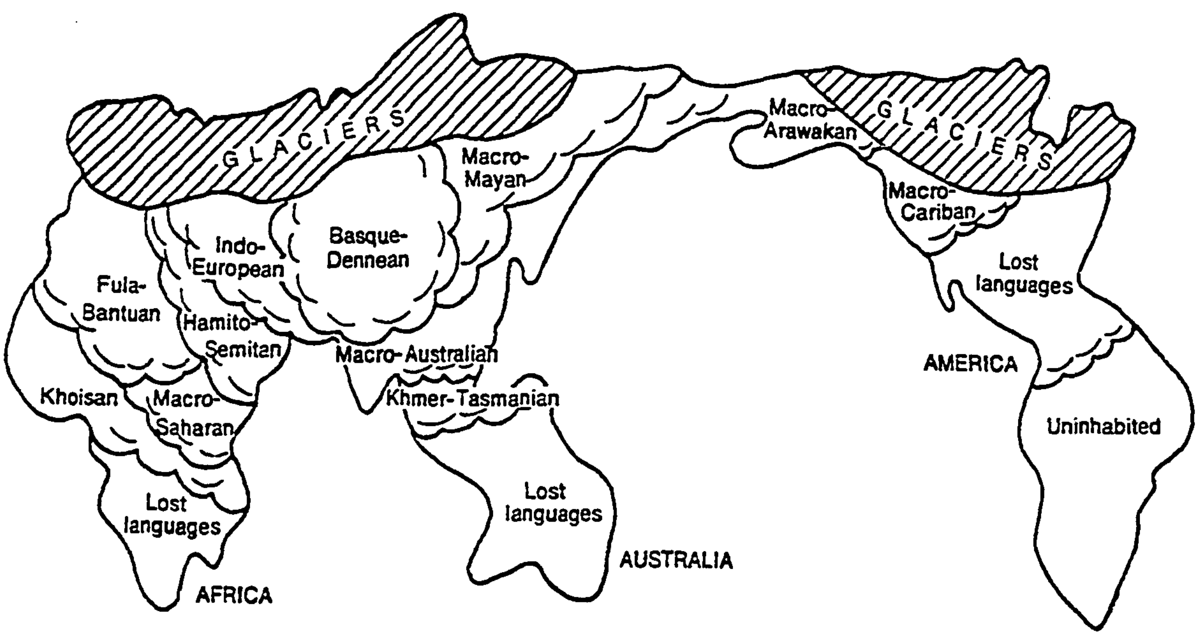
(a)

GLOTTOCHRONOLOGIC RELATIONSHIPS

Term	Centuries of Divergence	Percentage of Cognates	General Character	Example
Language	0–5	100–81	Mutual intelligibility of dialects	English
Family	5–25	81–36	Relationship obvious to anyone	Germanic languages
Stock	25–50	36–12	Obvious to linguist	Indo-European
Microphylum	50–75	12–4	Striking rare agreements	Salishan
Mesophylum	75–100	4–1	Rare, rare agreements	Penutian(?)
Macrophylum	over 100	under 1	Reconstruct able	Hokan-Siouan(?)

(b)

Figure 11.16 (Landar 1966:196)



The Theory of Linguistic Waves (Hypothetical Scheme About 25,000 B.C.)

Figure 11.17 (Swadesh 1971:224)

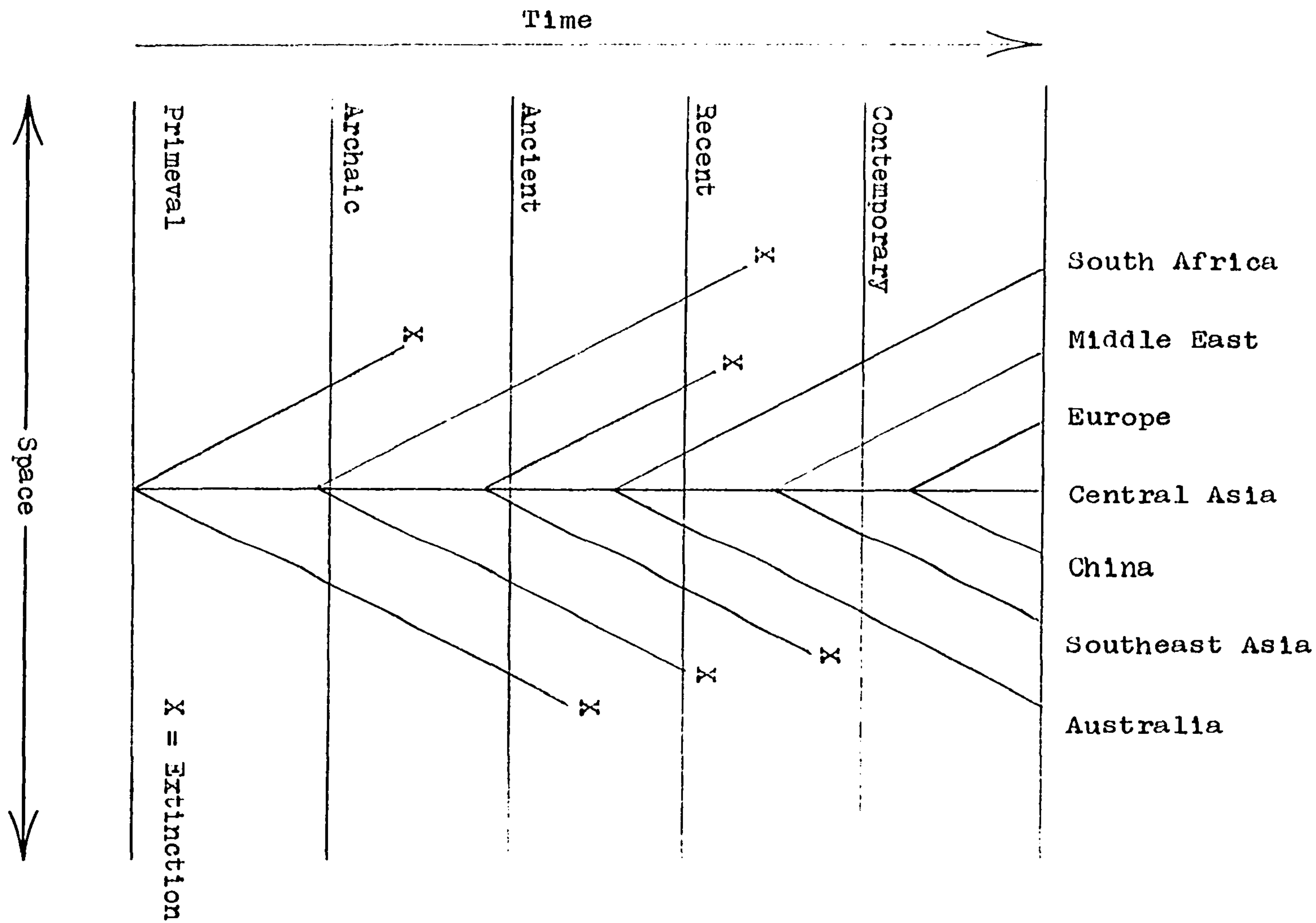
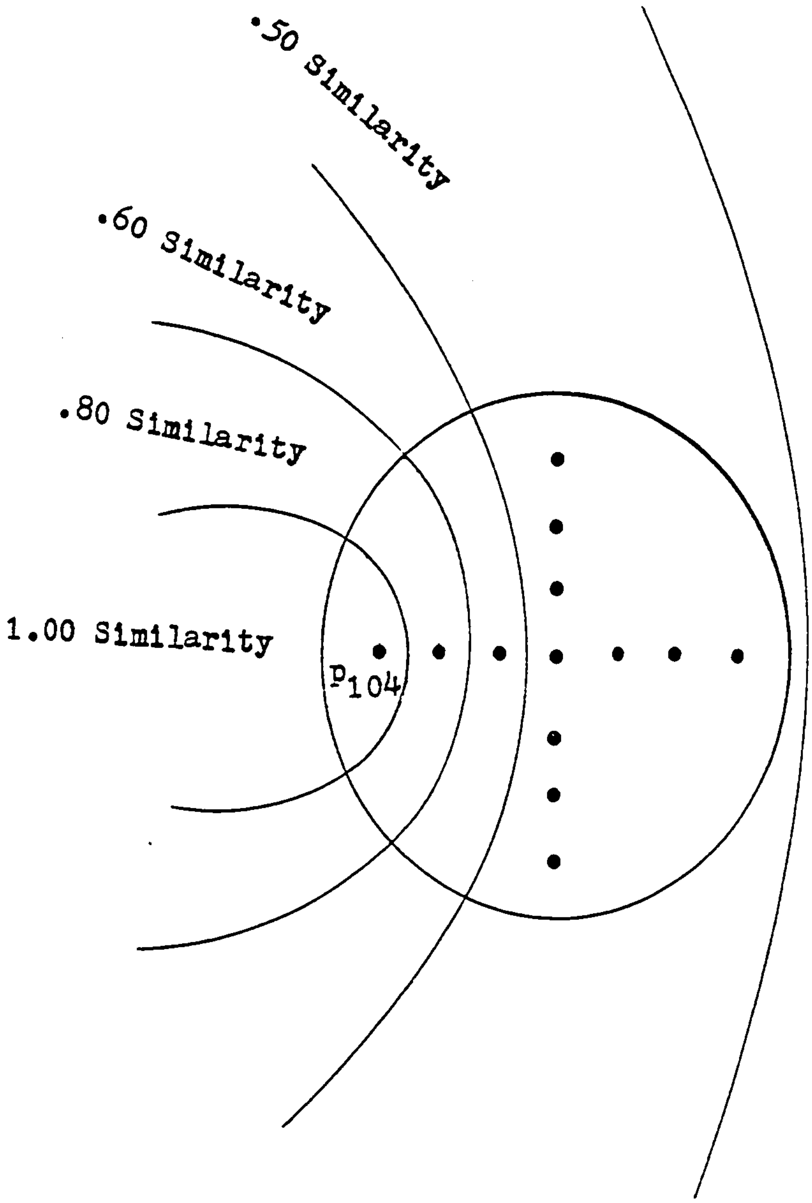

Time
Space
Primeval
Archaic
Ancient
Recent
Contemporary
South Africa
Middle East
Europe
Central Asia
China
Southeast Asia
Australia
X = Extinction

Figure 11.18

When compared to place p_{104}:	p_{104}	p_{103}	p_{102}	p_{101}	p_{105}	p_{106}	p_{107}
Probability of 1.00 similarity	1.00	.00	.00	.00	.00	.00	.00
Probability of .90 similarity	.00	.14	.00	.00	.00	.00	.00
Probability of .80 similarity	.00	.86	.03	.00	.00	.00	.00
Probability of .70 similarity	.00	.00	.43	.01	.01	.01	.01
Probability of .60 similarity	.00	.00	.54	.21	.21	.21	.21
Probability of .50 similarity	.00	.00	.00	.54	.54	.54	.54
Probability of .40 similarity	.00	.00	.00	.24	.24	.24	.24

Figure 11.19



Differentiation Surface as Seen from p_{104}

Figure 11.20

following the pattern of out-migration established in Figure 11.6.

It must be kept in mind that the similarities shown in Figure 11.20 are only the ones most likely to occur. In reality, a range of possible similarities exists within each of the four indicated zones. Places in the zone of least similarity, for instance, can have a similarity to place p_{104} of .40, .50, .60, or .70, although .50 (as Figure 11.19 indicates) is the most likely. Similar differentiation surfaces can be drawn for each of the other places on the circular plain as well.

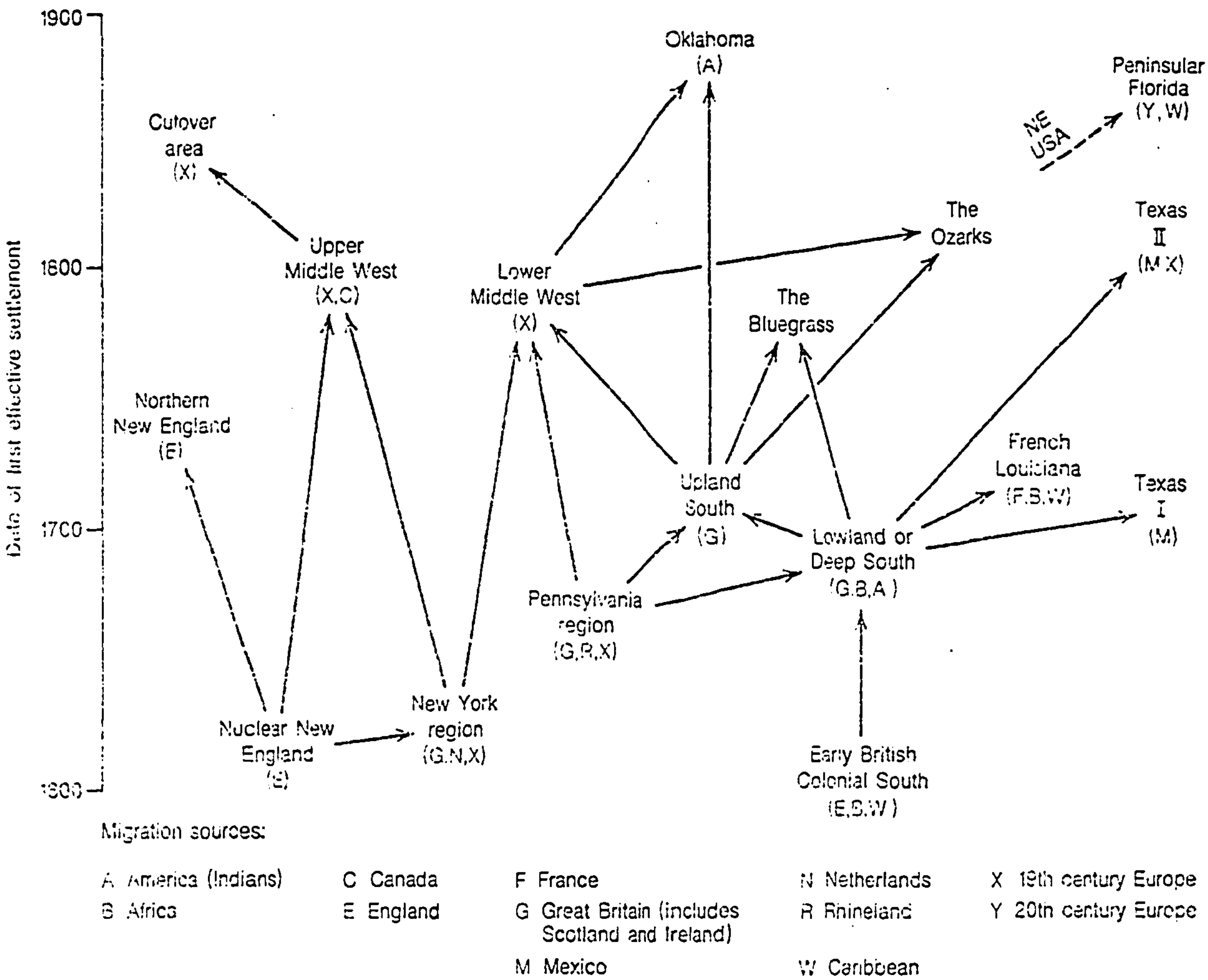
That the probabilities shown in Figure 11.19 produce several concentric rings of decreasing amounts of similarity around place p_{104} is due to the already discussed assumptions about migration, isolation, diffusion, and rates of change. If the migration of individuals does not follow the pattern shown in Figure 11.6, and instead develops according to some other pattern (like those appearing in Figure 11.7) phyletic patterns will be altered and the differentiation surface for each place will no longer take the form of concentric rings. In the real world these migration patterns would result from unique historical circumstances. It is likely, however, that distance between various origin and destination points would favor the establishment of some patterns over others.

In addition, since it has been assumed that complete isolation exists at each location, between-place diffusion has been discounted. Accordingly, the additive and subtractive processes have been shown as they might operate in the absence of outside influences. As stated before, this has been done for the purpose of simplification and is analogous to describing an object's velocity when there is no friction and no gravity, a frequent occurrence in discussions of theoretical physics.

If the processes producing the range of probabilities appearing in Figure 11.19 were the only ones contributing to differentiation, places throughout the world would exhibit more similarity to "first cousins" than to "second cousins" and regional resemblances everywhere would reflect migrational phylogeny to the exclusion of everything else. The relationships illustrated in Figure 11.21 would then provide the only explanation for why some regions resemble each other more than others. There are, of course, many more processes in operation. If, for example, the effects of inward diffusion are incorporated into the model, the additive process would be altered in such a way that new elements added to one place's inventory would be the same as elements already existing elsewhere. Some of the effects of diffusion on addition and subtraction could then be estimated from such things as the gravity model and constant divergence would then give way to occasional convergence.

DIFFERENTIATION UNDER VARIABLE RATES OF CHANGE

In order to expand the model to include diffusion and differential rates of change it will be necessary to start over again at the beginning and show how the circular plain will develop under different assumptions. To start with, we will assume that the same circular plain with the same flat surface exists. However, in this second example ecological conditions will vary with distance from the edge of the plain. Places p_{104}, p_{107}, p_{110}, and p_{113} will therefore share the same environment.



The origin of cultural regions. The chart shows the main cultural links between the sixteen cultural regions in Zelinsky's model of the eastern United States. The area's approximate geographic location is indicated on a north-to-south (left-to-right) horizontal scale. The date of the first effective settlement appears on the vertical scale. "Texas I" refers to Texas during its Spanish-American period (1690–1821) and "Texas II" to the area incorporated after 1821 into the United States. The arrows indicate major *internal* migrations and cultural contacts within the United States, and the letters indicate major *external* migrations from outside the United States.

Figure 11.21 (Haggett 1975:288)

Places p_{103}, p_{106}, p_{109}, and p_{112} will also share the same environment, as will places p_{102}, p_{105}, p_{108}, and p_{111}. Place p_{101} will have an environment unique unto itself. Ecological zones on the circular plain are shown in Figure 11.22. These zones will form a continuum as one blends into the other. Such an arrangement may have a bearing on the innovation process (whether or not different places are likely to invent the same things) and probably does affect the adoption process (whether or not different places are likely to adopt the same propagules). Although simultaneous invention of the same elements will not be part of this extension of the spatial model, the likelihood of adoption will be. The same pattern of migration appearing in Figure 11.6 will be postulated, but the assumption of equal and constant populations will be relaxed.

In the beginning, place p_{101} will emerge as an identifiable region (or settlement) at the center of the circular plain. As Figure 11.23 indicates, this will occur at time t_1. Through time, each place on the circular plain will grow at a rate of .33 units per time period. The population at p_{101}, for example, will be 1.00 at time t_1. At time t_2 it will grow to 1.33 and at t_3 the population will stand at 1.66. At time t_3 places p_{102}, p_{105}, p_{108}, and p_{111} will be occupied by migrants from p_{101}. At the time of settlement, the population of each of these places will be 1.00. They will then grow at a rate of .33 units per time period. The sequence of settlement, as well as the accompanying population growth is shown in Figure 11.23. This pattern of migration and growth is, like before, arbitrary. It could just as well follow another hypothetical pattern, such as that shown in Figure 11.24.

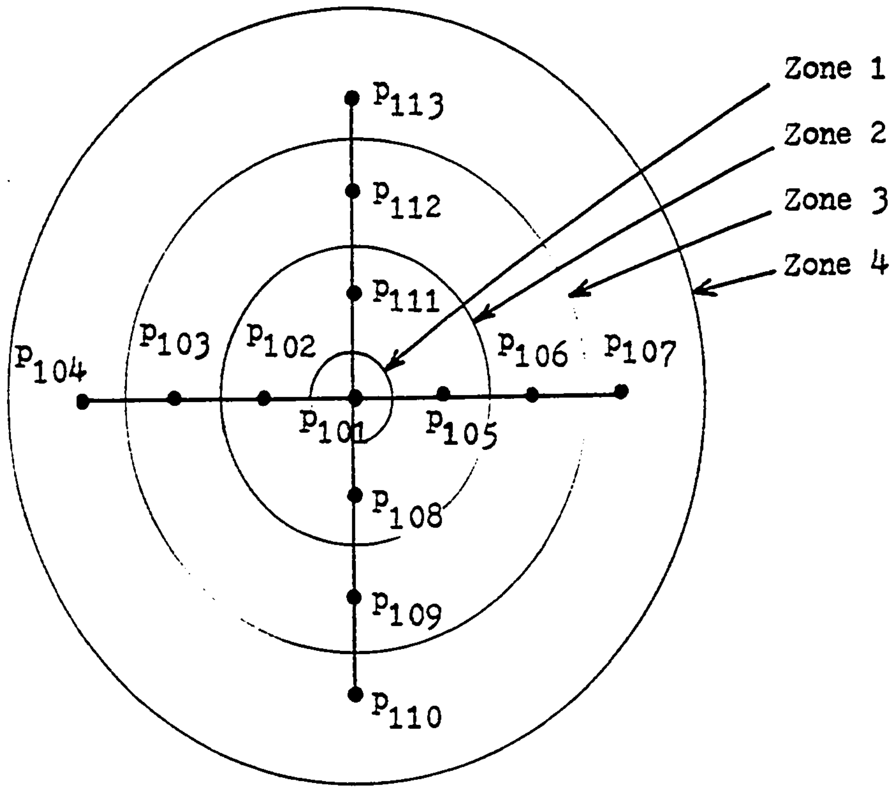

Zone 1
Zone 2
Zone 3
Zone 4
P113
P112
P111
P104
P103
P102
P106
P107
P101
P105
P108
P109
P110

Figure 11.22

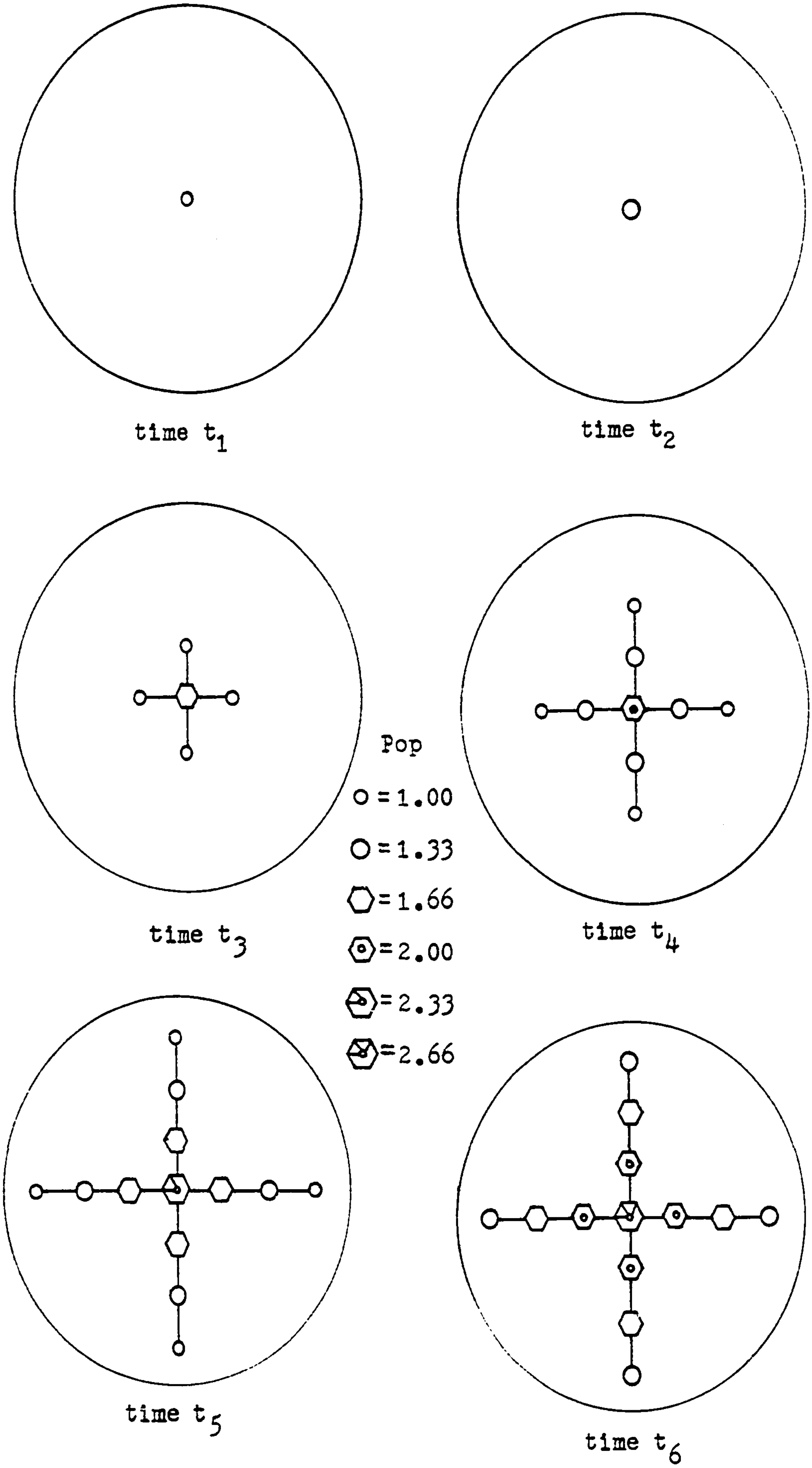
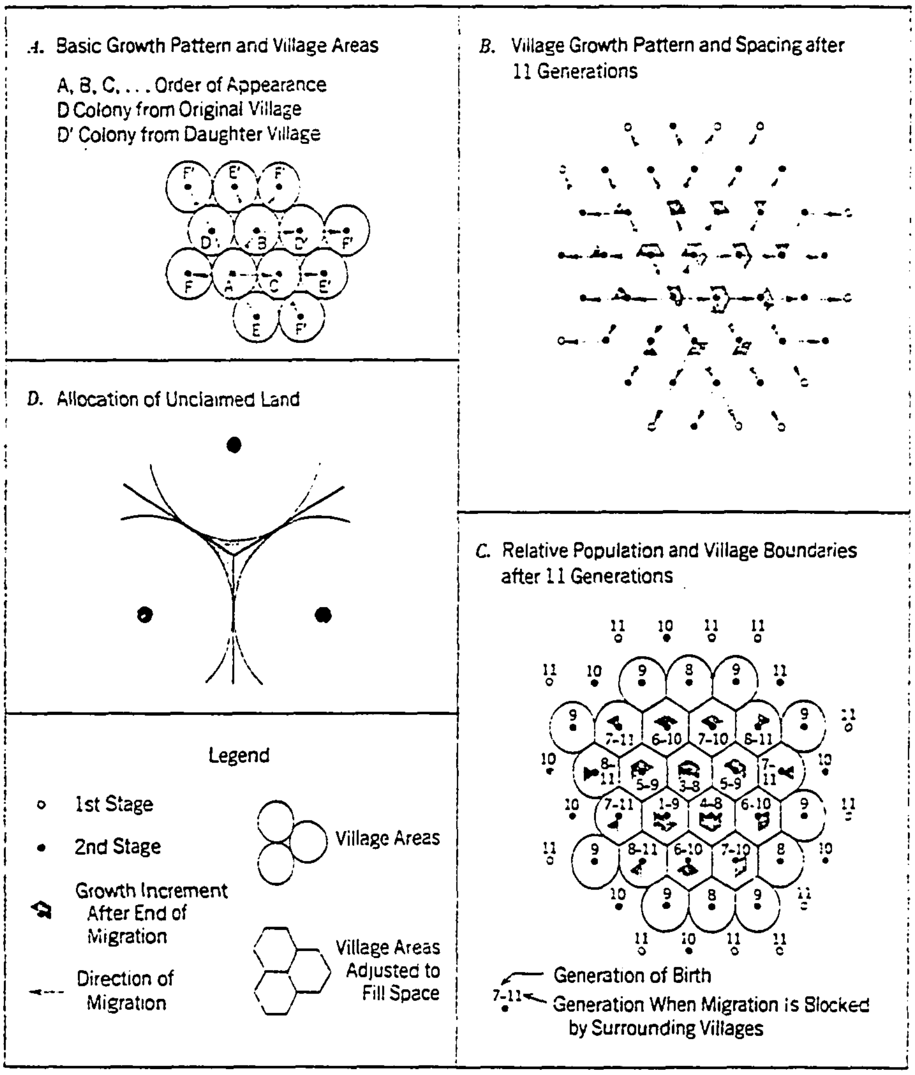

time t_1
time t_2
time t_3
time t_4
Pop
= 1.00
= 1.33
= 1.66
= 2.00
= 2.33
= 2.66
time t_5
time t_6

Figure 11.23



A growth model of village spacing Classical central place theory assumes as an initial condition that the underlying settlement pattern is an array of farm villages distributed at the nodes of a hexagonal lattice. A simple model of a settlement growth process that would result in such a pattern can be postulated. The key spatial assumtions necessary are that (*A*) each settlement requires a compact, finite, and local unit area for its functioning; (*B*) daughter colonies locate as near as possible to the parent colony when splitting off; and (*C*) an optimum size exists for the basic settlements.

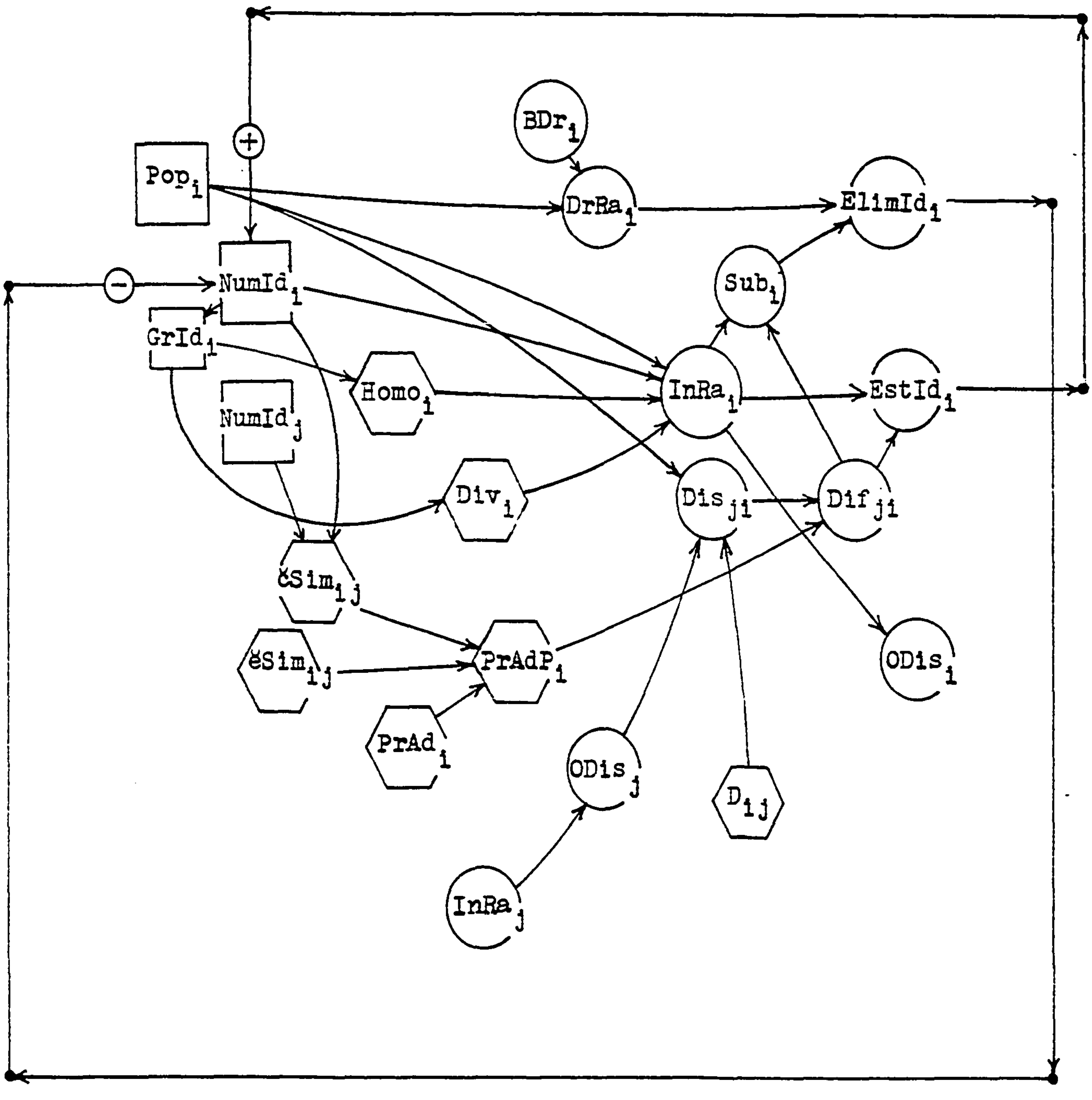
Figure 11.24 (Kolars and Nystuen 1974:74)

Once the settlement pattern has been established we can, using a simplified model of within-place change (Figure 11.25), follow the changes that might occur within each place. This simplified model represents the first approximation of an eventual operationalization of a larger and more complex model, a project that will take many years to complete.

Within-Place Change

Change in place p_{101} begins during the interval between time t_1 and t_2. As Figure 11.25 indicates, this change will be seen as progressing along certain stylized paths. In this diagram, each place's geographic inventory will consist of essentially one variable--ideas. For purposes of simplicity, most of the variables in the larger model have been eliminated in order to show how it might work in practice. Figure 11.26 gives an explanation for the abbreviations used in this model. Figure 11.27 shows how the magnitudes of each of these variables will change through time within place p_{101}.

As the first row in Figure 11.27 indicates, the population of p_{101} at time t_1 is 1.00. The fourth row in Figure 11.27 shows the inventory of ideas in p_{101} at t_1. As can be seen, it has been assumed that p_{101} starts its development with an inventory of 30 ideas. This triples the number of elements initially ascribed to p_{101} in Figure 11.14. Since we will now be dealing with varying rates of change, it has been necessary to increase the size of the initial inventory from ten to thirty. Homogeneity and diversity appear in rows two and three in Figure 11.27. These two variables will be computed according to where different ideas originated.



BDr$_i$
Pop$_i$
DrRa$_i$
ElimId$_i$
NumId$_i$
Sub$_i$
GrId$_i$
Homo$_i$
InRa$_i$
EstId$_i$
NumId$_j$
Div$_i$
Dis$_{ji}$
Dif$_{ji}$
čSim$_{ij}$
ěSim$_{ij}$
PrAdP$_i$
ODis$_i$
PrAd$_i$
ODis$_j$
D$_{ij}$
InRa$_j$

Figure 11.25

Pop_i	Population of place i
$NumId_i$	Number of ideas in place i
$NumId_j$	Number of ideas in place j
$GrId_i$	Groups of ideas in place i
$Homo_i$	Level of homogeneity in place i
Div_i	Level of diversity in place i
$PrAdP_i$	Propensity to adopt propagules in place i
$PrAd_i$	Propensity to adopt in place i
$cSim_{ij}$	Cultural similarity between places i and j
$eSim_{ij}$	Ecological similarity between places i and j
$InRa_i$	Innovation rate in place i
$InRa_j$	Innovation rate in place j
Dis_{ji}	Inward dispersal rate at place i
$ODis_i$	Outward dispersal rate at place i
$ODis_j$	Outward dispersal rate at place j
D_{ij}	Distance between i and j
Dif_{ji}	Inward diffusion rate at place i
$EstId_i$	Establishment of ideas at place i
Sub_i	Substitution rate at place i
$ElimId_i$	Elimination of ideas in place i
$DrRa_i$	Drift rate in place i
BDr_i	Boatload drift in place i

Figure 11.26

The formula for homogeneity is based on the proportion that each group of ideas makes up of the total number existing within a place. In this example, a group of ideas will be defined as those ideas originating in one specific place. Ideas originating in p_{101}, for example, constitute one group. Ideas originating in p_{102} constitute another group, and so on. Homogeneity can be calculated according to formula 11.1.

$$H = \frac{\Sigma P_i^{\,2}}{100(\Sigma P_i)} \tag{11.1}$$

where H = Homogeneity
P = Percentage that each group of ideas makes up of the total (times 100)
i = Each group of ideas having a common place of origin

Diversity is based on a similar measure. Here we are interested in determining how many different groups of ideas a place has. As was explained in earlier chapters, local diversity has a great effect on the local innovation rate. Diversity is a measure of variety rather than of proportion. Diversity will be calculated according to the formula

$$D = \frac{Gr}{Id} \tag{11.2}$$

where D = Diversity
Gr = Number of different groups of ideas (number of different locations where each place's ideas originate)
Id = Total number of ideas

Given these two formulas, along with the population of p_{101}, we can now calculate the initial conditions found in p_{101}. As Figure 11.27

Within-Place Change p_{101}

	t_1		t_2		t_3		t_4		t_5		t_6
Pop	1.00		1.33		1.66		2.00		2.33		2.66
Div	.03		.03		.03		.15		.14		.14
Homo	1.00		1.00		1.00		.77		.58		.34
NumId	30		30		31		32		34		35
InRa		1.00		1.33		1.70		2.92		4.14	
TIn		1.00		2.33		4.03		6.95		11.09	
In_t		+1		+1		+2		+2		+5	
IDif		--		--		+4		+4		+8	
EstId		+1		+1		+6		+6		+13	
DrRa		1.00		.75		.60		.50		.42	
TDr		1.00		1.75		2.35		2.85		3.27	
Dr_t		-1		--		-1		--		-1	
Sub		--		--		-4		-4		-11	
ElimId		-1		--		-5		-4		-12	
NCh		--		+1		+1		+2		+1	
RCog			29		29		24		20		8
AdId		101.001		101.002		101.003 101.004 102.001 105.001 108.001 111.001		101.005 101.006 102.002 105.002 108.002 111.002		101.007 101.008 101.009 101.010 101.111 102.003 102.004 105.003 105.004 108.003 108.004 111.003 111.004	
GrId		1		1		5		5		5	

Figure 11.27

indicates, the initial level of complexity in p_{101} is .03 (30 ideas, all of which originated in p_{101}), and the initial level of homogeneity is 1.00 (all 30 ideas, having originated in p_{101}, form one group). As will be demonstrated, these index numbers will change through time.

In the interval between time t_1 and t_2 a number of processes will occur. These are marked by the circles in Figure 11.25. The magnitude of these processes will depend on the magnitude of each level (boxes and hexagons) at the beginning of each time period.

The first of these processes is the innovation rate (InRa). The four variables contributing to the innovation rate within p_{101} are shown in Figure 11.25. They operate according to the formula

$$\text{InRa} = \text{Pop} \times (2 - \text{Homo}) \times \frac{\text{Id} - \text{i}}{\text{Id}} + \text{Div} \quad \times \frac{\text{Id}}{30} \qquad (11.3)$$

where InRa = Innovation rate
Homo = Level of homogeneity
Div = Level of diversity
Id = Number of ideas in the inventory

Since this formula will produce fractional results, a running total will be kept of how many innovations have occurred in p_{101} since time t_1. This running total appears in row six of Figure 11.27 (TIn). Because the number of innovations during any one time period must be a whole number, it will be assumed that the total number of innovations occurring within any one time period will include the fraction from the previous time period. Whenever a whole number is reached within any given time period, that number will be recorded as the number of innovations for that period (In_t). This appears in the seventh row in Figure 11.27.

For place p_{101} the total number of innovations between time t_1 and t_2 is 1 and it will be assumed in this abbreviated model that local innovations are immediately adopted (although it should be noted that the actual process is more complex, with each innovation going through some sort of selection process before adoption). Since there has been one innovation in p_{101} between t_1 and t_2, and since there has been no inward diffusion (no other places being in existence yet), the total number of elements established between t_1 and t_2 is 1 (row 9 in Figure 11.27). When diffusion becomes a factor in the change process it will become part of the establishment phenomenon (EstId) according to the formula

$$\mathrm{EstId} = \mathrm{In}_t + \mathrm{IDif} \tag{11.4}$$

where Est_t = Number of ideas being established during time period t
In_t = Number of local innovations being established during time period t
IDif = Number of ideas diffusing inward during time period t

One of the ways that ideas can be lost is through the drift process. This operates according to the formula

$$\mathrm{DrRa} = 1/\mathrm{Pop} \tag{11.5}$$

where DrRa = Drift rate
Pop = Population

Since this formula, like the one for innovation, yields fractional results (and losses from the ancestral inventory can only be whole numbers), a running total will be kept on the drift process. This will begin at time t_1 and will give the total accumulation for any given time period (TDr). When the total reaches a whole number, an element will be dropped from the original inventory (Dr_t).

Substitution occurs when an old element is discarded in favor of a new one. In this scheme, substitution will operate according to the formula

$$Sub = (In_t - 1) + (IDif - 1) \tag{11.6}$$

where Sub = Number of ideas dropped from the geographic inventory due to substitution
In_t = Number of local innovations being established during time period t
IDif = Number of ideas diffusing inward during time period t

Since it is unreasonable to expect that all adoptions will result in substitutions, an assumption is made in Formula 11.6 that substitution totals one less than the number of additions. As can be seen in Figure 11.27, this formula results in no losses for place p_{101} between t_1 and t_2. Later, however, the losses will begin to accumulate.

The number of elements lost due to drift, when added to the number lost due to substitution, gives the total number of elements eliminated (Elim) during any given time period. This produces the formula

$$ElimId = Dr_t + Sub \tag{11.7}$$

where IlimId = Number of elements subtracted from the original inventory during a given time period
Dr_t = Number of elements subtracted from the inventory due to drift
Sub = Number of elements subtracted from the inventory due to substitution

In place p_{101} this formula produces one elimination between t_1 and t_2

(recorded in the 14th row of Figure 11.27).

Net change in the size of place p_{101}'s inventory is computed by adding the number of ideas established during a given time period and subtracting the number of eliminations. This produces the formula

$$NCh = EstId - ElimId \tag{11.8}$$

where NCh = Net change in the size of a place's inventory during a given time period
EstId = Number of ideas established
ElimId = Number of ideas eliminated

Between t_1 and t_2 one element has been established in p_{101} and one element has been eliminated. This gives a net change of zero (row 15 in Figure 11.27). The number of ideas in p_{101} at t_2, therefore, stands unchanged at 30. However, the number of cognates (ideas present in the original inventory) has been reduced by one. The number of remaining cognates (RCog) at time t_2 is therefore 29. This index number will become important when between-place divergence is calculated (as was done in Figure 11.14).

When other places begin to appear on the circular plain, between-place diffusion becomes possible. As Figure 11.27 indicates, diffusion does not begin until the period between t_3 and t_4. Figure 11.25 illustrates the factors involved in this process. Incorporating diffusion into the model has made it necessary to calculate innovation and inward diffusion rates as they occur in all places on the circular plain during each time interval. The process will be outlined below.

Inward diffusion depends on the rate of inward dispersal. It also involves the local propensity to adopt the arriving propagules.

Inward diffusion will be calculated according to the following formula, with the results for each location being recorded on a table similar to the one appearing in Figure 11.28.

$$IDif_i = IDis_i \times PrAdP_i \tag{11.9}$$

where $IDif_i$ = Inward diffusion rate at place i during a given time period
$IDis_i$ = Inward dispersal rate at place i during a given time period
$PrAdP_i$ = Propensity to adopt propagules at place i during a given time period

Inward dispersal can be calculated according to Formula 11.10. Note that in this model it will be assumed that outward dispersal during any given time period is completely dependent on the innovation rate.

$$IDis_i = \frac{ODis_j}{.1D_{ij} \div Pop_i} \tag{11.10}$$

where $IDis_i$ = Inward dispersal rate at place i
Pop_i = Population of place i
$ODis_j$ = Outward dispersal rate at place j
D_{ij} = Distance between places i and j

and $ODis_j = InRa_j$

where $InRa_j$ = Innovation rate in place j during a given time period

Once a propagule arrives in a new location it must go through a selection process before it takes root. This selection process involves the local propensity to adopt and can be calculated according to the formula

Inward Diffusion $p_{102} - p_{101}$

	$t_3 - t_4$	$t_4 - t_5$	$t_5 - t_6$
$ODis_{102}$	102.001	102.002	102.003 102.004
$IDis_{101}$	1.66	2.00	4.76
$PrAd_{101}$	.83	.76	.75
IDifRa	1.37	1.52	3.57
$IDif_{101}$	+1	+1	+2

Figure 11.28

$$PrAdP_i = \frac{cSim_{ij} + eSim_{ij}}{2} \tag{11.11}$$

where $PrAdP_i$ = Propensity to adopt propagules at place i
$cSim_{ij}$ = Cultural similarity between places i and j
$eSim_{ij}$ = Ecological similarity between places i and j

Cultural similarity between two places will change during every time interval and therefore must be updated constantly during the operation of the model. Cultural similarity will be calculated according to Formula 11.12, which follows from Odum's index of similarity between two samples (Odum 1971:144).

$$cSim_{ij} = \frac{2CId_{ij}}{NumId_i + NumId_j} \tag{11.12}$$

where $cSim_{ij}$ = Cultural similarity between places i and j
CId_{ij} = Ideas common to both i and j
$NumId_i$ = Total number of ideas in place i
$NumId_j$ = Total number of ideas in place j

As was illustrated in Figure 11.14, all places start out with the same ideas at time t_1. In Figure 11.27, place p_{101} starts out with 30 ideas. All other places on the circular plain, regardless of when they were first settled, begin with the same 30 ideas. During the periods following time t_1 drift and substitution reduce the number of ideas common to different places. Local innovation and inward diffusion rates increase the number of ideas in each place's inventory. Inward diffusion also affects the number of ideas held in common with other places. When diffusion occurs, each place affected will experience an increase in the number of ideas held in common with the other place. Convergence between such places will then result. At the same time, divergence from places not receiving the same diffusion wave will occur.

Inward diffusion will also affect the innovation rate itself by reducing homogeneity and increasing complexity. These calculations must be done continuously for each place. The fate of each innovation must be traced to see if it is likely to disperse to another place, and if it is likely to be adopted. Such processes will greatly modify the initial differentiation surface shown in Figure 11.20.

Ecological similarity, the other factor in determining a place's propensity to adopt, can be calculated by counting the zones that separate two places on the circular plain. If two places are in the same ecological zone (see Figure 11.22), they will exhibit the maximum amount of ecological similarity. If they are in different zones, their similarity will be less. Ecological similarity can be estimated from the following scheme

$$eSim_{ij} = \text{Number of separations:} \tag{11.13}$$

$$\begin{aligned}
\text{Same zone} &= \sqrt{1/1} = 1.00 \\
\text{One zone} &= \sqrt{1/2} = .70 \\
\text{Two zones} &= \sqrt{1/3} = .57 \\
\text{Three zones} &= \sqrt{1/4} = .50
\end{aligned}$$

Row 17 in Figure 11.27 shows all the ideas added to place p_{101} during each time period (AdId). These ideas come to p_{101} either through local innovation or through diffusion. Each element shown in row 17 has been assigned a number. These elements are identified first by a place designation (where they were invented) and second by a sequence number. Idea 101.001, for example, is the first element invented in place p_{101} (after the original 30). Idea number 102.002 is the second element invented in place p_{102}, and so on. These element numbers follow the precedent set in Figure 11.12. Row 17 in Figure 11.27 thus provides a record of all the ideas that have been added to the inventory at p_{101} since time t_1.

The bottom row in Figure 11.27 identifies the variety of elements within place p_{101} (GrId). At time t_1, for instance, all the elements in p_{101} (including the original 30) originated in p_{101}. At t_1 its variety, or number of groups of ideas, was therefore 1. Between t_3 and t_4 elements from four other places were added to the inventory in p_{101} and this increased the number of groups to 5.

Figure 11.28 shows the calculations that produced the various diffusion rates between p_{102} and p_{101}. Such calculations were made for all 13 places on the circular plain and the results for p_{101} appear in row 8 of Figure 11.27 (IDif). Since so many calculations were made, only Figure 11.28 will be shown here. As this diagram illustrates, the invention of element number 102.001 occurred in p_{102} between t_3 and t_4.

Each time an idea is invented, it is emitted. In this way it becomes a propagule. If it survives the selection process, it may become a migrule to another place. It has been assumed, then, that idea number 102.001 was immediately emitted toward other places on the circular plain. One such place is p_{101}. Following Formula 11.10

(with between-place distances being given in Figure 11.29), it can easily be seen how the inward dispersal rate for this element at p_{101} is 1.66. If this number had been less than 1.00, it would have been assumed that the propagule had died in transit and never reached p_{101}. Most calculations of this nature yielded such results.

Since the number was greater than 1.00, we can now calculate the probability that the propagule will be adopted in p_{101}. As Figures 11.27 and 11.31 show, at time t_3 there were 29 remaining cognates in p_{101} (RCog) and 27 in p_{102}. These represent possible elements held in common at both places since these are the elements that were part of the ancestral inventory of both places at time t_1. The question then becomes, which particular ideas were lost in p_{101} and which ones were lost in p_{102}? To answer this question we must now return to a calculation of probabilities.

Loss of Cognates

Performing the probability calculations shown in Figure 11.15 will yield the most likely number of cognates remaining in two places from the original inventory. Since the probability tree shown in Figure 11.15 becomes unbelievably cumbersome after only a few steps, a modification of the procedure has been made for where there are many losses through time. An example of this modification is illustrated in Figure 11.30.

In this diagram, the total number of ideas remaining in places i and j is 24 out of an original 29 (remember that the loss between t_1 and t_2 of one idea from the original inventory of 30 is transmitted

	101	102	103	104	105	106	107	108	109	110	111	112
101												
102	10											
103	20	10										
104	30	20	10									
105	10	20	30	40								
106	20	30	40	50	10							
107	30	40	50	60	20	10						
108	10	15	22	31	15	22	32					
109	20	23	28	36	23	28	37	10				
110	30	32	42	42	32	42	43	20	10			
111	10	15	22	31	15	22	32	20	30	40		
112	20	23	28	36	23	28	37	30	40	50	10	
113	30	32	42	42	32	42	43	40	50	60	20	10

Between-Place Distances

Figure 11.29

to all subsequent generations on the circular plain). Since only the significant parts of the tree are shown, only a single pathway appears for each possible outcome. As was mentioned above, however, the total number of pathways to each possible outcome will follow the sequence of the binomial coefficient.

In this probability tree there are five possible outcomes, ranging from five identical eliminations in places i and j (leaving 24 identical elements, or cognates, in each place) to zero identical eliminations (leaving 19 remaining cognates in each place). The probability of each outcome ("S" or similar loss, "D" or different loss) is indicated on the edge of each branch on the tree (5 chances out of 29 possibilities, 4 chances out of 28 possibilities, etc.). Losses of similar elements descend down the left-hand side of the tree while losses of different elements descend down the right-hand side. By multiplying together all the probabilities along each pathway, the total probability of each outcome can be obtained. The complete procedure for calculating each of the five possible outcomes shown in Figure 11.30 follows from the formula

$$p_o = \frac{p \times b}{c} \tag{11.14}$$

where p_o = Probability that each outcome in i will also occur in j (5s, 4s. . .0s)

p = Probability calculation for each outcome
(5s = 1 x 2 x 3 x 4 x 5)
(4s = 24 x 2 x 3 x 4 x 5)
(3s = 23 x 24 x 3 x 4 x 5)
(etc.)

b = Binomial coefficient for each outcome (For an explanation of this element, see Figure 11.15 and its accompanying description)

c = Number of possible outcomes

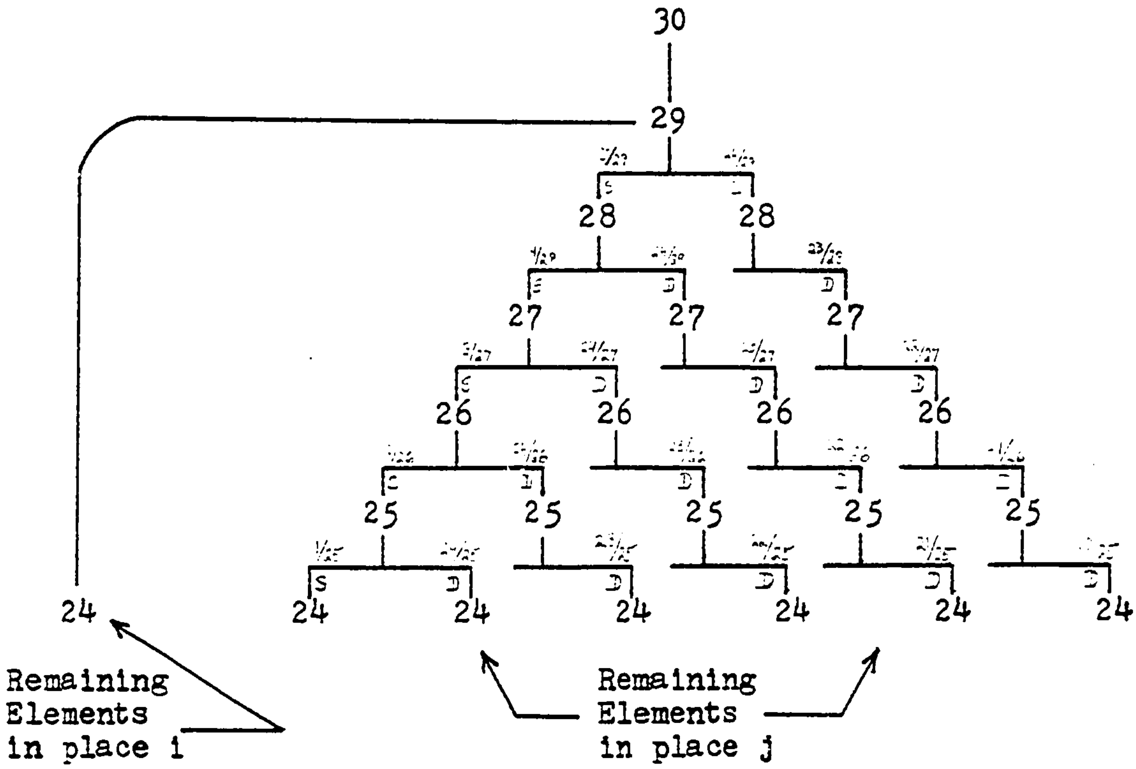
$$\text{and } c = \frac{N!}{(N - r)!} \tag{11.15}$$

where N = Number of original elements

r = Number of losses

The most likely outcome from this procedure represents the probable number of common ideas that have been retained in two different places. In the case of p_{101} and p_{102} the most likely number of cognates remaining in both places at time t_3 is 27. This number, plus ideas 101.001 and 101.002 (which were carried to p_{102} during the migration process) is then inserted into the numerator in Formula 11.12. This represents the number of ideas common to both places. The total number of ideas is the two places in 31 and 29 at time t_3 (see Figures 11.27 and 11.31). These form the denominator in Formula 11.12. The result of this calculation then becomes the first term in the numerator of Formula 11.11 (cultural similarity between i and j). Since the two places are in adjacent ecological zones (see Figure 11.22), the ecological similarity between them is .70 (from Formula 11.11). The results of Formula 11.12 indicate, then, that in p_{101} the propensity to adopt element 102.001 between t_3 and t_4 is .83.

Since the inward diffusion rate (IDifRa) shown in Figure 11.28 is greater than one, we can assume that this element has experienced establishment in place p_{101}. Also, since we are not dealing with



$r = 5 \qquad N = 29 \qquad \frac{N!}{(N - r)!} = 1.4 \times 10^7$

Possible Outcomes (Number of Similar Losses)	Resulting Number of Remaining Cognates	Binomial Coefficient	Probability Calculation Times Binomial Coefficient	Number of Combinations	Probability of Outcome
5s	24	1	120	1.4×10^7	>.001
4s	23	5	14400	1.4×10^7	.001
3s	22	10	331200	1.4×10^7	.02
2s	21	10	2428800	1.4×10^7	.17
1s	20	5	6375600	1.4×10^7	.44
0s	19	1	5100480	1.4×10^7	.35

Figure 11.30

fractions it will be assumed that there has been an addition of exactly one single element to the inventory of p_{101} ($IDif_{101}$ in Figure 11.28). Element 102.001 is then added to the tally shown in Figure 11.27 (AdId). During the next time period, when the propensity to adopt is again calculated, this new element will form part of the inventory common to both p_{101} and other places. This will increase slightly the propensity to adopt any propagules dispersing into p_{101} from p_{102} (or any other places adopting element number 102.001).

Note that in Figure 11.28 the inward diffusion rate (IDifRa) between time t_5 and t_6 is 3.57. This is greater than the total number of elements dispersed out of p_{102} during that particular time period. Although such discrepencies will have a use when the distance between places is greater, it is clearly impossible in this situation. Therefore, the stipulation must be made that

$$IDif_{ji} < ODis_j \tag{11.16}$$

where $IDif_{ji}$ = Number of elements diffused from place j to place i

$ODis_j$ = Number of elements dispersed out of place j

When migration occurs, it will be assumed that it occurs after all the within-place processes for that time period have been completed in the parent location. The sequence of events producing the various magnitudes in Figures 11.27 and 11.28 will therefore be as follows:

1. Drift
2. Innovation
3. Inward Diffusion
4. Substitution
5. Outward Migration
6. Boatload Drift

The last process mentioned, boatload drift, is the founder effect described in earlier chapters. This occurs when a small sample of a population (such as might be involved in a migratory movement) possesses a combination of elements that is different in size and proportion from the parent body. Since drift contributes to numerical contraction (see earlier chapters for an explanation of this phenomenon), it will be assumed that in a few cases this numerical contraction will result in elimination. Studies of small populations bear this out (Birdsell 1972: 407).

When a population migrates to a new place it will be assumed that upon settlement the population of the new place will be 1.00. From this base point, new growth will occur. While in transit the drift process will accelerate so that enroute drift will be added to the amount of drift experienced in the old location, according to the formula

$$BDr = \frac{2}{Pop_i} + \frac{1}{Pop_j} \tag{11.17}$$

where BDr = Boatload drift (founder effect)

Pop_i = Population of new location

Pop_j = Population of old location

Therefore, in Figure 11.31, note that the drift rate (DrRa) in p_{102} between t_2 and t_3 is 2.75. This higher drift rate will occur only once in a place's history.

Figures 11.31 through 11.33 show the within-place change that occurs in places p_{102}, p_{103}, and p_{104} in exactly the same say that Figure 11.27 illustrated the development of p_{101}. Other places on the circular plain have similar sequences of differentation.

Between-Place Divergence

Computing the cultural similarity between all places on the circular plain from time t_3 through t_6 produces the similarity matrices shown in Figures 11.34 through 11.37. These diagrams show how each place has diverged from each other place and the extent to which this has occurred. Given different parameters, the development would be different, but the ones used in this chapter will suffice for illustrative purposes. Arriving at a more adequate understanding of how each of these processes operates in real life will be the subject of many future studies. This thesis should be seen as an introduction to such endeavors.

Converting the similarity matrices into maps produces the diagrams shown in Figures 11.38 through 11.41. These maps show the differentation surfaces from four different places as they have developed through time. These maps, particularly the ones in Figure 11.41, can be compared with the map appearing in Figure 11.20. Whereas the earlier map showed the differentiation surface as it developed under conditions of equal change rates and without diffusion, the later maps illustrate what happens when change rates are not equal and when diffusion is taking place. Note, for example, how the highly regular circles in Figure 11.20 give

Within-Place Change p_{102}

	t_2	IMig	t_3		t_4		t_5		t_6
Pop			1.00		1.33		1.66		2.00
Div			.03		.06		.09		.18
Homo			1.00		.92		.81		.44
NumId	30		29		30		31		32
InRa				.96		1.47		2.15	
TIn		2.33		3.29		4.76		6.91	
In_t		+1		+1		+1		+1	
IDif		--		+1		+3		+11	
EstId		+1		+2		+4		+13	
DrRa		2.75		1.00		.75		.60	
TDr		3.75		4.75		5.50		6.10	
Dr_t		-2		-1		-1		-1	
Sub		--		--		-2		-11	
ElimId		-2		-1		-3		-12	
NCh		-1		+1		+1		+1	
RCog	29		27		26		25		13
AdId		101.001 101.002		102.001 101.003		102.002 101.005 101.006 103.001		102.003 102.004 101.007 101.008 101.009 101.110 101.111 103.002 105.003 108.003 108.004 111.003 111.004	
GrId		1		2		3		6	

Figure 11.31

Within-Place Change p_{103}

	t_3	IMIG	t_4		t_5		t_6
Pop			1.00		1.33		1.66
Div			.06		.10		.13
Homo			.92		.84		.63
NumId	29		28		28		29
InRa				1.03		1.53	
TIn		3.29		4.32		5.85	
In_t		+1		+1		+1	
IDif		+1		--		+5	
EstId		+2		+1		+6	
DrRa		3.00		1.00		.75	
TDr		6.75		7.75		8.50	
Dr_t		-3		-1		-1	
Sub		--		--		-4	
ElimId		-3		-1		-5	
NCh		-1		--		+1	
RCog	27		24		23		18
AdId		101.001 101.002 102.001 101.003		103.001		103.002 101.007 101.008 102.003 102.004 104.001	
GrId		2		3		4	

Figure 11.32

Within-Place Change p_{104}

	t_4	IMIG	t_5		t_6
Pop			1.00		1.33
Div			.11		.15
Homo			.84		.77
NumId	28		26		26
InRa		1.03		1.06	
TIn		4.32		5.38	
In_t		+1		+1	
IDif		--		--	
EstId		+1		+1	
DrRa		3.00		1.00	
TDr		9.75		10.75	
Dr_t		-3		-1	
Sub		--		--	
ElimId		-3		-1	
NCh		-2		--	
RCog	24		21		20
AdId	101.001 101.002 102.001 101.003 103.001			104.001	
GrId	3			4	

Figure 11.33

	101	102	105	108	111
101	1.00				
102	.96	1.00			
105	.96	.93	1.00		
108	.96	.93	.93	1.00	
111	.96	.93	.93	.93	1.00

Cultural Similarity at Time t_3

Figure 11.34

	101	102	103	105	106	108	109	111	112
101	1.00								
102	.83	1.00							
103	.80	.89	1.00						
105	.83	.86	.82	1.00					
106	.80	.82	.82	.89	1.00				
108	.83	.86	.82	.86	.82	1.00			
109	.80	.82	.82	.82	.82	.89	1.00		
111	.83	.86	.82	.86	.82	.82	.82	1.00	
112	.80	.82	.82	.82	.82	.82	.82	.89	1.00

Cultural Similarity at Time t_4

Figure 11.35

	101	102	103	104	105	106	107	108	109	110	111	112	113
101	1.00												
102	.80	1.00											
103	.67	.88	1.00										
104	.63	.80	.85	1.00									
105	.80	.83	.77	.77	1.00								
106	.67	.77	.75	.74	.88	1.00							
107	.63	.77	.74	.69	.80	.85	1.00						
108	.80	.83	.77	.77	.83	.77	.77	1.00					
109	.67	.77	.75	.74	.77	.75	.74	.88	1.00				
110	.63	.77	.74	.69	.77	.74	.69	.80	.85	1.00			
111	.80	.83	.77	.77	.83	.77	.77	.83	.77	.77	1.00		
112	.67	.77	.75	.74	.77	.75	.74	.77	.75	.74	.88	1.00	
113	.63	.77	.74	.69	.77	.74	.69	.77	.74	.69	.80	.85	1.00

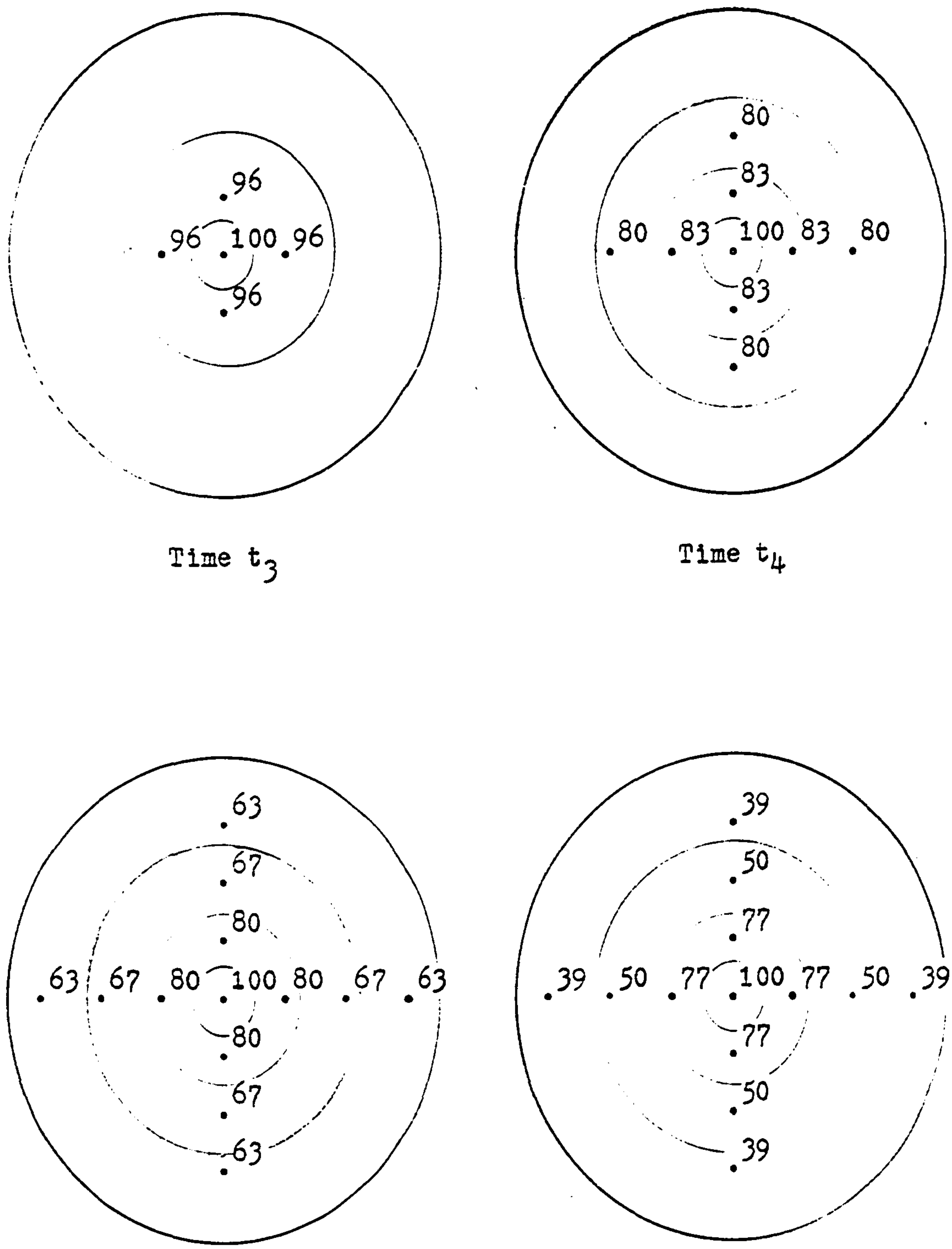
Cultural Similarity at Time t_5

Figure 11.36

	101	102	103	104	105	106	107	108	109	110	111	112	113
101	1.00												
102	.77	1.00											
103	.50	.68	1.00										
104	.39	.62	.76	1.00									
105	.77	.68	.55	.41	1.00								
106	.50	.55	.55	.58	.68	1.00							
107	.39	.41	.58	.65	.62	.76	1.00						
108	.77	.68	.55	.41	.68	.55	.41	1.00					
109	.50	.55	.55	.58	.55	.55	.58	.68	1.00				
110	.39	.41	.58	.65	.41	.58	.65	.62	.76	1.00			
111	.77	.68	.55	.41	.68	.55	.41	.68	.55	.41	1.00		
112	.50	.55	.55	.65	.55	.55	.58	.55	.55	.58	.68	1.00	
113	.39	.41	.58	.58	.41	.58	.65	.41	.58	.65	.62	.76	1.00

Cultural Similarity at Time t_6

Figure 11.37

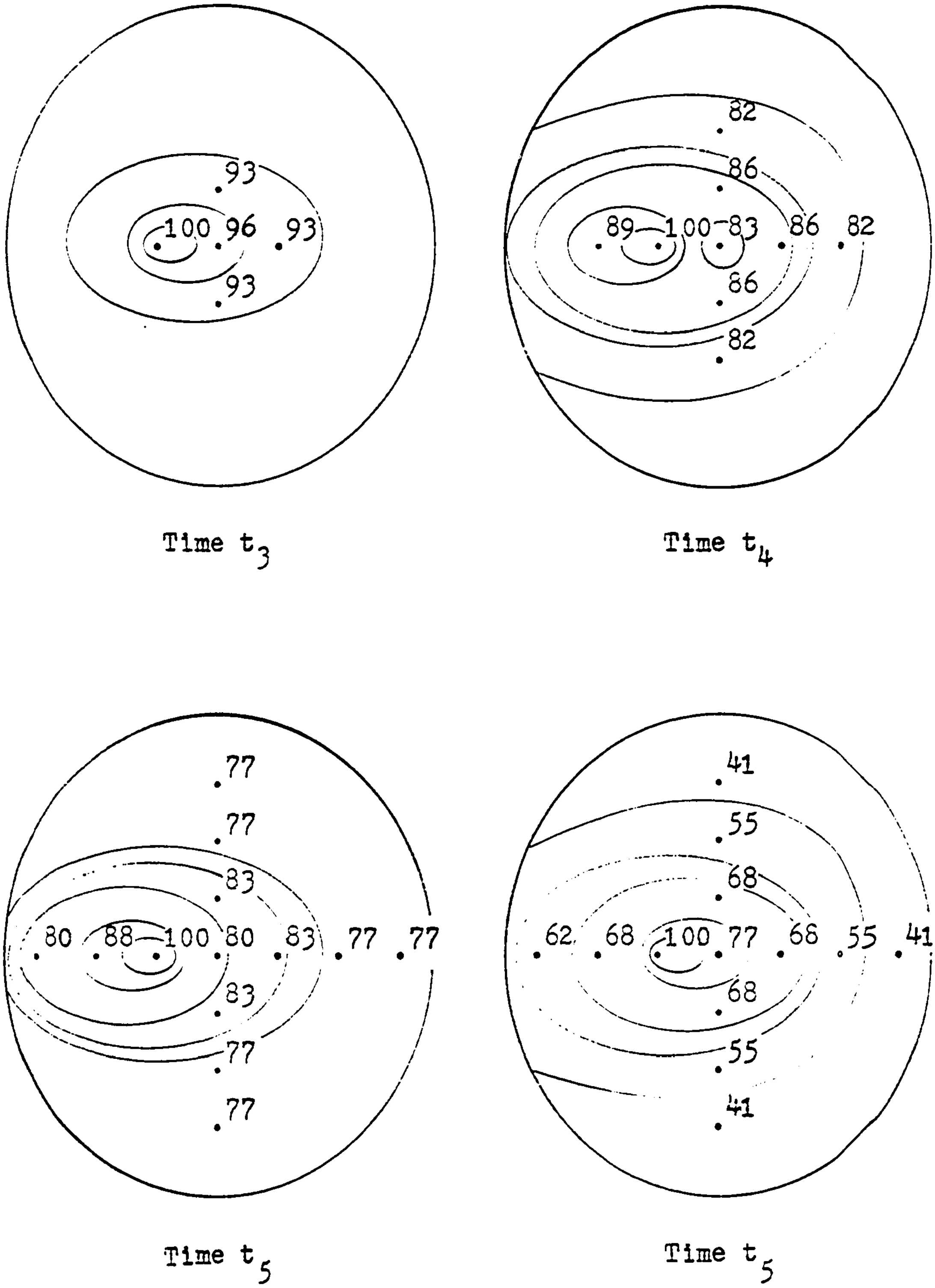


Time t_3 Time t_4

Time t_5 Time t_6

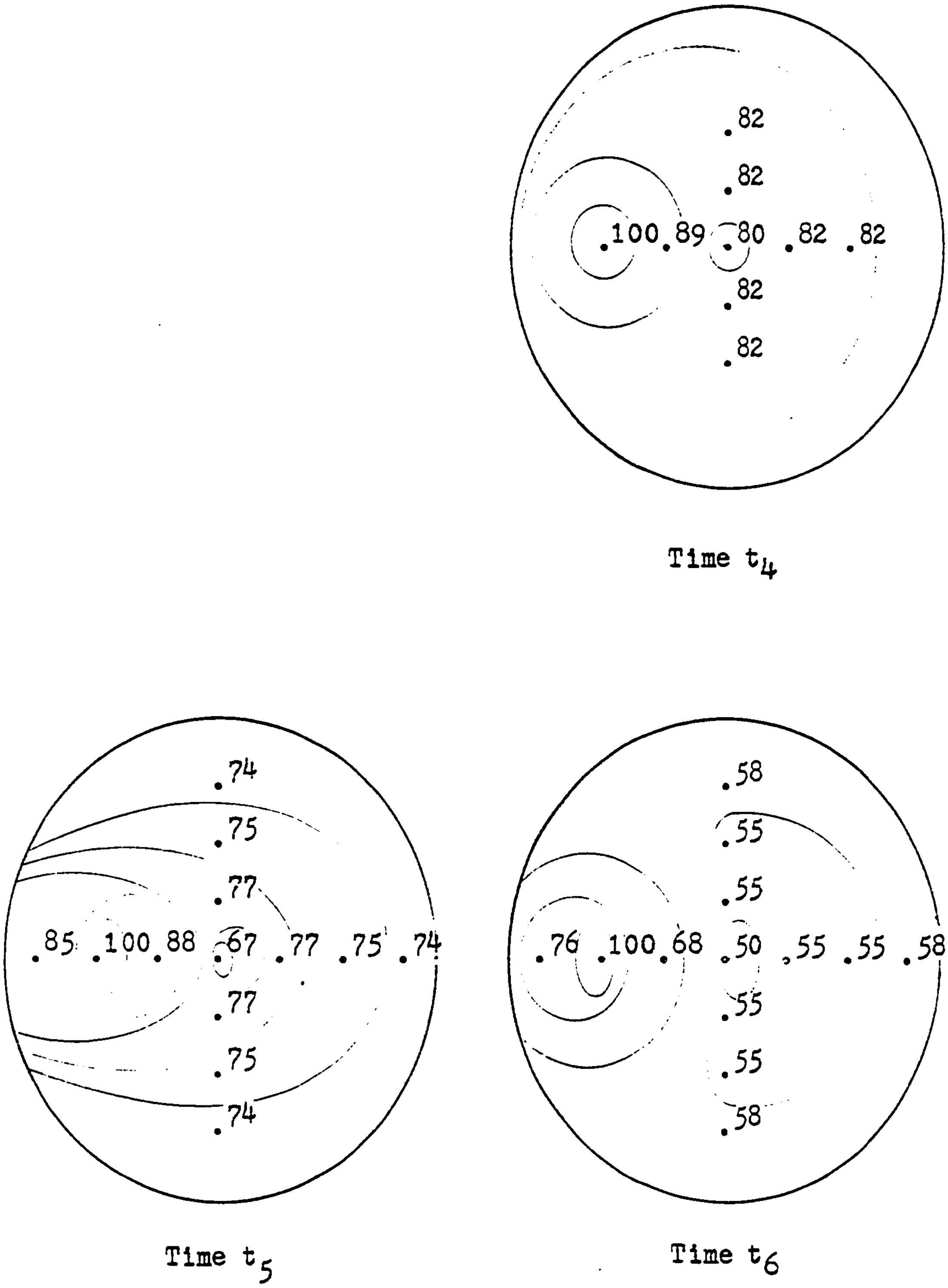
Differentiation Surface as Seen From Place p_{101}

Figure 11.38



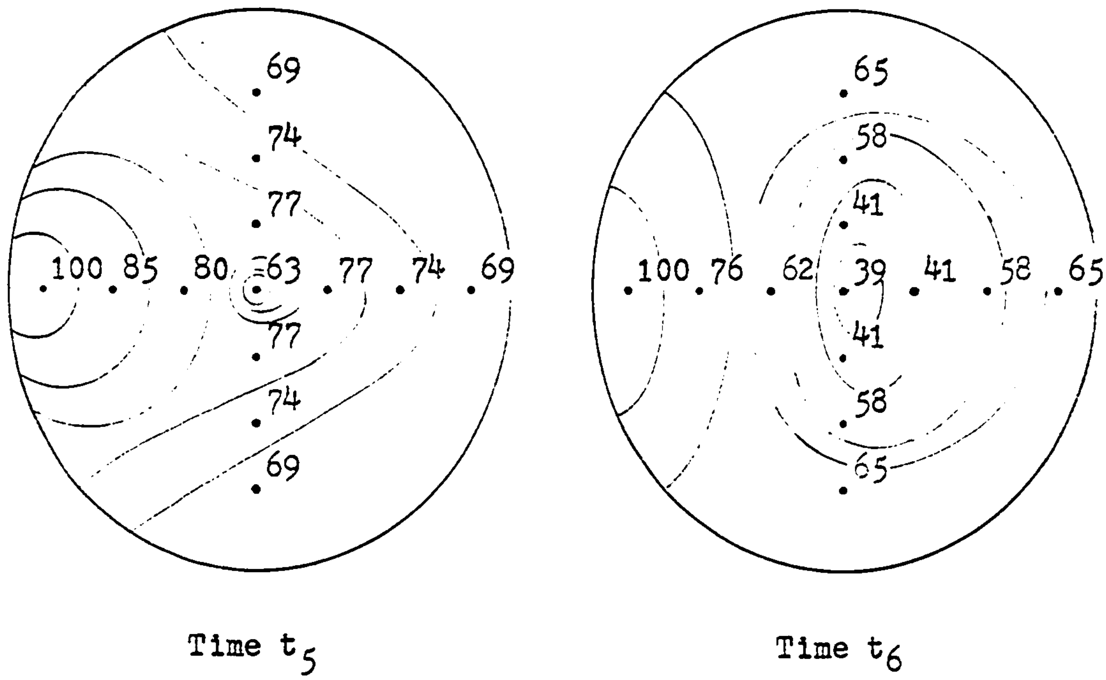
Differentiation Surface as Seen From Place p_{102}

Figure 11.39



Differentiation Surface as Seen From Place p_{103}

Figure 11.40



Differentiation Surface as Seen From Place p_{104}

Figure 11.41

way to the extensive trough located around place p_{101} in Figure 11.41. This trough represents increasing divergence between p_{104} and p_{101} (and places near p_{101}). This has come about primarily from the accelerated rate of change in p_{101}. As was explained in previous chapters, such divergence can be produced solely by different rates of change, even though two places may be changing in the same direction. The same pattern can be noted in Figure 11.40.

At the end of six time periods, then, the evolutionary development of 13 places has been traced. Adding diffusion to the dendritic model shown in Figure 11.9 will produce the more accurate reticulate model shown in Figure 11.42. The diagonal lines in Figure 11.42 represent the between-place diffusion illustrated in Figures 11.27 through 11.33. Any representation of an area's phylogeny must be reticulate in nature. The new model in Figure 11.42 is more complex and is closer to reality, but unfortunately it is still only an extremely simple and inadequate representation of what happens in actual life. Even to represent a portion of the vast interlocking network of processes and forces hinted at in Figure 11.25 may prove to be more than one lifetime can handle.

Nevertheless, this thesis has pointed the way toward a larger model of the geographic system and has identified many of the variables that must be part of such a system. The ultimate concern of the geographical scholar is the understanding of how regions change and differentiate from one another. By focusing on the processes that produce this change we may one day arrive at such an understanding. Empirical research will establish the exact rates at which each geographic process operates, but we also need a conceptual scheme of how

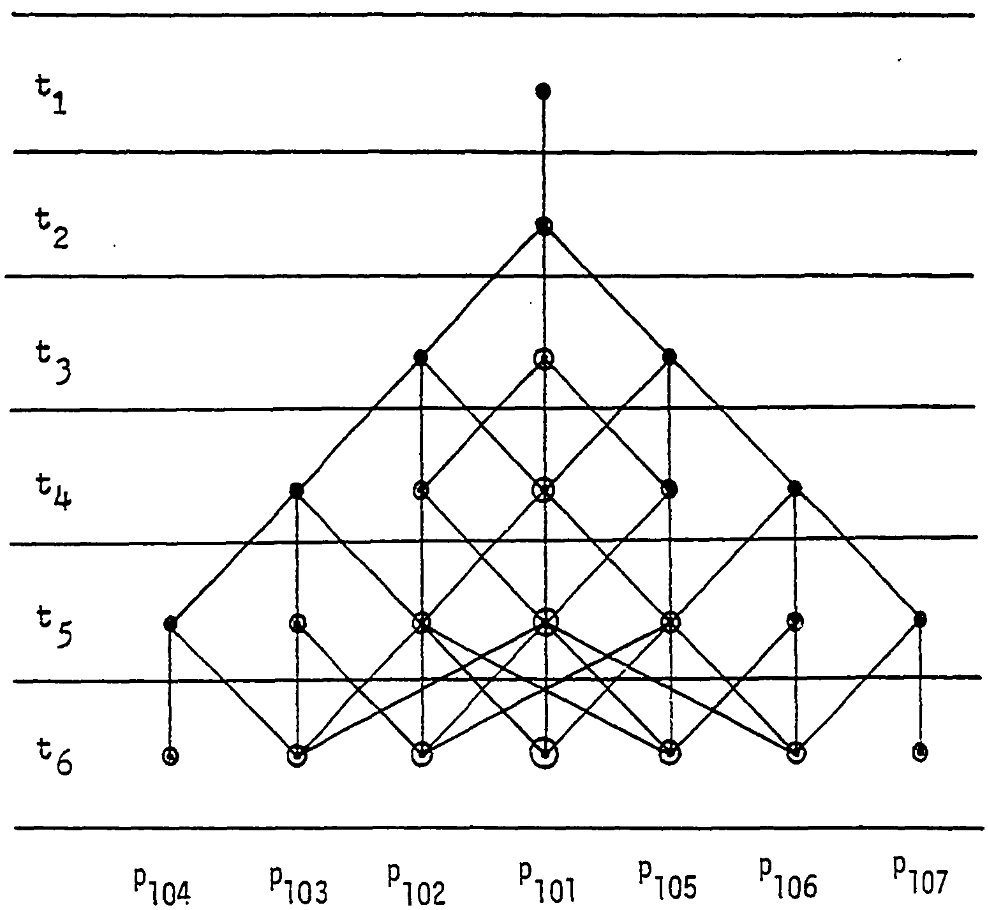


Figure 11.42

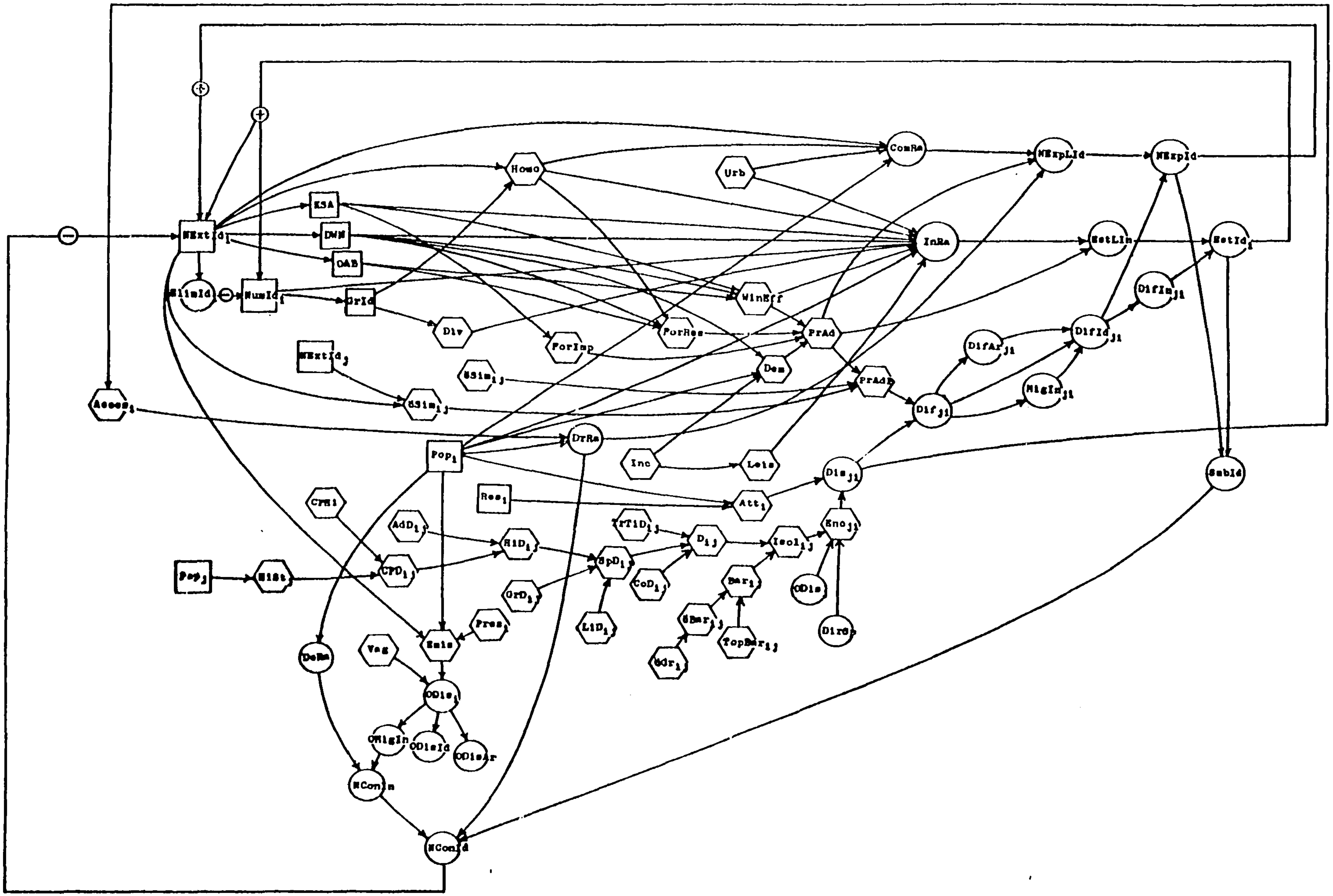
these processes interrelate. This dissertation provides such a scheme, which should be viewed as a springboard toward a larger and more adequate model.

Appendix

THE STRUCTURAL MODEL

On the following page appears an illustration of the entire structural model. In previous chapters, portions of this model have already been presented. Here, they have been combined into one complated diagram, which outlines the various arguments that have been the subject of this dissertation. As with all earlier examples, boxes indicate levels and circles indicate processes, while hexagons indicate states that are properly neither levels nor processes. Unless indicated, it is to be assumed that the variables shown refer to things occurring within place i, which is the primary focus of this model. The key to the abbreviations used is as follows:

NExtId	Numerical extent of ideas (chapter 3)
NumId	Number of different ideas (chapter 3)
KSA	Knowledge, skills, and abilities (chapter 3)
DWN	Desires, wants, and needs (chapter 3)
OAB	Opinions, attitudes, and beliefs (chapter 3)
EstId	Establishment of ideas (chapter 6)
EstLIn	Establishment of local innovations (chapter 6)
PrAd	Propensity to adopt (chapter 6)
WinEff	Window effect (chapter 6)



NExtId
SlimId
NumId
ESA
DWN
OAB
GrId
Homo
Div
ForImp
ForRes
Urb
ComRa
InRa
WinEff
PrAd
Dem
PrAdE
NExpLId
NExpId
EstLIn
EstId
DifIn
DifId
DifAr
MigIn
Dif
Dis
Att
Leis
Inc
DrRa
Pop
Acces
SSim
NExtId
Res
CPHi
AdD
HiD
CPD
HiSt
Pop
SpD
GrD
LiD
CoD
D
TrTiD
Isol
Eno
ODis
DirGp
Bar
SBar
TopBar
SGr
Pres
Emis
Veg
ODis
OMigIn
ODisId
ODisAr
DeRa
NConIn
NConId
SabId

ForRes	Forces of resistance (chapter 6)
ForImp	Forces of imposition (chapter 6)
Dem	Demand (chapter 6)
Pop_i	Population of place i (chapter 6)
Inc	Income (chapter 6)
Homo	Homogeneity (chapter 4)
Div	Diversity (chapter 4)
GrId	Groups of ideas (chapter 4)
InRa	Innovation rate (chapter 7)
Urb	Urbanization (chapter 7)
Leis	Leisure (chapter 7)
Dif_{ji}	Diffusion from place j to place i (chapter 8)
PrAdP	Propensity to adopt propagules (chapter 8)
$eSim_{ji}$	Ecological similarity between place i and place j (chapter 8)
cSim	Cultural similarity between place i and place j (chapter 8)
Dis_{ji}	Dispersal from place j to place i (chapter 8)
Enc_{ji}	Encroachment of place j upon place i (chapter 8)
Att_i	Attraction of place i (chapter 8)
Res_i	Resources (chapter 8)
$ODis_j$	Outward dispersal from place j (chapter 8)
DirSp	Directional specificity (chapter 8)
$Isol_{ij}$	Isolation of place i from place j (chapter 8)
Bar_{ij}	Barriers between places i and j (chapter 8)
$cBar_{ij}$	Cultural barriers between places i and j (chapter 8)

cGr_{ij}	Cultural groups between places i and j (chapter 8)
$TopBar_{ij}$	Topographic barriers between places i and j (chapter 8)
D_{ij}	Distance between places i and j (chapter 8)
$TrTiD_{ij}$	Travel time distance between places i and j (chapter 8)
SpD_{ij}	Spatial distance between places i and j (chapter 8)
CoD_{ij}	Cost distance between places i and j (chapter 8)
HiD_{ij}	Hierarchical distance between places i and j (chapter 8)
AdD_{ij}	Administrative distance between places i and j (chapter 8)
GrD_{ij}	Graphic distance between places i and j (chapter 8)
LiD_{ij}	Linear distance between places i and j (chapter 8)
CPD_{ij}	Central place distance between places i and j (chapter 8)
CPHi	Central place hierarchy (chapter 8)
$HiSt_j$	Hierarchical status of place j (chapter 8)
Pop_j	Population of place j (chapter 8)
NExpId	Numerical expansion of ideas (chapter 9)
NExpLId	Numerical expansion of local ideas (chapter 9)
$DifId_{ji}$	Diffusion of ideas from place j to place i (chapter 8)
$DifAr_{ji}$	Diffusion of artifacts from place j to place i (chapter 8)
$MigIn_{ji}$	Migration of individuals from place j to place i (chapter 8)
ComRa	Communication rate (chapter 9)
Access	Accessibility (chapter 9)

DrRa	Drift rate (chapter 9)
ElimId	Elimination of ideas (chapter 10)
SubId	Substitution of ideas (chapter 10)
NConId	Numerical contraction of ideas (chapter 10)
NConIn	Numerical contraction of individuals (chapter 10)
DeRa	Death rate (chapter 10)
OMigIn	Out-Migration of individuals (chapter 10)
ODisId	Outward dispersal of ideas (chapter 10)
ODisAr	Outward dispersal of artifacts (chapter 10)
$ODis_i$	Outward dispersal from place i (chapter 10)
Vag	Vagility (chapter 10)
Emis	Emissiveness (chapter 10)
Pres	Prestige (chapter 10)

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